

# Respiratory Physiology

- Respiration includes four distinct events
  - 1. Pulmonary ventilation**
  - 2. External respiration**
  - 3. Respiratory gas transport**
  - 4. Internal respiration**

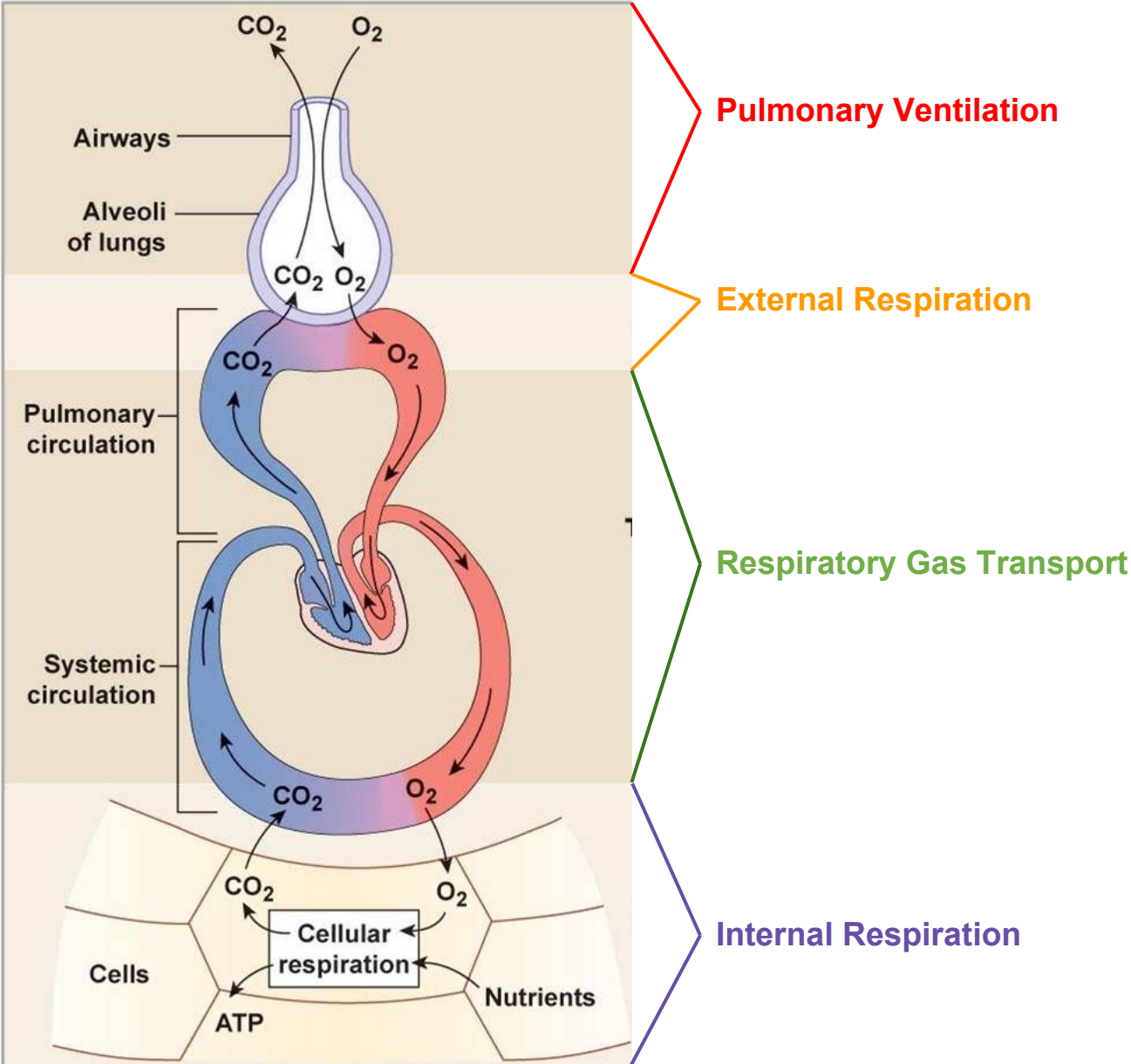
# Respiratory Physiology

1. Pulmonary ventilation (Breathing) — **moving air into and out of the lungs**
2. External respiration — **gas exchange between pulmonary blood and alveoli**
  - Oxygen is loaded into the blood
  - Carbon dioxide is unloaded from the blood

