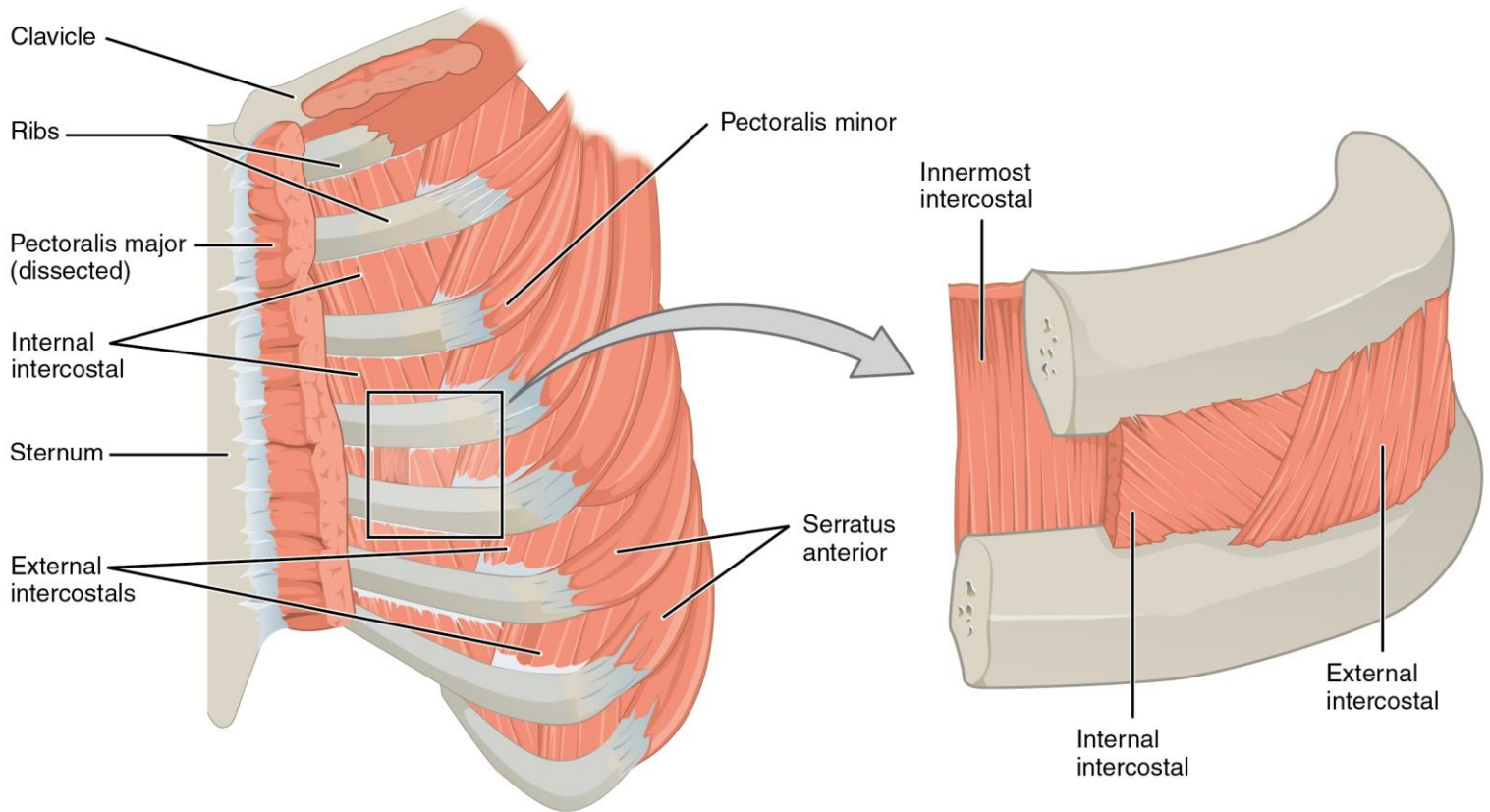


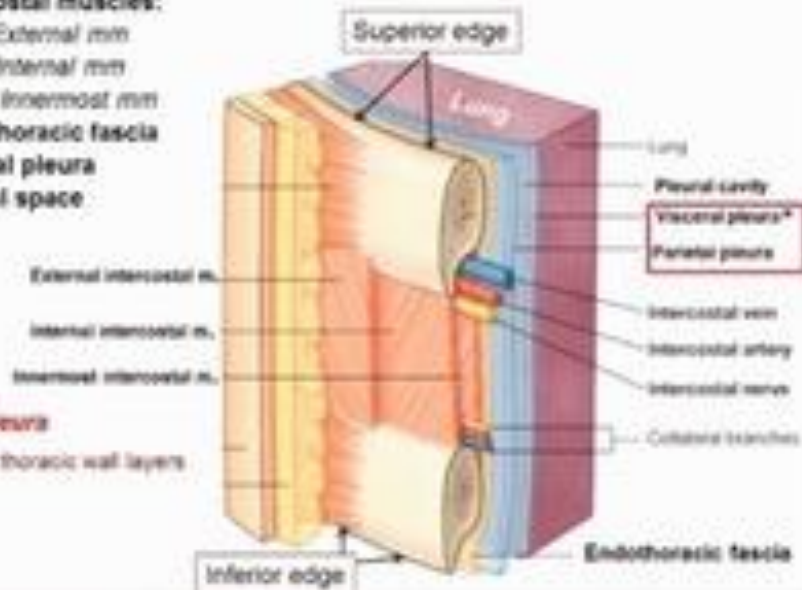
Thoracic cage

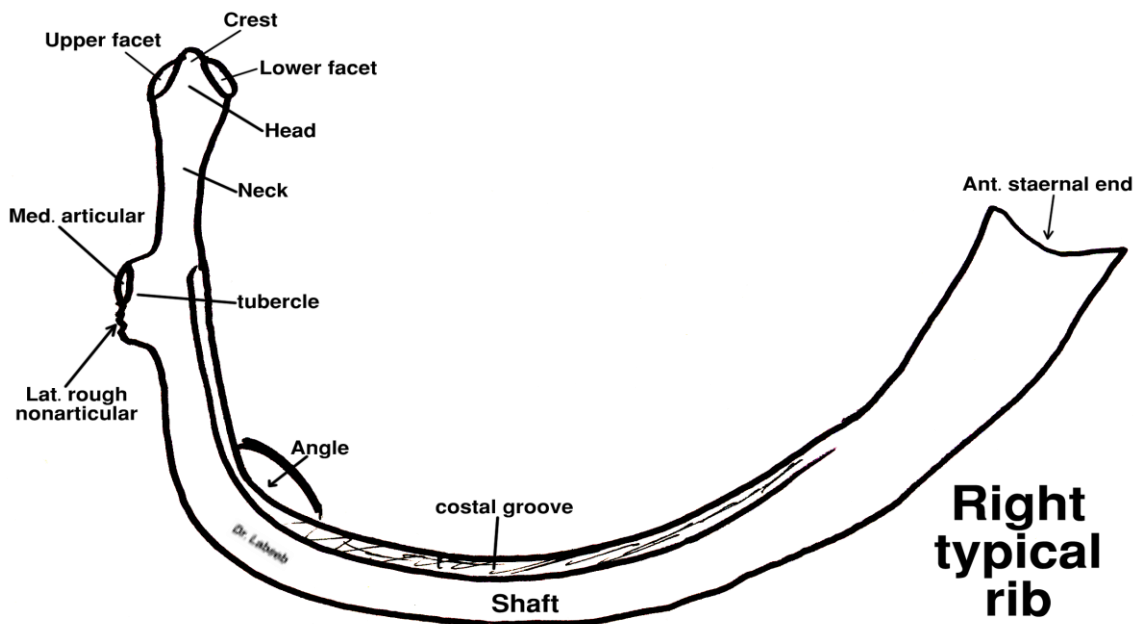
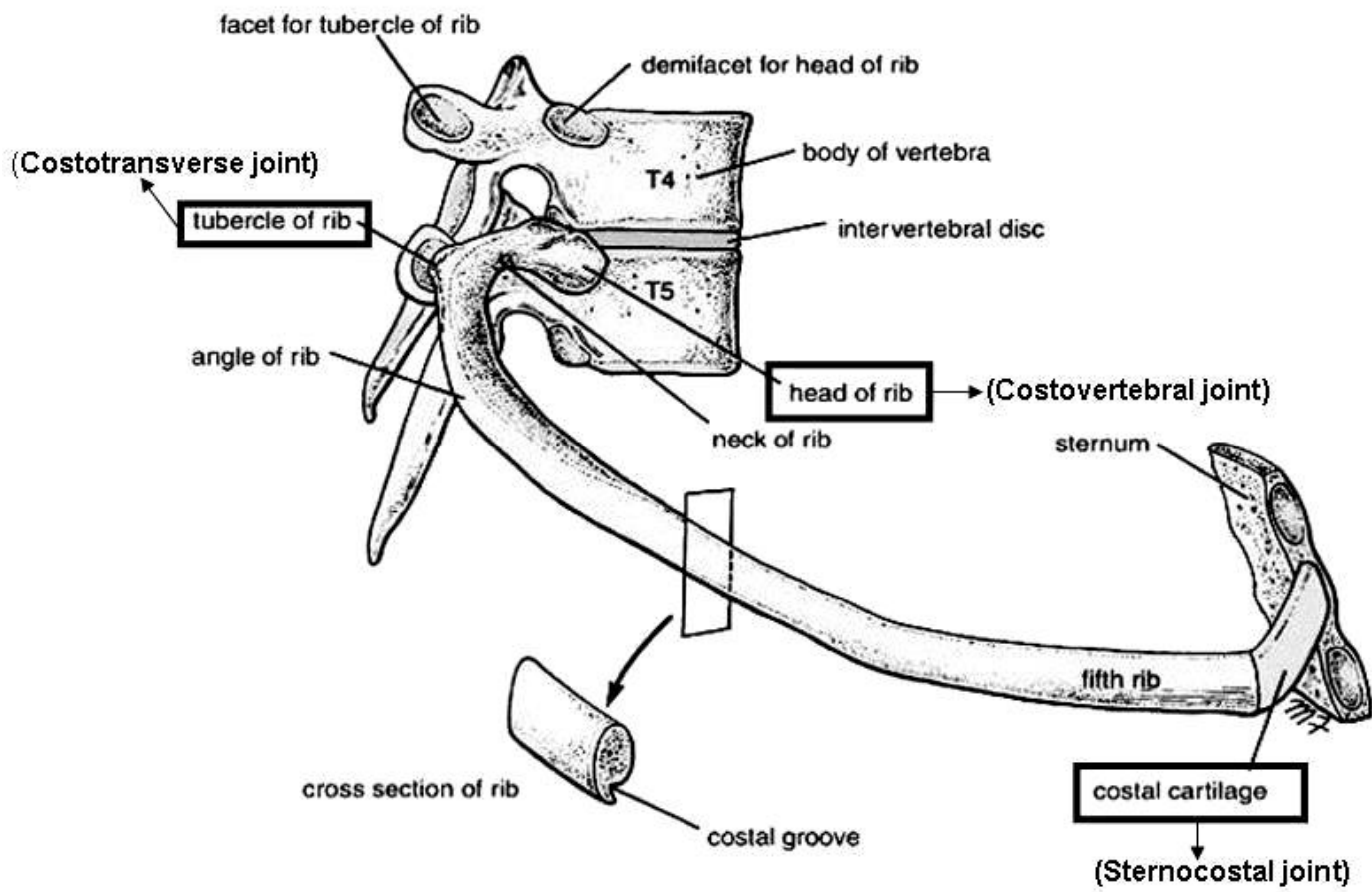


Layers of the Thoracic Wall (superficial to deep):

- 1 Skin
- 2 Superficial fascia
- 3 Intercostal muscles:
 - i) External int
 - ii) Internal int
 - iii) Innermost int
- 4 Endothoracic fascia
- 5 Parietal pleura
- 6 Pleural space

*Visceral pleura
is not part of thoracic wall layers





The Intercostal Spaces

The thoracic cage forms the skeletal framework of the wall of the thorax. The spaces between the ribs are called intercostal spaces; they are nine anterior and 11 posterior spaces. Each intercostal space contains:

A. Intercostal muscles:

- 1-External intercostal muscle
- 2-Internal intercostal muscle
- 3-Transversus thoracis (innermost, sternocostalis and subcostalis).

B. Intercostal neuro-vascular bundle:

- 1-Intercostal arteries (anterior and posterior).
- 2-Intercostal veins (anterior and posterior).
- 3-Intercostal nerve.

