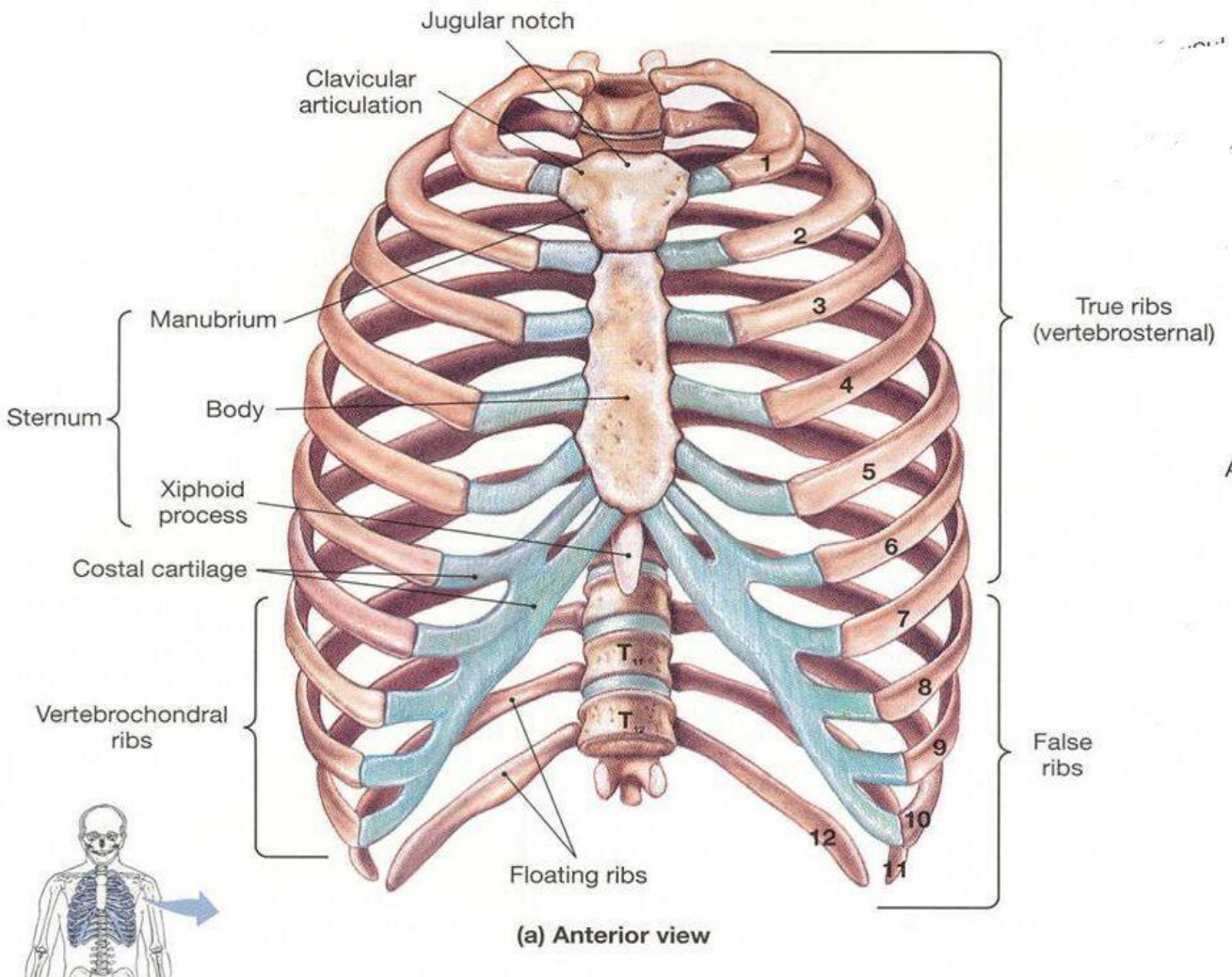
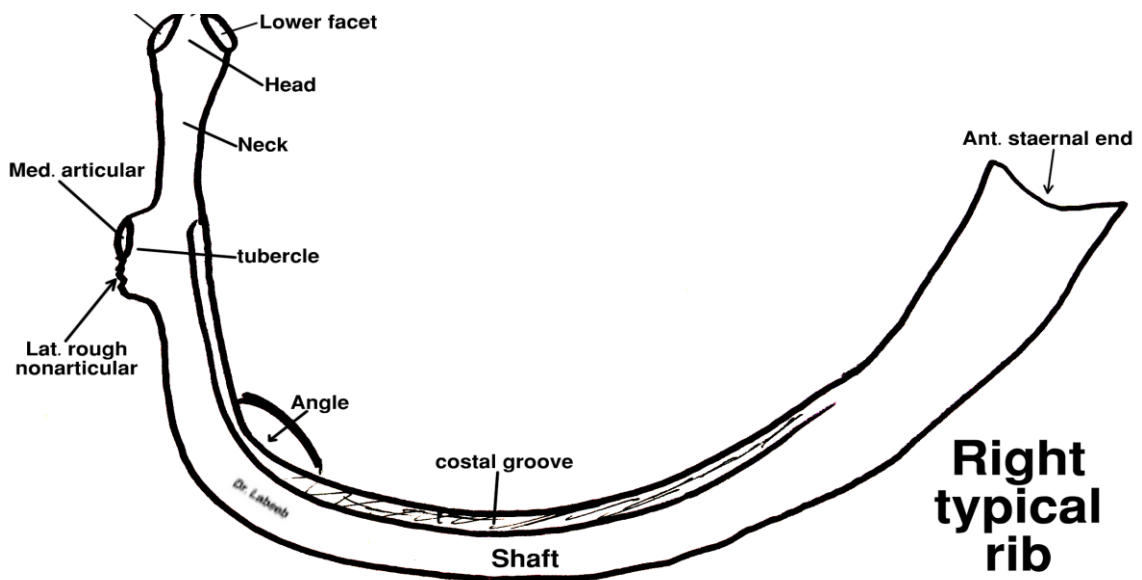
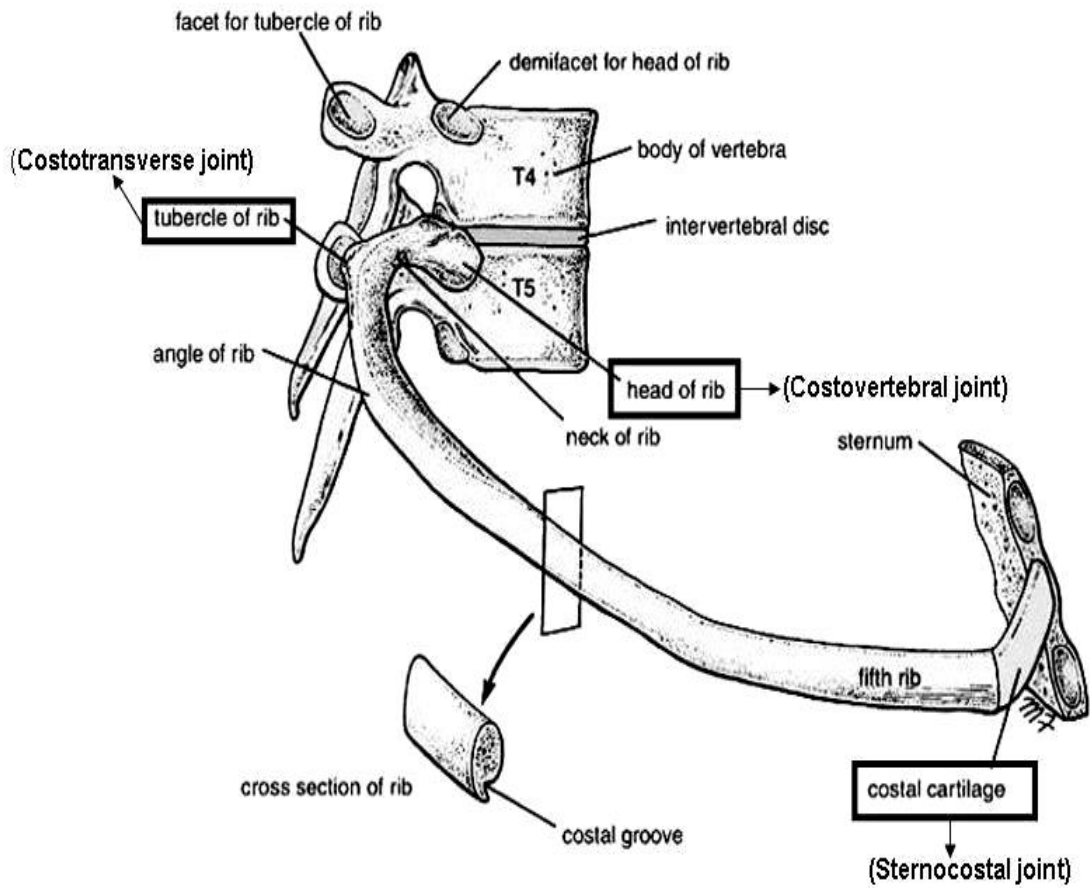


