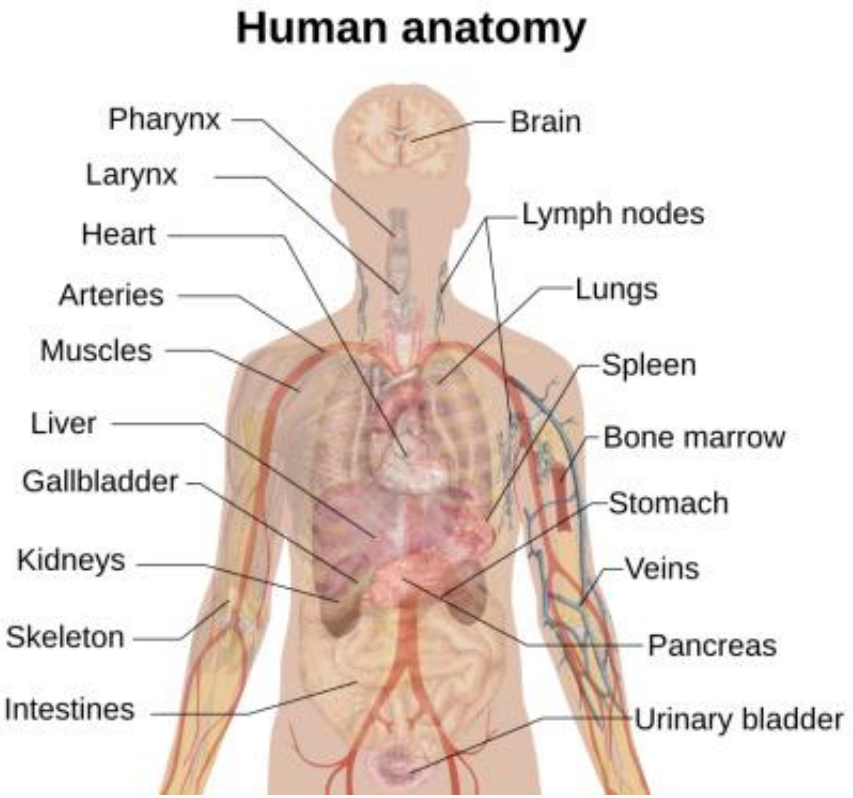
Sedation Dental Nursing:

Anatomy and physiology update:
Part 1: cardiovascular and respiratory systems

2025

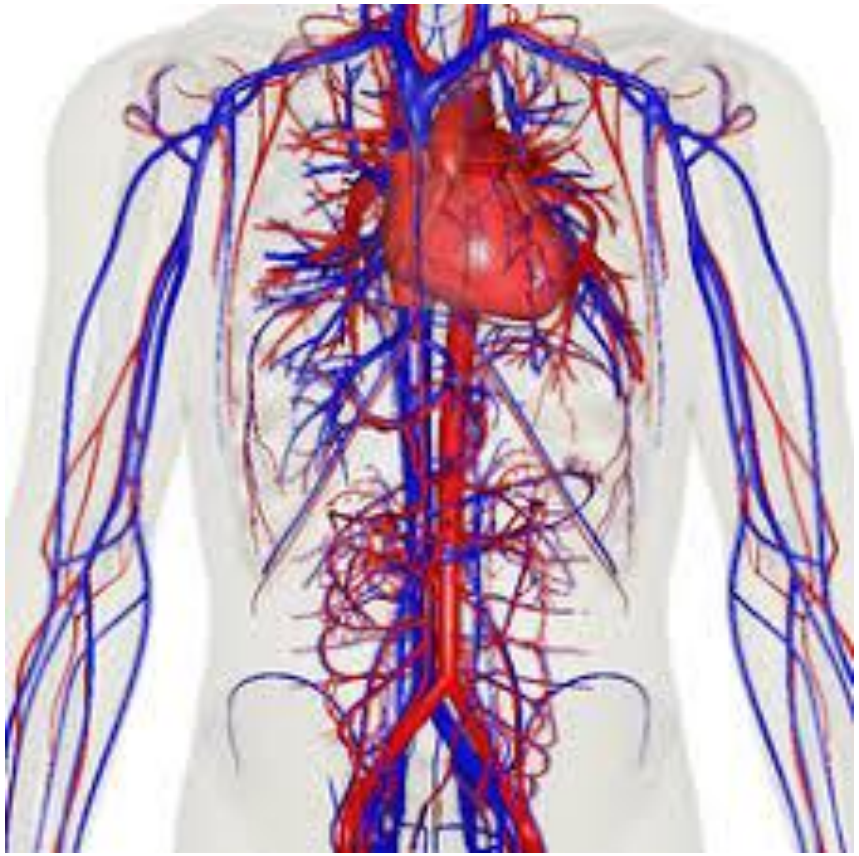
Structure

- 1/ Cardiovascular system
- 2/ Respiratory system
  - Anatomy
  - Physiology
  - Relevant medical conditions



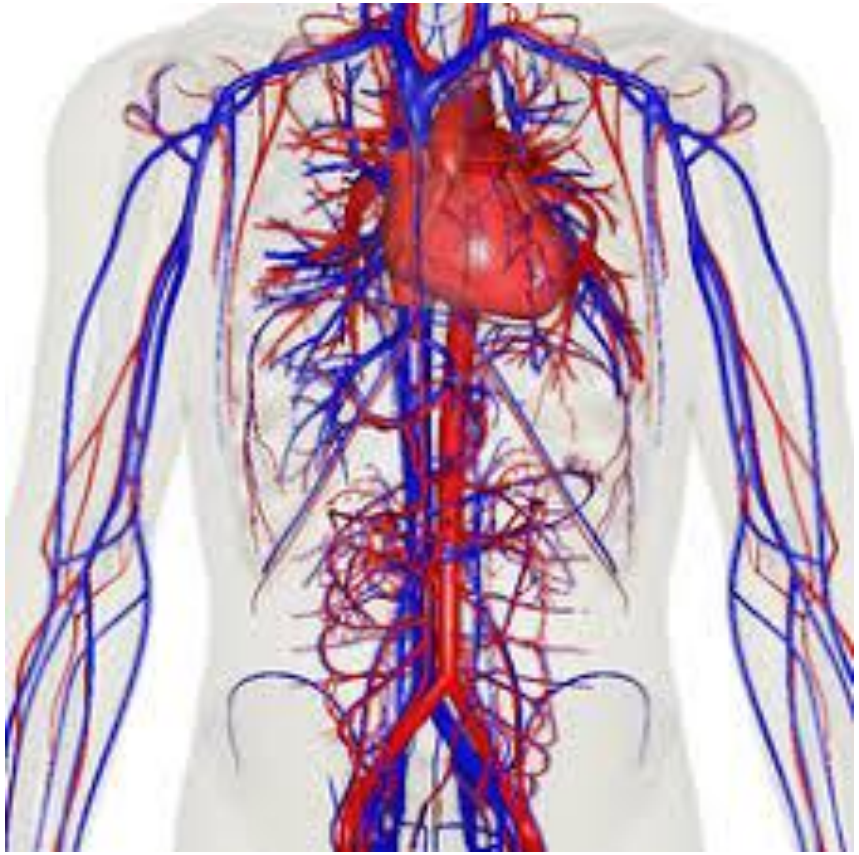
1/ Cardiovascular system: components

- **Heart**
- **Blood vessels**:
  - Arteries
  - Veins
  - Capillaries
- **Blood**



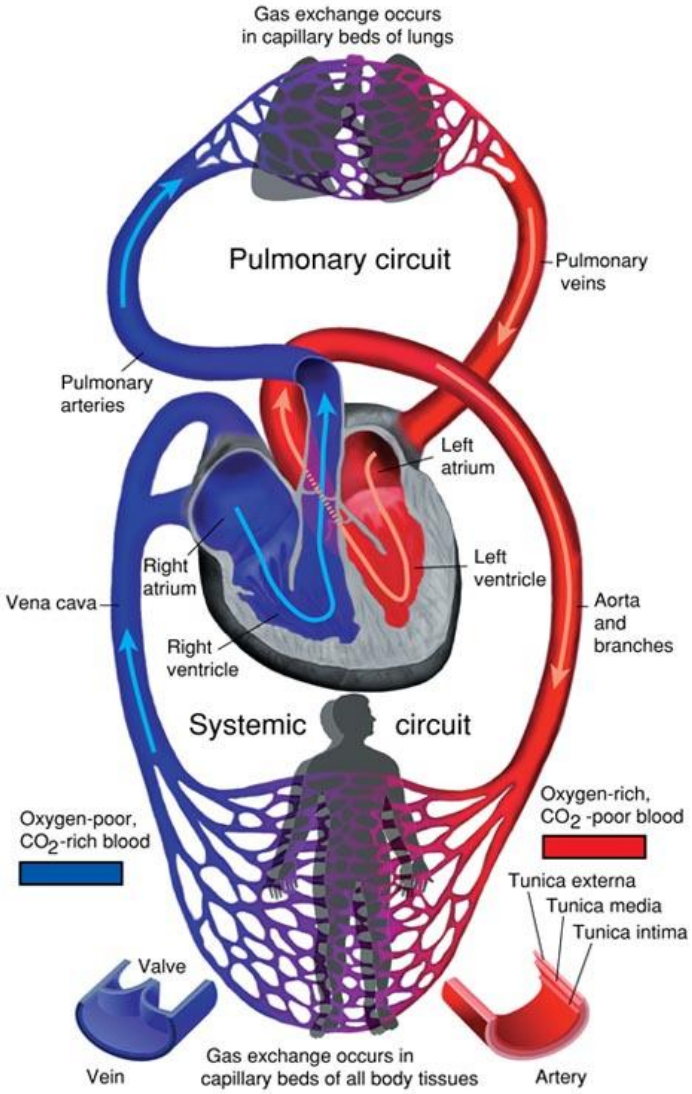
Cardiovascular system: function

- Main role of CVS is to pump blood around the body tissues
- Blood travels away from heart in **arteries**
- Returns to heart in **veins**
- **Capillaries** connect arteries and veins



