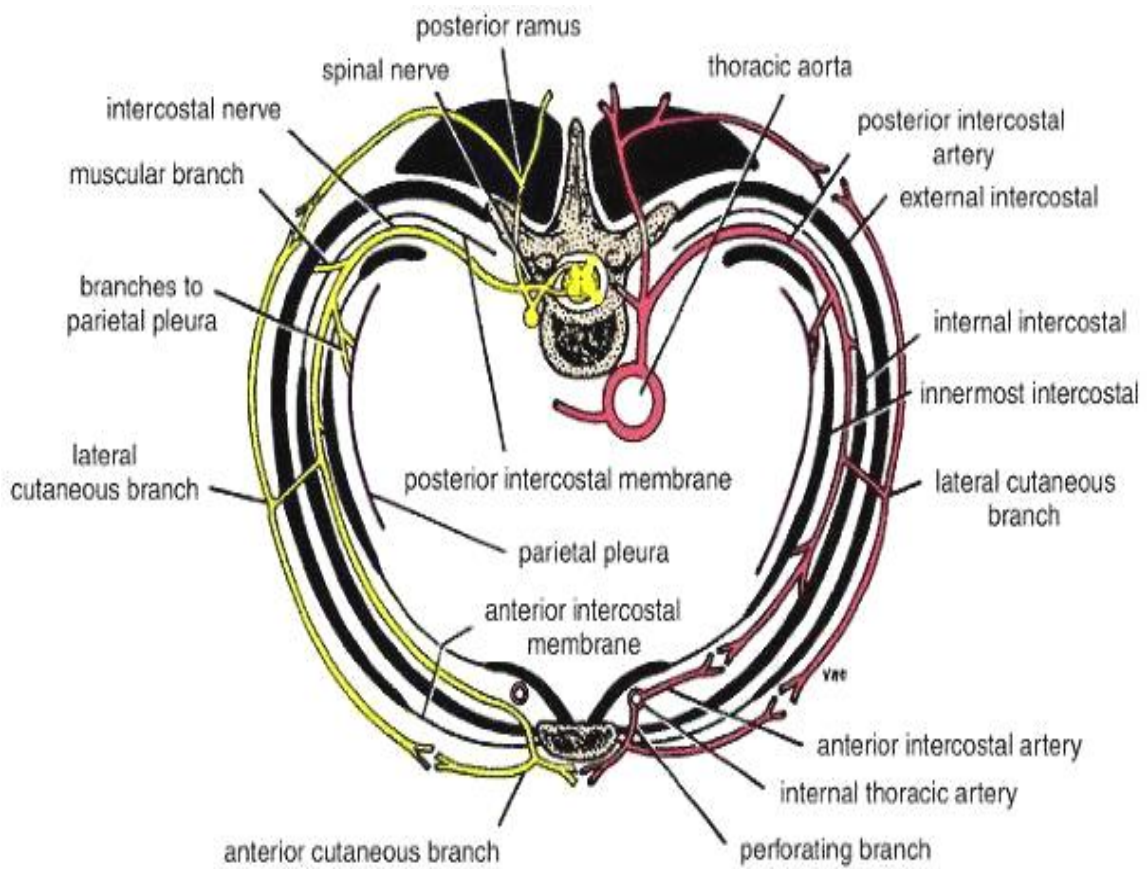
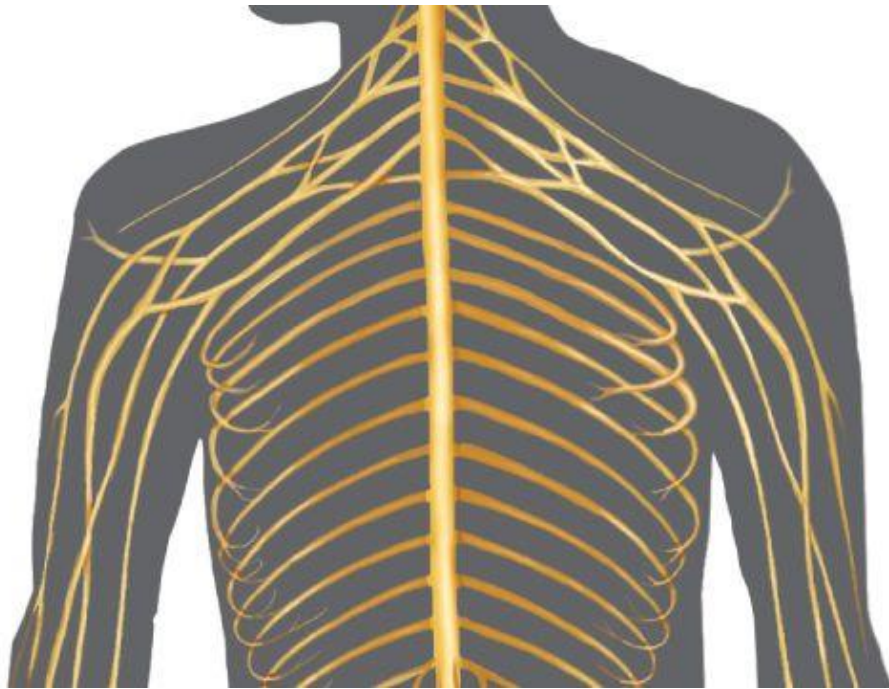


Neurovascular bundle of the chest wall



- Each neurovascular bundle is **formed of** the intercostal vein, artery and nerve.
- The 3 structures occupy the **costal groove** of the rib, passing in the **neurovascular plane** between the internal and innermost intercostal muscles.
- They are arranged from above downwards as **VAN** i.e. the intercostal vein is uppermost, then the artery while the intercostal nerve is lowermost.
- There are **12 thoracic nerves and vessels** on each side.
- There are only **11 spaces**, the structures in these spaces are called **intercostal** nerves and vessels.
- The nerves and vessels pass along the **lower border of last rib** are called **subcostal** nerve and vessels.

Thoracic nerves

- There are **12 thoracic spinal nerves**.
- Each divides into **dorsal** (posterior) and **ventral** (anterior) primary rami.
- The **anterior 11 rami** of the **upper 11** thoracic spinal nerves constitute the **intercostal** nerves, while that of the **last** (T12) is the **subcostal** nerve.
- **Classification** of intercostal & subcostal nerves:
 - 1- Typical intercostal nerves:** from the 3rd to the 6th nerves; they run their whole course in the thoracic wall.
 - 2- Non-typical intercostal nerves:**
 - a) The 1st nerve:** most of its fibers ascend to join the **brachial plexus**.
 - b) 2nd intercostal nerve:**

➤ It differs from typical intercostal nerve only in that its **lateral cutaneous branch** is called the **intercosto-brachial** nerve which supplies the skin of the **floor of axilla**.

c) From the 7th to the 11th nerves: they run part of their course in the thoracic wall and part in the abdominal wall.

d) The 12th (subcostal) nerve: runs its whole course in the abdominal wall.

Typical intercostal nerve

(3rd – 6th)

