ANATOMY OF DIAPHRAGM

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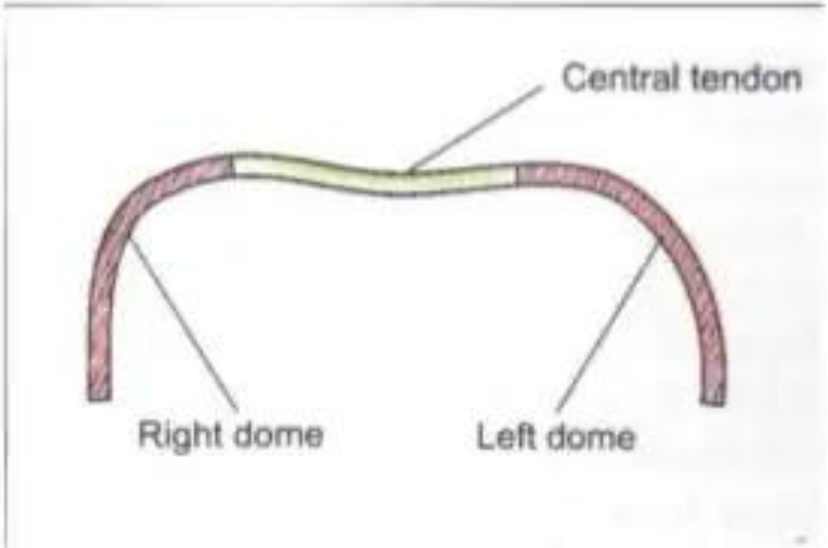
LECTURER ANATOMY KGMC

Introduction

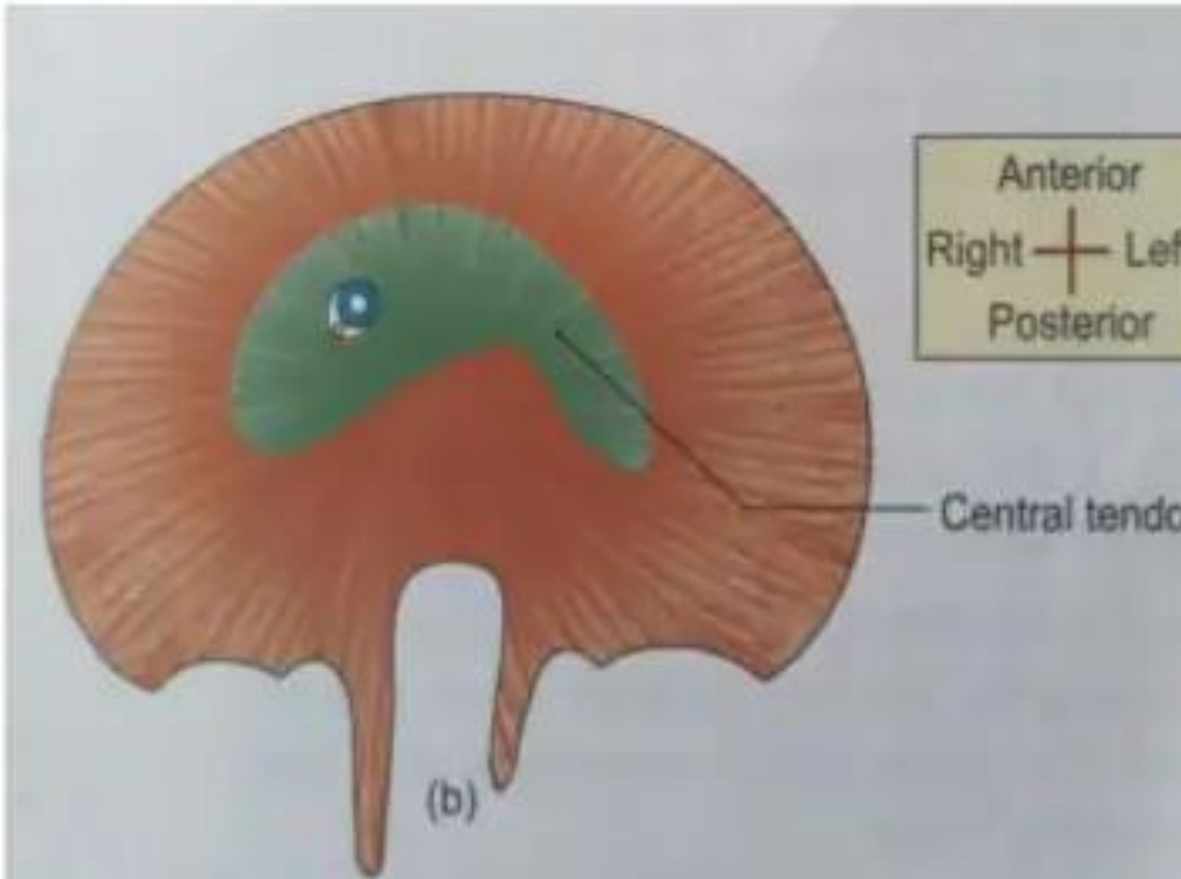
- Greek: dia = through, apart; phragma = fence
- A domed musculotendinous sheet.
- Separates the thoracic and abdominal cavities.
- Thoracic surface: Superior surface.
  - convex on right and left sides (Summit = Cupulae)
  - depressed in the middle
- Abdominal surface:
  -concave, inferior surface.



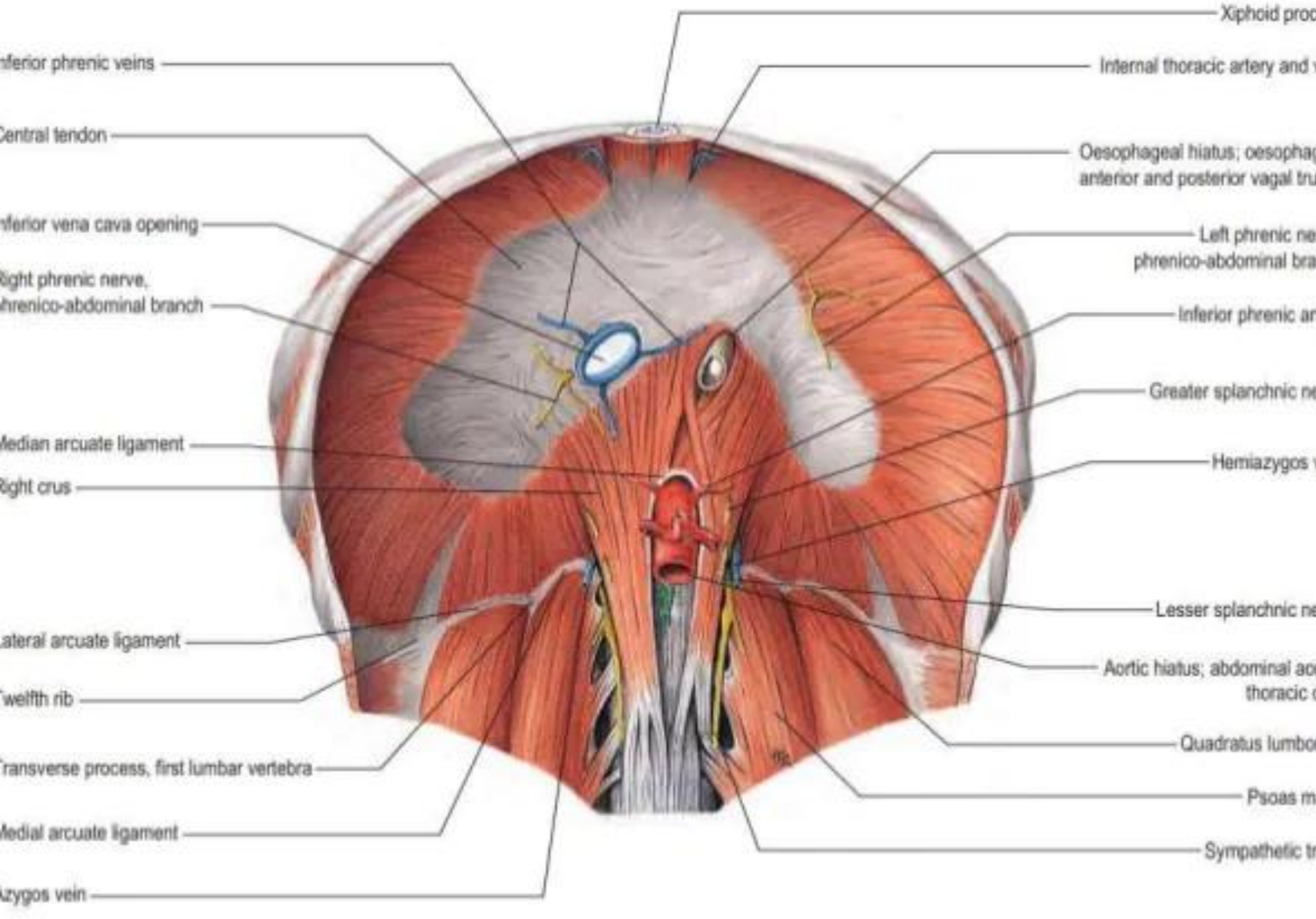
Introduction contd..

