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**Course Title : Human Anatomy &
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Unit-IV

TOPIC: Respiratory System

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Gross Anatomy of the Lungs

- Each lung has a conical shape. Its wide, concave **base** rests upon the muscular diaphragm.
- Its superior region called the **apex** projects superiorly to a point that is slightly superior and posterior to the clavicle.
- Both lungs are bordered by the thoracic wall anteriorly, laterally, and posteriorly, and supported by the rib cage.
- Toward the midline, the lungs are separated from each other by the **mediastinum**.
- The relatively broad, rounded surface in contact with the thoracic wall is called the **costal surface** of the lung.

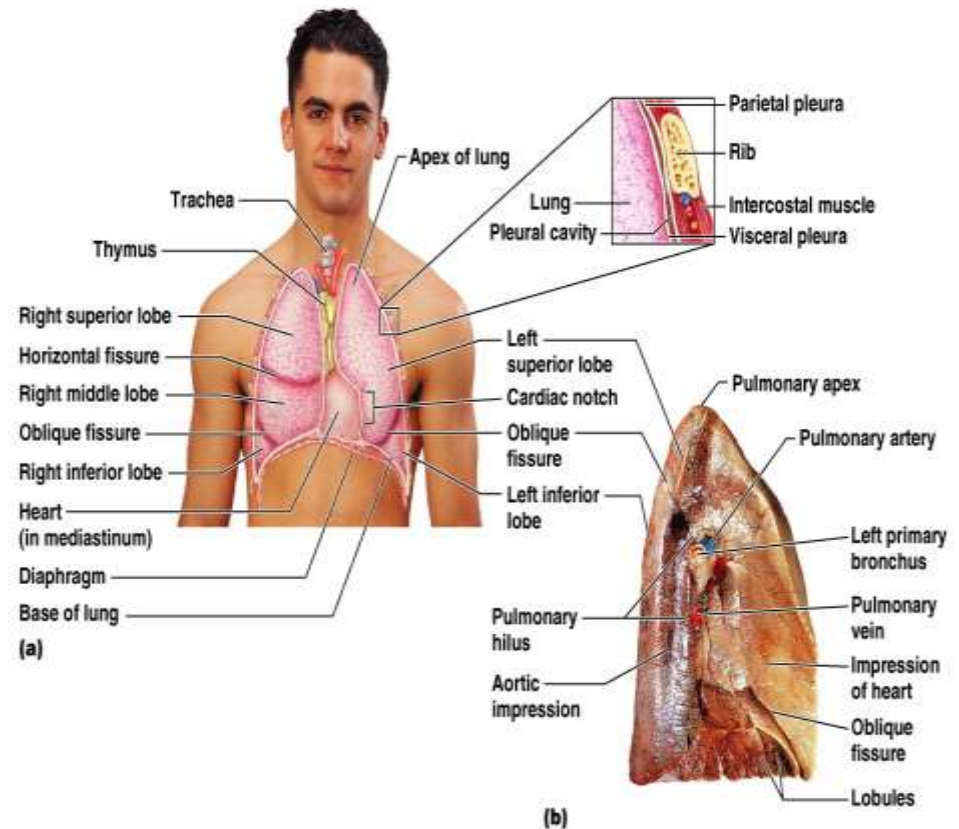
Lungs

Left lung

- divided into 2 lobes by **oblique fissure**
- smaller than the right lung
- **cardiac notch** accommodates the heart

Right

- divided into 3 lobes by **oblique and horizontal fissure**
- located more superiorly in the body due to liver on right side





Pleura and Pleural Cavities

- The outer surface of each lung and the adjacent internal thoracic wall are lined by a serous membrane called **pleura**.
- The outer surface of each lung is tightly covered by the **visceral pleura**.
- while the internal thoracic walls, the lateral surfaces of the mediastinum, and the superior surface of the diaphragm are lined by the **parietal pleura**.
- The parietal and visceral pleural layers are continuous at the **hilus** of each lung.



Pleural Cavities

- The potential space between the serous membrane layers is a **pleural cavity**.
- The pleural membranes produce a thin, serous **pleural fluid** that circulates in the pleural cavity and acts as a lubricant, ensuring minimal friction during breathing.
 - **Pleural effusion** – pleuritis with too much fluid



Blood supply of Lungs

- **pulmonary circulation -**
- **bronchial circulation** – bronchial arteries supply oxygenated blood to lungs, bronchial veins carry away deoxygenated blood from lung tissue → superior vena cava
- **Response of two systems to hypoxia** –
pulmonary vessels undergo **vasoconstriction**
bronchial vessels like all other systemic vessels undergo **vasodilation**



Respiratory events

- **Pulmonary ventilation** = exchange of gases between lungs and atmosphere
- **External respiration** = exchange of gases between alveoli and pulmonary capillaries
- **Internal respiration** = exchange of gases between systemic capillaries and tissue cells



Two phases of pulmonary ventilation

- **Inspiration, or inhalation** - a very active process that requires input of energy. The **diaphragm**, contracts, moving downward and flattening, when stimulated by **phrenic nerves**.
- **Expiration, or exhalation** - a passive process that takes advantage of the recoil properties of elastic fiber. · The diaphragm relaxes. The elasticity of the lungs and the thoracic cage allows them to return to their normal size and shape.



Muscles that ASSIST with respiration

- The **scalenes** help increase thoracic cavity dimensions by elevating the first and second ribs during forced inhalation.
- The ribs elevate upon contraction of the **external intercostals**, thereby increasing the transverse dimensions of the thoracic cavity during inhalation.
- Contraction of the **internal intercostals** depresses the ribs, but this only occurs during forced exhalation.
- Normal exhalation requires no active muscular effort.



Muscles that ASSIST with respiration

- Other accessory muscles assist with respiratory activities.
- The **pectoralis minor, serratus anterior, and sternocleidomastoid** help with forced inhalation,
- while the **abdominal muscles(external and internal obliques, transversus abdominis, and rectus abdominis)** assist in active exhalation.