Intercostal Spaces

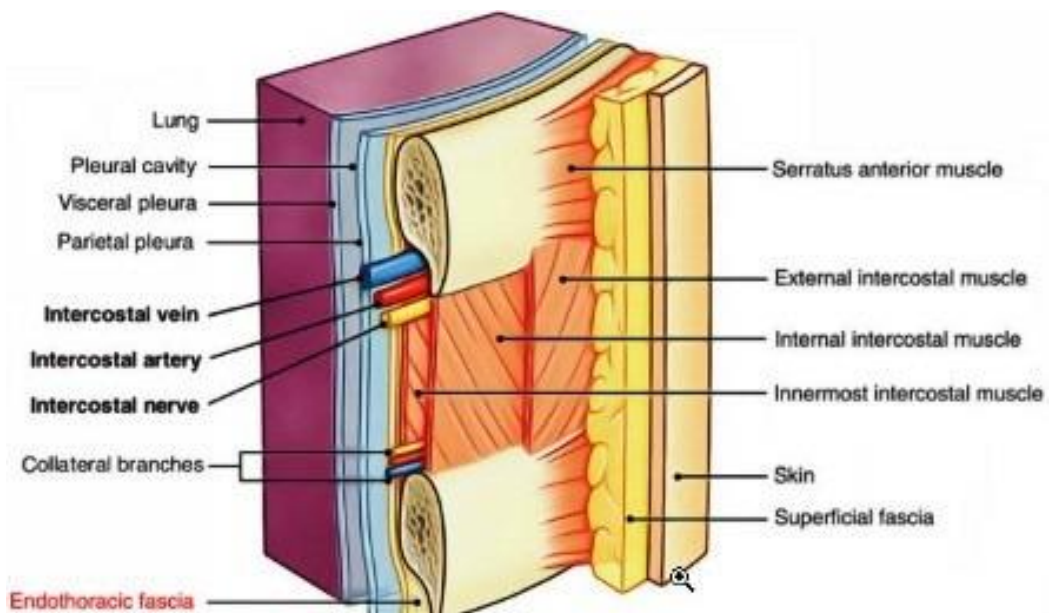
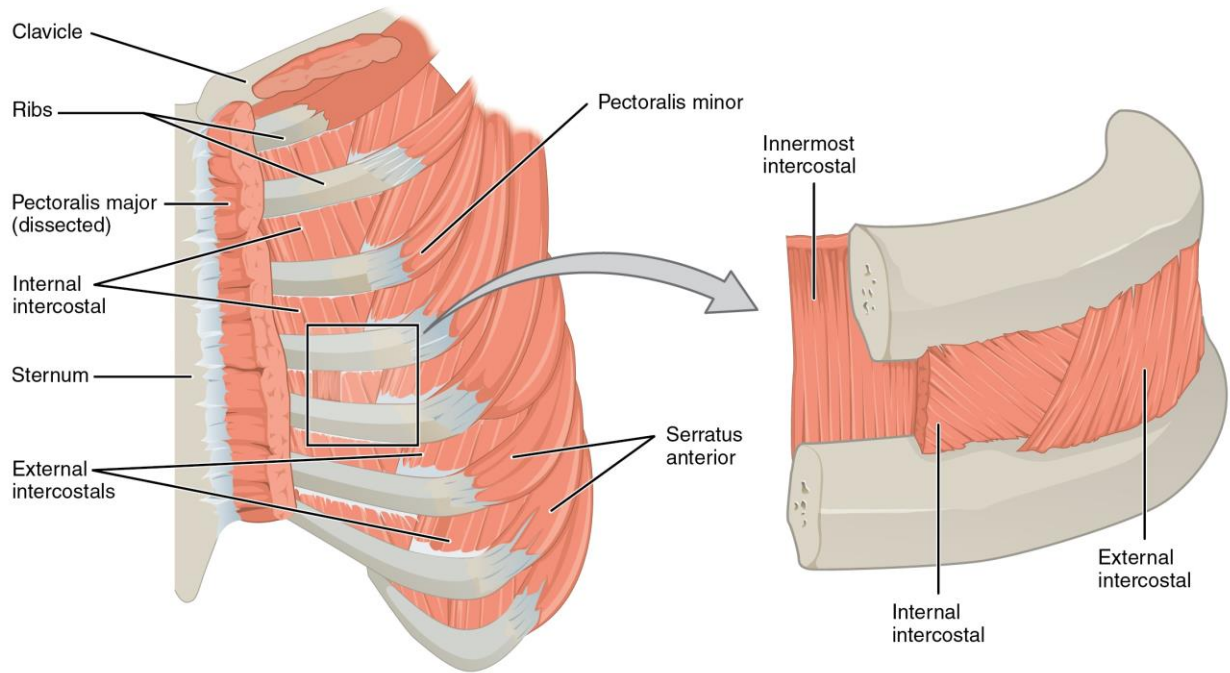


Thoracic cage

Intercostal Spaces



Intercostal Spaces



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

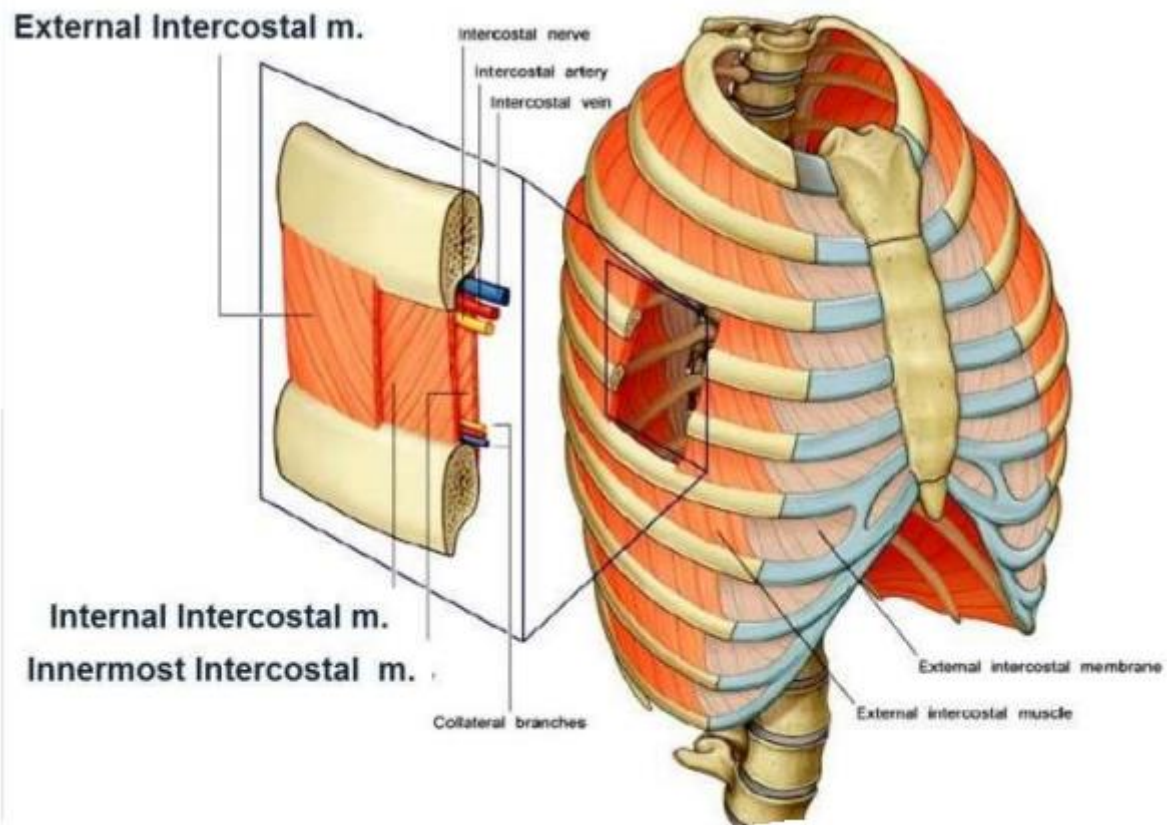
- These are 3 thin layers of muscles and tendinous fibers occupying the intercostal space arranged from outside inwards as: (External, Internal and inner most intercostal muscles).
1. **External intercostal muscle:**
 - It arises from the **lower border** of the rib above to the **upper border** of the rib below.

Intercostal Spaces

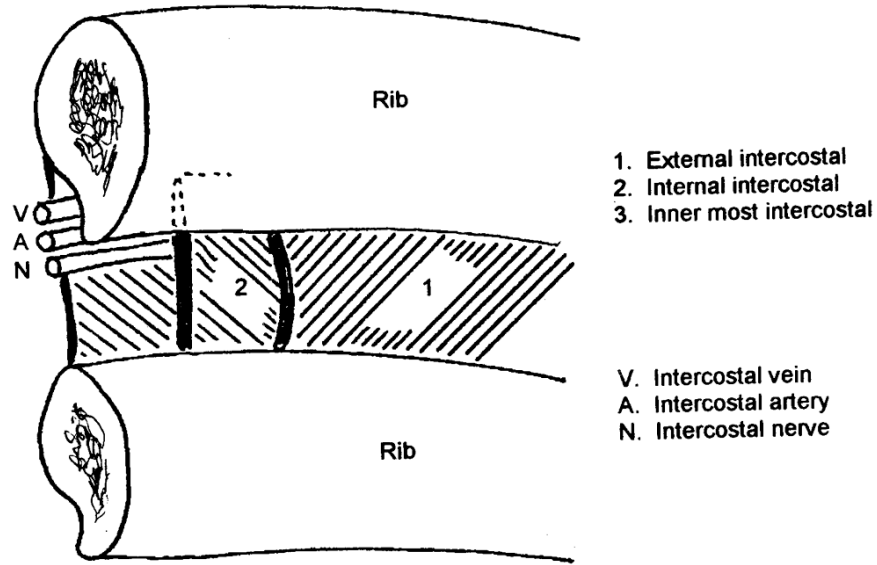
- The fibers extend from the **tubercle** of rib till the **costochondral** junction , where the muscle fibers become aponeurotic and extend to the sternum as **anterior intercostal membrane**.
- **Direction** of fibers downwards and forwards.

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.



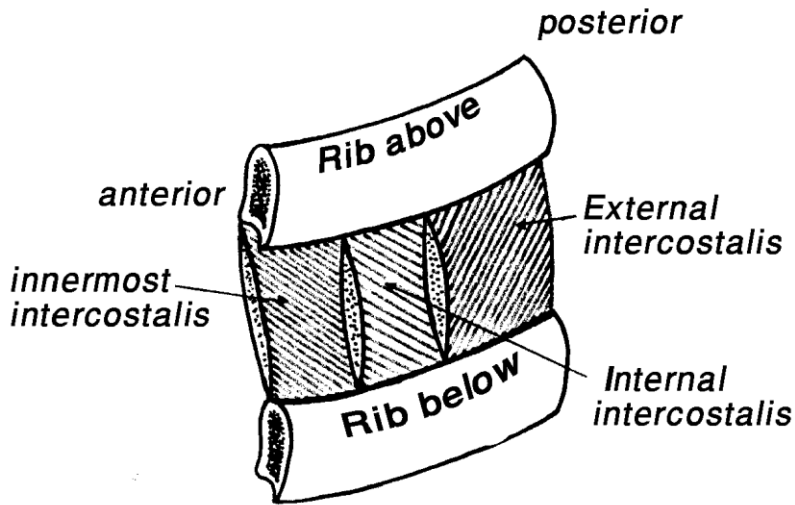
Intercostal Spaces



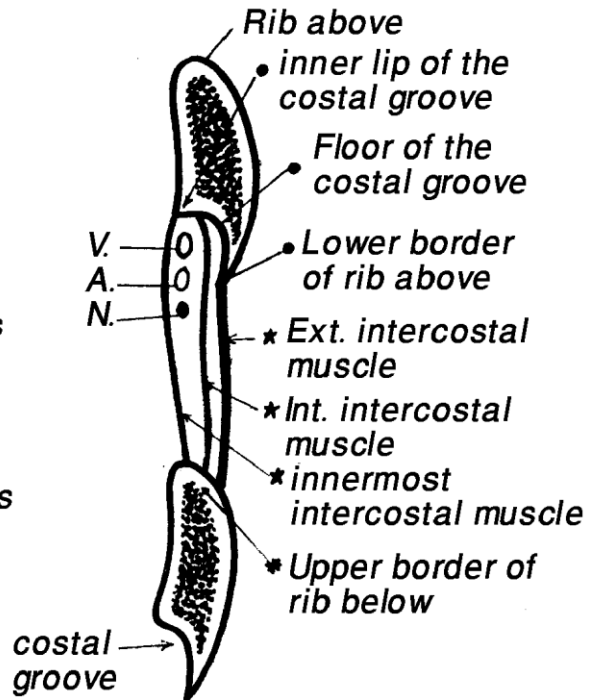
- 1. External intercostal
- 2. Internal intercostal
- 3. Inner most intercostal