A. Intercostal muscles

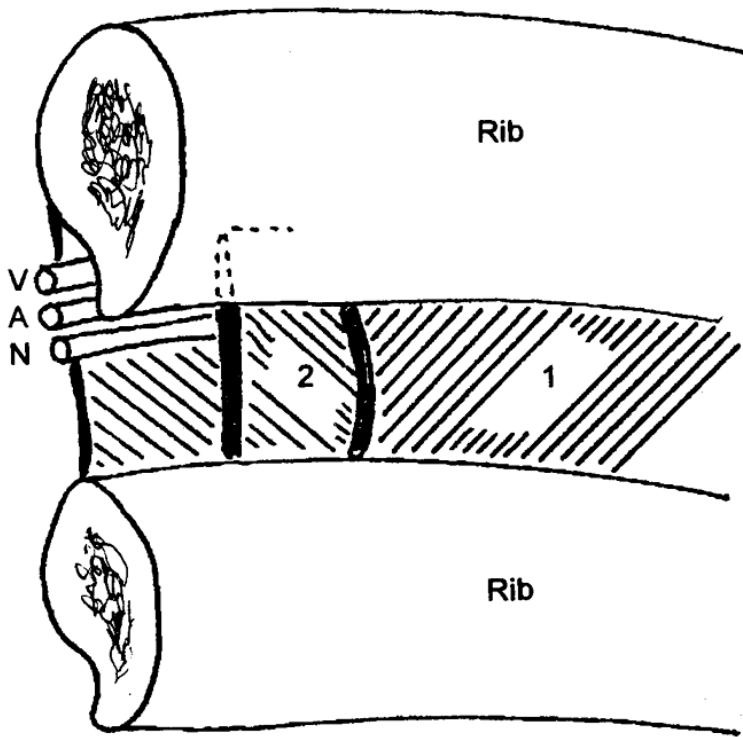
These are 3 thin layers of muscles and tendinous fibers occupying the intercostal space arranged from outside inwards as: (External, Internal and inner most intercostal muscles).

1. External intercostal muscle:

- It arises from the lower border of the rib above to the upper border of the rib below.
- The fibers extend from the tubercle of rib till the costochondral junction , where the muscle fibers become aponeurotic and extend to the sternum as anterior intercostal membrane.
- Direction of fibers downwards and forwards.

2. Internal intercostal muscle:

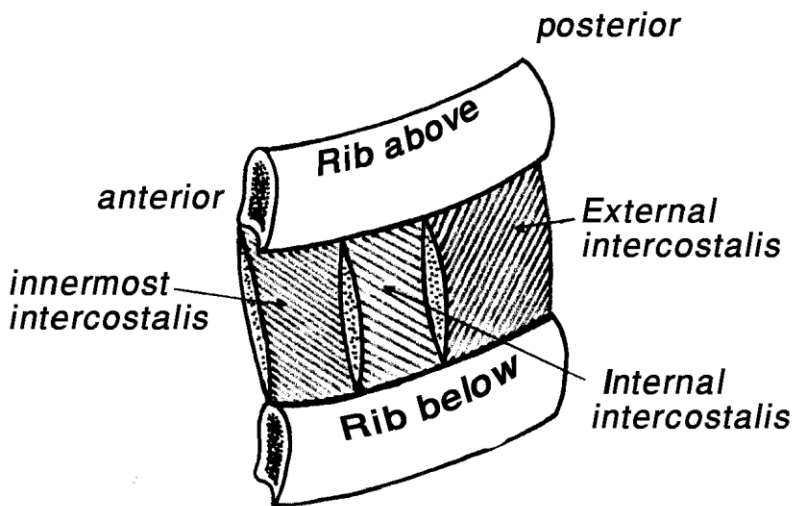
- It arises from the floor of the costal groove of the rib above to the upper border of the rib below.



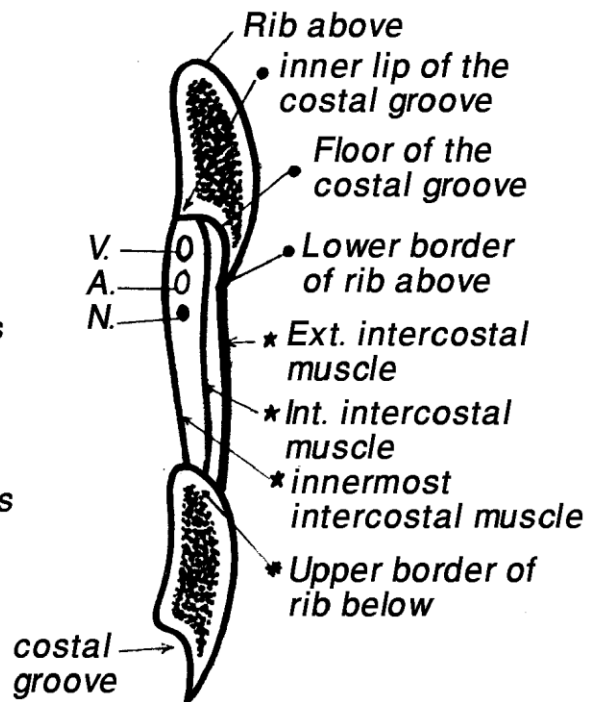
1. External intercostal
2. Internal intercostal
3. Inner most intercostal

- V. Intercostal vein
 A. Intercostal artery
 N. Intercostal nerve

Intercostal muscles



A segment of 2 succeeding ribs



Transverse section of 2 succeeding ribs

- It extends from the sternum (anteriorly) till a little behind mid axillary line, where it continues as the posterior intercostal membrane.
- Direction of the fibers: downwards and backwards.

3. **Innermost intercostal muscle :**

- It arises from the inner lip of the costal groove of the rib above to the upper border to the rib below, extending from in front of midaxillary line to the angle of the rib.
- Lies in the middle of the intercostal space.
- Direction of fibers: as internal intercostal muscle.