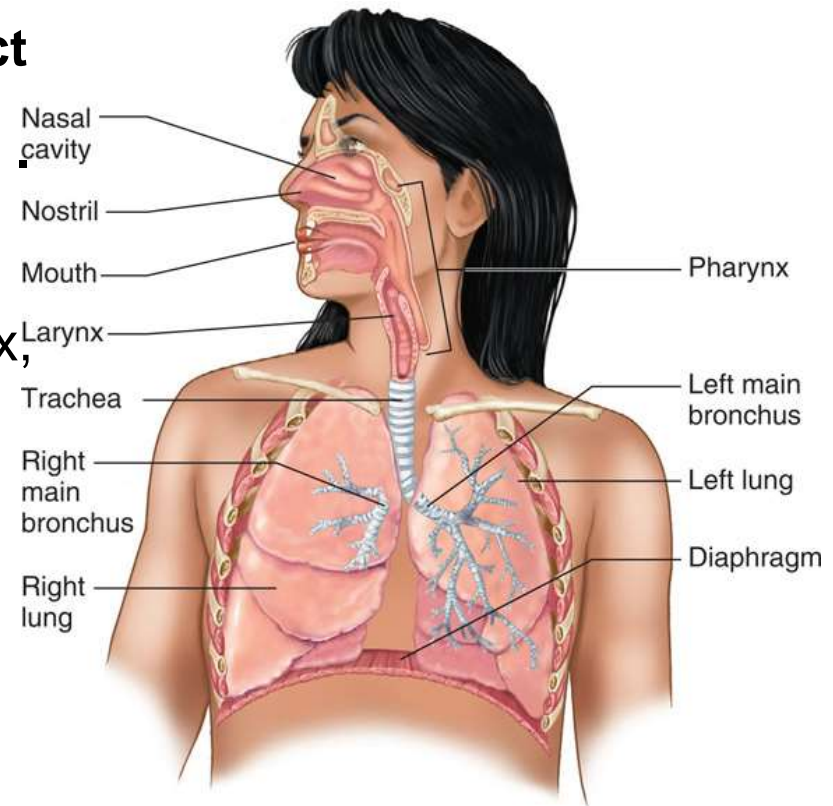


Ventilation Control by Respiratory Centers of the Brain

- The trachea, bronchial tree, and lungs are innervated by the **autonomic nervous system**.
- The autonomic nerve fibers that innervate the heart also send branches to the respiratory structures.
- The involuntary, rhythmic activities that deliver and remove respiratory gases are regulated in the **brainstem** within the reticular formation through **both the medulla oblongata and pons**.

Organization and Functions of the Respiratory System

- Consists of an **upper respiratory tract (nose to larynx)** and a **lower respiratory tract (trachea onwards)**.
- **Conducting portion** transports air.
 - includes the nose, nasal cavity, pharynx, larynx, trachea, and progressively smaller airways, from the primary bronchi to the terminal bronchioles
- **Respiratory portion** carries out gas exchange.
 - composed of small airways called respiratory bronchioles and alveolar ducts as well as air sacs called alveoli





	Name of branches	Number of tubes in branch
Conducting zone	Trachea	1
	Bronchi	2
		4
		8
		16
	Bronchioles	32
Terminal bronchioles	6×10^4	
Respiratory zone	Respiratory bronchioles	5×10^5
	Alveolar ducts	
	Alveolar sacs	8×10^6



Respiratory System Functions

1. supplies the body with oxygen and disposes of carbon dioxide
2. filters inspired air
3. produces sound
4. contains receptors for smell
5. rids the body of some excess water and heat
6. helps regulate blood pH



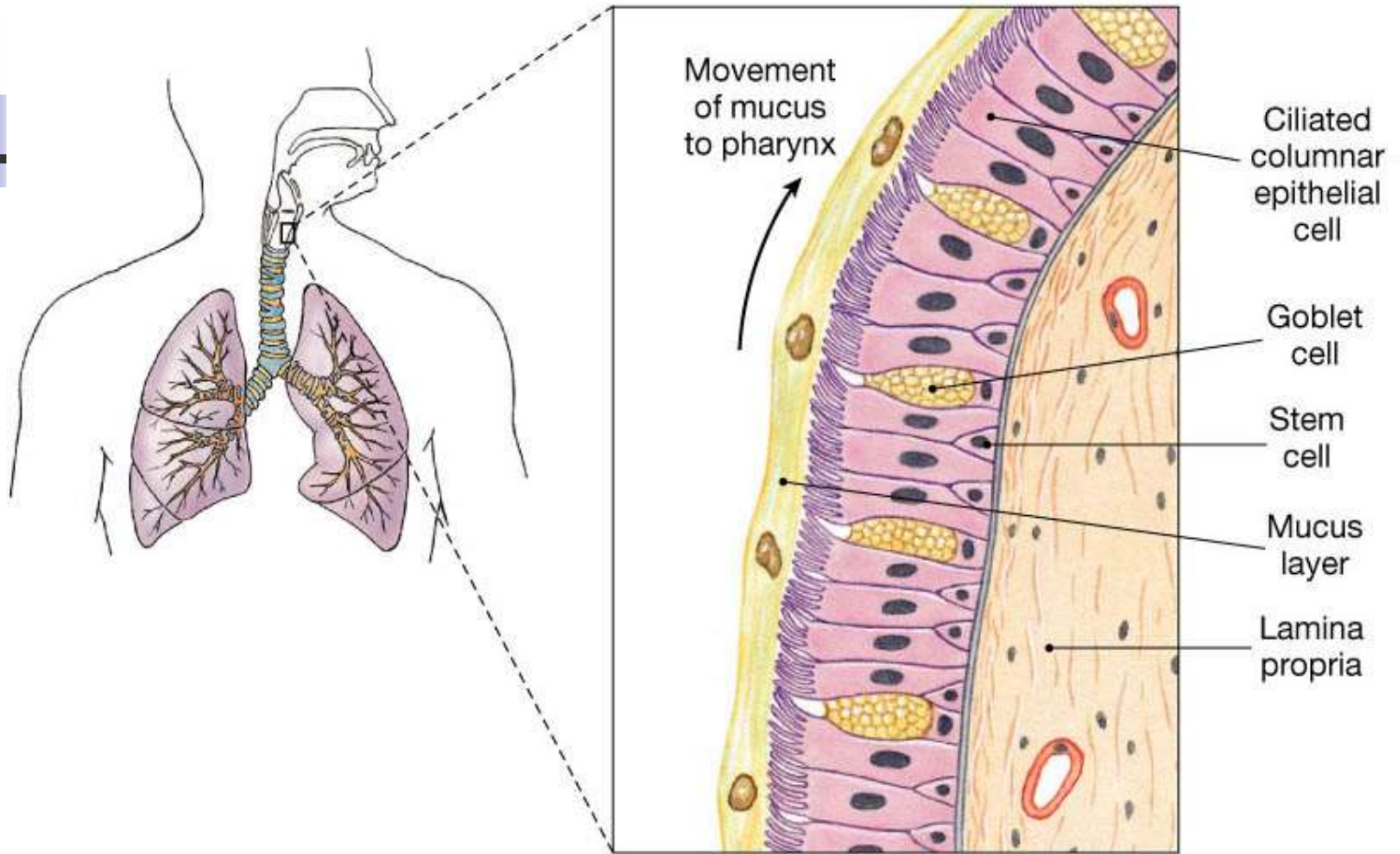
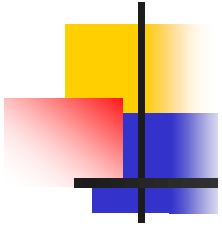
Breathing

