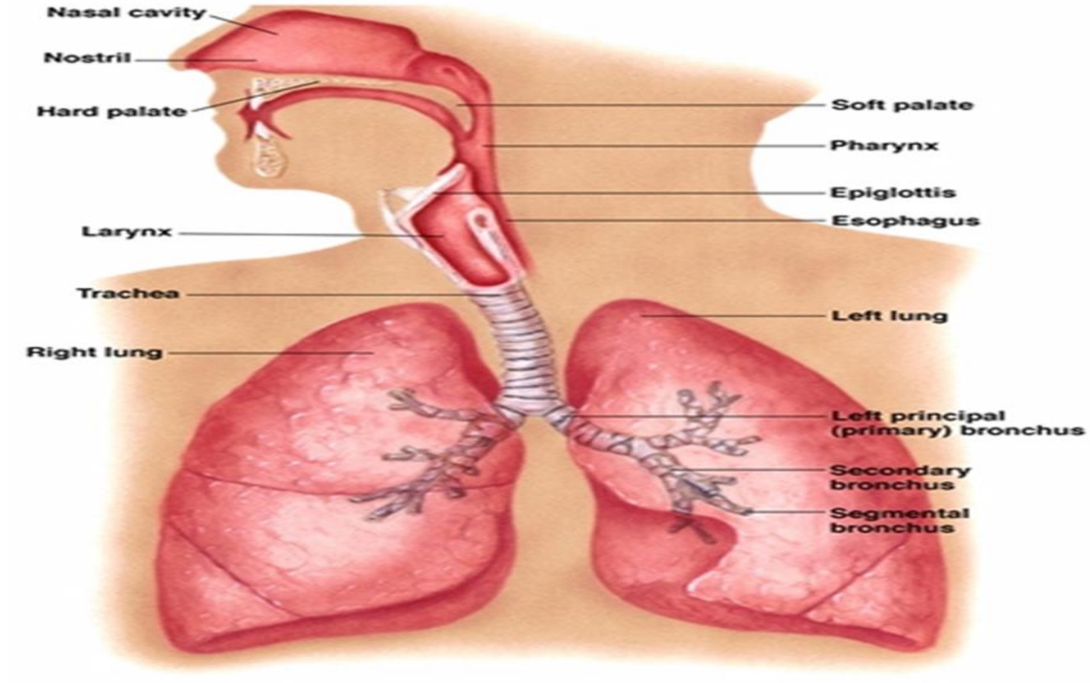


Respiratory system & exercise

Dr. Rehab F Gwada

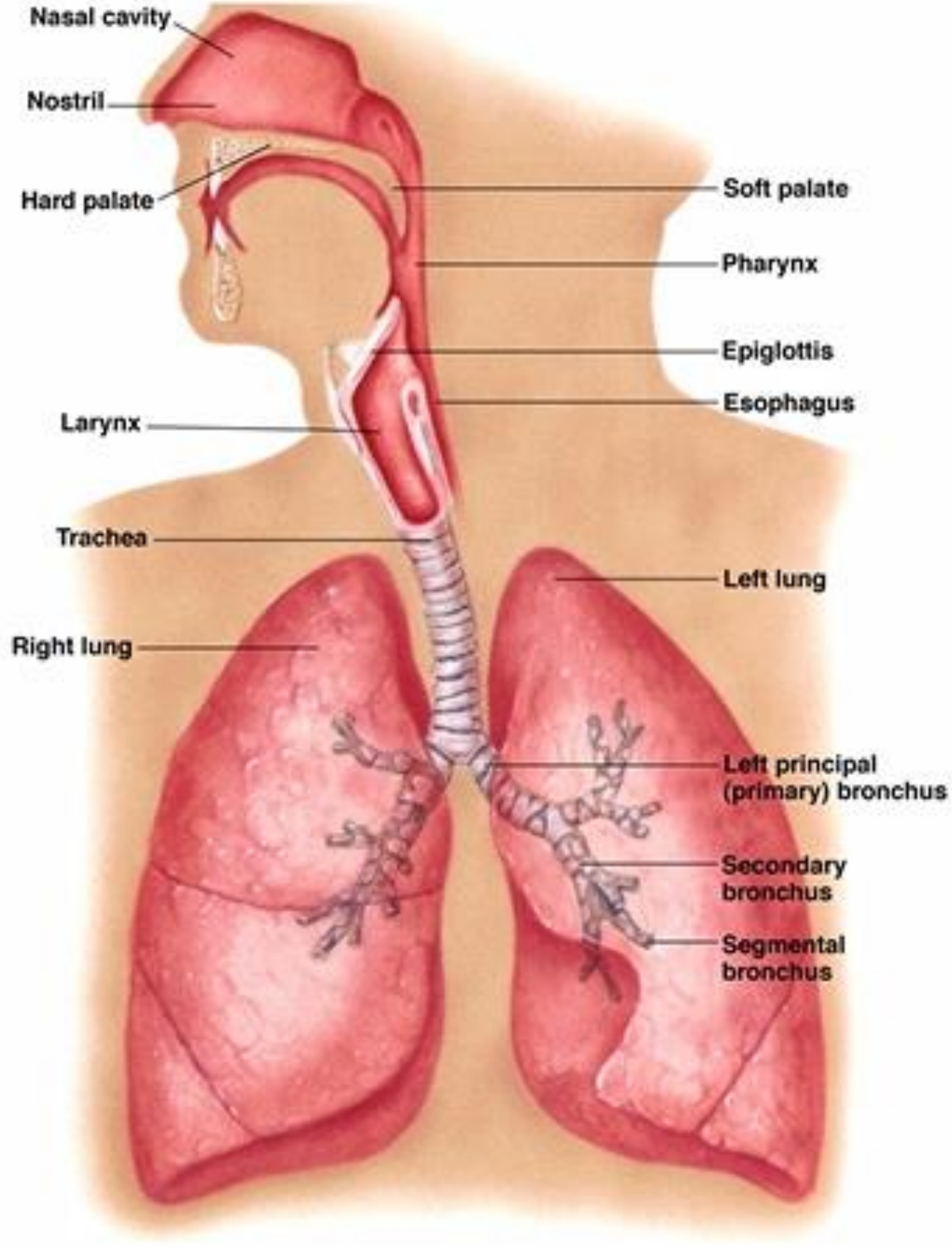
Objectives of lecture

- **Outline the major anatomical components & important functions of the respiratory system.**
- **Describe the mechanics of ventilation.**
- **List major muscles involved in inspiration and expiration, at rest and during exercise.**
- **Identify Lung volume and capacity.**
- **Describe pulmonary ventilation & its response to ex.**
- **Outline disruptions in normal breathing patterns during exercise.**
- **Describe Bohr effect and its important in exercise .**