# Respiratory Physiology

3. Respiratory gas transport — **transport of oxygen and carbon dioxide via the bloodstream**
4. Internal respiration — **gas exchange between blood and tissue cells in systemic capillaries**

# Respiratory Physiology



# Mechanics of Breathing

- Pulmonary ventilation (Breathing)
  - Mechanical process that depends on **volume changes in the thoracic cavity**
  - Volume changes lead to **pressure changes**, which lead to the **flow of gases to equalize pressure**

# Mechanics of Breathing

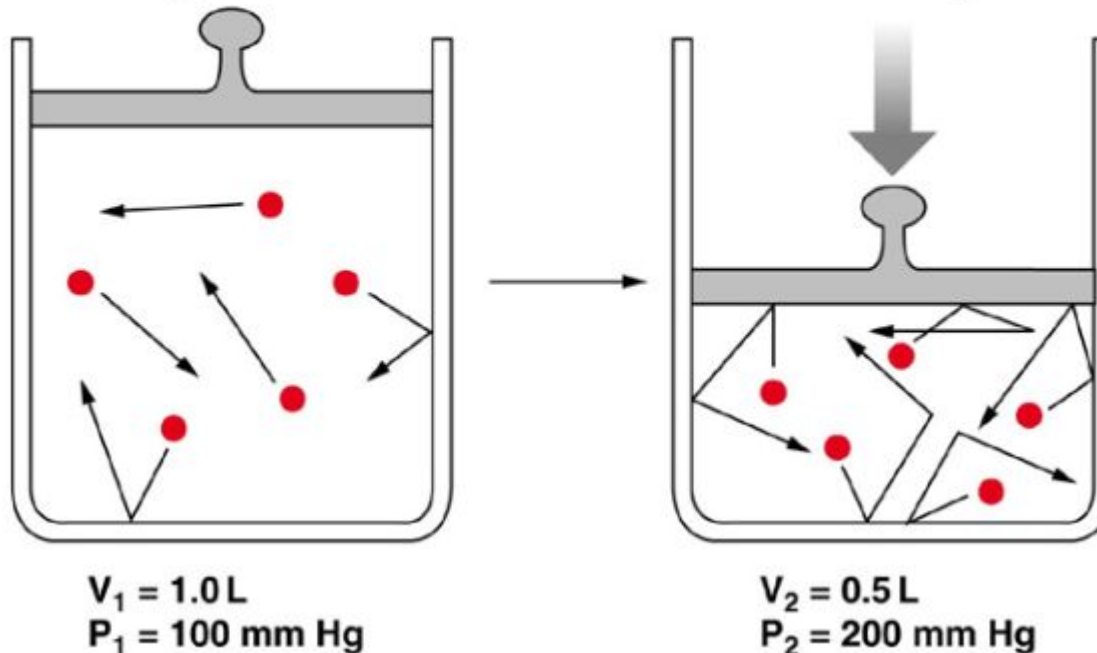
- Pulmonary ventilation (Breathing)
  - A gas always conforms to the **shape of its container**.
  - In a large **volume**, the gas molecules will be **far apart**, and the **pressure** (created by the gas molecules hitting each other and the walls of the container) will be **low**.

# Mechanics of Breathing

- Pulmonary ventilation (Breathing)
  - Assuming the amount of gas remains **constant**, if the volume is **reduced**, the gas molecules will be **closer together**, and the pressure will **rise**.