- Breathing (pulmonary ventilation). consists of two cyclic phases:
- **inhalation**, also called inspiration - draws gases into the lungs.
- **exhalation**, also called expiration - forces gases out of the lungs.



Upper Respiratory Tract

- Composed of the nose and nasal cavity, paranasal sinuses, pharynx (throat), larynx.
- All part of the conducting portion of the respiratory system.



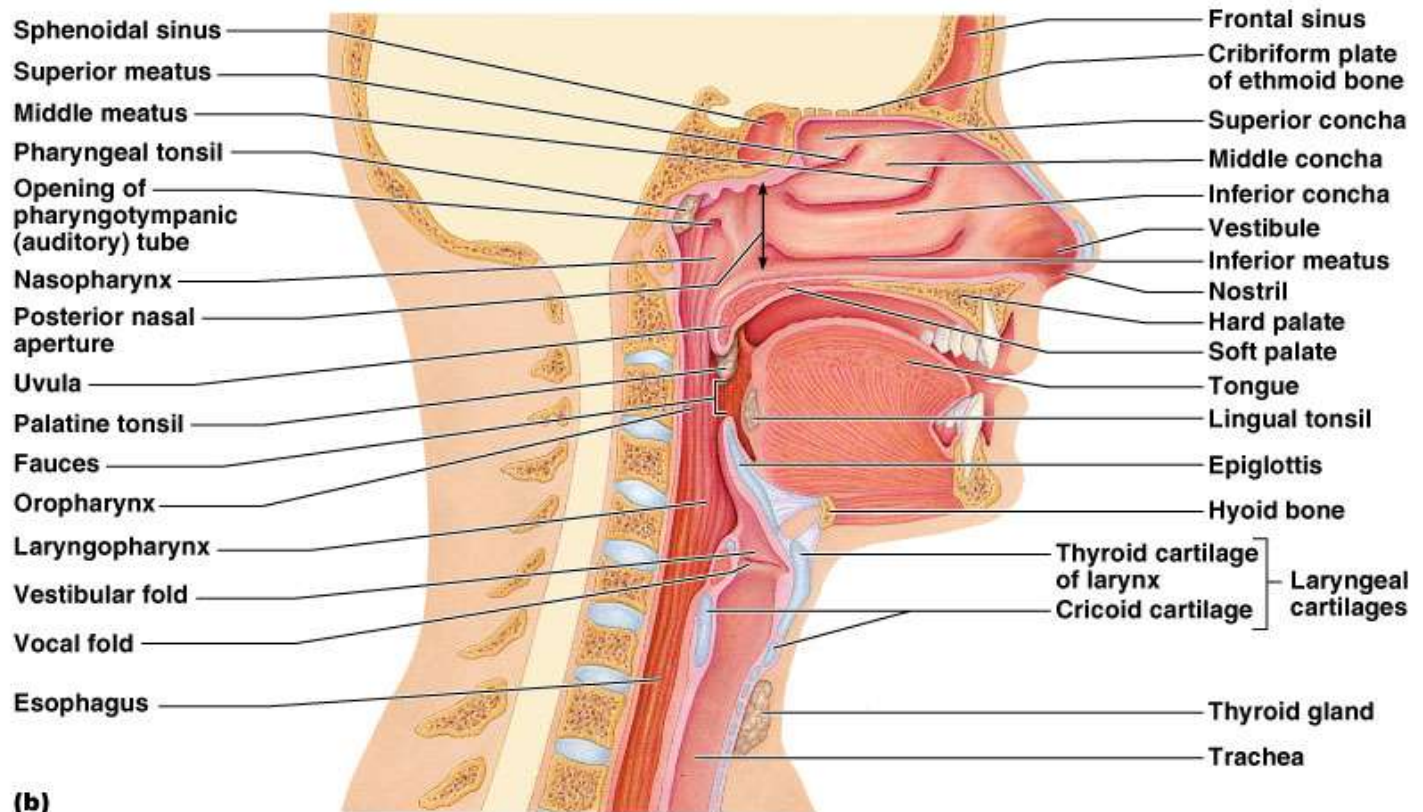
(a)



Respiratory mucosa

- A layer of **pseudostratified ciliated columnar epithelial cells** that secrete mucus
- Found in nose, sinuses, pharynx, larynx and trachea
- Mucus can trap contaminants
 - Cilia move mucus up towards mouth

Upper Respiratory Tract



(b)

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Nose

- **Internal nares** - opening to exterior
- **External nares** opening to pharynx
- **Nasal conchae** - folds in the mucous membrane that increase air turbulence and ensures that most air contacts the mucous membranes



Nose

- rich supply of capillaries warm the inspired air
- **olfactory mucosa** – mucous membranes that contain smell receptors
- **respiratory mucosa** – pseudostratified ciliated columnar epithelium containing goblet cells that secrete mucus which traps inhaled particles,
- **lysozyme** kills bacteria and lymphocytes and
- **IgA antibodies** that protect against bacteria