- **Outline** O_2 & CO_2 Transport in the Blood
- **Identify The Energy Cost of Breathing during rest & ex.**

Major function of respiratory system

- Supplies oxygen to cells and removes carbon dioxide.
- Regulate H+ ion to maintain acid-base balance.
- Ventilation refers to the mechanical process of moving air into and out of lungs.

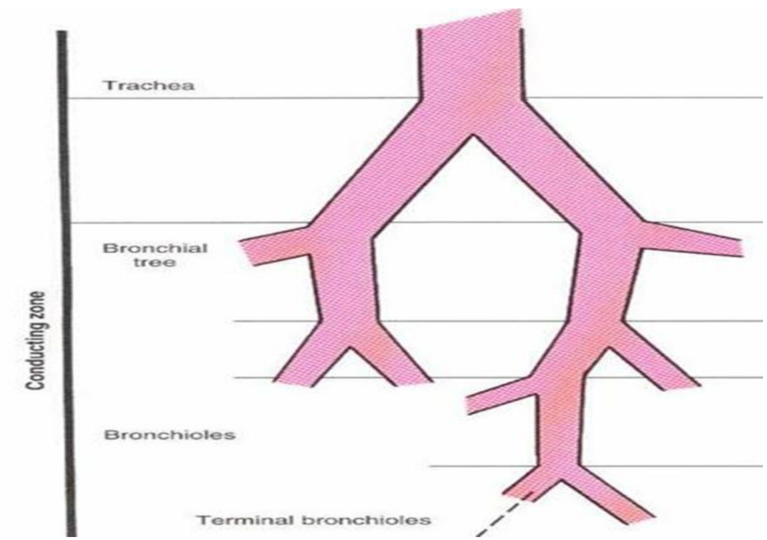
Major Organs of the Respiratory System



Conducting and Respiratory Zones

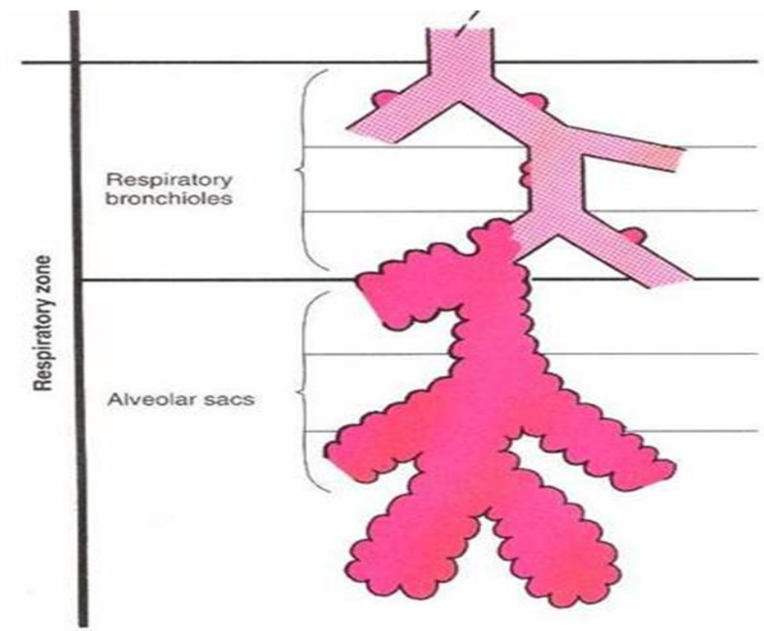
Conducting zone

- Conducts air to respiratory zone
- Humidifies, warms, and filters air
  - Components:(Trachea, Bronchial tree, Bronchioles)



