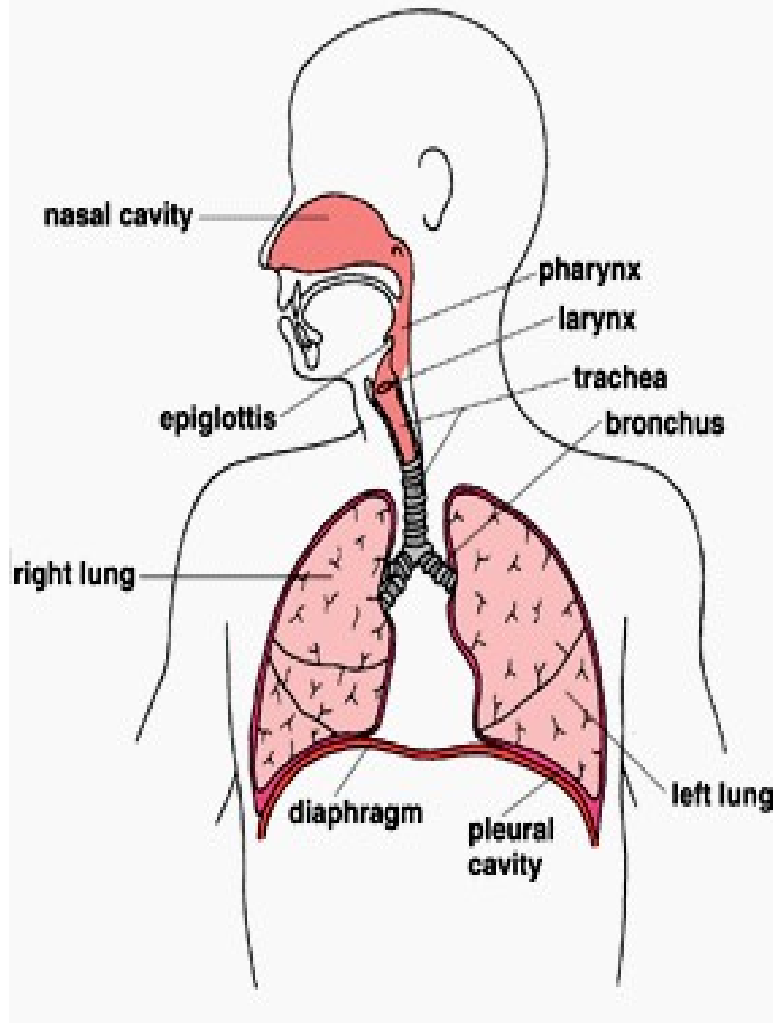


CHAPTER VII THE RESPIRATORY SYSTEM



Learning objectives

- Describe the anatomy and histology of the nose, pharynx, larynx, trachea, bronchi, and lungs.
- Identify the anatomy of each respiratory system structure.
- Name the two major parts of pleura.

- **Introduction**

- refers to three separate but related functions:
 - Ventilation (breathing),
 - gas exchange between the lungs and blood
 - gas exchange between the blood and tissues oxygen utilization by the tissues in the energy liberating reactions of cellular respiration.

- external respiration:
 - the exchange of gases b/n the air and blood.
- internal respiration:
 - gas exchange between the blood and tissues .
- It is estimated that a relaxed adult breathes about 9 to 20 times a minute, ventilating about 5 to 6 liters of air during this period.
- If breathing stops, a person will lose consciousness after 4 or 5 minutes.

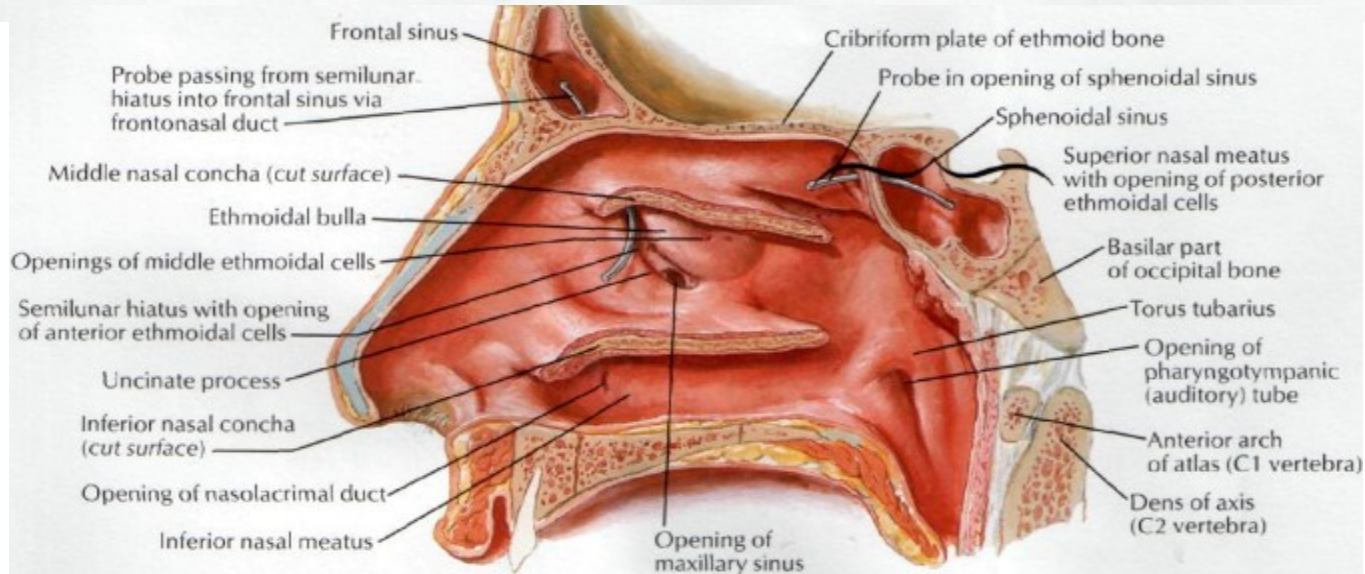
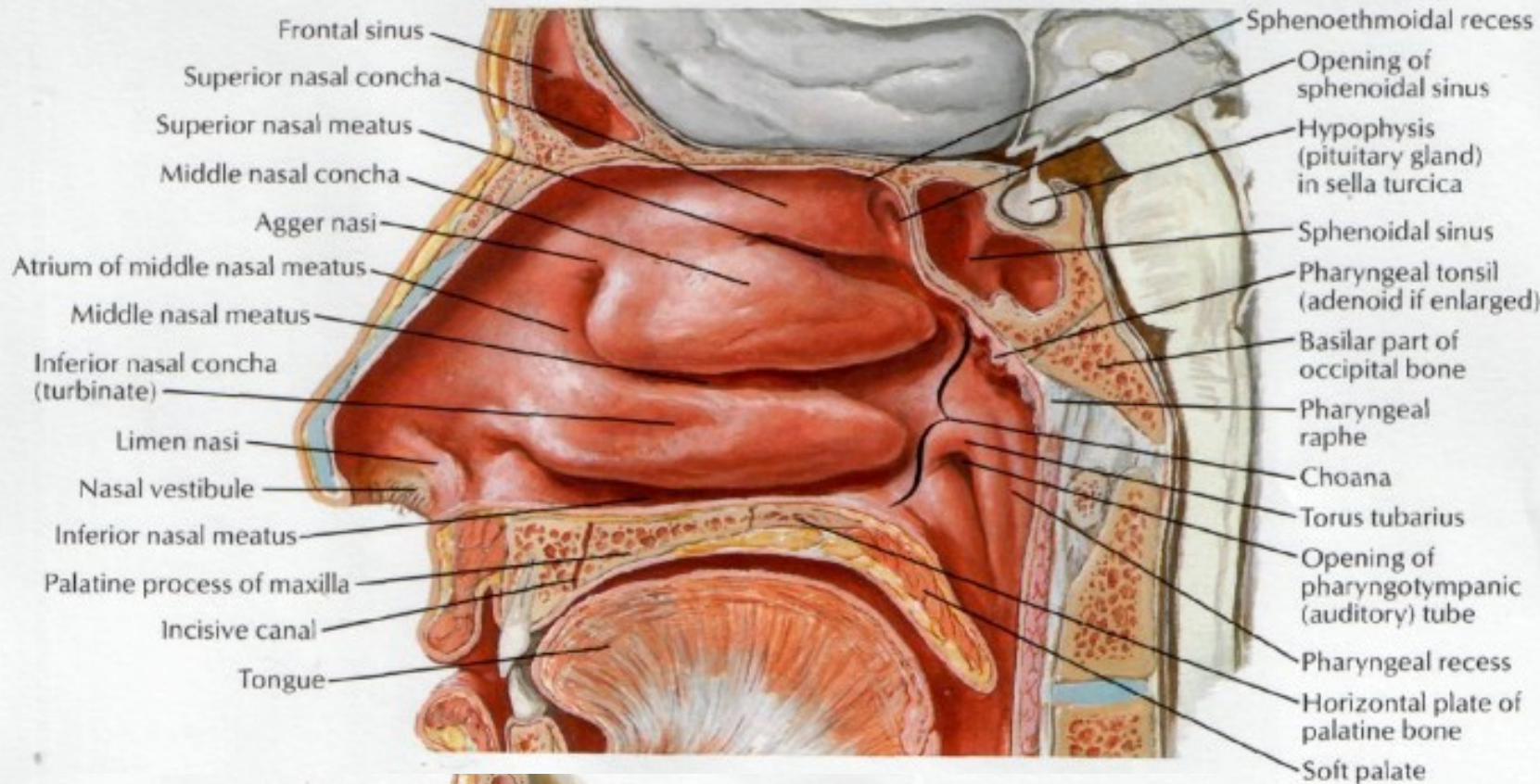
- **Basic structure of the respiratory system**
- The major passages and structures of the respiratory system are:
 - the nasal cavity
 - pharynx
 - larynx
 - trachea
 - the bronchi
 - bronchioles
 - alveoli within the lungs
- The respiratory system is frequently divided into
 - the *conducting division* and
 - the *respiratory division*.

