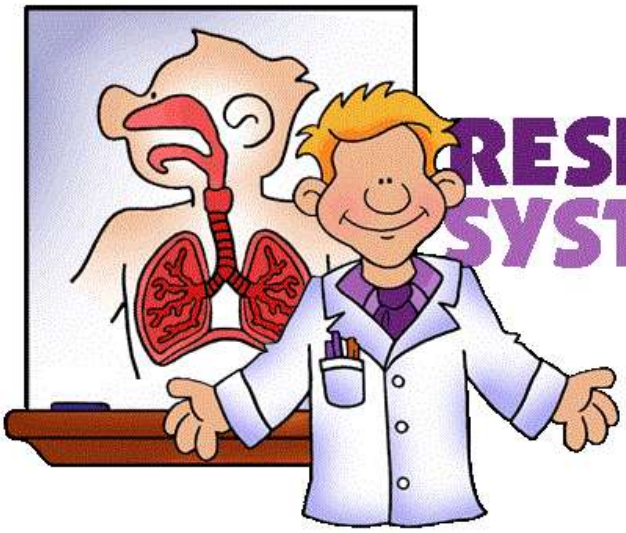
Physiology Team 432



2th Lecture

Mechanics of Breathing

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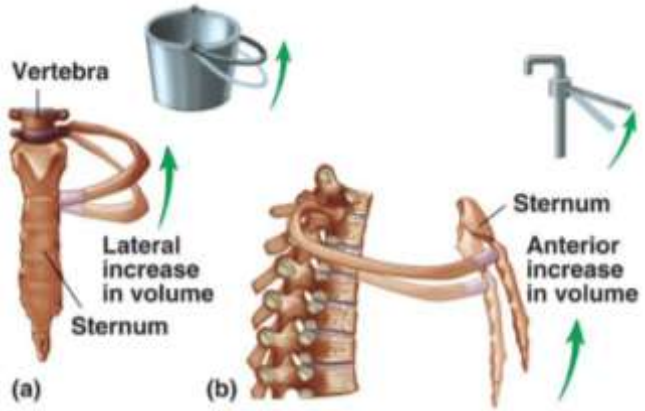
Objectives:

- List the muscles of respiration and describe their roles during inspiration and expiration
- Importance of the following pressures in respiration:
  Atmospheric pressure
  Alveolar pressure
  Intra-pleural pressure
  Trans-pulmonary pressure
- Pulmonary ventilation [Inspiration and Expiration]

Pulmo=lungs **ventilation=breathing**



Breathing mechanics: is interplay of force generated by pressure, volume and flow changes occurring during the breathing cycle.

1- Muscles of inspiration:

In normal and forced inspiration we need muscles .

A- Principal (major) muscles: (in normal inspiration)

- **Diaphragm** (increasing the longitudinal size of thoracic cavity, and helps in elevating of lower ribs)
- **External intercostal** (elevate the ribs, thus increasing the width of thoracic cavity)

B- **Accessory(supporting) muscles:** (in forced inspiration)

- **Sternocleidomastoid** (elevate the sternum)
- **Scaleni** (elevate the 1st & 2nd ribs)
- **Serratus anterior** (fix the ribs)
- **Pectoralis minor** (elevate the 3rd, 4th & 5th ribs)

2- Muscles of expiration :

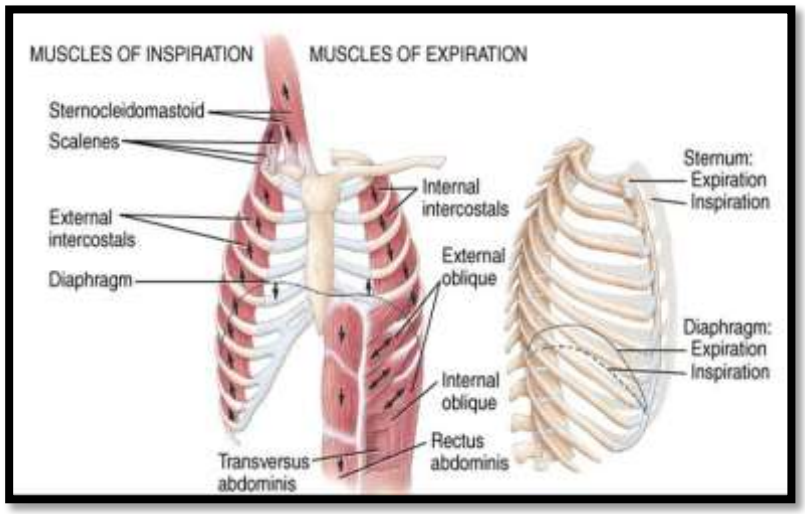
We need muscles in <u>forced expiration only</u> because the Normal expiration is due to elastic recoil of lungs and associated structures (passive expiration).