- Peripheral part: Muscular (striated)
- Central part: Tendinous, occupied by Central tendon.
- Muscle fibres:

Directed upwards and inwards.



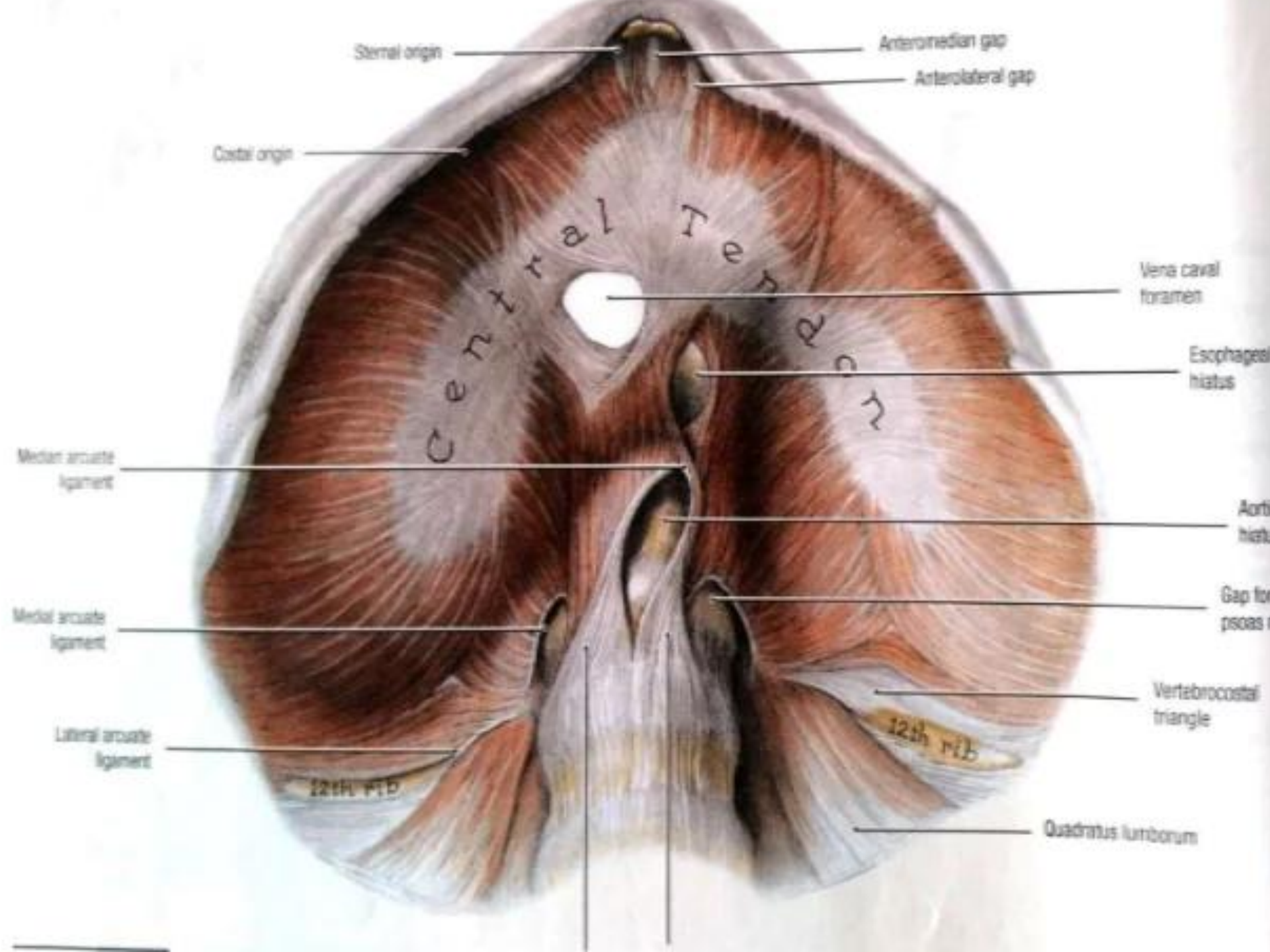
The Diaphragm



ORIGIN

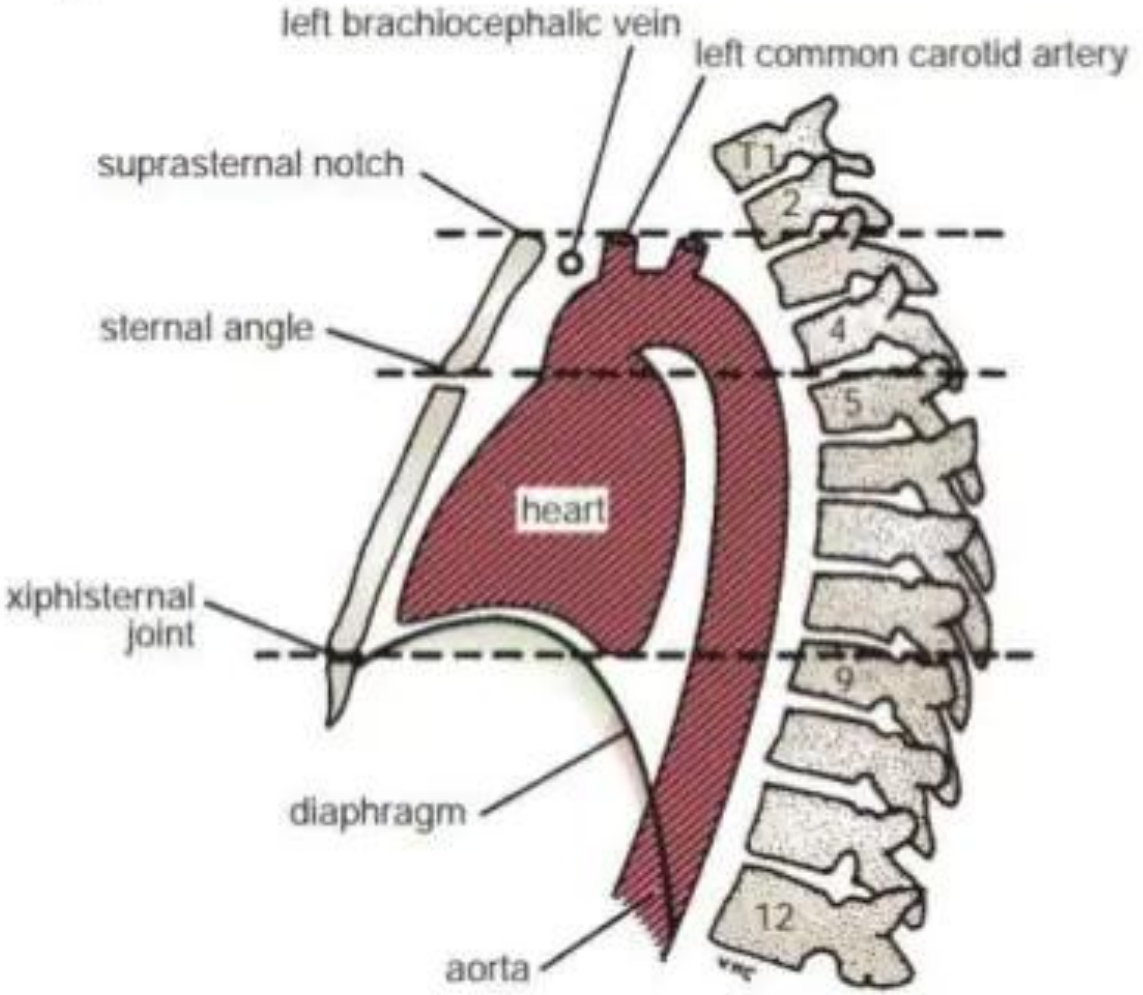
- Arises from circumference of inner surface of thoracic outlet.
- Muscle fibres grouped into **three** parts:
  1. Sternal part
  2. Costal part
  3. Lumbar part (Vertebral):

- Medial lumbocostal arch/ Medial arcuate ligament
- Lateral lumbocostal arch / Lateral arcuate ligament
- Right crus
- Left crus


Sternal origin
Anteromedian gap
Anterolateral gap
Costal origin
Central Tendon
Vena caval foramen
Esophageal hiatus
Median arcuate ligament
Aortic hiatus
Medial arcuate ligament
Gap for psoas
Vertebrocostal triangle
Lateral arcuate ligament
12th rib
12th rib
Quadratus lumborum

