

Anatomy of the thoracic wall

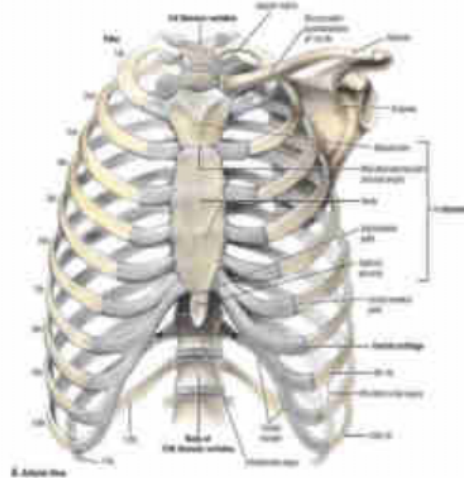
Learning objectives:

- ✓ Describe the different parts of the respiratory system.
- ✓ Describe the structure forming the thoracic cage.
- ✓ Identify the muscles of the thoracic wall, the intercostal nerves and vessels.

➤ The Thoracic cage:

Boundaries:

- Posteriorly: thoracic part of the vertebral column.
- Anteriorly: sternum and costal cartilages.
- Laterally: ribs and intercostal spaces.
- Superiorly: the supra-pleural membrane.
- Inferiorly: the diaphragm.



➤ The Sternum:

The sternum is a flat bone that may be divided into three parts:

- 1- Manubrium sterni 2- Body 3- Xiphoid process.

The manubrium:

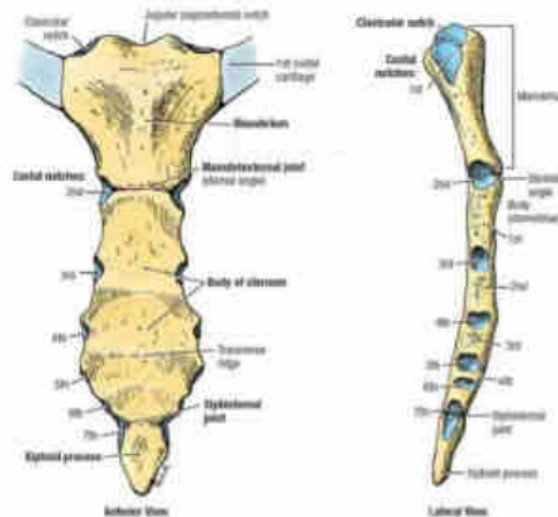
- Its upper border shows the jugular (suprasternal) notch and clavicular notch on either side for articulation with the clavicle.
- Its lower border articulates with the body of the sternum (manubriosternal joint) at a projected ridge called the sternal angle (angle of Louis) that lies opposite the 2nd costal cartilage.
- Its lateral border shows an upper facet for articulation with the first costal cartilage and a smaller lower facet for articulation with the upper part of the 2nd costal cartilage.

The body:

- It articulates with the xiphoid process (xiphisternal joint).
- On each lateral border are notches for articulation with the lower part of the 2nd costal cartilage and the 3rd to the 7th costal cartilages.

The xiphoid process:

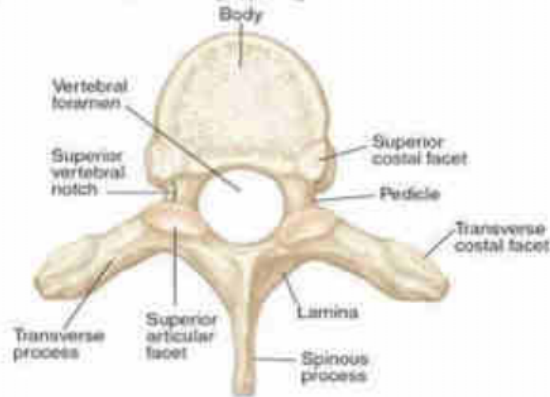
Is the lowest and smallest part of the sternum.



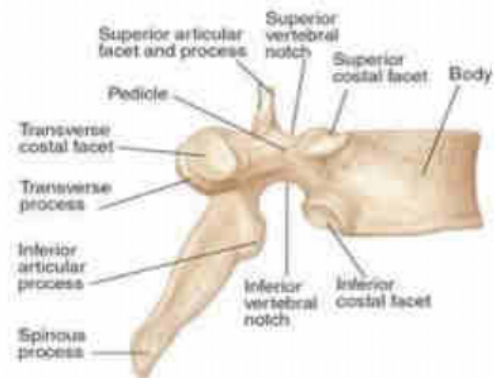
➤ The Thoracic Part of the Vertebral Column

- It is made of twelve vertebrae, together with their intervertebral discs.
- The thoracic vertebrae have the following characteristics:
 - (1) Heart shape body, shows costal facets for articulation with the heads of the ribs.
 - (2) The transverse process shows a costal facet for articulation with the tubercle of the rib (T11 and T12 have no facets on their transverse processes)
 - (3) Long spines, inclined downward.

