Unit 1

PHYSIOLOGY OF RESPIRATORY SYSTEM

VENTILATION

: describes only the movement of air. Air is inspired through the nose or mouth, through all of the conducting airways until it reaches the distal respiratory unit (alveoli).

RESPIRATION

- Respiration is a general term used to describe gas exchange within the body.
- I t can be categorized as external and internal respiration.
- External respiration describes the exchange of gas at the alveolar capillary membrane and the pulmonary capillaries.
- Internal respiration describes the gas exchange between the pulmonary capillaries and the cells of the surrounding tissues.

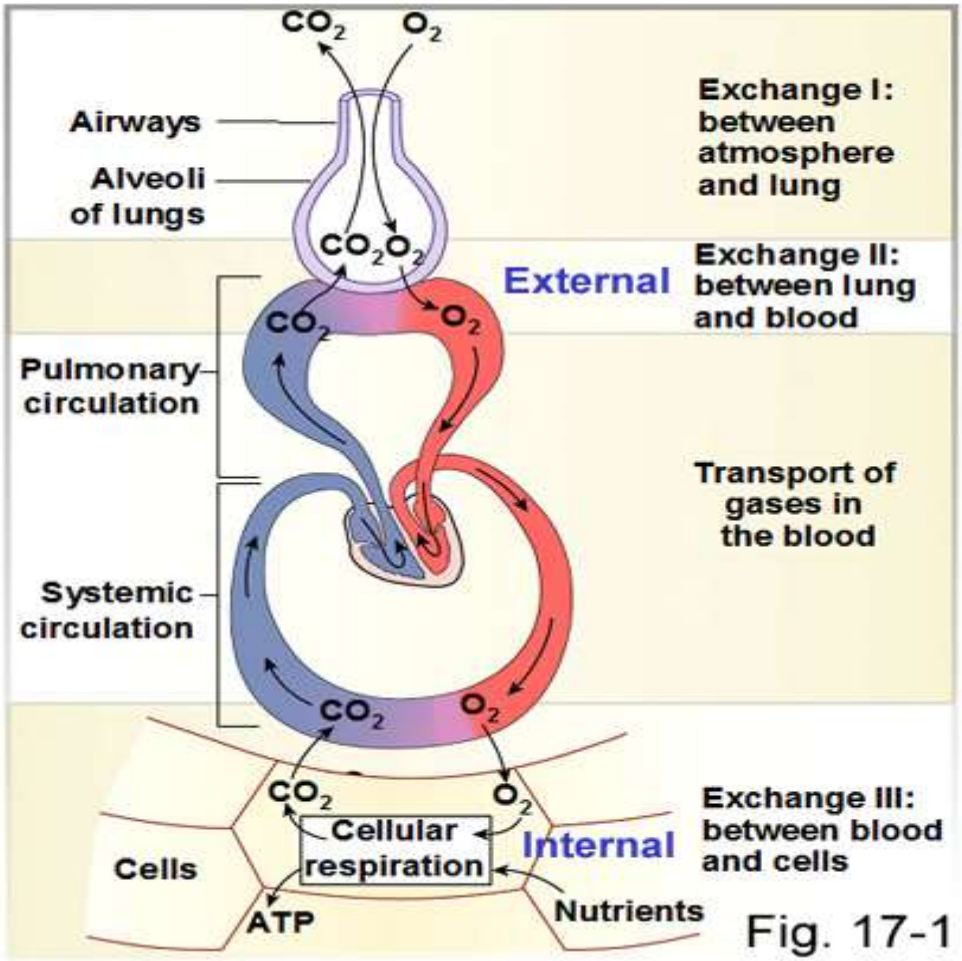


Fig. 17-1

MECHASIM OF BREATHING

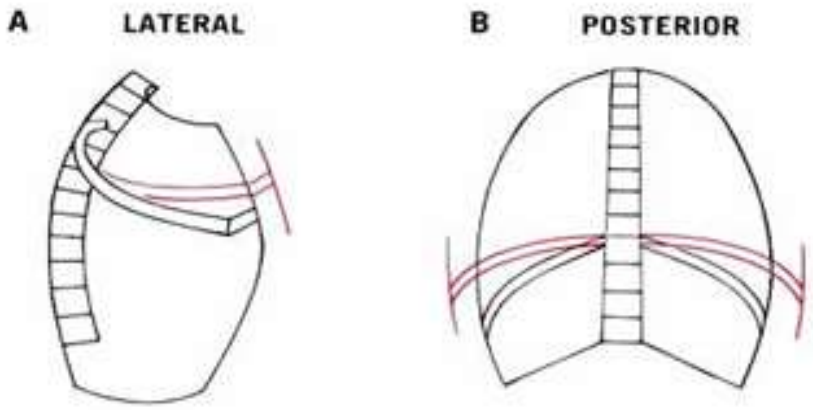
- Eupnoea means rhythmic breathing at rest
- It consists of
    1. Inpiration