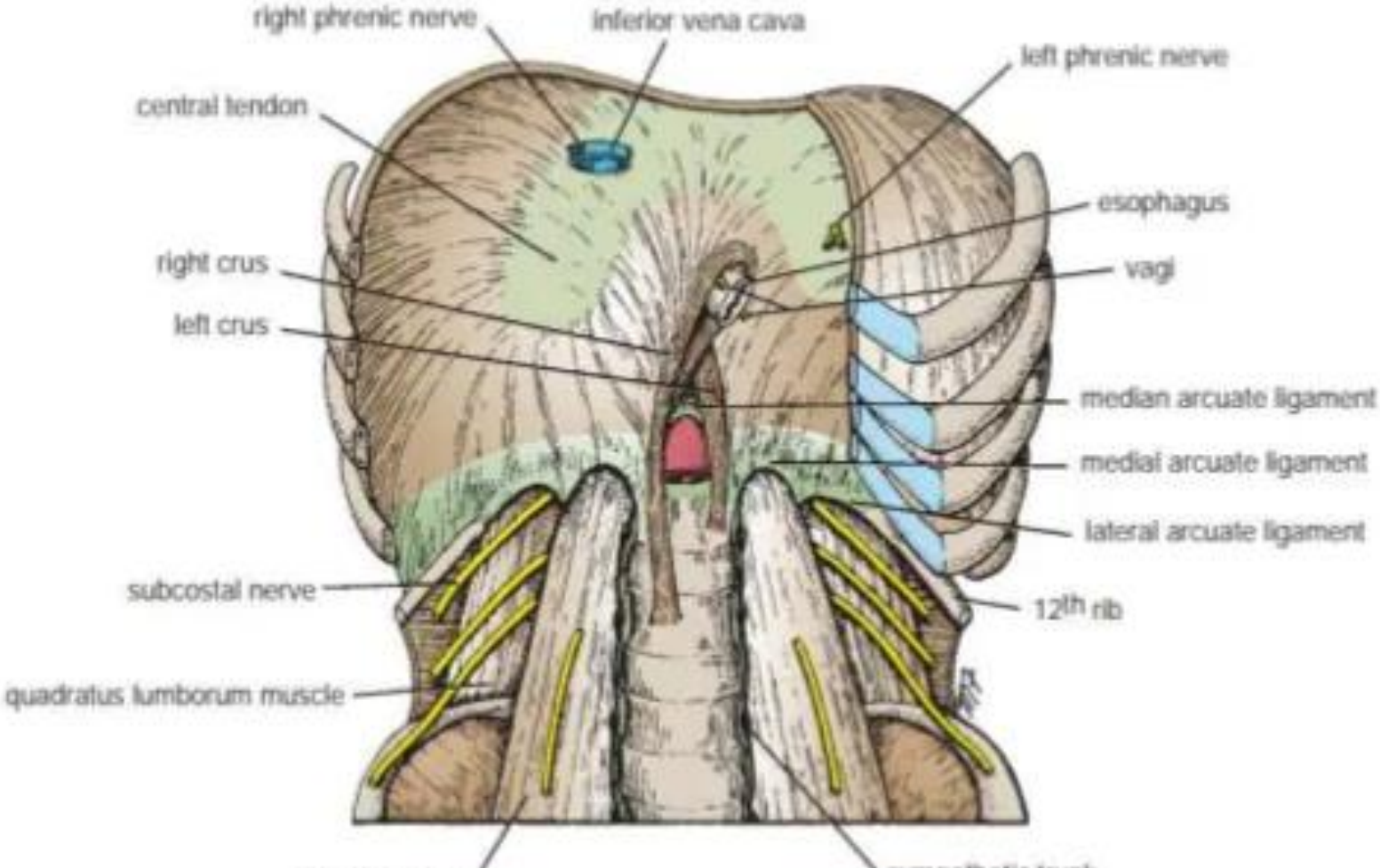
Sternal origin

- Arises by two fleshy slips from the posterior aspec of the xiphoid process.



Costal origin

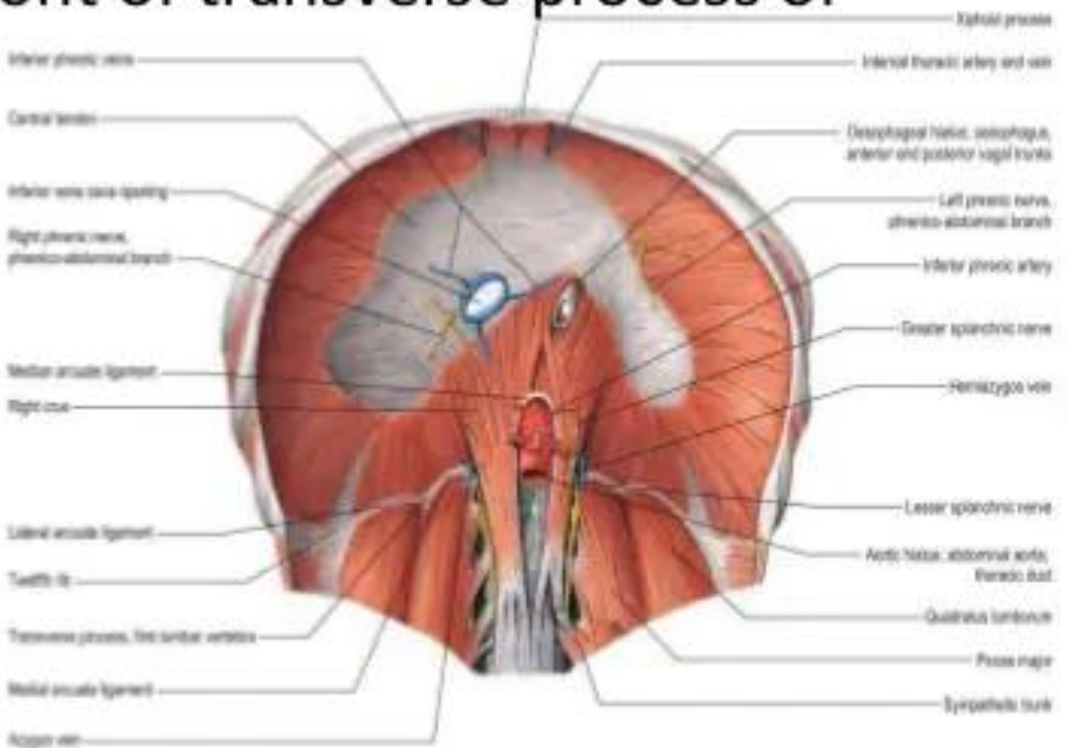
- Arises from the inner surfaces of the lower six ribs and their costal cartilages interdigitating with transversus abdominis.



Lumbar origin

- **Medial lumbocostal arch/ Medial arcuate ligament**

- Tendinous arch in fascia covering psoas major
- Medially, attach to the side of the body of vertebra L1.
- Laterally, attach to the front of transverse process of vertebra L1



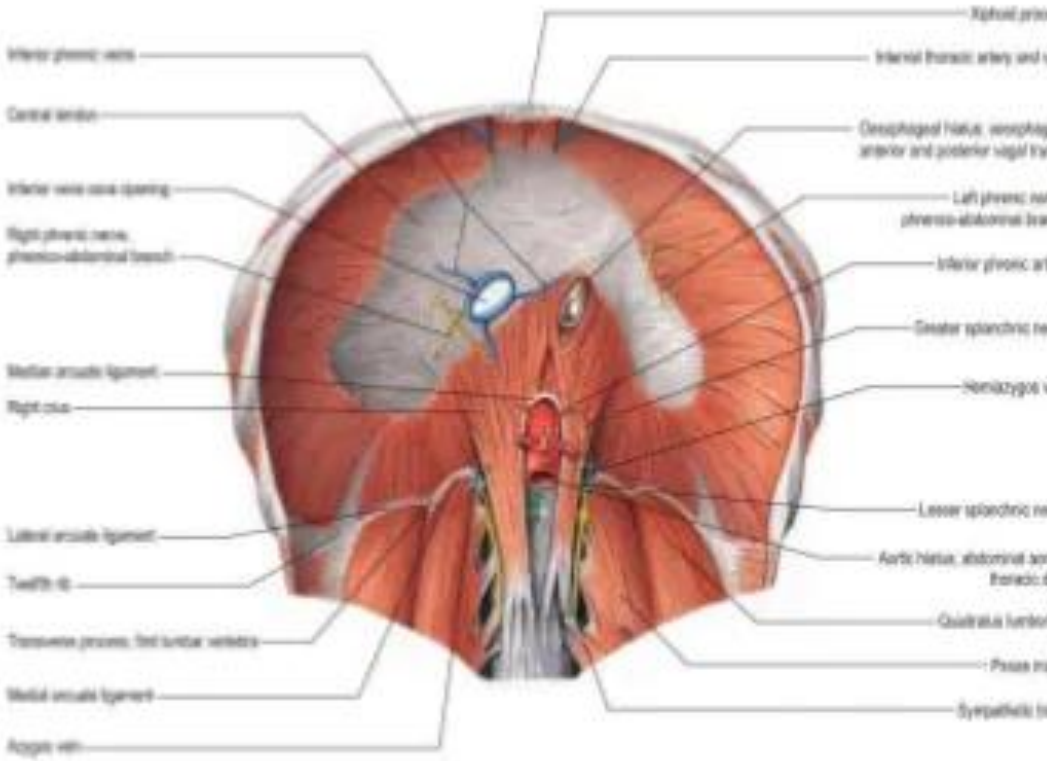
Lumbar origin contd…

- **Lateral lumbocostal arch/ Lateral arcuate ligament**

- Tendinous arch in fascia covering upper part of quadratus lumborum.