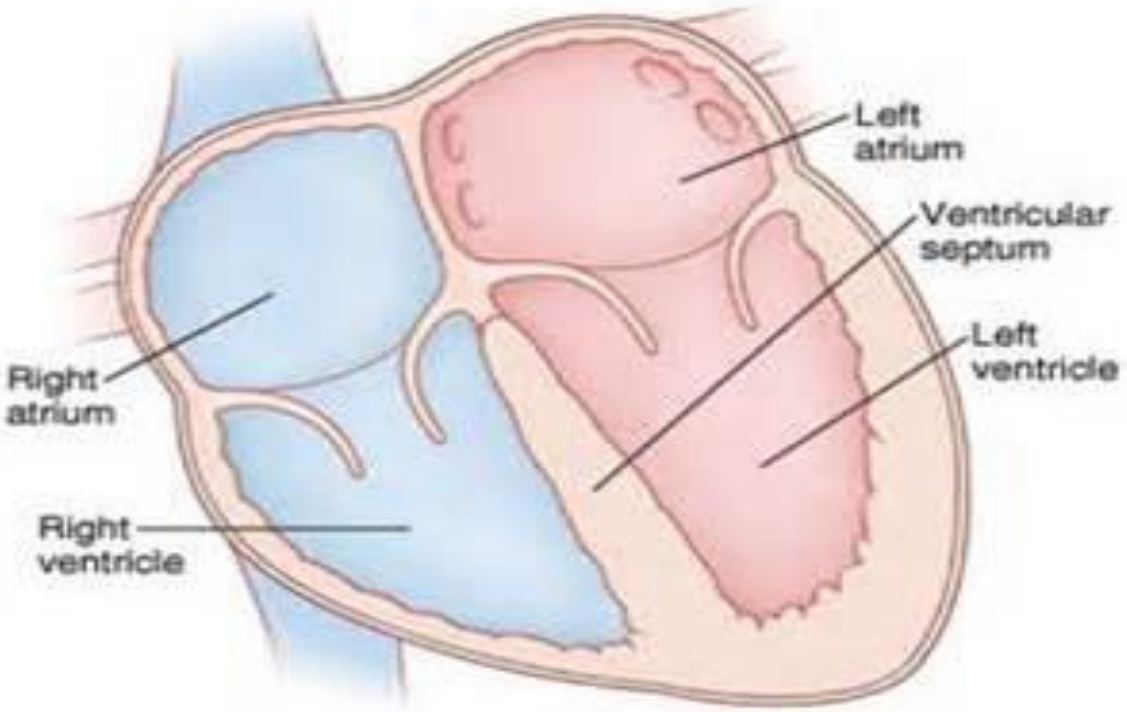
Overview of the circulatory system

- Heart is a basically 2 pumps side by side
- **Right side** pumps blood to the lungs
- **Left side** pumps blood around the body



Structure of the heart

- 4 chambers
- 2 **atria** (singular: atrium)
- 2 **ventricles**
- Right and left sides

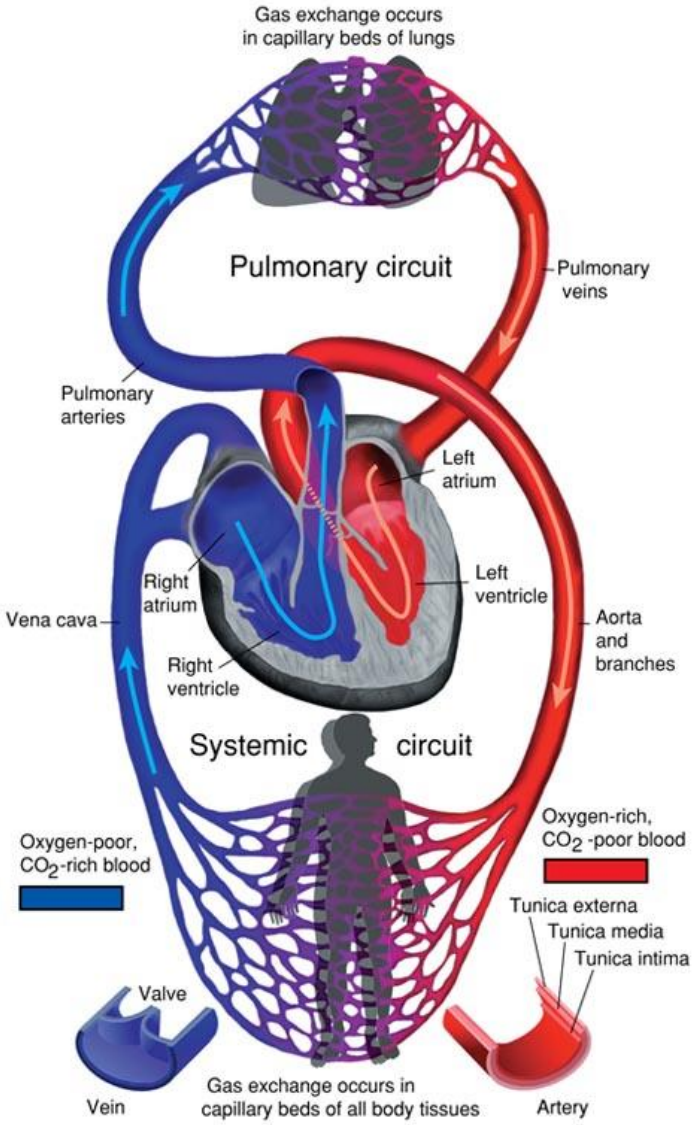


Pathway of blood through heart

- Blood pumped from atrium to ventricle on both sides
- **A → V**

- From right ventricle pumped to lungs (“**pulmonary circulation**”) to be oxygenated

- From left ventricle to rest of body via **aorta**

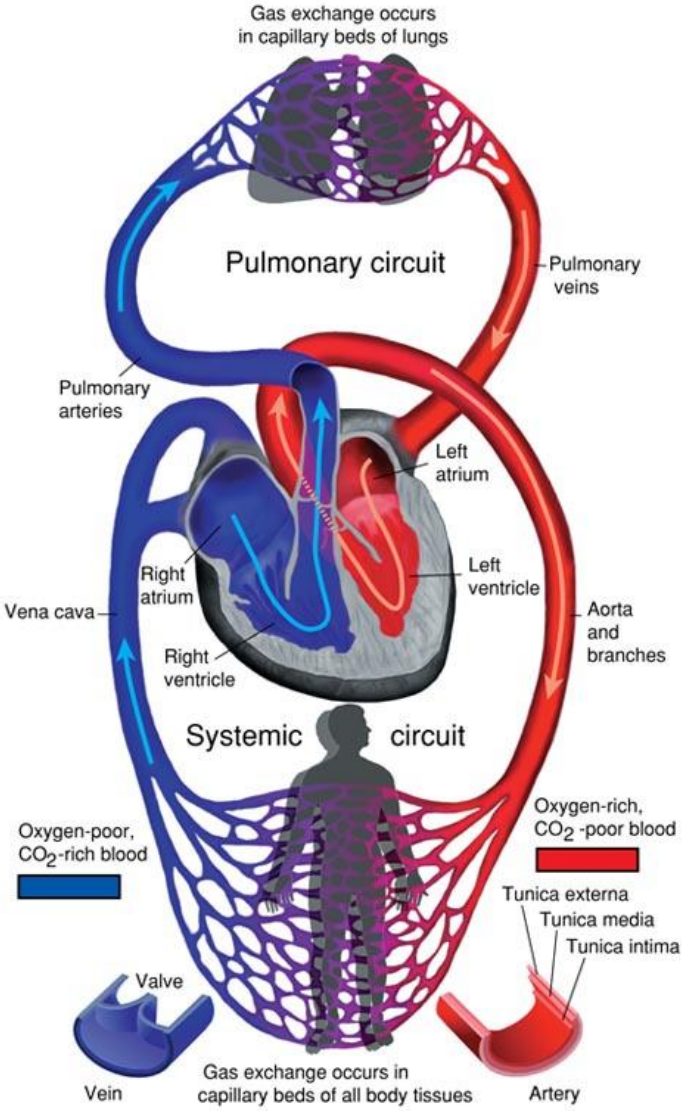


Pathway of blood through heart

- Blood is pumped from the left ventricle to the **aorta** (largest artery in body), and from here to the rest of the body

- Blood returns deoxygenated to the right atrium, via the **superior vena cava** and **inferior vena cava** (largest veins in body)

- (note position of IVC on right side of body: relevance?)



Cardiac cycle and Blood Pressure

- **Systole**:
  - atria contract, then…
  - ventricles contract
- **Diastole**:
  - relaxation
- **Blood pressure**
  - e.g. 120 / 80 mmHg
  - systolic / diastolic

Blood Pressure

- **Hypertension (high blood pressure):**
  - >140/90

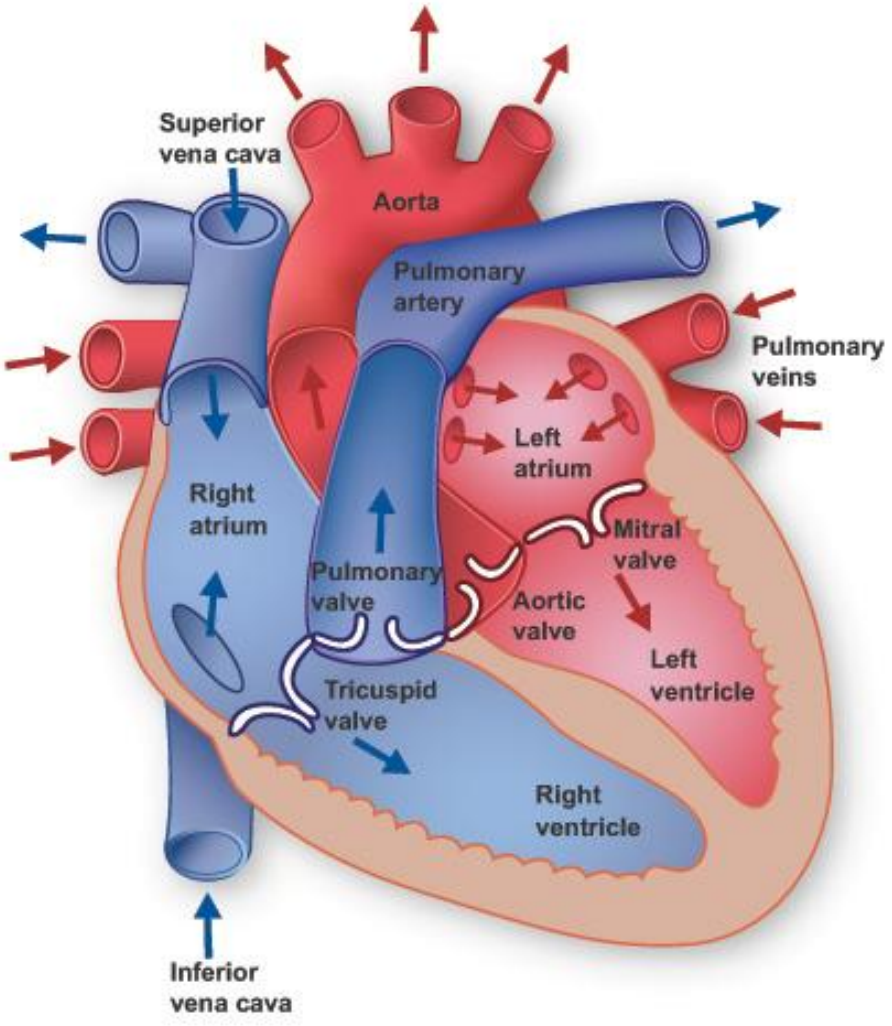
  (if aged under 80 years old)