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

Intercostal muscles

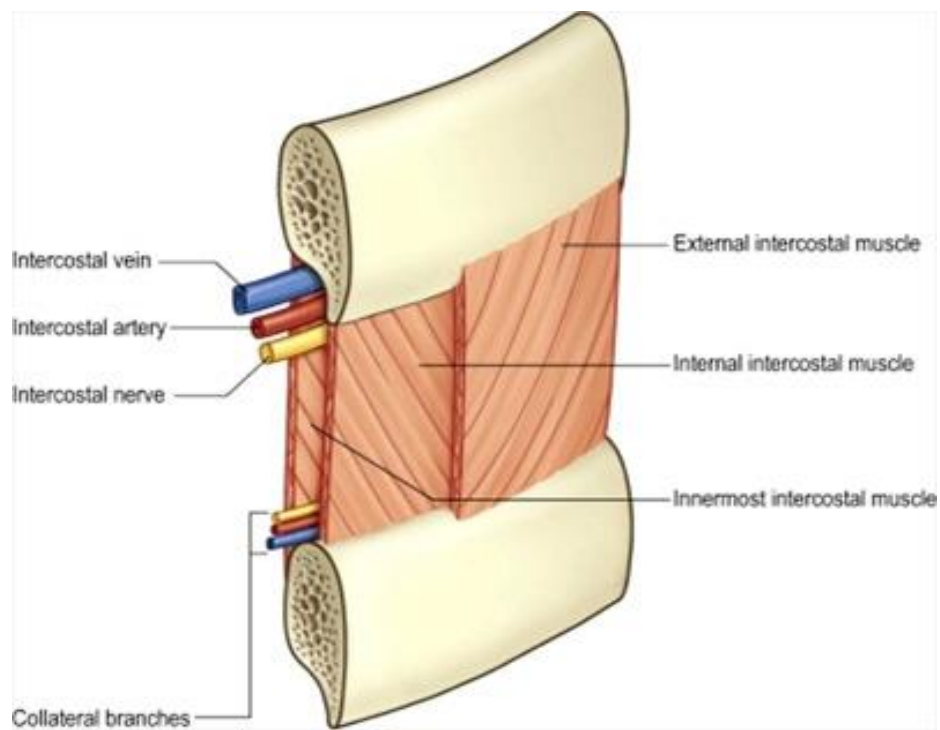
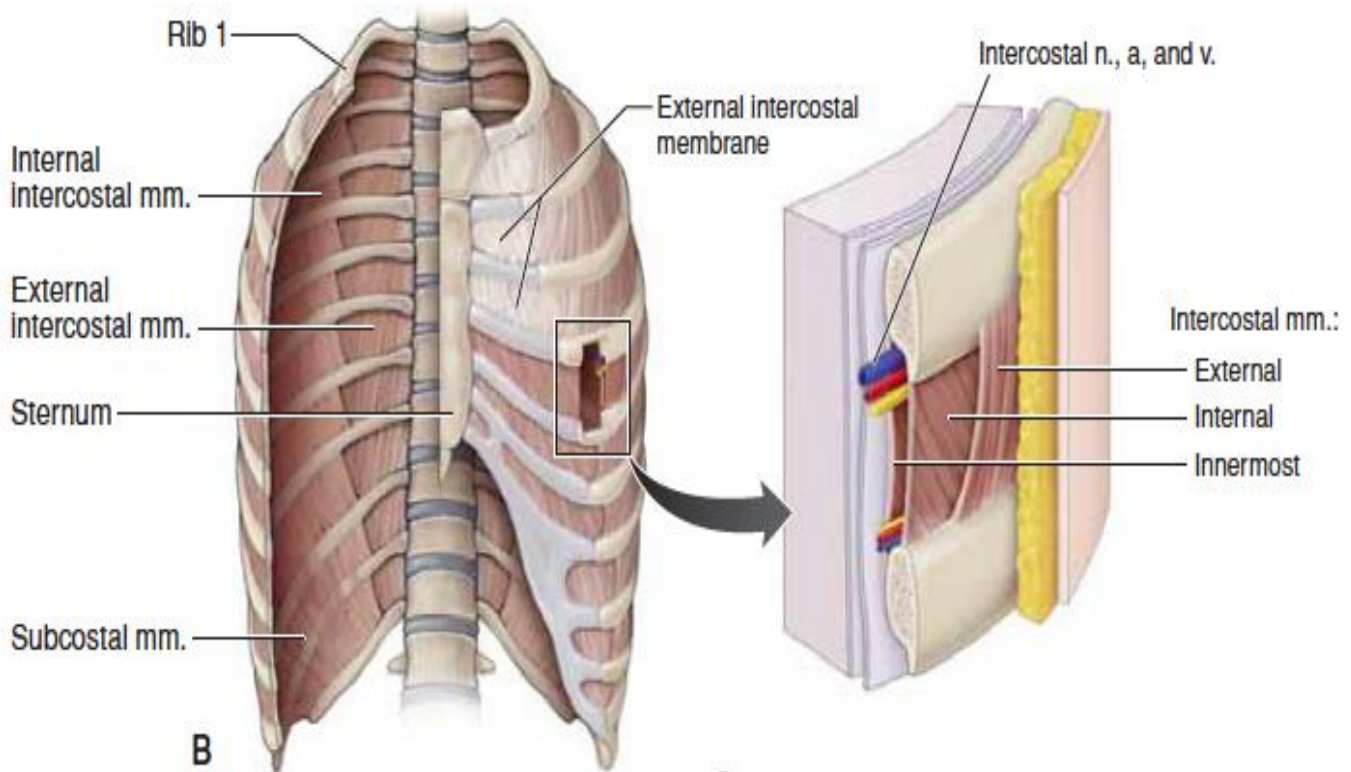


A segment of 2 succeeding ribs



Transverse section of 2 succeeding ribs

Intercostal Spaces



- 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.

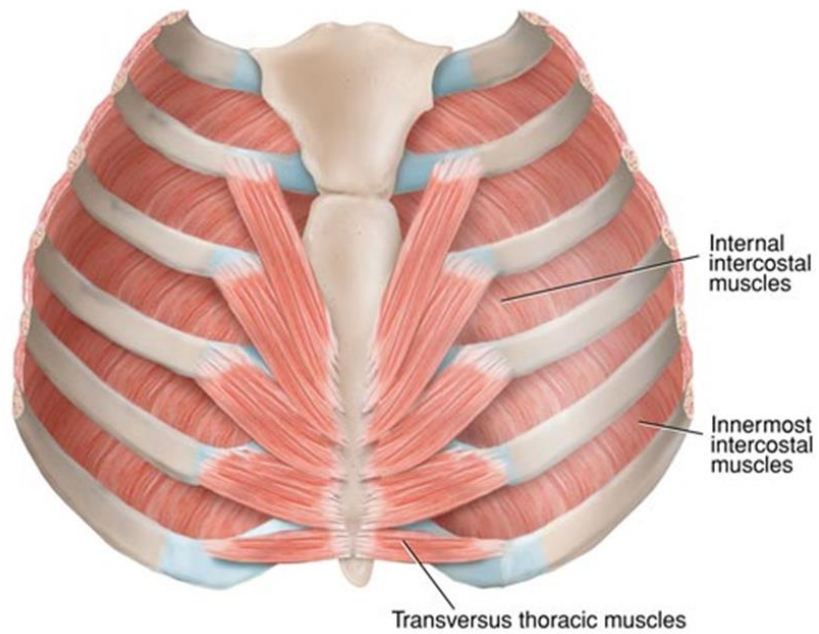
***Nerve supply:** branches of the intercostal nerves.

***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.**

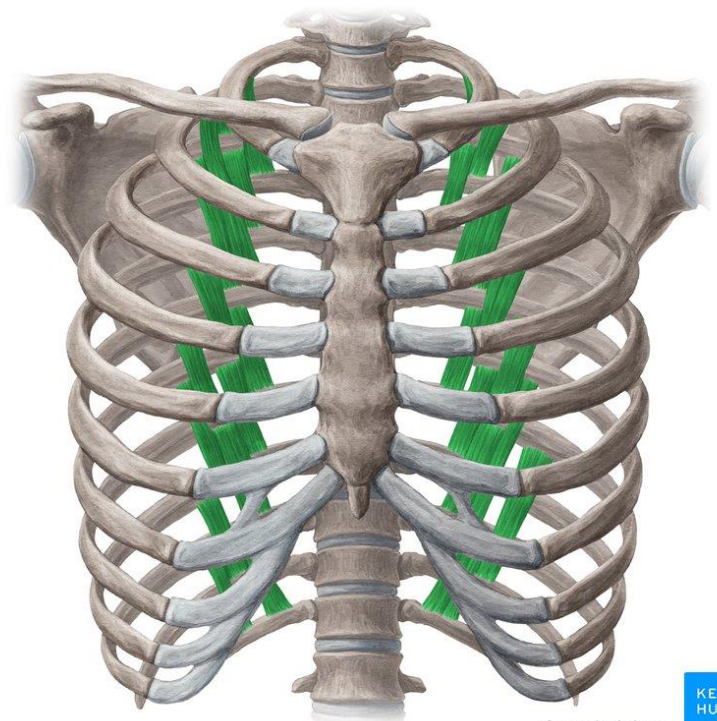
- **Transversus thoracis muscle is formed of three muscles :**
 - a. **Sternocostalis** : lies in the **anterior part** of the intercostal space.
 - b. **Innermost intercostal** : lies in the **middle** of the intercostal space.
 - c. **Subcostalis** : lies in the **posterior** part of the intercostal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