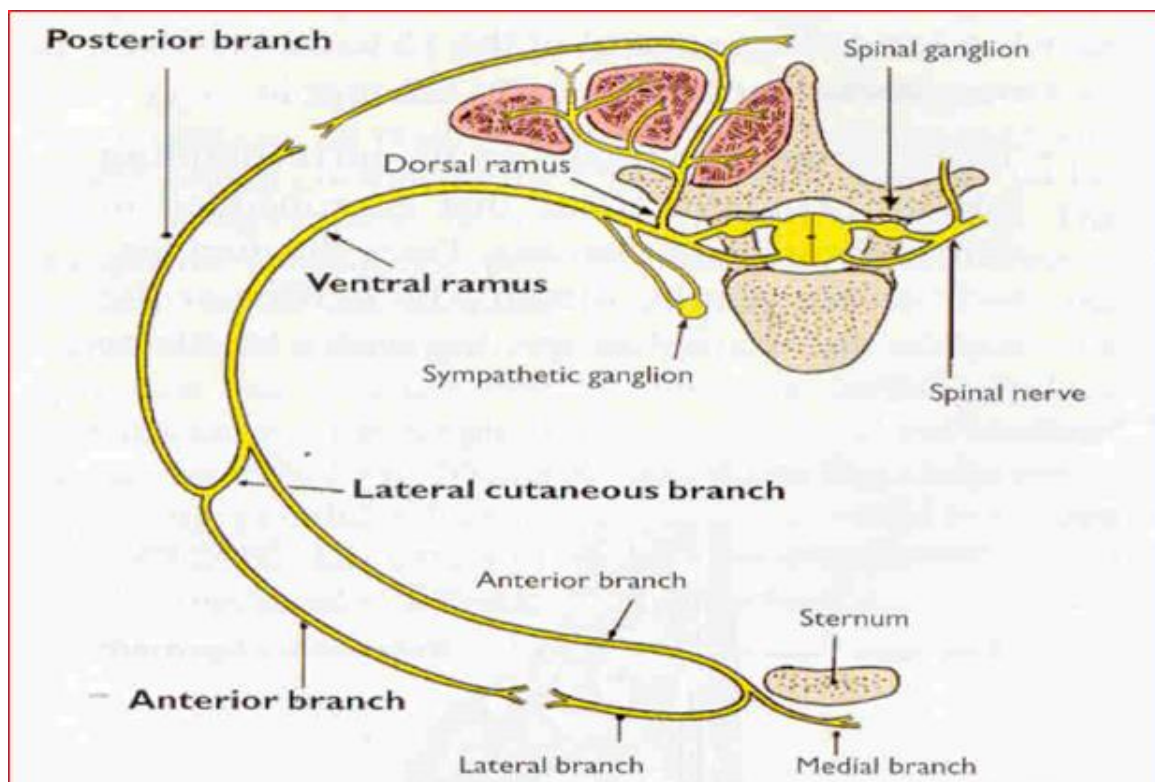
★Course and relations:

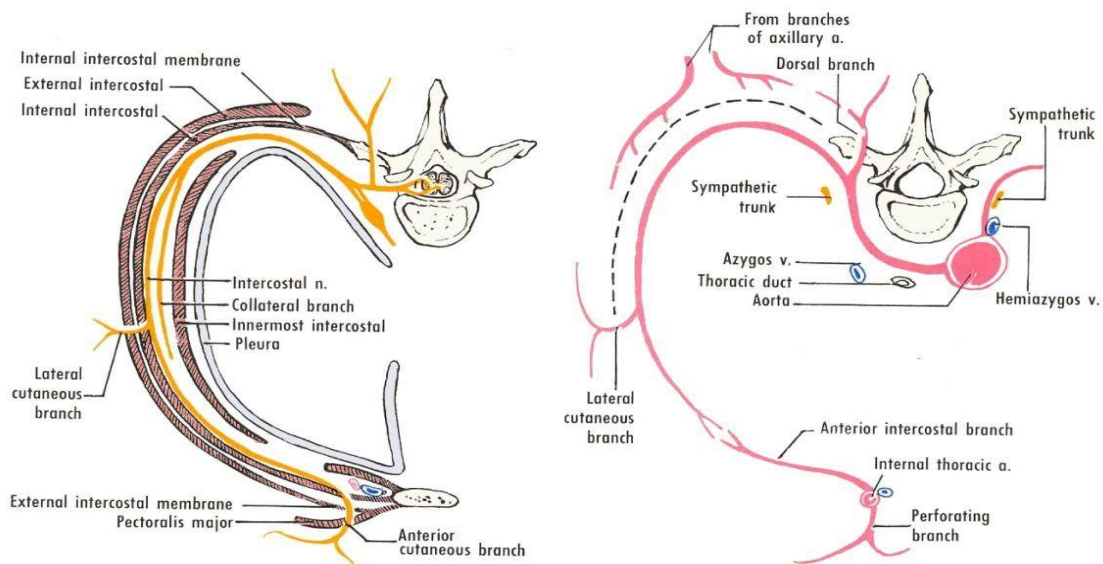
- In the intercostal space **medial to the angle** of the rib:
 - The nerve comes out from the **intervertebral foramen** and runs **laterally behind the sympathetic chain**.
 - There, it lies **between** the parietal **pleura** (in front) and the posterior intercostal **membrane** (behind).
- In the intercostal space **lateral to the angle of the rib**:
 - It passes in the **intercostal groove** below intercostal vessels (**V.A.N**) in the **neurosvascular plane** between the internal intercostal muscle (to the outside) and the innermost intercostal muscle (to the inside).
- **Near the sternum** it **passes** in front of the **internal thoracic** vessels and **sternocostalis** then **pierces** internal intercostal muscle, anterior intercostal membrane and pectoralis major muscle **to end as anterior cutaneous nerve** which gives **medial and lateral branches**.

★ **Branches of intercostal nerve:**

- 1) **White (preganglionic) and grey rami (postganglionic) communicanes:** to communicate with the **sympathetic ganglia**.
- 2) **Collateral branch:** runs along the **upper border of the rib below**; it supplies the **intercostal muscles**.
- 3) **Muscular:** to intercostal muscles.
- 4) **Lateral cutaneous branch:** arises opposite the **mid axillary** line , **pierces** the intercostal muscles & serratus anterior then **divides** into anterior and posterior divisions to supply the skin on side of thorax.
- 5) **Anterior cutaneous branch:** supply the skin of the front of the thorax.
- 6) **Pleural branches:** to the adjacent parts of the parietal pleura.
- 7) **Articular branch:** supplies the joints of the rib.

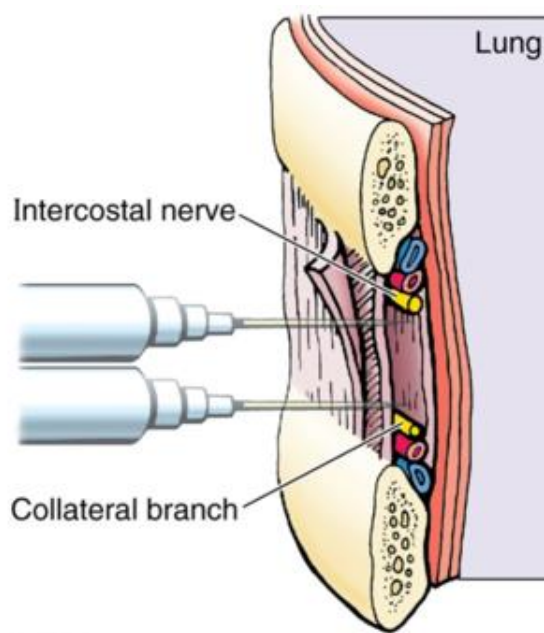
Typical intercostal nerve





★ **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 around intercostal nerve at the **lower border of the ribs above** and its collateral branch at the **upper border of the rib below**.



Intercostal nerve block

- **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 branches of thoracic nerve and may appear as cold abscess either lateral to sacrospinalis or in mid-axillary line or lateral to sternum.
- The intercostal nerves may be infected by a virus called **herpes zoster**; severe burning sensation and a red strip of skin with small vesicles appear along the course of the affected nerve