- Medially, attach to front of the transverse process of vertebra L1.

-Laterally, attach to lower border of 12th rib.



Lumbar origin contd..

- **Right crus:**

- Arises from anterolateral surfaces of the bodies of the upper three lumbar vertebrae and the intervening intervertebral disc.

- **Left crus:**

- Arises from the corresponding parts of the upper two lumbar vertebrae.

- Medial margin of two crura form tendinous arc across the front of the aorta called the median arcuate ligament.

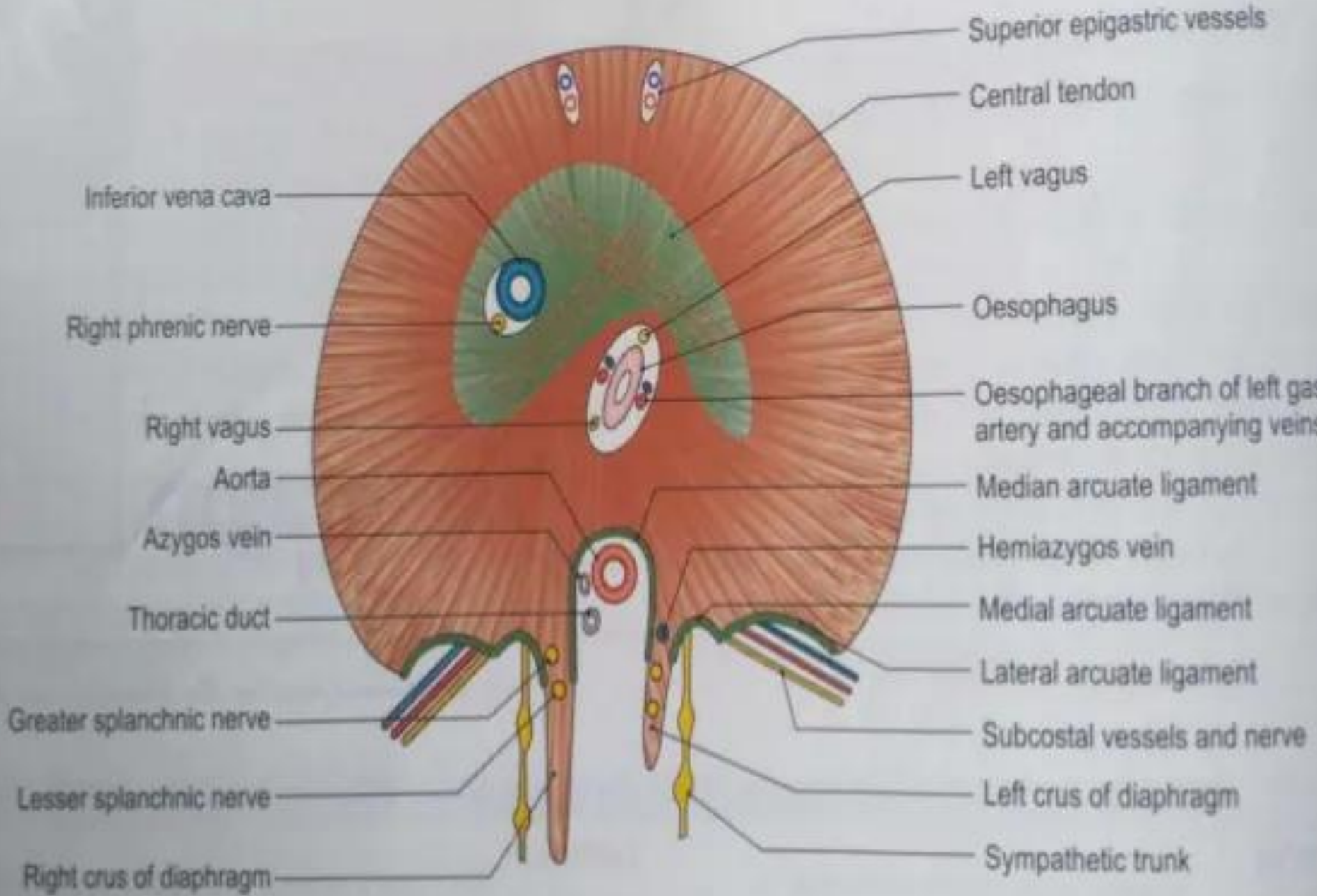
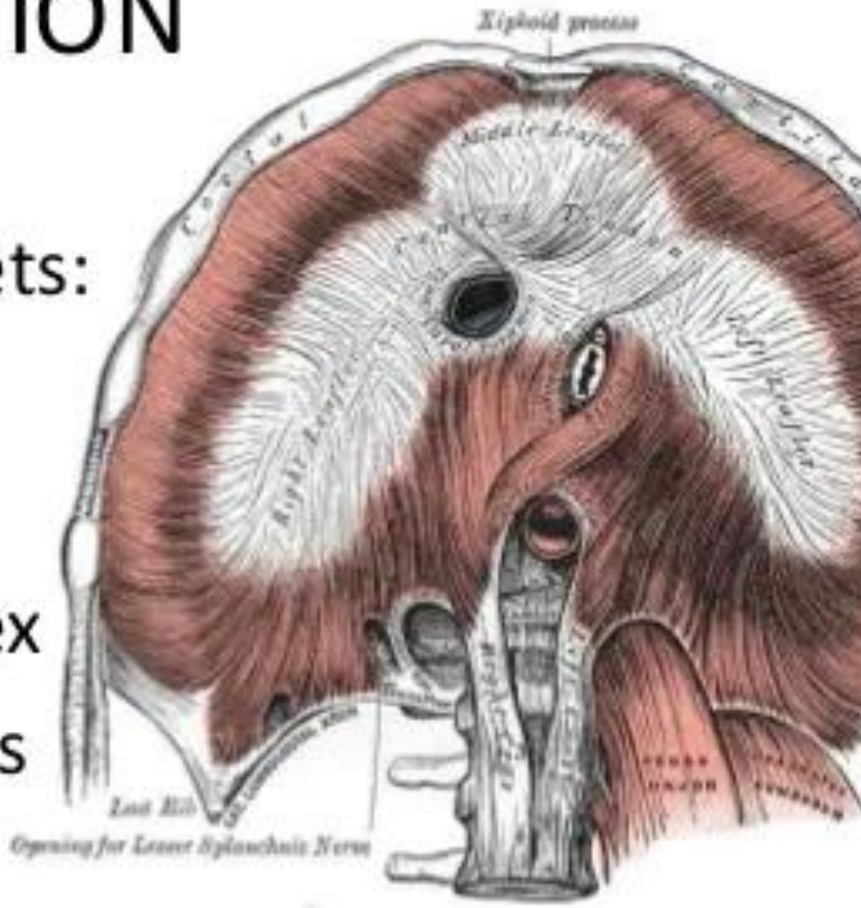


Fig. 26.1: The diaphragm as seen from below

INSERTION

- Into the Central tendon

- Trilobar in shape. With 3 leaflets:



) **Middle leaflet**:

-Triangular in shape with its apex

directed towards xiphoid process

i) **Right and left leaflets:**

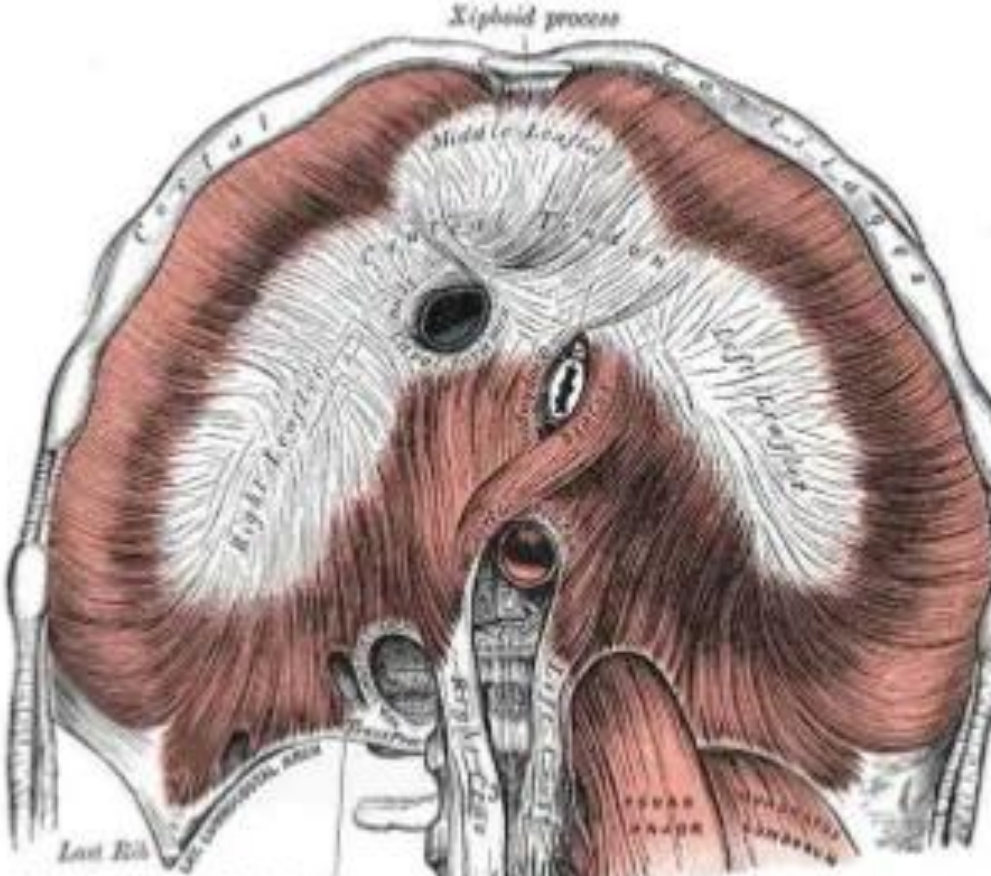
- Tongue shaped, curve laterally and backwards

- Left is narrower than right

Insertion contd..

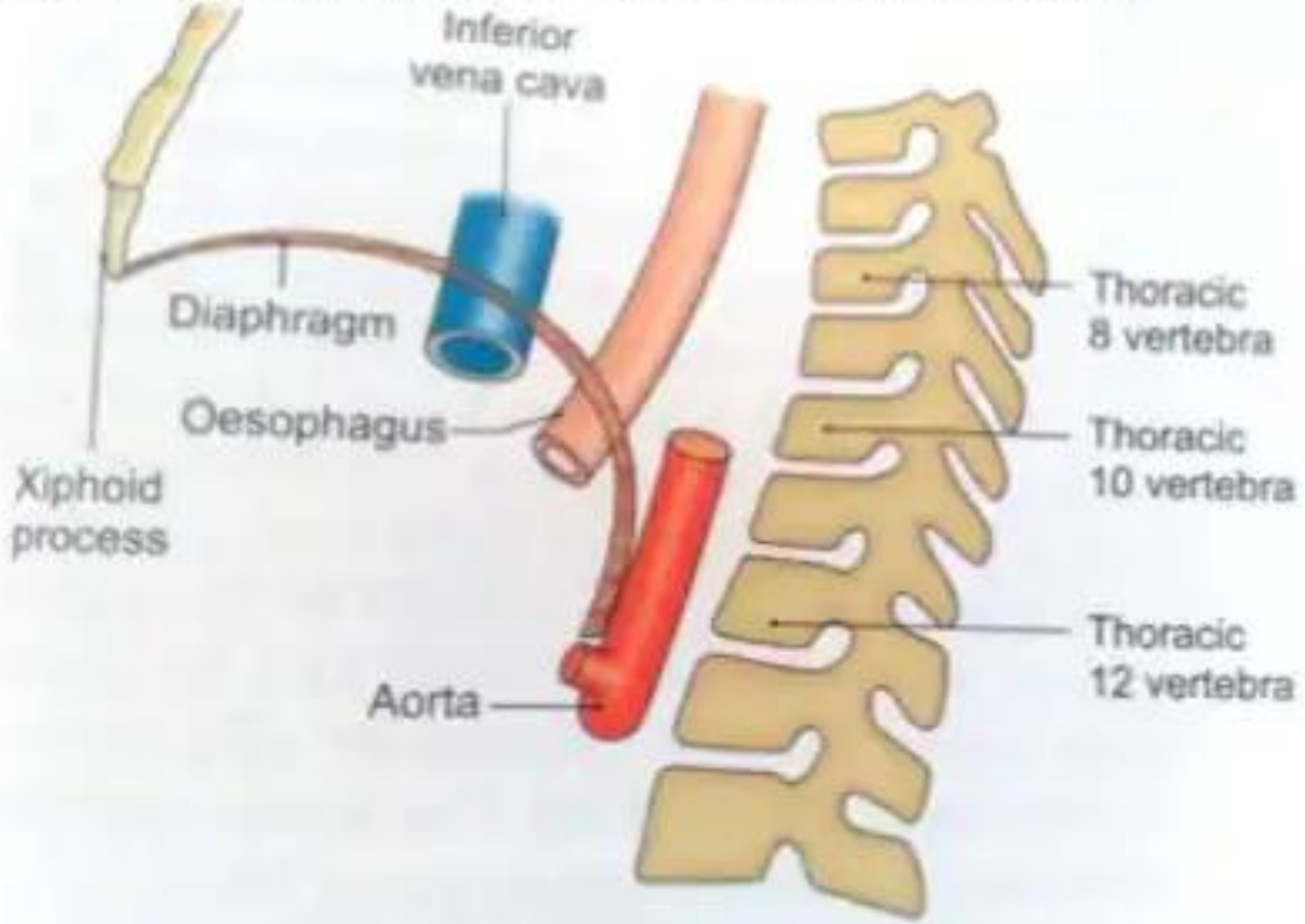
i) **Central point**:

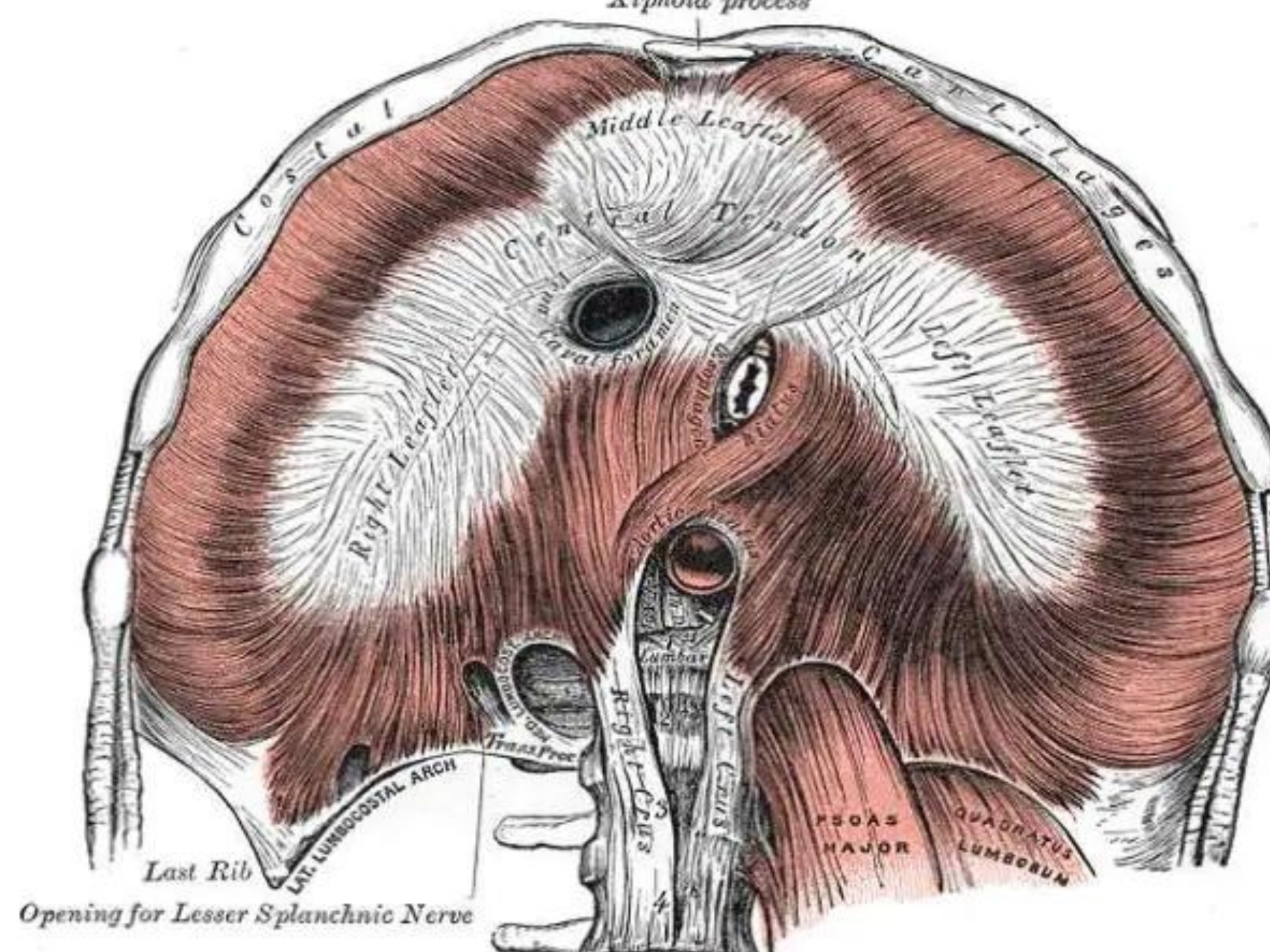
Four well-marked diagonal bands fan out from central point of intersection; located in front of esophagus opening.