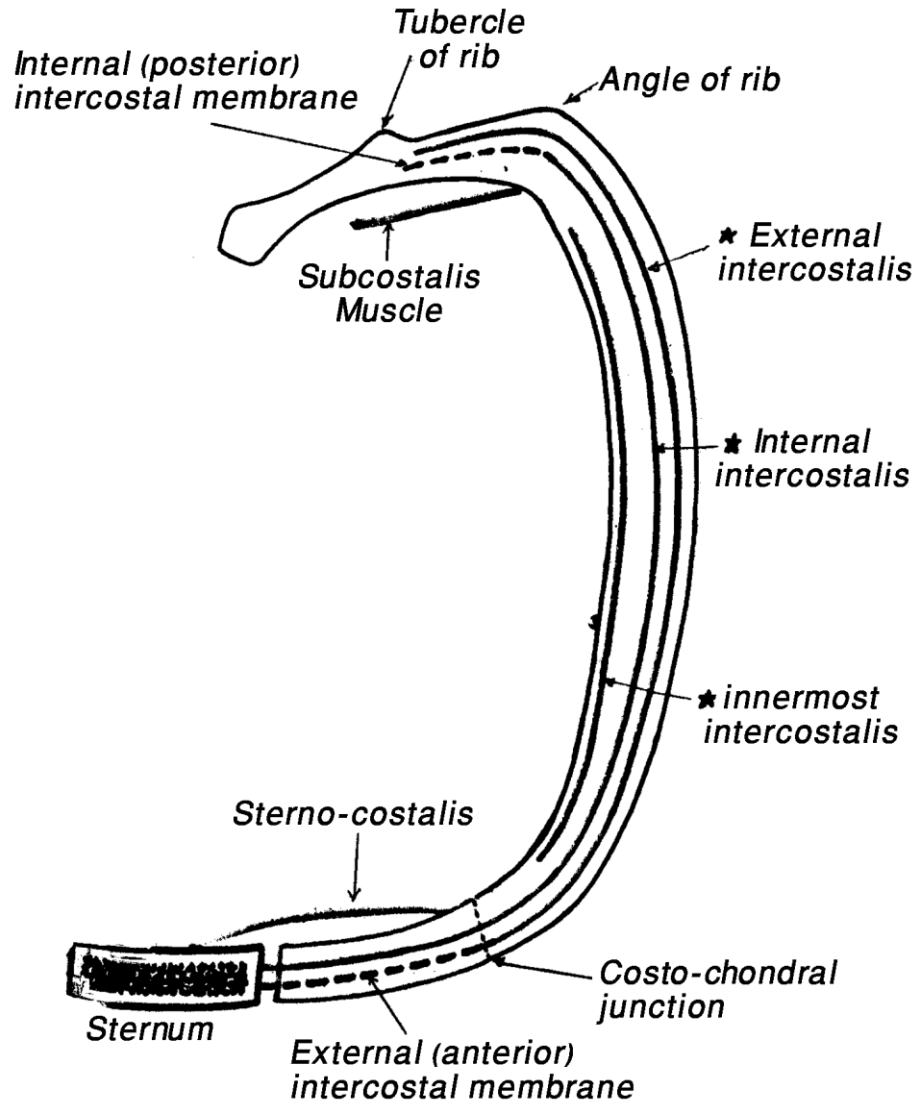


View from within thoracic cavity

Posterior surface of sternum

Subcostalis





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:**

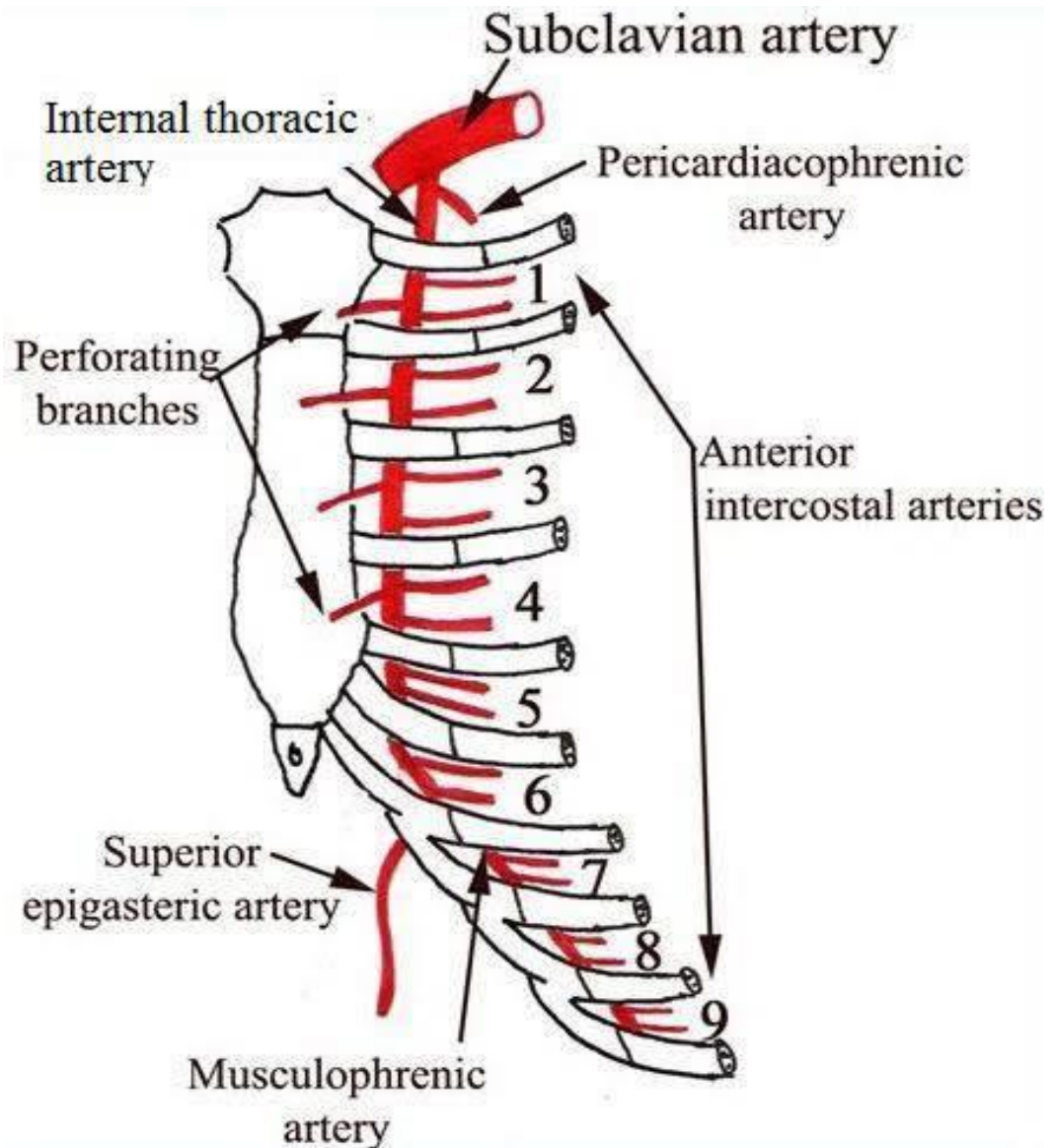
- They are **two arteries** in each of the **upper nine** intercostal spaces.
- The **upper six** pairs arise from the **internal thoracic** artery
- The **7th, 8th and 9th** are branches of the **musculophrenic** artery [one of the two terminal branches of internal thoracic artery].
- There are **no** anterior intercostals 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 **collateral 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:**

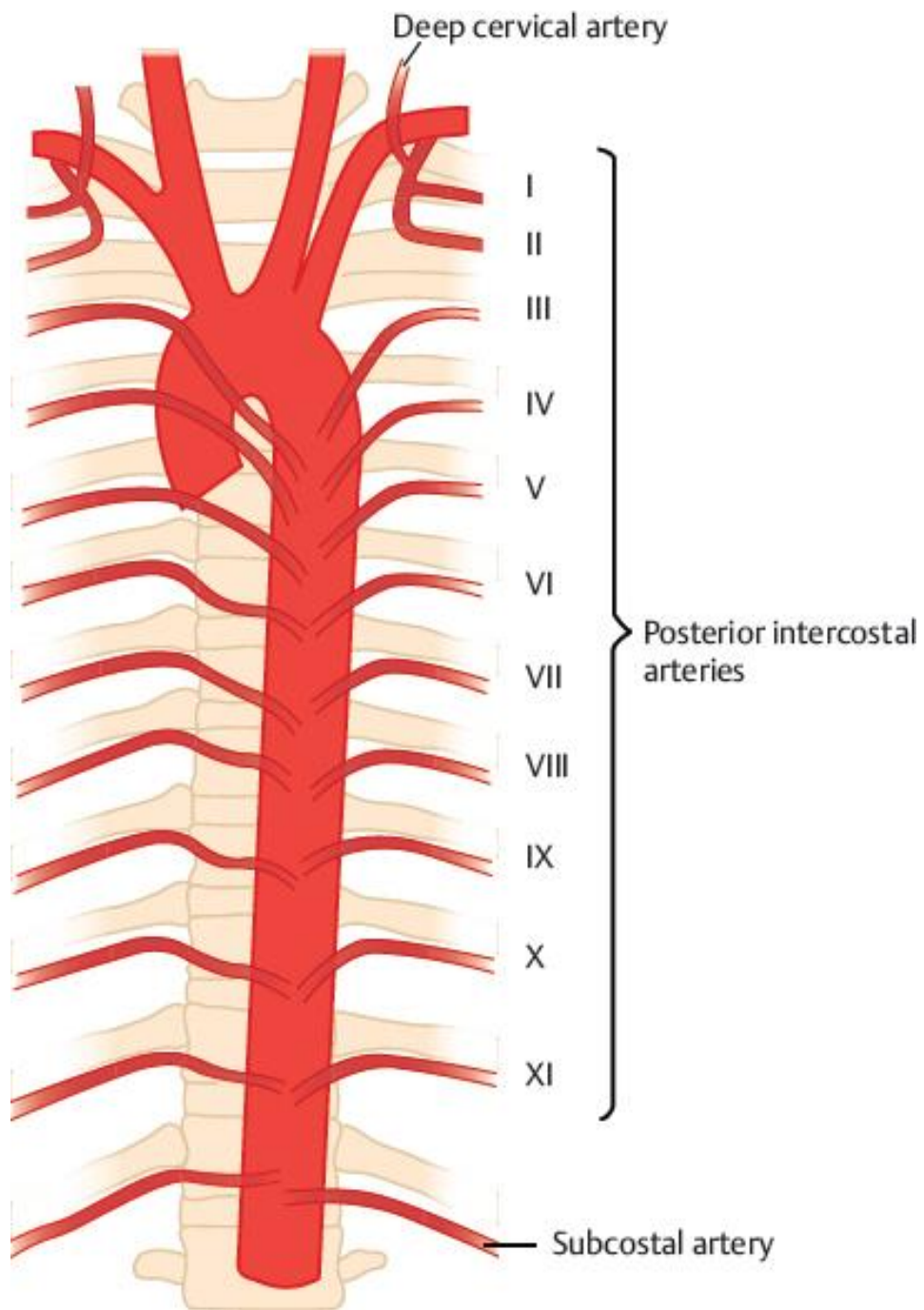
- **The 1st and 2nd posterior intercostal arteries** : arise from the **superior intercostal artery** (branch from costocervical trunk of the 2nd part of subclavian artery) which descends in front of the neck of the 1st rib and gives the 1st and 2nd posterior intercostal arteries.
- **The lower nine posterior intercostal arteries** (from 3rd to 11th) and subcostal arteries) : Are branches of **descending thoracic aorta**.

