



KATHMANDU UNIVERSITY
SCHOOL OF MEDICAL SCIENCES
Collaborative Program of Kathmandu University and Dhulikhel Hospital

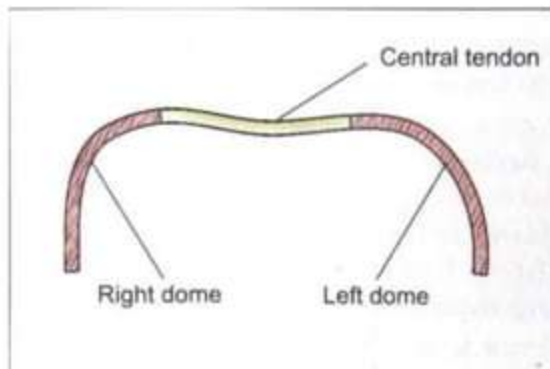


THE DIAPHRAGM

Presented By: Trishna Kisiju

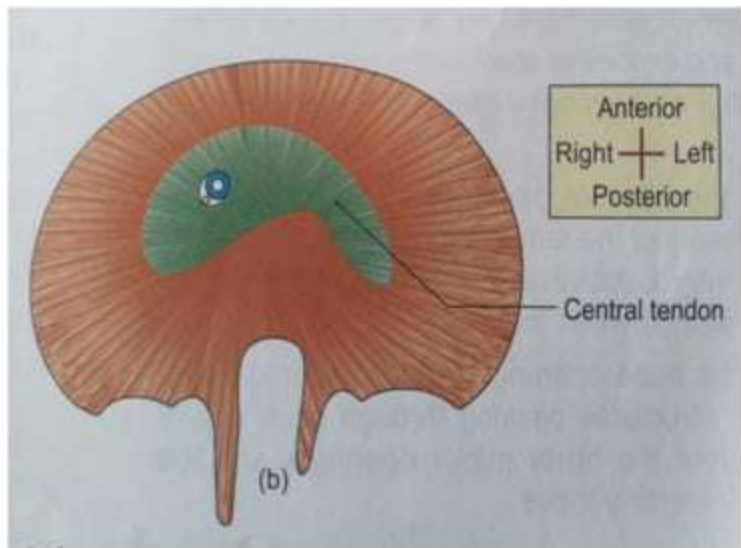
Introduction

- 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.

