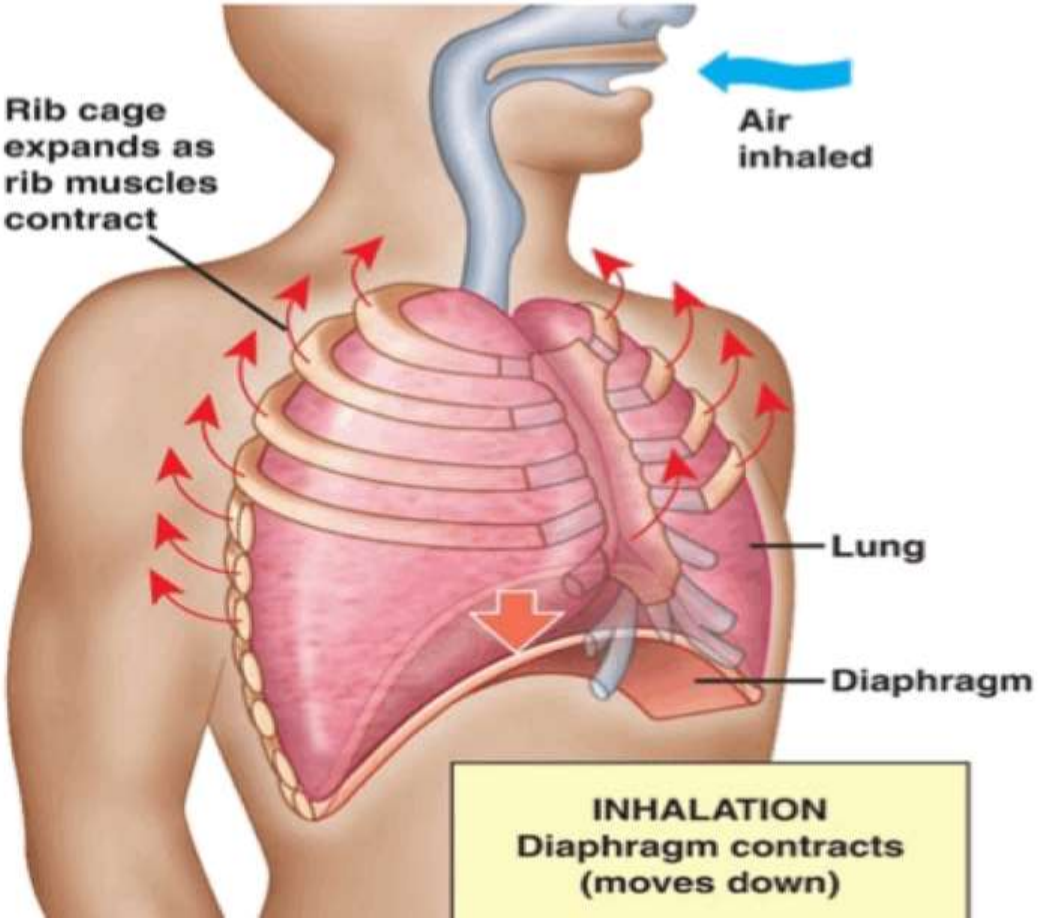
Mechanism Of Breathing & Respiratory Muscles



Introduction

- ***Respiration precisely includes:***

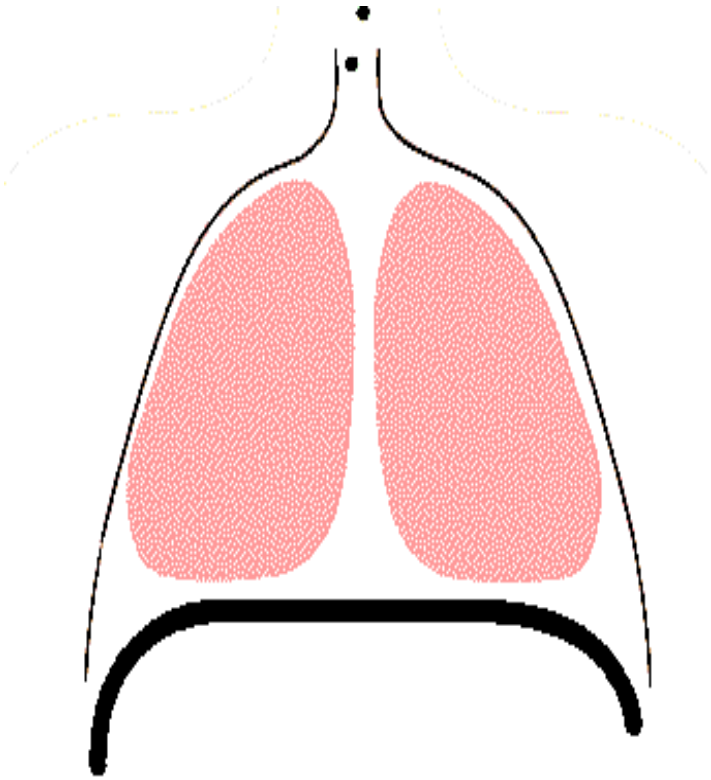
A. Pulmonary Ventilation

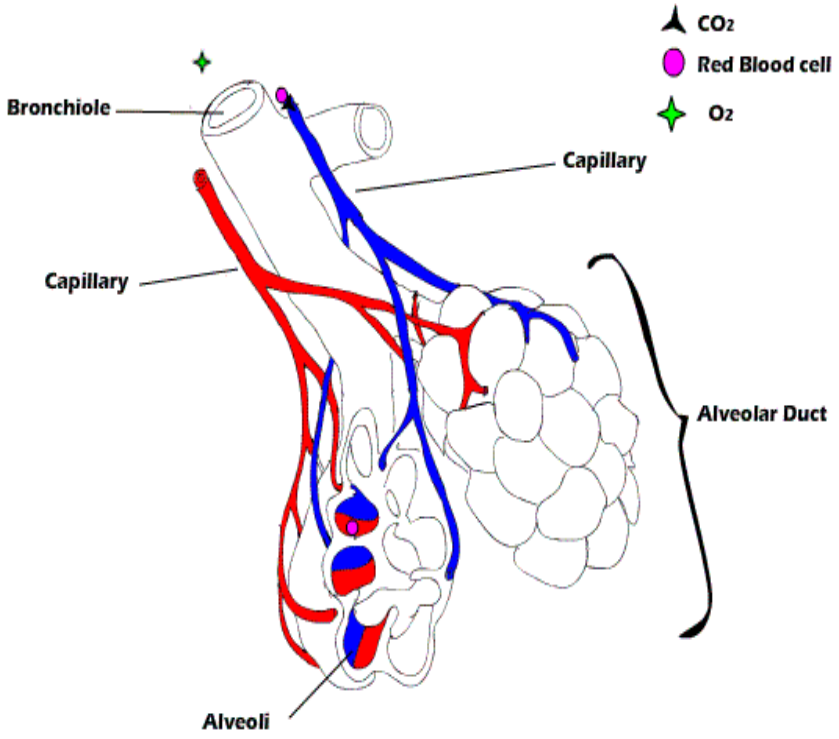
B. Pulmonary Diffusion

C. Transport of Gases

D. Regulation of respiration

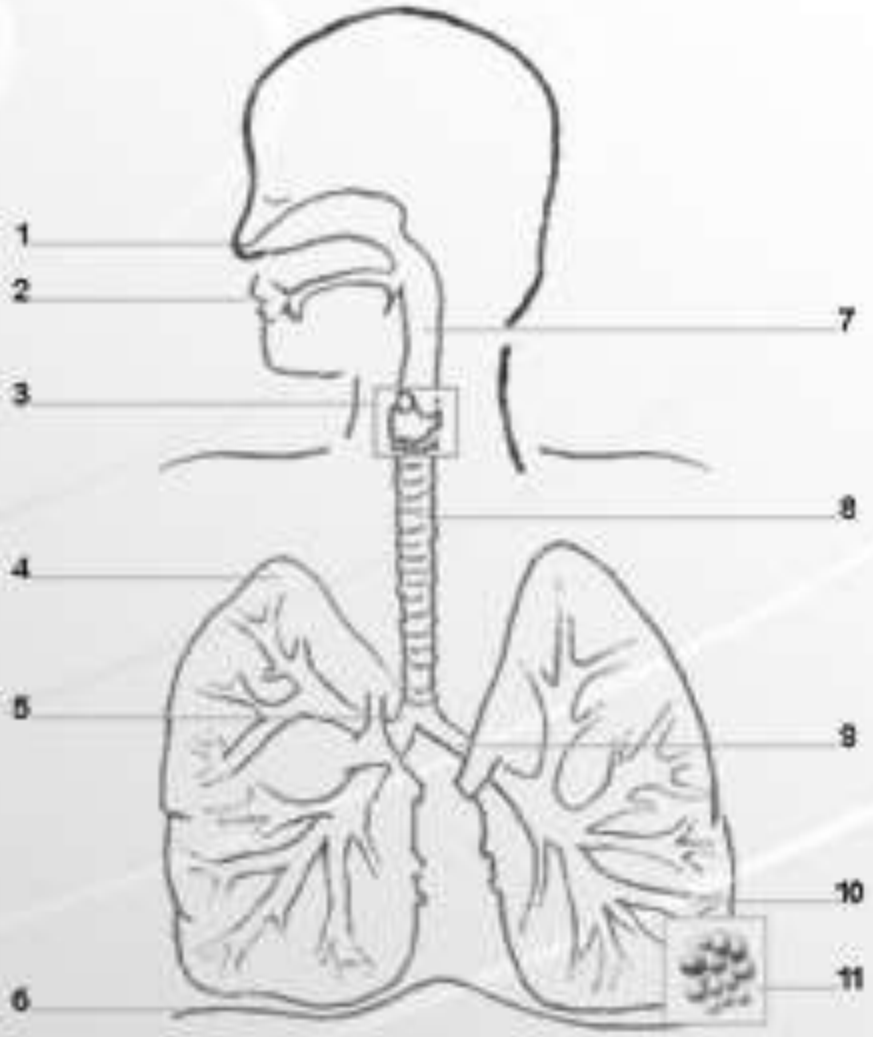
Mechanism of Pulmonary Ventilation





Respiratory System

1. Nasal Cavity
2. Oral Cavity
3. Larynx
4. Right Lung
5. Right Bronchus
6. Diaphragm
7. Pharynx
8. Trachea
9. Left Bronchus
10. Bronchiole
11. Alveoli