Intercostal Spaces

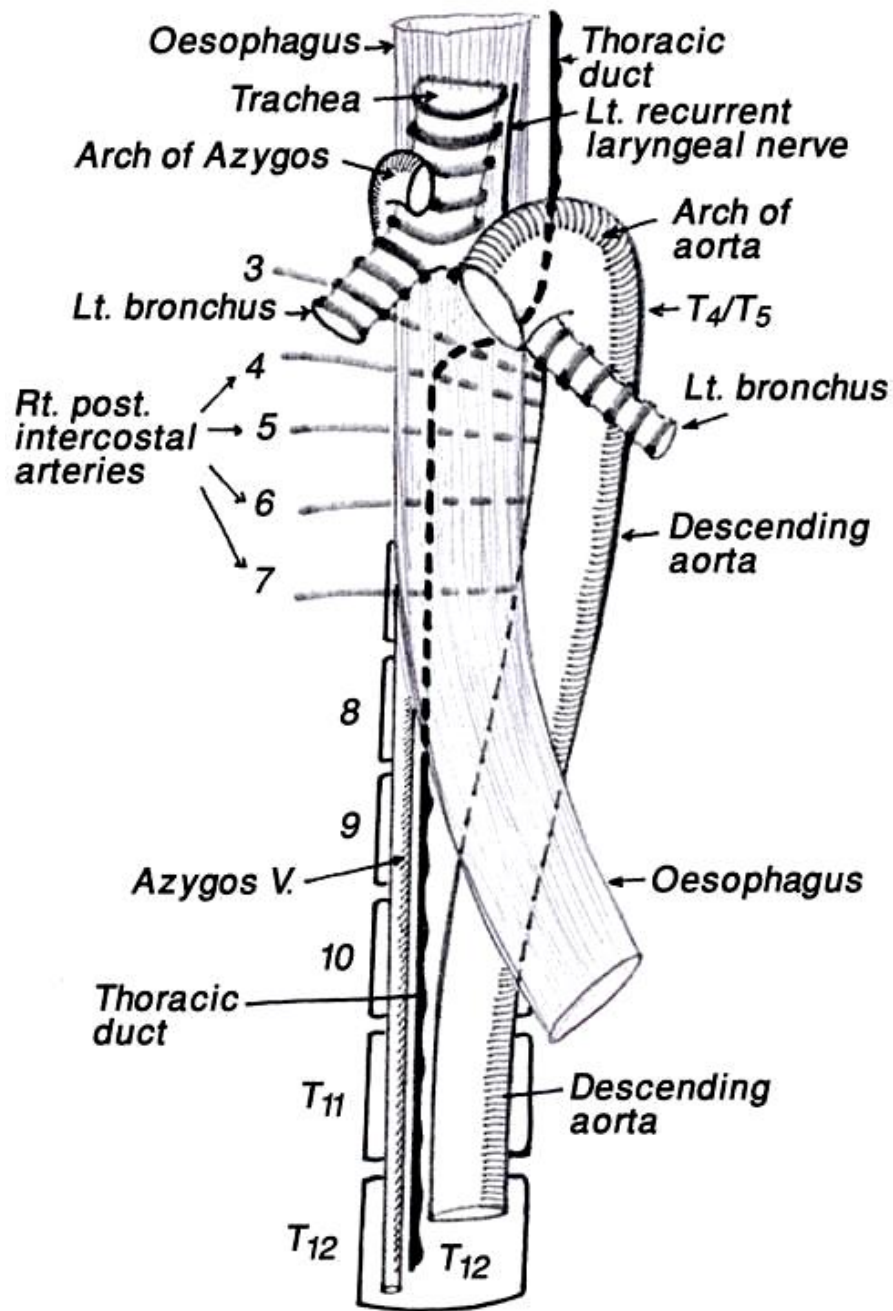
- The **right** arteries are **longer** than the left. They **pass behind** the thoracic duct, vena azygos, oesophagus and the right sympathetic chain to reach their spaces.
- Each posterior intercostal artery gives a **collateral branch**, both the artery and its collateral branch run together to **anastomose**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



Anterior intercostal arteries

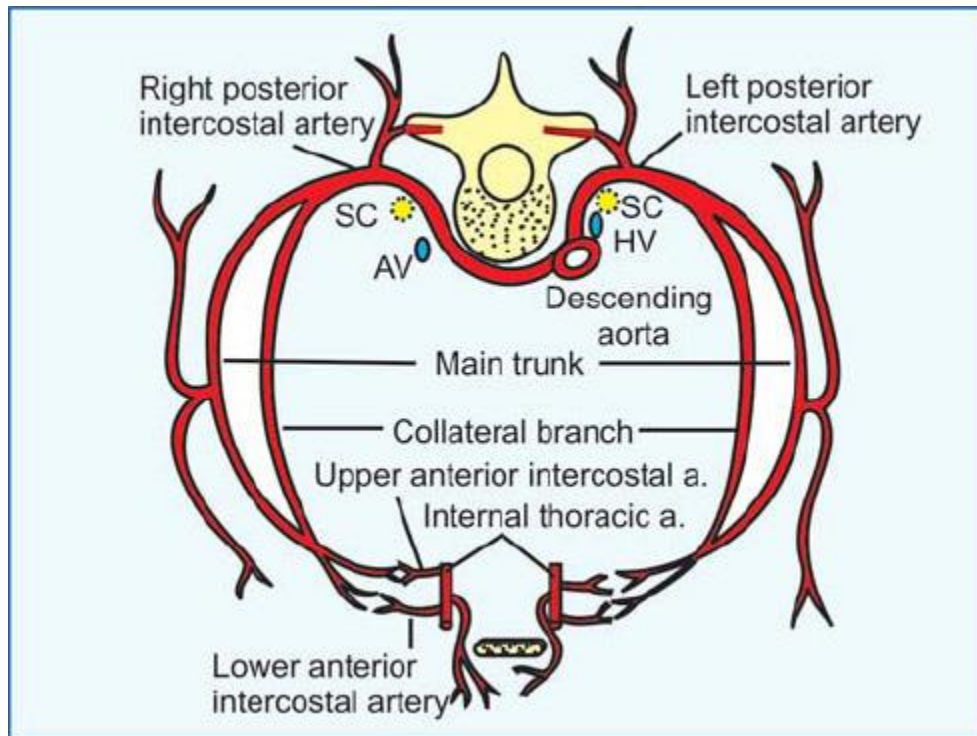


Posterior intercostal arteries

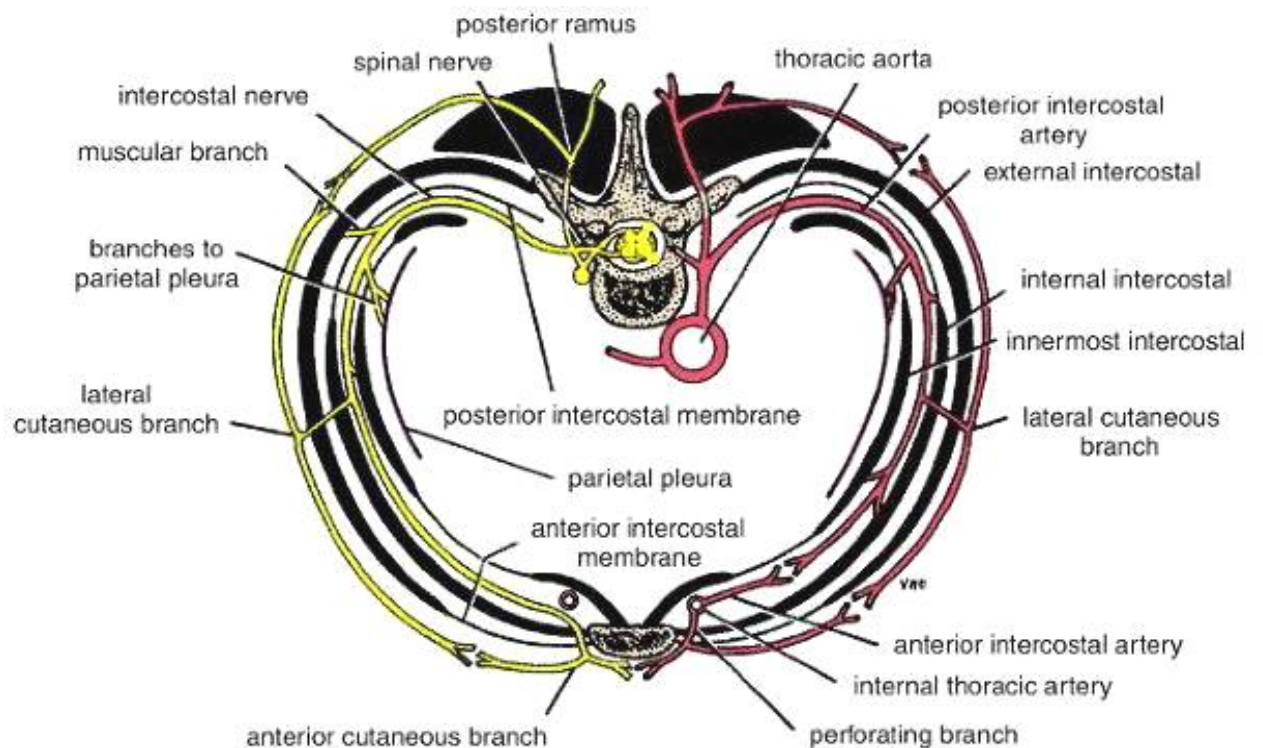


Relations of lower posterior intercostals arteries and azygos vein

Intercostal Spaces



Intrcostal 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.