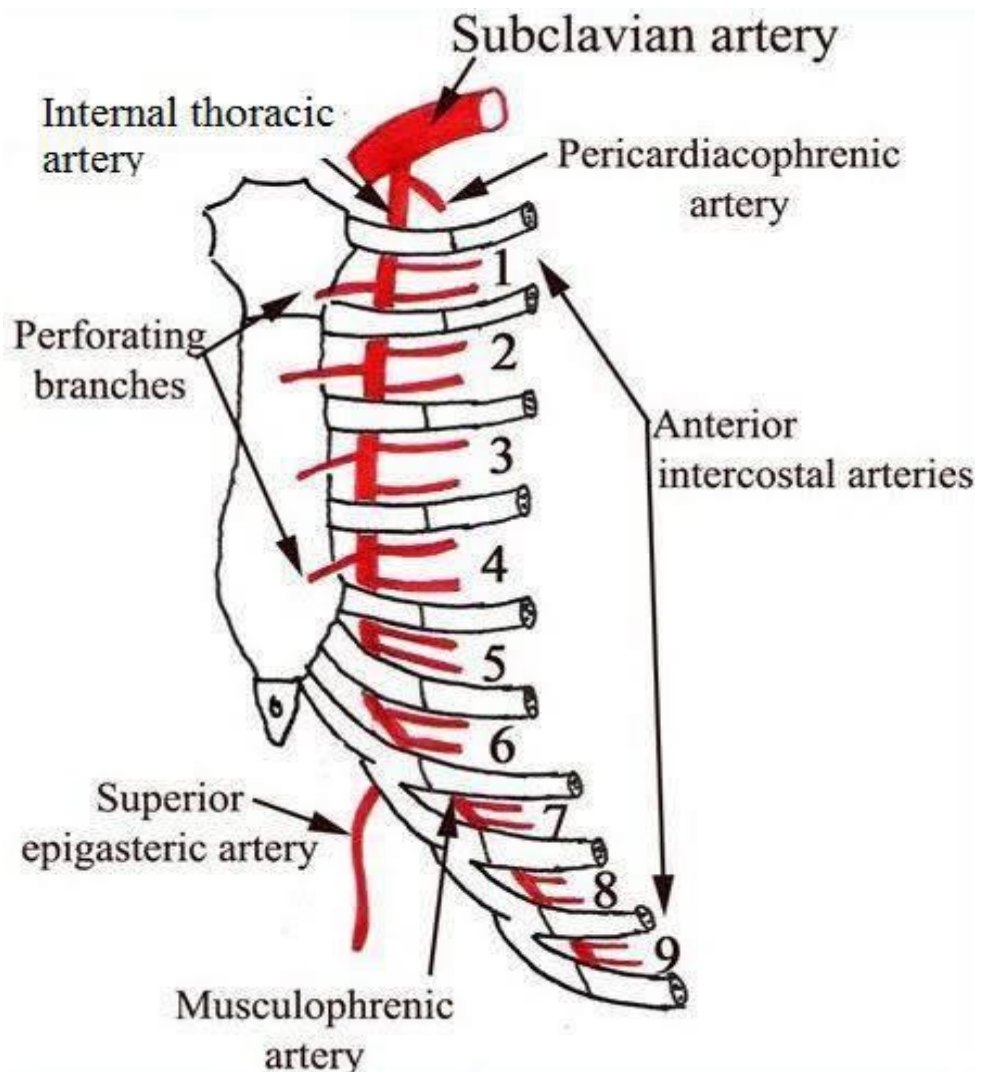


Herpes zoster

Arteries of the thoracic wall

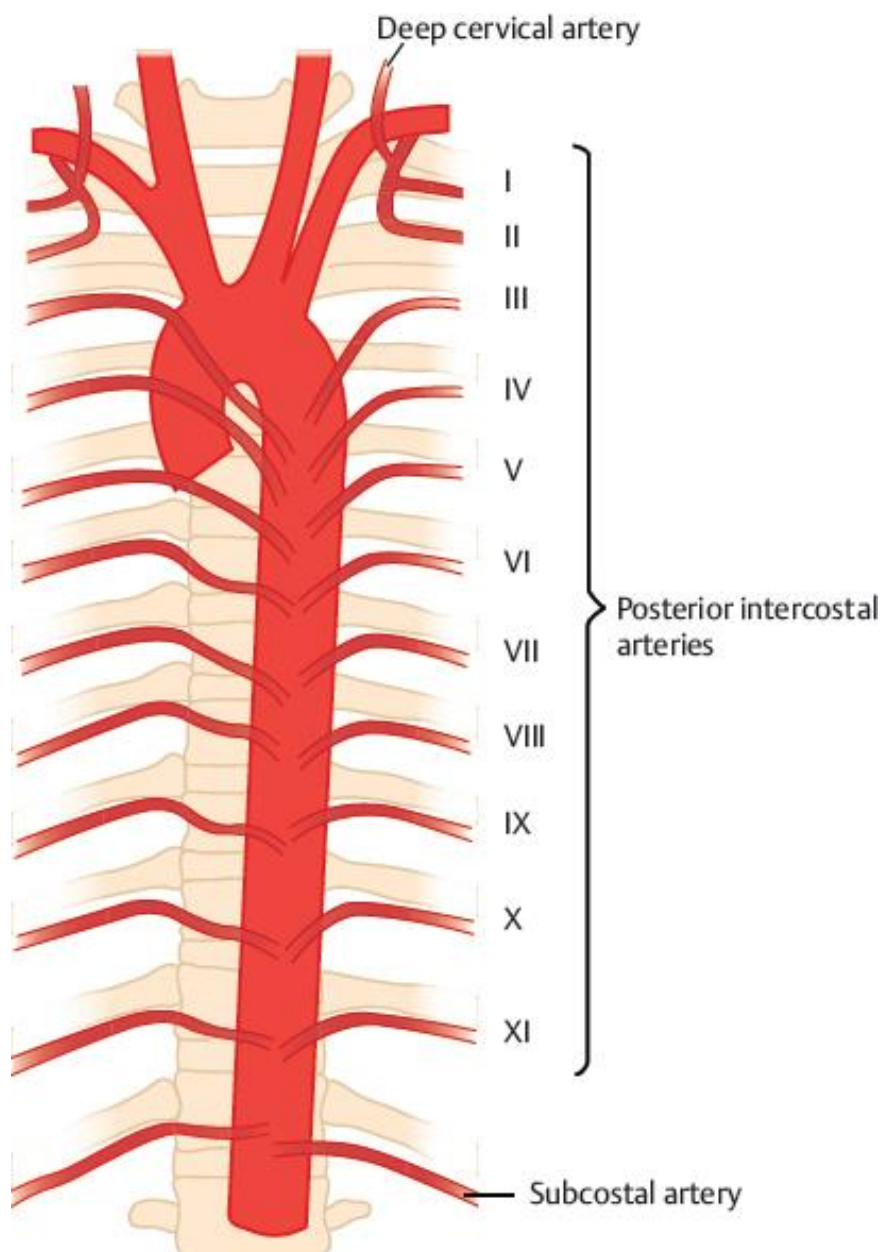
I) Anterior intercostal arteries

- They are **2 anterior intercostal arteries** in each of the **upper 9** intercostal spaces.
- The **upper 6** pairs arise from the **internal thoracic** artery
- The **lower 3** are branches of the **musculophrenic** artery (one of the two terminal branches of internal thoracic artery).
- There are **no** anterior intercostals arteries in the **10th and 11th** spaces because these spaces are not complete anterior.
- **Course and termination:** each pair of arteries **enters** its space at its **anterior end** and **runs** laterally to **end** by anastomosing with the corresponding posterior intercostal artery and its collateral branch.