Openings in the diaphragm

A. Large or Main Openings in the diaphragm
B. Small Openings in the diaphragm




Xiphoid process
Costal
Cartilages
Middle Leaflet
Central Tendon
Caval foramen
Right Leaflet
Left Leaflet
Aortic
Lumbar
Right Crus
Left Crus
Psoas Major
Quadratus Lumborum
Last Rib
Lat. Lumbocostal Arch
Opening for Lesser Splanchnic Nerve

Large Openings

1. Aortic Opening/Hiatus:

-Osseoaponeurotic

-**Situation**: Lies at lower border of T12.

- **Shape**: Rounded

-**Structures passing:**

i)Abdominal aorta

ii) Thoracic duct

iii) Azygous vein.

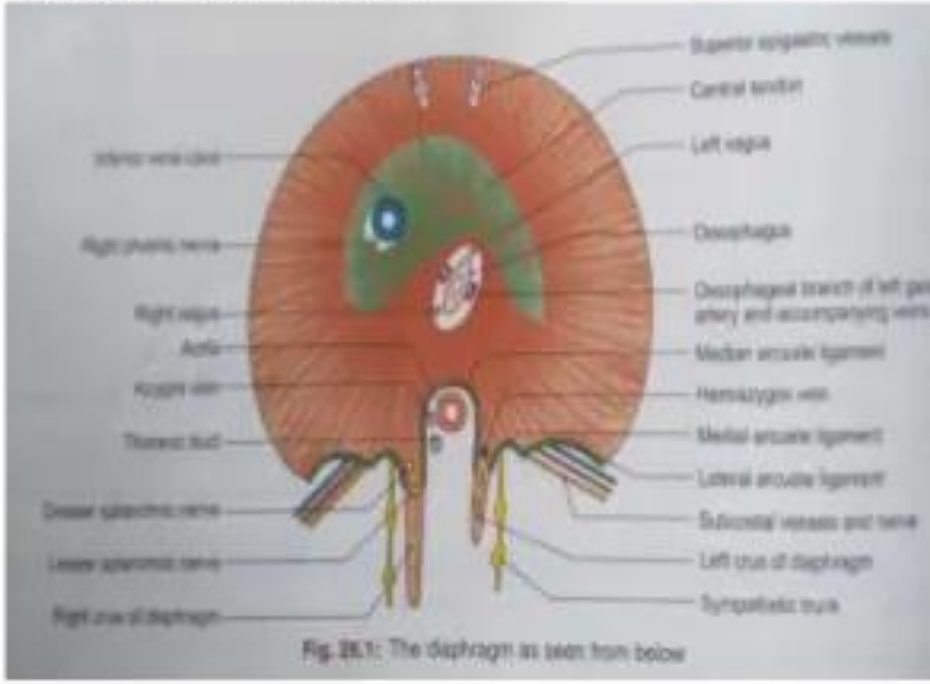


Fig. 28.1: The diaphragm as seen from below

-Effect of contraction of diaphragm: No change.

2. Oesophageal opening:

- **Situation**: Lies in the muscular part of diaphragm, at the level of T10.
- **Shape**: Elliptical
- **Structures passing:**

i) Oesophagus ii) Gastric or Vagus nerves

iii) Oesophageal branches of left gastric artery and corresponding tributaries of left gastric veins.

iv) Phreno- oesophageal ligament

v) Lymphatics from liver

- **Effect of contraction of diaphragm**:

Opening is constricted

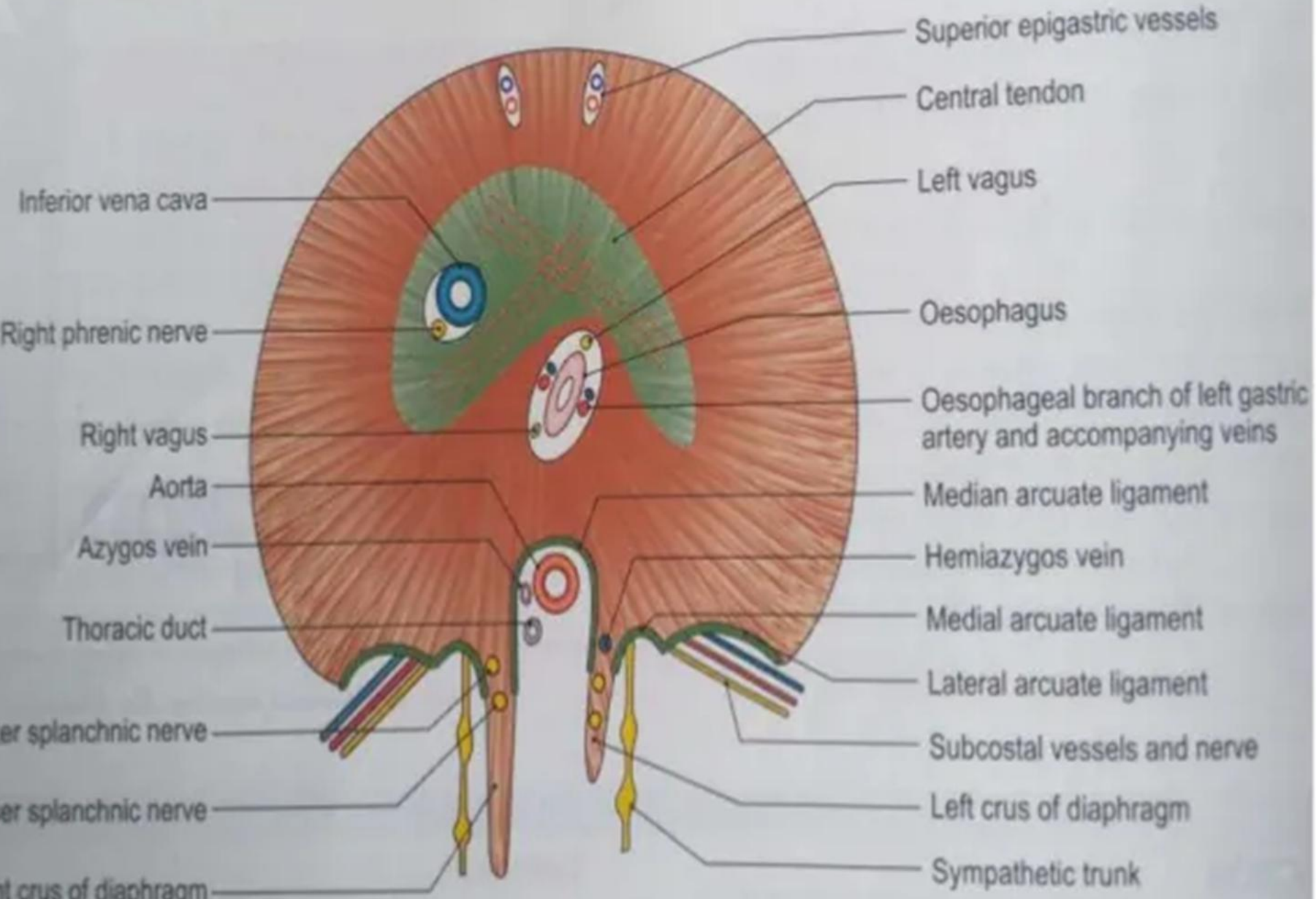


Fig. 26.1: The diaphragm as seen from below

3. Vena caval Opening:

-**Situation**: Lies in the central tendon of diaphragm at the level of T8.

- **Shape**: Quadrilateral

- **Structures passing**:

i) Inferior vena cava.

ii) Branches of the right phrenic nerve.

iii)Few lymph vessels from the liver.

-**Effect of contraction of diaphragm**:

-Vena caval opening dilates

-more blood enters right atrium.

Small Openings

1. Each crus pierced by : Greater Splanchnic Nerve
   Lesser Splanchnic Nerve

Additionally,left crus pierced by Hemiazygos Vein.

