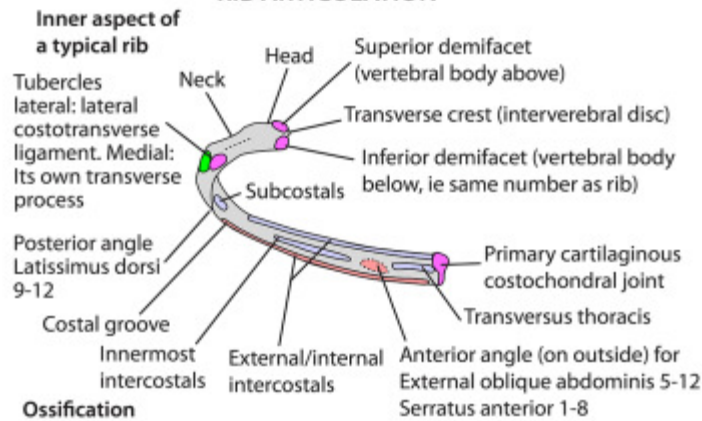


Respiration and the Diaphragm

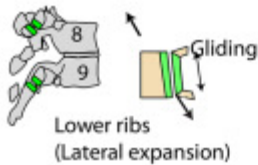
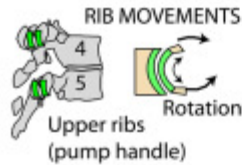
RIB ARTICULATION



Ossification

Posterior angle:
8 weeks intra-uterine
Head/tubercle:
15 years. Fuse 25 years

- 1st rib** Short, broad, most curved, single facet on head
- 2nd rib** Poorly marked costal groove, rough area for serratus anterior & scalenus posterior
- 3-10 ribs** Typical. 7th longest
- 11/12 ribs** Floating, single facet, no tubercle, tapered end. 12th no groove
- 1-7 ribs** articulate with sternum
- 8-10 ribs** with each other



- Muscles attached to outer ribs**
- Serratus anterior 1-8
- External oblique abdominis 5-12
- Pectoralis minor 3,4,5
- Latissimus dorsi 9-12

- Muscles attached to costal cartil**
- Pectoralis major 1-7 (often 2-6)

Typically:

Each rib articulates with its own vertebral body and own transverse process and with the lower edge of the body above.

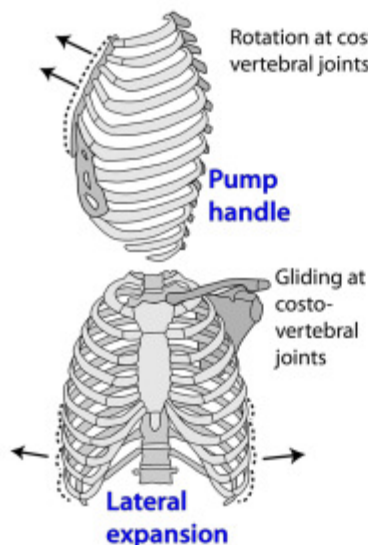
But:

1st rib articulates with its own body and transverse process only

Ribs 11 & 12 articulate with their own bodies only

Note: All joints are synovial except costotransverse for 11 & 12 which are fibrous joints