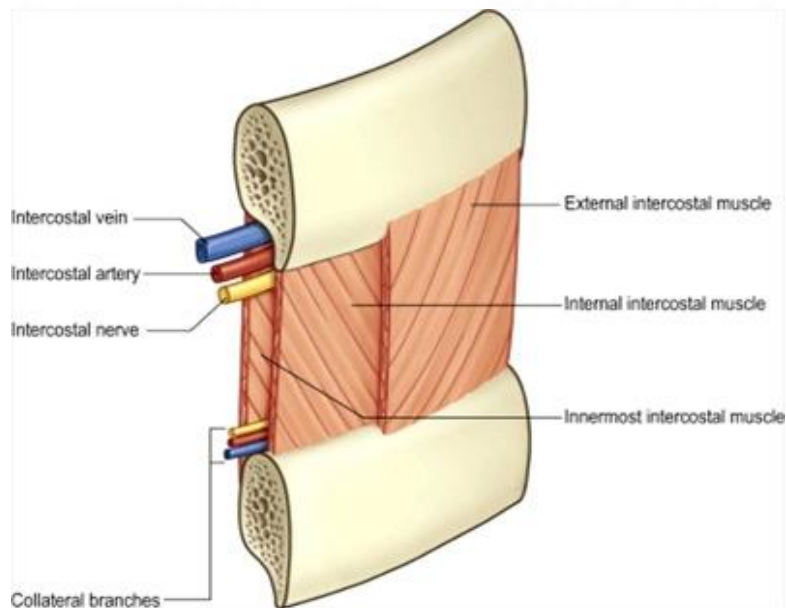
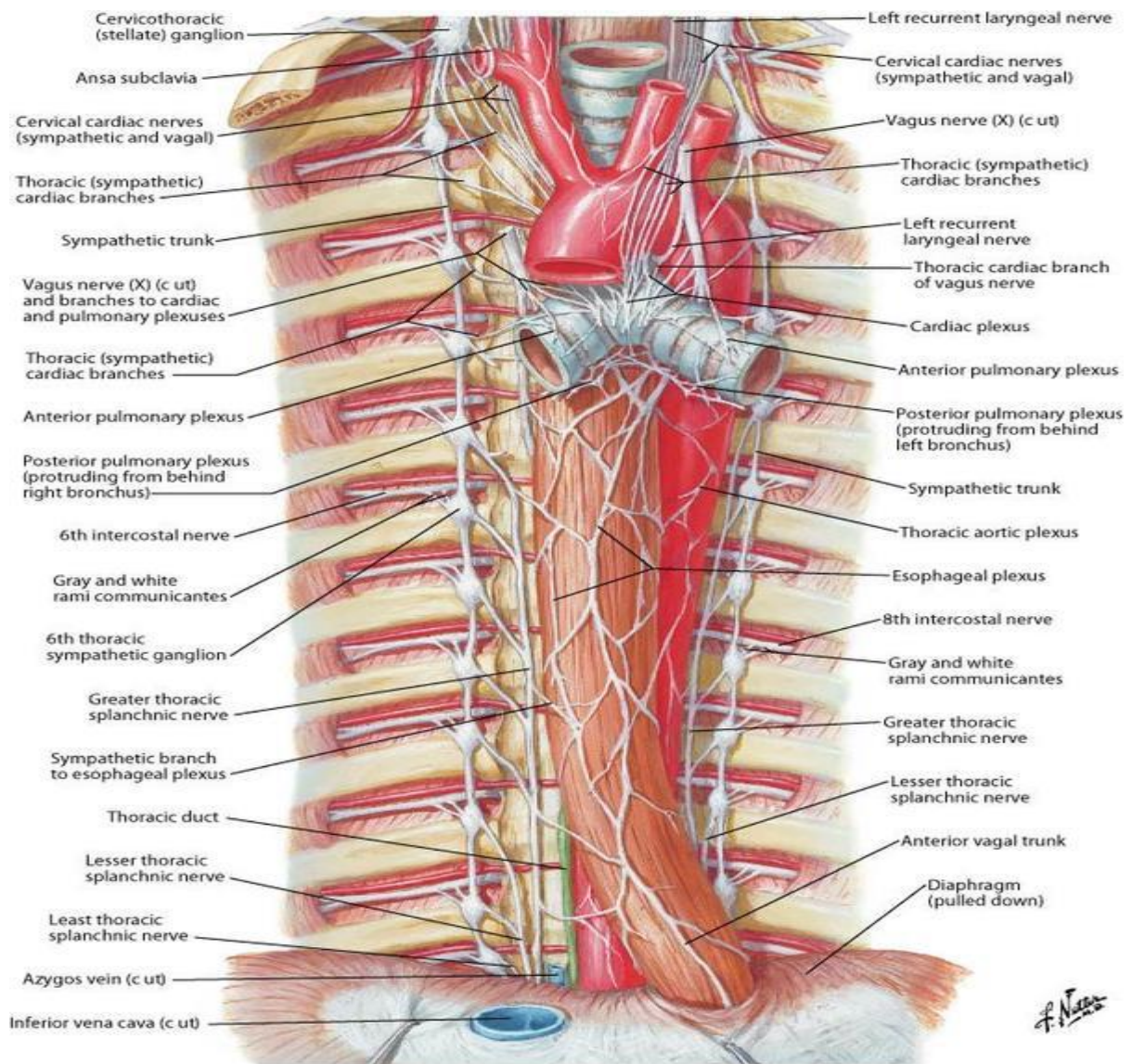


II) Posterior intercostal arteries

- **Origin:** There are 11 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 9 posterior intercostal arteries** (from 3rd to 11th) and **subcostal** arteries are branches of **descending thoracic aorta**.



• **Relations:**

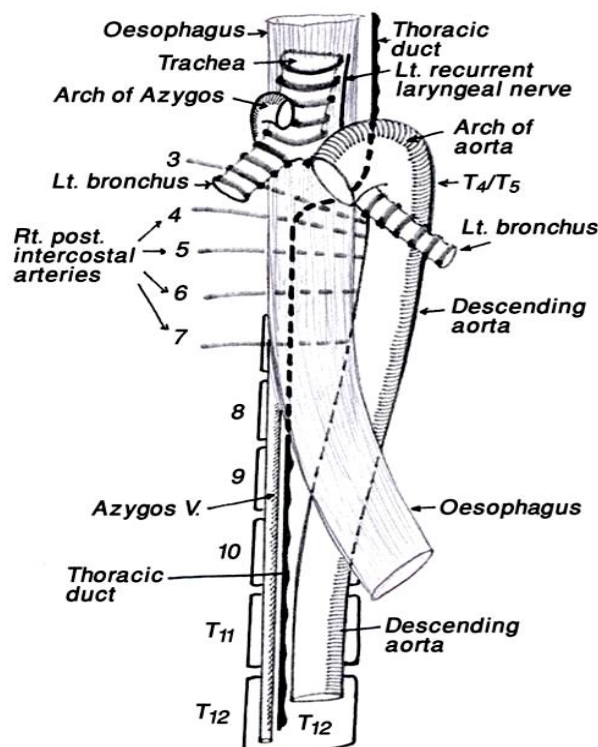


1) Medial to angle of rib:

- The arteries **run laterally** to reach their corresponding intercostal space.
- The **right** arteries are longer as it crosses the midline in front of the vertebral column then pass behind the esophagus, thoracic duct and azygos vein.
- The **left** arteries pass behind the hemiazygos veins.
- **On both sides**, the arteries pass laterally, behind the sympathetic chain and the parietal pleura to reach their spaces.

2) Lateral to angle of rib:

- The artery runs in costal groove in the neurovascular plane between internal and innermost intercostal muscles with the vein above and nerve below (VAN).
- Each artery **ends** anteriorly by anastomosing with the **uppermost** of the corresponding anterior intercostal arteries.
- The **lower 2** posterior intercostal arteries and the **subcostal** artery pass into the anterior abdominal wall.



- **Branches:**

- 1- Dorsal branch:**

- It passes backwards to supply the **muscles** of the back and gives also a **spinal branch** to the spinal cord.

- 2- Collateral branch:**

- It runs forwards along the **upper border of the rib below** with the collateral branch of the intercostal nerve.
- It anastomoses with the **lowermost** of the anterior intercostal arteries of the corresponding space.

- 3- Lateral cutaneous branch:**

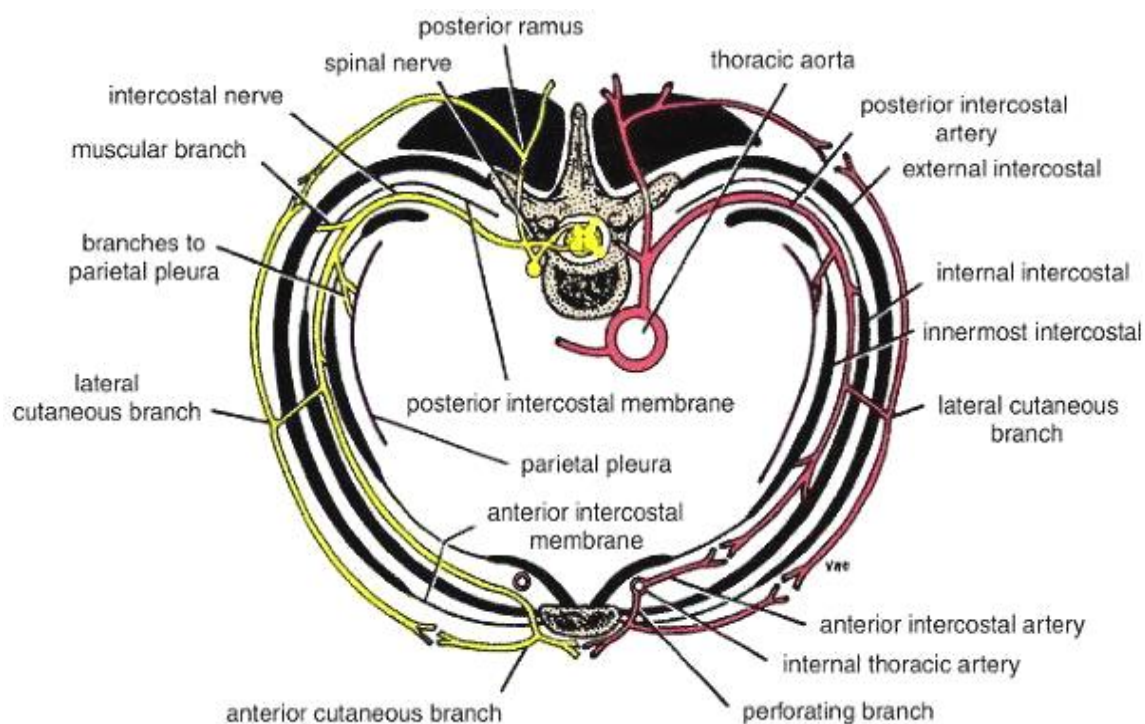
- It **accompanies** the lateral cutaneous branch of the intercostal **nerve** to emerge on the side of the thorax in the **midaxillary** line.