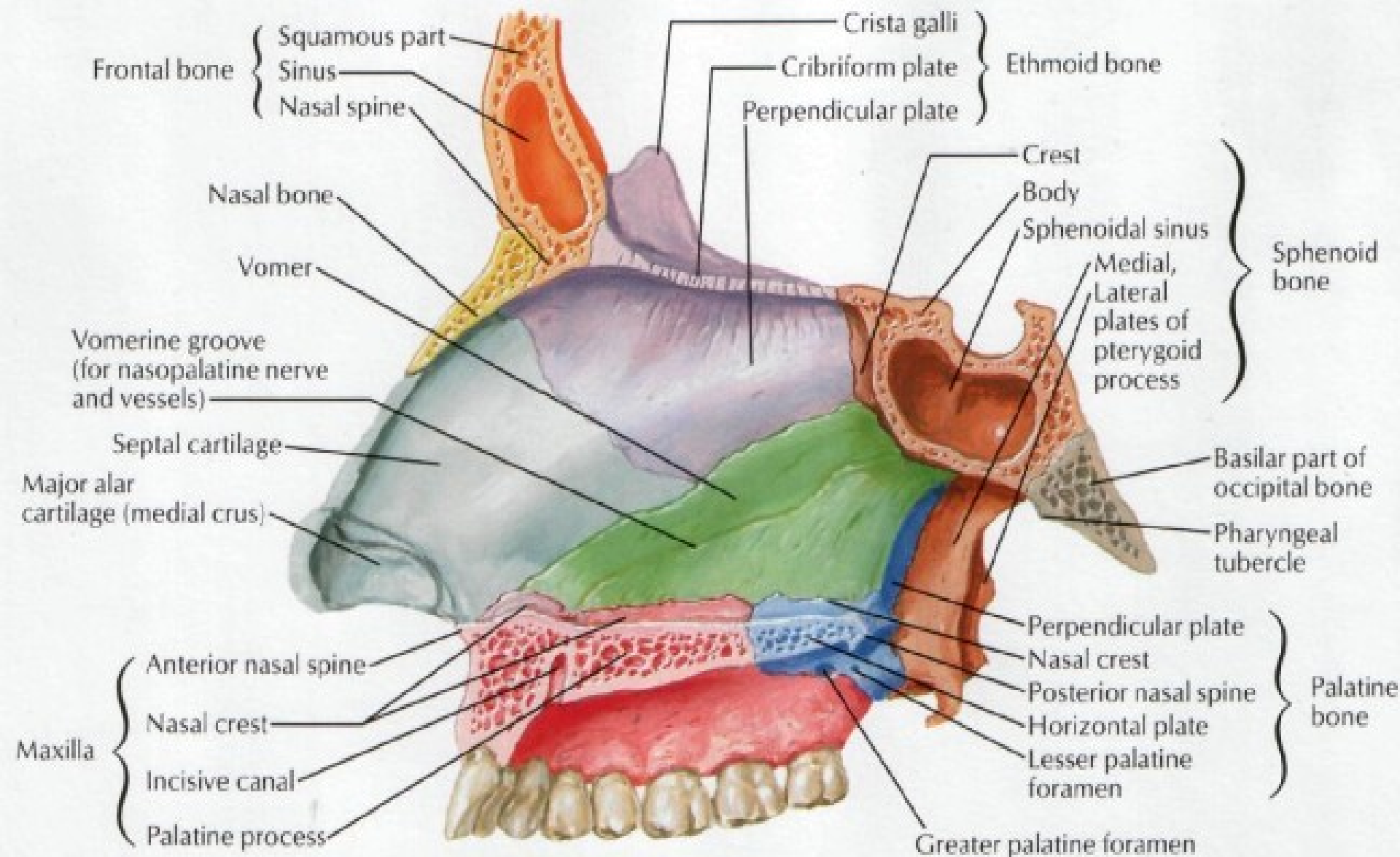
- The conducting portion
 - delivers air to the respiratory tissue and is characterized by rigid walls that keep the airways open.
- consists of
 - nasal cavities
 - pharynx
 - larynx
 - trachea
 - various subdivisions of the bronchial tree.
 - Parts of the conducting system are within the lungs (intrapulmonary), parts are outside the lungs (extra pulmonary)