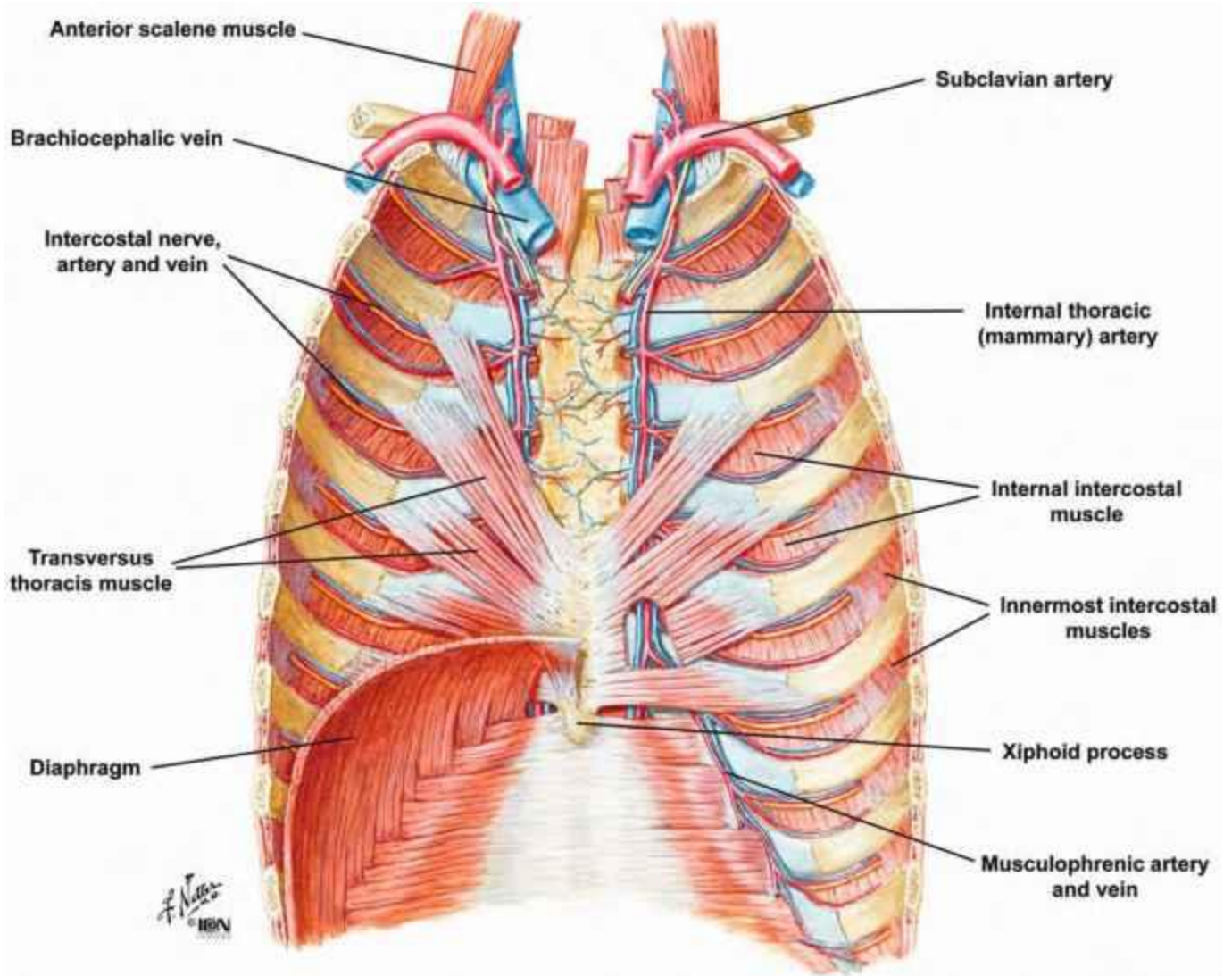
3. Six perforating branches: which pierce the intercostal muscles, and pectoralis major muscle. The 2nd, 3rd and 4th perforators supply the mammary gland .

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.

Intercostal Spaces



Internal thoracic artery

2. Intercostal veins

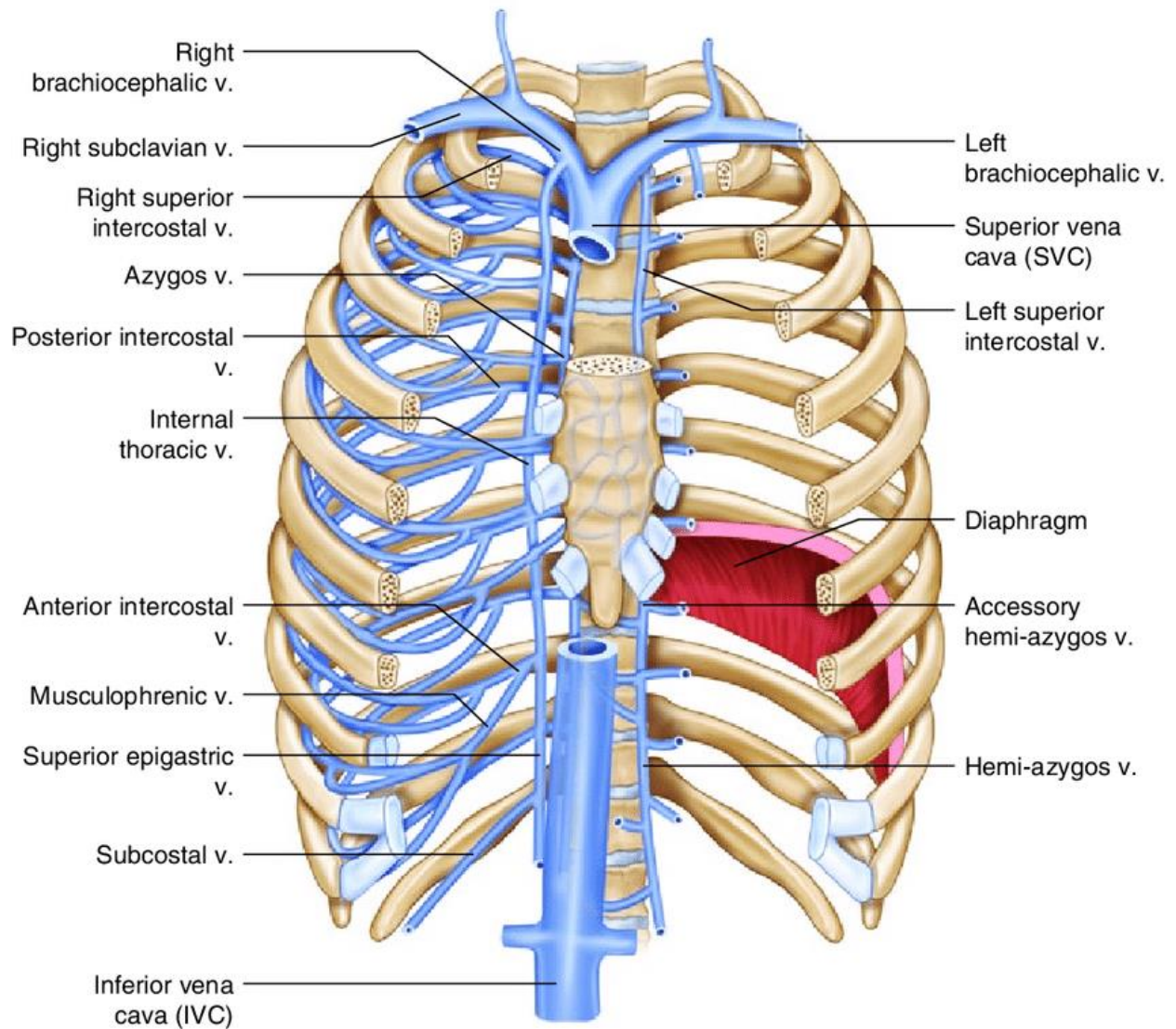
A) Anterior intercostal veins:

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

B) Posterior intercostal veins:

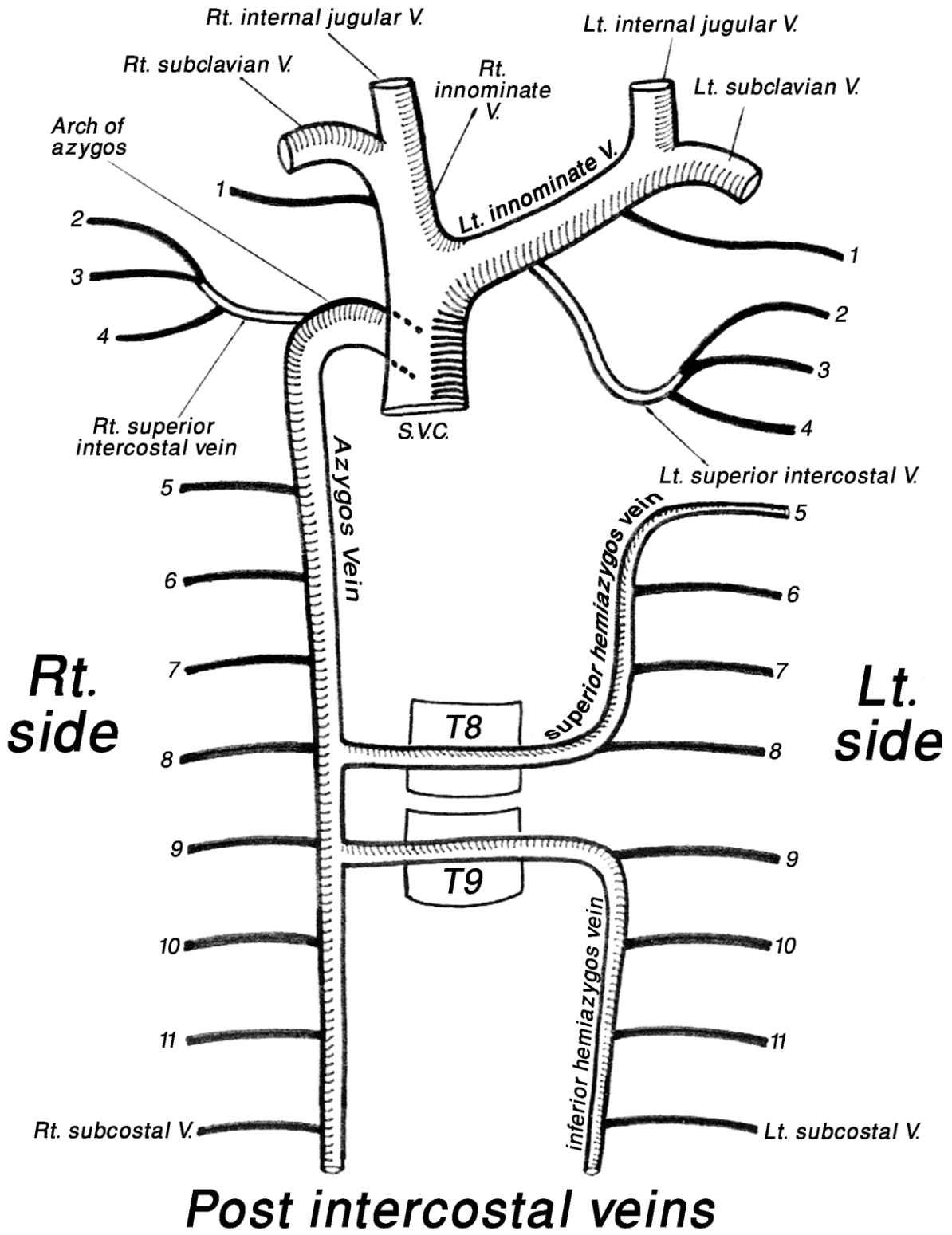
Right side	Left side
<ul style="list-style-type: none"> • The 1st ends in the corresponding brachiocephalic vein 	
<ul style="list-style-type: none"> • 2nd, 3rd and 4th end in right superior intercostal vein which ends in arch of azygos. 	<ul style="list-style-type: none"> • 2nd, 3rd and 4th end in left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