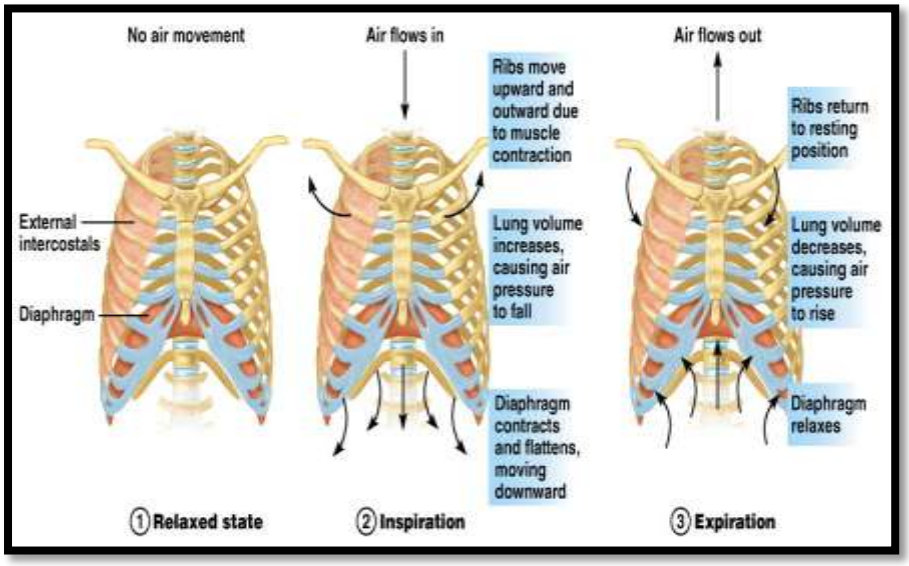
Muscles of forced expiration

- **Internal intercostal (lower the ribs, thus decreasing the width of thoracic cavity)**
- **External oblique abdominis**
- **Internal oblique abdominis**
- **Rectus abdominis**
- **Transversus abdominis**

Abdominal muscles

(Depress the lower ribs and compress the abdominal contents, thus pushing up the diaphragm)





Pressure changes in the lungs during breathing

1- alveolar pressure (intra-alveolar pressure) :

Pressure inside the alveoli. The process of inspiration and expiration depends upon this pressure.

- **Normal alveolar pressure "between breaths" (0): is equal to the atmospheric pressure=760 mm Hg.**
- **Alveolar pressure during inspiration (-1) : The alveolar pressure is lower than the atmospheric pressure (760 to 758 mm Hg) so air moves from the atmosphere towards the lung alveoli.**
- **At the end of inspiration (0) : is equal to the atmospheric pressure=760 mm Hg, so air flow stops.**
- **Alveolar pressure during expiration (+1) : Alveolar pressure is higher than the atmospheric pressure (760 to 763 mm Hg) so air moves from lungs to the atmosphere (outside).**

2- Intrapleural pressure (pleural pressure) :

Pressure in pleural space (Pressure in the narrow space between the lung pleura and chest wall pleura). Negative pressure in the pleural space prevent the collapse of the lungs.

- **Why is negative ?**

1- The lung's elastic tissue causes it to recoil, while that of the chest wall causes it to expand. Because of these 2 opposing forces the pressure in the pleural cavity becomes negative.so it helps for inspiration.

2-The pleural space is a potential space, empty due to continuous suction of fluids by lymphatics.

- **Values of intrapleural pressure :**

-5 cm H_2O at the beginning of inspiration.
-7.5 cm H_2O at the peak of inspiration.

Forced ventilation:
Insp. :-20 to -40 cm H2O
Exp. : + 30 cm H2O Dr.