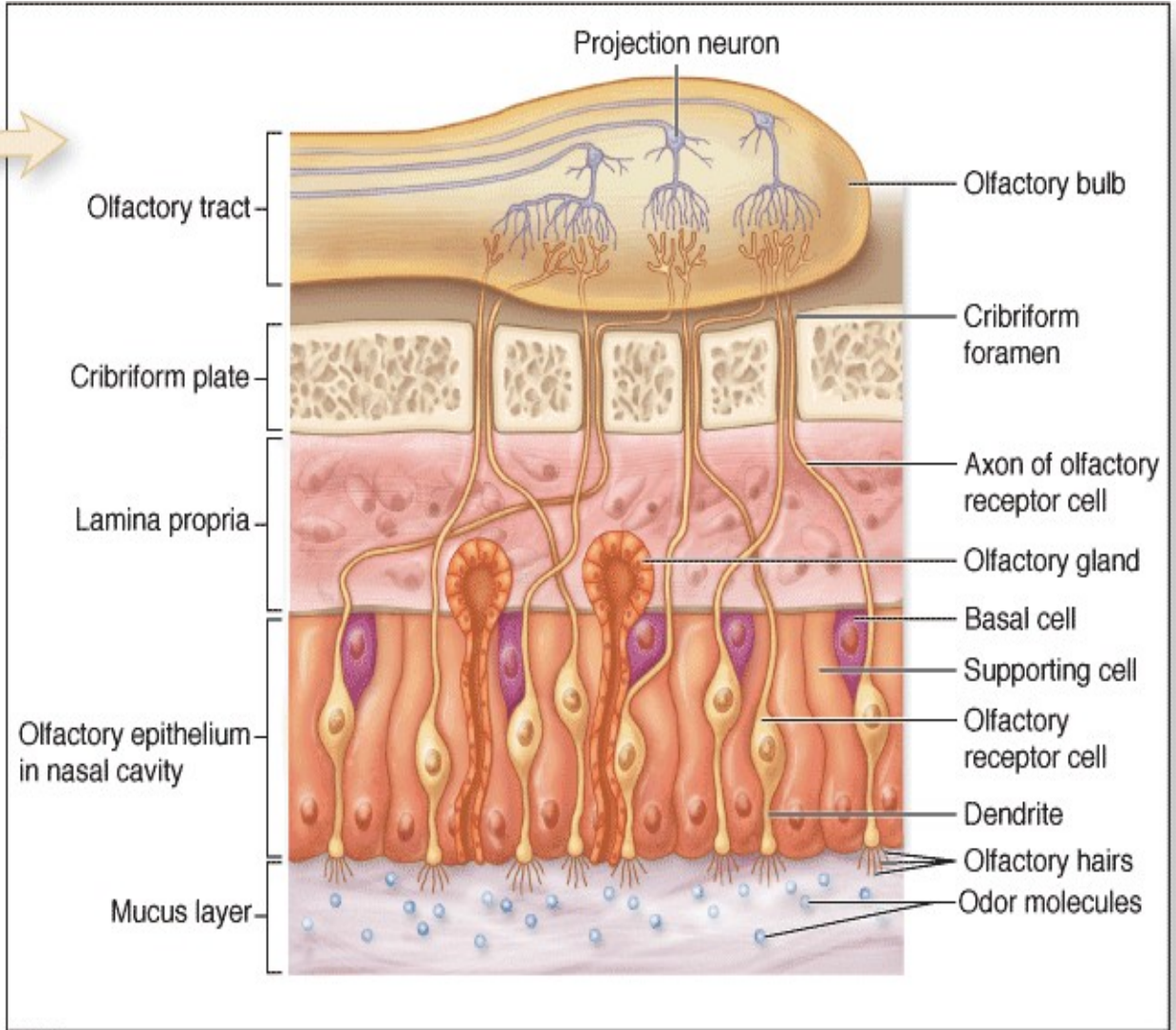
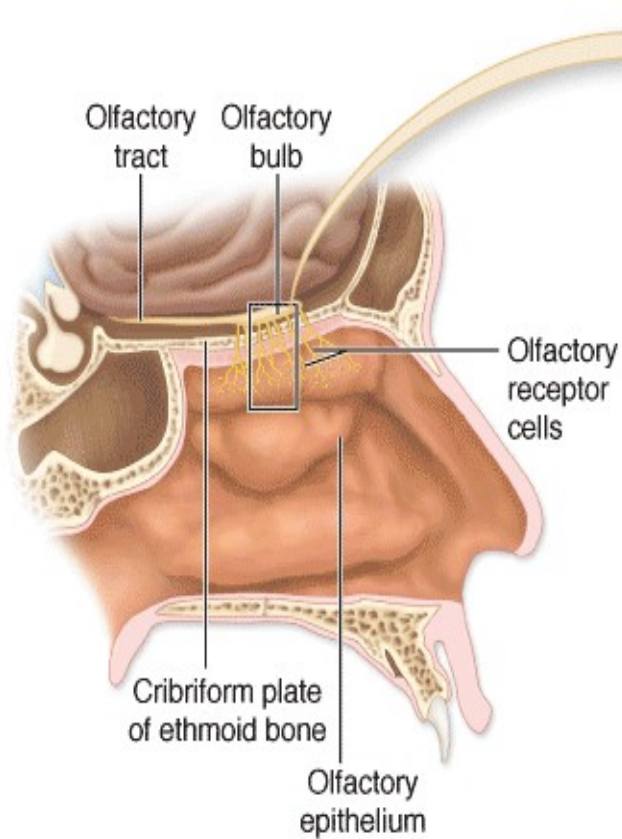
- **Conducting passages**
 - Air is conducted through the oral and nasal cavities → to the pharynx → and then through the larynx → to the trachea → and bronchial tree.
 - These structures deliver warmed and humidified air to the respiratory division in the lungs.
 - The passageways are lined with various types of epithelia to prepare the air properly for utilization.
 - The majority of conducting passages are held **permanently open** by muscle on a bony or cartilaginous framework.

I. The nose

- The nose includes
 - an external portion: visible outer part
 - an internal nasal cavity: invisible internal part
 - nasal septum-divides the nasal cavity into two lateral halves
 - made up of
 - The perpendicular plate of ethmoid bone,
 - the vomer,
 - the septal cartilage
 - Each half is referred to as a nasal fossa.
 - The vestibule is the anterior expanded portion & lined by stratified squamous epithelium
 - Each nasal fossa opens anteriorly through







a

Source: Mescher AL: *Junqueira's Basic Histology: Text and Atlas*, 12th Edition: <http://www.accessmedicine.com>

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- Three functions of the nasal cavity:
 1. warm, moisten, and cleanse the inspired air.
 2. detecting olfactory stimuli; and
 3. modifying speech vibrations as they pass through the large, hollow resonating chambers.
- This is highly vascular connective tissue under nasal epithelium (PSCCE) is important to warm the air but also makes humans susceptible to *nosebleeds*.
- Nasal hairs (or vibrissae) filter macroparticles that might otherwise be inhaled.
- The mucous layer contains IgA and other immunoglobulins that protect against local

- **Olfactory epithelium:** over roof of nasal cavity concerned with the sense of smell.
- The **paranasal air sinuses**
 - lie within bones of the same name surrounding the nasal cavity
 - are continuous with it through small openings.
- these are:
 - **maxillary** - **Frontal**
 - **Sphenoid** - **ethmoid**
 - are responsible for
 - some sound resonance
 - most importantly, to decrease the weight of the skull.
 - Air passages between the conchae are called *meatuses*.