Nose

provides and airway for respiration

- moistens and warms entering air
- filters and cleans inspired air
- resonating chamber for speech

detects odors in the air stream

rhinoplasty: surgery to change shape of external nose

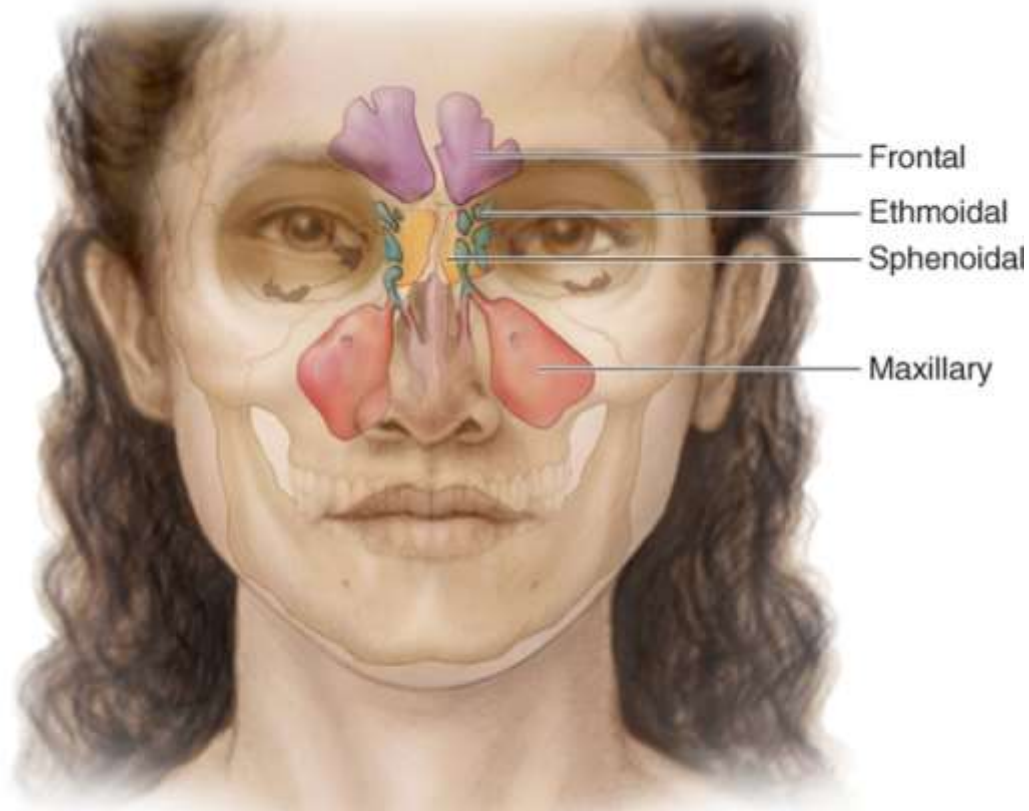


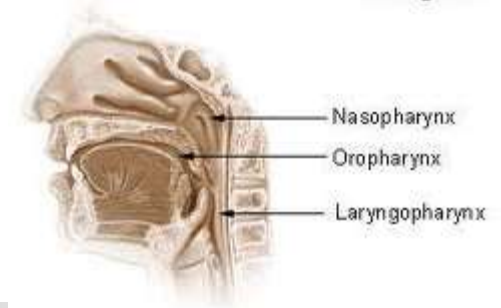
Paranasal Sinuses

- Four bones of the skull contain paired air spaces called the paranasal sinuses - **frontal, ethmoidal, sphenoidal, maxillary**
- Decrease skull bone weight
- Warm, moisten and filter incoming air
- Add resonance to voice.
- Communicate with the nasal cavity by ducts.
- Lined by **pseudostratified ciliated columnar epithelium.**

Paranasal sinuses

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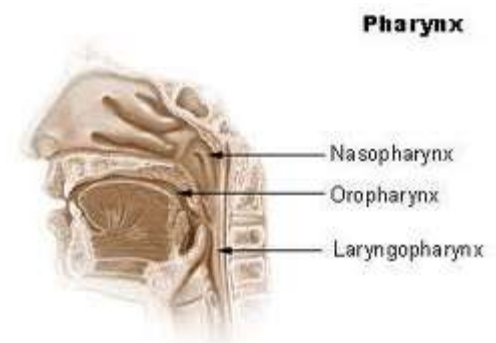


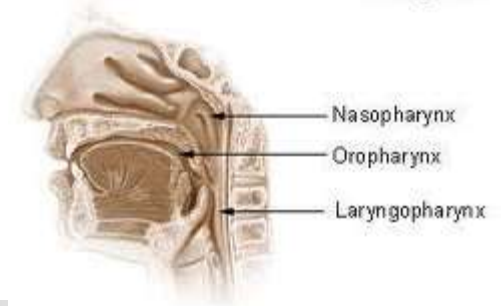
Pharynx

- Common space used by both the respiratory and digestive systems.
- Commonly called the throat.
- Originates posterior to the nasal and oral cavities and extends inferiorly near the level of the bifurcation of the larynx and esophagus.
- Common pathway for both air and food.