RIB MOVEMENTS IN RESPIRATION



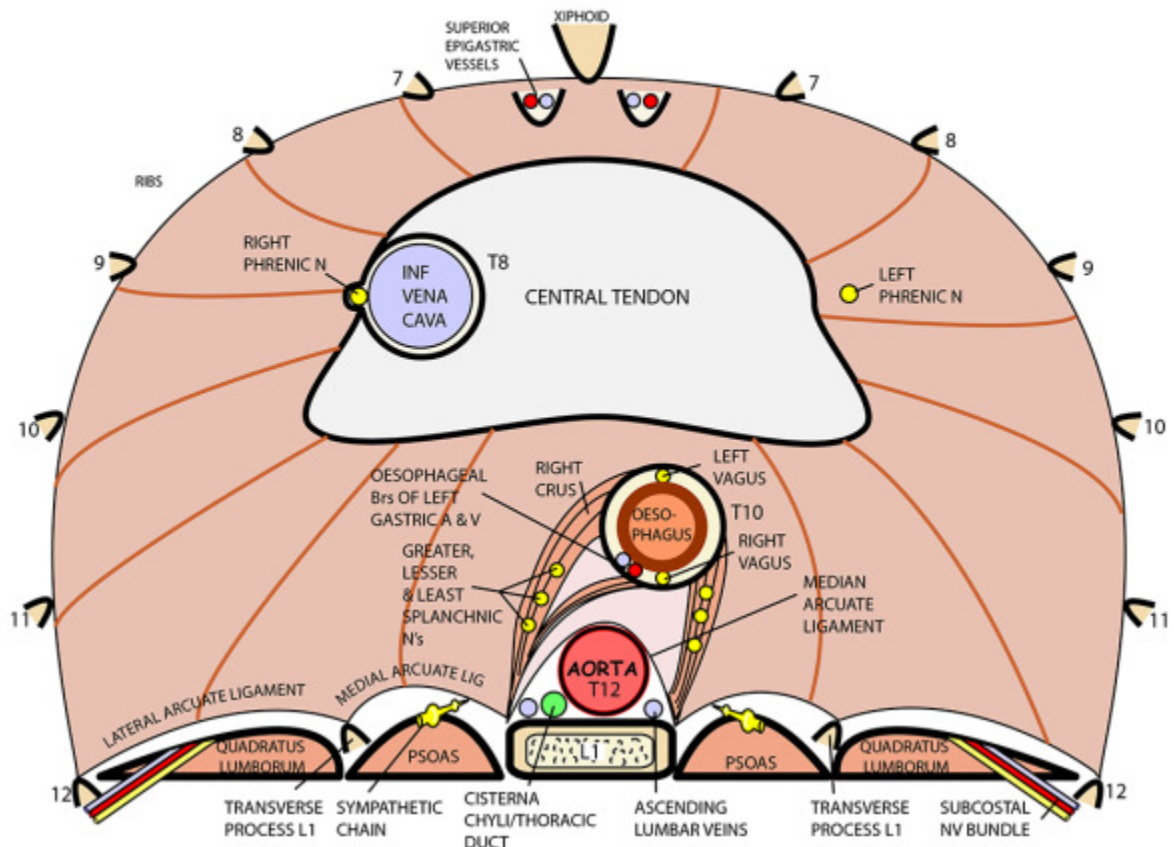
Upper thorax (ribs 1-6)

There is **pump handle** movement on inspiration. Mostly anteroposterior expansion - minimal lateral expansion

Lower thorax (ribs 7-10)

In quiet inspiration the costal margins separate producing **lateral** and slight upwards movement of the whole lower thorax. In forced inspiration there is an additional eversion of the last few ribs by the diaphragm pulling on them. This is likened to the lifting of a **bucket handle** (not illustrated)

UNDER SURFACE OF DIAPHRAGM



Origin:

Vertebral - Right crus (L1,2,3), left crus (L1,2), 5 arcuate ligaments
 Sternal - Xiphoid, Costal - Rib & costal cartilages 7-12

Insertion:

Central tendon (trefoil-1 ant, 2 post, fused with pericardium)

Action:

Inspiration - 70% at rest (5cm of movement)

Less % on exertion (10cm movement)

Straining - Outlet of chest is fixed to raise intra-abdominal pressure

Nerve supply:

Phrenic nerves - C3,4,5. 1/3 sensory, 2/3 motor. Diaphragm has no other motor supply

Blood supply:

Outer - lower 5 intercostals & subcostal arteries

Inner - Inferior phrenic (aorta), musculophrenic/pericardiophrenic (internal thoracic)

DIAPHRAGM - OPENINGS & RELATIONS

OPENINGS

Caval (T8):

- Inferior vena cava & right phrenic nerve
- Left phrenic nerve

Anterior hiatus (T9):

- Superior epigastric artery & vein

Oesophageal (T10):

- Oesophagus
- Left & right vagus nerves
- Oesophageal branches of left gastric artery/vein
- Lymphatics

Aortic (T12) (Strictly behind diaphragm):

- Aorta
- Azygos vein & hemiazygos vein
- Thoracic duct

Crura (T12):