- **Hypotension (Low Blood Pressure):**
  - < 90/60

- Some variations in these, depending on age, and circumstances e.g. lower threshold if “ambulatory” or self-monitored

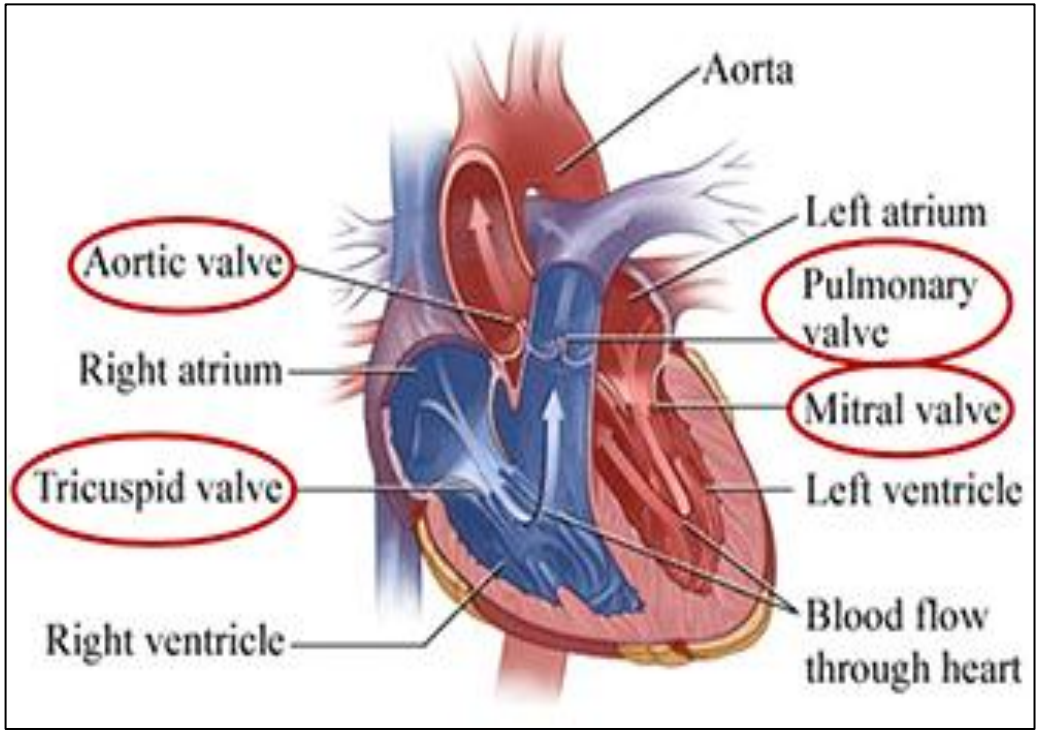
Internal structure of the heart

- The heart has:
  - Muscle (pumping)
  - Electrical circuitry (control of rate of pumping)
  - Valves between chambers (to prevent backflow)
  - Its own arteries and veins
- Diseases can affect any of these



Heart Valves

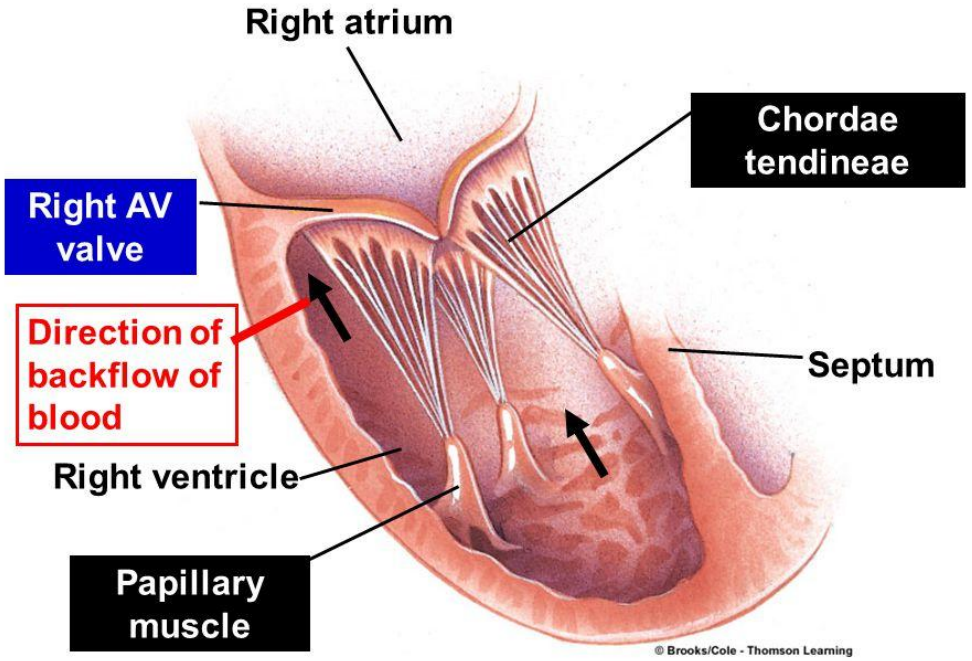
- Semi-rigid structures:
  - between 2 chambers
  - between chamber & artery
- Prevent backflow when a chamber contracts



Heart Valves

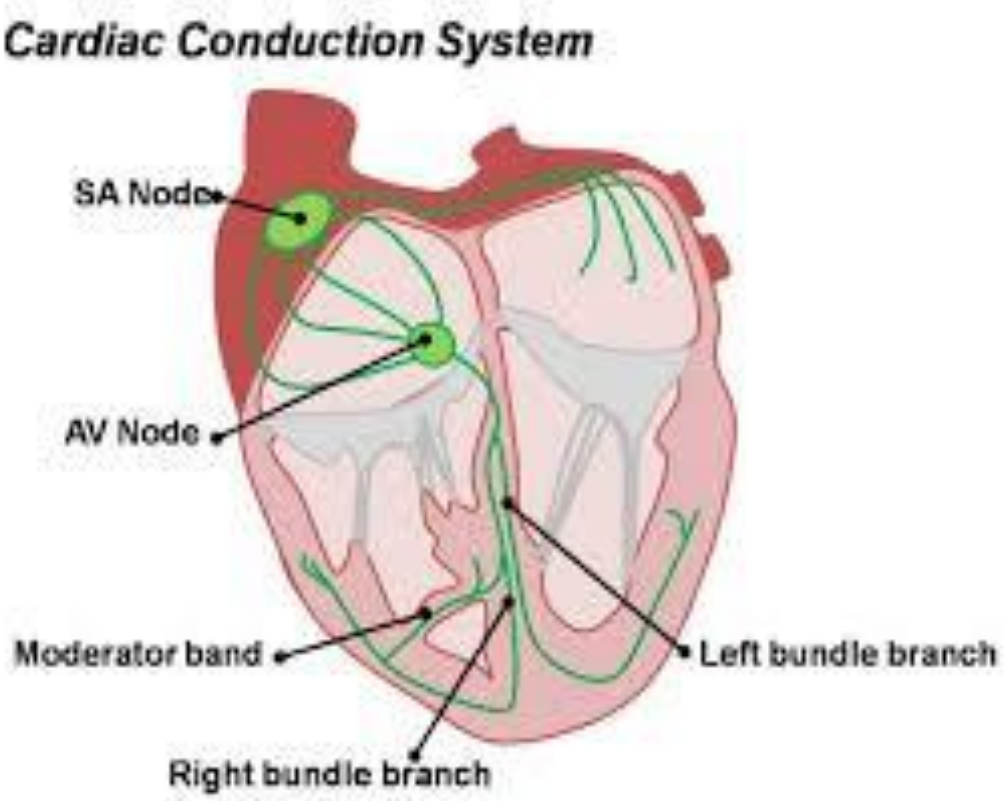
- Atrio-ventricular valves attached to fibrous cords to prevent them turning “inside out”

- Disease:
  - Stenosis
  - Incompetence
  - Infective endocarditis



Conducting system: coordinated contraction

- **Sino-Atrial (SA) node:** in wall of right atrium
- **Atrio-Ventricular (AV node):** between 2 atria
- Bundle branches
- Purkinje fibres
- Affected by :
  - demands (e.g. exercise)
  - other nerves (e.g. vagus)
  - hormones (e.g. adrenaline)