- 4- Mammary branches:**

- It arises from the **2nd, 3rd and 4th** posterior intercostal arteries to supply the **mammary gland**.

- 5- Right bronchial artery:**

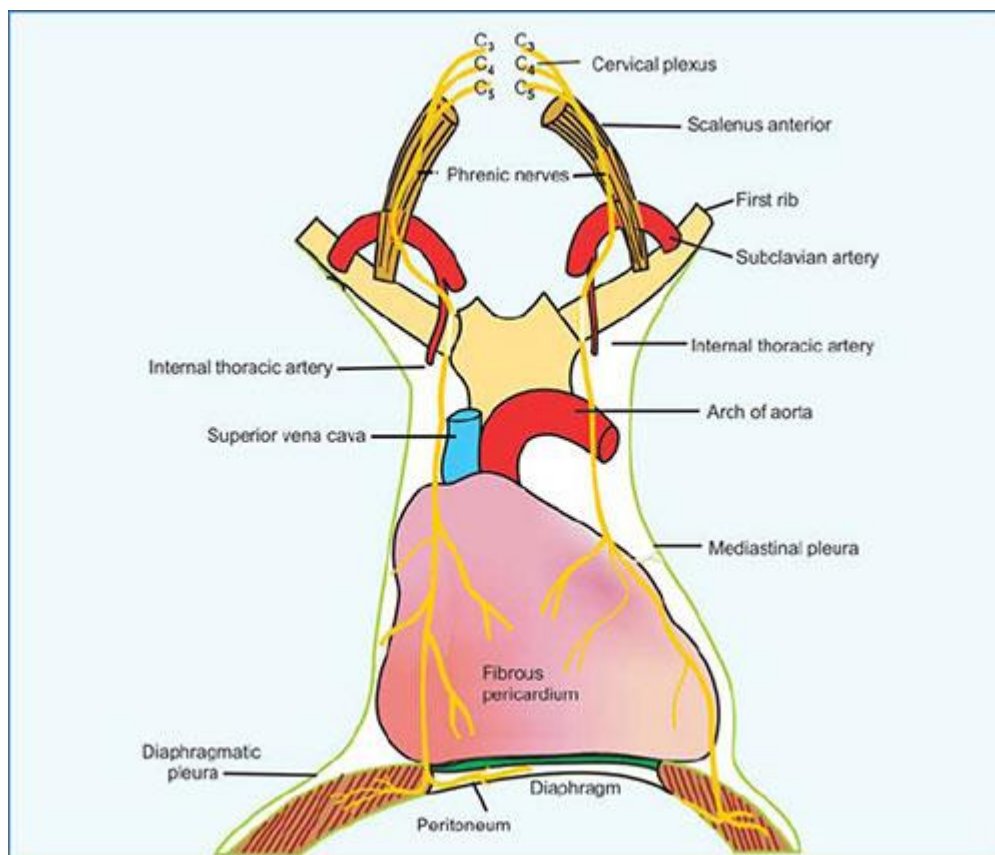
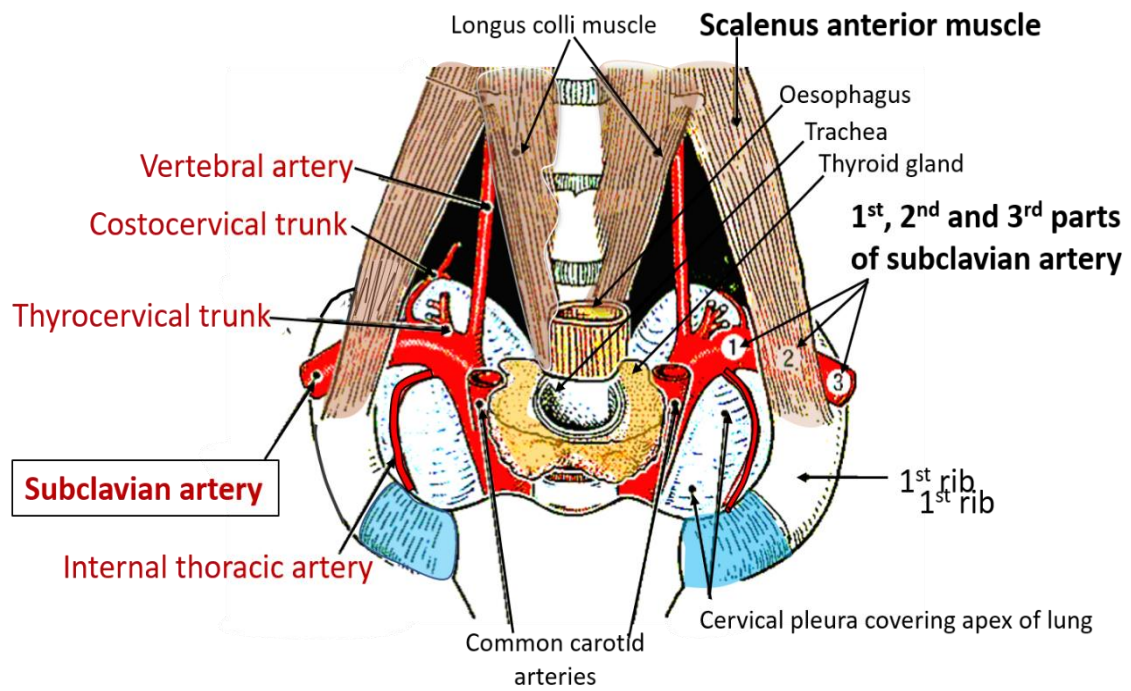
- It arises from the **3rd** posterior intercostal artery.