- **Main function :**

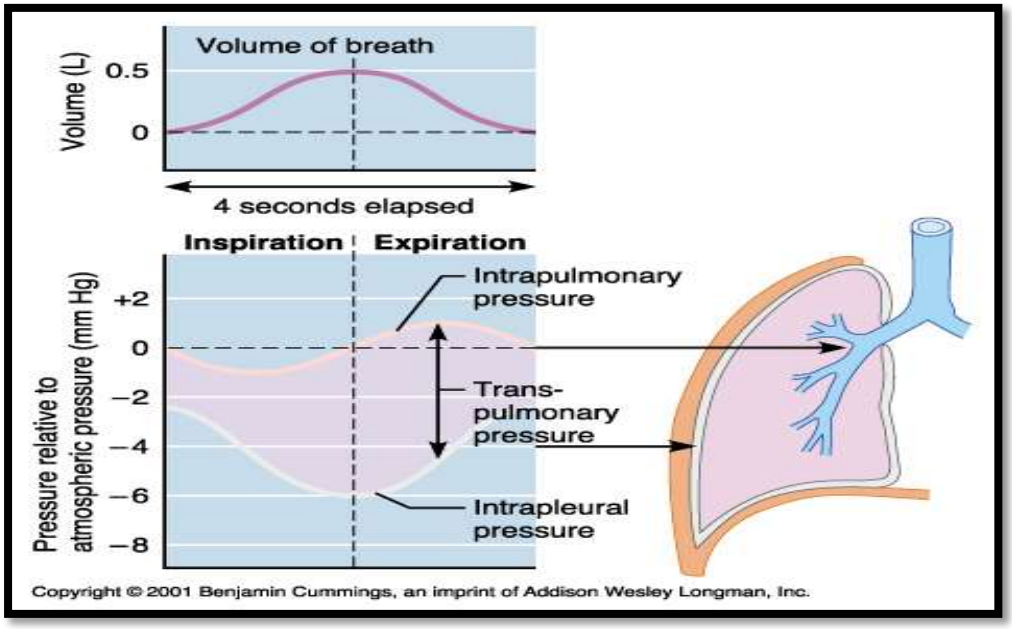
it prevents the lungs from collapsing and the chest wall from going out.

3- transpulmonary pressure :

The difference between the alveolar pressure (Palv) and the pleural pressure(Ppl).

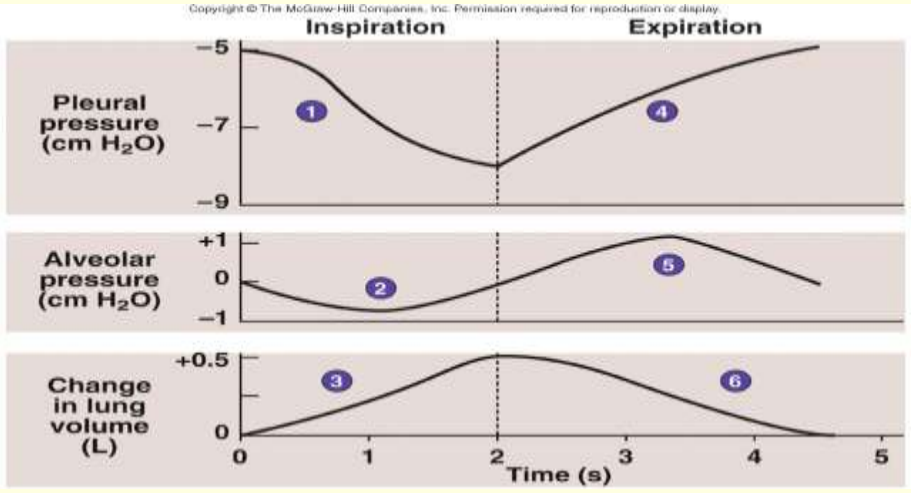
TPp = Palv-Ppl

- **It is a measure of the elastic forces in the lungs that tend to collapse the lungs (the recoil pressure).**
- **It prevents lung collapse.**
- **The bigger the volume of the lung the higher will be its tendency to recoil.**