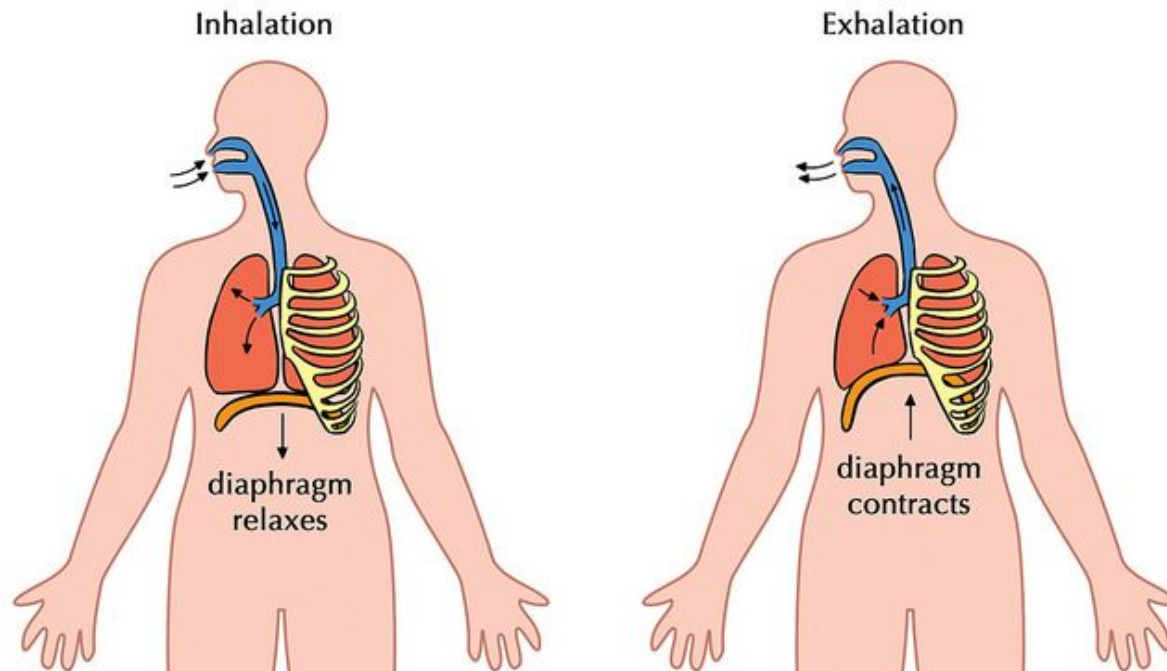
$$\text{Boyle's Law: } P_1 V_1 = P_2 V_2$$

Decreasing volume increases collisions and increases pressure.



# Mechanics of Breathing

- Two phases of pulmonary ventilation
  - Inspiration = **inhalation**
    - Flow of air **into** lungs
  - Expiration = **exhalation**
    - Air **leaving** lungs