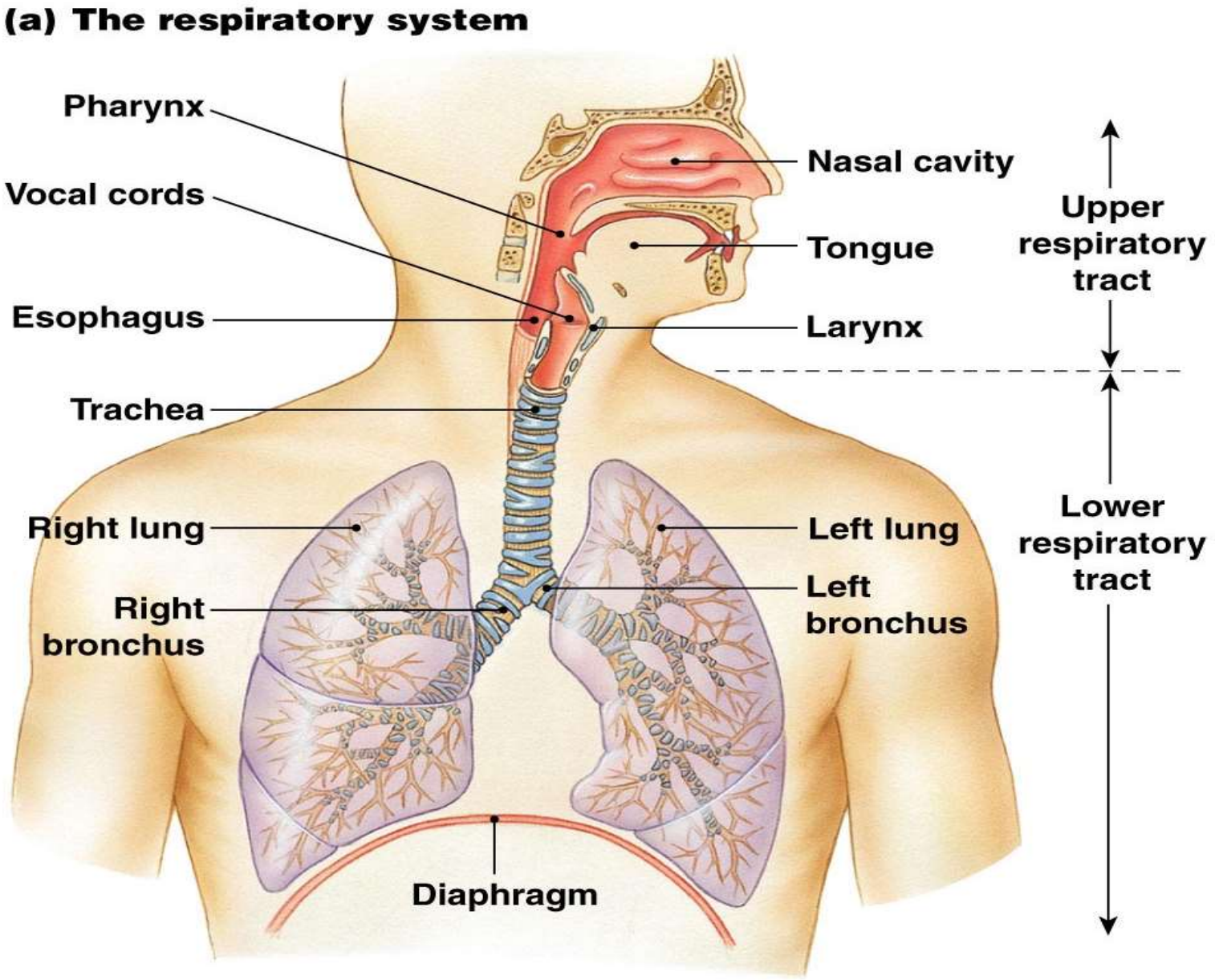

(a) The respiratory system
Pharynx
Vocal cords
Esophagus
Trachea
Right lung
Right bronchus
Nasal cavity
Tongue
Larynx
Left lung
Left bronchus
Diaphragm
Upper respiratory tract
Lower respiratory tract

Figure 17-2a

Boyle's Law

Gases move from areas of high pressure to areas of low pressure

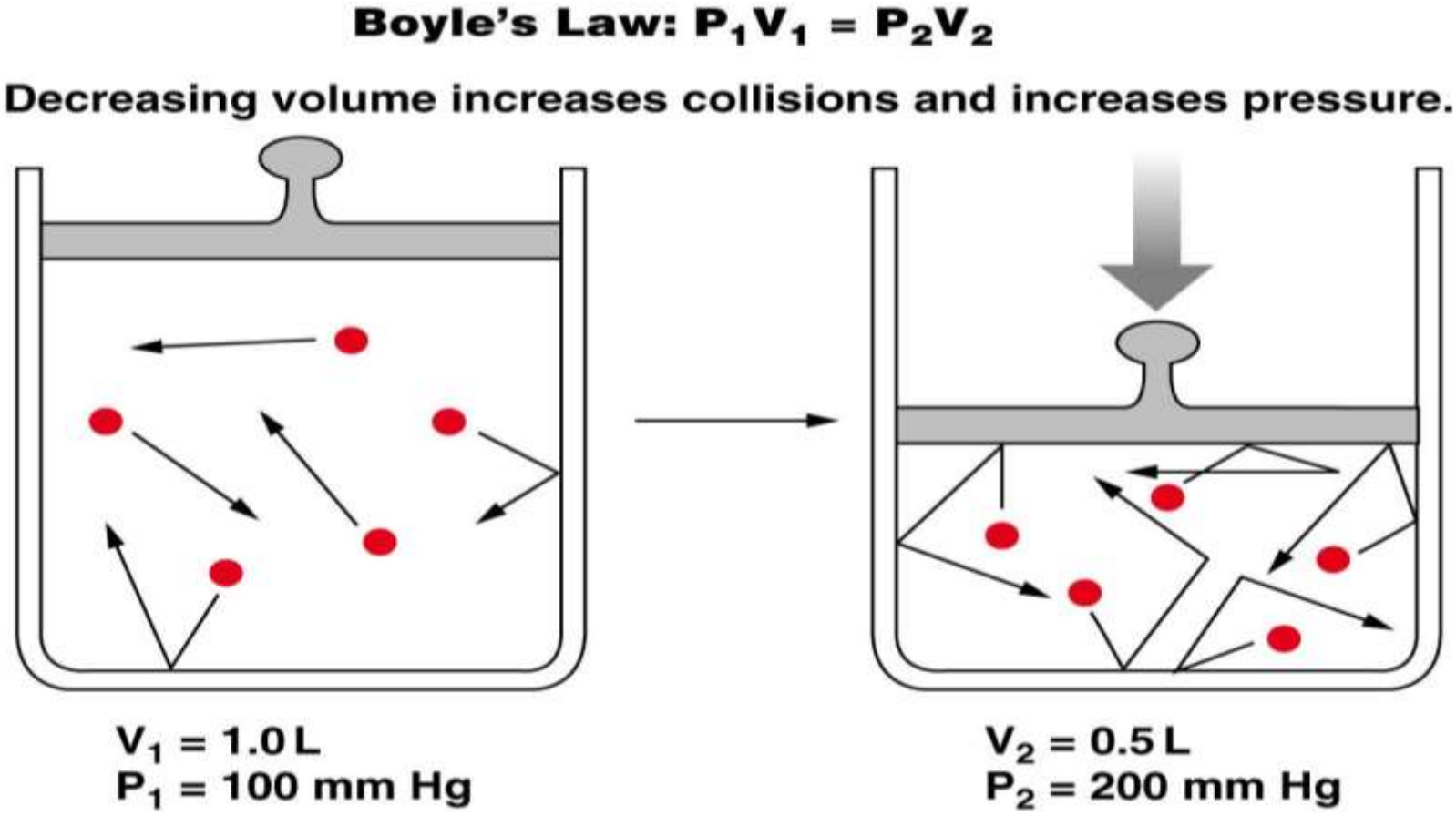


Figure 17-5

Mechanism Of Breathing includes:

Inspiration- refers to inflow of atmospheric air into the lungs

Expiration- refers to the outflow of air from the lungs into the atmosphere

Muscles Of Respiration are:

Tidal Inspiration

- Diaphragm
- External Intercostals

Accessory Muscle of Inspiration

- Scaleni
- Strenocleidomastoid
- Serratus Anterior
- Alae Nasi,
- Pectoralis

Muscles Of Expiration:

Internal Intercostal

Abdominal Recti

Muscles Used for Ventilation

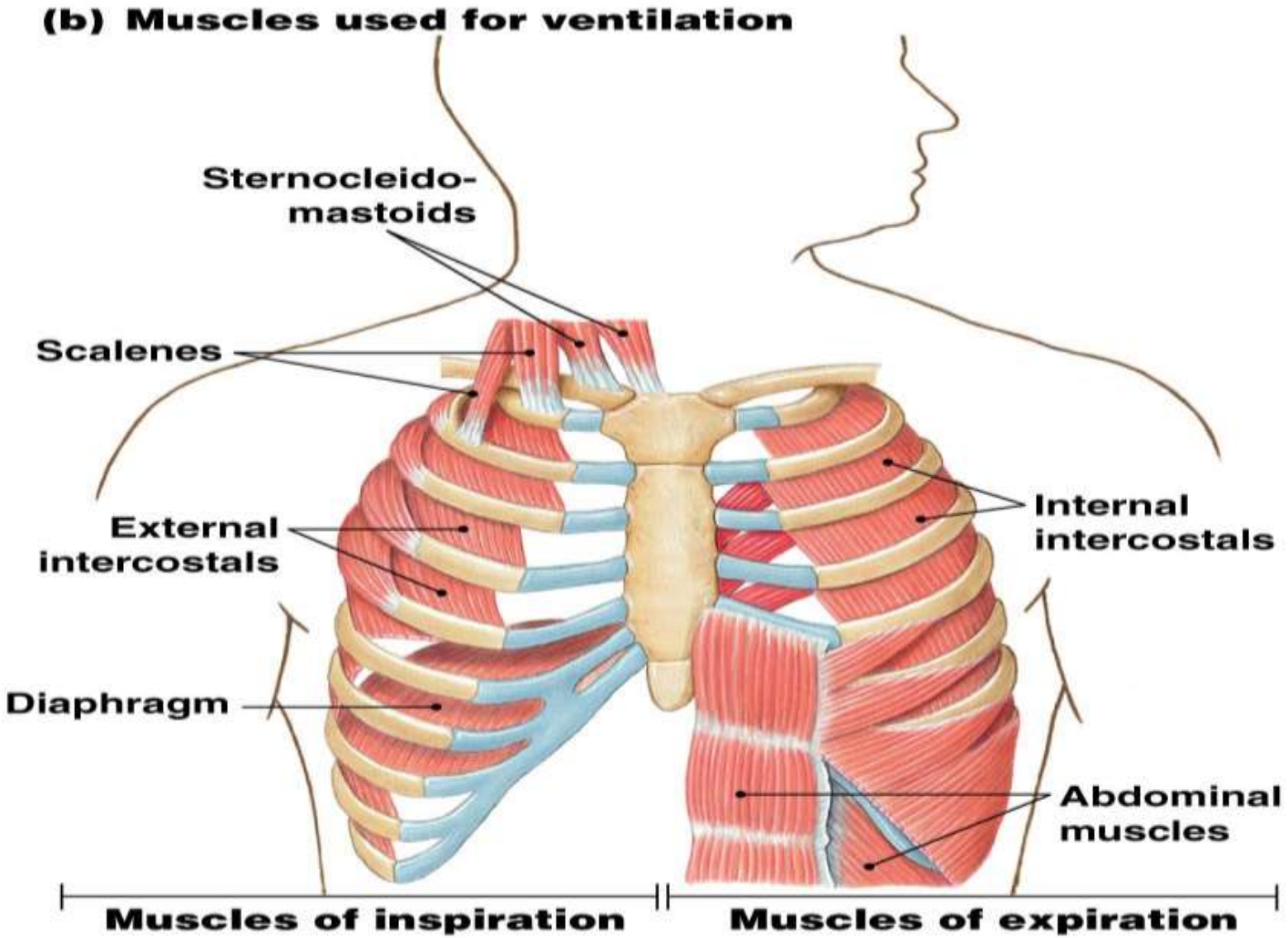
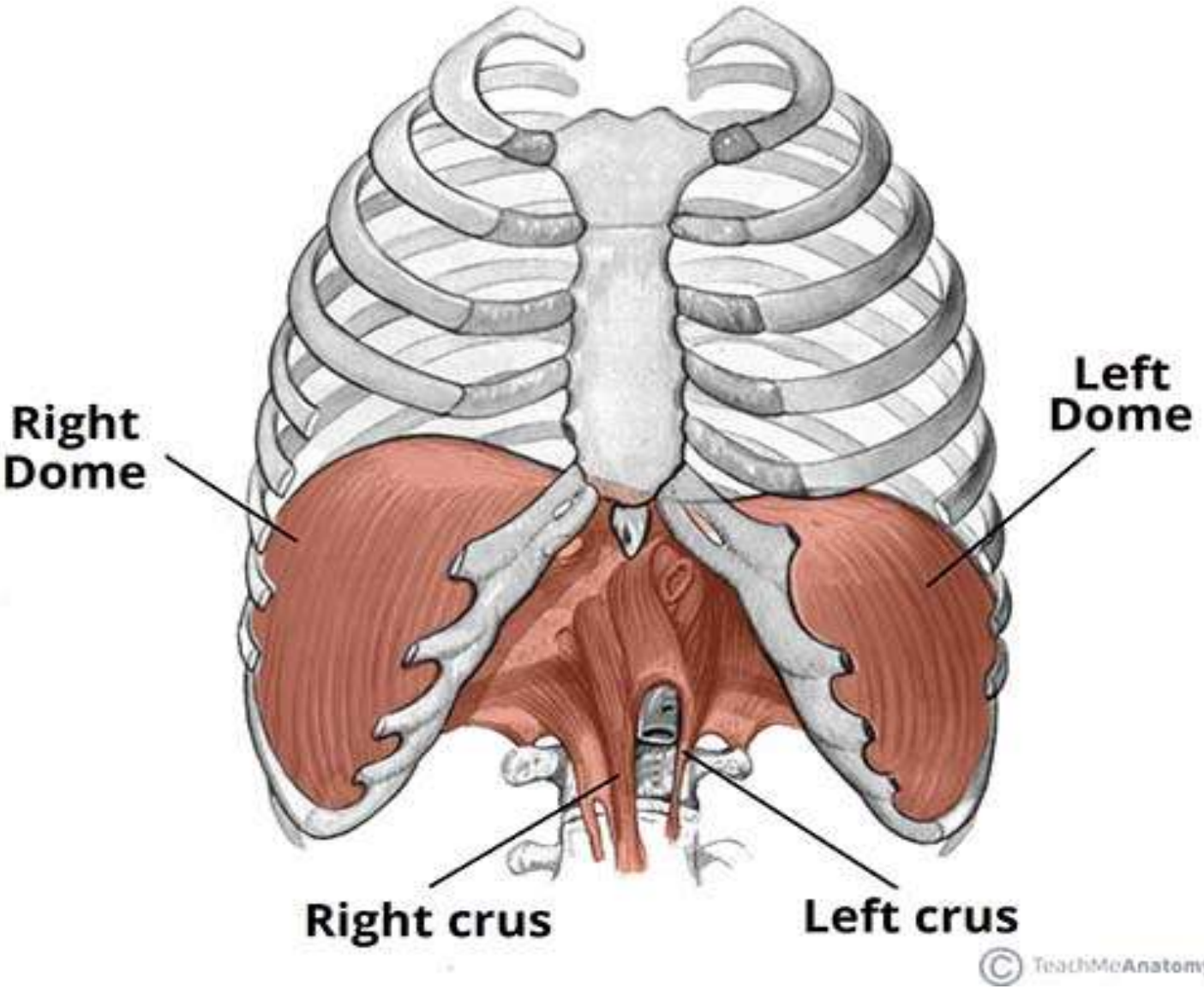


Figure 17-2b


Right Dome
Left Dome
Right crus
Left crus
© TeachMeAnatomy

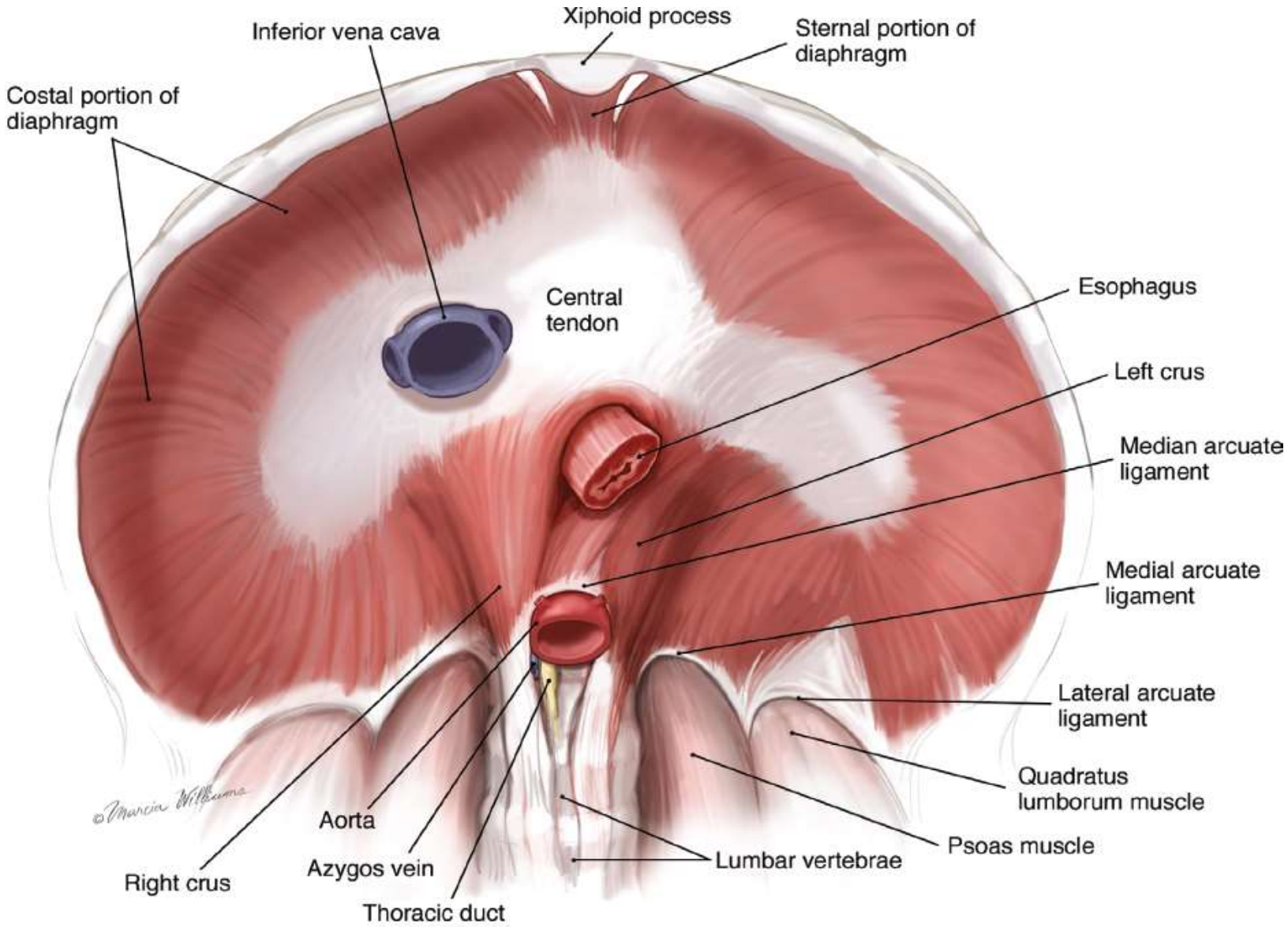
- **Diaphragm is a dome shaped muscle, that acts an anatomical barrier**
- **Separates Thoracic cavity from Abdominal cavity**
- **It is attached to lumbar portion of spine by CRUS of Diaphragm**
- **Also attached to thoracic wall by sternum**
- **Innervated by Phrenic Nerve (C3-C5)**