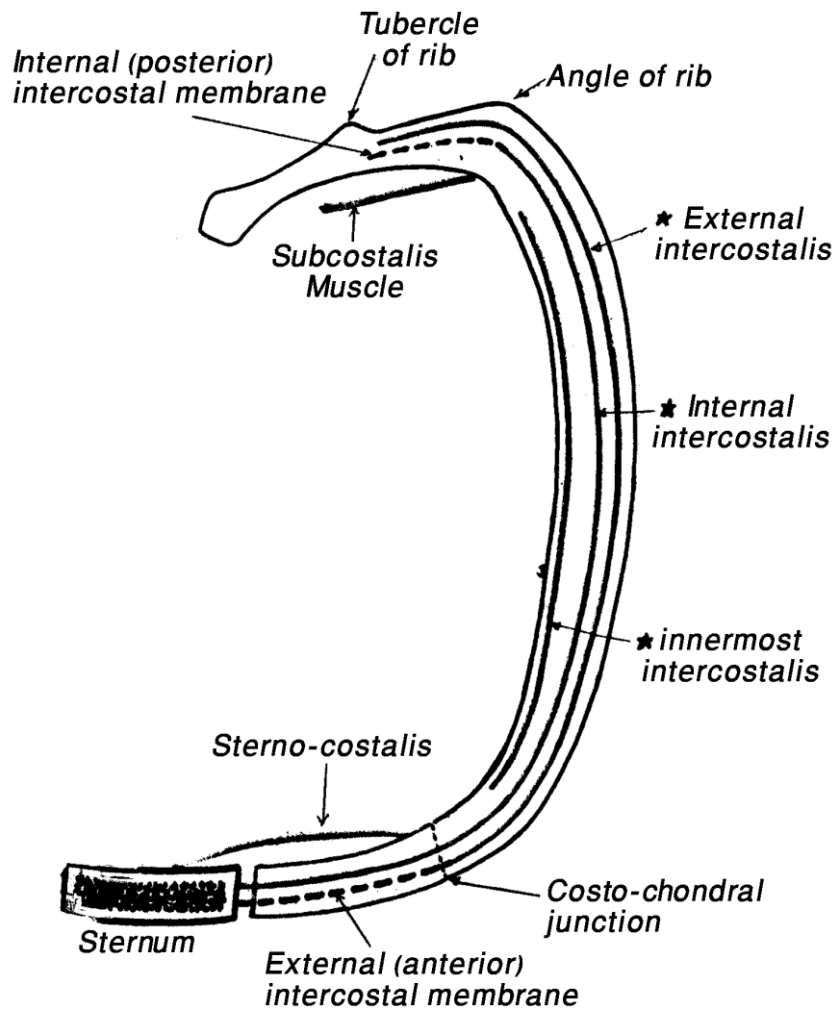
***Nerve supply:** branches of the intercostal nerves.

***Action:**

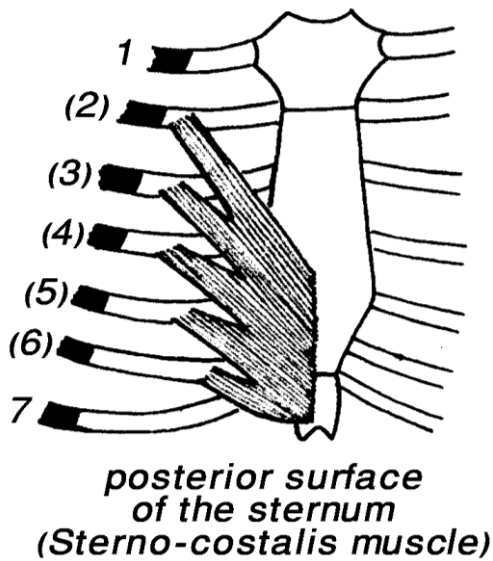
1. Intercostal muscles are elevators of ribs during forced respiration .
2. Tension of intercostal muscles prevents the intercostal spaces being drawn inwards in inspiration or ballooned out during expiration.

N.B.

- **Transversus thoracis muscle is formed of three muscles :**
 - a. **Sternocostalis** : lies in the anterior part of the intercostal space.
 - b. **Innermost intercostal** : lies in the middle of the intercostal space.
 - c. **Subcostalis** : lies in the posterior part of the intercostal space.
- The three abdominal muscles (external oblique, internal oblique and transversus abdominis) correspond to the intercostal muscles.



Intercostal muscles



B. Intercostal neuro-vascular bundle

1. Intercostal arteries

The intercostal arteries supply the wall of the thorax. They are anterior and posterior.

a) Nine pairs of anterior intercostal arteries:

They are two arteries in each of the upper nine intercostal spaces.

The upper six pairs arise from the internal thoracic artery, while the 7th, 8th and 9th are branches of the musculophrenic artery [one of the two terminal branches of internal thoracic artery].

There are no anterior intercostal arteries in the 10th and 11th spaces because these spaces are not complete in front.

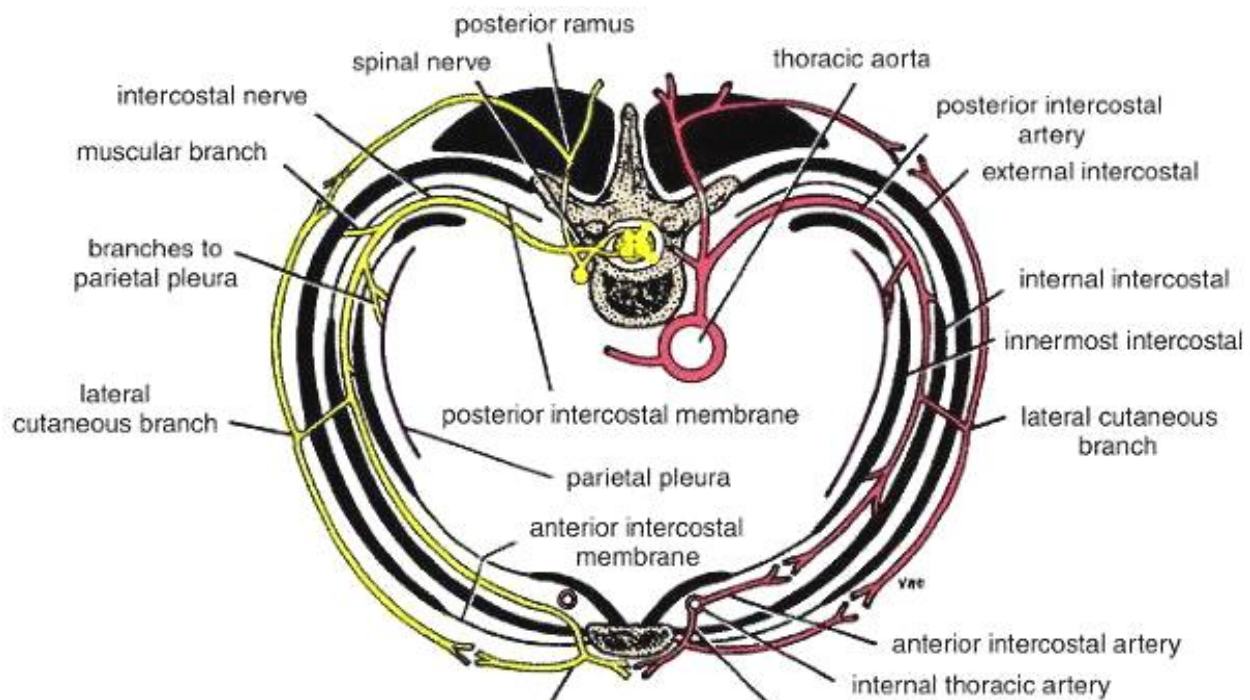
N.B. The posterior intercostal artery anastomoses with upper anterior intercostal artery and it gives branch to anastomose with the lower anterior intercostal artery in each space of the upper intercostal space.

b) Eleven posterior intercostal arteries and subcostal artery:

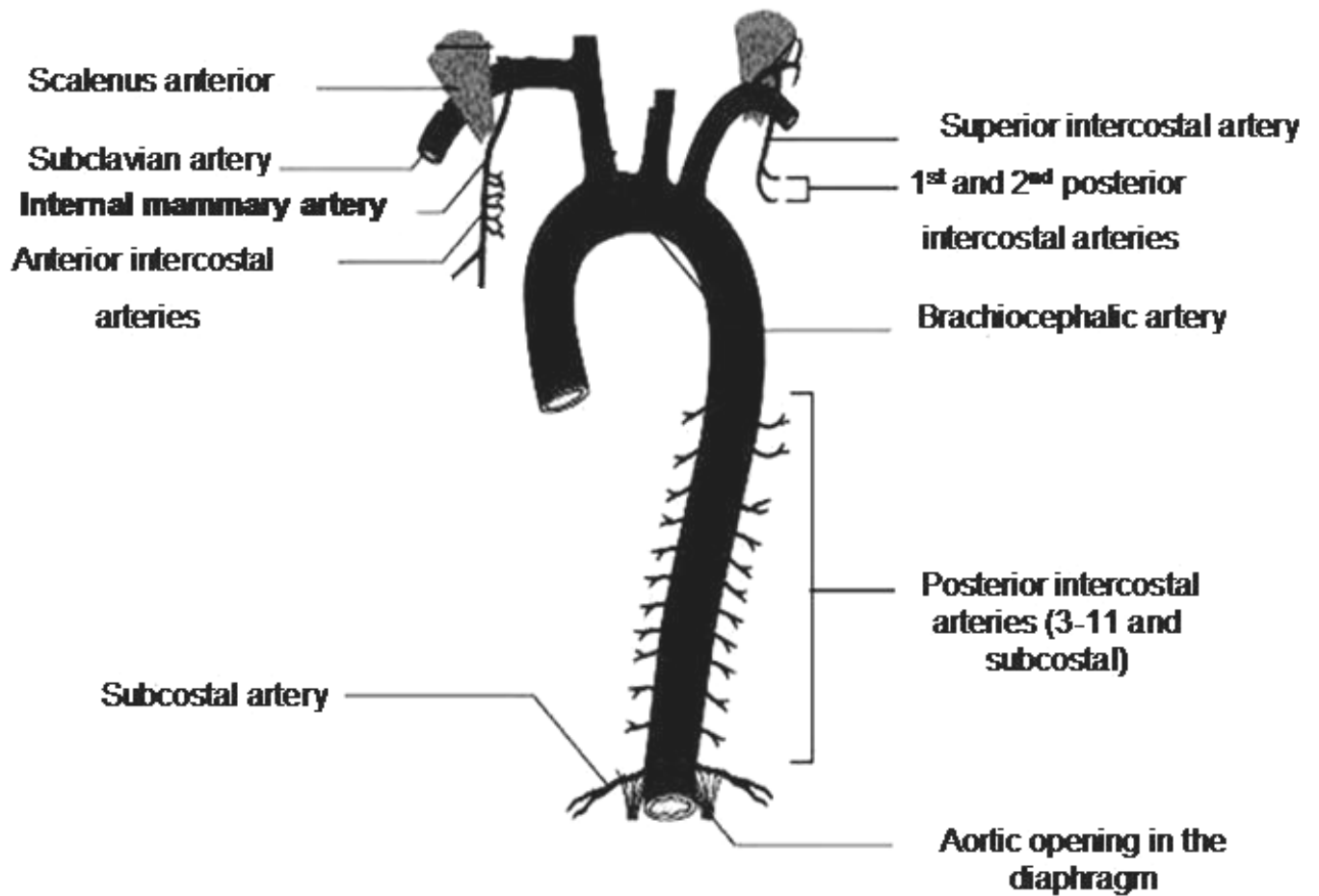
- **The 1st and 2nd posterior intercostal arteries** : arise from the superior intercostal artery (branch from costocervical trunk of the 2nd part of subclavian artery) which descends in front of the neck of the 1st rib and gives the 1st and 2nd posterior intercostal arteries.

- **The lower nine posterior intercostal arteries** (from 3rd to 11th) and subcostal arteries) :

Are branches of descending thoracic aorta. The right arteries are longer than the left. They pass behind the thoracic duct, vena azygos, oesophagus and the right sympathetic chain to reach their spaces. Each posterior intercostal artery gives a collateral branch, both the artery and its collateral branch run together to anastomose with the two anterior intercostal arteries.



Intracostal arteries



Internal thoracic artery

○ **Begins:**

- It begins in the neck as a branch of 1st part of subclavian artery, it descends behind the upper six costal cartilages (1.5 cm lateral to the sternum) below the 3rd costal cartilage accompanied by one vein which lies medial to it.

○ **Ends:**

- It ends opposite the 6th intercostal space by dividing into superior epigastric artery and the musculophrenic artery.

