

THORAX

- ANATOMY
- RADIOLOGY
- ORGAN SYSTEMS
- PHYSIOLOGY of the organ systems contained
- PATHOLOGY of the organ systems contained
- PHARMACOLOGY of the organ systems contained

Dr. Robin Paudel

Anatomy of Thoracic Region

- Chest Wall
 - Skeletal elements:
 - Vertebrae :
 - 12 thoracic vertebrae
 - Vertebrae have facets on their bodies to articulate with the head of the ribs
 - Each rib head articulates with the body of the numerically corresponding vertebra and the one below it.
 - Thoracic vertebrae have facets on their transverse processes to articulate with the tubercles of the numerically corresponding ribs.

- Sternum
 - Manubrium: Articulates with clavicle and first rib
 - Sternal Angle:
 - » Manubrium joins body
 - » Important anatomical / clinical landmark
 - 2nd rib articulates here
 - Intervertebral disc betn T4 and T5
 - Beginning and end of aortic arch
 - Bifurcation of the trachea into left and right main bronchi
 - Mediastinum is divided into superior and inferior mediastinum.
 - » Angle is approximately 140 degrees (!!)
 - Body of Sternum
 - » Articulates directly with ribs 3-7
 - » Xiphoid process
 - » Xiphoid process cartilagenous at birth. Usually ossifies and unites with the body at approx age 40.

- Ribs and costal cartilages
 - 12 pairs of ribs, attached posteriorly to thoracic vertebrae
 - 1-7 : true ribs, attach directly to the sternum by the costal cartilages
 - 8-10 : false ribs, attach to the costal cartilages above
 - 11-12: floating ribs
 - Costal groove : protects nerve, artery and vein.
- Muscles
 - External intercostal muscles
 - 11 pairs
 - Fibres run anteriorly and inferiorly (Like hands in pockets)
 - Tubercles of ribs posteriorly to costo-chondral junction anteriorly
 - External intercostal membranes replace them anteriorly

- Internal intercostal muscles
 - 11 pairs
 - Fibres run posteriorly and inferiorly
 - Sternum to the angles of the ribs posteriorly
 - Internal inter costal membranes replace them posteriorly
- Innermost intercostal muscles
 - Intercostal nerves and vessels run in between internal intercostal muscles and innermost intercostal muscles

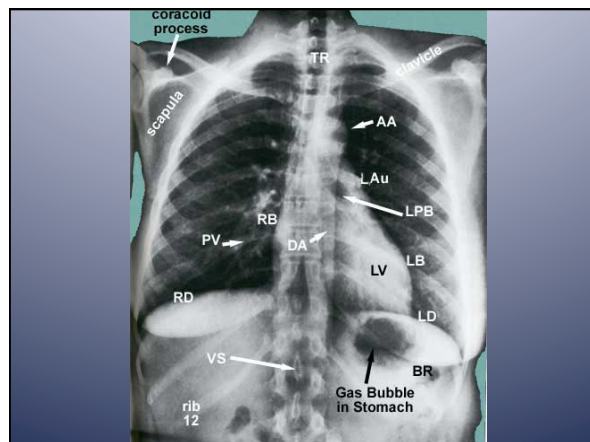
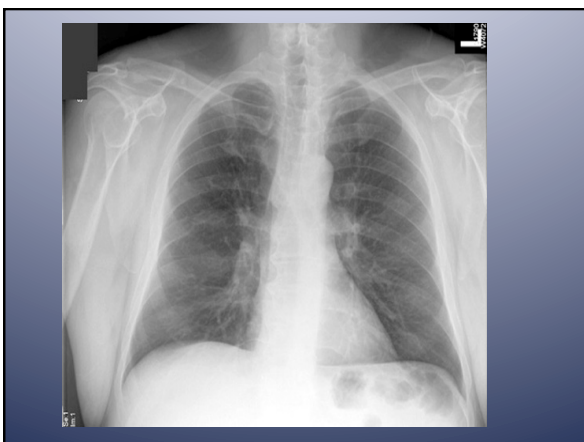
- Intercostal structures
 - Intercostal nerves
 - 12 thoracic nerves
 - 11 intercostal
 - 1 subcostal
 - Supply the skin and musculature of the thoracic and abdominal walls and the parietal pleura and parietal peritoneum.
 - Intercostal arteries
 - 12 pairs of anterior and posterior intercostal arteries
 - 11 intercostal 1 subcostal
 - Intercostal veins