Three parts of Diaphragm

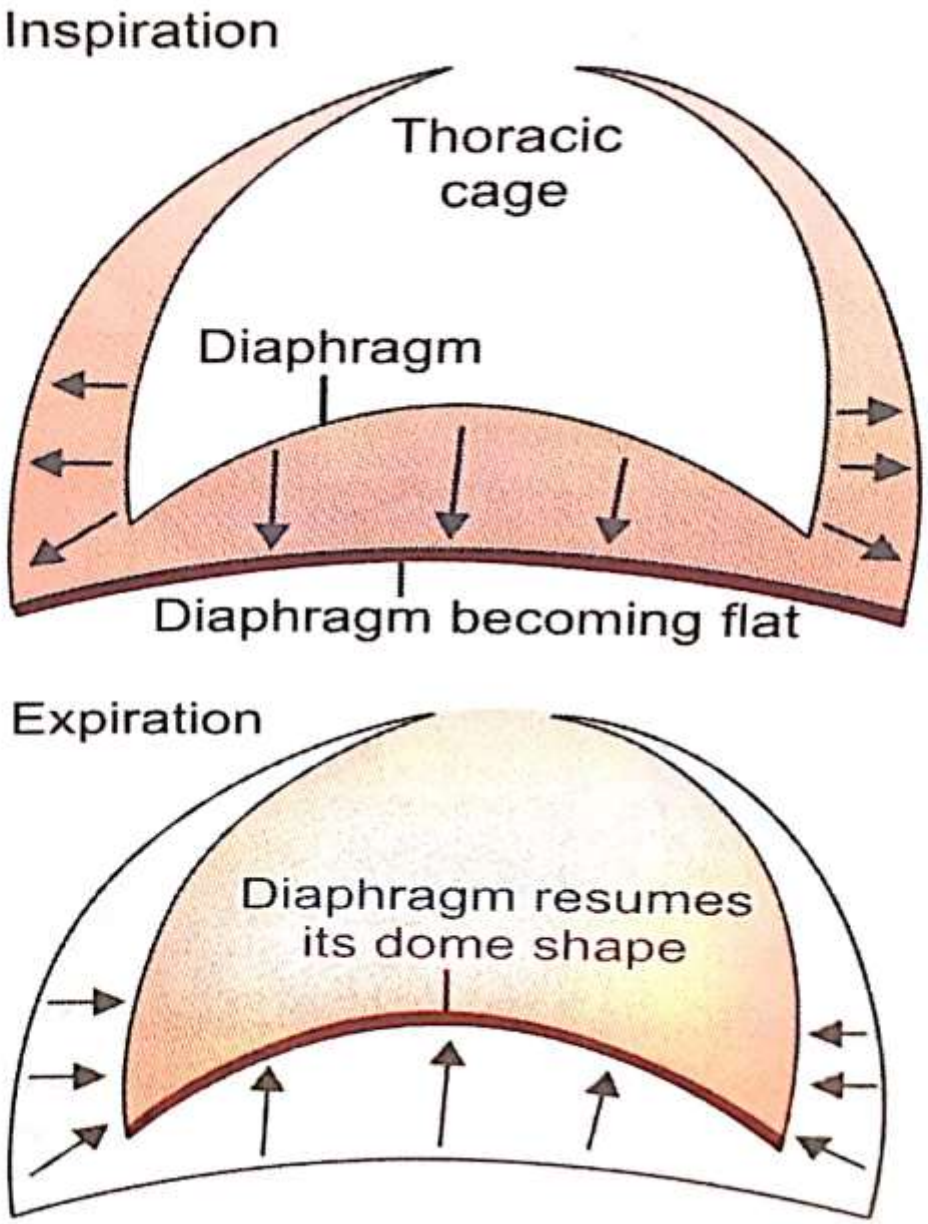
Costal

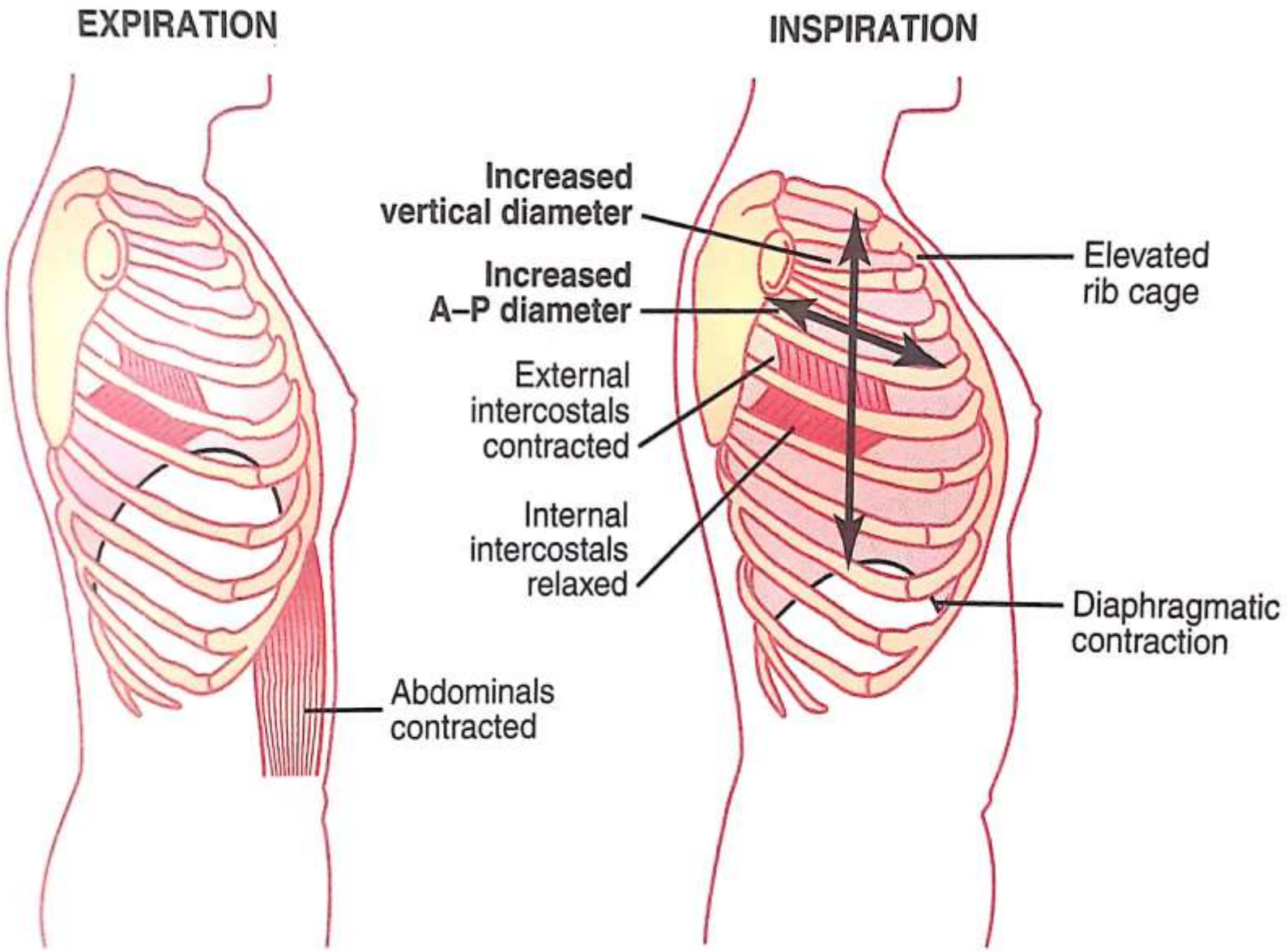
Central Tendon

Crural



Source: D. J. Sugarbaker, R. Bueno, Y. L. Colson, M. T. Jaklitsch, M. J. Krasna, S. J. Mentzer, M. Williams, A. Adams: *Adult Chest Surgery*, 2nd Edition: www.accesssurgery.com


Inspiration
Thoracic cage
Diaphragm
Diaphragm becoming flat
Expiration
Diaphragm resumes its dome shape


EXPIRATION
INSPIRATION
Increased vertical diameter
Increased A–P diameter
External intercostals contracted
Internal intercostals relaxed
Elevated rib cage
Diaphragmatic contraction
Abdominals contracted

Quiet Inspiration

Role Of Diaphragm

- **When Diaphragm contracts-**

The diaphragm becomes flattened, level of diaphragm is lowered increasing vertical diameter of thoracic cavity

The upward & downward movement of Diaphragm lengthens & shortens the chest cavity