○ **Branches of internal thoracic artery:**

1. Six pairs of anterior intercostal arteries : in the upper six spaces.

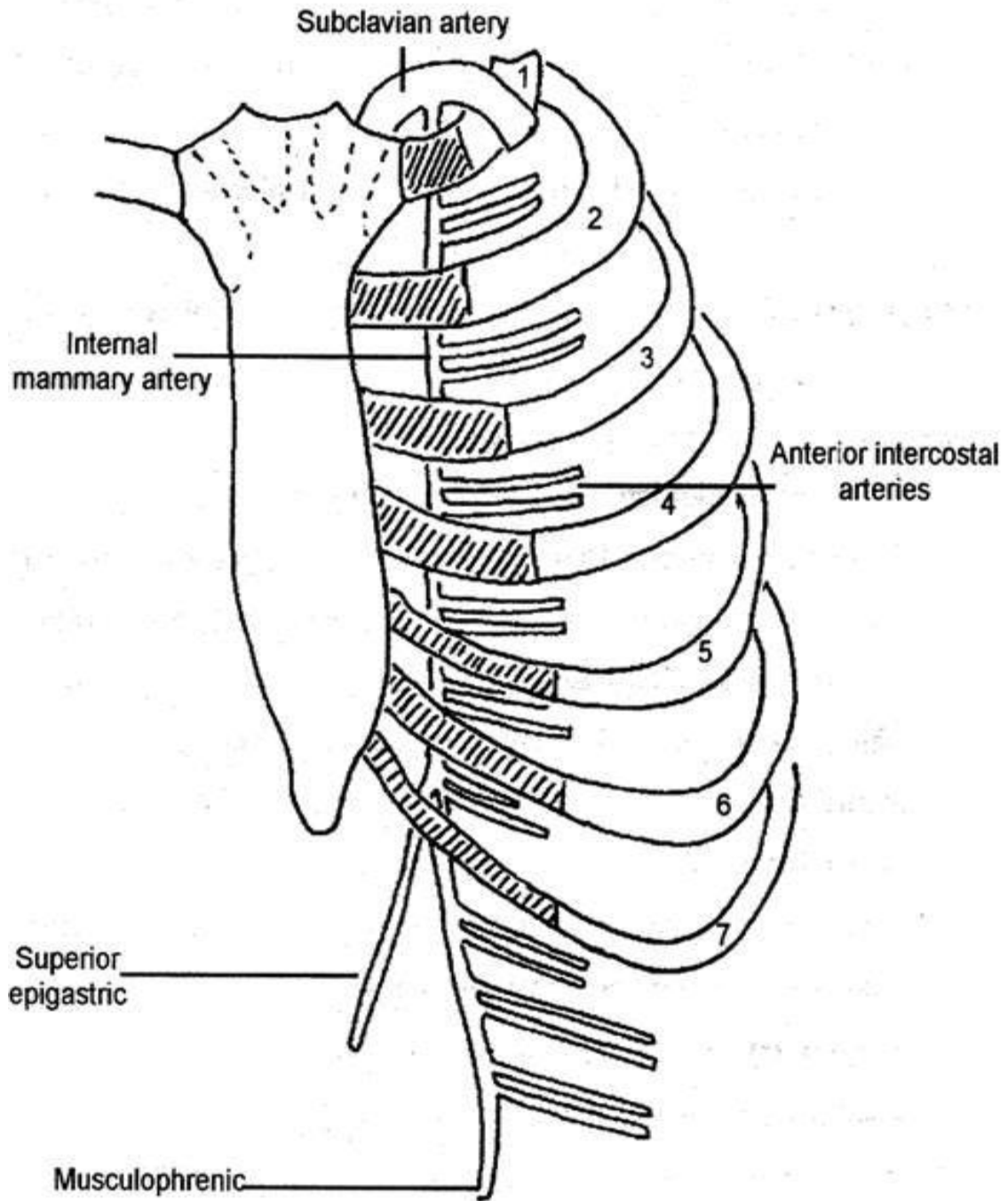
2. Pericardiophrenic artery: passes down with the phrenic nerve to supply pleura, pericardium and diaphragm.

3. Six perforating branches: which pierce the intercostal muscles, and pectoralis major muscle. The 2nd, 3rd and 4th perforators supply the mammary gland .

4. Two terminal branches:

a) **Superior epigastric artery:** passes downwards in rectus sheath posterior to the rectus muscle till the level of umbilicus where it ends by anastomosing with the inferior epigastric artery (a branch of external iliac artery).

b) **Musculophrenic artery:** passes downwards along the costal margin to supply the diaphragm, it gives the 7th, 8th and 9th pairs of anterior intercostal arteries.



Internal thoracic artery

2. Intercostal veins

A) Anterior intercostal veins:

They accompany the arteries; they end in the musculo-phrenic vein and the internal thoracic vein which drain into the brachiocephalic vein.

B) Posterior intercostal veins:

1. On the right side:

The 1st ends in right brachiocephalic vein , 2nd, 3rd and 4th end in right superior intercostal vein which ends in arch of azygos.

From 5th to 11th and right subcostal end in vena azygos.

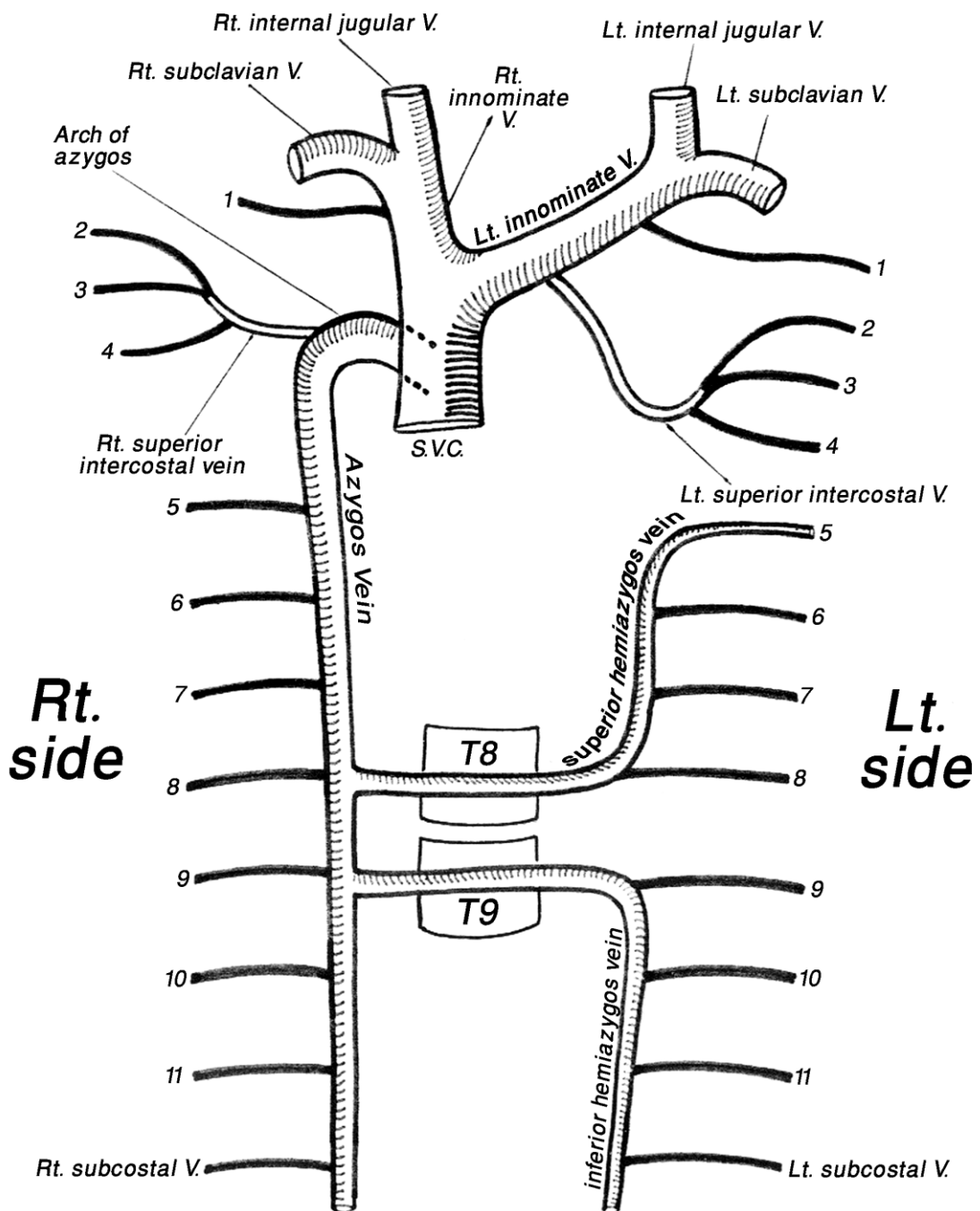
2. On the left side:

The 1st ends in left brachiocephalic vein.