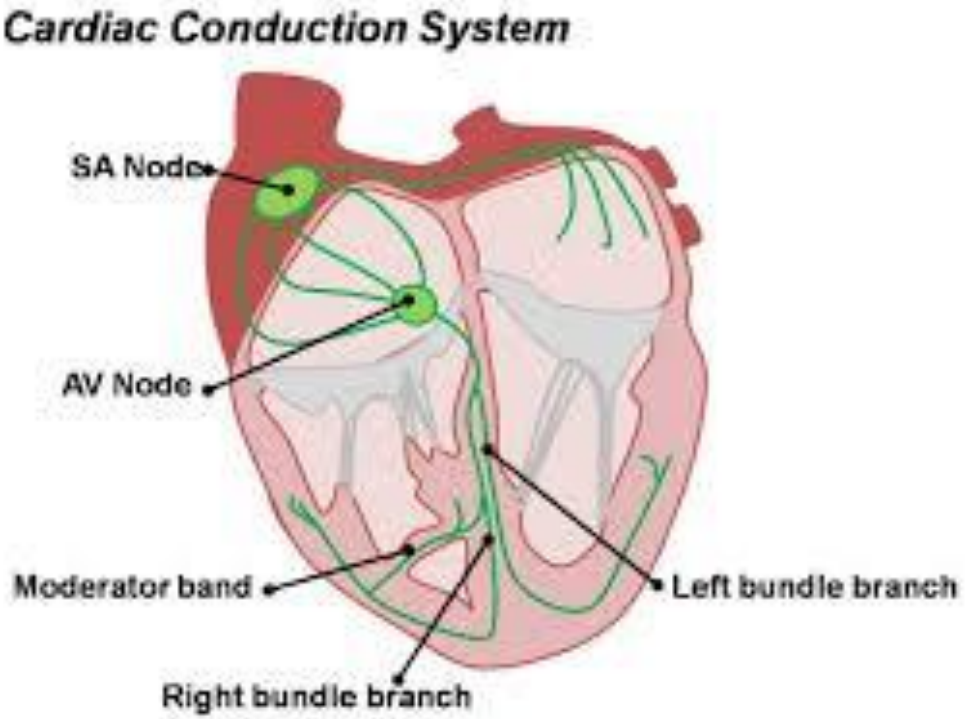


Heart rate / Pulse

- Normally 60-100 beats per minute at rest

- Below 60: Bradycardia
- - may be normal in very fit athletes

- Above 100: Tachycardia
- -may be normal with anxiety, pain or exercise



Measuring Pulse

- Pulse is felt as a function of heart rate
- e.g. Radial Pulse in the wrist on the thumb side
- Use of pulse oximeter

Heart Contractions

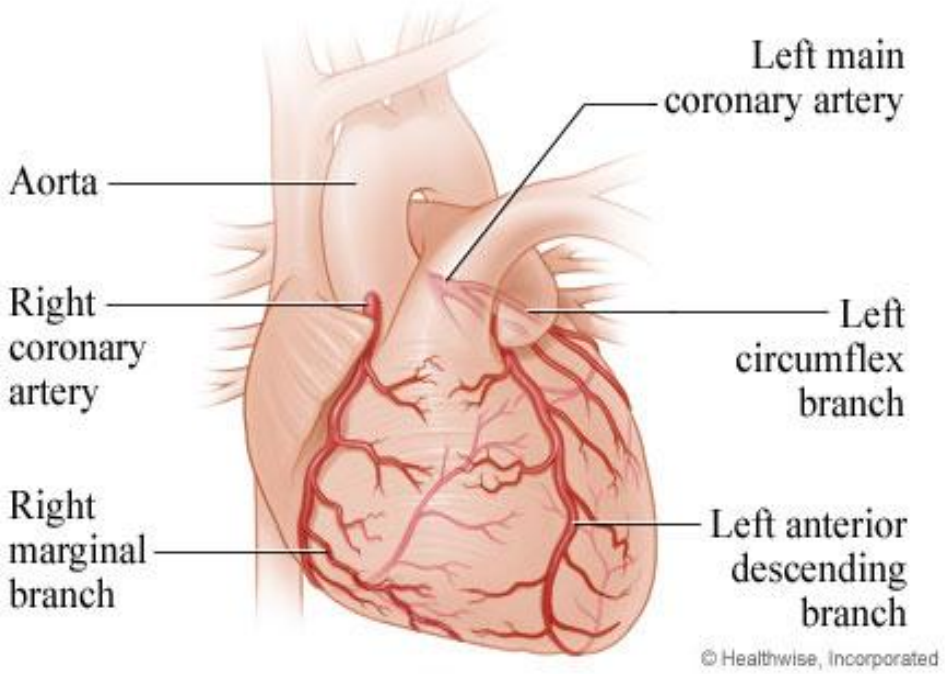
- Normal electrical activity and coordinated contractions is called **Sinus Rhythm**

- Measured with an ECG

Arterial supply to the heart

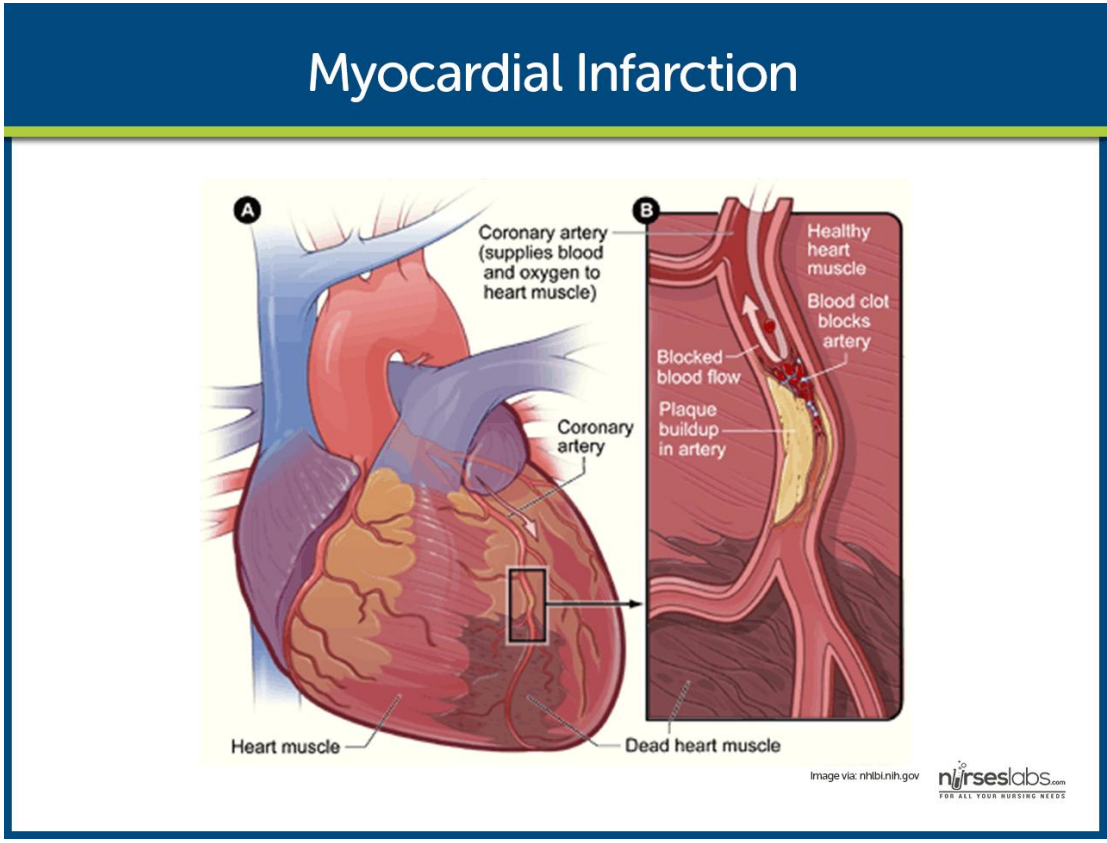
- Heart muscle pumps continuously and uses a lot of oxygen

- **Coronary arteries** supply heart muscle
- Equivalent veins empty into right atrium



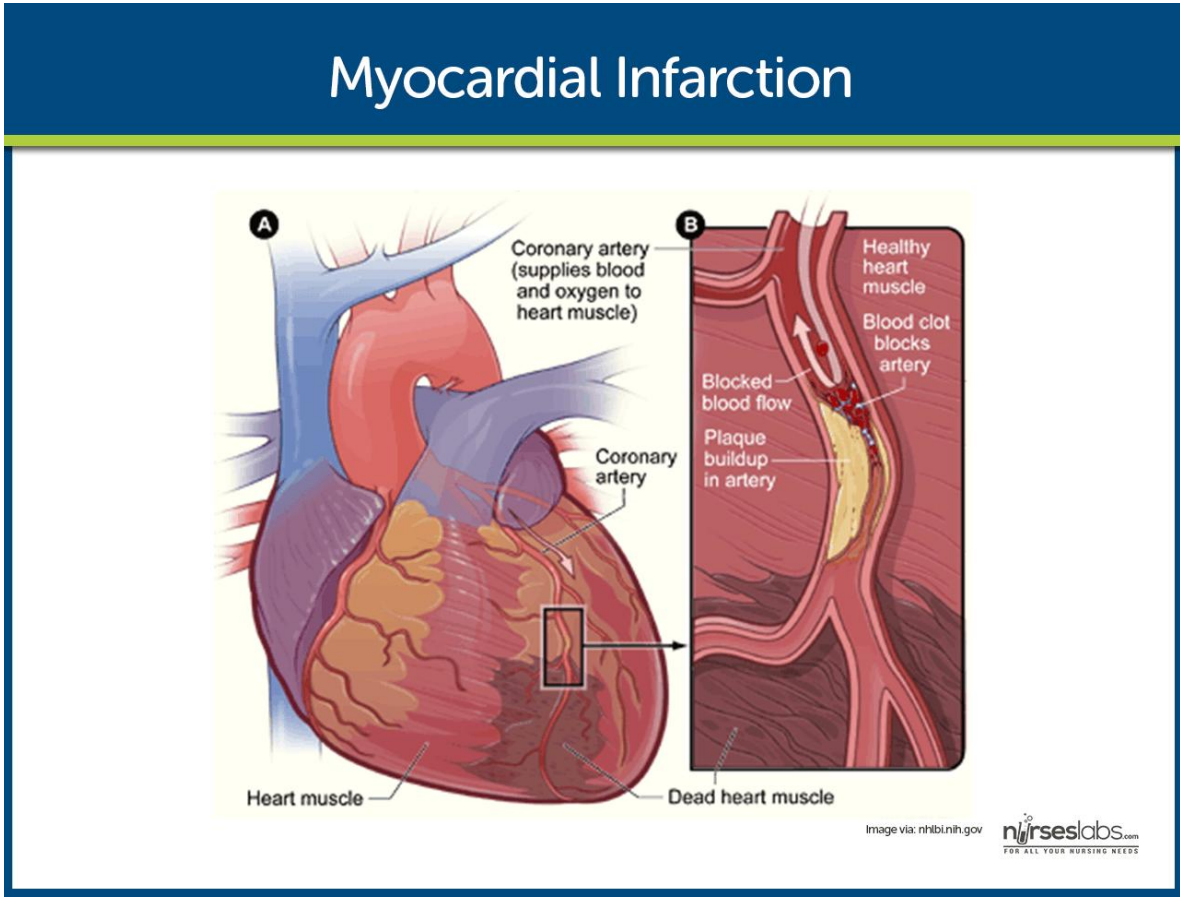
Disorders: Angina

- Narrowing in coronary arteries
- Due to fatty deposits in vessels (**atherosclerosis**)
- Reduced oxygen to heart muscle
- Pain usually on exertion (stable), sometimes randomly (unstable)