2. Expiration

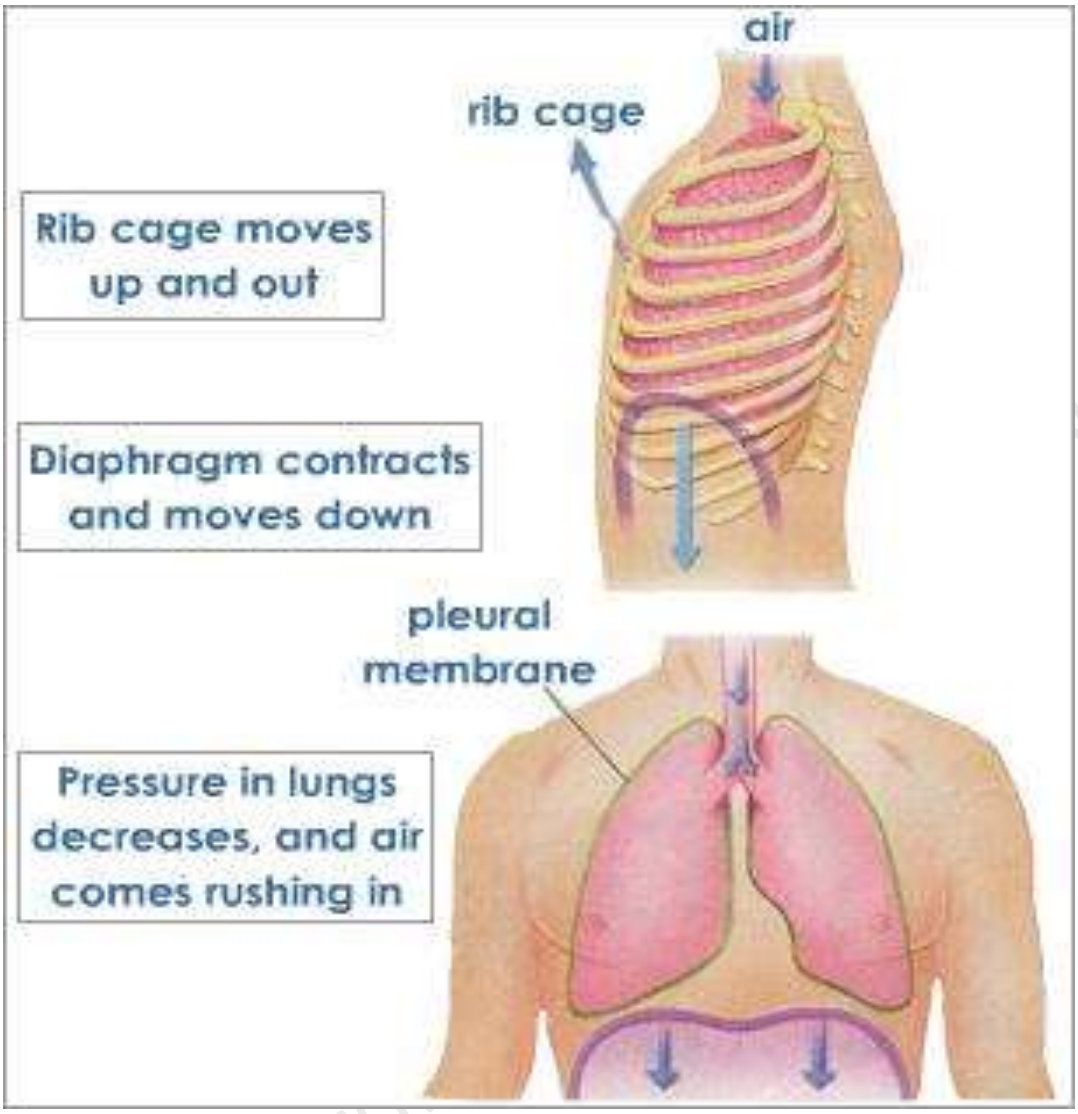
MECHANISM OF INSPIRATION

- Inspiration is an active process.
- During inspiration the thorax is enlarged by:

1. Movement of ribs

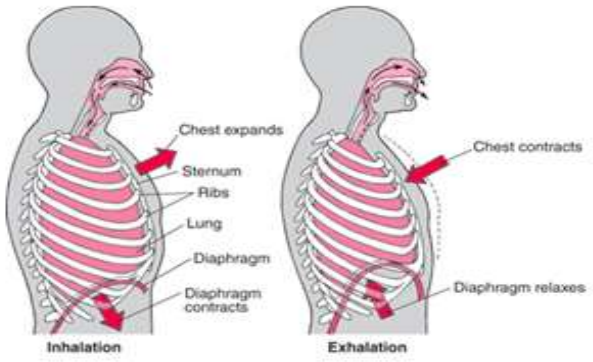


In A, when the upper ribs are elevated, the anteroposterior diameter of the thorax is increased ("pump-handle" movement). In B, the lower ribs move laterally when they are elevated, and the transverse diameter of the thorax is increased ("bucket-handle" movement)



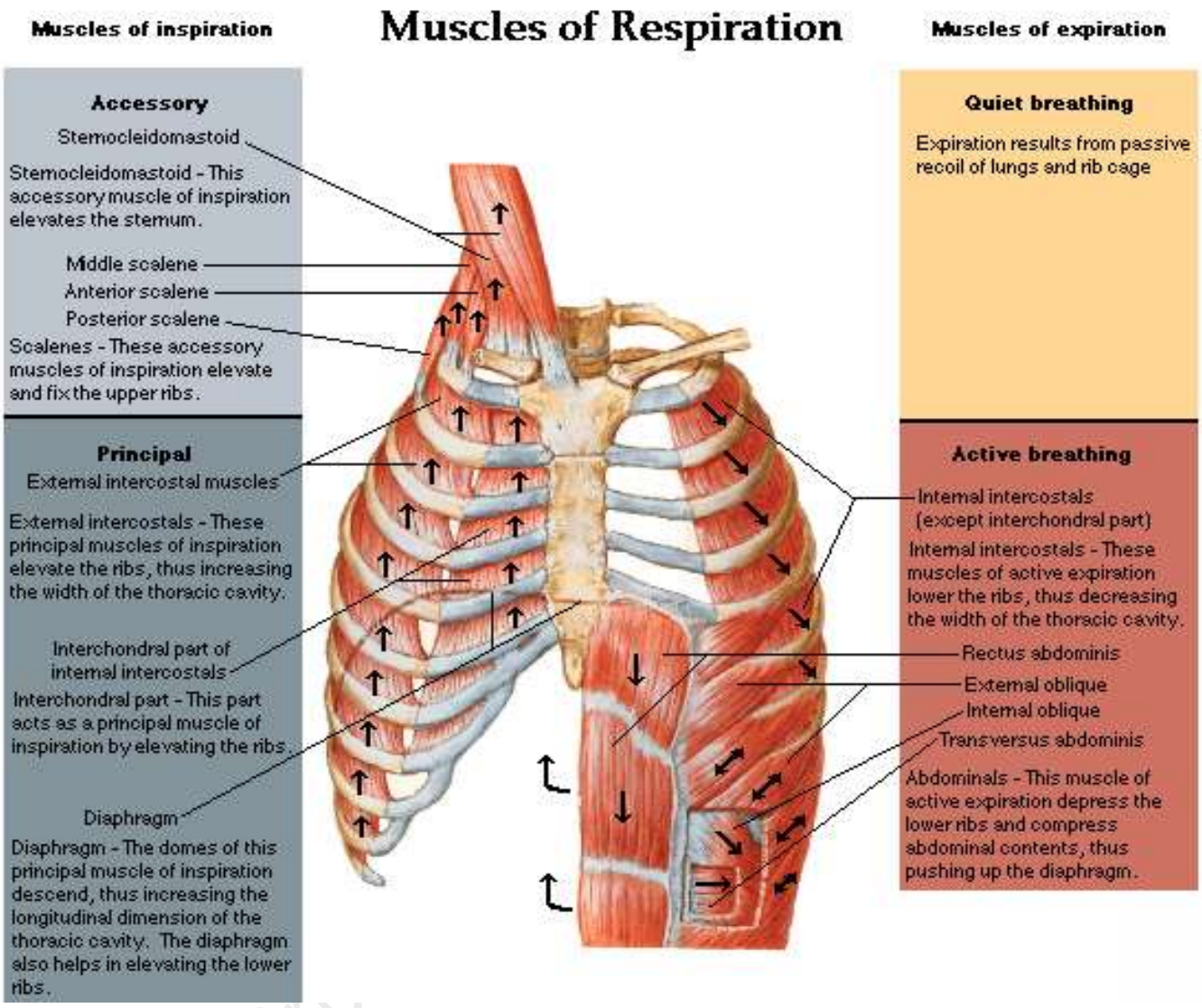
MECHANISM OF EXPIRATION

- In quiet breathing expiration is a **passive** process.[3]

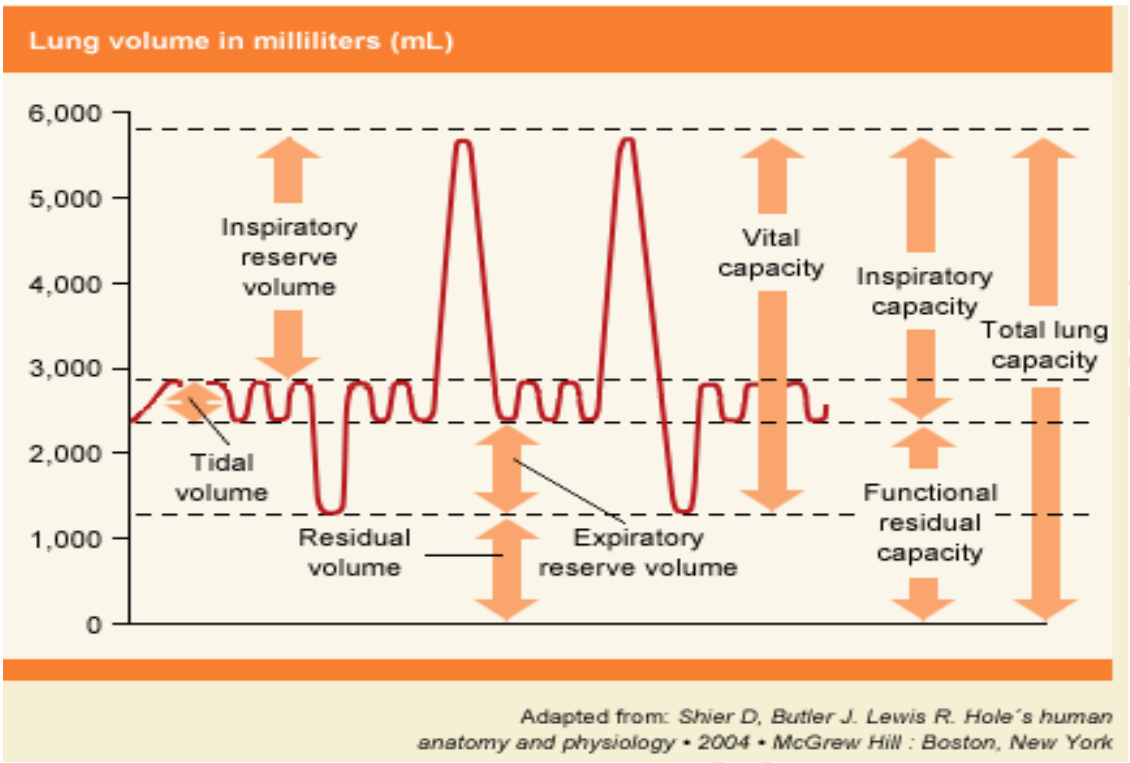


PRESSURE CHANGES DURING VENTILATION

Stage of breathing	**Intrapulmonary pressure**
Quiet breathing at end expiration and end inspiration	760mm Hg
Inspiration	760-3mm Hg
Expiration	760+3mm Hg



STATIC LUNG VOLUME AND CAPACITIES



DYNAMIC LUNG VOLUMES AND CAPACITIES

Dynamic lung volume and capacities	**Normal values**
Forced vital capacity FEV1 FEV2 FEV3	80% of FVC 95% of FVC 98-100% of FV
Minute volume= TV*RR	6l/min
Peak Expiratory Flow Rate	400-450l/min
Maximum Voluntary Ventilation	90-170l/min
Pulmonary Reserve	%PR>60-70%

Tidal Volume: TV

The amount of gas inspired or expired with each normal breath.
About 500 ml

Inspiratory Reserve Volume: IRV

Maximum amount of additional air that can be inspired from the end of a normal inspiration.