II. Pharynx

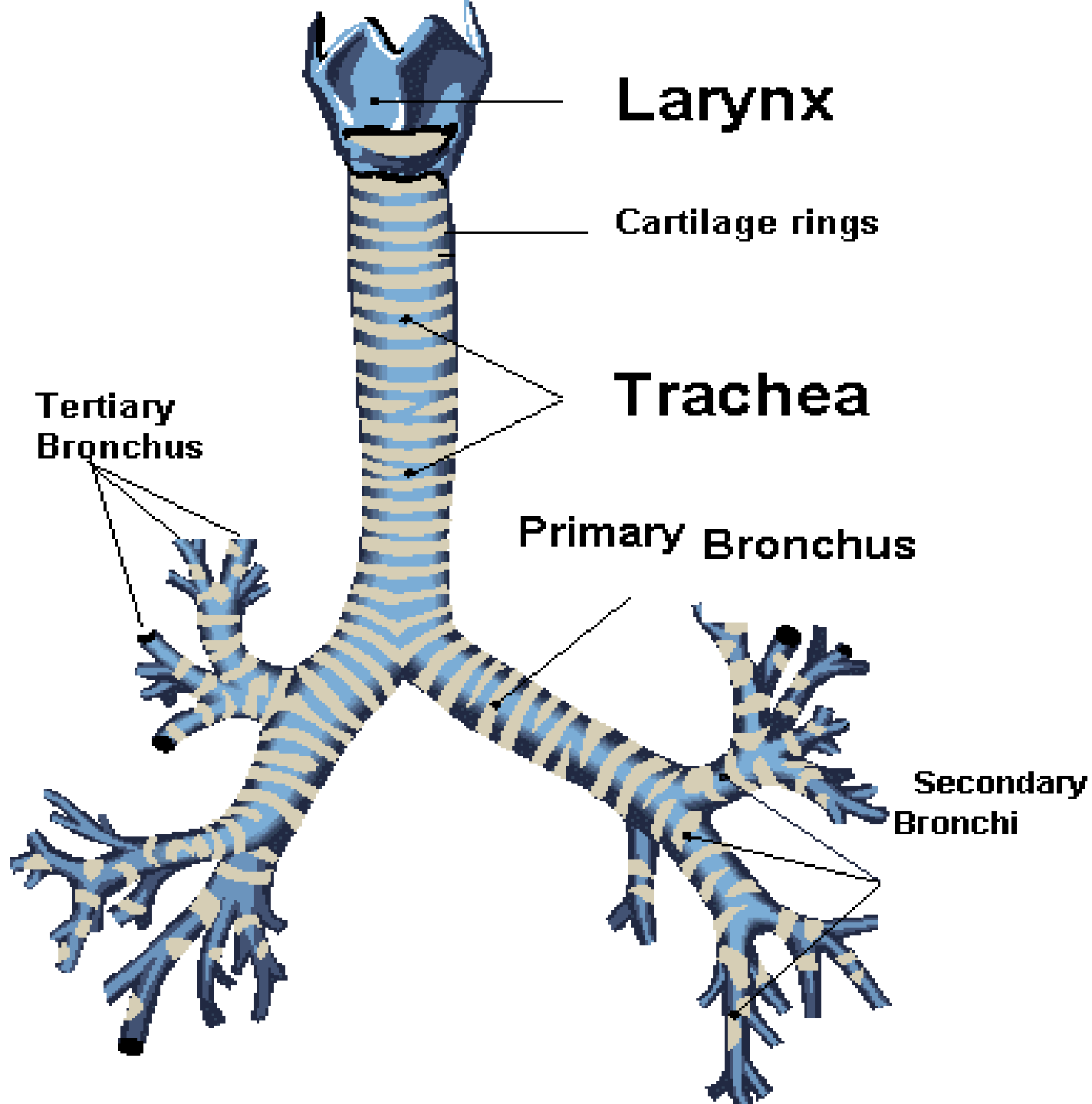
- is posterior continuation of the nasal cavities and mouth.
- has 3 parts
 - nasopharynx
 - Oropharynx
 - laryngeal pharynx.