Disorder: Myocardial infarction ("Heart Attack")

- Blockage of coronary arteries
- Muscle death due to lack of oxygen
- Leads to acute heart failure (cardiac arrest) and often fatal



Drugs used in heart disease

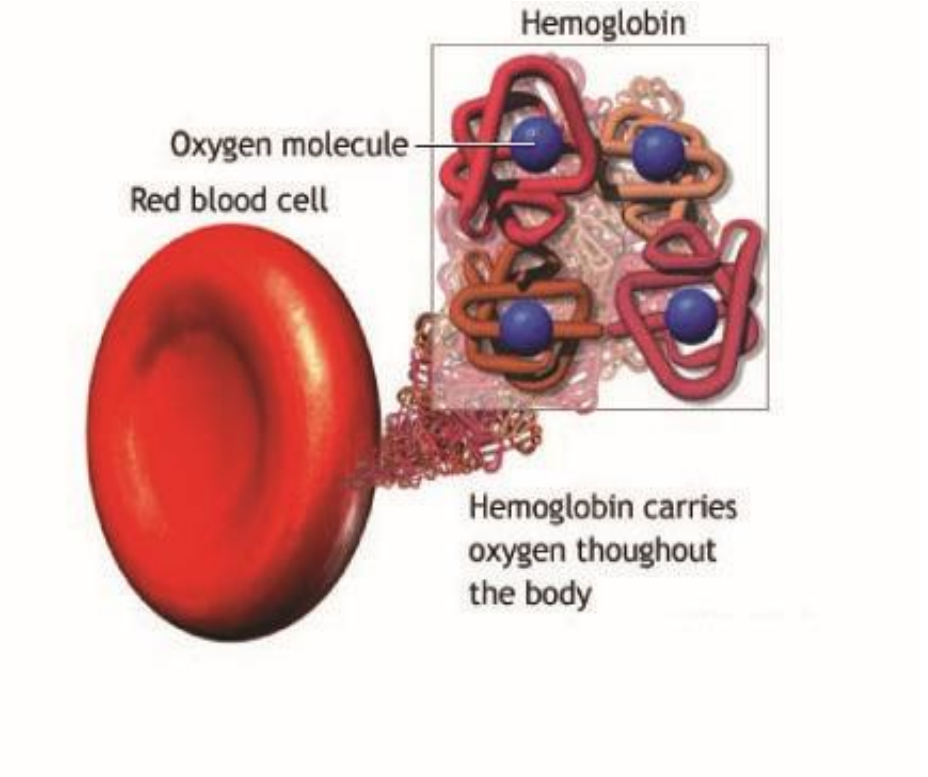
- Many!
- **GTN** – vasodilator- opens up coronary arteries (angina attack)
- **Aspirin** (anti-platelet) – prevents clotting and thrombus propagation

Blood

- **Red blood cells-** carries oxygen
- **White blood cells-** fight infection
- **Platelets** and **clotting factors** – clotting
- **Plasma**- fluid component, contains proteins, glucose, hormones, ions etc

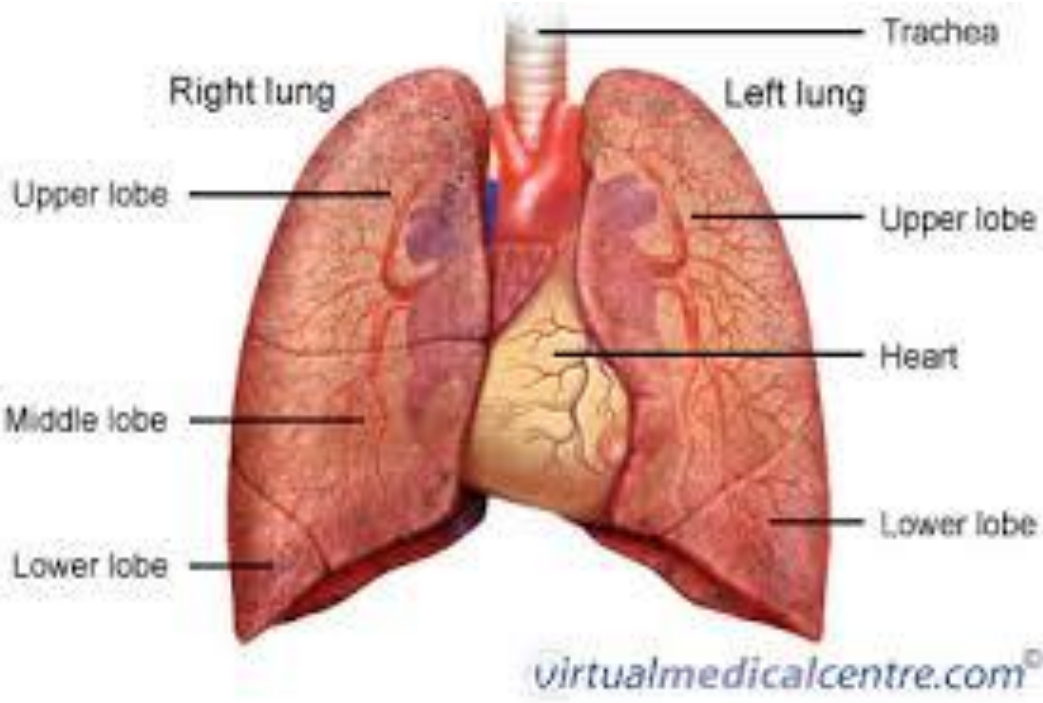
Disorder: Anaemia

- Insufficient **haemoglobin** in blood (protein that carries oxygen)
- Breathless, fast heart rate
- Pallor, fatigue
- Causes include deficiency of iron, folate, B12, or blood loss
- **Caution with IV sedation**
- Pulse oximetry may be inaccurate (usually only severe anaemia)
- N_2O usually ok



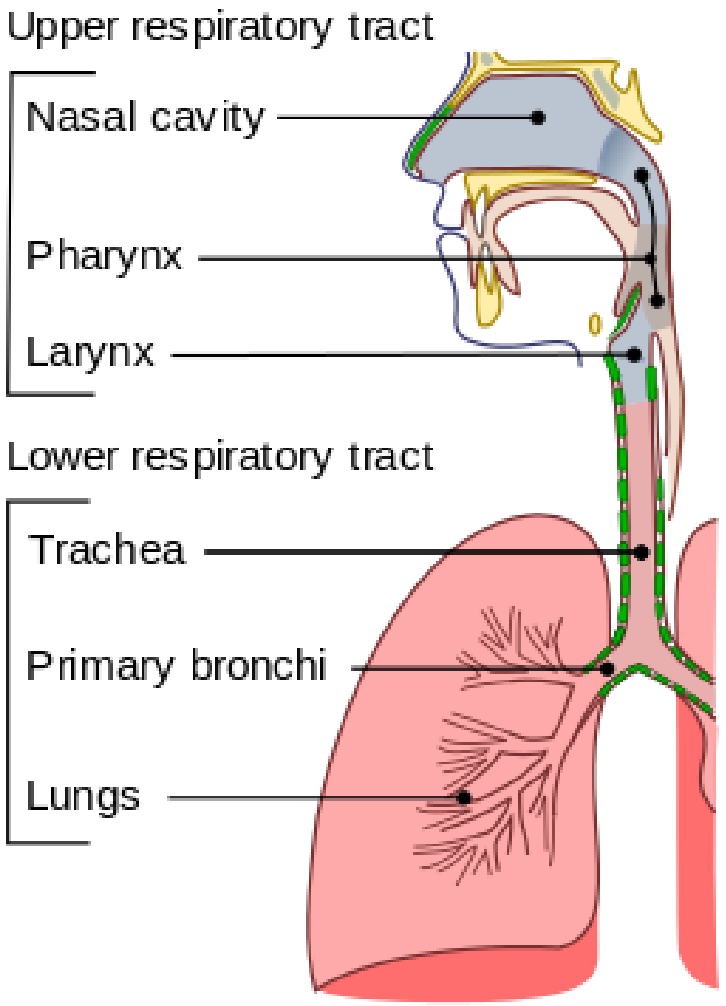
2/ Respiratory System: overview

- **Breathing**- gas exchange between atmosphere and bloodstream
  - uptake of **oxygen** (needed for metabolic activities, e.g. getting energy from food)
  - excretion of **carbon dioxide** (waste product of metabolic reactions)



