

## Anatomy and Physiology of Cardiovascular and Respiratory System

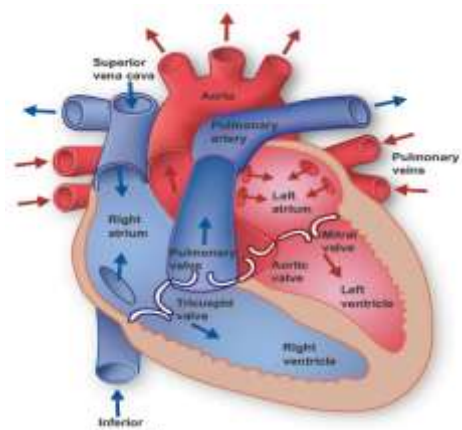
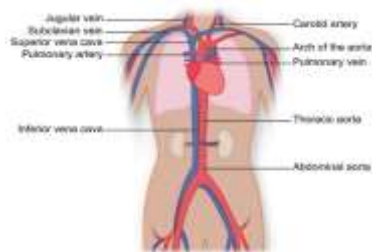
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### Cardiovascular System

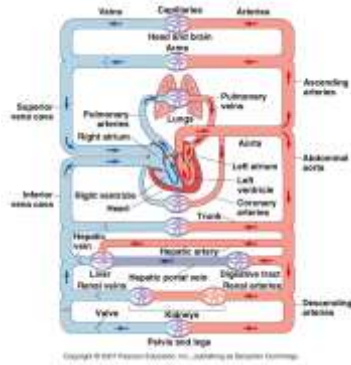
3 components:

- Heart
- Blood vessels
- Blood

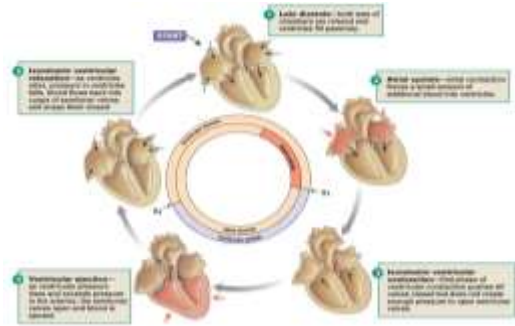
### Anatomy of the Heart



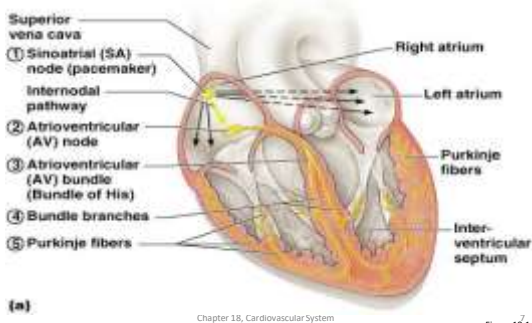
## Circulation Review



## Cardiac cycle



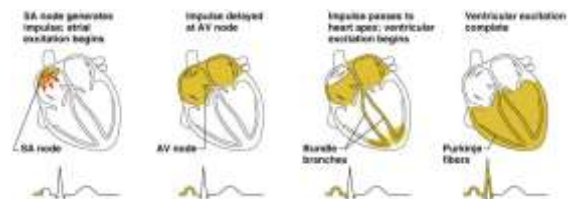
## The Conduction system



Chapter 18, Cardiovascular System

Figure 18.14a

## Heart Excitation Related to ECG



## Anatomy of Respiratory System



## Respiration

Respiration is the act of breathing:

- inhaling (inspiration) - taking in oxygen
- exhaling (expiration) - giving off carbon dioxide

## Respiratory system

The respiratory system is made up of the organs involved in breathing and consists of the:

- nose
- pharynx
- larynx
- trachea
- bronchi
- lungs

## Upper respiratory tract

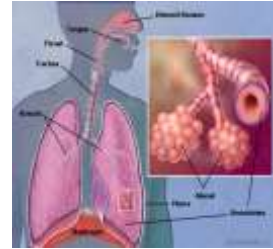
- nose
- nasal cavity
- ethmoidal air cells
- frontal sinuses
- maxillary sinus
- larynx
- trachea

## Lower respiratory tract

- lungs
- bronchi
- alveoli

The lungs are separated from each other by the **mediastinum**, an area that contains the following:

- heart and its large vessels
- trachea (windpipe)
- esophagus
- thymus
- lymph nodes



## Anatomy

The right lung has three sections, called **lobes**. The left lung has two lobes. When we breathe, the air:

- enters the body through the nose or the mouth
- travels down the throat through the **larynx** (voice box) and **trachea** (windpipe)
- goes into the lungs through tubes called main-stem **bronchi**
  - one main-stem bronchus leads to the right lung and one to the left lung
  - in the lungs, the main-stem bronchi divide into **smaller bronchi**
  - and then into even smaller tubes called **bronchioles**
  - bronchioles end in tiny air sacs called **alveoli**

## Respiration

- Inspiration
  - Active process – by muscular action
    - Contraction of diaphragm
      - Increase in vertical diameter
    - Contraction of intercostals muscles
      - Elevation of ribs and sternum
      - Increase in antero-posterior and transverse diameter
    - Expansion of lungs due to negative pressure
      - Air drawn inwards
- Expiration
  - Passive process
  - Elastic recoil of the lungs due to Relaxation of diaphragm and inter costal muscle.
  - Positive pressure created in lungs
  - Internal intercostals, rectus abdominus, transverse abdominus, internal and external oblique.
- Control of Respiration
  - Control of Inspiration and Expiration by medulla oblongata