Pharynx

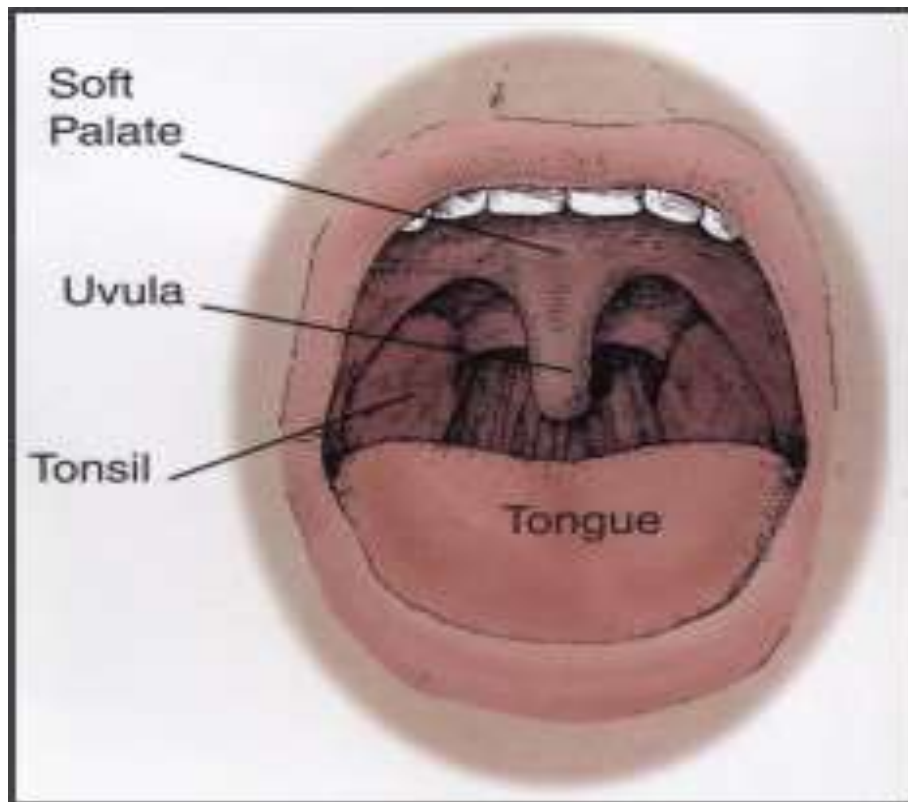
- Walls are lined by a mucosa and contain skeletal muscles that are primarily used for swallowing.
- Flexible lateral walls are distensible in order to force swallowed food into the esophagus.
- Partitioned into three adjoining regions:
 - nasopharynx
 - oropharynx
 - laryngopharynx



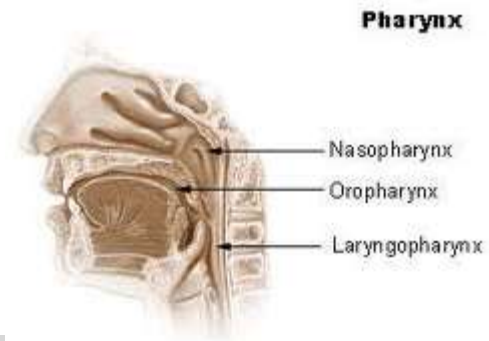


Nasopharynx

- Superior-most region of the pharynx. Covered with **pseudostratified ciliated columnar epithelium**.
- Located directly posterior to the nasal cavity and superior to the soft palate, which separates the oral cavity.
- Normally, only air passes through.
- Material from the oral cavity and oropharynx is typically blocked from entering the nasopharynx by the **uvula** of soft palate, which elevates when we swallow.
- In the lateral walls of the nasopharynx, paired **auditory/eustachian tubes** connect the nasopharynx to the middle ear.
- Posterior nasopharynx wall also houses a single pharyngeal tonsil (commonly called the **adenoids**).

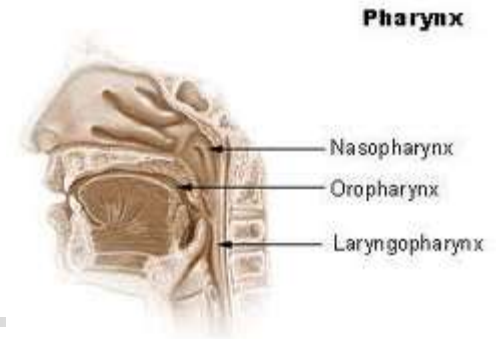


Oropharynx



- The middle pharyngeal region.
- Immediately posterior to the oral cavity.
- Bounded by the edge of the soft palate superiorly and the hyoid bone inferiorly.
- Common respiratory and digestive pathway through which both air and swallowed food and drink pass.
- Contains **nonkeratinized stratified squamous epithelium**.
- Lymphatic organs here provide the first line of defense against ingested or inhaled foreign materials. **Palatine tonsils** are on the lateral wall between the arches, and the **lingual tonsils** are at the base of the tongue.

Laryngopharynx



- Inferior, narrowed region of the pharynx.
- Extends inferiorly from the hyoid bone to the larynx and esophagus.
- Terminates at the superior border of the esophagus and the epiglottis of the larynx.
- Lined with a **nonkeratinized stratified squamous epithelium**.
- Permits passage of both food and air.