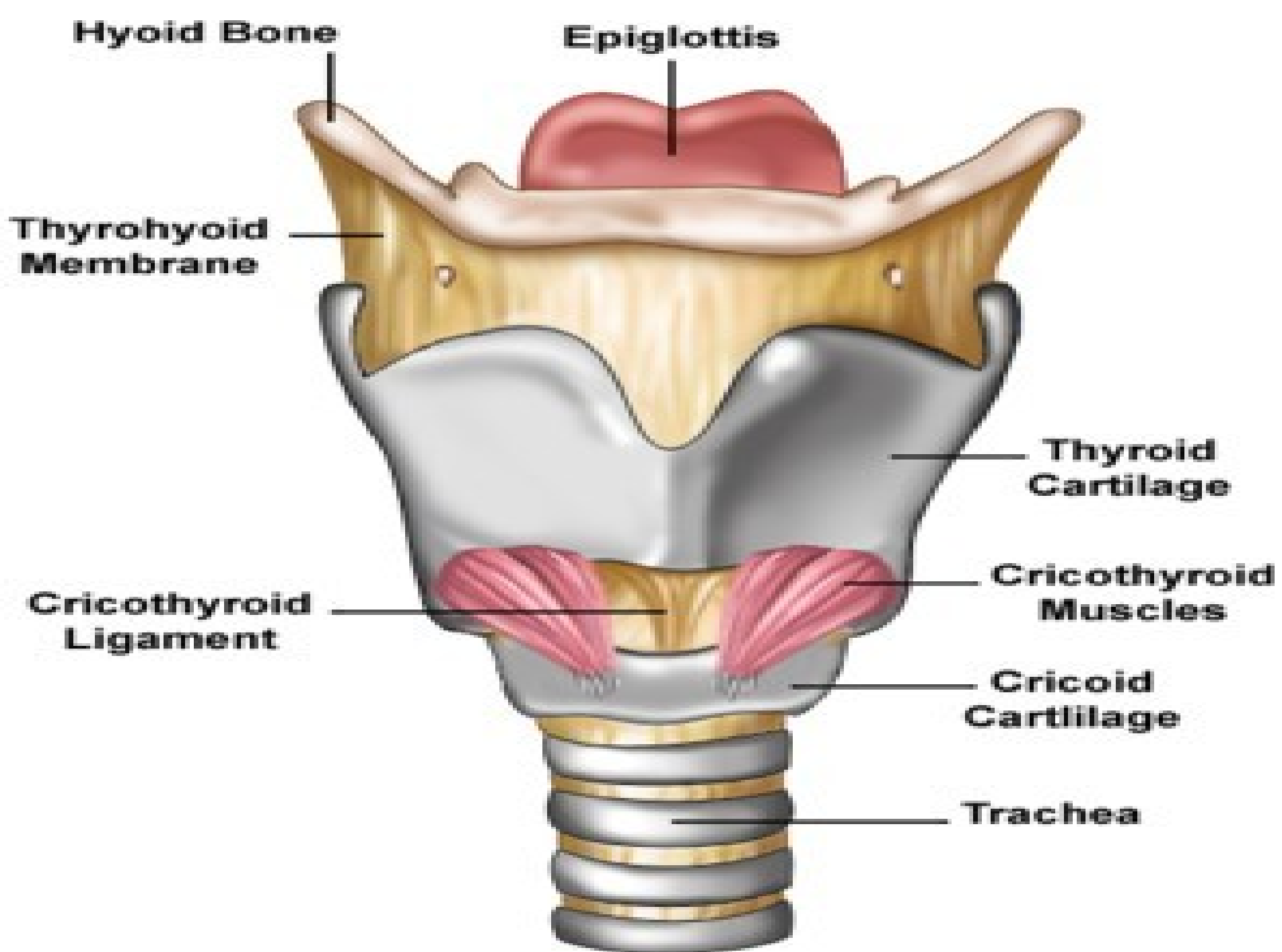
- The nasopharynx

- the most superior part,
- is directly continuous with the nasal cavities
- lined by the same respiratory passage epithelium-with goblet cells).
- In areas subject to abrasion,
 - a non-keratinized stratified squamous epithelium may occur.

- The underlying connective tissue contains
 - mucous
 - serous
 - mixed mucoserous glands
 - abundant lymphatic tissue.
- The lymphatic tissue
 - is irregularly scattered throughout the connective tissue
 - forms tonsillar structures:
 - the pharyngeal tonsils
 - around the openings of the eustachean tubes into the nasopharynx, and
 - the palatine and lingual tonsils
 - at the junctions of the oral cavity and oropharynx.

- **The larynx(*voice box*)**
 - forms the entrance into the lower respiratory system
 - connects the laryngopharynx with the trachea.
 - positioned in the anterior midline of the neck at the level of the 4th – 6th cervical vertebrae.
- **The cartilage of larynx: has 9 (3paired: corniculate, arytenoids, and cuneiform; and 3singular: thyroid, cricoid and epiglottis)**
 - **The epiglottis**
 - is a cartilaginous flap behind the root of the tongue
 - helps to close the **glottides** (laryngeal opening) during swallowing.
 - **Thyroid cartilage (Adam's Apple)**





- **The Trachea**

- The trachea (or wind pipe) is a rigid tube connecting the larynx to the primary bronchi.
- It is about 12cm long and 2.5cm in diameter.
- It is found anterior to the oesophagus as it extends into the thoracic cavity.
- A series of incomplete **C-shaped rings of hyaline cartilage** form the walls of the trachea.
- These cartilages help to keep the air way permanently open.

Layers over the wall of trachea has:

- 1) The **mucosa** consists of
 - the epithelium,
 - the elastic lamina.

- **Respiratory epithelium of the trachea:**
 - The lumen of the trachea is lined by a ciliated pseudostratified columnar epithelium.
 - The epithelium is composed of 3 cell types:
 1. ciliated columnar cells, with long cilia on their apical surfaces,
 2. goblet cells, with mucous droplets and
 3. basal cells with basally located round nuclei.
 - Are believed to be the source of replacement of ciliated and goblet cells

- **Lungs**

- The lungs are large, spongy, paired organs within the thoracic cavity
- extending from the diaphragm to a point just above the clavicles.
- The lungs are separated from each other by the heart and other structures of the mediastinum.
- All structures of the respiratory system beyond the primary bronchi, including the bronchial tree and alveoli, are contained in the lungs.

– The left lung

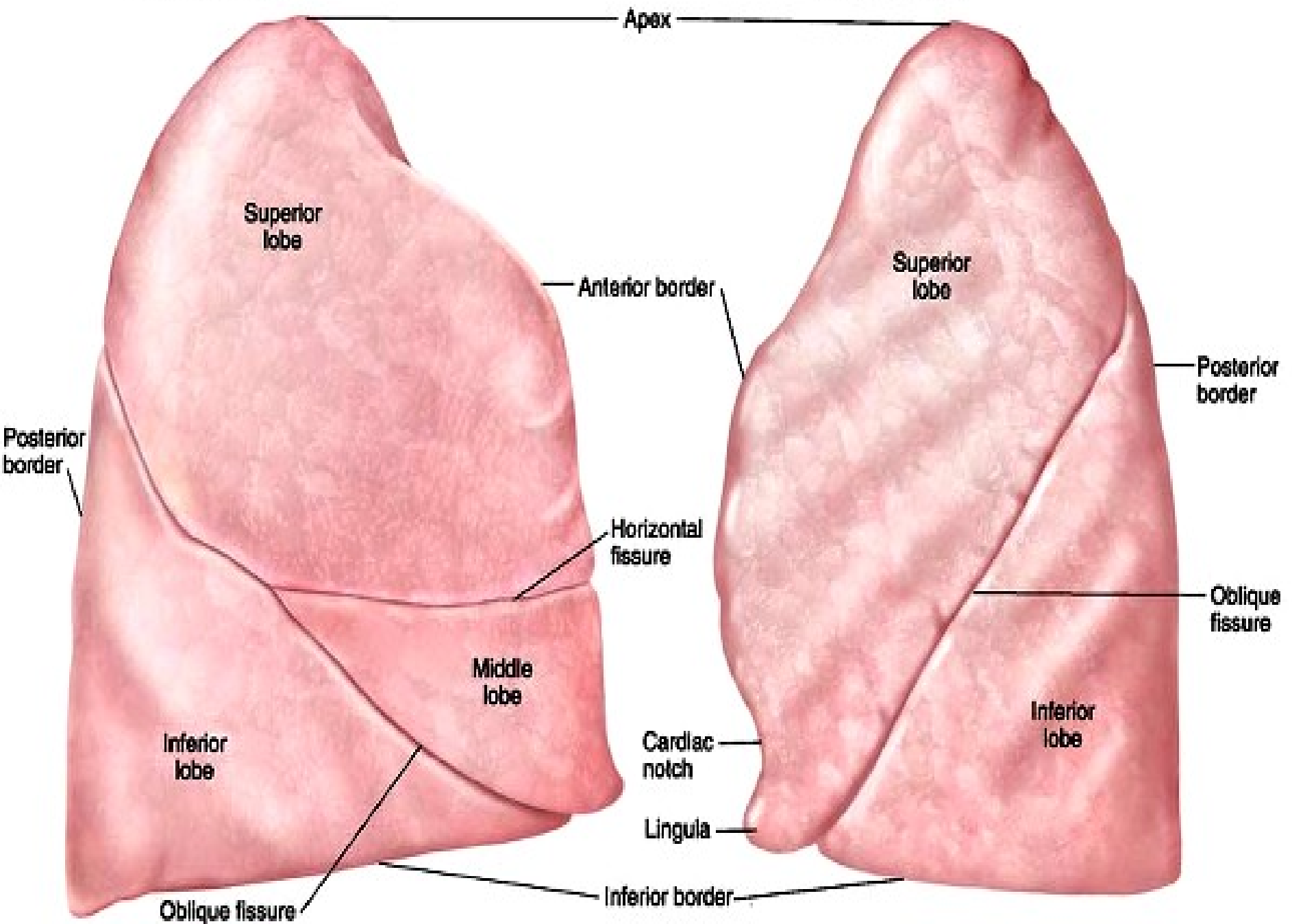
- is some what smaller than the right
- has a cardiac notch (an indentation in its anterior border) to accommodate the heart.
- divided into
 - a superior lobe and
 - an inferior lobe by an oblique fissure.