Respiratory zone

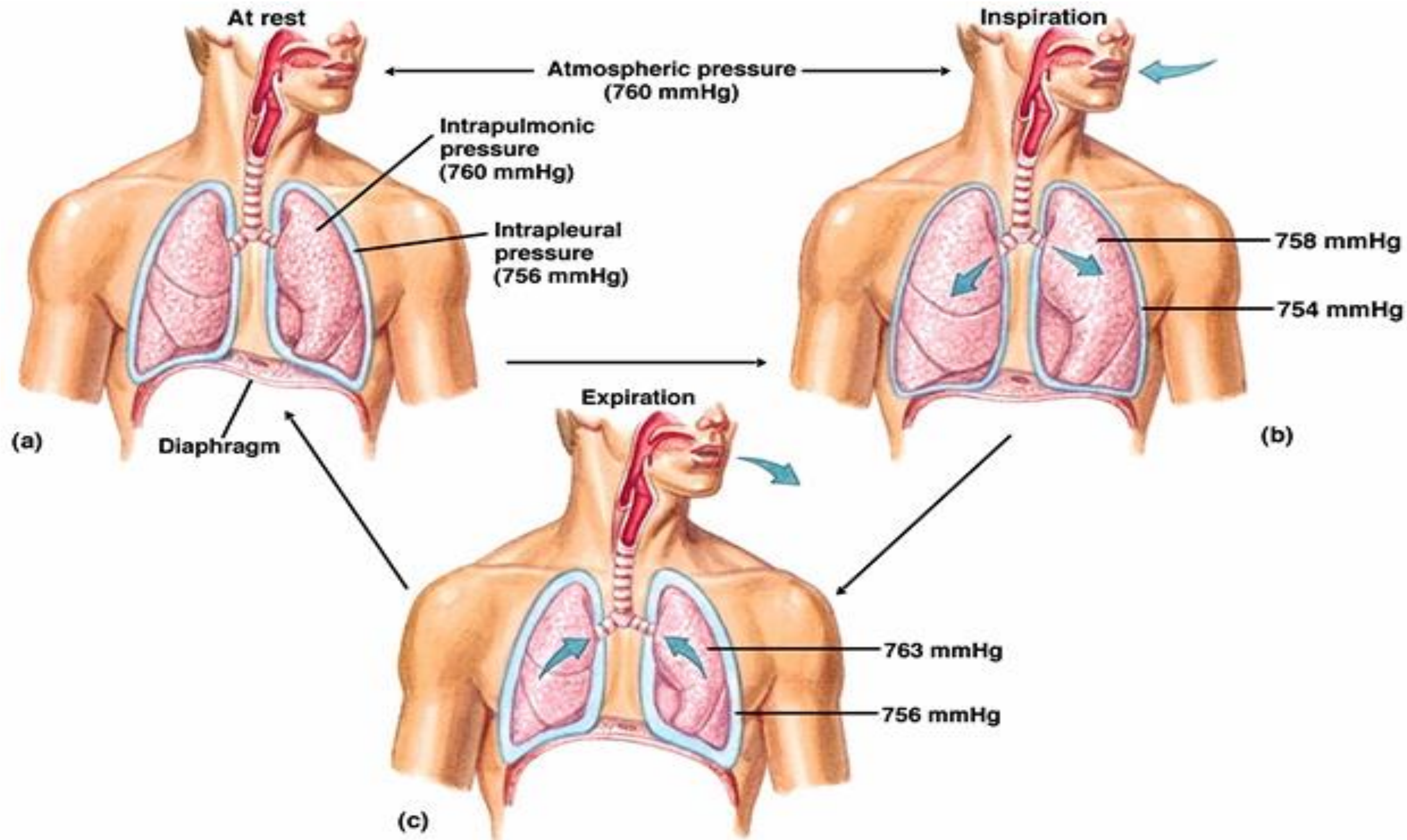
- Exchange of gases between air and blood
- Components:(Respiratory bronchioles, Alveolar sacs)