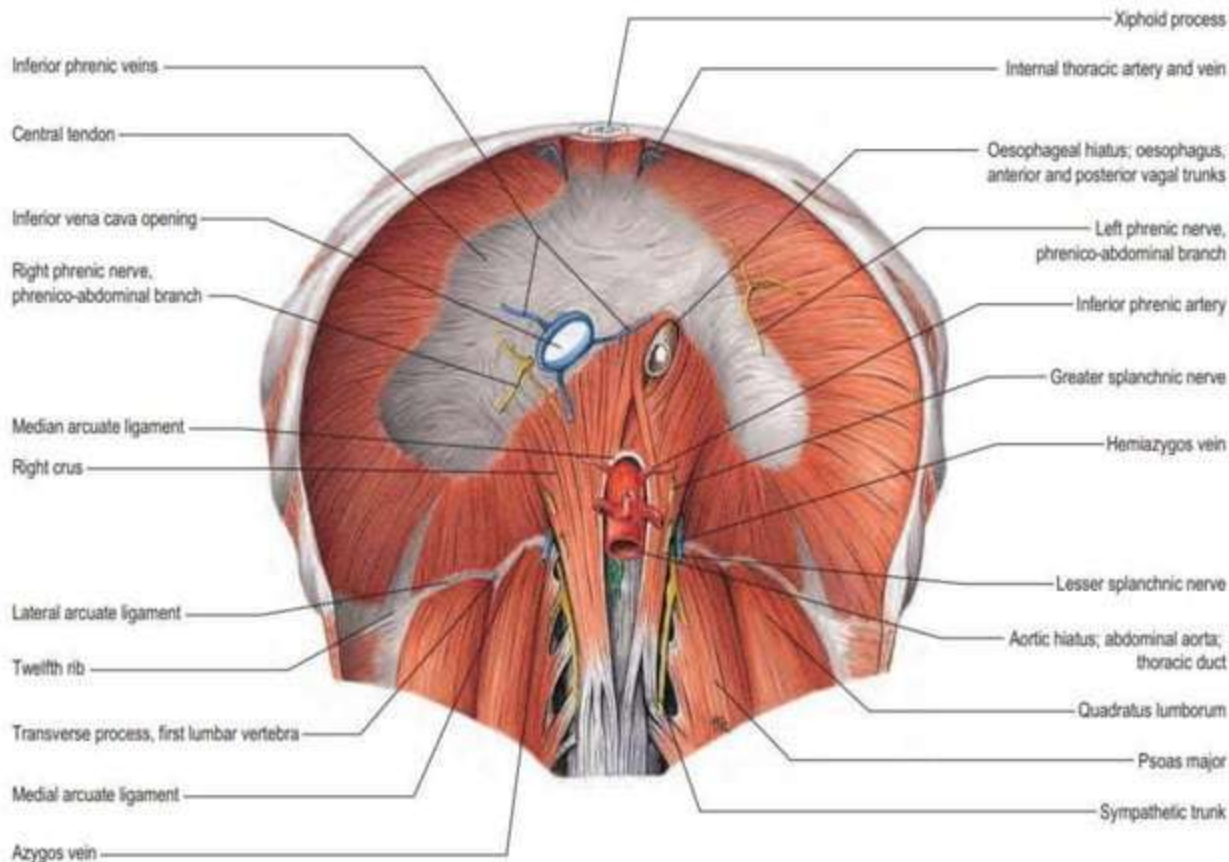


Introduction contd..