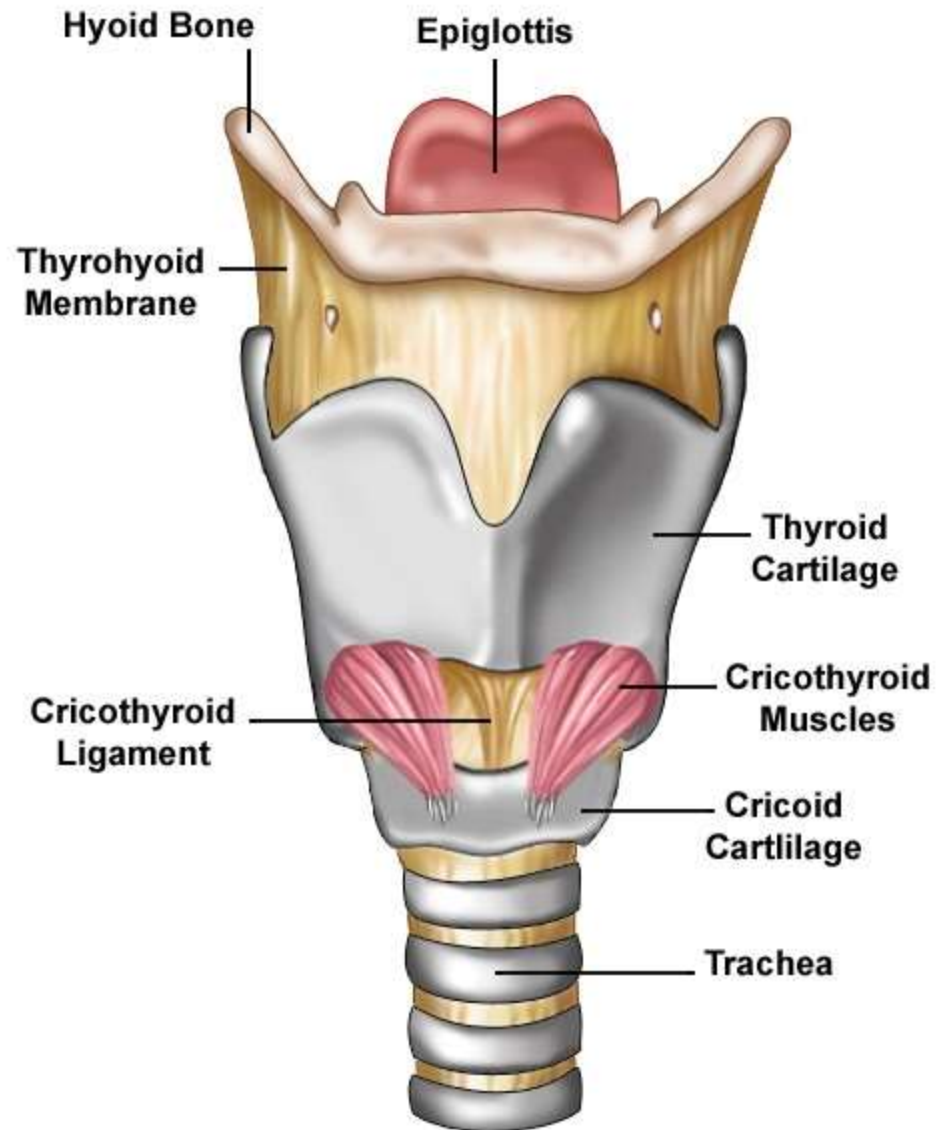


Lower Respiratory Tract

- **Conducting airways** (trachea, bronchi, up to terminal bronchioles).
- **Respiratory portion** of the respiratory system (respiratory bronchioles, alveolar ducts, and alveoli).

Larynx

- **Voice box** is a short, somewhat cylindrical airway ends in the trachea.
- Prevents swallowed materials from entering the lower respiratory tract.
- Conducts air into the lower respiratory tract.
- Produces sounds.
- Supported by a framework of nine pieces of cartilage (three individual pieces and three cartilage pairs) that are held in place by ligaments and muscles.





Larynx

- Nine c-rings of cartilage form the framework of the larynx
- **thyroid cartilage** – (1) Adam's apple, hyaline, anterior attachment of vocal folds, testosterone increases size after puberty
- **cricoid cartilage** – (1) ring-shaped, hyaline
- **arytenoid cartilages** – (2) hyaline, posterior attachment of vocal folds, hyaline
- **cuneiform cartilages** - (2) hyaline
- **corniculate cartilages** - (2) hyaline
- **epiglottis** – (1) **elastic cartilage**



Larynx

- Muscular walls aid in voice production and the swallowing reflex
- **Glottis** – the superior opening of the larynx
- **Epiglottis** – prevents food and drink from entering airway when swallowing
- **pseudostratified ciliated columnar epithelium**

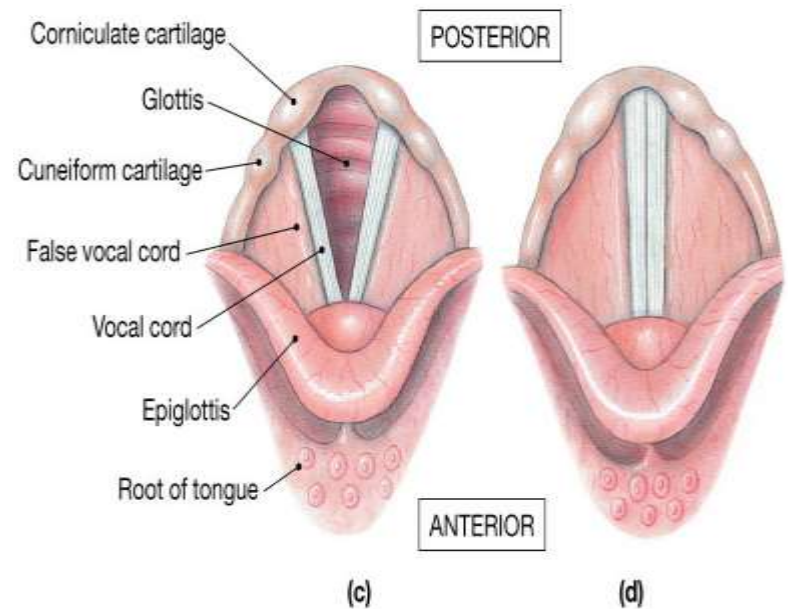


Sound Production

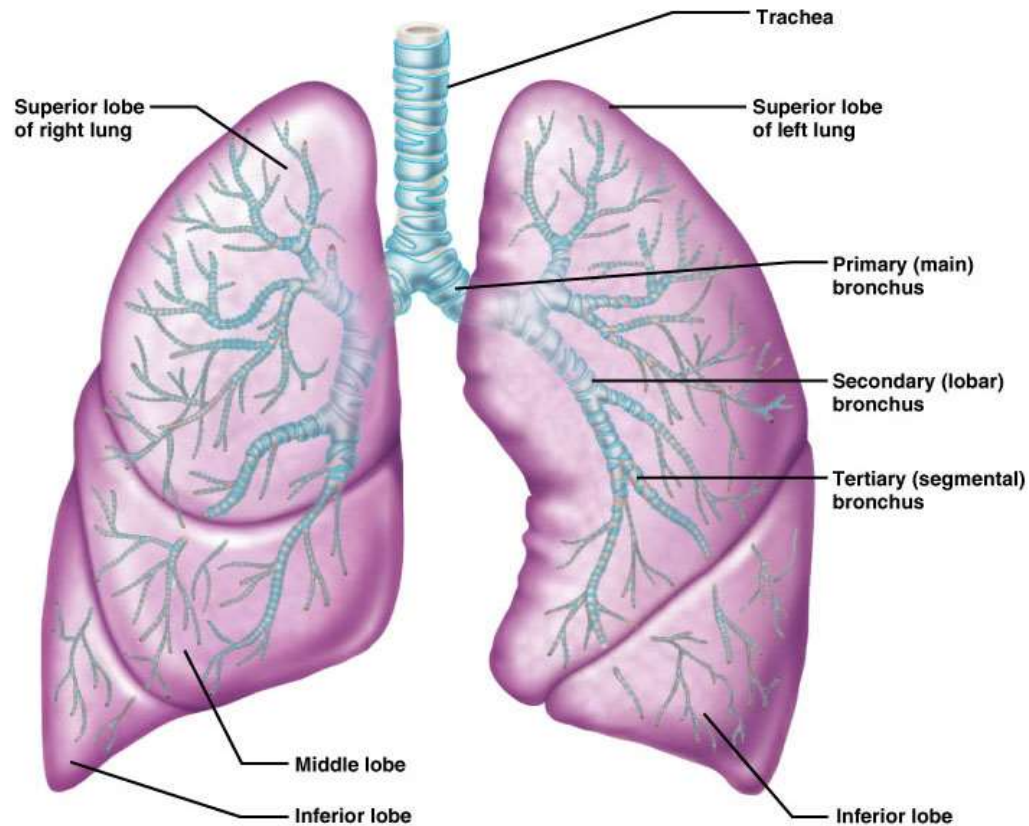
- Inferior ligaments are called the **vocal folds**.
 - are **true vocal cords** because they produce sound when air passes between them
- Superior ligaments are called the **vestibular folds**.
 - are **false vocal cords** because they have no function in sound production, but protect the vocal folds.
- The tension, length, and position of the vocal folds determine the quality of the sound.