Movement of the Diaphragm

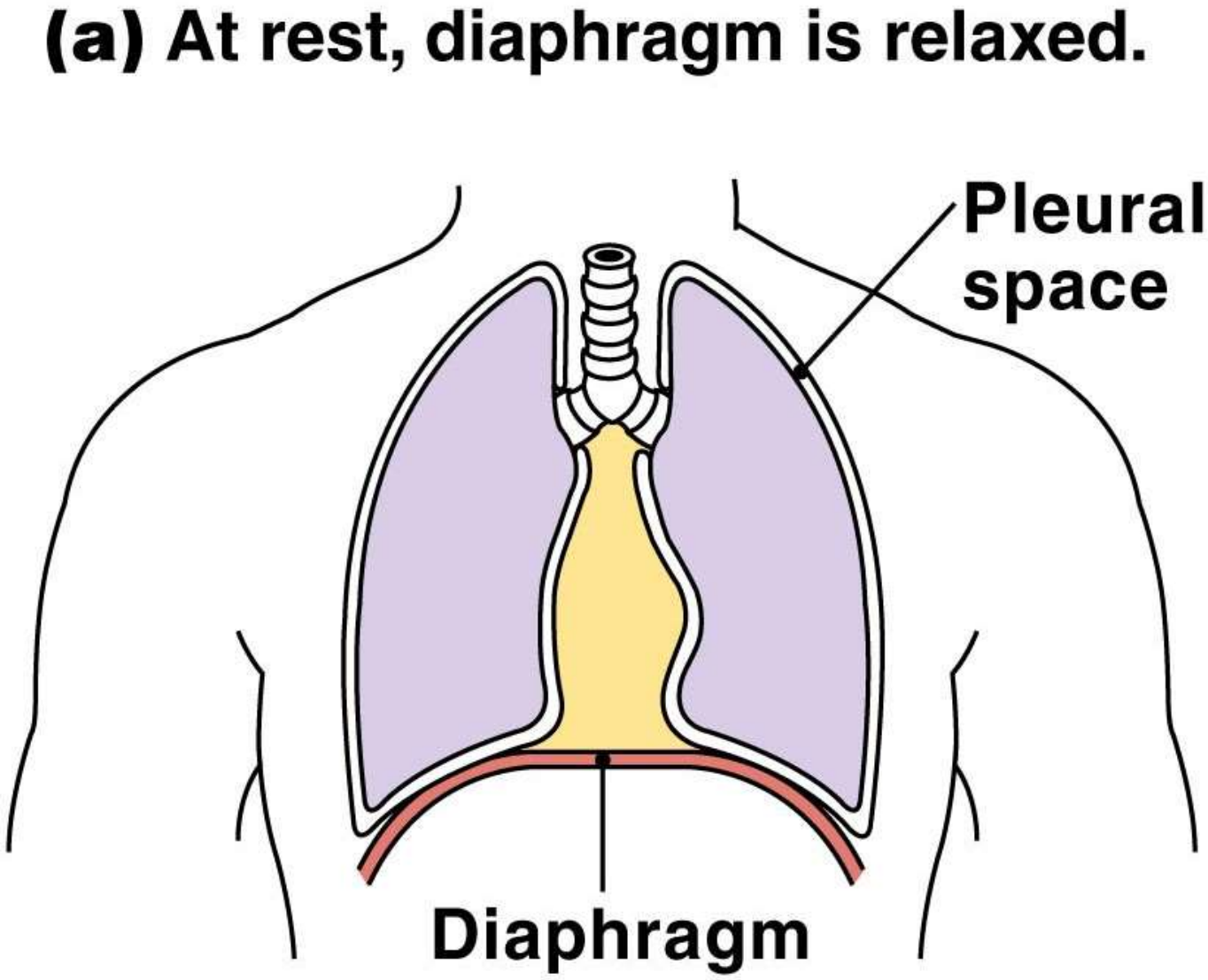


Figure 17-9a

Movement of the Diaphragm

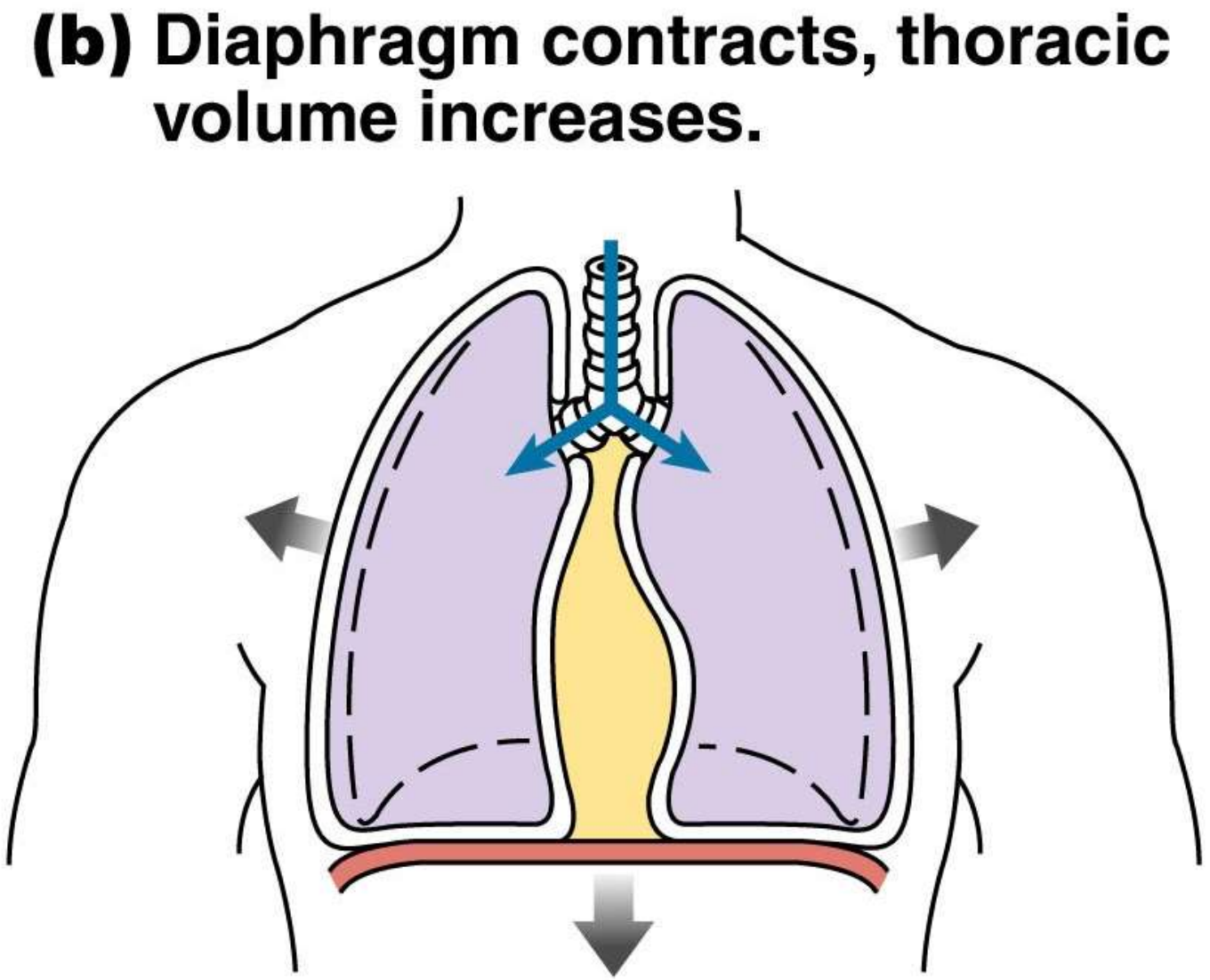


Figure 17-9b

Movement of the Diaphragm

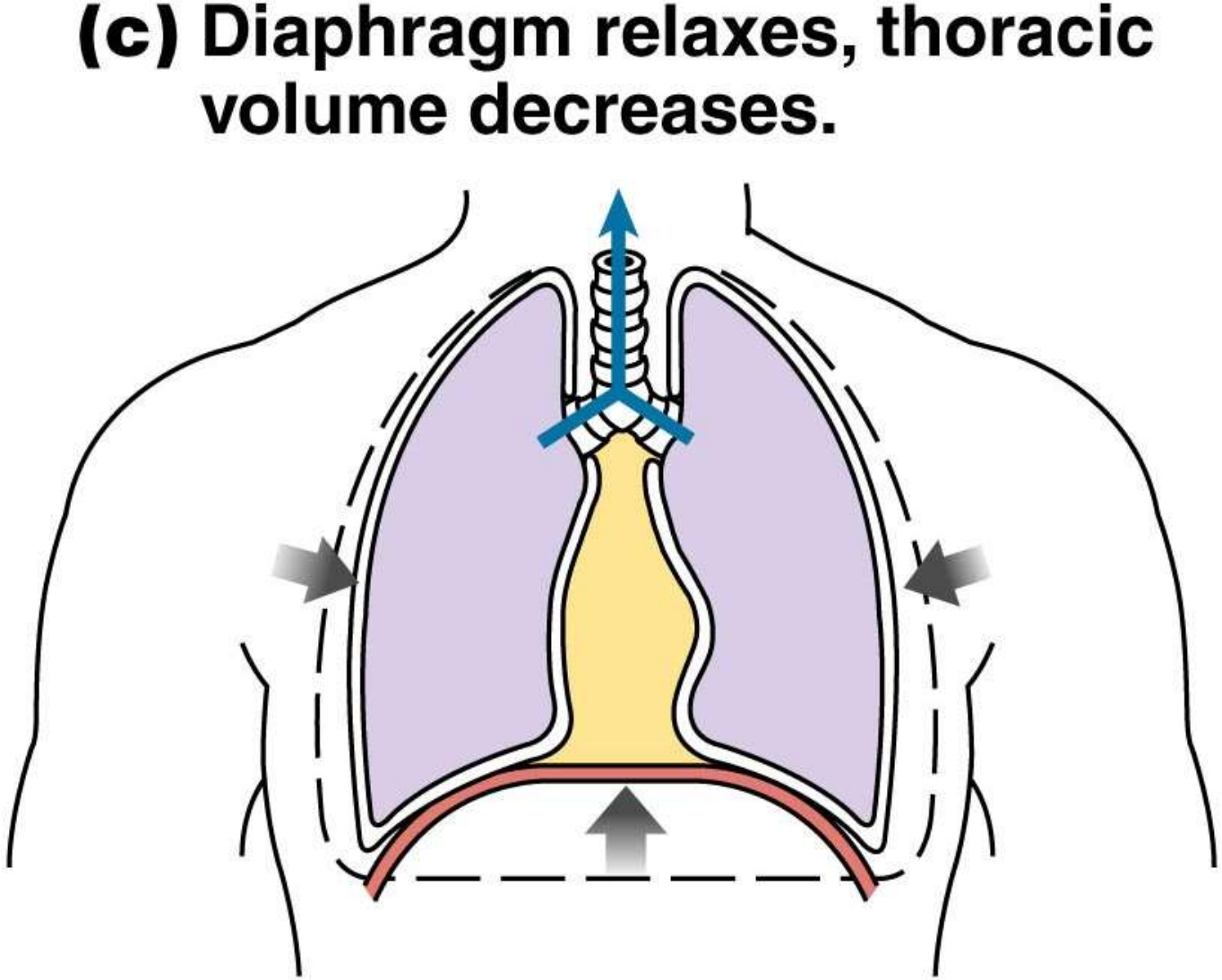
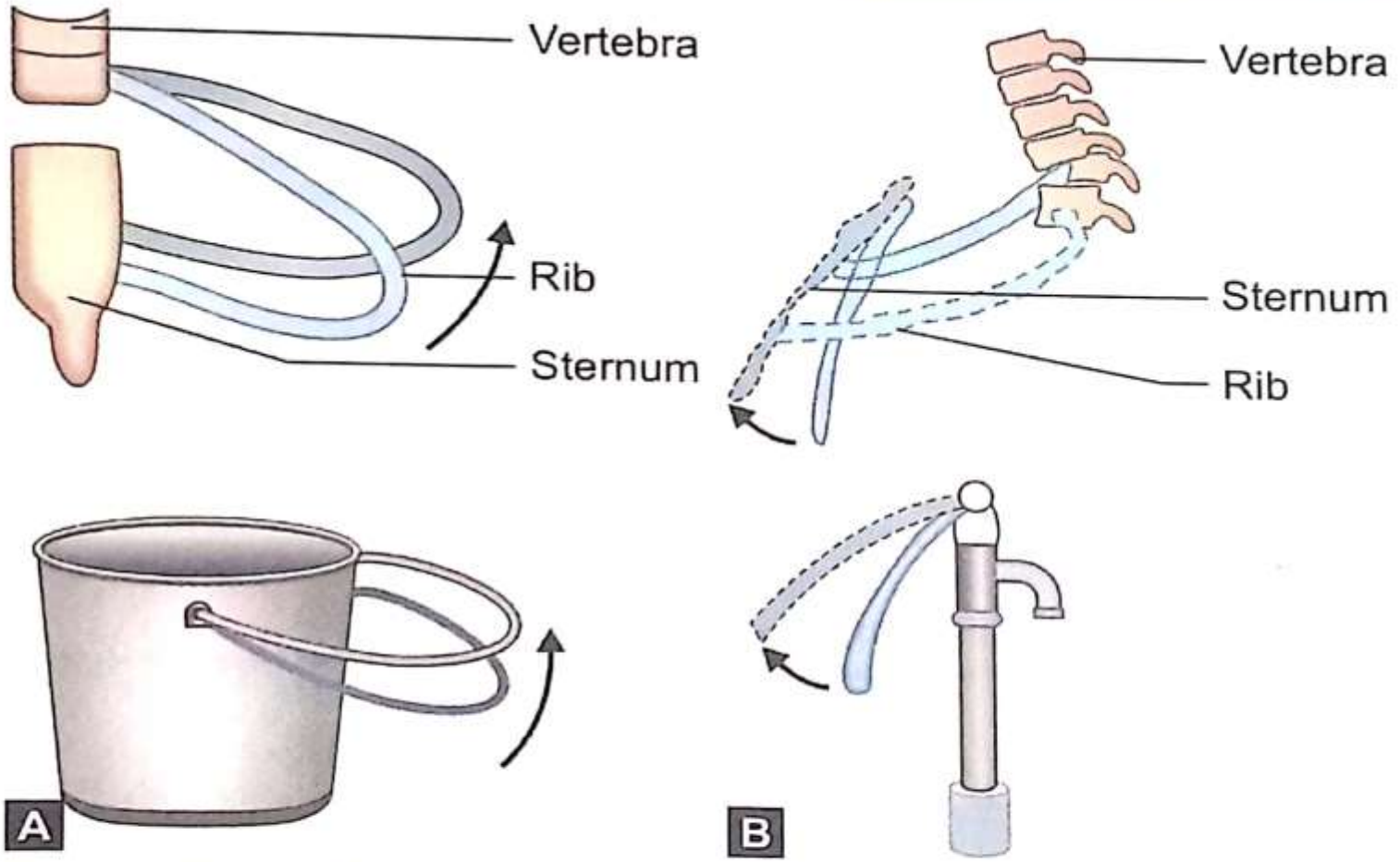


Figure 17-9c

- **Diaphragm accounts for 75% of the change in the intrathoracic volume during quiet inspiration**
- **Attached around bottom of the thoracic cage, arches over the liver**
- **Moves down like a piston when it contracts**
- **Descent is 1.5 to 2 cms during normal quiet breathing and about 7 cms with deep inspiration**