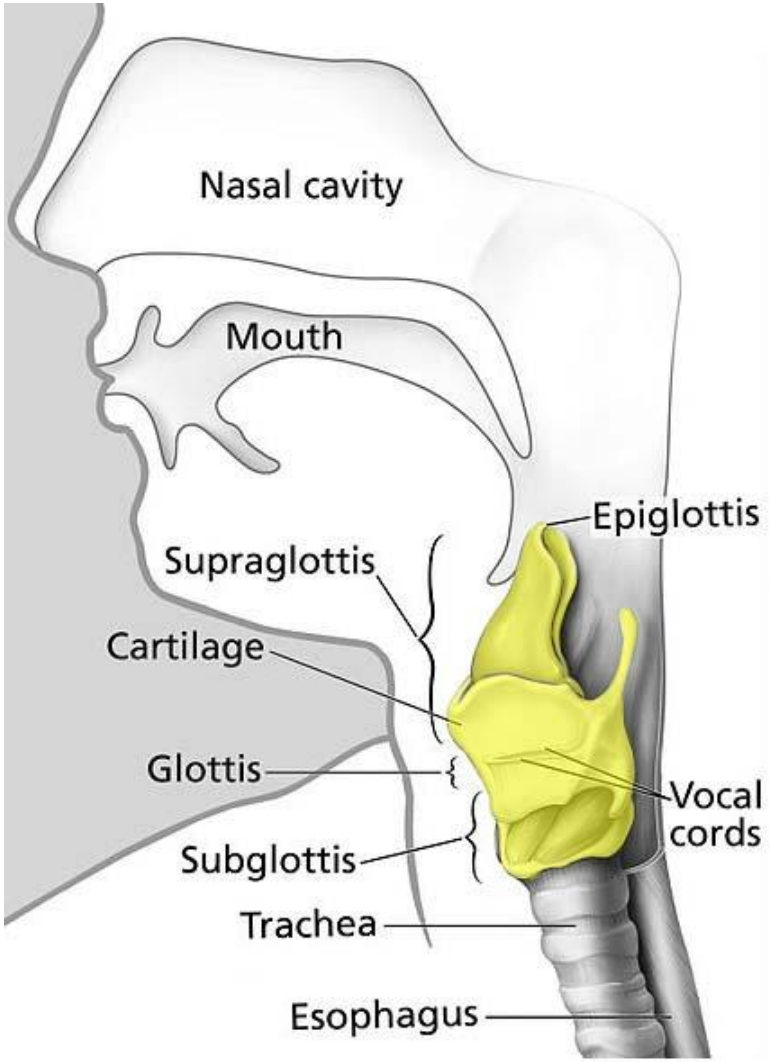
Respiratory system: conducting system

- **Pharynx**
- **Larynx**
- **Trachea** (tube of C-shaped rings of cartilage)
- Divides to a **main bronchus** to each lung
- Divides further within the lung

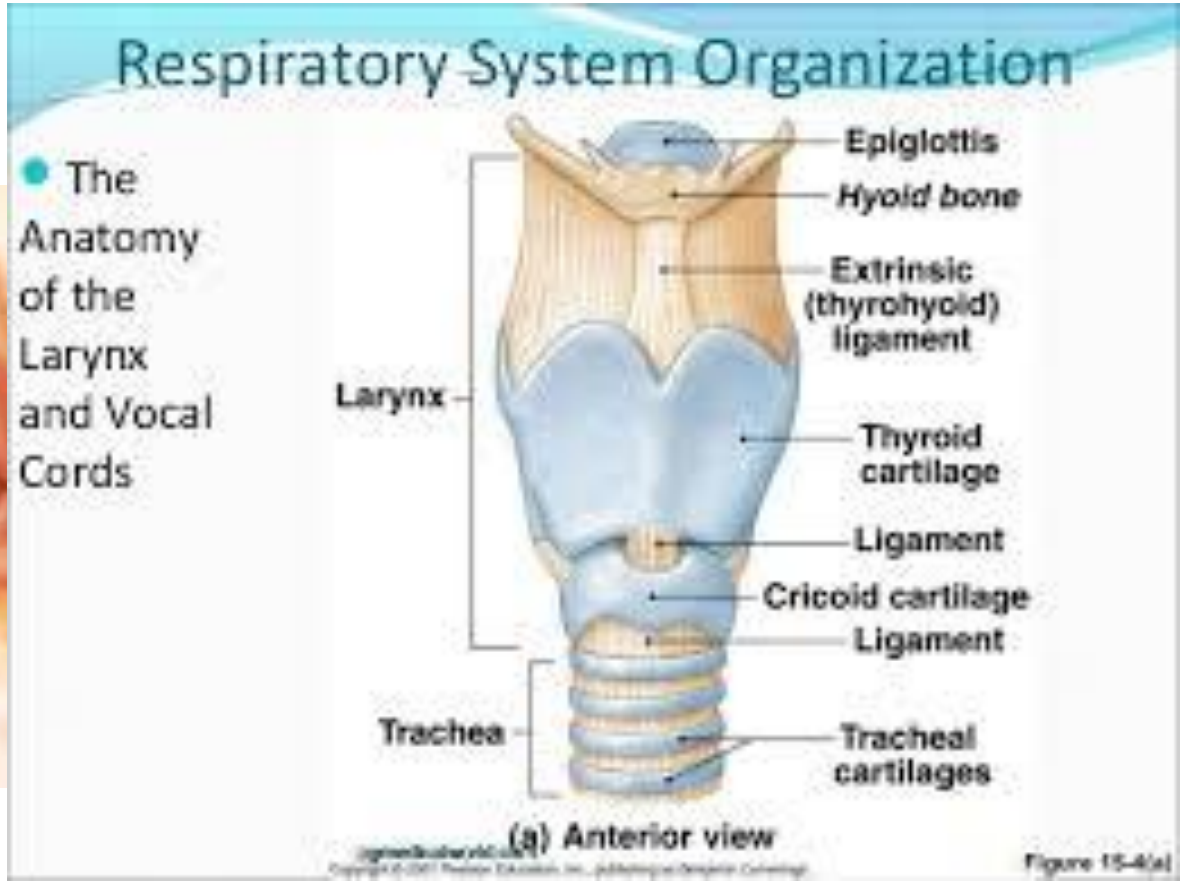


Larynx

- Structure above **trachea**, attached to back of tongue and hyoid bone
- Made of 9 cartilages
- Contains **vocal cords**
- Vocal cords are held open during breathing
- **Epiglottis** covers opening during swallowing
- **Soft palate** closes nasopharynx

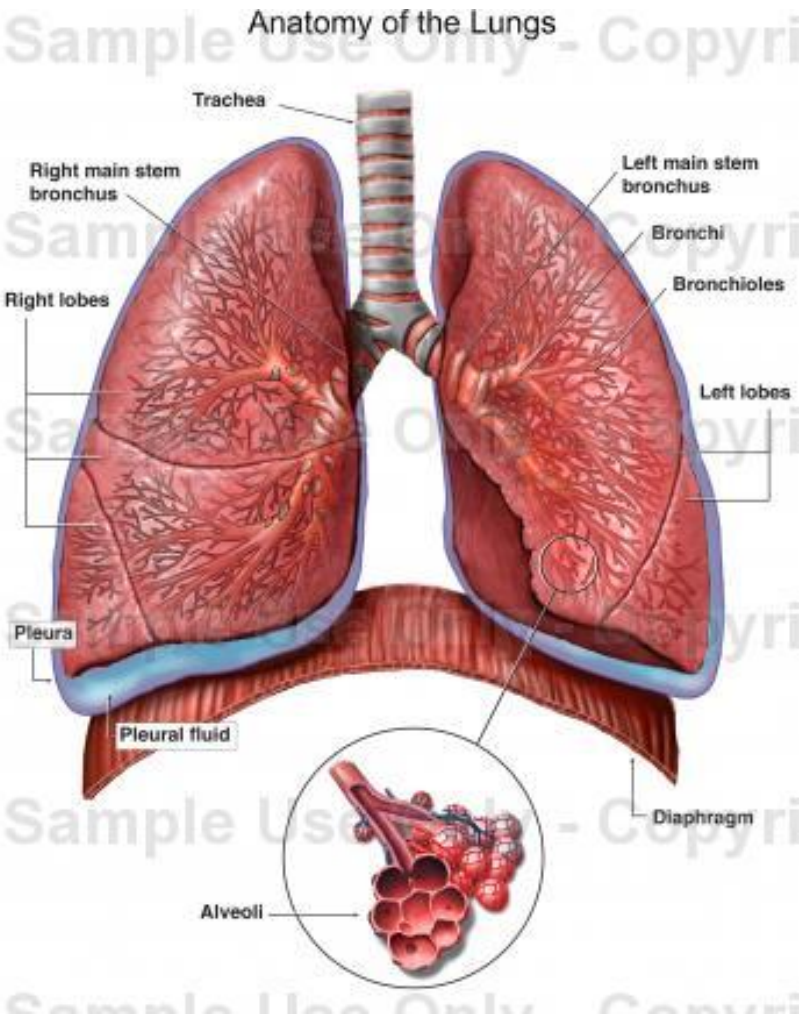


Larynx


Respiratory System Organization
The Anatomy of the Larynx and Vocal Cords
Epiglottis
Hyoid bone
Extrinsic (thyrohyoid) ligament
Larynx
Thyroid cartilage
Ligament
Cricoid cartilage
Ligament
Trachea
Tracheal cartilages
(a) Anterior view
Figure 15-4(a)