– The right lung

- is subdivided into three lobes;
- superior,
- middle, and
- inferior lobes by a horizontal and an oblique fissure.

A. Right lung

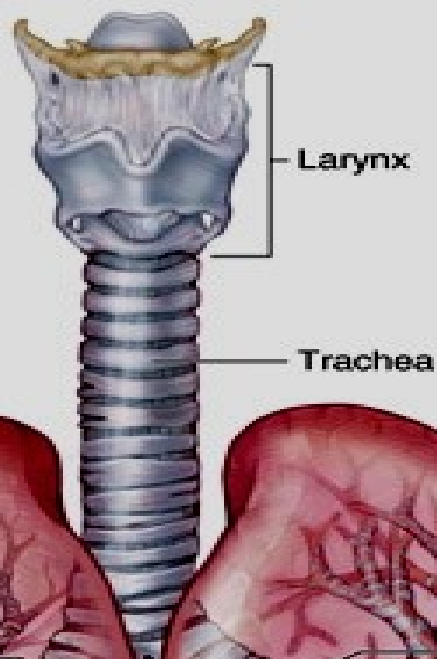
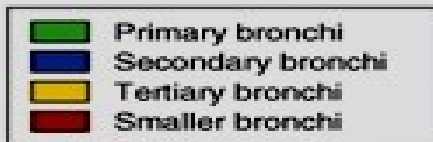
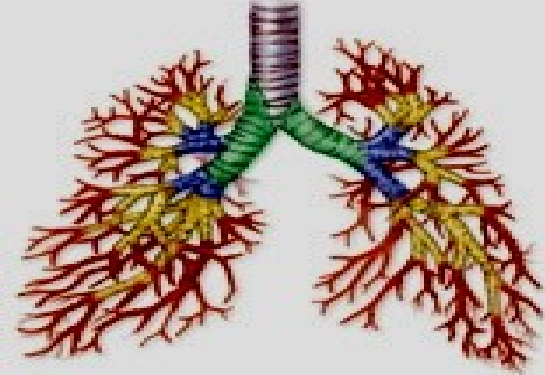
B. Left lung



- Lobular divisions of the lungs make up specific bronchial segments.
 - The right lung contains ten bronchial segments and
 - the left lung contains eight.

A Bronchial tree

- This is composed of a series of respiratory tubes that branch in to progressively narrow tubes as they extend in to the lungs
- divides in to
 - primary bronchus
 - secondary bronchus
 - tertiary bronchus



Right primary
bronchus

Right secondary
bronchus

Right tertiary
bronchus

Smaller bronchi

Left primary
bronchus

Left secondary
bronchus

Left tertiary
bronchus

Smaller
bronchi

- **Bronchial Tree**

1. The primary (main) bronchi:

- enter the hilum of each lung together with:
 - the pulmonary vessels, lymphatic vessels, and nerves
 - Right main bronchus:*** is shorter, wider, and more vertically oriented than the left primary bronchus.
- Each branches into several secondary bronchi (or lobar bronchi).

2. ***Secondary bronchi (or lobar bronchi)***

- The left lung: has two secondary bronchi since it has two lobes.
- The right lung: has 3 secondary bronchi since it has 3 lobes.

3. Tertiary bronchi

- Right lung: supplied by 10 tertiary bronchi,
- left lung: supplied by 8 tertiary bronchi.

4. Bronchioles

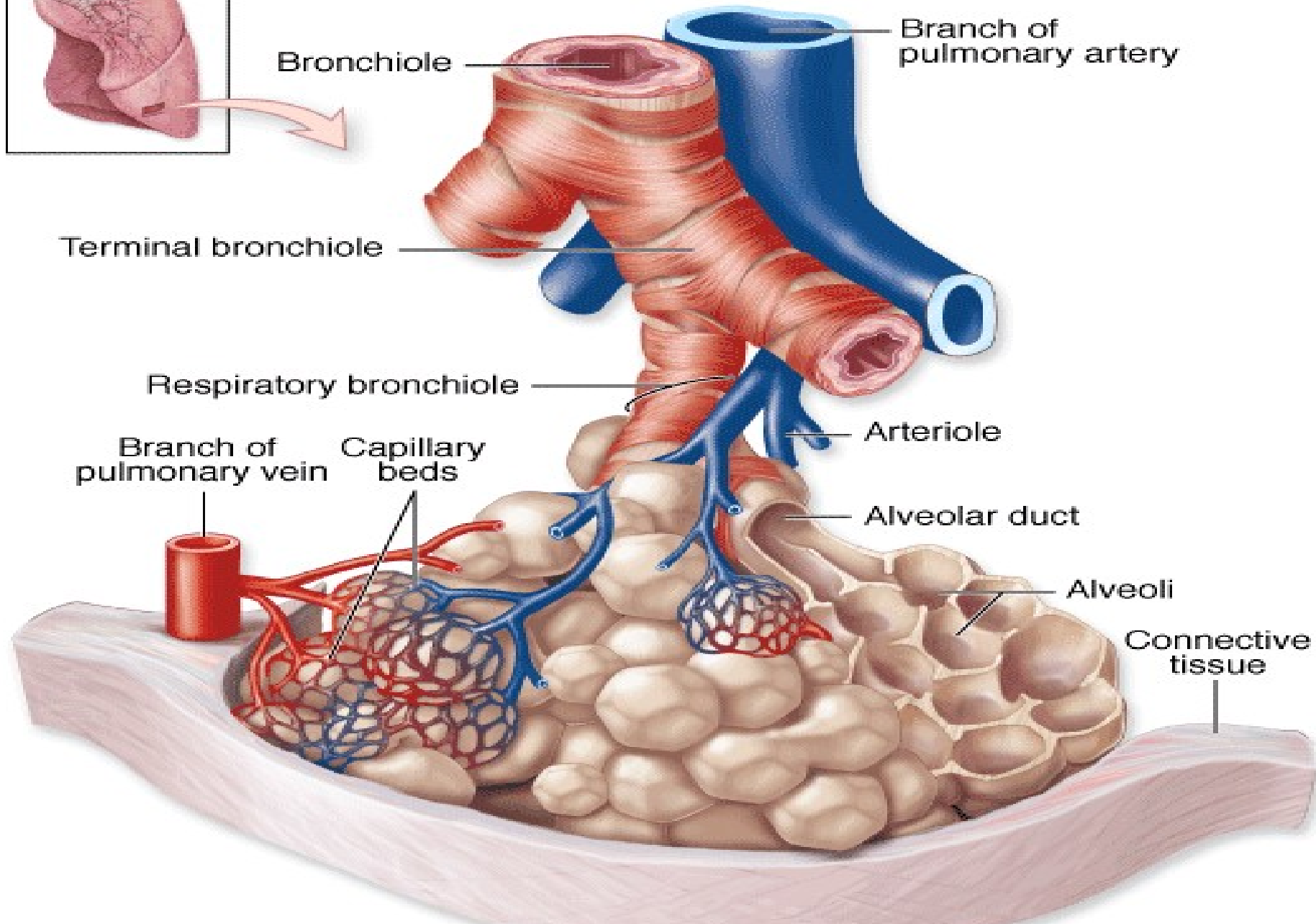
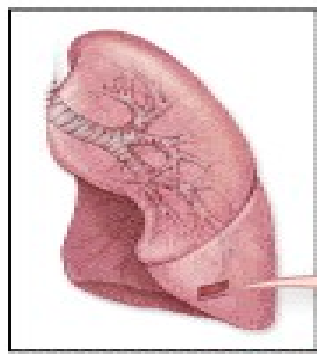
- small airways less than 1 mm in diameter
- do not have cartilage plates.
- **clara cells**, also called bronchiolar secretory cells secrete **surfactant**,
 - a phospholipid that alters the surface tension of the fluid layer covering the cell surface.