- Anterior intercostal arteries
 - 1-6 : from internal thoracic arteries
 - 7-9 : from musculo phrenic arteries
 - No anterior intercostal arteries in the last 2 spaces. Branches of the posterior intercostal arteries supply them.
- Posterior intercostal arteries
 - 11 intercostal
 - 1 subcostal
- Intercostal veins
 - Anterior branches drain to the internal thoracic and musculo phrenic veins.
 - Posterior branches to the azygous system of veins

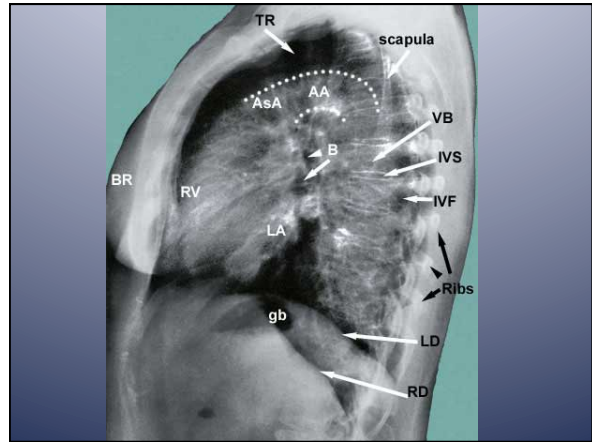
- Breast : modified sweat gland
 - Nipple : 4th intercostal space in nulliparous women and in men
 - Cooper ligaments : are the suspensory ligaments
 - Arterial supply
 - Branches from Internal thoracic (main supply)
 - Other contributors:
 - Lateral thoracic and thoraco acromial branches of axillary artery
 - Intercostal arteries
 - Venous drainage : to the axillary vein

- Lymphatic drainage
 - Axillary nodes (several groups)
- Innervation
 - Sensory : intercostal nerves 2-6
 - These nerves also carry sympathetic fibres to the areola

Radiology



- scapula
- coracoid process
- clavicle
- trachea (TR)
- aortic arch (AA)
- left auricle (LAU)
- left primary bronchus (LPB)
- right border of the heart (RB). Remember that the right atrium forms this border.
- pulmonary vessels (PV)
- descending aorta (DA)
- left border of the heart (LB) formed by the left ventricle (LV)
- right diaphragm (RD) Usually slightly higher than the left diaphragm (LD)
- vertebral spine (VS)
- 12th rib
- lower border of the breast in the female (BR)
- gas bubble in the stomach (usually gives a clue to where the stomach is)

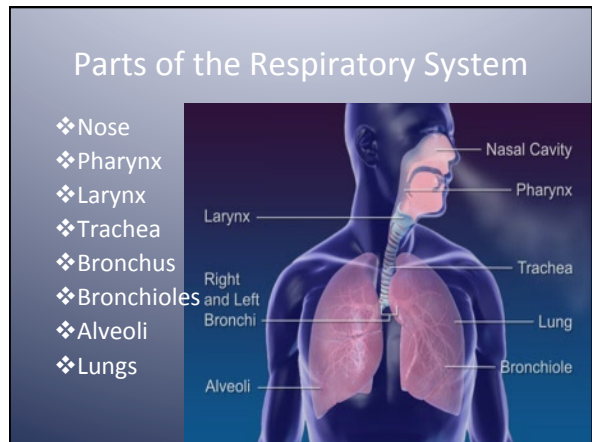


- scapula
- breast (BR) if a female
- right ventricle (RV)
- left atrium (LA)
- primary bronchi (B)
- ascending aorta (AsA)
- aortic arch (AA)
- left and right diaphragms
- gas bubble (gb) in the stomach. Since the stomach is on the left side of the body, it should also be under the left diaphragm. From the lateral view, the right diaphragm is not always higher than the left.
- bodies of the vertebrae (VB)
- intervertebral space (IVS)
- intervertebral foramen (IVF)
- ribs

For better understanding of radiology


- http://www.upstate.edu/cdb/grossanat/th_slide1a.html
- http://www.meddean.luc.edu/lumen/MedEd/Radiology/curriculum/Pulmonary/Thorax_anatomy_1.htm