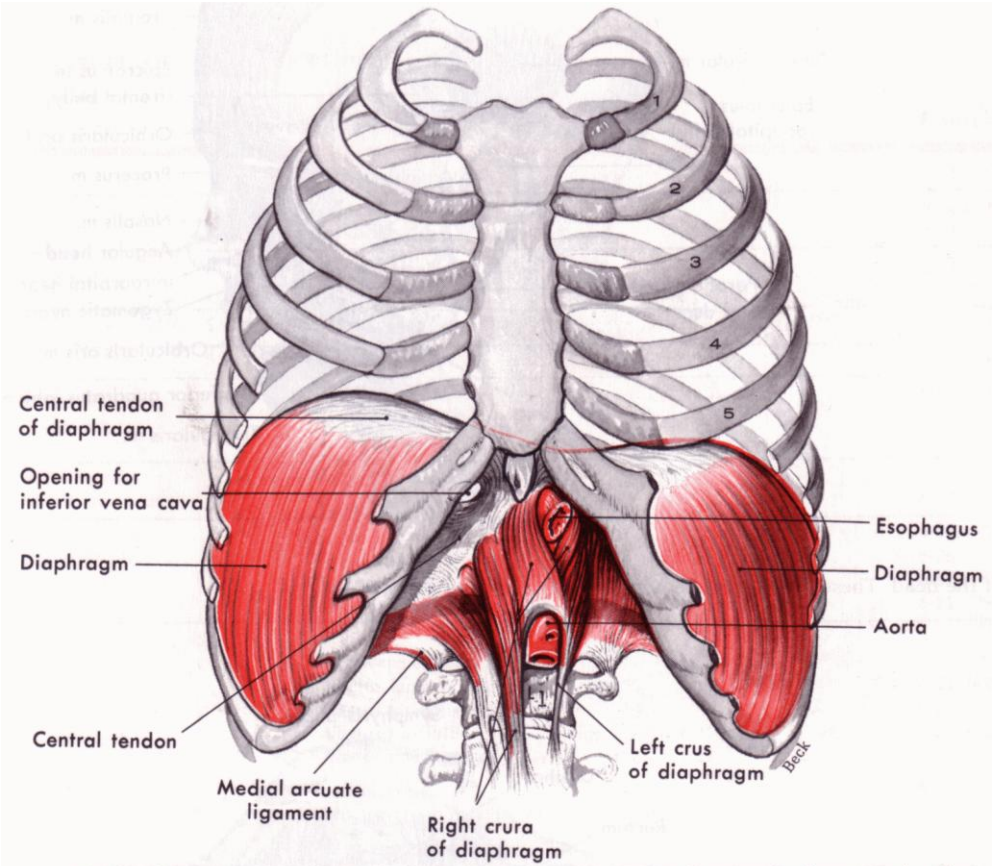
Lungs

- 2 lungs – asymmetrical
- Attached to the inside of the chest wall, under tension, via **pleural membranes** with fluid between
- Movement of chest wall (breathing) mainly due to :
  - **Diaphragm**
  - **Intercostal muscles**



Diaphragm

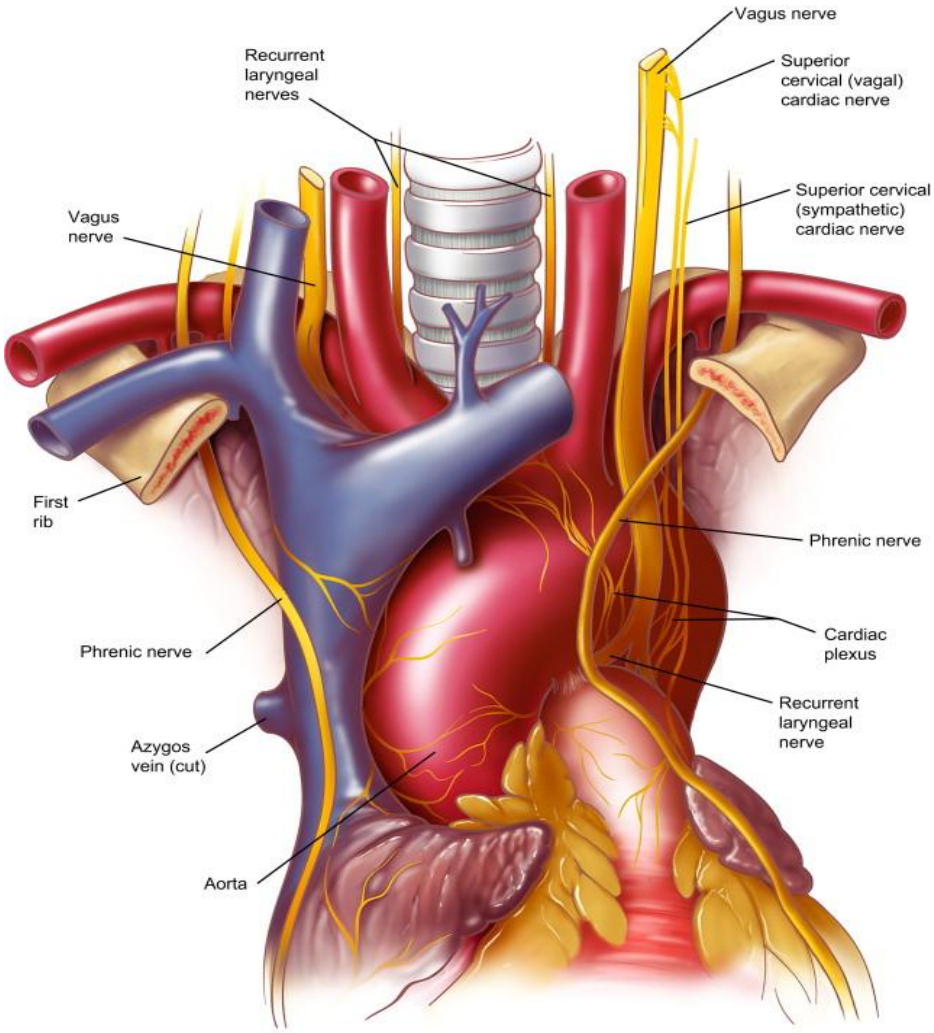
- Muscle separating thorax (chest) from abdomen
- Moves down when contracts
- Increases volume of thorax- air drawn in
- Relaxes passively – air expelled



The diaphragm as seen from the front. Note the openings in the vertebral portion for the inferior vena cava, esophagus, and aorta.

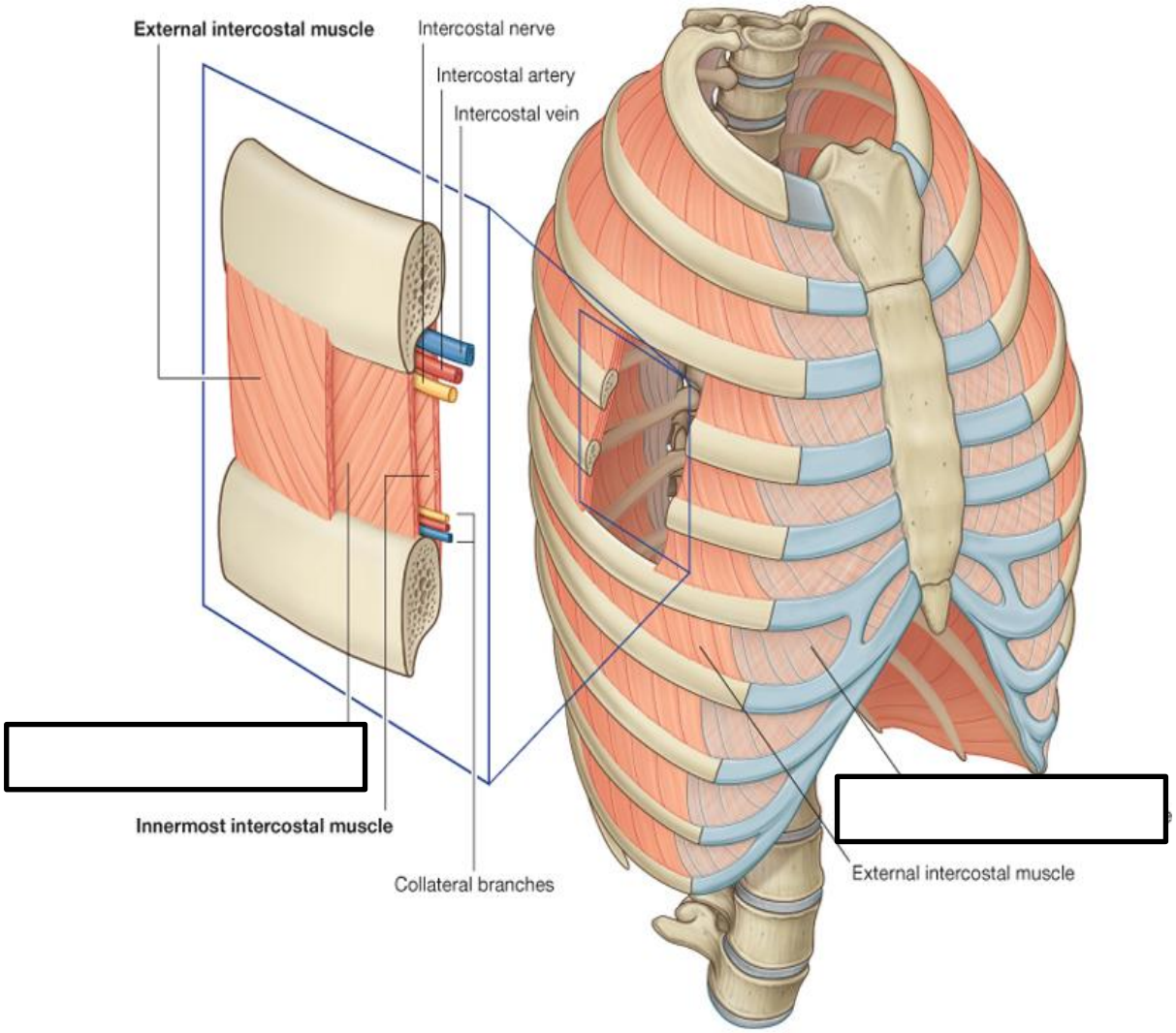
Diaphragm

- Controlled by **Phrenic nerve** from cervical plexus in neck
- Neck injury can therefore affect breathing