Mechanics of Breathing

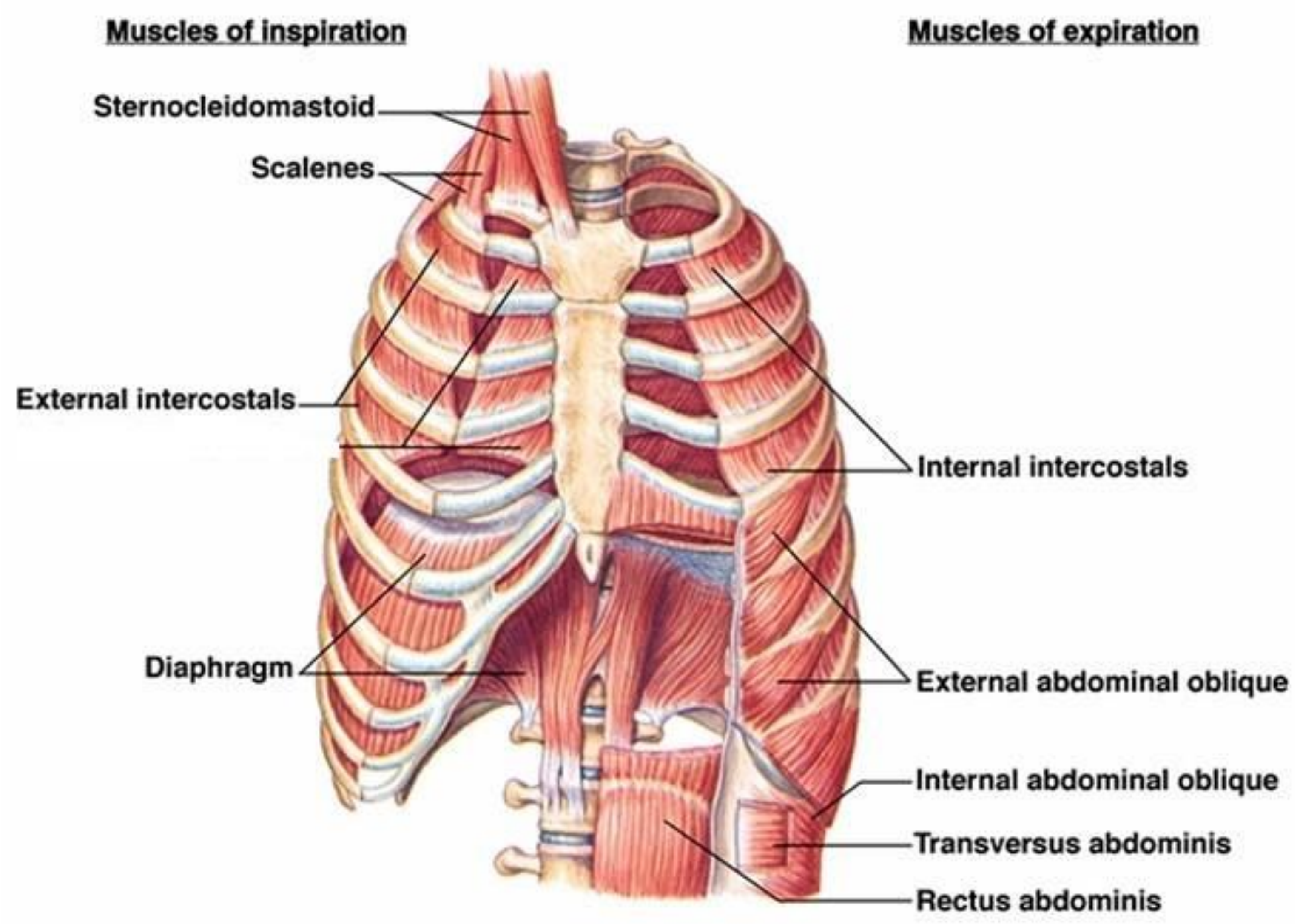
- Inspiration
  - The chest cavity increase in size because ribs raise and diaphragm pushes downward, lowering intrapulmonary pressure
- Expiration
  - the ribs swing down and diaphragm relaxes, reducing thoracic cavity volume , raising intrapulmonary pressure, and air rushes out .

The Mechanics of Inspiration and Expiration



- ✓ Pulmonary airflow depend on pressure differences bet. Ambient air and air within lung.
- ✓ Action of resp. muscles alter dimension of thoracic cavity produces these pressure differences.