Respiratory System



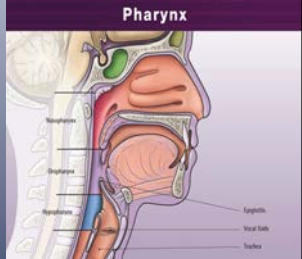
Nose

- Nasal septum divides the nasal cavity into two equal passages
- Lateral wall has 3 projections called nasal conchae
- Roof is formed by cribriform plate of ethmoid
- Functions of nose
 1. Passage for inspired & expired air
 2. Filtering, Warming & humidifying of inspired air
 3. Sensation of smell
 4. Resonance of voice




Pharynx

- ❖ 12-14 cm long muscular tube
- ❖ Extend from nose to larynx
- ❖ Divided into 3 parts
 1. Nasopharynx
 2. Oropharynx
 3. Laryngopharynx
- ❖ Functions
 - Passage for air & food
 - Warming and humidifying
 - Helps in Hearing
 - Protect from microbes
 - Helps in speech



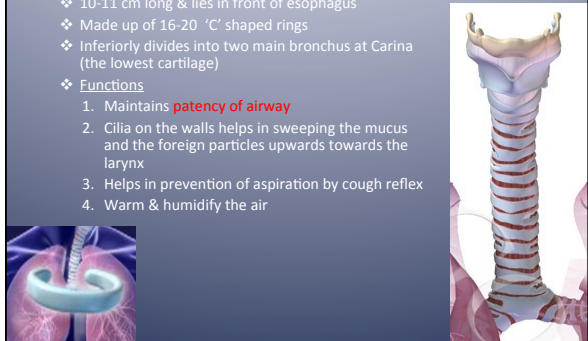
Larynx

- ❖ Is a cartilaginous and muscular organ also known as "Voice box"
- ❖ Is made up of nine cartilages
- ❖ Extends from root of tongue to the trachea
- ❖ Lies in front of laryngopharynx (@ 3rd to 6th cervical vertebra)
- ❖ Around 2 inches long (~5cms)
- ❖ Functions
 - ❖ Sound production
 - ❖ Protects the lower respiratory tract during swallowing
 - ❖ Passage for air
 - ❖ Warming & humidifying the air




Trachea

- ❖ Is a continuation of larynx
- ❖ 10-11 cm long & lies in front of esophagus
- ❖ Made up of 16-20 'C' shaped rings
- ❖ Inferiorly divides into two main bronchus at Carina (the lowest cartilage)
- ❖ Functions
 1. Maintains **patency of airway**
 2. Cilia on the walls helps in sweeping the mucus and the foreign particles upwards towards the larynx
 3. Helps in prevention of aspiration by cough reflex
 4. Warm & humidify the air



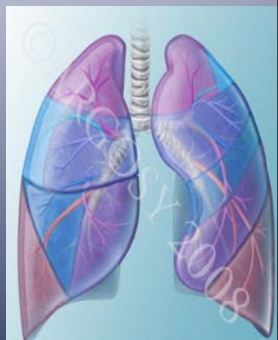
Bronchus & Bronchioles

- ❖ Two main bronchus formed by the division of trachea
 - ❖ Right bronchus Wider, Shorter (2.5 cm) & more vertical
 - ❖ Left Bronchus Narrower, longer (5 cm)
- ❖ They progressively divide and sub divide into
 - ❖ Bronchioles
 - ❖ Terminal bronchioles
 - ❖ Respiratory bronchioles
 - ❖ Alveolar duct
 - ❖ Alveoli



Lungs

- ❖ Two cone shaped lungs
 - ❖ Right lung 3 lobes
 - ❖ Left lung 2lobes
- ❖ Are covered with Pleura
- ❖ Area between two lungs is called Mediastinum
- ❖ Each lung is composed of
 - ❖ Bronchi and bronchioles
 - ❖ Alveoli
 - ❖ Blood vessels
 - ❖ Nerves
 - ❖ Lymphatics



Pleura

- ❖ Is a serous membrane which surrounds each lung
- ❖ Has two layers
 - ❖ Parietal pleura (outer)
 - ❖ Visceral Pleura (inner) attached to the lung surface
- ❖ Has space in between the two layers called pleural cavity
- ❖ The cavity is filled with small amount of pleural fluid
- ❖ This fluid helps two layers to glide over each other, Preventing the friction between them during breathing