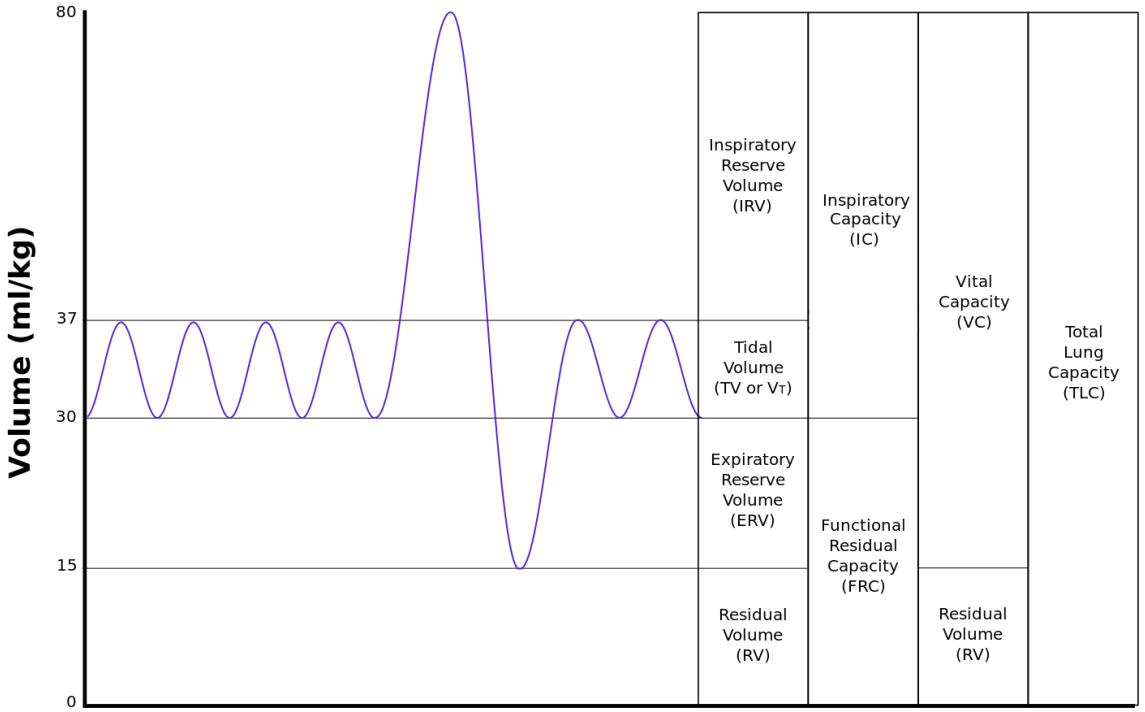
Intercostal Muscles

- 3 muscle layers between ribs
- Involved in breathing in and out
- Forceful breathing



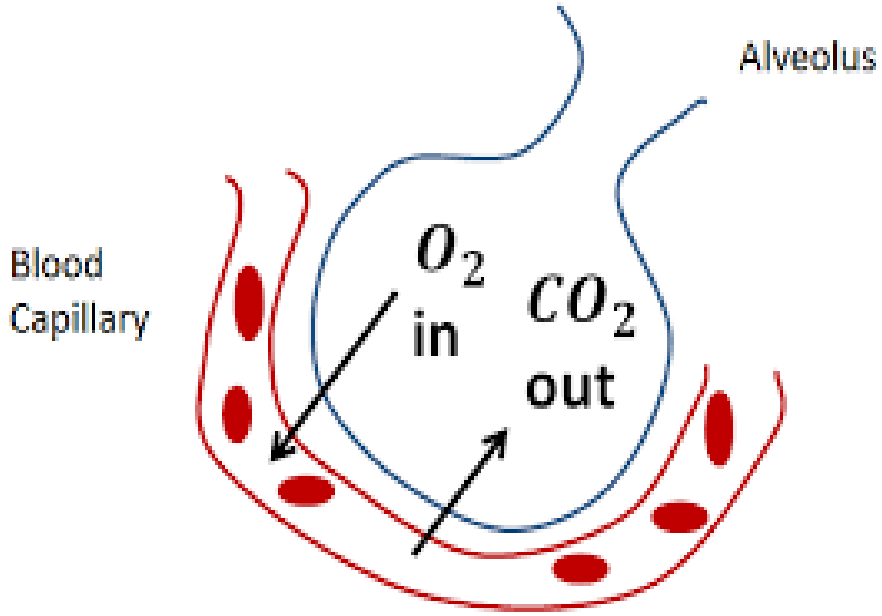
Breathing Volumes

- **Total Lung Capacity:** 5-6 litres
- **Tidal Volume:** volume of air inspired or expired with each passive breath i.e. approx. 500 ml
- **Respiratory rate:** approx. 12 per min
- **Minute Volume:** volume of air inspired or expired in a minute e.g. 500 ml x 12 = 6000 ml (6 litres) at rest



Reason for breathing: Gas exchange

- Conducting tubules repeatedly divide, and eventually end in thin-walled sacs ("**alveoli**")
- These are surrounded by fine blood vessels
- Gas exchange across this thin wall

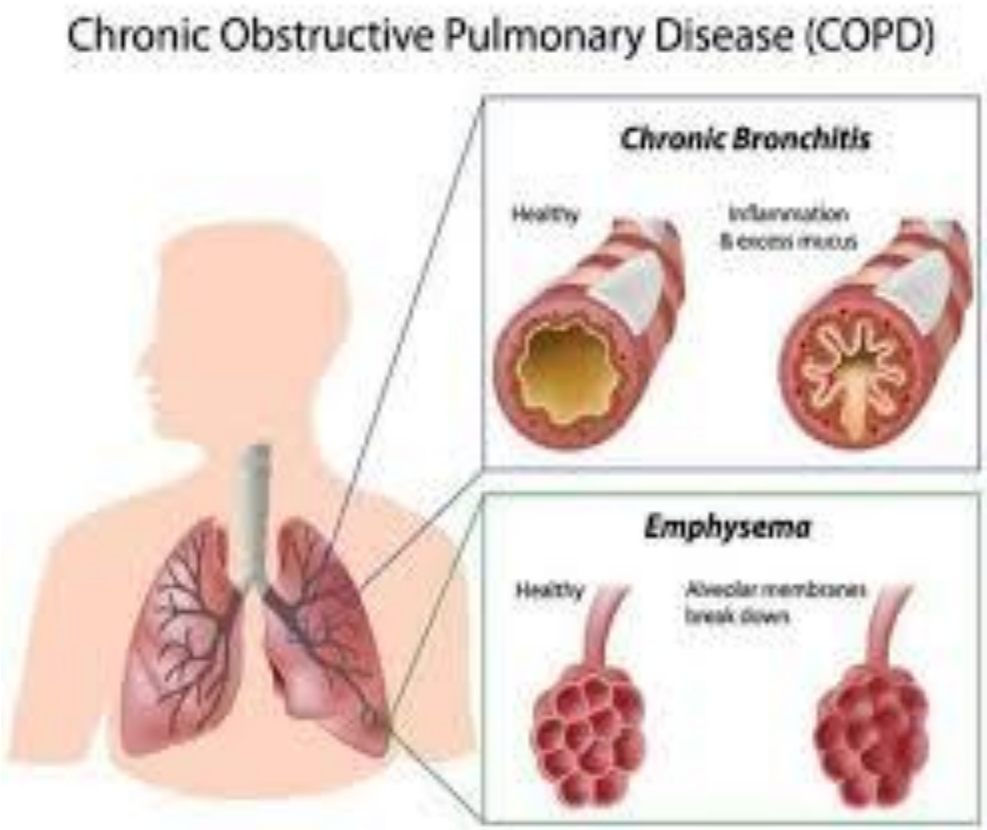


Gas proportions in Inspired and Expired Air

Gas	Inspired air (%)	Expired air (%)
Nitrogen	79	79
Oxygen	21	16
Carbon dioxide	0.04	4
Water vapour	Variable	Saturated

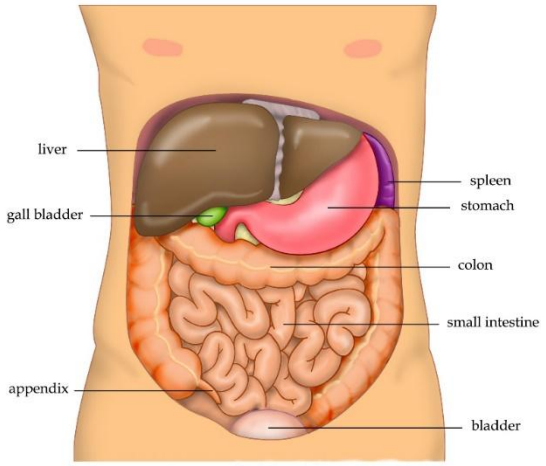
Disorder: Chronic Obstructive Pulmonary Disease (COPD)

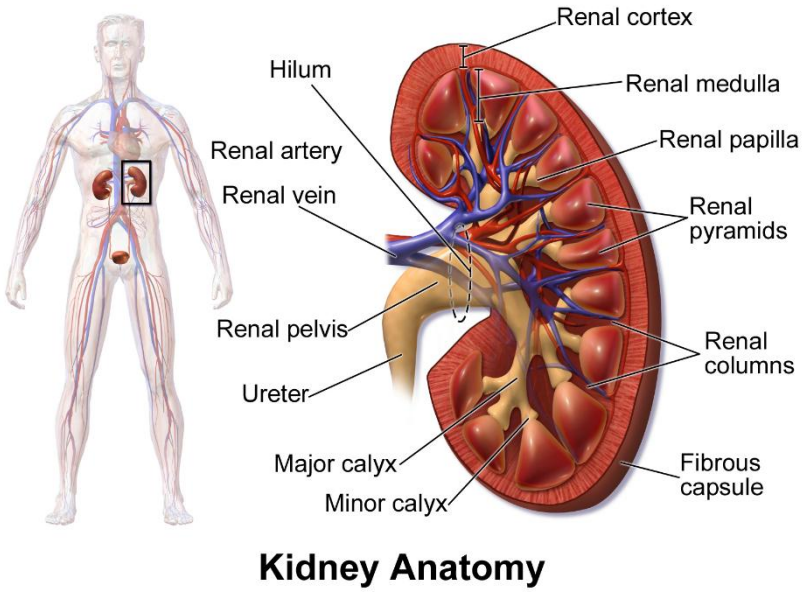
- General term for a variety of progressive lung diseases:
  - chronic bronchitis
  - emphysema
- Dental Treatment:
  - position in chair
  - drugs – inhalers, steroids
  - IV sedation contra-indicated



Other organ systems of relevance

- Liver: site of most drug metabolism, including midazolam
- Kidney: site of much drug excretion, including midazolam
- Generally avoid IV sedation in significant liver or kidney disease





Kidney Anatomy

References

- https://www.webmd.com/heart/anatomy-picture-of-blood
- http://www.flspinalcord.us/gas-exchange-in-alveoli/gas-exchange-in-alveoli-gas-exchange-across-respiratory-surfaces-boundless-biology/#s
- https://www.ncbi.nlm.nih.gov/pubmedhealth/PMHT0022080/
- https://igcseaid.com/notes/coordinated-science-0654/b6-2-gas-exchange/