Muscles of Respiration

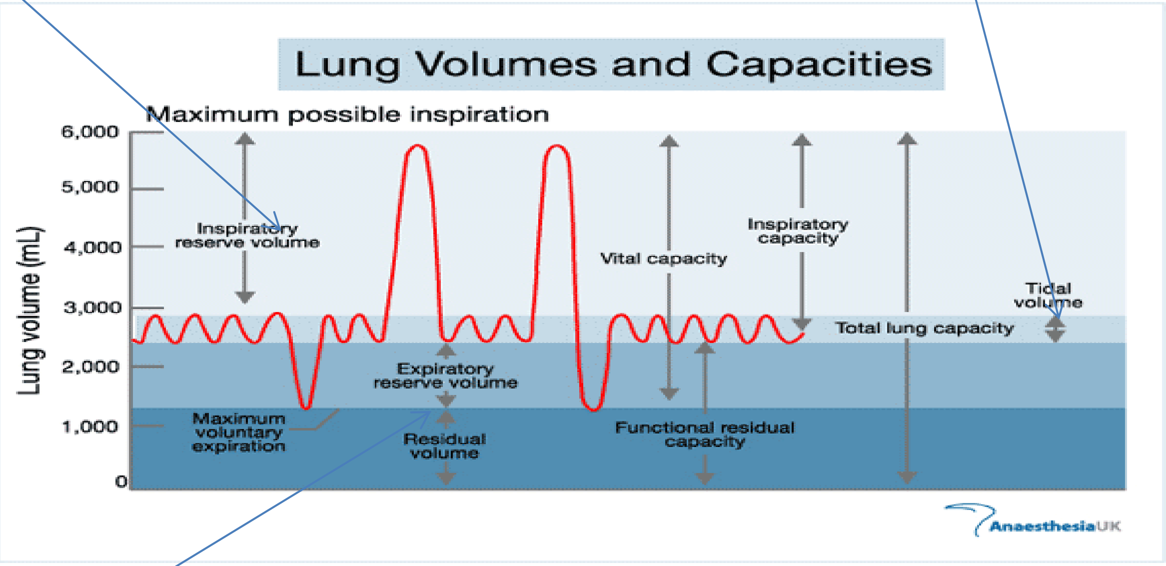


Lung volume and capacity

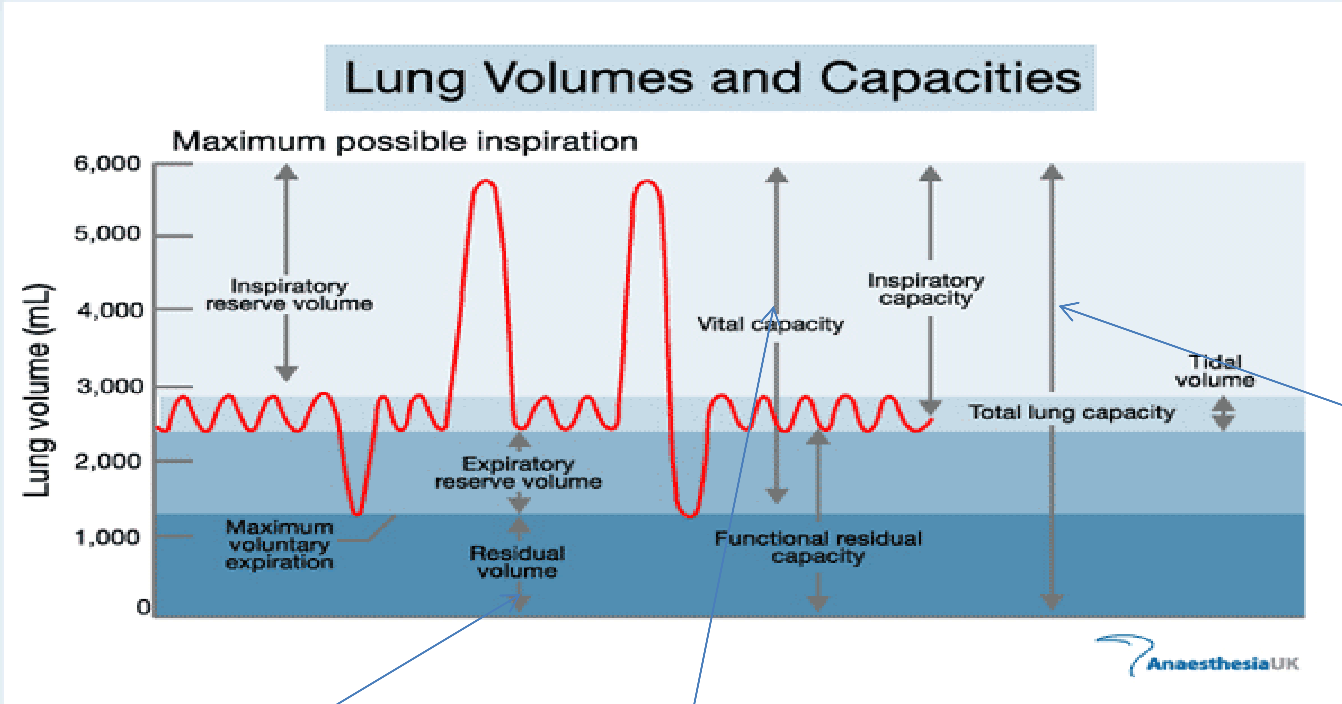
- **Tidal Volume (TV)**
  - The volume of air inspired or expired per breath (Approx 500ml at rest)

- **Inspiratory Reserve Volume**
  - Max. inspiration at end of TV

  E.g; Breathe in normally, then breathe in more. This extra capacity is your IRV



- **Expiratory Reserve Volume**
  - Max. expiration at end of TV
    - Eg: Breathe out normally, then force out more air. This is your ERV.



- **Total Lung Capacity**
  - Volume in lung after max. insp.
  - Take in as much breath as possible
  - =ERV+IRV+TV+RV (Approx 6000ml)

- **Residual Volume**
  - Volume of air left in lung after max. expiration
  - ➢ This is your RV (Approx 1200ml)

- **Vital Capacity**
  - Max. volume expired after max. inspiration .
  - Breathe in as much as you can, and then force as much air out of your lungs as possible.
    - This is your IRV+ERV+TV, and is your Vital Capacity

Pulmonary ventilation

Minute ventilation(VE)

- the total volume of gas entering the lungs per minute
- =RR x TV
- 6000= 12x 500

Alveolar ventilation

- It portion of (VE)
- the volume of gas per unit time that reaches the alveoli, the respiratory portions of the lungs where gas exchange occurs:
- VA = TV – anatomical dead space x RR

Dead space ventilation

- the volume of gas per unit time that does not reach these respiratory portions, but instead remains in the airways (trachea, bronchi, etc.).
- =dead space x RR

Minute ventilation & exercise

- During exercise : An increase in the TV and rate of breathing increase minute ventilation .
- minute ventilation =6 L at rest may reach 200 L in athletes at max. ex.

Alveolar ventilation& ex.

- Adjustments in breathing rate & depth maintain alveolar ventilation as ex. intensity increases.
- In moderate exercise :

Trained endurance athletes maintain adequate alveolar ventilation by increasing TV & minimally by increasing in RR.

- With deeper breathing , alveolar ventilation increases from 70% of minutes ventilation at rest to more than 85% of total ventilation in ex. This increase due to large TV enters alveoli with deep breathing .

Cont.

- TV increases during ex. By encroachment on IRV & ERV.
- As ex. Intensity increase , TV plateaus at about 60% of vital capacity, further increases in VE result from increase in RR.
- This ventilator adjustment occur unconsciously.