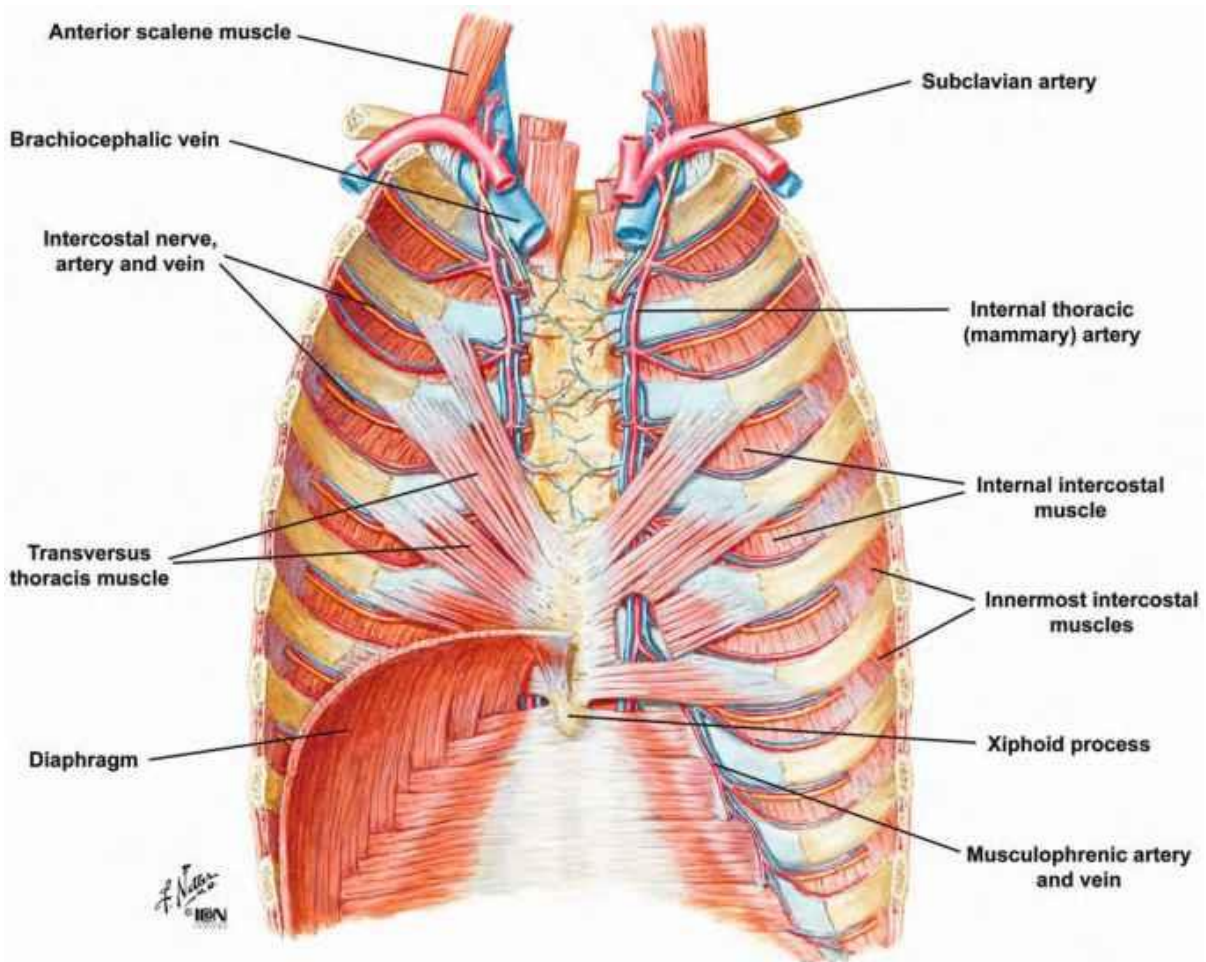


- **Anastomoses of Posterior Intercostal Arteries:**
 - The posterior intercostal arteries have anastomoses with the following arteries:
 - 1) The **anterior intercostal** arteries by the main artery and its collateral branch.
 - 2) The arteries sharing in the anastomosis **around scapula** by dorsal and lateral cutaneous branches.

III) Internal thoracic artery

- It **begins** in the neck as a branch of 1st part of **subclavian** artery.
- It **ends** opposite the **6th intercostal space** by dividing into **superior epigastric** artery and the **musculophrenic** artery.
- **Relations:**
 - It descends downwards and medially behind the **medial end of clavicle**, in front of the **cervical pleura and apex of the lung**.
 - It **enters the thorax** by through the **thoracic inlet behind the 1st costal cartilage** where the **phrenic nerve crosses** from lateral to medial in front of the artery.
 - It descends vertically behind the **upper six costal cartilages** (1/2 inch lateral to the sternum) where it is **crossed** anteriorly by the **intercostal nerves**.
 - The **upper part** of the artery lies directly in front of the **pleura** while its **lower part** is separated from the pleura by **sternocostalis**.
 - **Below the 3rd costal cartilage**, it is accompanied by **2 vena commitants**.
 - **Above the 3rd costal cartilage**, it is accompanied by one vein which lies **medial** to the artery.
 - **Parasternal lymph nodes**.





Internal thoracic artery

- **Branches:**
 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) Muscophrenic artery:

- It passes downwards and lateral along the **costal margin** to end opposite the **last intercostal** space.
- It supplies the **diaphragm**, surrounding muscles and it gives the 7th, 8th and 9th pairs of **anterior intercostal** arteries.

Veins of the thoracic wall

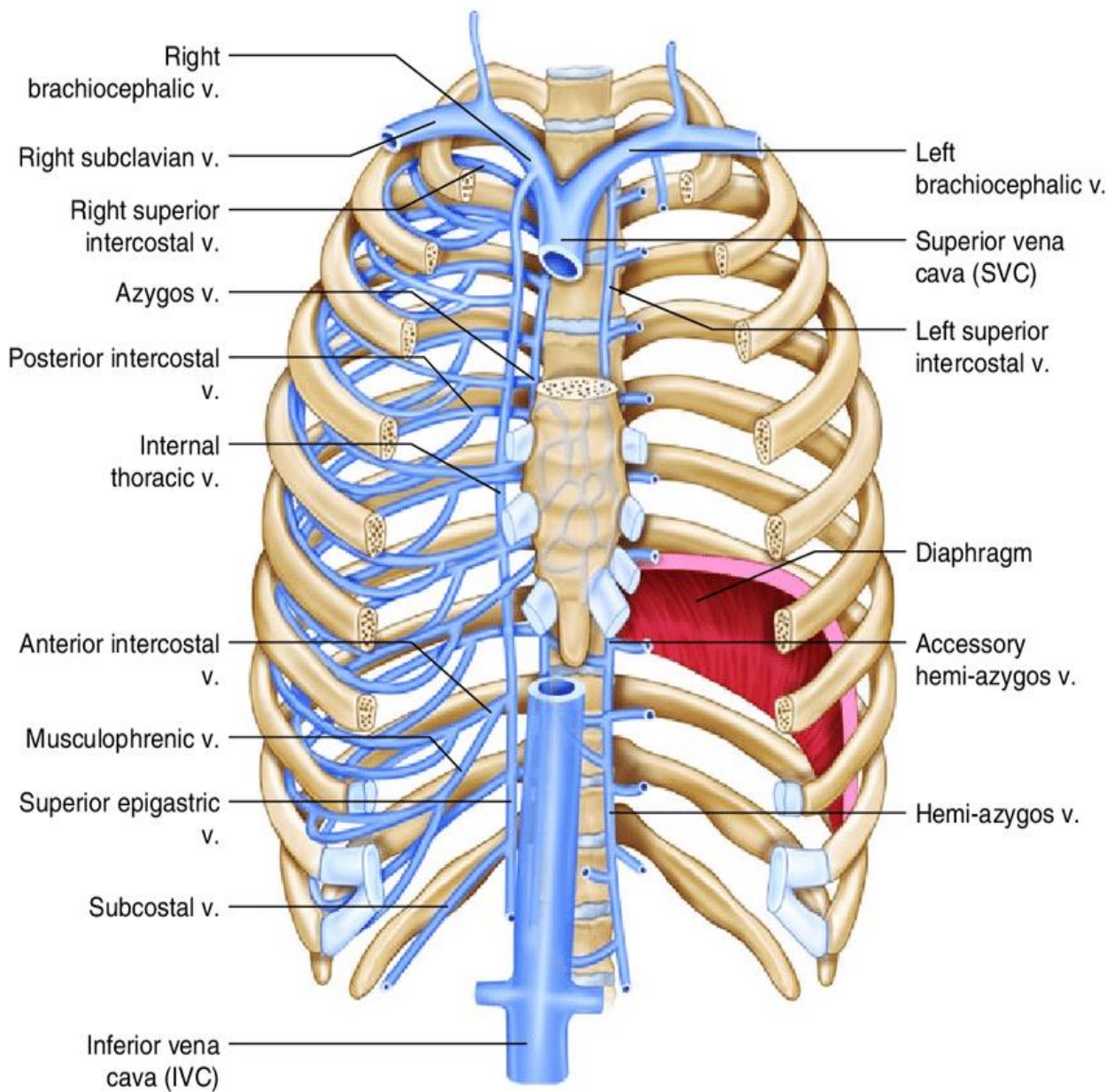
I) Intercostal veins

A) Anterior intercostal veins:

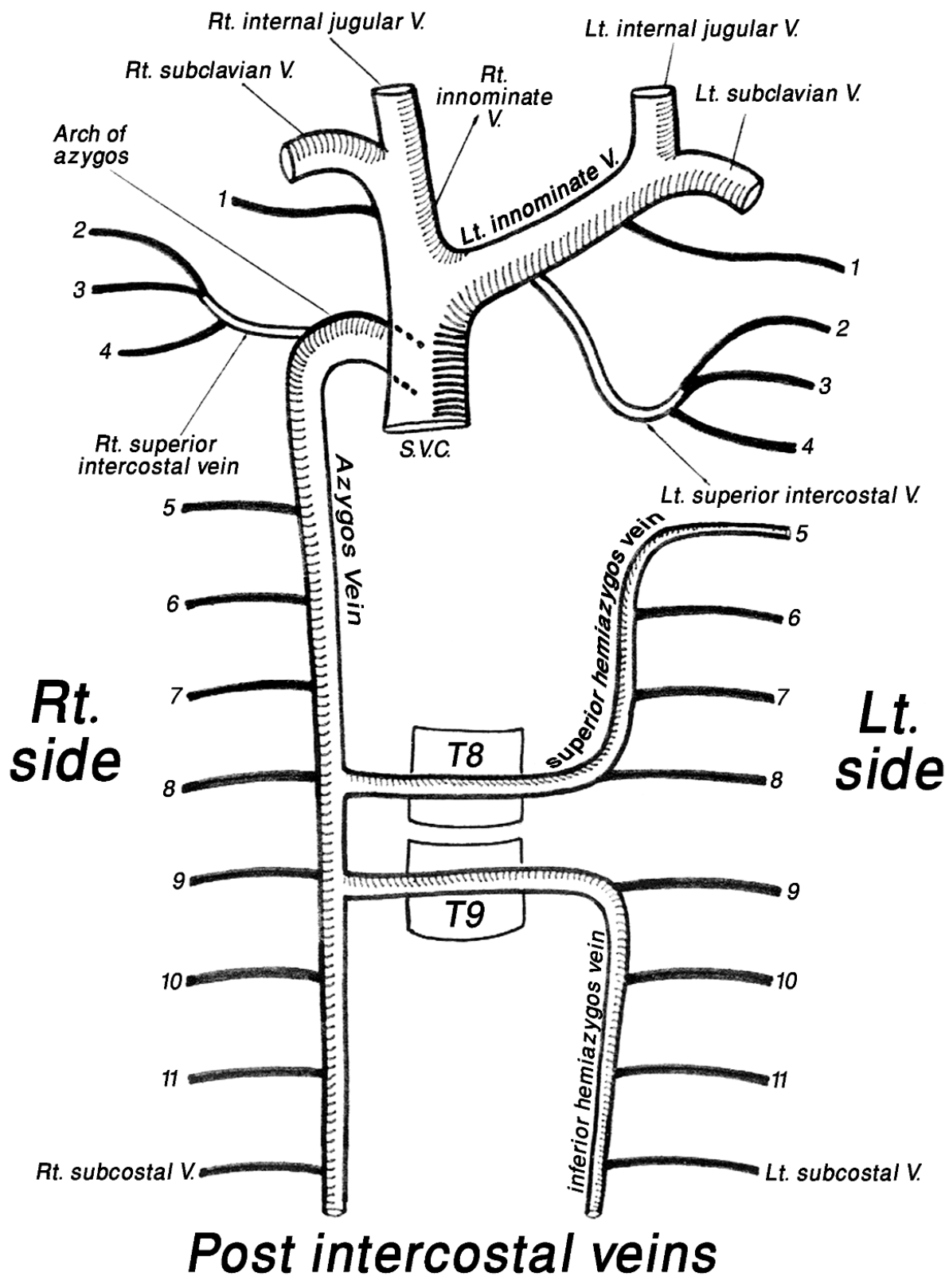
- They accompany the arteries; they end in the **musculo-phrenic** vein and the **internal thoracic** vein which drain into the **brachiocephalic vein**.

B) Posterior intercostal veins:

Right side	Left side
<ul style="list-style-type: none"> • The 1st ends in the corresponding brachiocephalic vein 	<ul style="list-style-type: none"> • 2nd, 3rd and 4th end in left superior intercostal vein which ends in left brachiocephalic vein.
<ul style="list-style-type: none"> • 2nd, 3rd and 4th end in right superior intercostal vein which ends in arch of azygos. 	<ul style="list-style-type: none"> • 5th-8th end in superior hemiazygos which ends in azygos.
<ul style="list-style-type: none"> • 5th-11th and subcostal end in zygos vein. 	<ul style="list-style-type: none"> • 9th-11th and left subcostal end in inferior hemiazygos which ends in azygos.



Anterior intercostal veins



II) Internal Thoracic Vein

- It **begins** at the level of the **3rd costal cartilage** by the union of the **2 venae comitantes** which accompany the lower part of the internal thoracic artery.
- It **ascends** on the **medial** side of the internal thoracic artery, having the same course and relations,
- It **ends** in the corresponding **brachiocephalic vein**.
- It **drains** the veins which accompany the branches of the internal thoracic artery.

III) Azygos vein

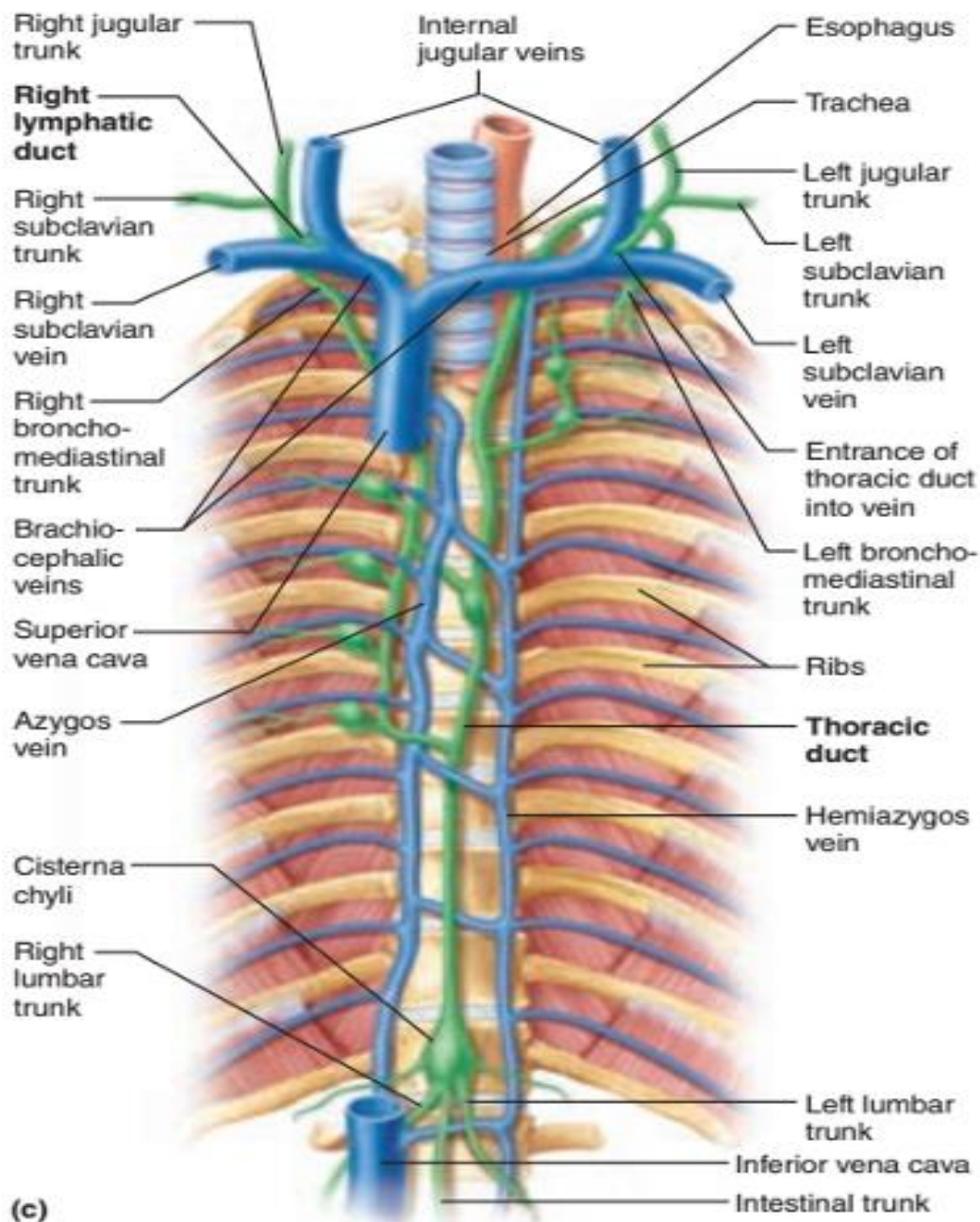
- It **begins** in the abdomen usually from the **back of inferior vena cava** at the level of **L₂** Vertebra.
- **Course:**
 - It enters the thorax by passing through **aortic opening** of diaphragm
 - Then ascends in **posterior mediastinum** till the level of lower border of **T4** where the **arch** of azygos begins and passes in **superior mediastinum** arching forwards **above root of right lung**.
- **It ends** in the **middle** of the back of superior vena cava (**S.V.C.**) at level of **2nd right costal cartilage** (just above the level of pericardium).
- **Relations:**
 - **In the aortic opening of the diaphragm:** The thoracic duct and abdominal aorta lie on left side of azygos vein.
 - **In the posterior mediastinum:**
 - 1) On the **left** side: **thoracic duct** separates it from descending **aorta**.
 - 2) On the **right** side: right **pleura and lung**.