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

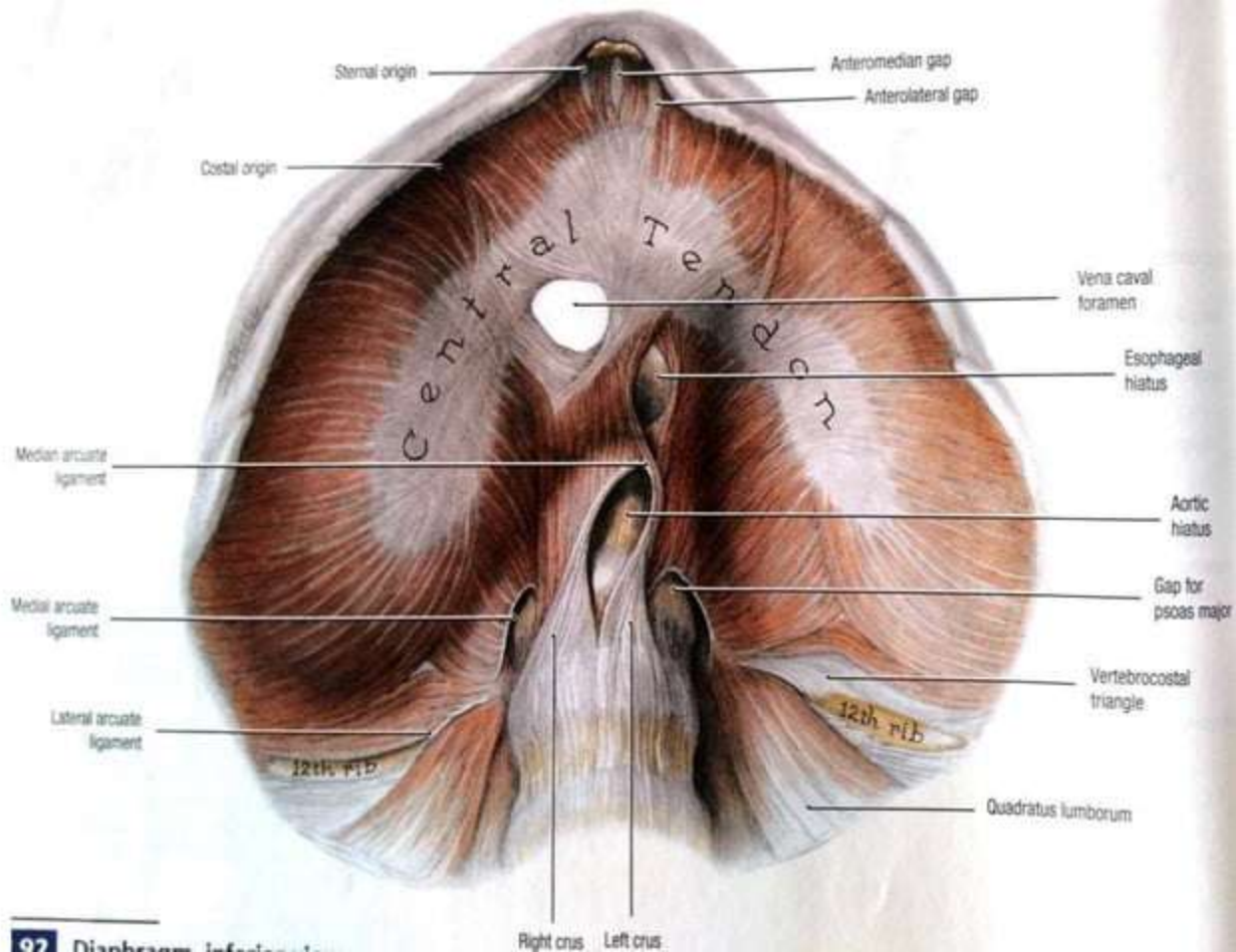


The Diaphragm



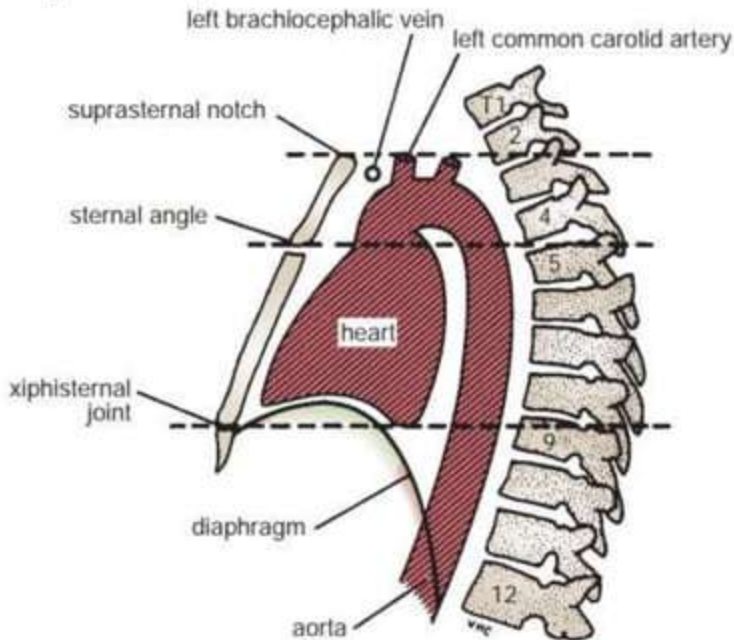
ORIGIN

- 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



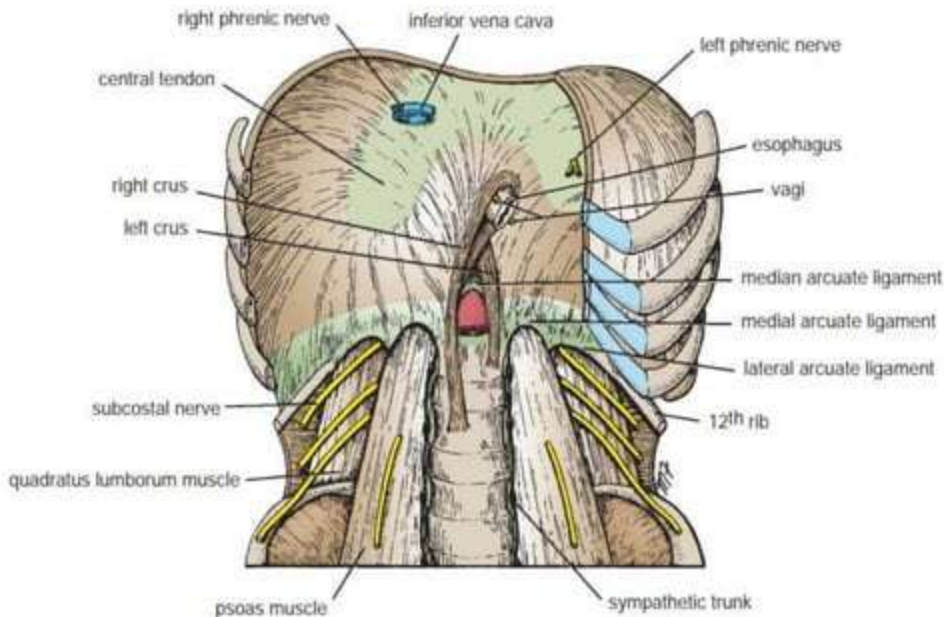
Sternal origin