5. Terminal bronchioles

- less than 0.5 mm in diameter,
- have simple cuboidal epithelium with some ciliated cells lining their lumina with no goblet cells
- They are the smallest of the "purely conducting" passages of the respiratory tree.
- Each terminal bronchiole divides into short branches called "respiratory bronchioles"

6. Respiratory bronchioles

- Allows Exchange of gases between air and blood.
- form a transition between the purely conducting and purely respiratory regions of the tract.
- The larger are lined by simple cuboidal epithelium with only a few ciliated cells; goblet cells are lacking

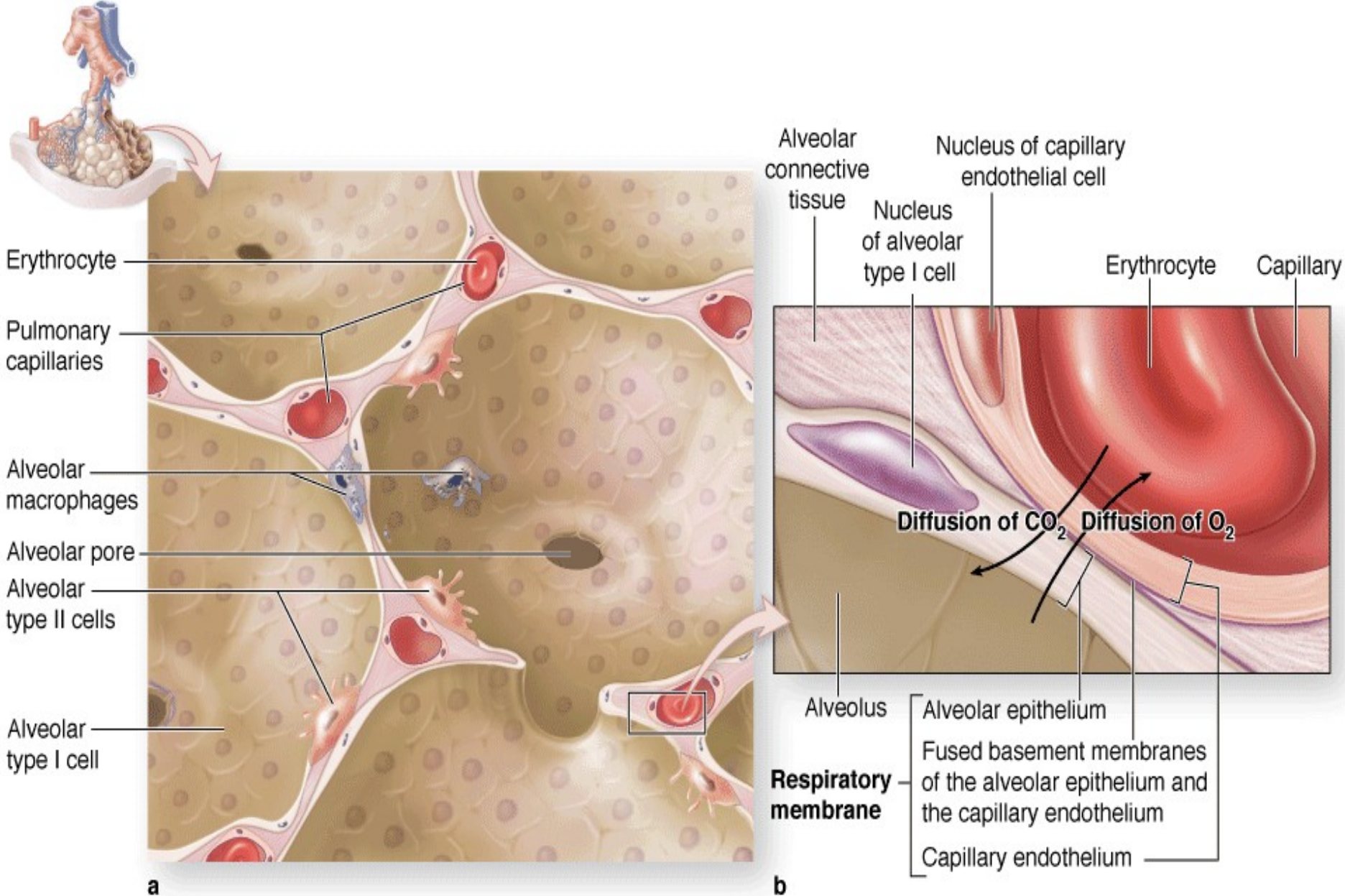


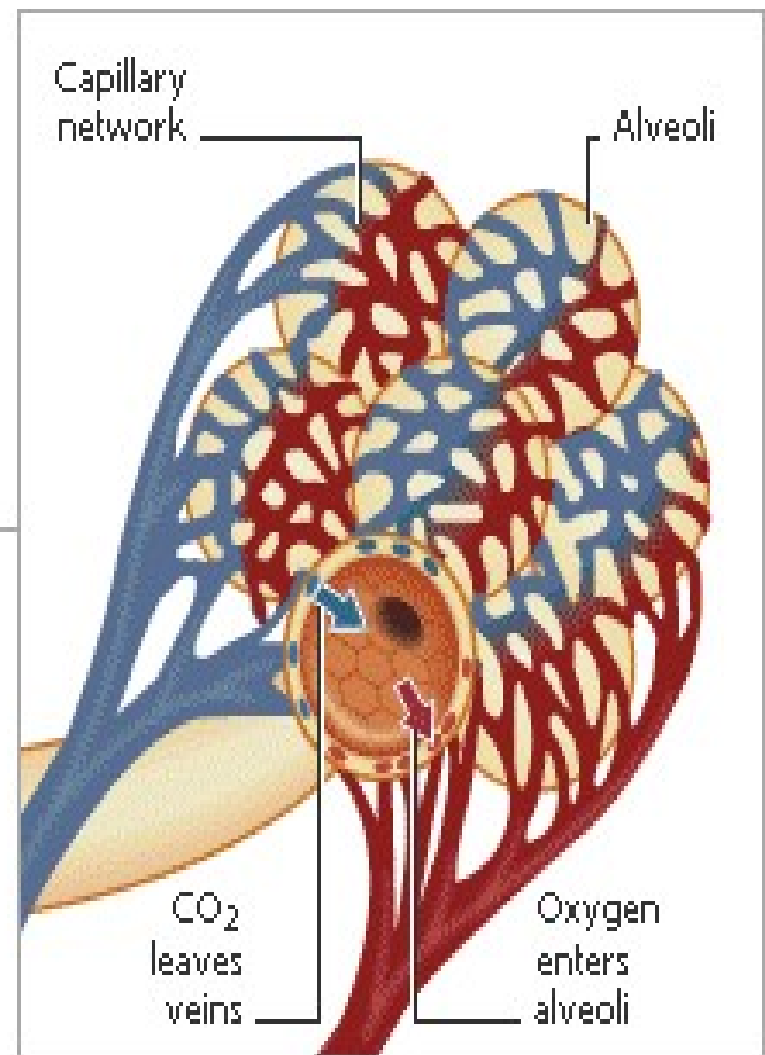
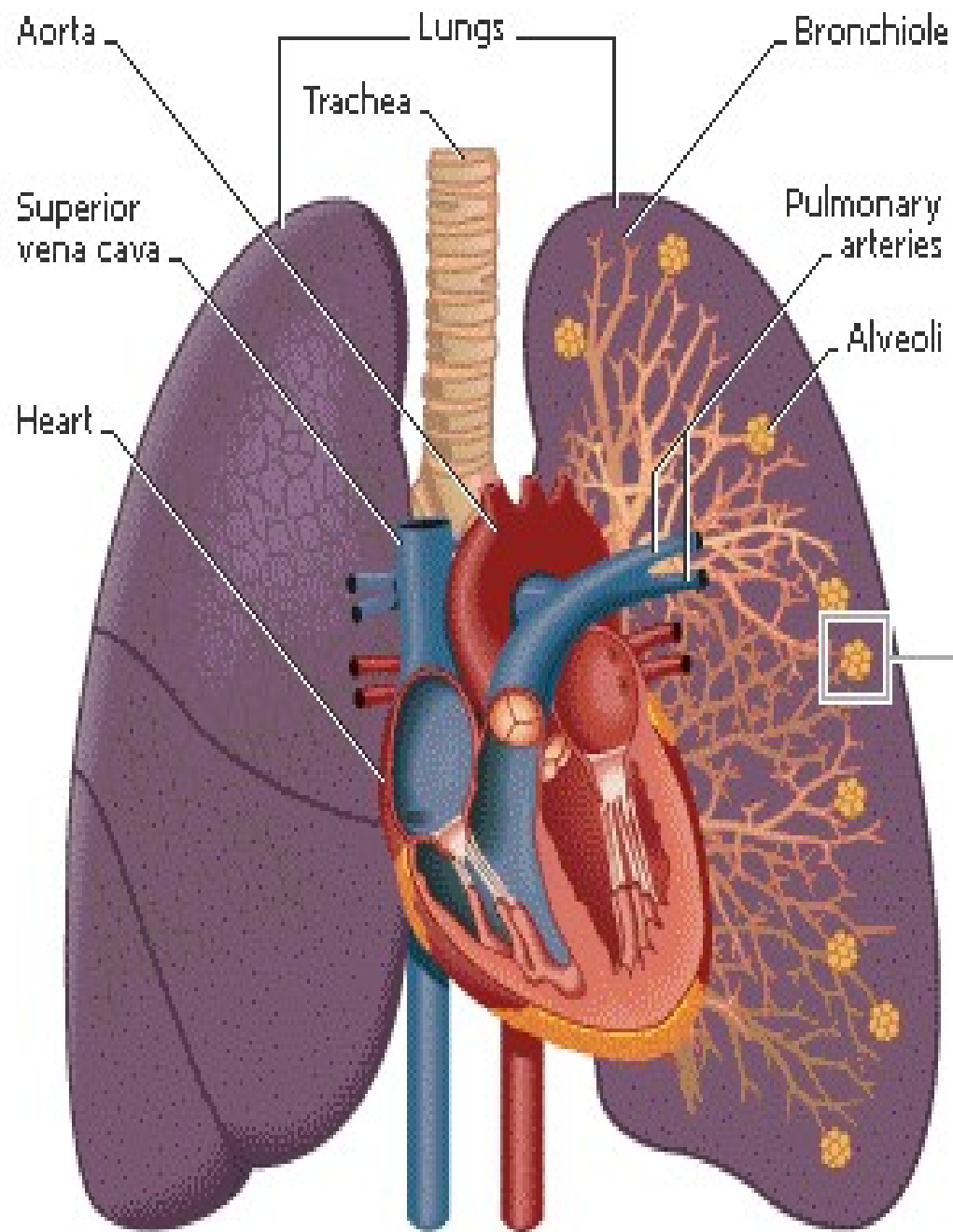
- In the smaller respiratory bronchioles, the epithelium becomes low cuboidal without cilia.
- end by branching into alveolar ducts.

- **Alveoli bud**

- from the walls of the respiratory bronchioles and represent **the respiratory portions** of these airways.
- The alveoli become more numerous distally.
- Gas exchange occurs across the **walls of the alveoli** (0.25 – 0.50mm in diameter).

- **Alveoli**
 - are thin- walled,
 - polyhedral structures
 - open at one side to allow air into their cavities.
- Adjacent alveoli are separated by a common interalveolar septum, whose most conspicuous feature is a rich network of capillaries that bulge the septal wall to expose most of the capillary surface to alveolar air.
 - alveolar pores:
 - Small openings in the septal wall,
 - permit communication and equalization of air pressure between alveoli.





- ***Surfactant***
 - is about 90 percent phospholipid and consists mainly of phosphatidylcholine.
 - It is synthesized by septal cells and released by exocytosis.
 - The released surfactant forms a monolayer over the thin film of fluid that coats alveoli and thereby lowers surface tension at the liquid- air interphase.
 - The lowering of surface tension aids in preventing the collapse of alveoli at the end of expiration.

2. Alveolar macrophages

- are present within the interalveolar septa and alveolar lumina.
- Many contain particles of inhaled material and have been called ‘dust’ cells.
- As with all macrophages, the alveolar macrophages originate from blood monocytes.
- Most of these cells ultimately are eliminated via the air passages and appear in the sputum:
- a few may migrate into lymphatics and escape the lungs by this route.

- **Pleura**

- The pleura are thin membranes made up of collagenous and elastic fibers, covered by a single layer of mesothelial cells.
- The layer lining the wall of the thoracic cavity is the parietal pleura, which reflects from the thoracic wall onto the surface of the lungs, where it becomes the visceral pleura.
- The pleura secrete a small amount of fluid between the two layers to permit frictionless free movement