2nd, 3rd and 4th end in left superior intercostal vein which ends in left brachiocephalic vein.

From 5th till 8th end in superior hemiazygos which ends in azygos.

From 9th to 11th and left subcostal end in inferior hemiazygos which ends in azygos.



Post intercostal veins

Vena azygos

- **Begins:** it begins in the abdomen usually from the back of inferior vena cava at the level of L₂.
- **Course:** It enters the thorax by passing through aortic opening of diaphragm then ascends in posterior mediastinum till the level of lower border of T4 where the arch of azygos begins and passes in superior mediastinum arching forwards above root of right lung.
- **Ends:** in the middle of the back of superior vena cava (S.V.C.) at level of 2nd right costal cartilage (above the level of pericardium).

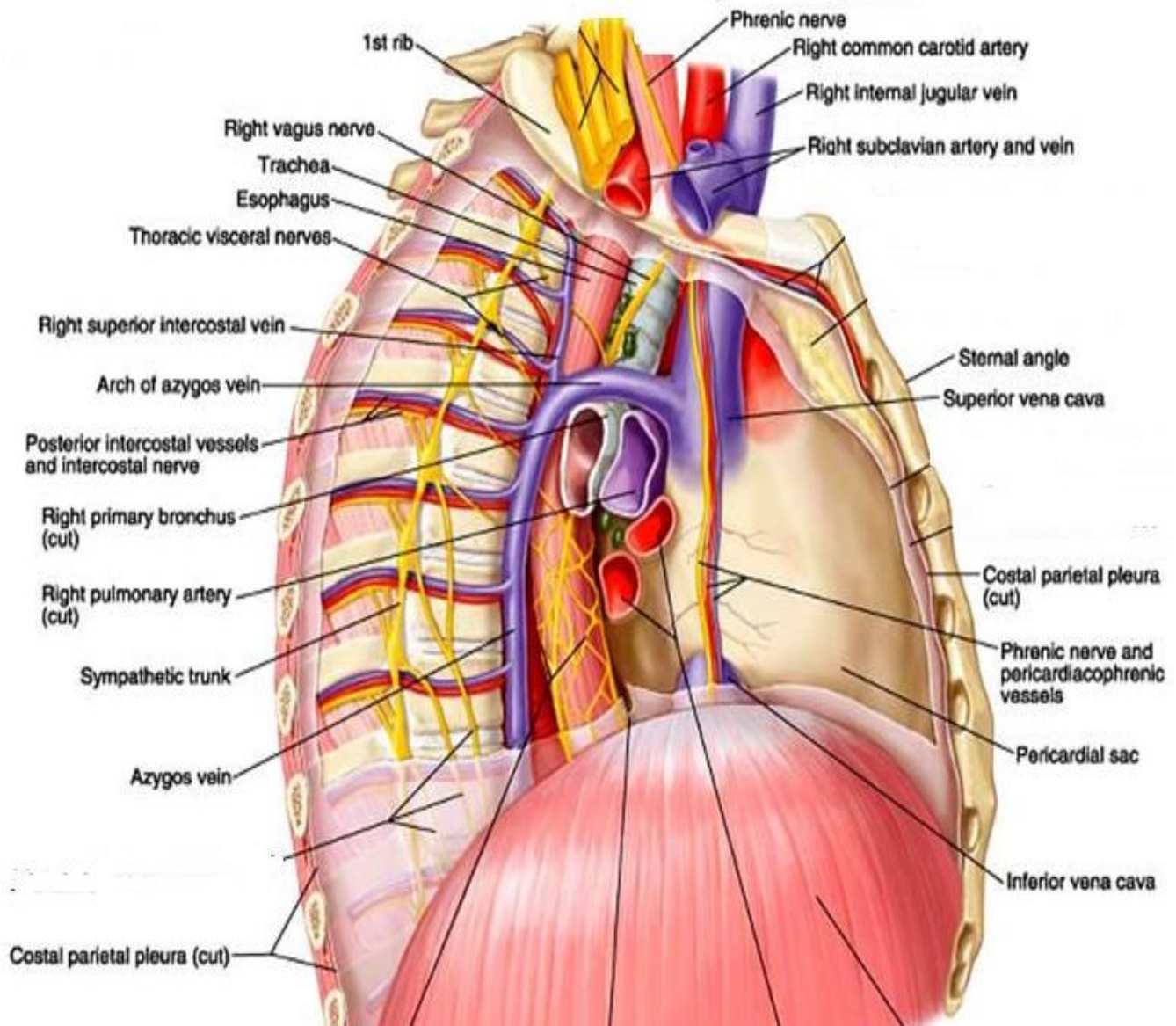
- **Relations:**

Relations of the azygos vein in the posterior mediastinum:

- On the left side: thoracic duct separates it from descending aorta.
- On the right side: right pleura and lung.
- Anterior: oesophagus and root of right lung.
- Posterior: the right posterior intercostal and subcostal arteries separate it from vertebral column and anterior longitudinal ligament.

Relations of the arch of azygos (in superior mediastinum):

- Below: root of right lung.
- On its right side: right pleura and lung.
- On its left side: trachea, right vagus and oesophagus.



Azygos vein

Tributaries:

1. From 5th to 11th right posterior intercostal veins and right subcostal vein.
2. Right ascending lumbar vein.
3. Superior and inferior hemiazygos veins.
4. Two bronchial veins from right lung.
5. Oesophageal and pericardial veins.
6. Right superior intercostal vein opens in arch of azygos.

Hemiazygos veins**a) Superior hemiazygos:**

- Begins at the posterior end of the 5th left intercostal space.
- Passes down on the left side of the descending aorta till the level of T₈ where it turns to the right passing behind the descending aorta and thoracic duct, in front of the anterior longitudinal ligament, to end in vena azygos.
- It receives the posterior intercostal veins from 5th to 8th.

b) Inferior hemiazygos :

- Usually begins from the back of left renal vein.
- Pierces left crus of diaphragm and passes to the left side of thoracic vertebrae.
- At the level of T₉ it turns to the right behind the ascending aorta and thoracic duct to end in vena azygos.
- It receives the left posterior intercostal veins from 9th till 11th and left subcostal vein.