Sound production

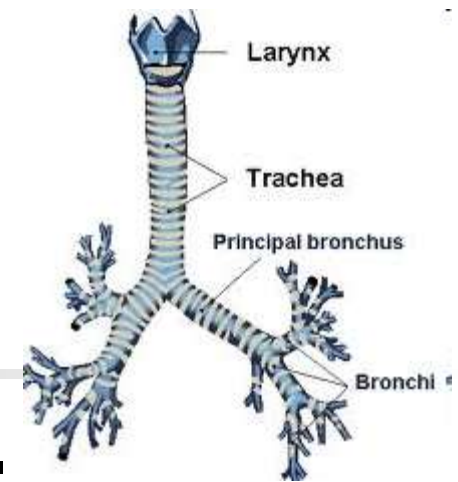
- Intermittent release of exhaled air through the vocal folds
- Loudness – depends on the force with which air is exhaled through the cords
- Pharynx, oral cavity, nasal cavity, paranasal sinuses act as **resonating chambers** that add quality to the sound
- Muscles of the face, tongue, and lips help with **enunciation of words**



Conducting zone of lower respiratory tract

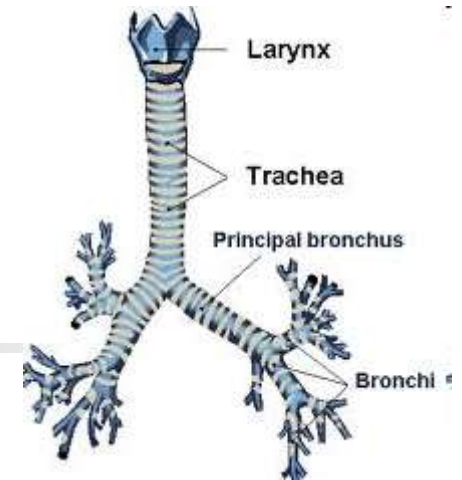


Trachea



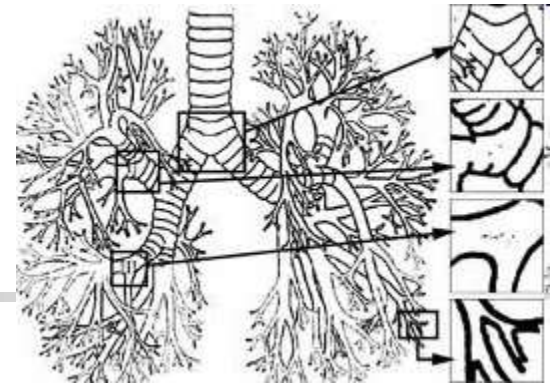
- A flexible tube also called **windpipe**.
- Extends through the mediastinum and lies anterior to the esophagus and inferior to the larynx.
- Anterior and lateral walls of the trachea supported by 15 to 20 C-shaped **tracheal cartilages**.
- Cartilage rings reinforce and provide rigidity to the tracheal wall to ensure that the trachea remains open at all times
- Posterior part of tube lined by **trachealis** muscle
- Lined by **ciliated pseudostratified columnar epithelium**.

Trachea



- At the level of the sternal angle, the trachea bifurcates into two smaller tubes, called the **right and left primary bronchi**.
- Each primary bronchus projects laterally toward each lung.
- The most inferior tracheal cartilage separates the primary bronchi at their origin and forms an internal ridge called the **carina**.

Bronchial tree



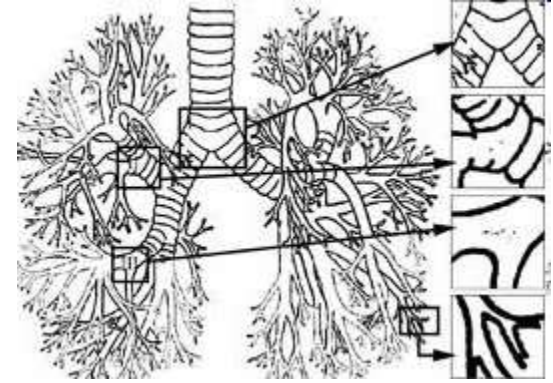
- A highly branched system of air-conducting passages that originate from the left and right primary bronchi.
- Progressively branch into narrower tubes as they diverge throughout the lungs before terminating in **terminal bronchioles**.
- **Incomplete rings of hyaline cartilage** support the walls of the primary bronchi to ensure that they remain open.
- Right primary bronchus is shorter, wider, and more vertically oriented than the left primary bronchus.
- Foreign particles are more likely to lodge in the right primary bronchus.