Expiratory Reserve Volume: ERV

The maximum volume of additional air that can be expired from the end of a normal expiration.

Residual Volume: RV

The volume of air remaining in the lung after a maximal expiration. This is the only lung volume which cannot be measured with a spirometer.

- Gas dilution tech
- ✓ nitrogen
- ✓ helium
- Body Plethysmography

Inspiratory Capacity: IC

Maximum volume of air that can be inspired from end expiratory position.
Called a capacity because it is the sum of tidal volume and inspiratory reserve volume.
This capacity is of less clinical significance than the other three.
IC= TV+IRV

Total Lung Capacity: TLC

The volume of air contained in the lungs at the end of a maximal inspiration.
Called a capacity because it is the sum of the 4 basic lung volumes
TLC= RV+IRV+TV+ERV

Vital Capacity: VC

The maximum volume of air that can be forcefully expelled from the lungs following a maximal inspiration.
Called a capacity because it is the sum of inspiratory reserve volume, tidal volume and expiratory reserve volume.
VC= IRV+TV+ERV = TLC – RV

Functional Residual Capacity: FRC

The volume of air remaining in the lung at the end of a normal expiration.
Called a capacity because it equal residual volume plus expiratory reserve volume.
FRC= RV+ERV

DEAD SPACE

- It is the amount of air in the respiratory passage which doesnot takes part in the exchange of gases
- **.Types of dead spaces**
  .Anatomical
  .Alveolar
  .PhysiologicaL

SURFACTANT

- Surfactant is a mixture of protein lipid complex
- It is a surface tension lowering agent
- It keeps the alveoli dry thus helps in exchange of gases.
- Helps to prevent the pulmonary oedema by reducing the surface tension**.**

LUNG COMPLIANCE

- Lung compliance is the volume change (lung expansion) per unit pressure change.

- It is the distensibility of the lung and the chest wall**.**
- C= ΔV/ Δ P

WORK DONE DURING BREATHING

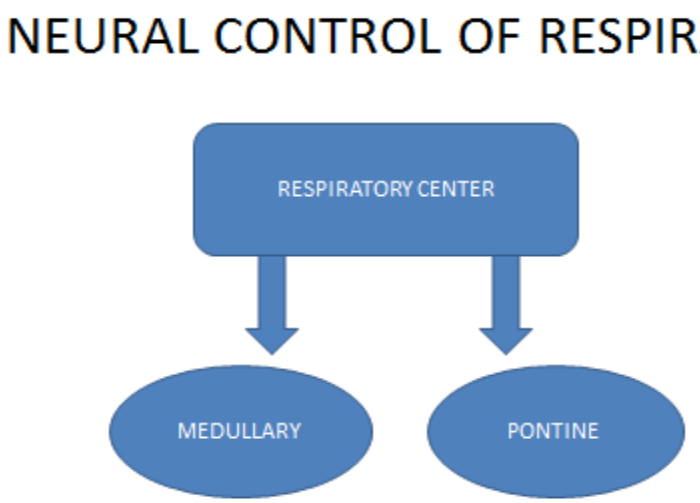
- Work is done by respiratory muscles to overcome
  - Elastic resistance
  - Non-elastic resistance
  - Viscous resistance
  - Airway resistance