CHANGING ALVEOLAR VOLUME

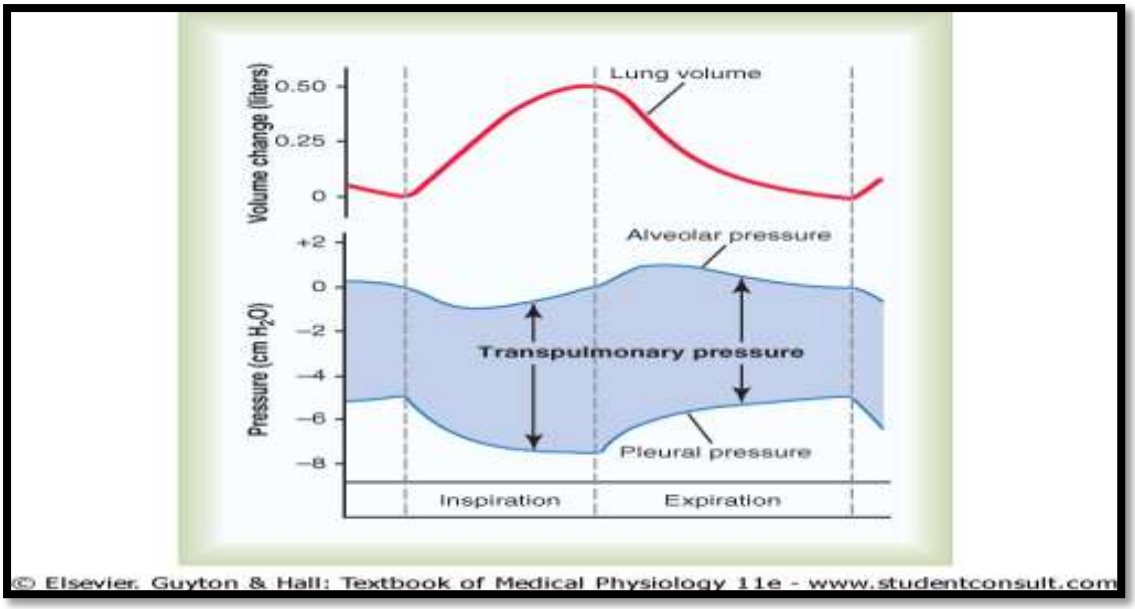
NORMAL BREATHING CYCLE



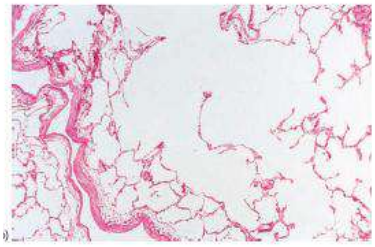
Compliance of the lung

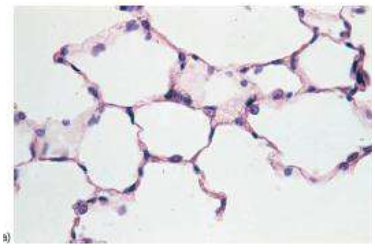
The ratio of change in the lung volume produced per unit change in distending pressure.
The extent to which the lungs expand for each unit increase in the transpulmonary pressure.

- CL= Volume change (Δ V) / Transpulmonary pressure change (Δ P)
- CL = (Δ V) / (Δ P)



- ✓ For both lungs in adult = 200 ml of air /cm H20.
- ✓ For lungs and thorax together= 110 ml/cm H20.
- ✓ Is reduced in pulmonary fibrosis , pulmonary edema, diseases of the chest wall (kyphosis, scoliosis).
- ✓ Emphysema increases the compliance of the lungs because it destroys the alveolar septal tissue rich with elastic fibers that normally oppose lung expansion.





PULMONARY VENTILATION

Pulmonary is the inspiration (inflow) and expiration (outflow) of air between the atmosphere and lungs.

- **In ventilation: important factor called the pressure gradient exists.**
- **Air moves into the lungs when the pressure inside the lungs is less than that of the atmospheric pressure.**
- **Air moves from the lungs to the atmosphere, when the pressure in the lungs is greater than the atmospheric pressure.**

1- Inspiration :

2- expiration :

Relaxation of inspiratory muscle

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Decreased vertical and antero-posterior diameter of the chest cavity

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Increased intra-thoracic pressure

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Size of lungs decreases

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Increased alveolar pressure from 760-763 mm Hg

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Air moves from lung alveoli towards atmosphere

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Expiration

Useful videos:

- http://www.youtube.com/watch?v=ZvTdc1nAuBo
- http://www.youtube.com/watch?v=rPKyoD4Jkoc

GOOD LUCK