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



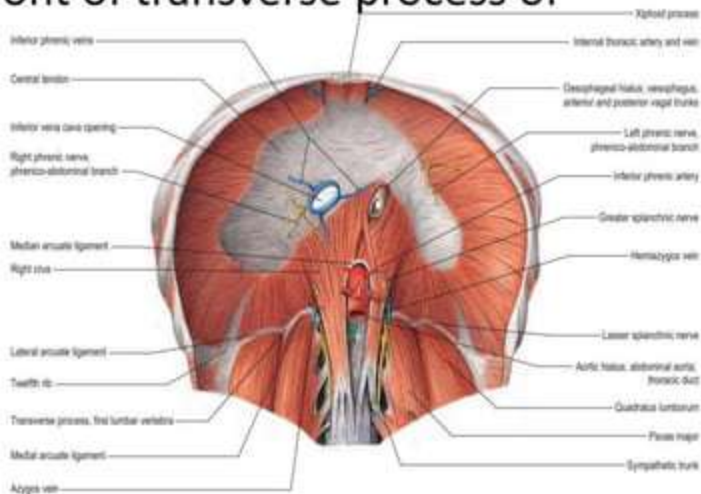
Costal origin

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



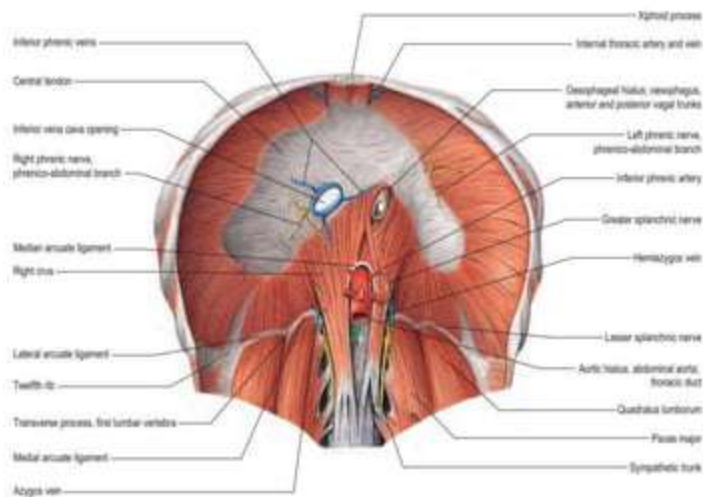
Lumbar origin

- **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.