Respiration

- ❖ Respiration is a physiological process with two phases
 - ❖ Active phase (inspiration) —intake of air into lungs
 - ❖ Passive phase (expiration) – Exhalation of air from lungs
- ❖ Duration
 - ❖ Inspiration 2 sec
 - ❖ Expiration 3 sec
- ❖ Muscles of respiration
 - ❖ Diaphragm : vertical dimension
 - ❖ Intercostal muscles : AP dimension
 - ❖ Muscles of neck, shoulder & abdomen
- ❖ Respiratory centre in brain stem & Chemo receptors help in the control of respiration

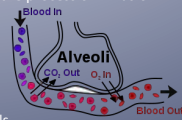


External respiration

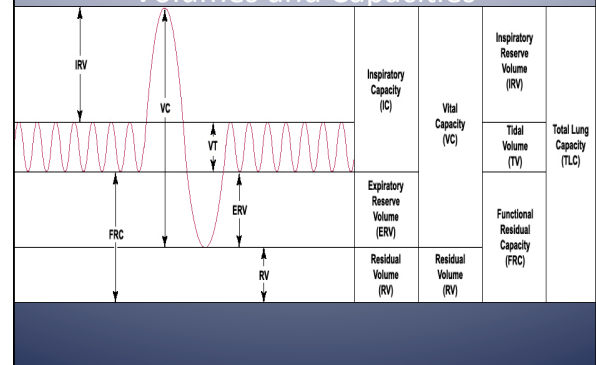
- ❖ Intake of atmospheric oxygen into the lungs and removal of Carbon dioxide from lungs to the atmosphere is called external respiration
- ❖ Gaseous exchange takes place in the alveoli by the process of Diffusion

Internal respiration

- Oxygen is transported in blood form lungs to cells
- Cells utilize Oxygen and produce Carbon dioxide which is diffused out from cell into the capillary blood
- This exchange of oxygen and carbon dioxide between capillary blood and tissue cells is called Internal Respiration



Volumes and Capacities



- Tidal volume (V_t):
 - The amount of air that enters or leaves the lung in a single respiratory cycle at rest
 - 500 ml
- Functional Residual Capacity (FRC):
 - Volume of gas in the lungs at the end of a passive expiration.
 - 2700 ml
- Inspiratory capacity (IC):
 - Maximal volume of gas that can be inspired from FRC
 - 4000 ml
- Inspiratory reserve volume (IRV):
 - Additional amount of air that can be inhaled after a normal inspiration
 - 3500 ml

- Expiratory reserve volume (ERV):
 - Additional volume that can be expired after a normal expiration
 - 1500 ml
- Residual volume (RV):
 - Amount of air in the lung after a maximal expiration
 - 1200 ml
- Vital capacity
 - Maximal volume that can be expired after a maximal inspiration
 - 5500 ml
- Total lung capacity
 - The amount of air in the lung after a maximal inspiration
 - 6700 ml

Pulmonary Ventilation

- Total ventilation / Minute ventilation
- Dead space
 - Anatomic dead space
 - Alveolar dead space
 - Physiologic dead space

- Total ventilation:
 - Also referred to as minute volume or minute ventilation
 - Total volume of air moved in or out of the lungs per minute
 - $V_E = V_T * f$
 - V_E = total ventilation
 - V_T = tidal volume
 - f = respiratory rate
 - Normal values: $500 \text{ ml} * 15 / \text{min} = 7500 \text{ ml/min}$
- Dead spaces: regions of the respiratory system that contain air but are not exchanging oxygen and carbon-di-oxide with blood
 - Anatomic dead space:
 - Because of inherent structure, are not capable of exchange with the blood
 - Conducting zone, till terminal bronchioles
 - The size of anatomical dead space is ml is approximately equal to person's weight in pounds. ~150 ml

- Alveolar dead space:
 - Alveoli conducting air but are without blood flow in the surrounding capillaries
- Physiologic dead space:
 - Total dead space.
 - Anatomic + Alveolar
- Alveolar ventilation:
 - Room air delivered to the respiratory zone per minute
 - First 150 ml coming from the dead space doesn't contribute to the alveolar ventilation.
 - $(\text{tidal volume} - \text{dead space}) * \text{respiratory rate}$
 - $(500 \text{ ml} - 150 \text{ ml}) * 15 = 5250 \text{ ml}$

Gaseous Exchange