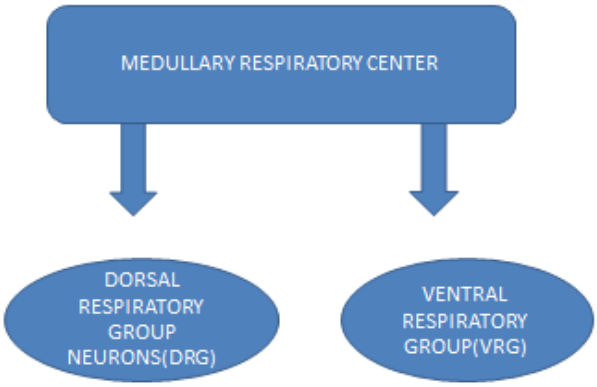
DIFFUSION CAPACITY OF LUNGS

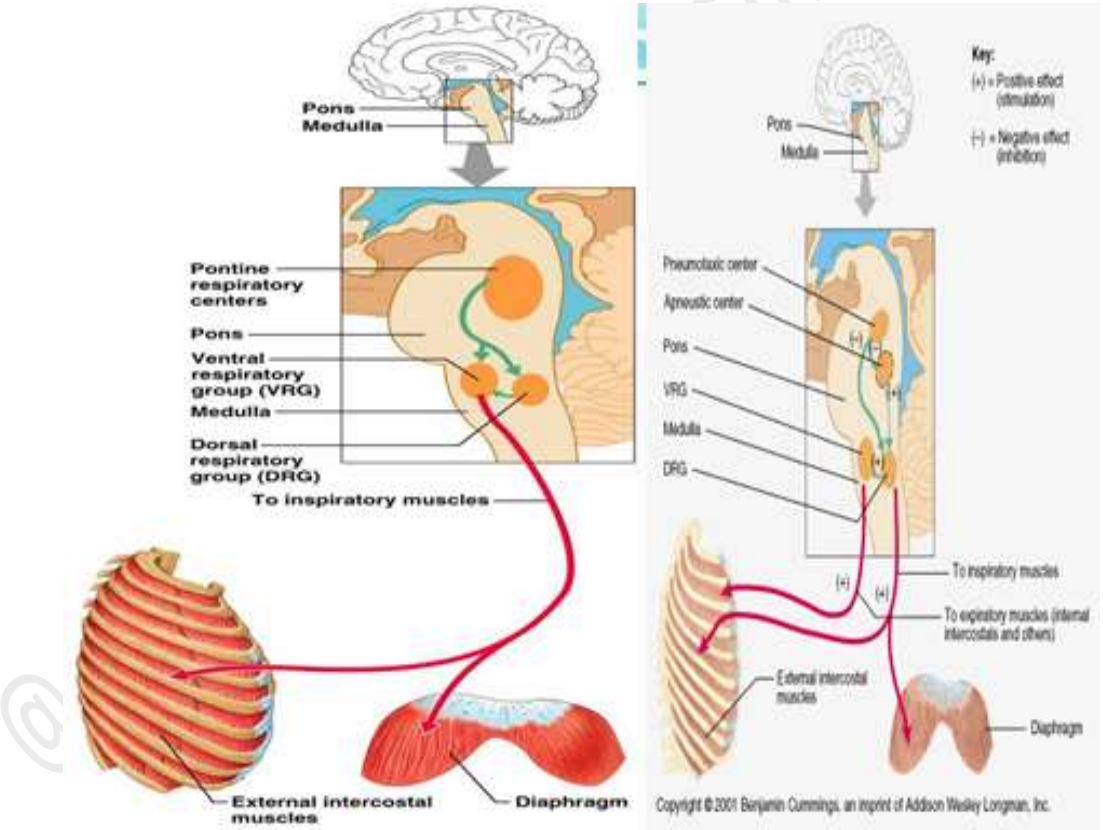
- It is the amount of a gas that crosses the alveolar capillary membrane per minute per mm Hg difference in partial pressure of gas on the two sides of the membrane

NEURAL CONTROL OF RESPIRATION

- Inspiratory muscles must rhythmically contract and relax to alternately fill the lung with air and empty them out
- The rhythmic pattern breathing is established by cyclical neural activity to the respiratory muscles




MEDULLARY RESPIRATORY CENTER
DORSAL RESPIRATORY GROUP NEURONS(DRG)
VENTRAL RESPIRATORY GROUP(VRG)