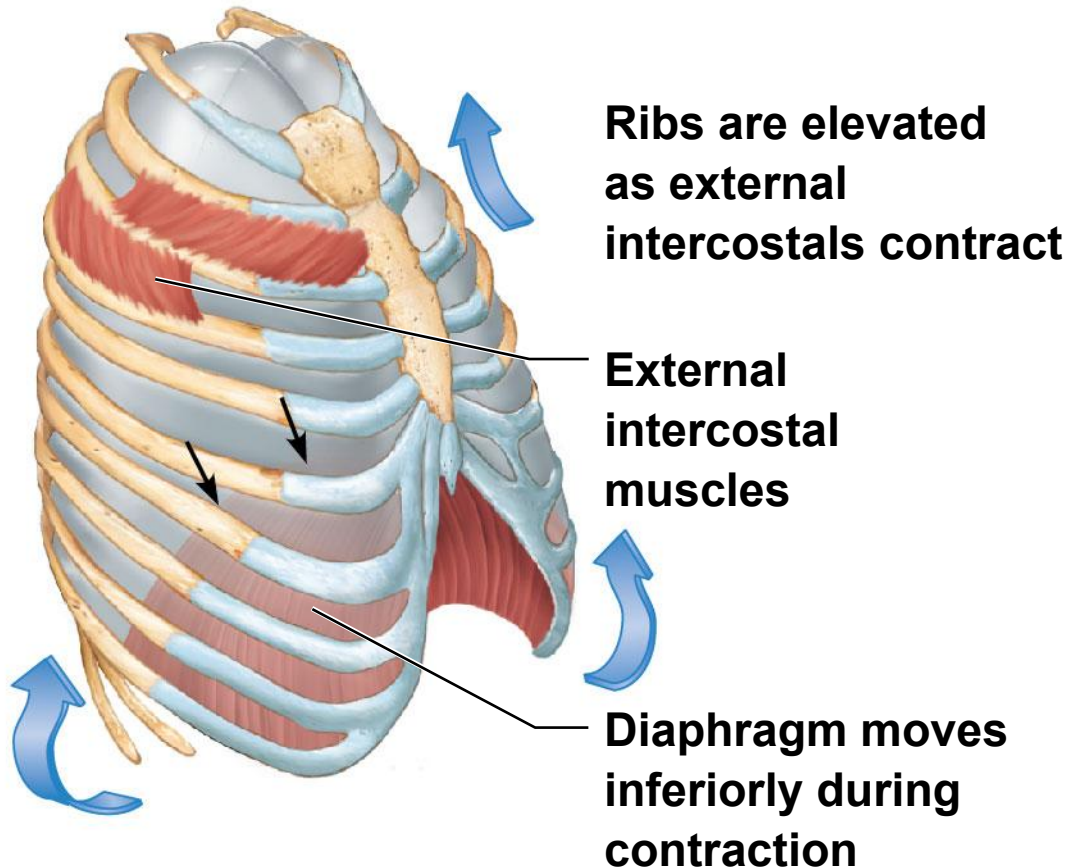




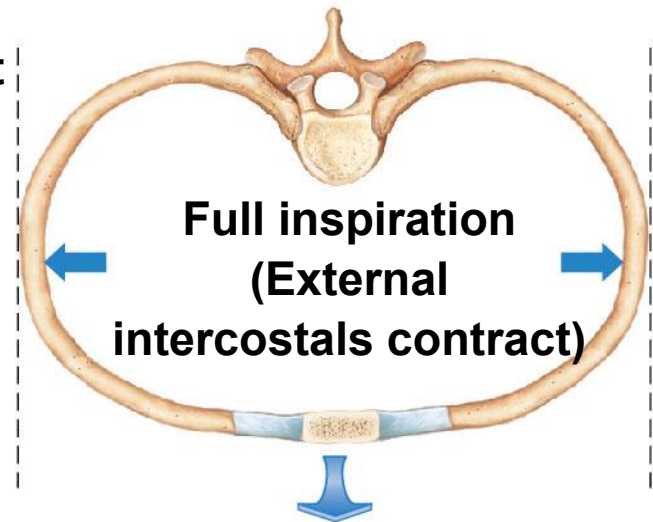
# Mechanics of Breathing

- Inspiration (inhalation)
  - Diaphragm and external intercostal muscles **contract**
  - Intrapulmonary volume **increases**
  - Gas pressure **decreases**
  - Air flows **into the lungs** until intrapulmonary pressure **equals** atmospheric pressure