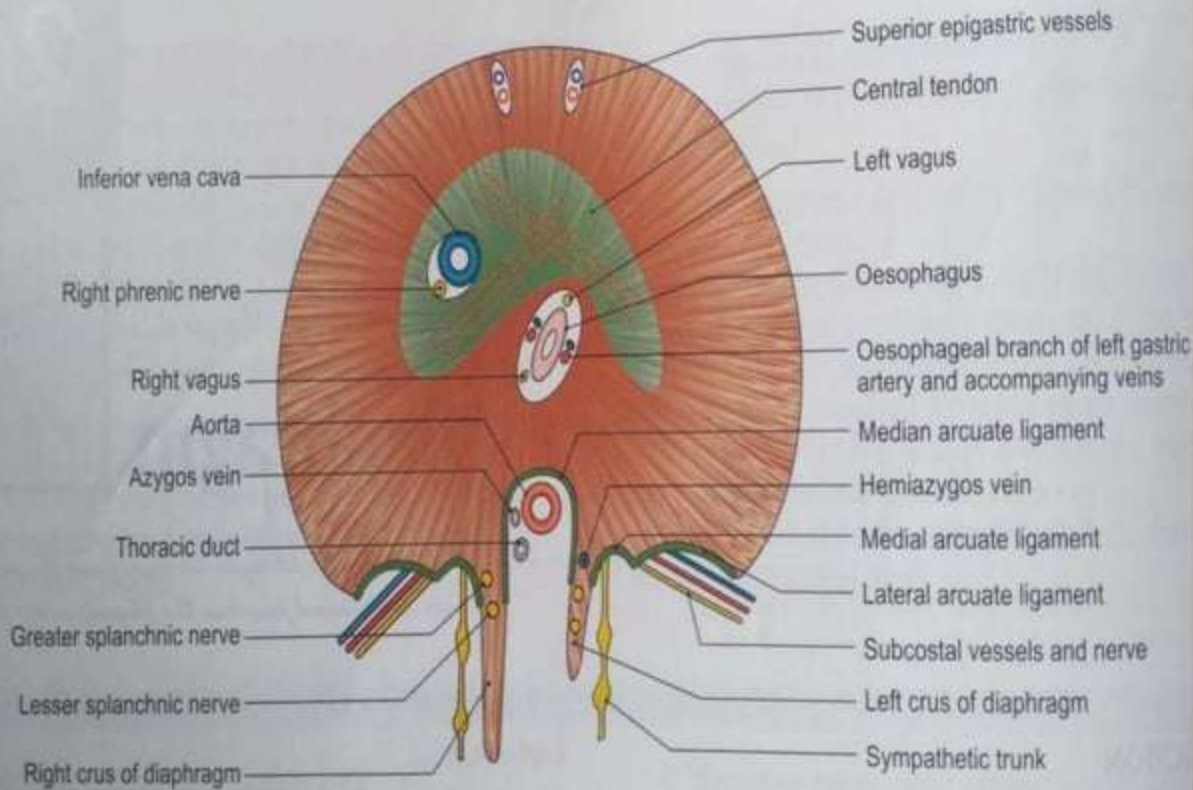


Fig. 26.1: The diaphragm as seen from below

INSERTION

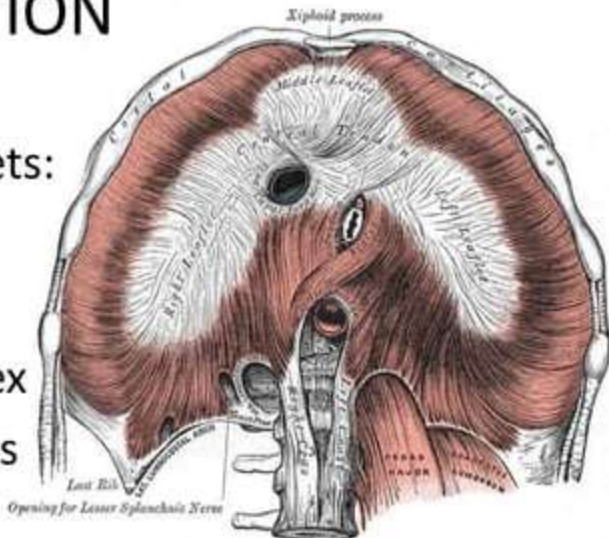
- Into the Central tendon
 - Trilobar in shape. With 3 leaflets:

i) Middle leaflet:

- Triangular in shape with its apex directed towards xiphoid process

ii) Right and left leaflets:

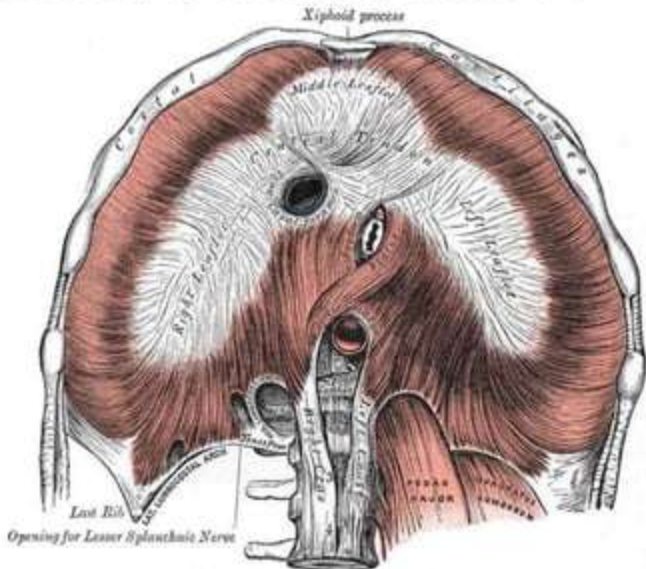
- Tongue shaped, curve laterally and backwards
- Left is narrower than right



Insertion contd..