2. Behind the medial arcuate ligament: Sympathetic chain passes from thorax to abdomen.
3. Behind the lateral arcuate ligament:
   Subcostal nerves and vessels.
4. Larry's space or Foramen of Morgagni: Passage of Superior epigastric vessels and lymphatics.
5. Musculophrenic vessels pierce the diaphragm at level of 9^{th} costal cartilage.

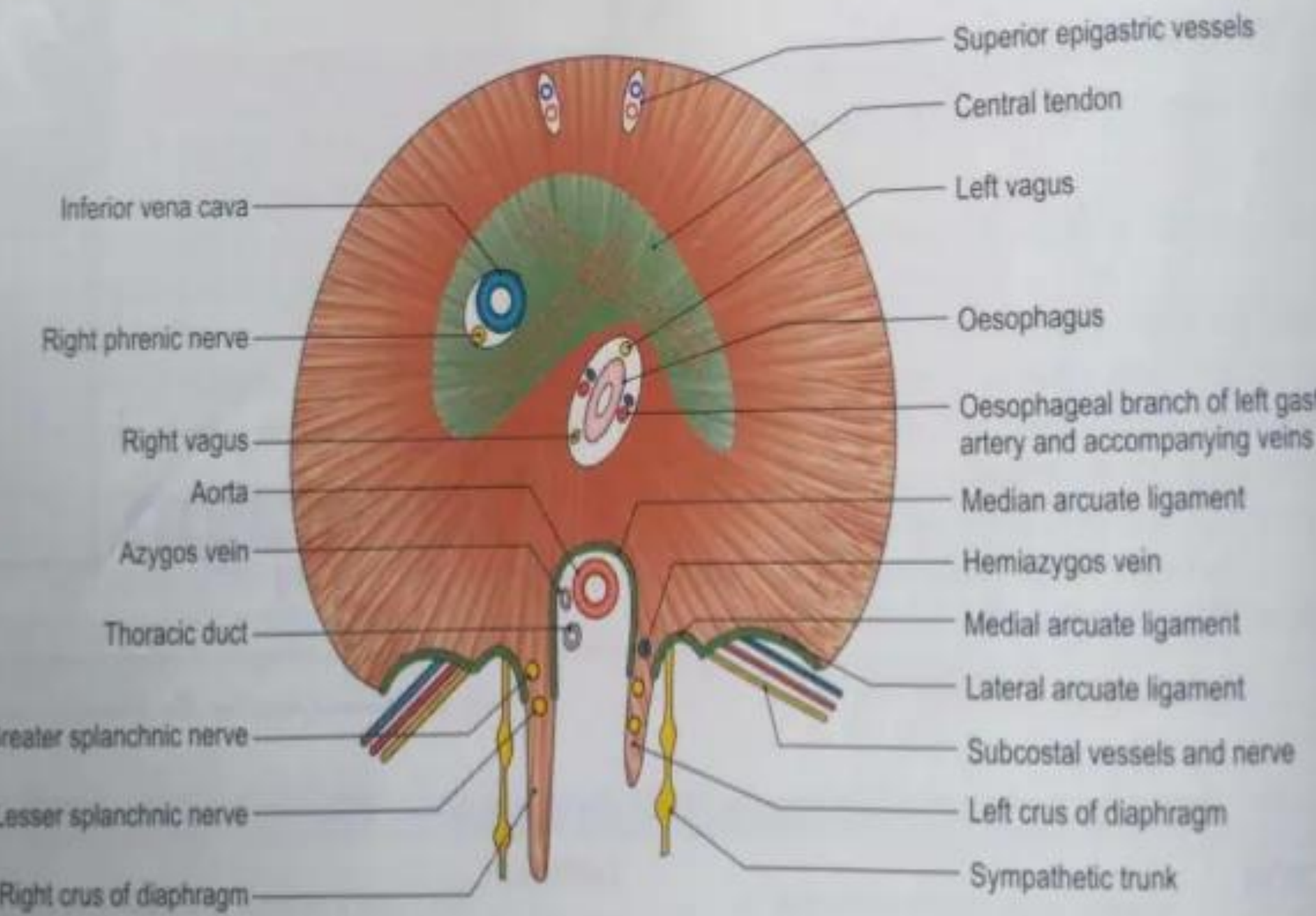


Fig. 26.1: The diaphragm as seen from below

Relations

- Superiorly:
    1. Pleurae
    2. Pericardium
- Inferiorly:
    1. Peritoneum
    2. Liver
    3. Fundus of the stomach
    4. Spleen
    5. Kidneys
    6. Suprarenals

Blood Supply:

- The costal margin of the diaphragm –by the lower five intercostal and the subcostal arteries.

- The main mass of fibres rising up from the crura are supplied on their abdominal surface by right and left inferior phrenic arteries from the abdominal aorta.

The pericardiacophrenic and musculophrenic branches of the internal thoracic artery and the superior phrenic branches of the thoracic aorta make small contributions to the blood supply of the diaphragm

Nerve Supply

- **Motor**:

  Phrenic Nerves

  (ventral rami C3, C4, C5)

- **Sensory**:

1. Central part: Phrenic nerve
2. Peripheral part: Lower six thoracic nerves

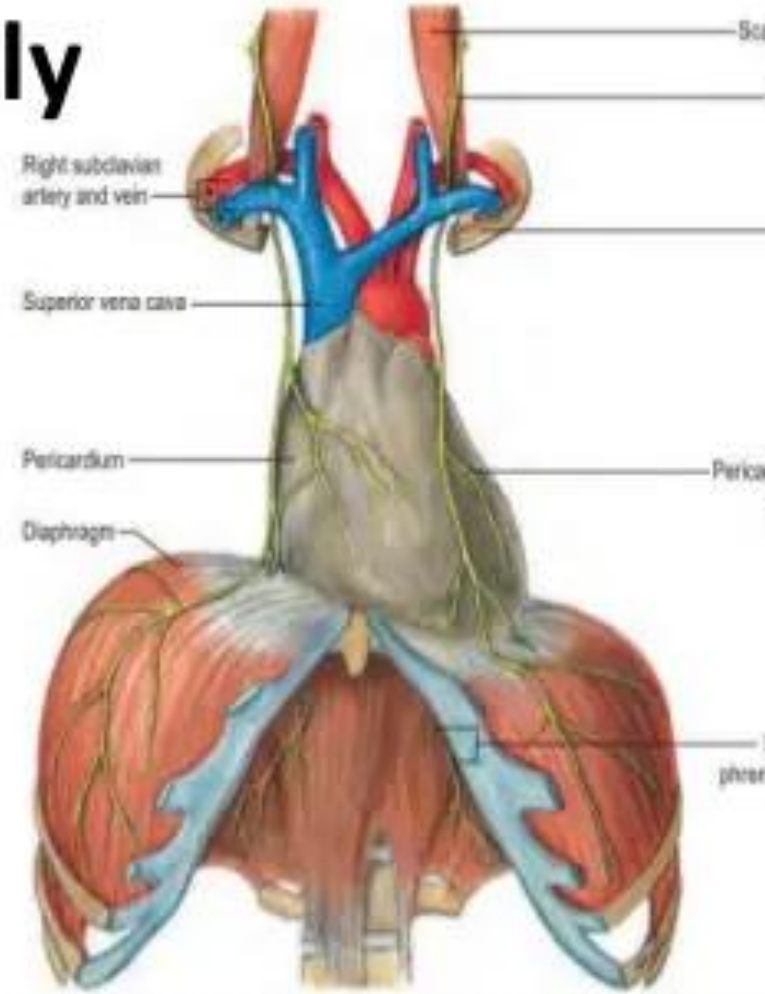


Fig. 55.7 The distribution of the right and left phrenic nerves. (W permission from Waschke J, Paulsen F (eds), Sobotta Atlas of H Anatomy, 15th ed, Elsevier, Urban & Fischer. Copyright 2013.)

Action

- Muscle of inspiration
- Muscle of abdominal straining
- Weight-lifting muscle
- Thoracoabdominal pump

Clinical anatomy

- **Diaphragmatic Hernias:**

1. Congenital Hernia:

   i) Retrosternal Hernia : through Foramen of Morgagni or Space of Larry.

   ii) Posterolateral Hernia: through Foramen of Bochdalek.

   iii) Posterior Hernia: Due to failure of development of posterior part of diaphragm.

   iv) Central Hernia: Rupture of foetal membranous diaphragm in the left dome.

Clinical anatomy

. Acquired Hernia:

i)Traumatic Hernia: Due to bullet injuries of diahragm.

ii) Hiatal hernia:

- Congenital Hiatal Hernia (Rolling Hernia):

Due to persistence of embryonic peritoneal process in posterior mediastinum infront of cardaic end of stomach.

- Acquired Hiatal Hernia (Sliding Hernia): Due to weakness of phrenico-oesophageal membrane.