## Changes in anterior-posterior and superior-inferior dimensions



## Changes in lateral dimensions

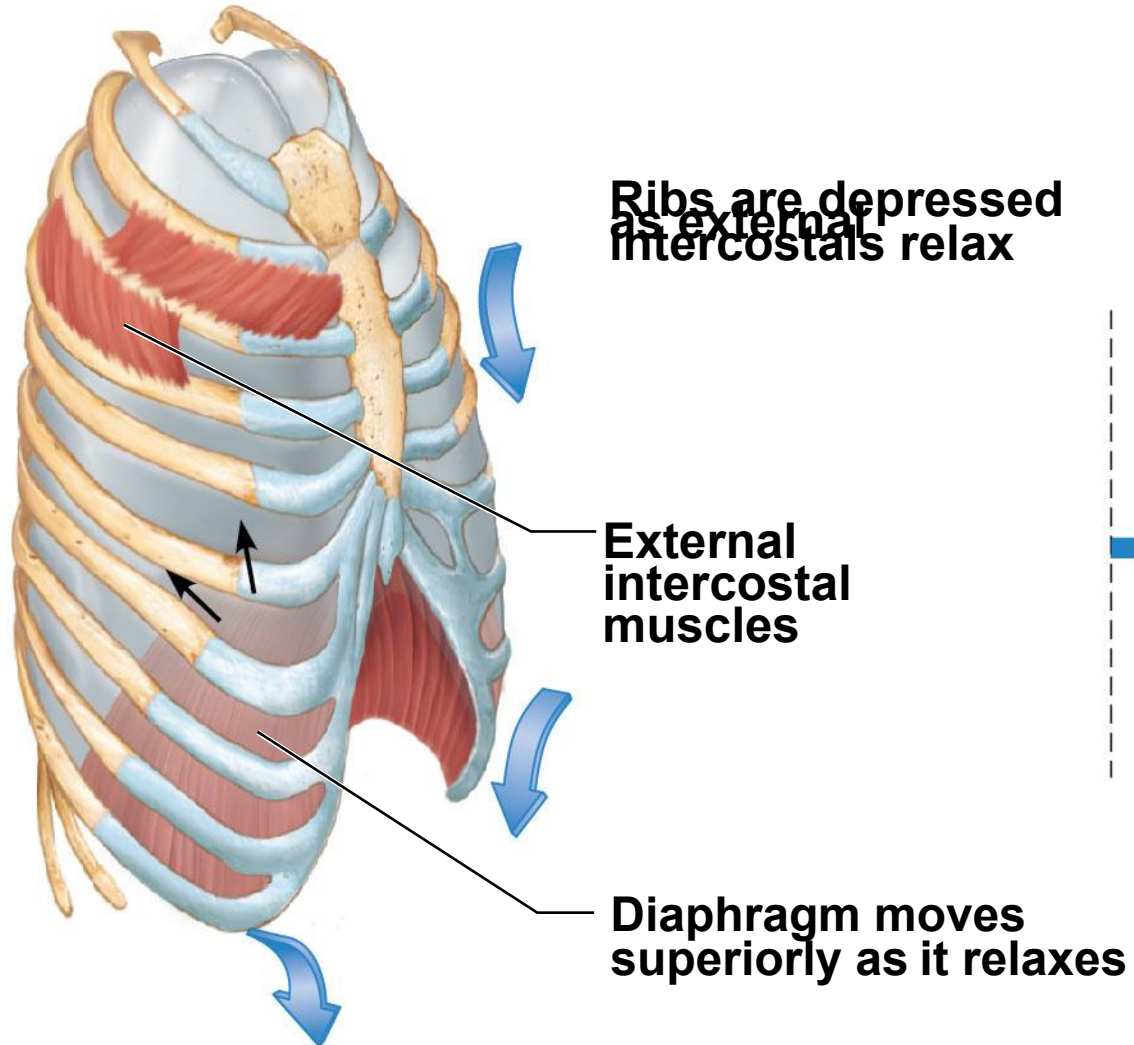


**Inspiration: Air (gases) flows into the lungs**

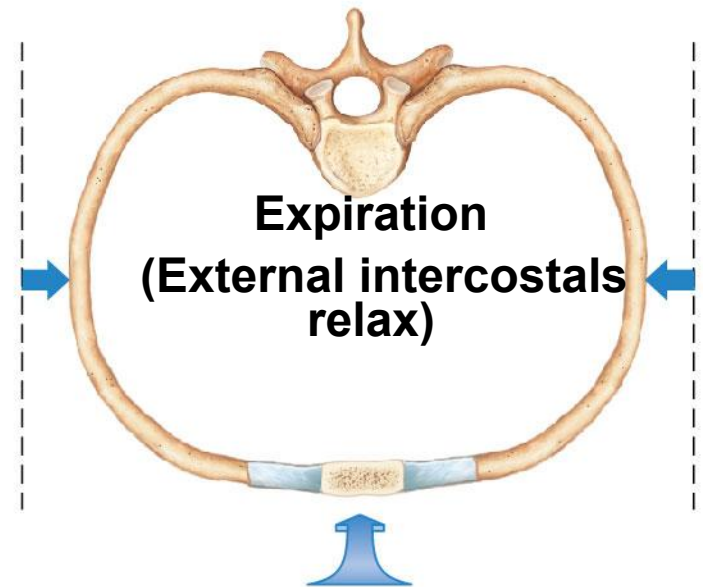
# Mechanics of Breathing

- Expiration (exhalation)
  - Largely a **passive** process that depends on natural lung elasticity
  - Diaphragm and external intercostal muscles **relax**
  - Intrapulmonary volume **decreases**
  - Gas pressure **increases**
  - Gases **passively flow out** to **equalize** the pressure
  - Forced expiration can occur mostly by contraction of internal intercostal muscles to depress the rib cage