3. Intercostal nerves and subcostal nerve

- They are the anterior 1st rami of the 12 thoracic spinal nerves. The upper eleven are known as intercostal nerves while the lower one is known as subcostal nerve.
- **Classification :**
 1. **Typical intercostal nerves:** from 2nd till 6th. They run in the thoracic wall.
 2. **Atypical intercostal nerves (thoraco- abdominal nerves):** from 7th till 11th. They run part of their course in the thoracic wall and part in the abdominal wall in their neurovascular plane to supply the abdominal muscles.
- 3. **Two nerves of special features:**
 - The 1st intercostal nerve: most of it joins brachial plexus.
 - The subcostal nerve: runs in the abdominal wall.

Typical intercostal nerve (2nd – 6th)

- **Course:**

Passes in the intercostal space below intercostal vessels [vein, artery and nerve] [V.A.N] lying first between the pleura and posterior intercostal membrane, then between internal intercostal muscle and the subcostalis and inner most intercostal muscles (i.e. between the 2nd. And 3rd. layers of intercostal muscles).

Near the sternum it crosses the internal thoracic vessels, and then pierces the internal intercostal muscle and the anterior intercostal membrane and pectoralis major muscle to end as anterior cutaneous nerve which gives medial and lateral divisions to skin of front of chest.
- **Branches of intercostal nerve :**
 - a) **Muscular:** to intercostal muscles.

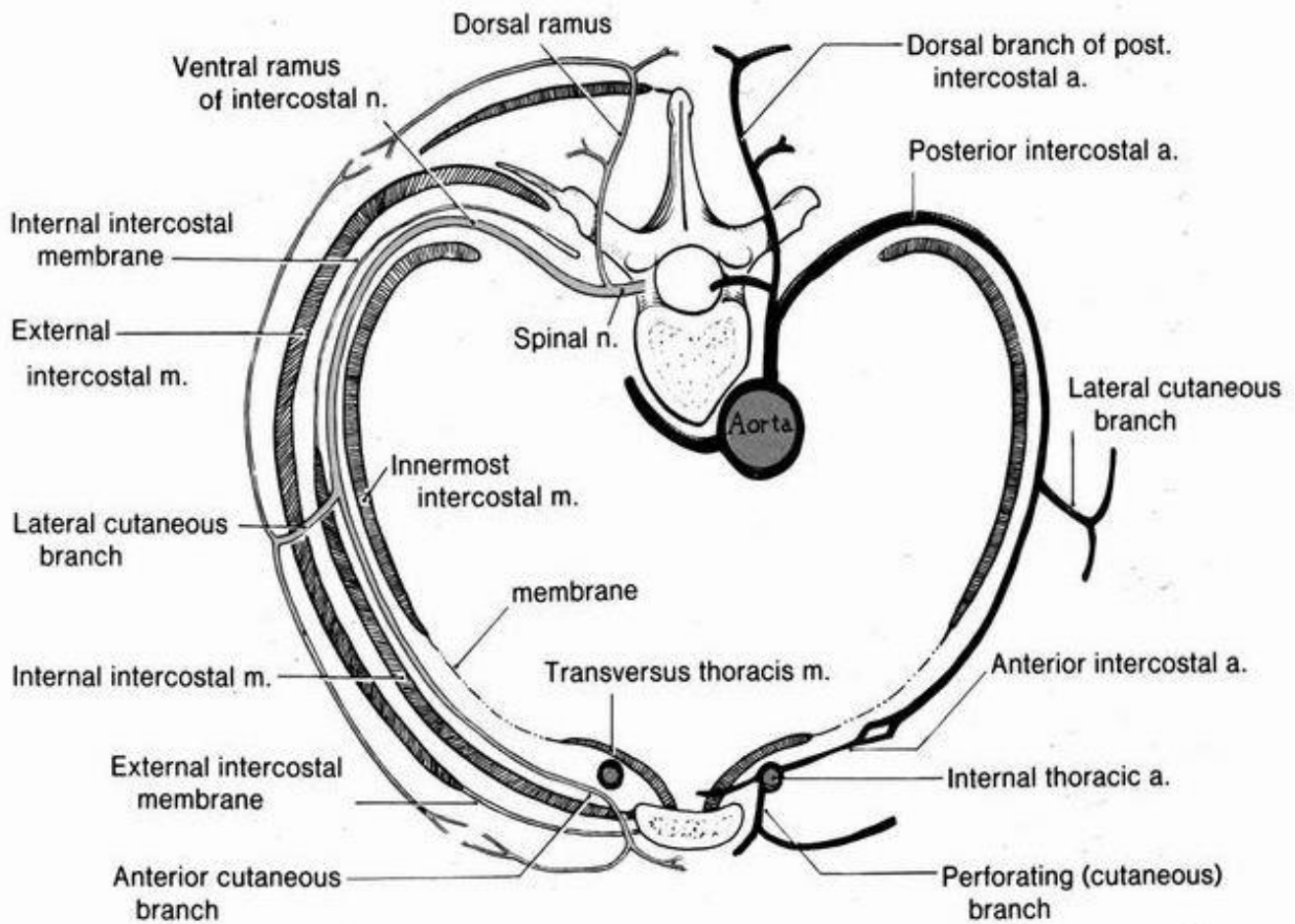
- b) ***Lateral cutaneous branch***: arises opposite the mid axillary line and pierces the internal and external intercostal muscles and divides into anterior and posterior divisions on side of thorax.
- c) ***Anterior cutaneous branch***: is the end of the intercostal nerve. It pierces the internal intercostal muscles, anterior intercostal membrane and the pectoralis major to supply the skin of the front of the chest.
- d) **White and grey rami communicantes**: to communicate with spinal nerve.
- e) **Collateral branch**: supplies the intercostal muscles.
- f) **Articular branch**: supplies the joints of the rib.

N.B.

The intercostobrachial nerve is the lateral cutaneous branch of the 2nd intercostal nerve; it supplies the skin of the floor of axilla.

- **Clinical importance:**

- Fracture of ribs is very painful due to irritation of intercostal nerves .
- Fracture ribs may be due to direct trauma leading to fracture at the site of trauma but in case of indirect trauma (due to antero-posterior compression) leading to fracture at the angle of the ribs .
- Intercostal nerve block: is injection of local anesthesia at around intercostal nerve at the lower border of the ribs.
- Irritation of the intercostal nerve e.g. by a disease in the thoracic vertebrae gives rise to pain in anterior or lateral aspect of chest or abdomen .
- In T.B of thoracic vertebrae , casease material follows the course of the intercostal nerve and may appear as cold abscess either lateral to sacrospinalis or in mid axillary line or lateral to sternum.



**Typical intercostal nerve
(Course and branches)**