Pons
Medulla
Pontine respiratory centers
Pons
Ventral respiratory group (VRG)
Medulla
Dorsal respiratory group (DRG)
To inspiratory muscles
External intercostal muscles
Diaphragm
Key:
(+) = Positive effect (stimulation)
(–) = Negative effect (inhibition)
Pons
Medulla
Pneumotaxic center
Apneustic center
Pons
VRG
Medulla
DRG
To inspiratory muscles
To expiratory muscles (internal intercostals and others)
External intercostal muscles
Diaphragm
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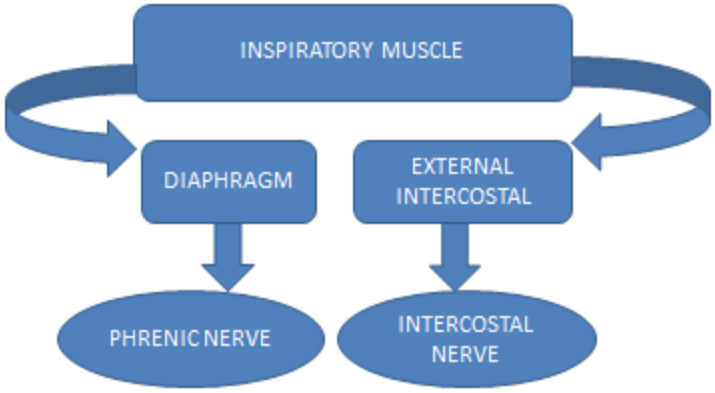
DORSAL RESPIRATORY GROUP NEURONS (DRG)

- Consists of inspiratory neurons which terminate on motor neurons that supply .

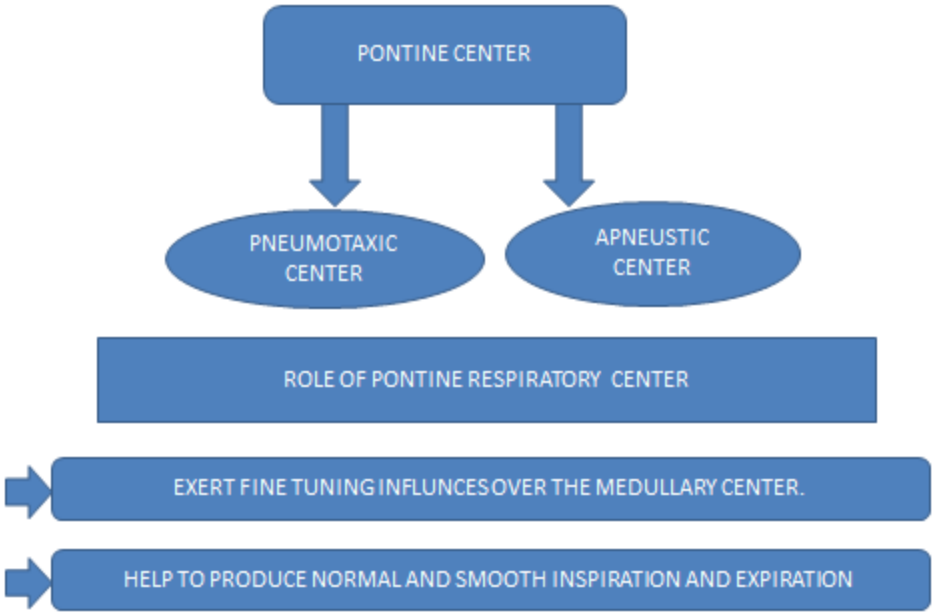


ROLE OF DRG OF NEURONS

- When the DRG inspiratory neurons fire, inspiration takes place.
- When DRG inspiratory cease firing, expiration occurs.
- PRE-POTZINGER COMPLEX is situated just above the DRG neurons .
- Display self –induced action potential causing rhythmic firing of inspiratory neurons of DRG
- Neurons in Pre-potzinger c complex are responsible for the basic rhythm of ventilation

VENTRAL RESPIRATORY GROUP(VRG) NEURON

- Consists of inspiratory and expiratory neurons.
- Both of them remain inactive during quiet breathing.
- VRG respiratory neurons are stimulated by DRG respiratory neurons during periods when demands for ventilation increased.
- During active expiration DRG respiratory neurons stimulate VRG respiratory neurons which further stimulate expiratory muscle and active expiration occurs.



PONTINE CENTER

PNEUMOTAXIC CENTER

- Switch off the inspiratory neurons,
- As a result the duration of inspiration is limited

APNEUSTIC CENTER

- Prevents inspiratory neurons from being switched off
- It thus prolongs inspiratory drive.

Pneumotaxic center is dominant over Apneustic center

Without Pneumotaxic center prolonged gasps occur interrupted by brief expiration

This abnormal pattern of breathing is called APNEUSIS