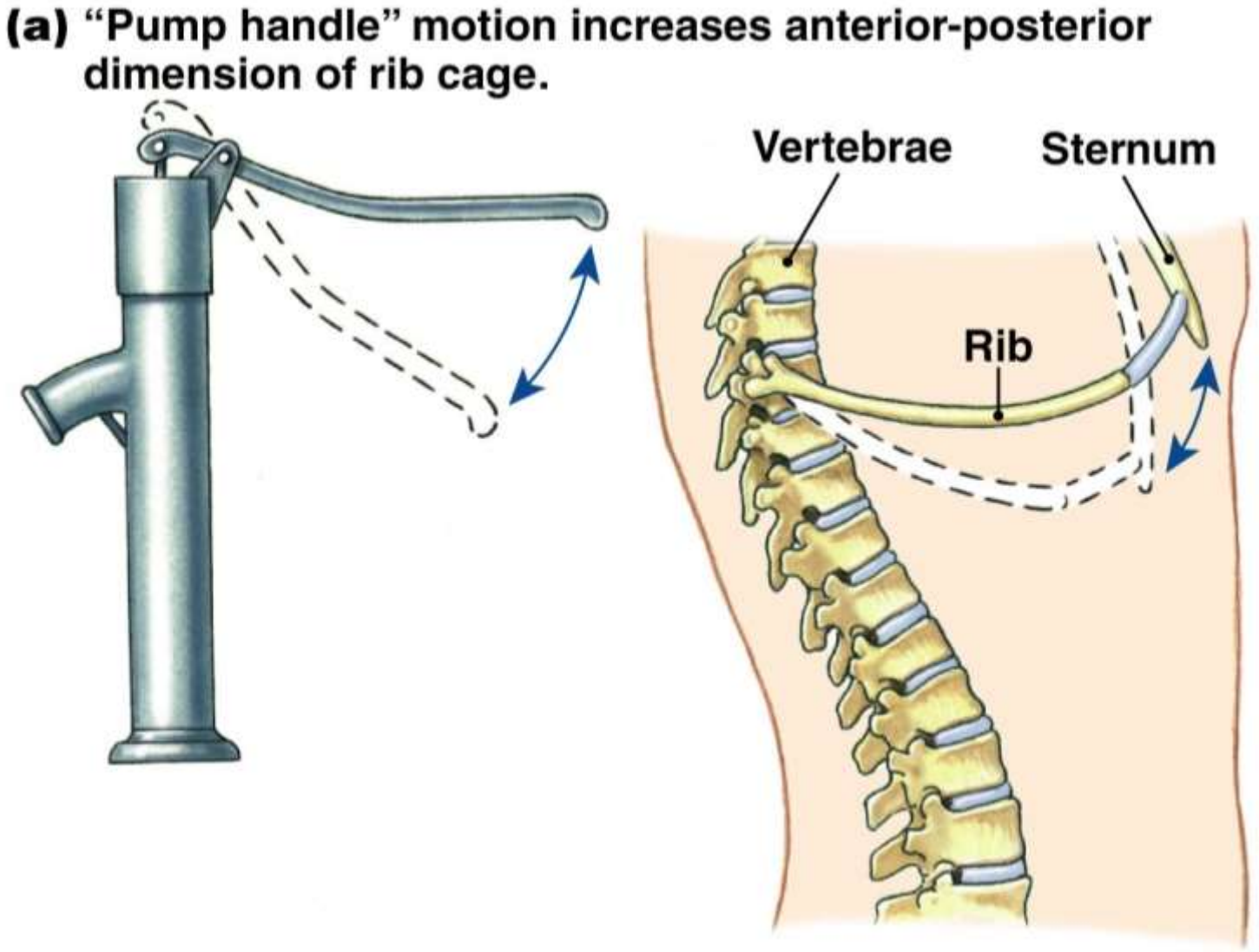
Rise in intraabdominal pressure, reciprocal relaxation of abdominal wall

Lifts the lower ribs causing the thoracic expansion transversely (Bucket handle movement) & vertically (Pump handle effect)



Figs. 66.2A and B: Mechanism of bucket-handle (A) and pump-handle (B) movements of ribs of thoracic cage. Note bucket-handle effect increases transverse diameter and pump-handle effect increases vertical diameter of thoracic cage.

Movement of the Rib Cage during Inspiration



re 17-10a

Movement of the Rib Cage during Inspiration

(b) "Bucket handle" motion increases lateral dimension of rib cage.