Bronchial tree

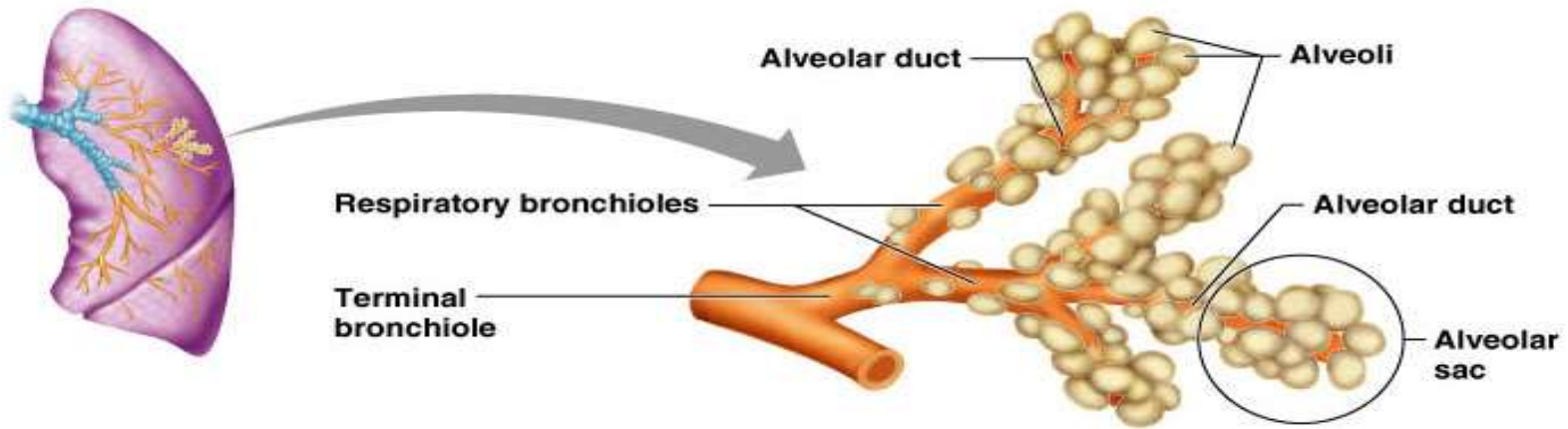
- The primary bronchi enter the **hilus** of each lung together with the pulmonary vessels, lymphatic vessels, and nerves.
- Each primary bronchus branches into several **secondary bronchi** (or lobar bronchi).
- The left lung has two secondary bronchi. The right lung has three secondary bronchi.
- They further divide into **tertiary bronchi**.
- Each tertiary bronchus is called a segmental bronchus because it supplies a part of the lung called a **bronchopulmonary segment**.

Bronchial Tree

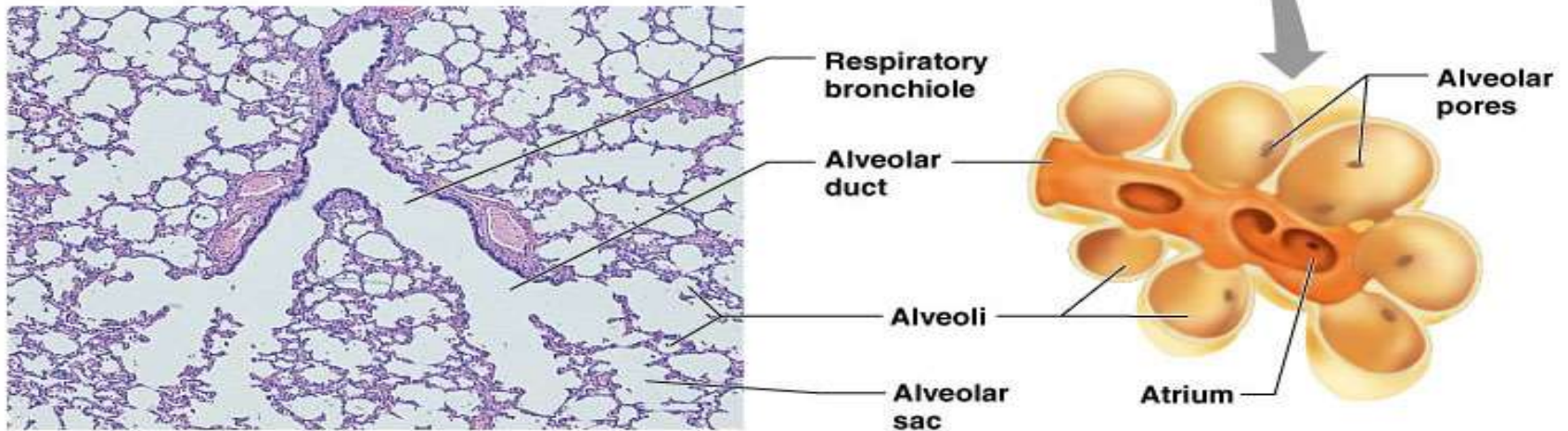


- **Secondary bronchi** → **tertiary bronchi** → **bronchioles** → **terminal bronchioles**
- with successive branching amount of cartilage decreases and amount of smooth muscle increases, this allows for variation in airway diameter
- during exertion and when sympathetic division active → **bronchodilation**
- mediators of allergic reactions like histamine → **bronchoconstriction**
- epithelium gradually changes from **ciliated pseudostratified columnar epithelium** to **simple cuboidal epithelium** in terminal bronchioles

Respiratory Zone of Lower Respiratory Tract



(a)



(b)



Conduction vs. Respiratory zones

- Most of the tubing in the lungs makes up **conduction zone**
 - Consists of nasal cavity to terminal bronchioles
- The **respiratory zone** is where gas is exchanged
 - Consists of alveoli, alveolar sacs, alveolar ducts and respiratory bronchioles



Respiratory Bronchioles, Alveolar Ducts, and Alveoli

- Lungs contain small saccular outpocketings called **alveoli**.
- They have a thin wall specialized to promote diffusion of gases between the alveolus and the blood in the pulmonary capillaries.
- Gas exchange can take place in the **respiratory bronchioles and alveolar ducts** as well as in the **alveoli**, each lung contains approximately 300 to 400 million alveoli.
- The spongy nature of the lung is due to the packing of millions of alveoli together.



Acknowledgement

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