iii) **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

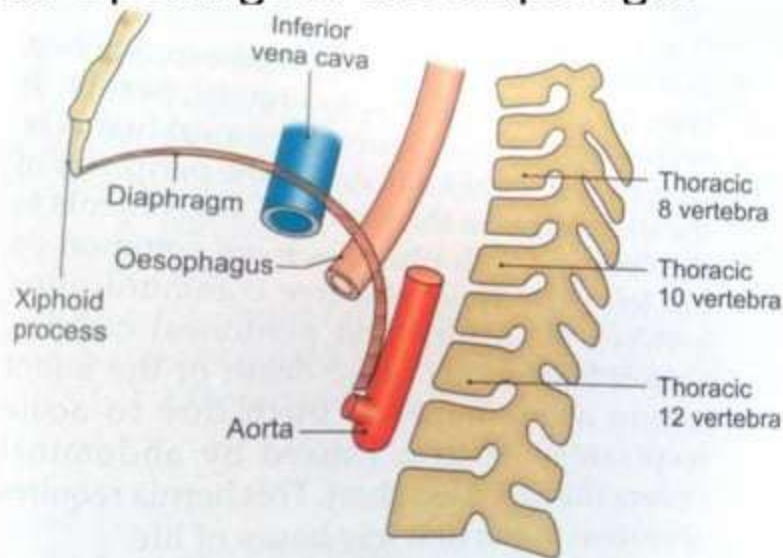


Fig. 26.3: Main openings in the diaphragm

Large Openings

1. Aortic Opening/Hiatus:

-Osseoaponeurotic

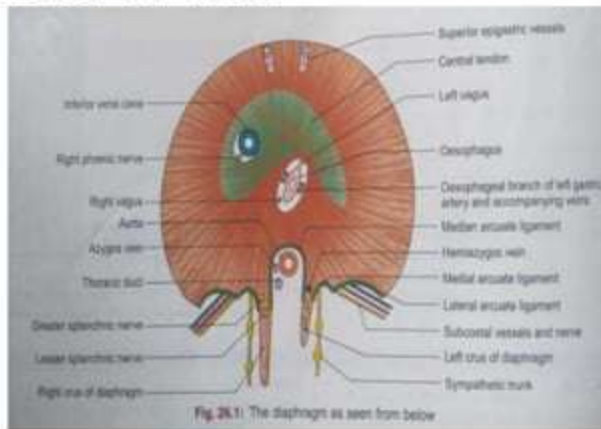
-**Situation:** Lies at lower border of T12.

- **Shape:** Rounded

-**Structures passing:**

- i) Abdominal aorta
- ii) Thoracic duct
- iii) Azygous vein.

-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

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 9th costal cartilage.