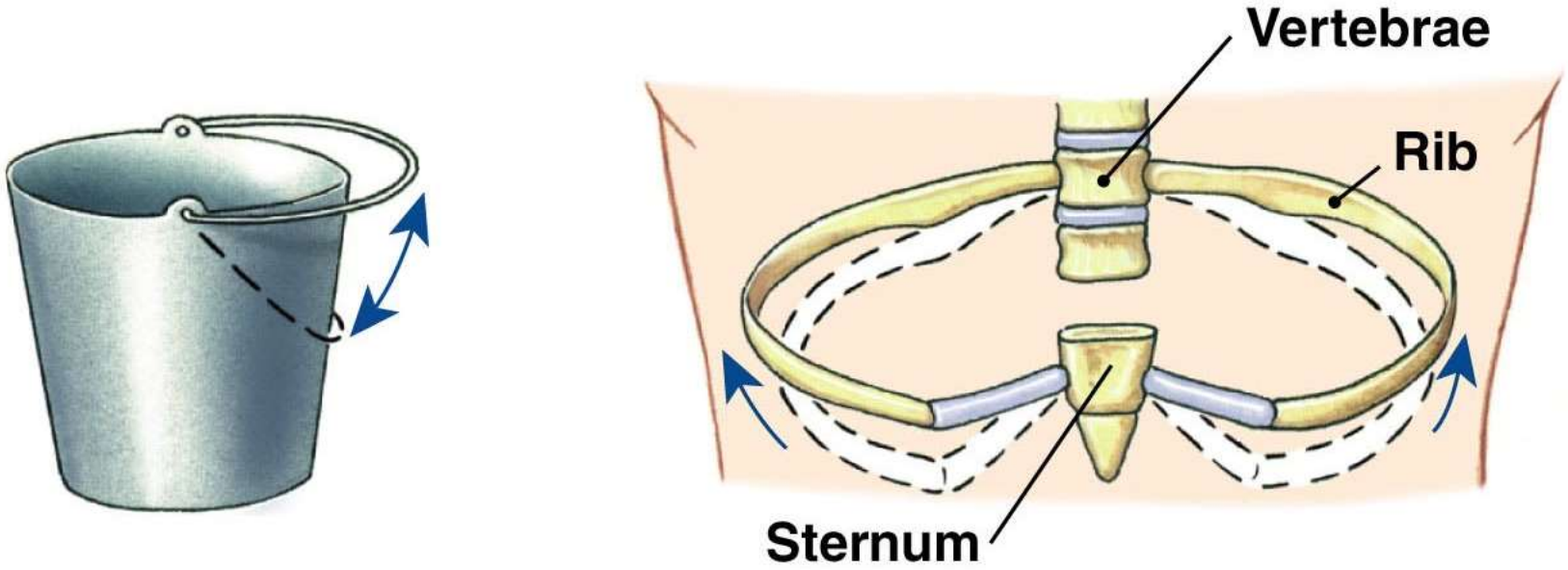
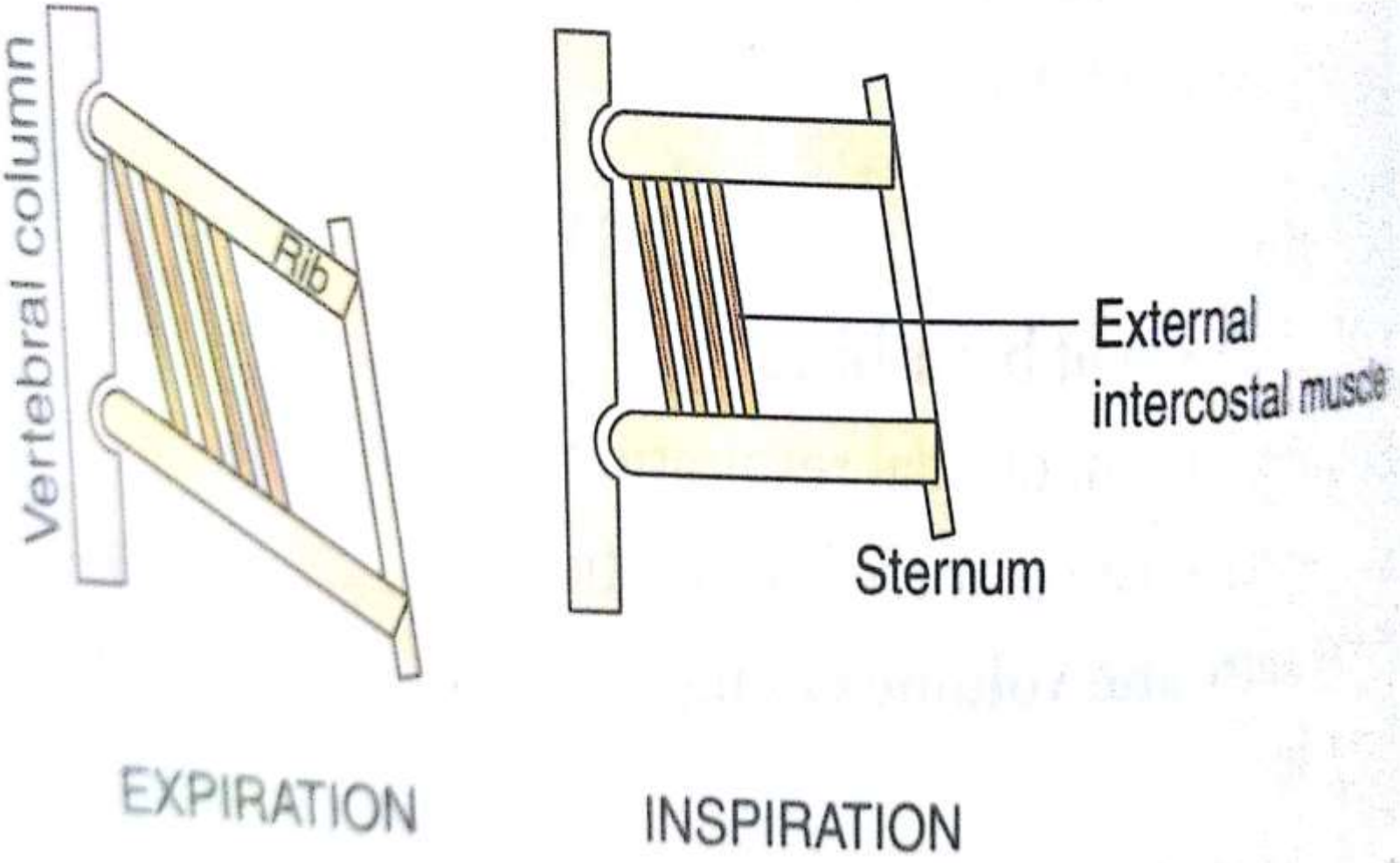


Figure 17-10b

Role Of External Intercostals:

- Fibers of this muscle slope downwards & forward, attached close to the vertebral ends of the upper ribs

- When they contract-
- The ribs are elevated causing lateral or transverse (Bucket handle effect) & anteropoterior or vertical (pump handle effect) enlargement of the thoracic cavity
- Sternum is pushed outwards causing increase in anteroposterior diameter


Vertebral column
Rib
External
intercostal muscle
Sternum
EXPIRATION
INSPIRATION

Forced Inspiration

- **Forceful contraction of Diaphragm**
- **Forceful contraction of External Intercostals muscles**
- **Contraction of Accessory muscles of Inspiration**

❖**Sternocleidomastoid muscles contract & lifts the sternum upwards**

❖**Ant. Serrati muscle contracts lifts many muscles**

❖**Scaleni muscle contract & lifts first two ribs**

Expiration

- **Passive Mechanism, unlike the Inspiration which is an Active mechanism**

Bought about by :

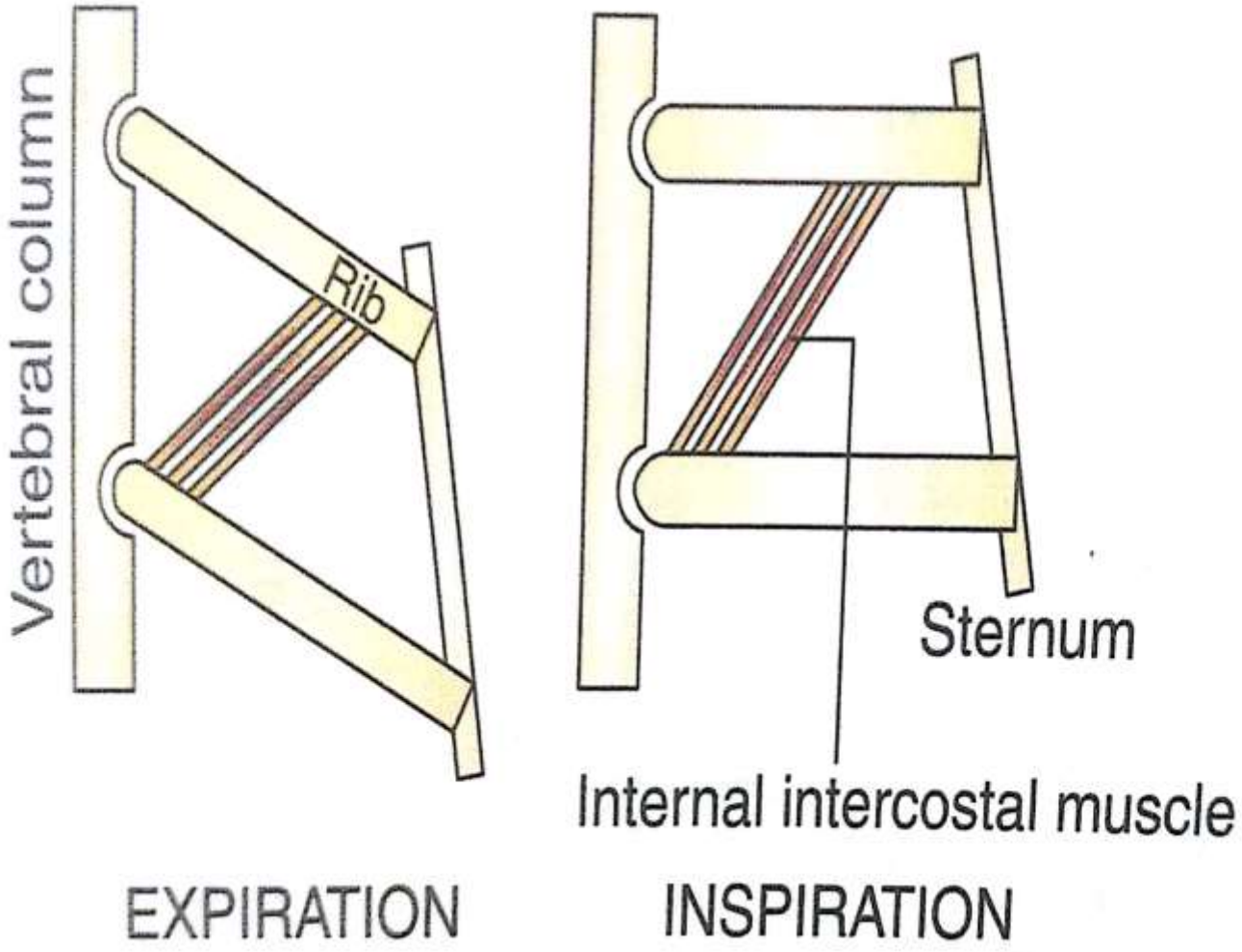
A. Elastic recoil of the lungs

B. Decrease in size of the thoracic cavity due to relaxation of Diaphragm & external intercostal muscles

C. Increase in tone of muscle of anterior abdominal wall, pulls Diaphragm upwards (by increasing the intra-abdominal pressure)