Intercostal Spaces



Anterior intercostal veins

Intercostal Spaces

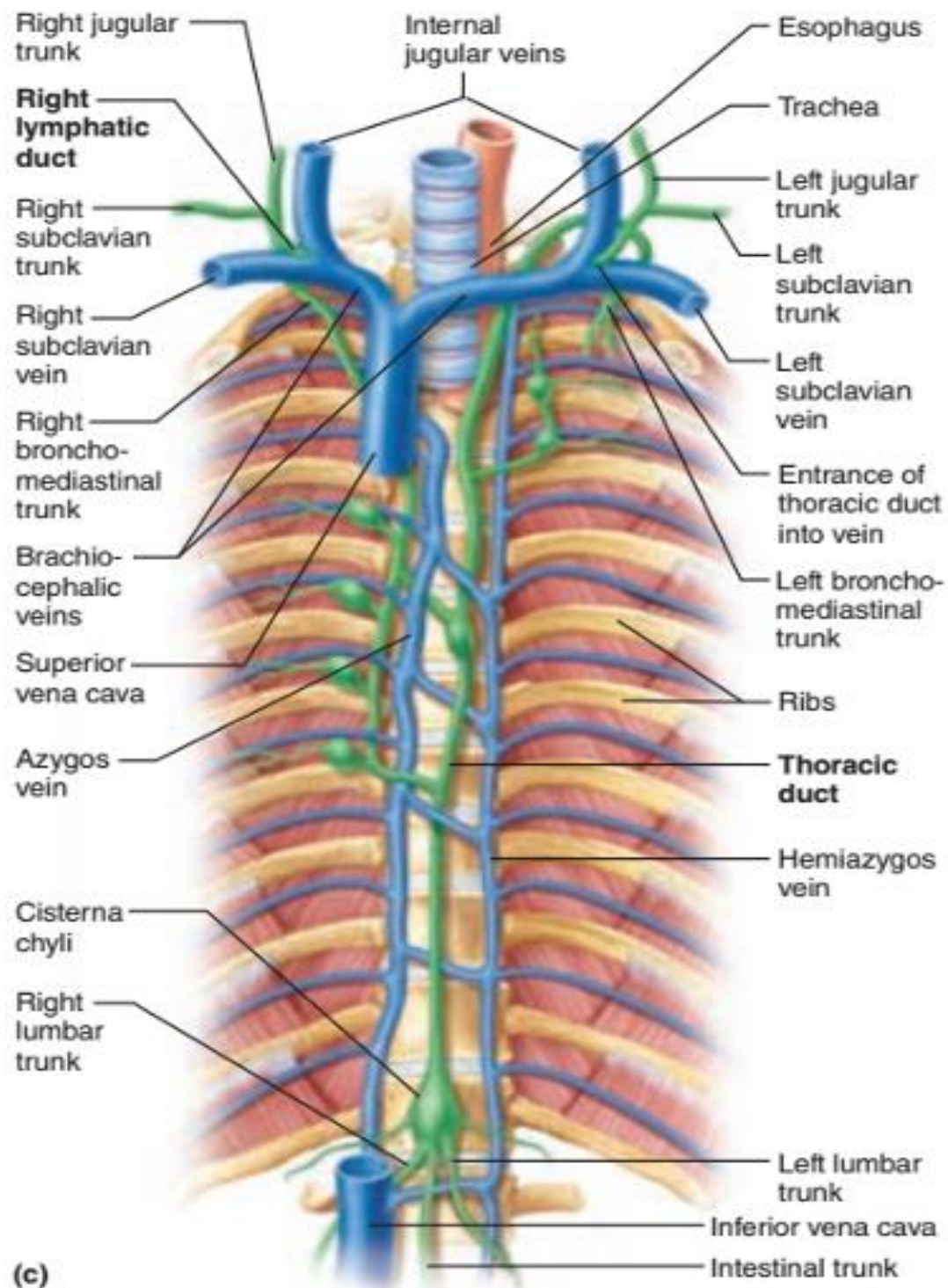


Vena azygos

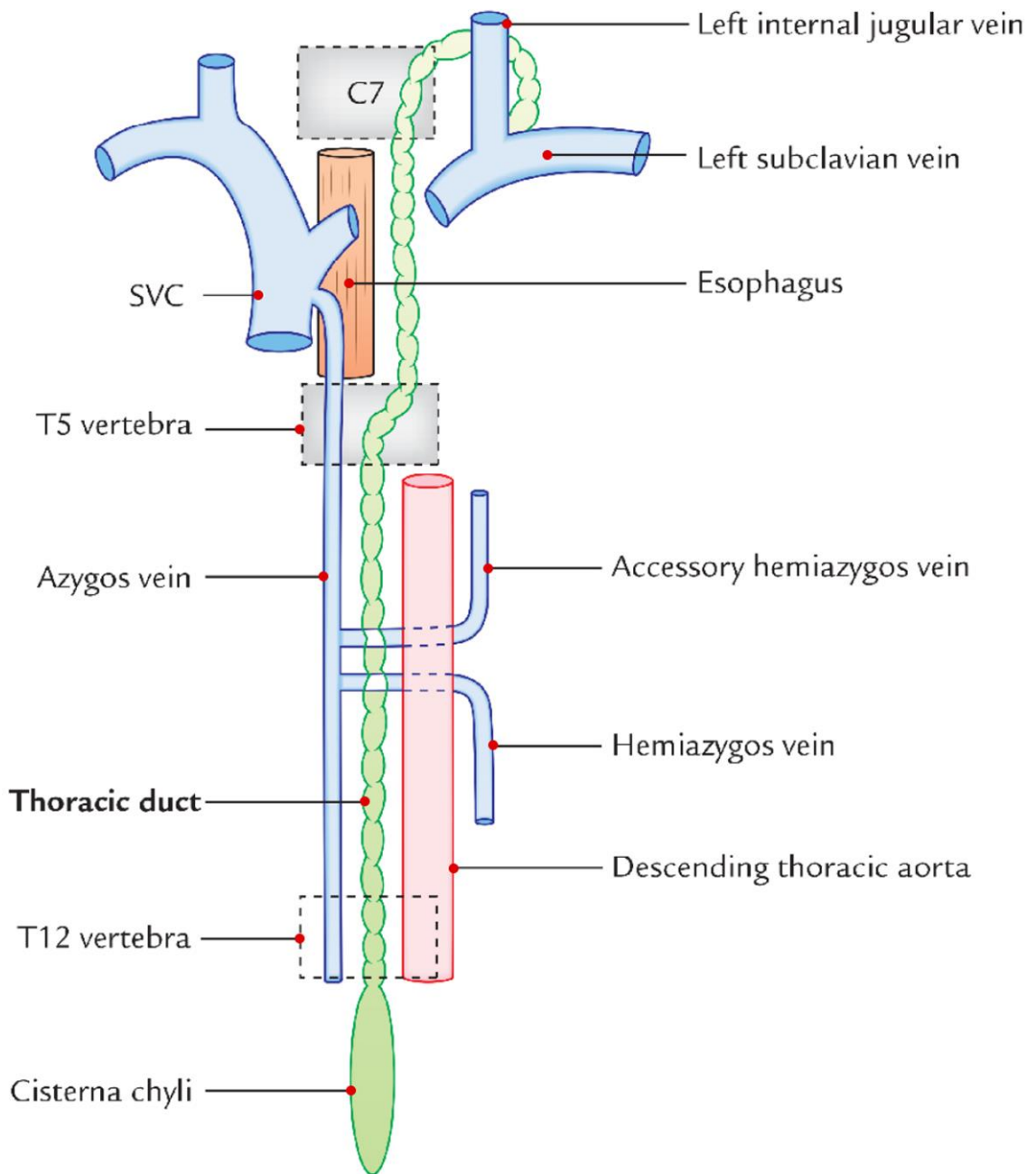
- * **Begins:** it begins in the abdomen usually from the **back of inferior vena cava** at the level of **L₂**.
- * **Course:**
 - It enters the thorax by passing through **aortic opening** of diaphragm
 - Then ascends in **posterior mediastinum** till the level of lower border of **T₄** where the **arch** 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** (just above the level of pericardium).
- * **Relations:**
 - **Relations of the azygos vein in the aortic opening of the diaphragm :** The thoracic duct and abdominal aorta lie on left side of azygos vein
 - **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**.