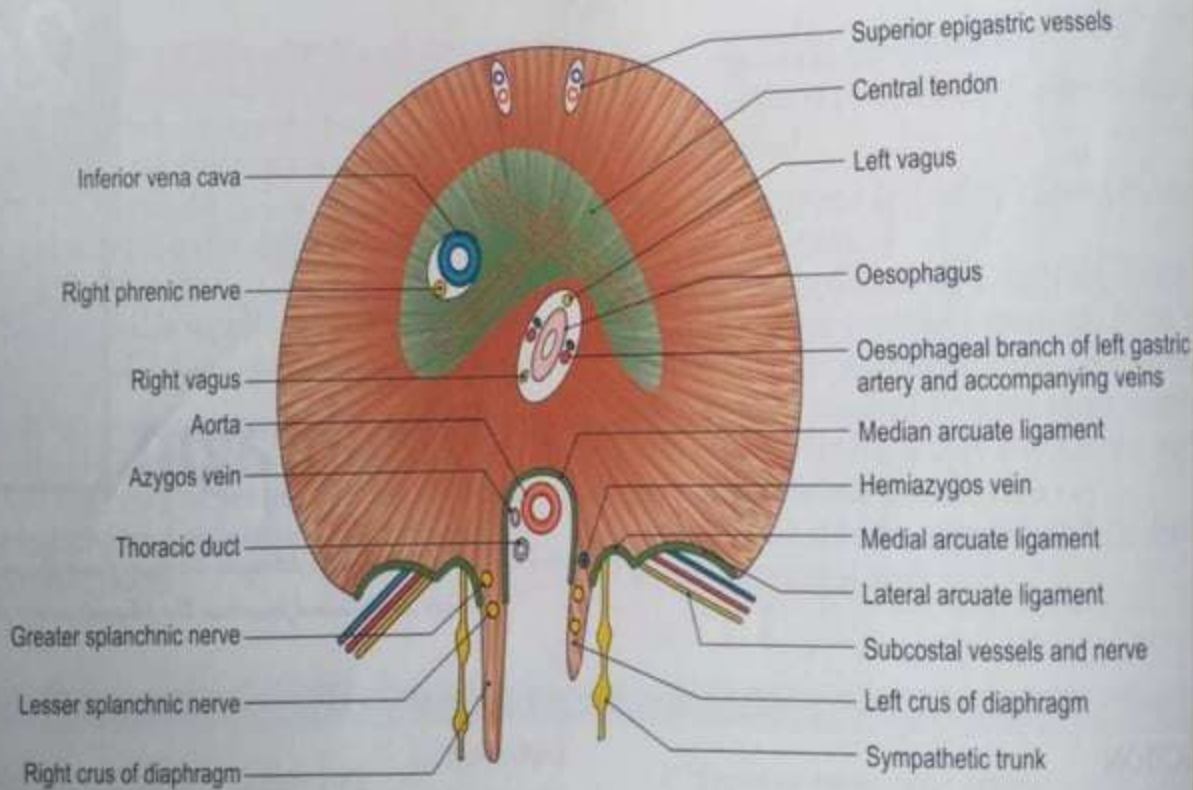


Fig. 26.1: The diaphragm as seen from below

Relations

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

Nerve Supply

- **Motor:**

Phrenic Nerves

(ventral rami C3, C4, C5)

- **Sensory:**

1. Central part: Phrenic nerve

2. Peripheral part: Lower six thoracic nerves

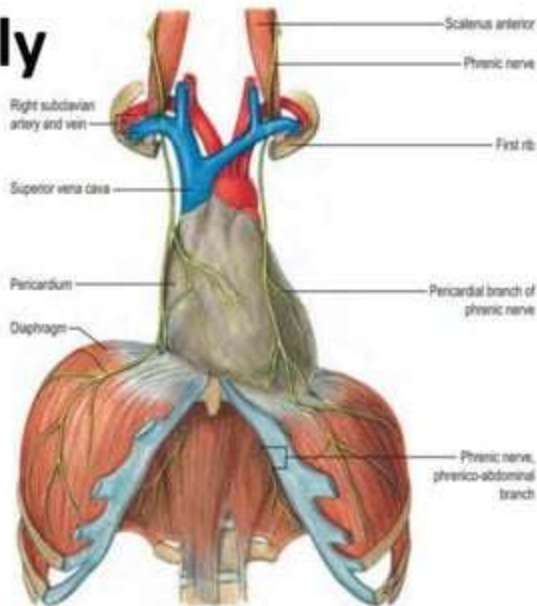


Fig. 55.7 The distribution of the right and left phrenic nerves. (With permission from Waschke J, Paulsen F (eds), Sobotta Atlas of Human Anatomy, 15th ed, Elsevier, Urban & Fischer. Copyright 2013.)

Action

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

Development

- Septum transversum forms the central tendon
- Pleuriperitoneal membrane form the dorsal paired portion.
- Lateral thoracic wall contributes to the circumferential portion of the diaphragm.
- Dorsal mesentery of esophagus forms the dorsal unpaired portion.

Development contd..

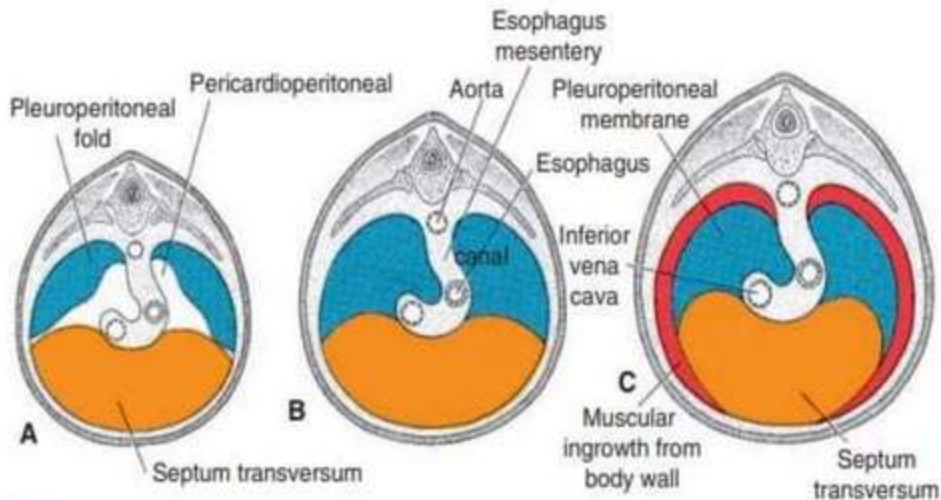


Figure 7.7 Development of the diaphragm. **A.** Pleuroperitoneal folds appear at the beginning of the fifth week. **B.** Pleuroperitoneal folds fuse with the septum transversum and mesentery of the esophagus in the seventh week, separating the thoracic cavity from the abdominal cavity. **C.** Transverse section at the fourth month of development. An additional rim derived from the body wall forms the most peripheral part of the diaphragm.