Clinical Anatomy

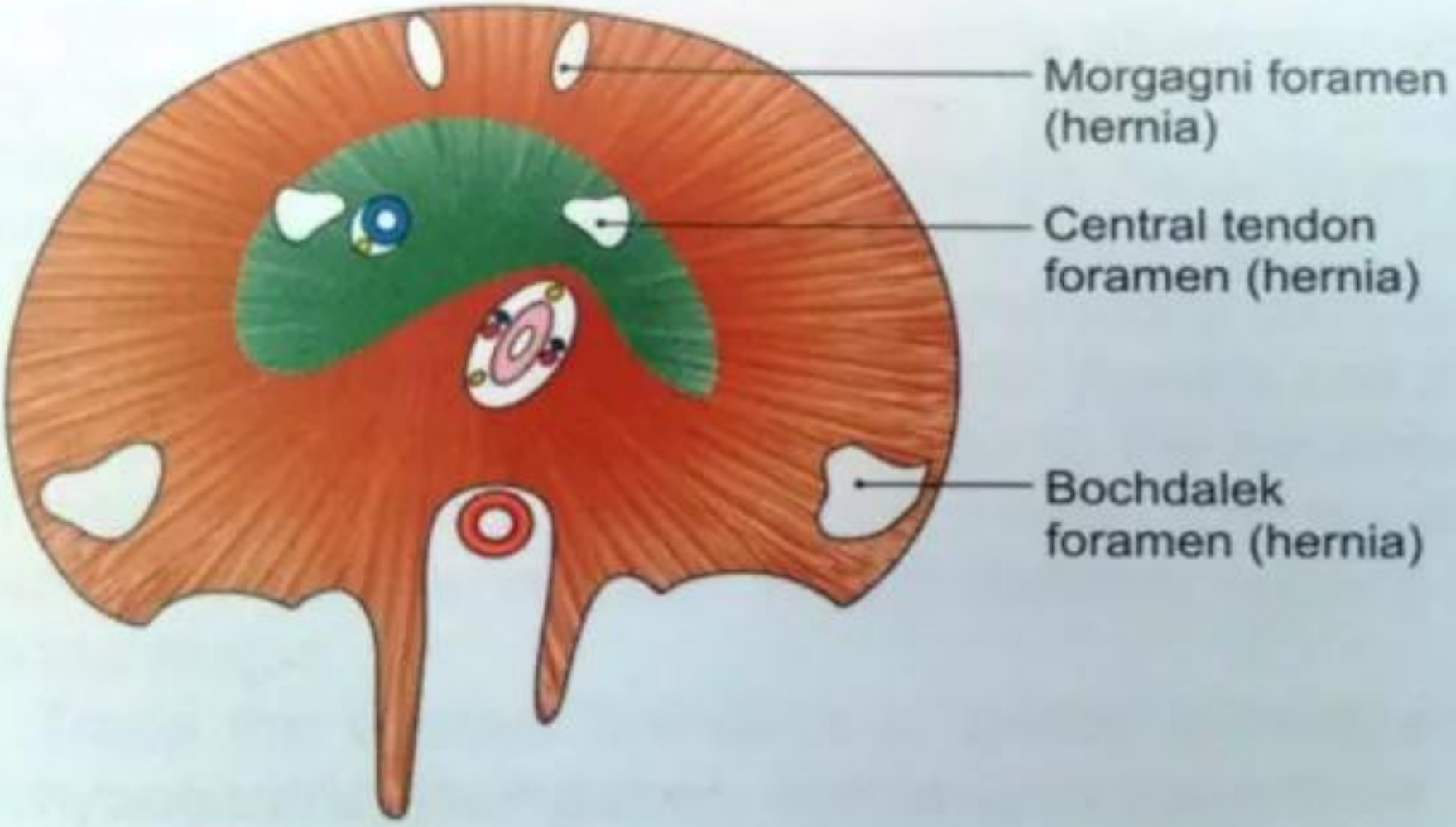
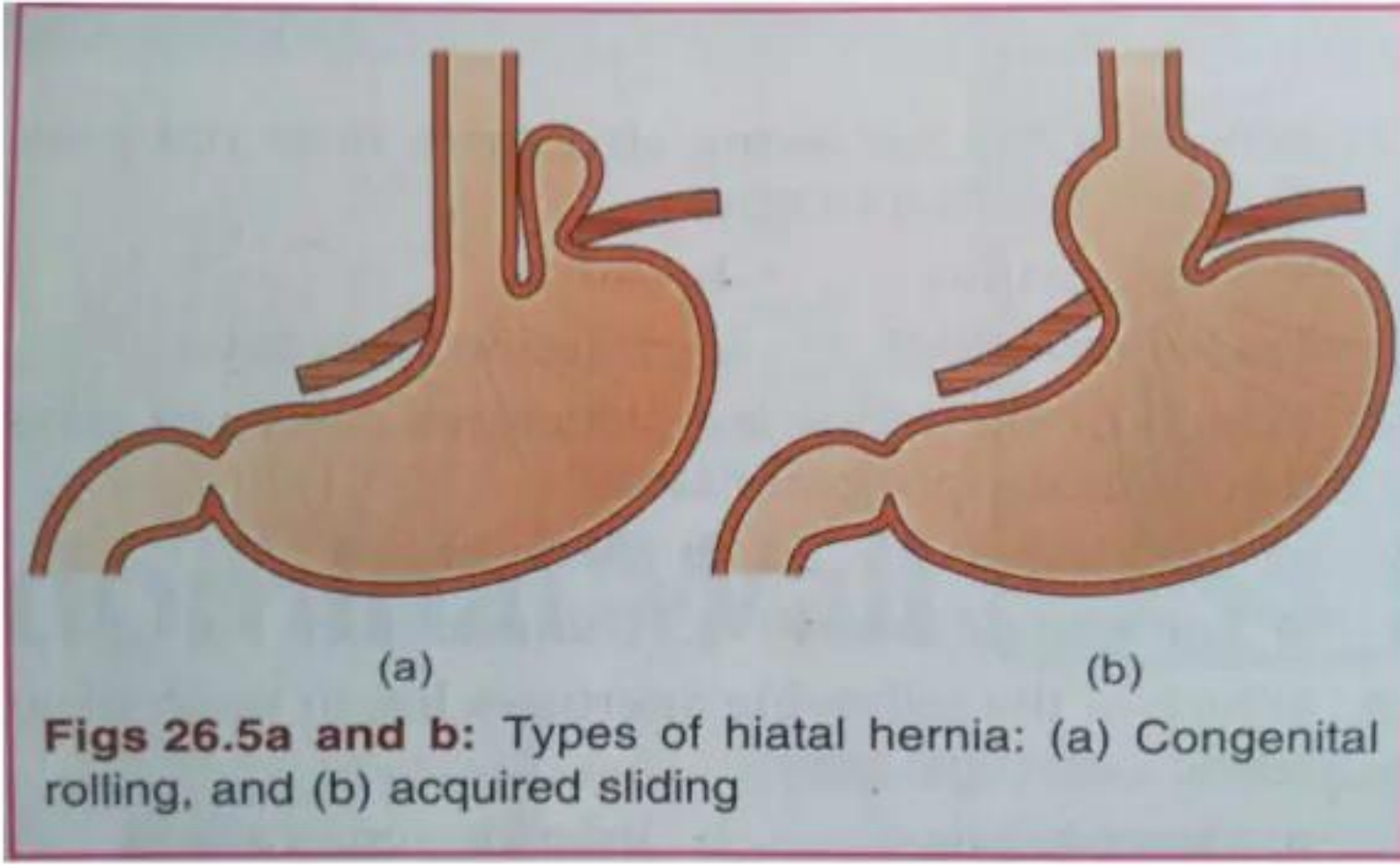


Fig. 26.4: Sites of diaphragmatic hernia

Clinical Anatomy



Figs 26.5a and b: Types of hiatal hernia: (a) Congenital rolling, and (b) acquired sliding

Clinical anatomy

- Hiccup
- Shoulder tip pain
- Unilateral paralysis of diaphragm
- Eventration

EVENTRATION

- Failure of muscular development of all or part of diaphragm
- Complete – almost always left sided.
- Partial – common on right side
- More common in men
- Confused with diaphragmatic hernia and pleuro – pericardial cyst on x-ray

TRAUMATIC TEAR

- Blunt or penetrating injury
- Usually on left
- Dyspnoea and substernal pain

PARALYSIS

- Due to interruption or dysfunction of phrenic nerve
- Disruption of spinal cord at or above the level of phrenic n.roots
- Most common causes:

unilateral:ca, surgical section,trauma,post inflammatory neuropathy like GBS

bilateral: spinal cord trauma, idiopathic or infection,cardiac surgery,

CONCLUSION

Why diaphragm is important to us?

- **Main muscle in respiration**

  (75% in normal inspiration); by contracting

- **Separating thorax and abdomen**