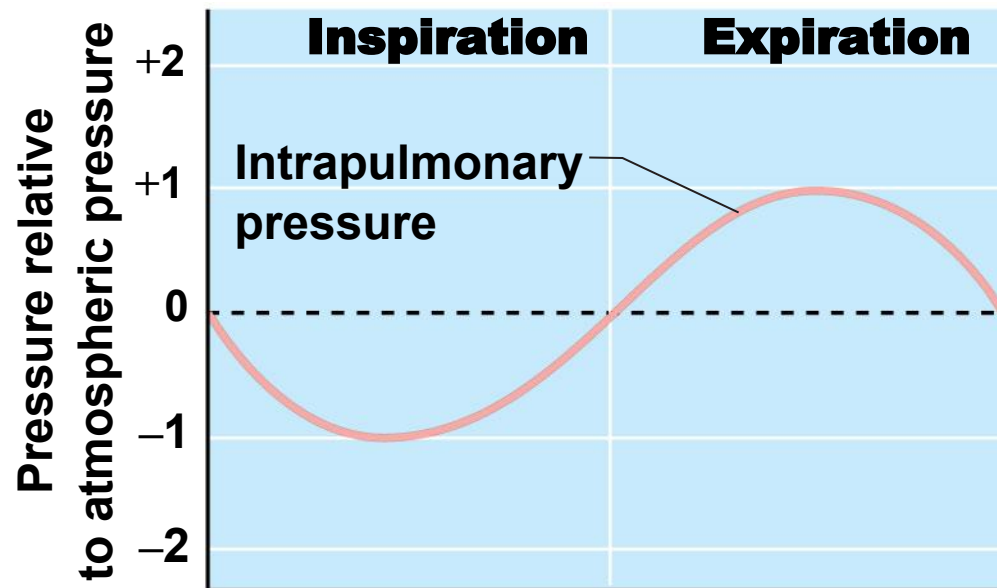
## Changes in anterior-posterior and superior-inferior dimensions



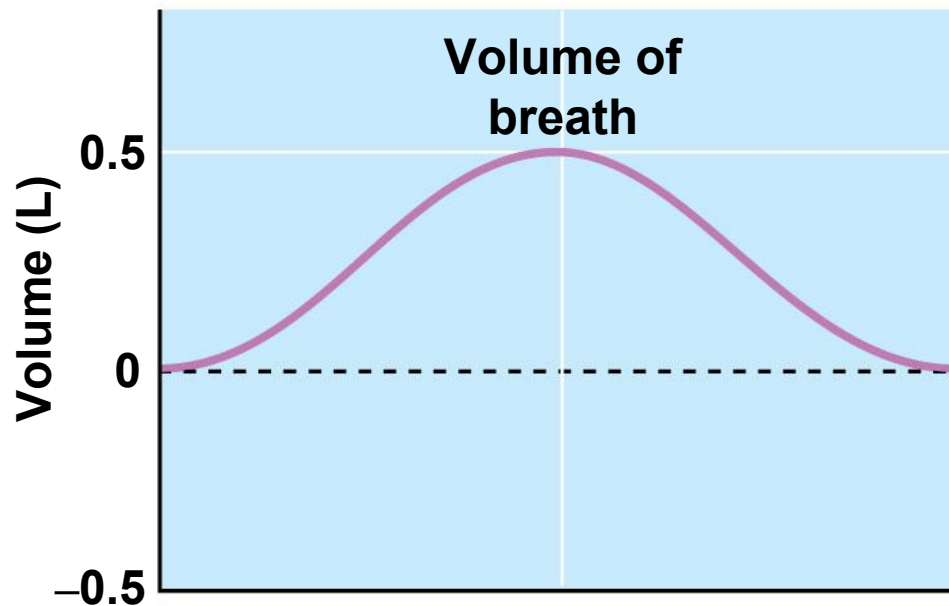
## Changes in lateral dimensions



**Expiration: Air (gases) flows out of the lungs**



**(a)**



**(b)**

# Mechanics of Breathing

- Intrapleural pressure
  - The pressure within the pleural space is **always negative**
    - Major factor preventing lung collapse
  - If intrapleural pressure **equals** atmospheric pressure, the lungs **recoil and collapse**

## MECHANICS OF BREATHING