3) **Anterior: oesophagus and root of right lung.**

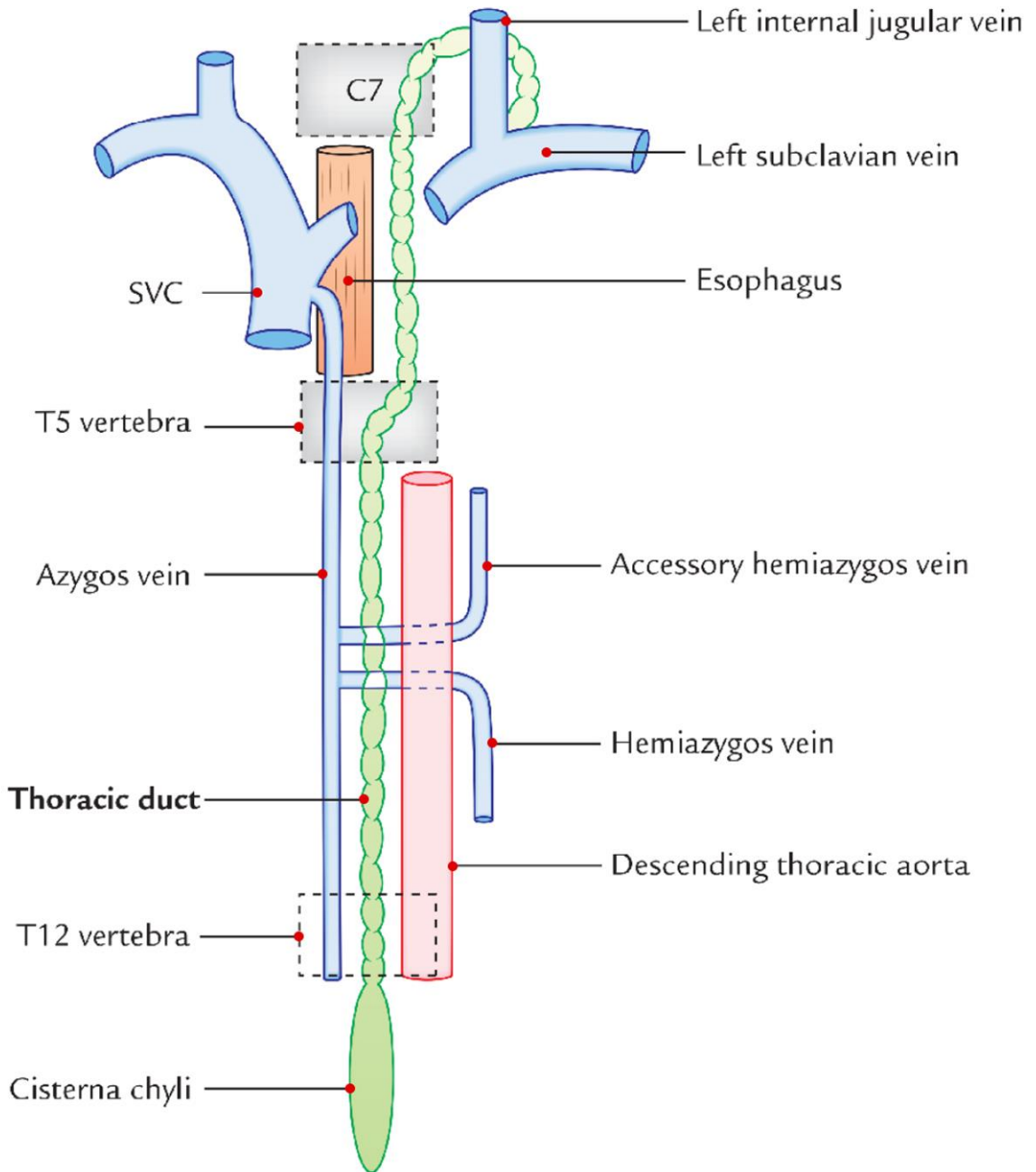
4) **Posterior: the right posterior intercostal and subcostal arteries separate it from vertebral column .**

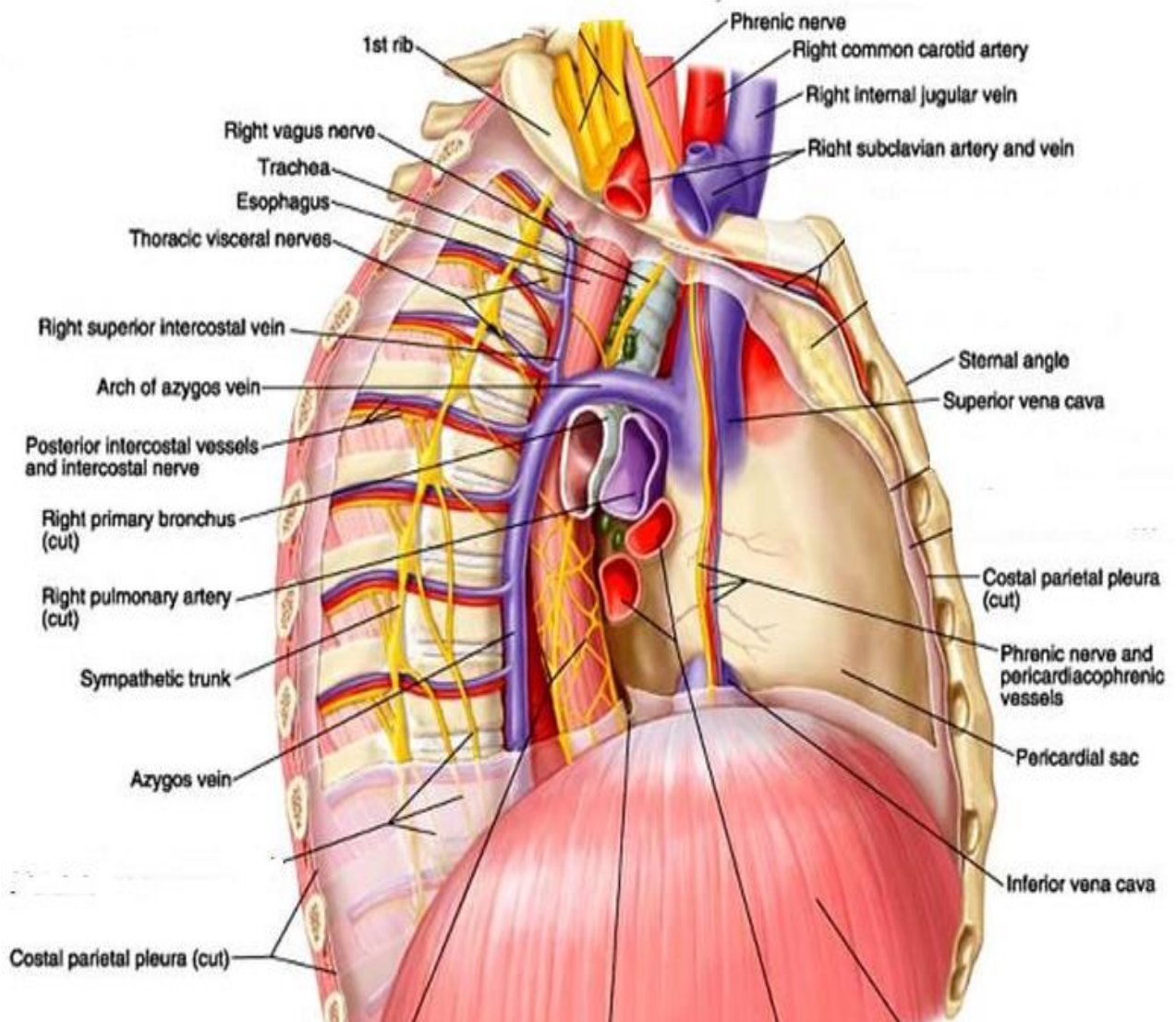
• **Relations of the arch of azygos (in superior mediastinum):**

- **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) **Right superior intercostal vein.**

2) From **5th to 11th right posterior intercostal** veins and right **subcostal vein.**

3) Right **ascending lumbar** vein.

4) Superior and inferior **hemiazygos** veins.

5) Two **bronchial** veins from right lung.

6) **Oesophageal** and **pericardial** veins.

IV) Hemiazygos veins

a) Superior hemiazygos :

- **It begins** at the posterior end of the **5th left intercostal** space.
- **It 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 **left 5th - 8th posterior intercostal veins**.

b) Inferior hemiazygos :

- It usually **begins** from the back of **left renal vein**.
- It 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 .