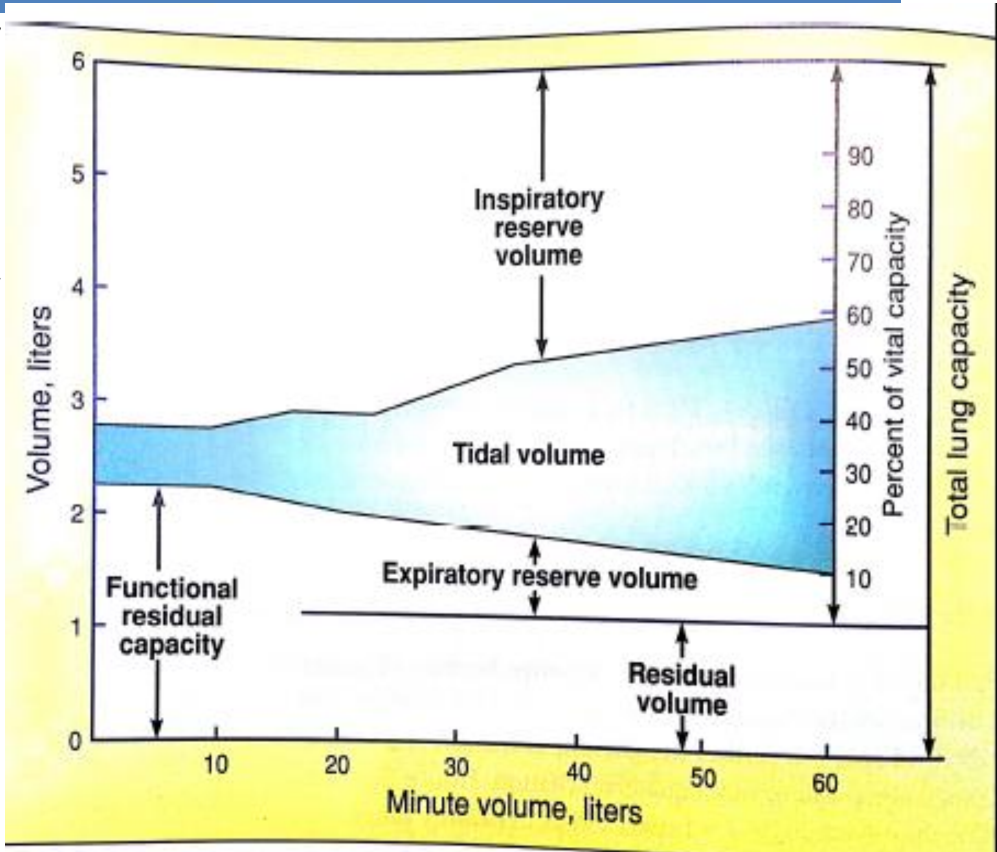


Figure 9.6 Tidal volume and subdivisions of pulmonary air during rest and exercise.

Cont.

- N.B:

Most individuals who perform rhythmical walking running …..naturally synchronize breathing frequency with limb movements. this breathing pattern termed entrainment , reduce the energy cost of activity .

How does pulmonary ventilation increase during exercise?

- ✓ During light exercise (walking)?
  - ✓ It increase more By increasing the tidal volume (breathing deeper)

- ✓ During steady state exercise (jogging)?
  - ✓ By increasing both the tidal volume and the frequency of breathing

- ✓ During intense exercise (sprinting)?
  - ✓ It increase more By increasing the frequency of breathing

Disruptions in normal breathing patterns during exercise

Dyspnea

- Shortness of breath(accompanies $\uparrow$ CO_2 & H^+
- Failure to adequately regulate CO_2 & H^+ due to low aerobic fitness level & poorly condition respiratory musculatures

Hyperventilation

- Over breathing (remove of CO_2 & $\downarrow$ H^+)
- Prolonged hyperventilation can lead to unconscious

Valsalva maneuver

- Forcefully try to exhale against a closed glottis
- Increase intra thoracic and intra abdominal pressures
- Optimize force generating capacity of chest musculatures
- This occurs in wt. lifting .

Thought Question

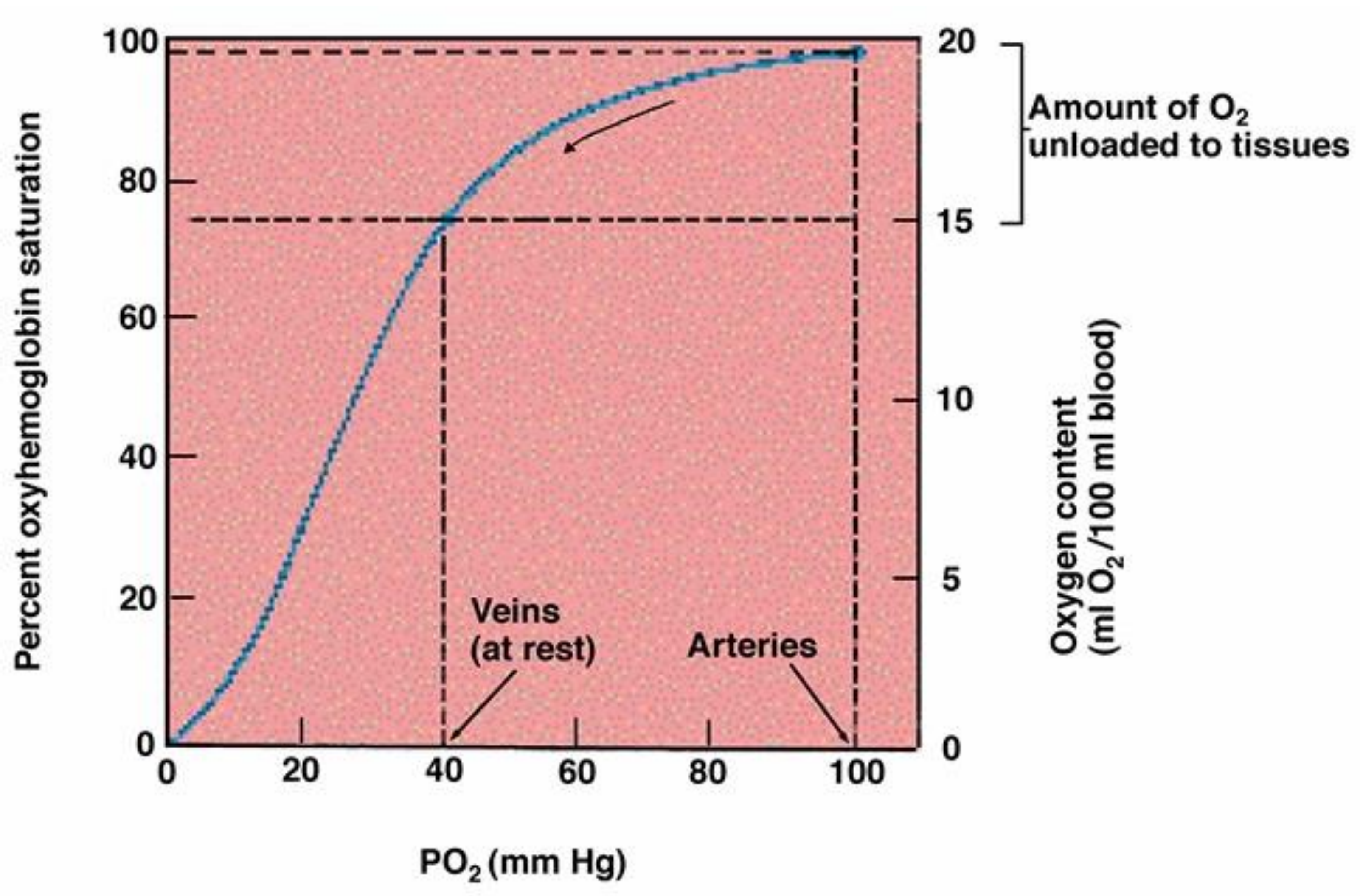
- Athletes frequently bend forward from the waist to facilitate breathing after intense ex, Discuss.