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

2. Acquired Hernia:

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

ii) Hiatal hernia:

- Congenital Hiatal Hernia (Rolling Hernia):

Due to persistence of embryonic peritoneal process in posterior mediastinum in front of cardiac end of stomach.

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

Clinical Anatomy

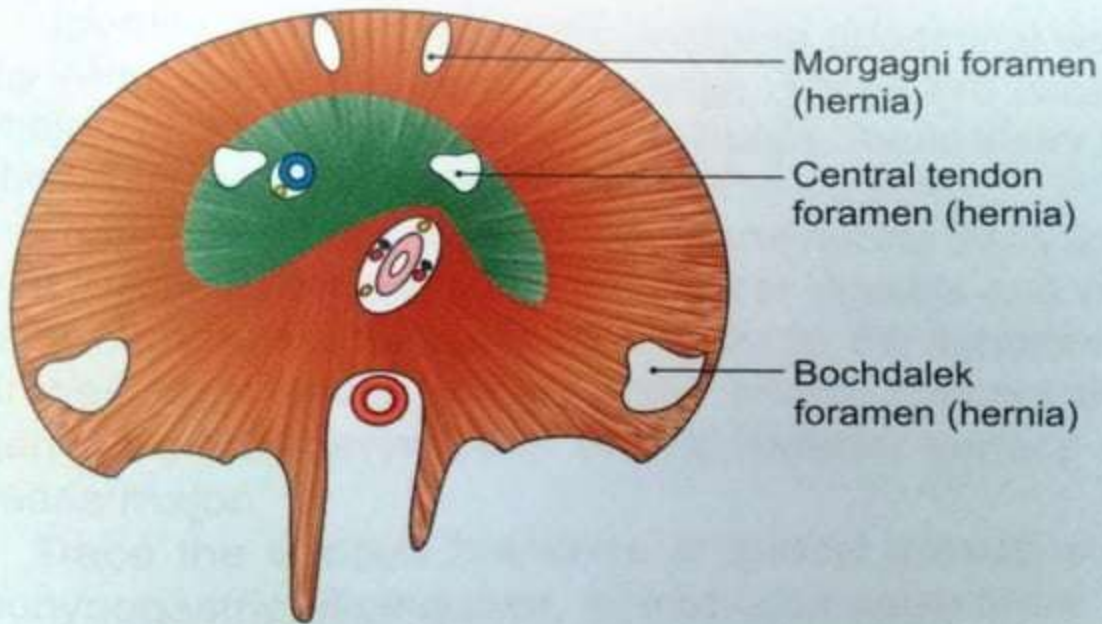
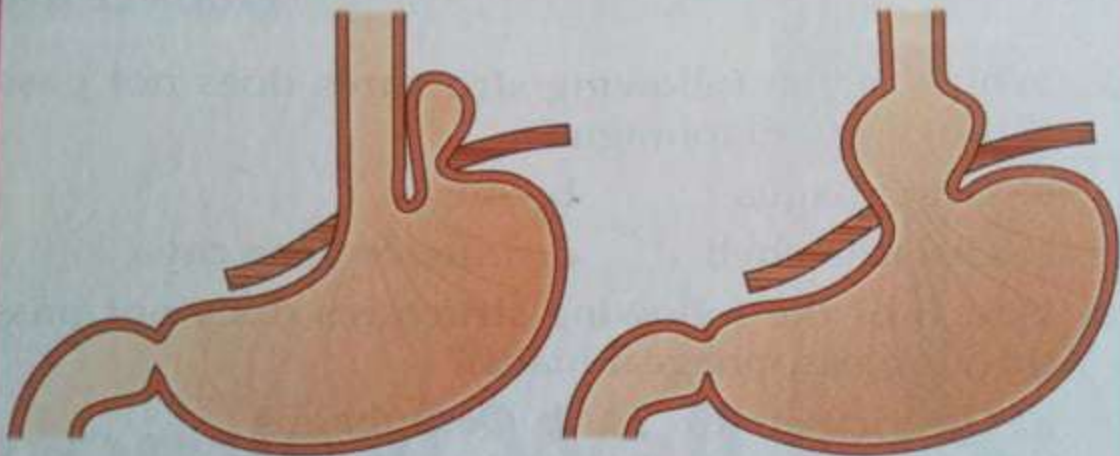


Fig. 26.4: Sites of diaphragmatic hernia

Clinical Anatomy



(a)

(b)

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

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