- Greater, lesser & least splanchnic nerves

Behind medial arcuate ligament:

- Sympathetic chain

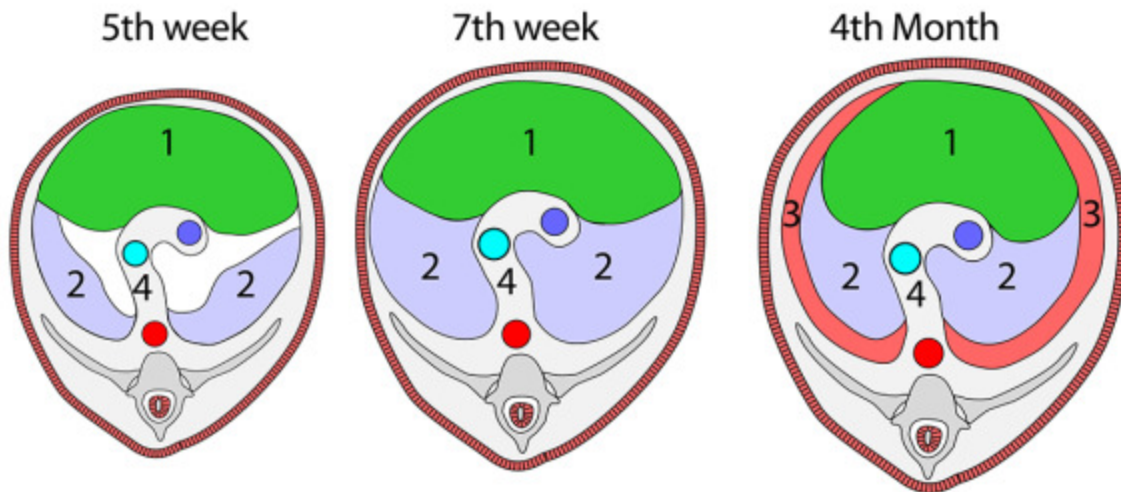
Behind lateral arcuate ligament:

- Subcostal (T12) neurovascular bundle

RELATIONS

- Right dome reaches 4th costal space (nipple) in expiration
- Left dome reaches 5th rib in expiration
- Superior - pericardium, basal lung segments
- Inferior - Right - liver, suprarenal, kidney
- Left - stomach, suprarenal, kidney & spleen
- Posterior - Aorta, azygos veins, oesophagus, vagi, pleural folds

FORMATION OF THE DIAPHRAGM



Forms from:

- | | | |
|---------------------------------------|---|------------------------------|
| 1. Septum transversum | → | Tendinous part of diaphragm |
| 2. 2 pleuroperitoneal membranes | } | → Muscular part of diaphragm |
| 3. Peripheral body wall muscle | | |
| 4. Mesentery of oesophagus | → | Crura of diaphragm |

SEPTUM TRANSVERSUM

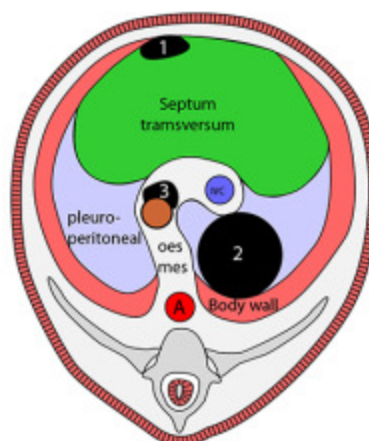
Separates pericardial development from developing gut by moving to lie caudal to pericardial cavity. It descends from neck.

BODY WALL and PLEUROPERITONEAL MEMBRANES. Both grow in to fuse with septum transversum

DORSAL MESENTERY OF OESOPHAGUS

Completes the diaphragm posteriorly

Note: Despite this complex development few defects occur in the diaphragm. Perhaps the severer ones are incompatible with life. The important sites for hernia are shown here



CONGENITAL DIAPHRAGMATIC HERNIAS

1. Foramen of Morgagni (Parasternal - nearly "midline")
2. Foramen of Bochdalek (at "back") (Pleuroperitoneal hernia)
3. Oesophageal hiatus
4. Dome of diaphragm