O_2 & CO_2 Transport in the Blood

O_2 Transport in the Blood

- Approximately 99% of O_2 is transported in the blood bound to hemoglobin (Hb)
  - Oxyhemoglobin: O_2 bound to Hb
  - Deoxyhemoglobin: O_2 not bound to Hb
- Amount of O_2 that can be transported per unit volume of blood in dependent on the concentration of hemoglobin

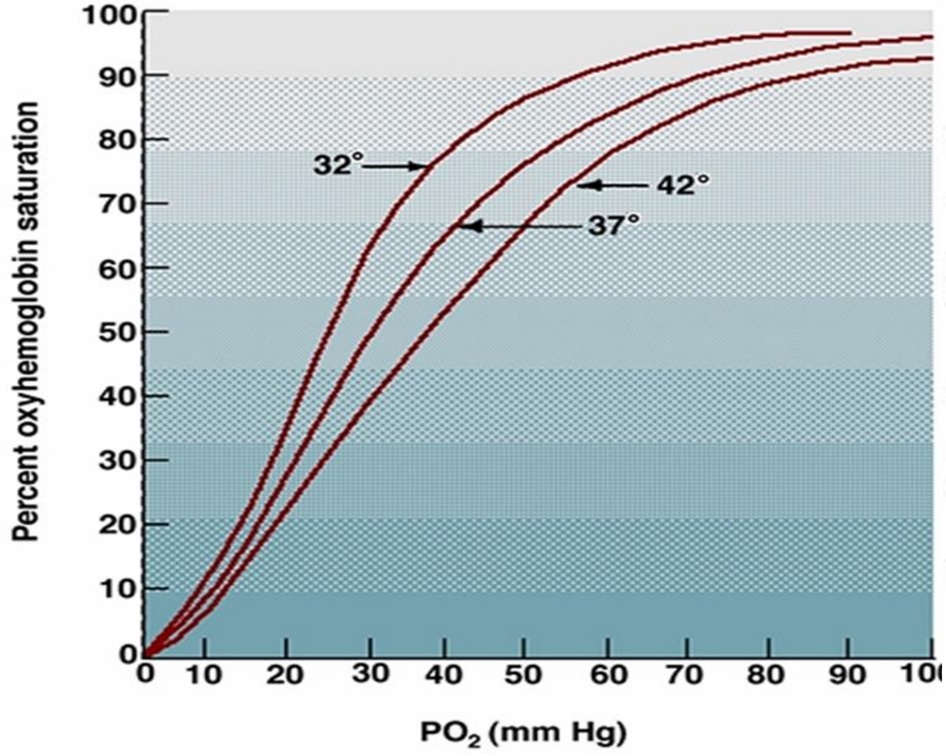
Oxyhemoglobin Dissociation Curve

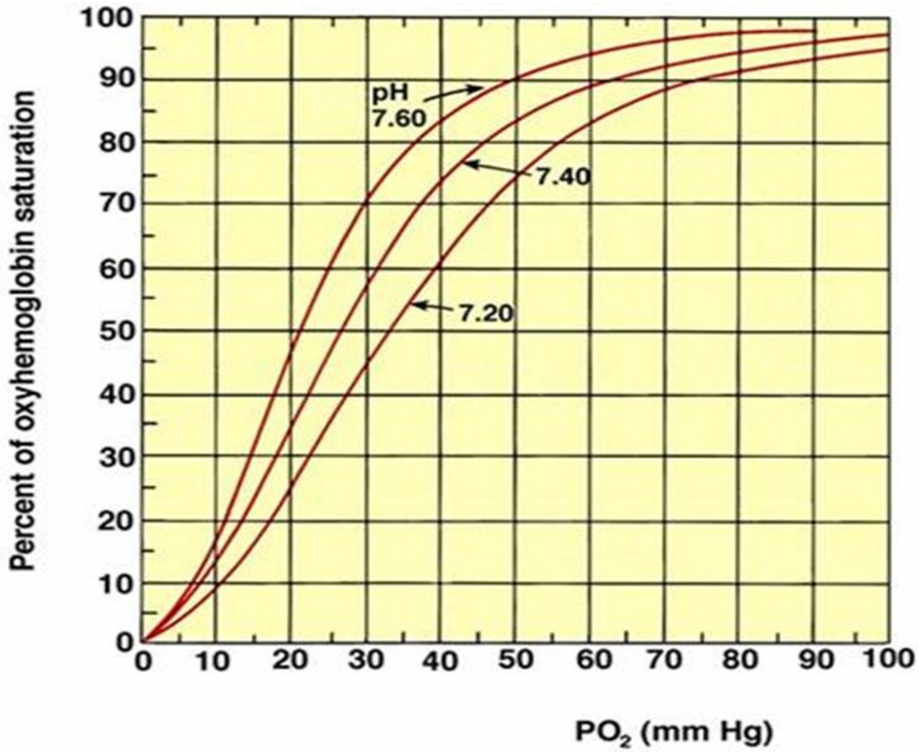


Bohr effect

the effects of temp. & acidity in alteration Hb affinity for o2

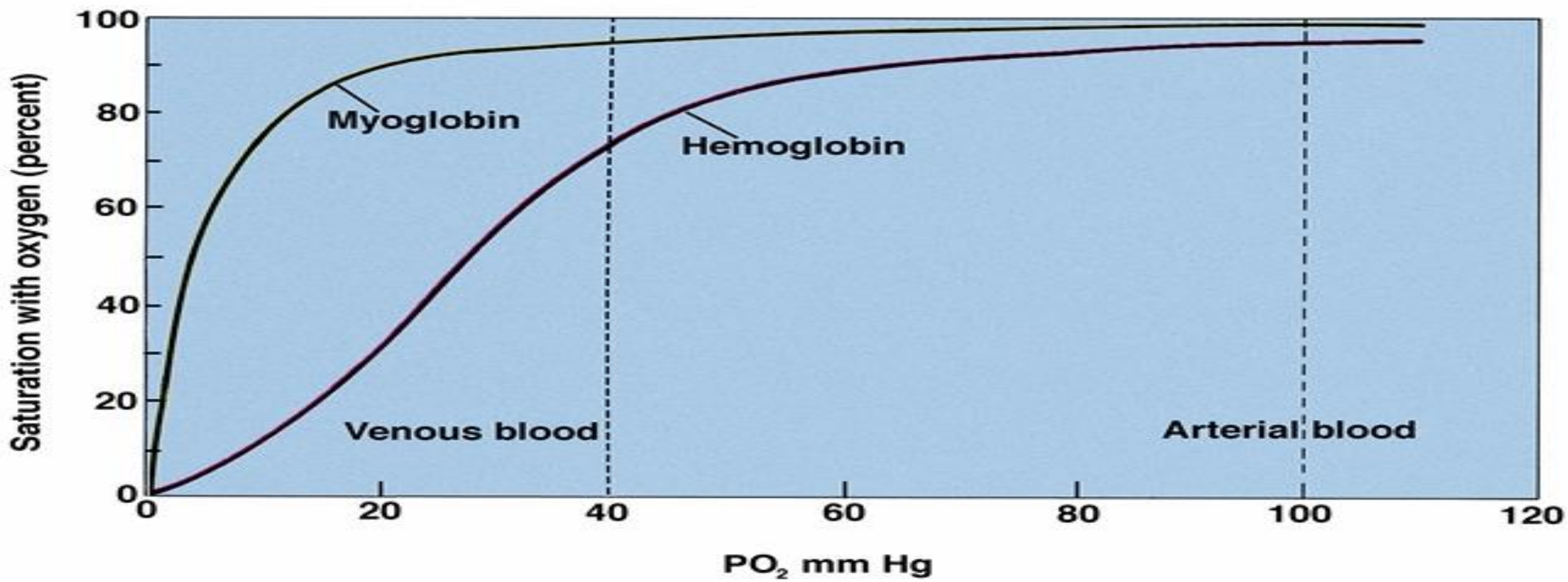
- Blood pH declines & Increased blood temperature during heavy exercise result in :
- right \downward shift of the O_2-Hb curve
- Enhance unloading” of O_2 to the tissues.





O_2 Transport in Muscle

- Myoglobin (Mb) transfers O_2 from the cell membrane to the mitochondria during strenuous ex.
- It has Higher affinity for O_2 than hemoglobin(store o2 in skeletal &cardiac MS.)
  - Even at low PO_2 , Allows Mb to store O_2



CO_2 Transport in Blood

- Dissolved in plasma (7-10%)
- Bound to Hb (20%)
- Bicarbonate (70%)
  - $CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^-$
  - This reaction reverses in lung to allow CO_2 to leave blood and diffuse into alveoli.

The Energy Cost of Breathing

At rest and with light exercise

- the energy cost of breathing is minimal (4% of energy)

During intense exercise

- the energy use may increase from 10-20% of total energy expenditure

Thank you