Intercostal Spaces

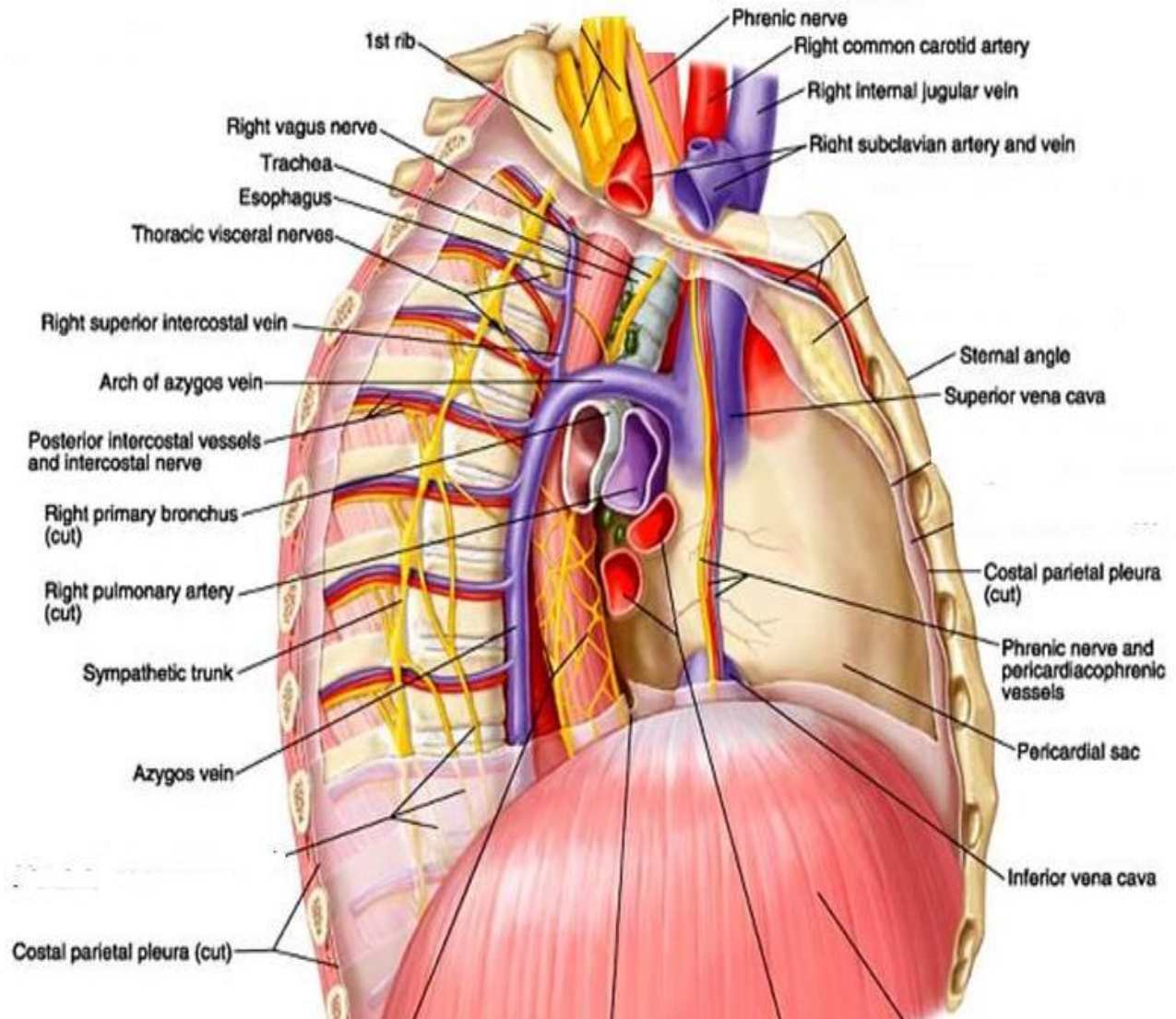
- On its **left** side: **trachea, right vagus and oesophagus.**



Azygos vein



Intercostal Spaces



* 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 1^{ry} 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

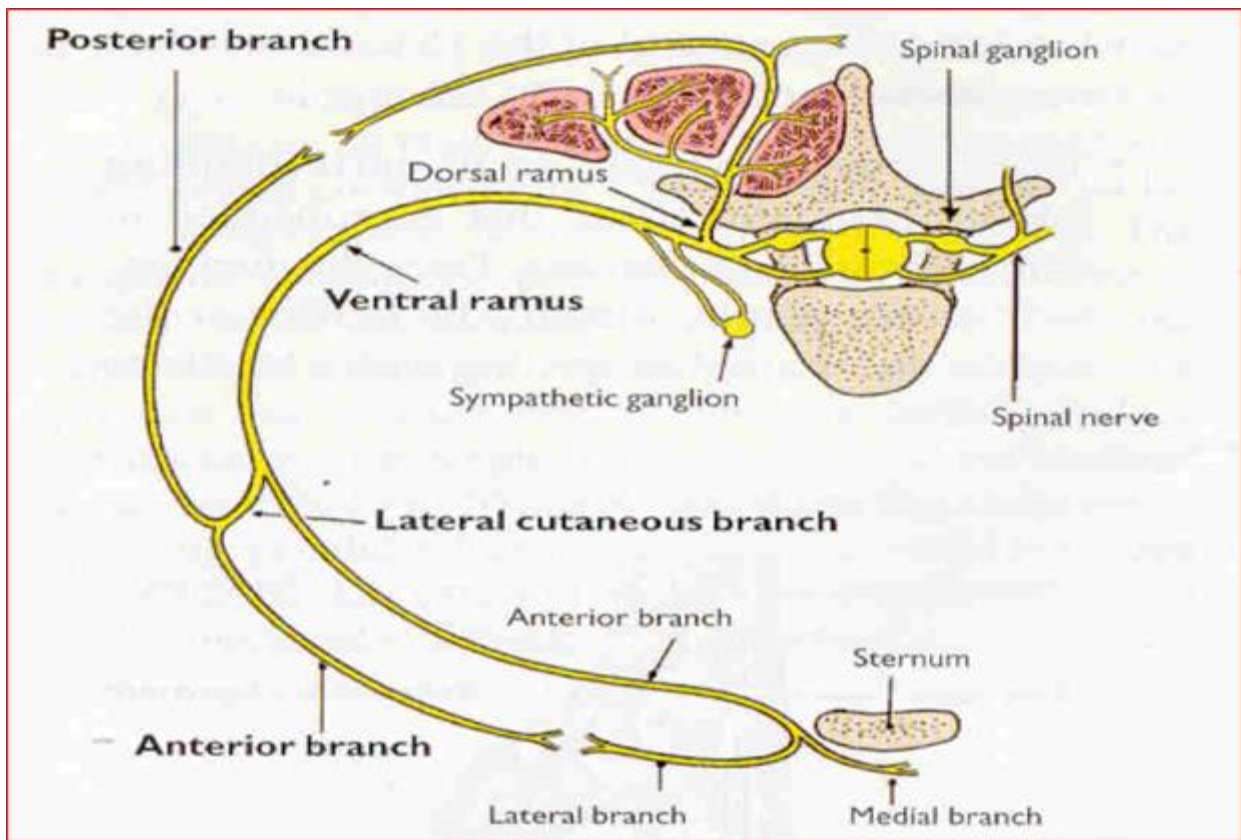
(2nd – 6th)

* Course:

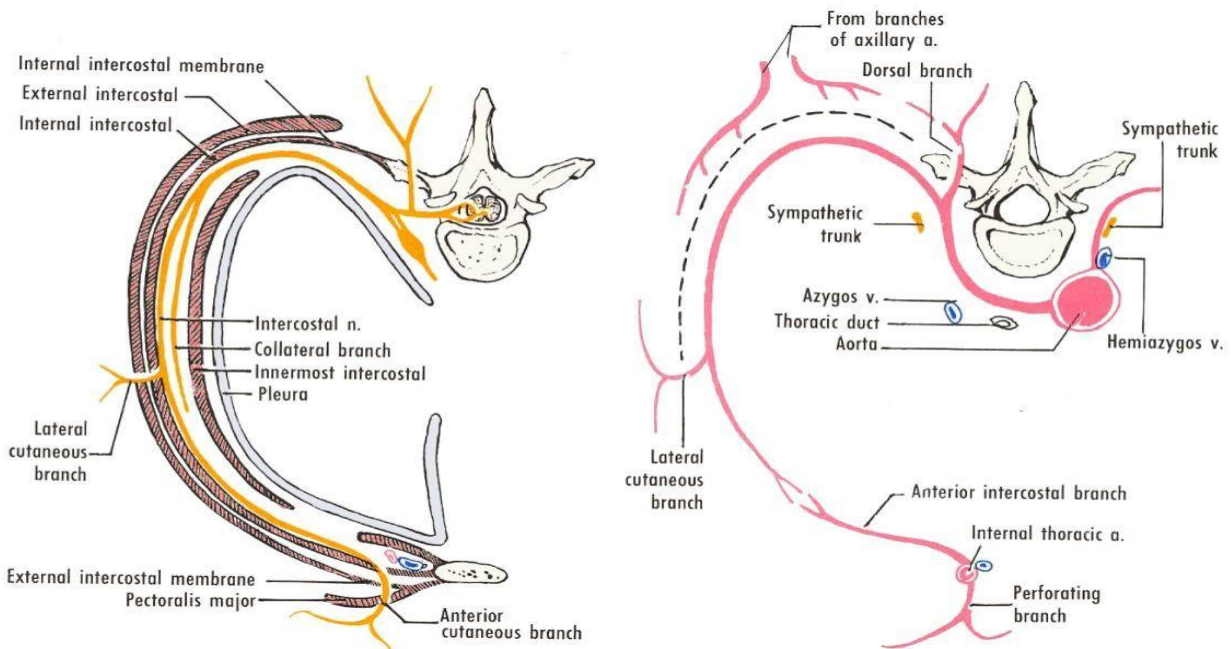
- Passes in the **intercostal space** below intercostal vessels [vein, artery and nerve] [**V.A.N**] lying first **between** the pleura and posterior intercostal membrane, **then run in the neurovascular plane** between the 2nd. and 3rd. layers of intercostal muscles).
- **Near the sternum** it **crosses** the internal thoracic vessels, and then **pierces** the intercostal muscles 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 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 intercostal muscles and the pectoralis major to supply the skin of the front of the chest.
 - d) **White and grey rami communicantes:** to communicate with the sympathetic ganglia .
 - e) **Collateral branch:** supplies the **intercostal muscles.**

Intercostal Spaces

- 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**.



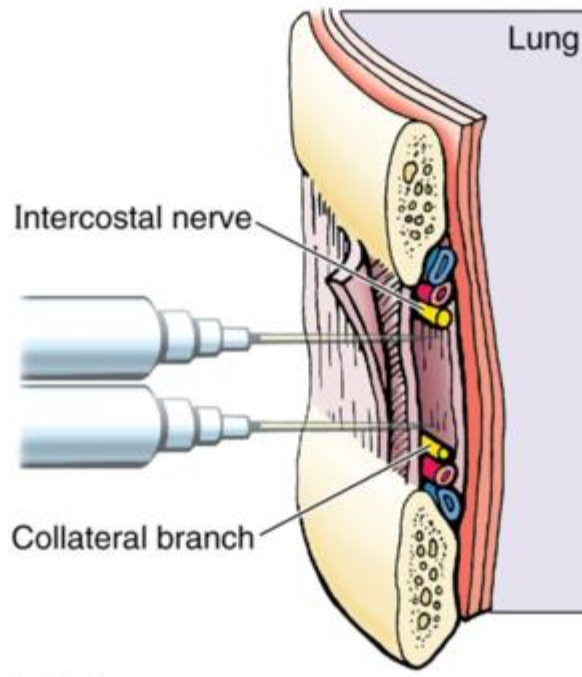
Intercostal Spaces



* 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 Spaces



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 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)