Role of Internal Intercostals:

These muscles pass obliquely downwards & posteriorly from rib to rib therefore pull the rib cage downwards when they contract


Vertebral column
Rib
Sternum
Internal intercostal muscle
EXPIRATION
INSPIRATION

Forced Expiration

- **Contraction of the abdominal muscles, (reducing vertical diameter of thoracic cavity)**

- **Downward pull on the lower ribs, (decreasing the anteroposterior diameter)**
- **Contraction of the internal intercostals, (pulls all the ribs downwards- reducing anteroposterior & transverse diameter)**

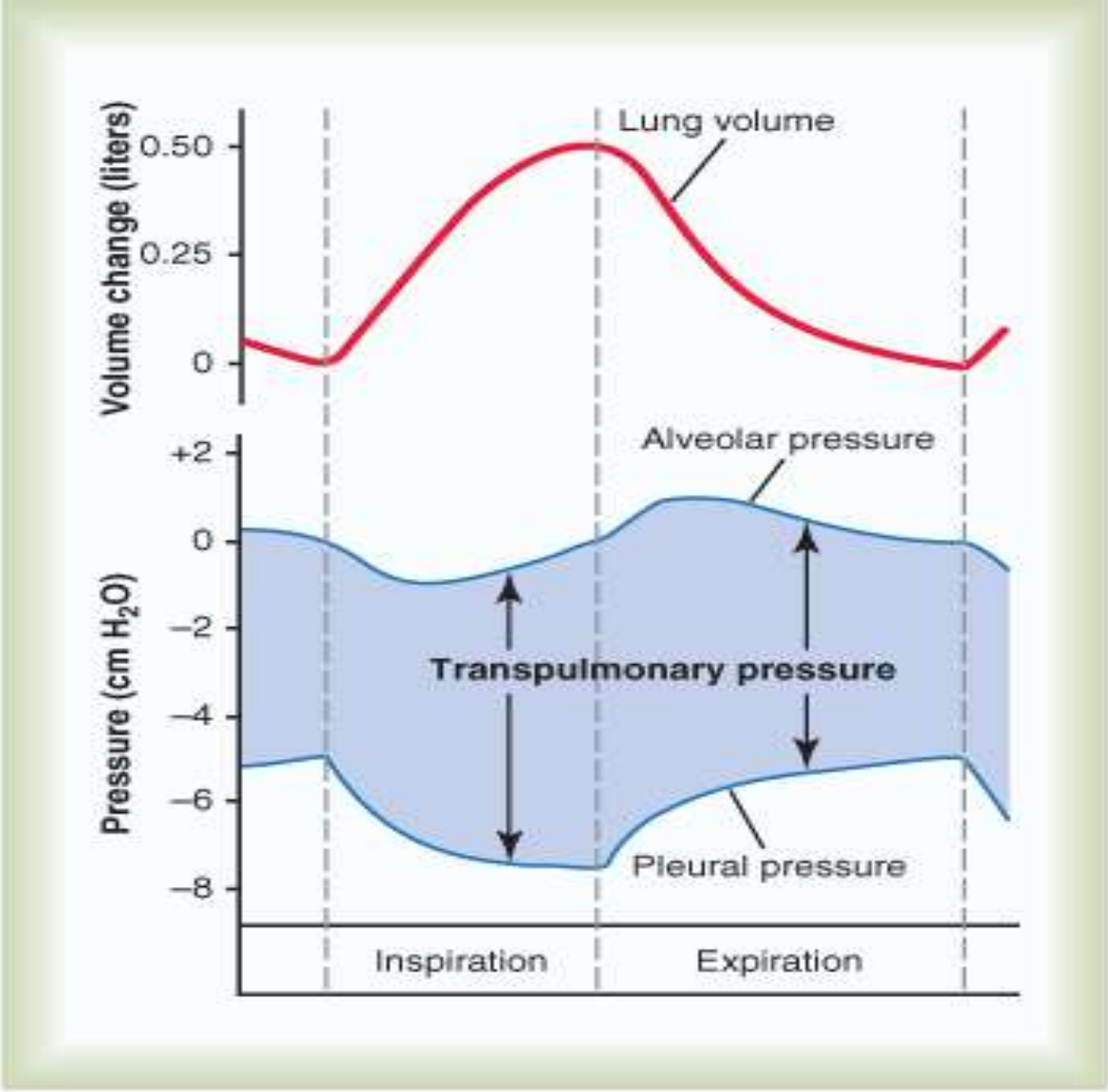
Pressure & Volume changes during Respiratory Cycle

- **Movement of air in & out of the lungs depends on the pressure gradient between alveoli & the atmospheric pressure (TRANSAIRWAY PRESSURE)**

1. PLEURAL Pressure

2. ALVEOLAR PRESSURE

3. TRANSPULMONARY PRESSURE-



Clinical Application

1. Lesion of phrenic nerve causes paralysis of Diaphragm

2. Emphysema, injury to Chest affects Pleural Pressure

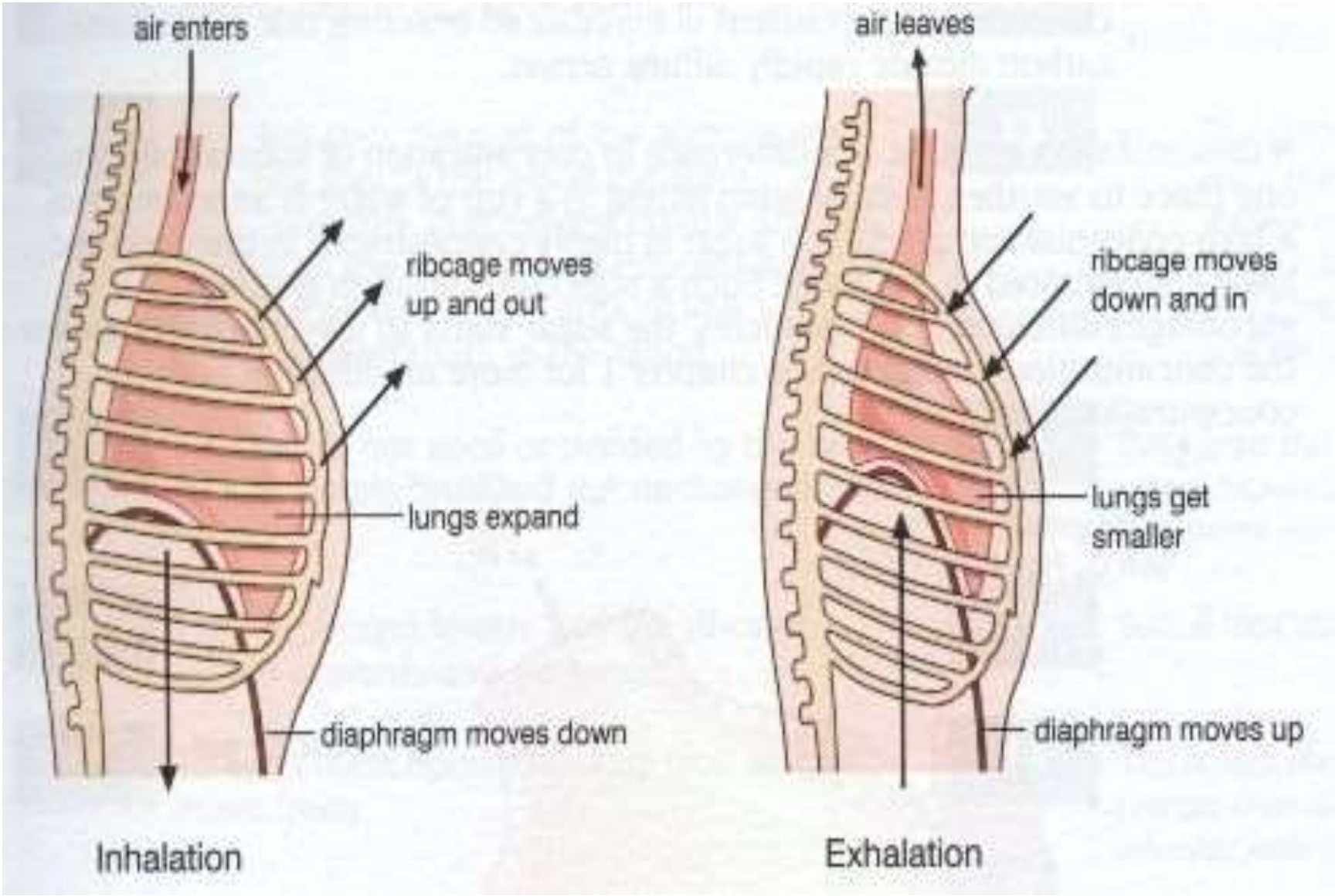
3. Pranayama increases thoracic cage expansion

Clinical Application

4. Airway diseases causing altered airflow:

A. Asthma

B. Emphysema


air enters
ribcage moves
up and out
lungs expand
diaphragm moves down
Inhalation
air leaves
ribcage moves
down and in
lungs get
smaller
diaphragm moves up
Exhalation

Mechanism of Breathing also takes into consideration:

- **Role of Surfactant (surface tension lowering agent)**
- **Compliance of lung (extent to which lungs can expand for each unit increase in transpulmonary pressure**)
- **Work of breathing**