## Lung Volumes

- The volume of air normally exhaled or inhaled with each breath during quiet breathing is called TIDAL VOLUME. (500ml)
- The additional volume of air that can be taken into the lungs beyond the normal tidal inhalation is called INSPIRATORY RESERVE VOLUME (3000ml)
- The additional volume of air that can be let out beyond the normal tidal exhalation is called EXPIRATORY RESERVE VOLUME (1100)
- The volume of air that remains in the lungs after a forceful expiratory effort is called RESIDUAL VOLUME (1200ml)

## Lung Capacities

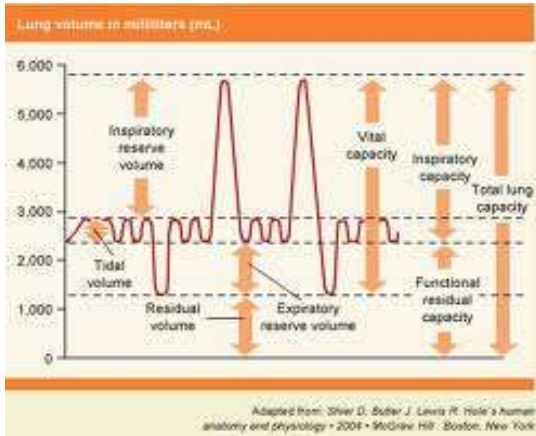
- The INSPIRATORY CAPACITY is the maximum amount of air that can be inhaled after a normal tidal exhalation (TV + IRV) (3500ml)
- FUNCTIONAL RESIDUAL CAPACITY is the amount of air remaining in the lungs at the end of normal tidal exhalation (ERV +RV) (2300ml)
- VITAL CPACITY is the maximum amount of air that can b e exhaled, following a maximum inhalation (IRV+TV+ERV) (4600ml)
- TOTAL LUNG CAPACITY is the sum of all the pulmonary volumes (5800ml)

### Pulmonary Volumes:

- Tidal volume 500ml
- Inspiratory reserve volume 3000ml
- Expiratory reserve volume 1100ml
- Residual volume 1200ml

### Pulmonary capacities:

- Inspiratory reserve capacity : 3500ml
- Vital capacity : 4600ml
- Functional residual capacity : 2300ml
- Total lung capacity : 6000ml



## Dead Spaces

- Some of the air the person breathes never reaches the gas exchange areas but simply fills respiratory passages where gas exchange does not occur, such as the nose, pharynx, and trachea.
- This air is called dead space air because it is not useful for gas exchange.
- The normal dead space air in a young adult man is about 150ml. This increases slightly with age.

## Ventilation

Exchange of air between the lungs and the ambient air

- Tidal volume is 500ml
- Breathing frequency 15<sup>th</sup> breaths/ min
- Total ventilation 7500ml/min
- Anatomical dead space 150ml
- Total ventilation 5250ml/min

- Analysis of gases in respiration

	O <sub>2</sub>	N <sub>2</sub>	CO <sub>2</sub>
Inspired air	21%	79%	-
Exhaled air	16%	79%	5%

## Lung Compliance

The extent to which the lungs will expand for each unit increase in transpulmonary pressure is called the lung compliance.

(transpulmonary pressure: difference between alveolar pressure and pleural pressure)

- Lung compliance: expandibility of lungs
- Lung elastic recoil: tends to collapse

## Surface Tension

- Surfactant is fluid present in alveoli excreted by alveolar type 2 epithelial cells.
- is a complex mixture of several phospholipids, proteins and ions.
- The most important components are phospholipid dipalmitoyl phosphatidyl choline, surfactant apoproteins and calcium ions.
- Increases lung compliance, prevents collapse of alveoli and decreases the work of breathing.

## Diffusion

- The passive tendency of molecules to move from an area of high concentration to an area of lower concentration
- Responsible for the passage of oxygen and carbon dioxide between the alveoli and pulmonary capillary blood.

## Oxygen Transport

Oxygen diffuses through the pulmonary alveolar capillary membrane and is then carried to the tissues in two forms:

1. Physically dissolve in plasma
2. Chemically bound to hemoglobin

## Carbon Dioxide Transport

Carbon dioxide diffuses through the tissue capillary membrane and is often carried to the lungs in three forms:

1. Physically dissolved
2. Bound to proteins as carbamino compounds
3. In bicarbonate form

## Ventilation -Perfusion

Three criteria must be satisfied

- Alveoli must be ventilated,
- Perfused, and
- Ventilation must match perfusion

## Cardiac Output (CO) and Reserve

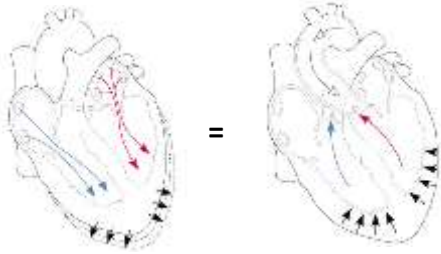
- **Cardiac Output** is the amount of blood pumped by each ventricle in one minute
  - CO is the product of heart rate (HR) and stroke volume (SV)
    - HR is the number of heart beats per minute
    - SV is the amount of blood pumped out by a ventricle with each beat
- **Cardiac reserve** is the difference between resting and maximal CO

## Frank Starling Law of the Heart

- The more cardiac muscle is stretched within physiological limits, the more forcibly it will contract.
- Rubber band analogy
- Increasing volumes of blood in ventricles increase the stretch & thus the force generated by ventricular wall contraction.
- Greater stretch means more blood volume is pumped out, up to physical limits.



## Frank Starling Law of the Heart



Thanks

Increased blood volume = increased stretch of myocardium      Increased force to pump blood out.