A. Thoracic vertebra (T6), superior view

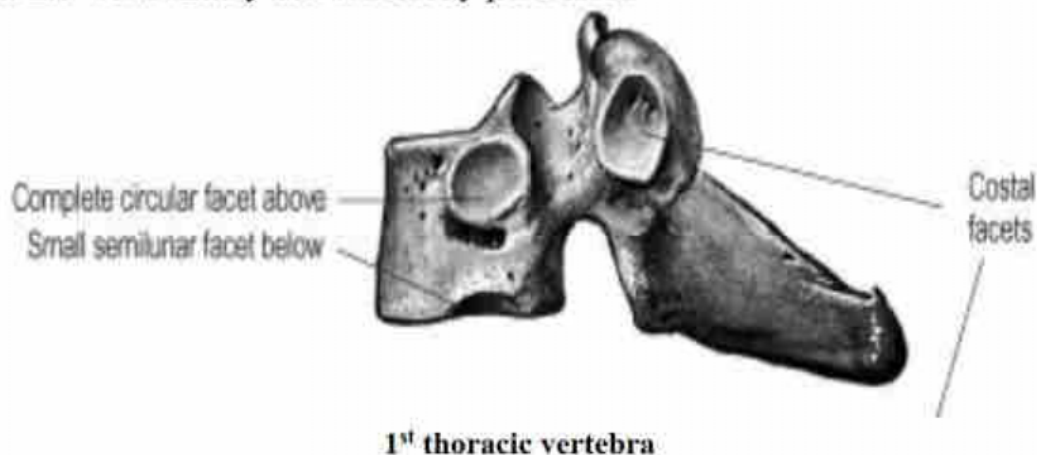


B. Thoracic vertebra (T6), lateral view

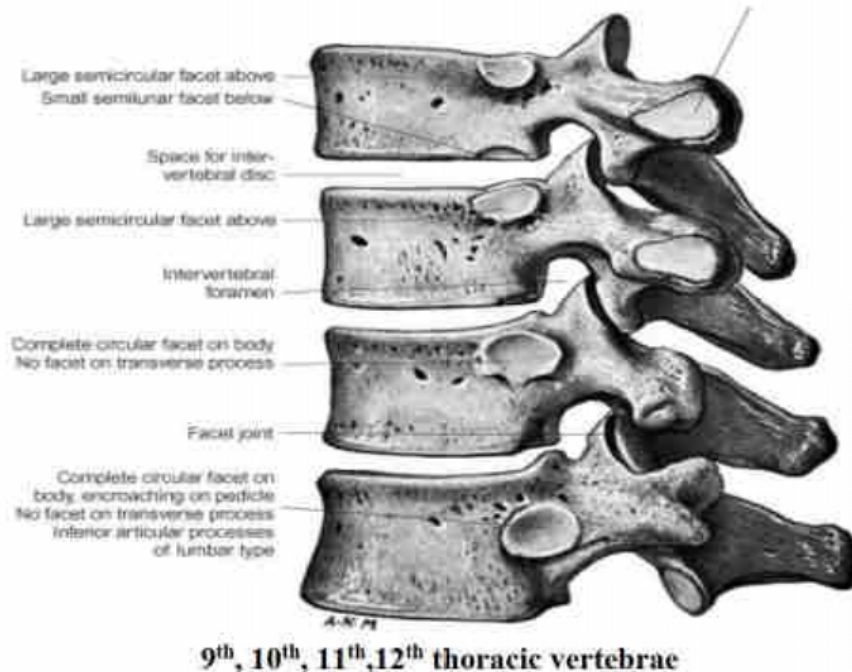


The 1st, 10th, 11th and 12th thoracic vertebrae are atypical ones:

- 1-The 1st thoracic vertebra has a complete circular upper costal facet.
- 2-The 10th thoracic vertebra has no lower facet on the side of the body as the 11th rib does not articulate with the 10th vertebra.
- 3-The 11th thoracic vertebra has a single circular facet near the upper border for articulation with the head of the 11th rib. Its transverse process is short with no facet.
- 4-The 12th thoracic vertebra: The body has a single circular facet which a space between it and the upper border. The transverse process has no facet and has a mamillary and accessory processes.



1st thoracic vertebra



➤ The ribs

- They are 12 pairs.
- Types:

1-True ribs: The upper seven, articulate anteriorly by their costal cartilages with the sternum.

2-False ribs: The 8th, 9th and 10th, each of their costal cartilages joins the one above.

3-Floating ribs: 11th and 12th; have free anterior ends.

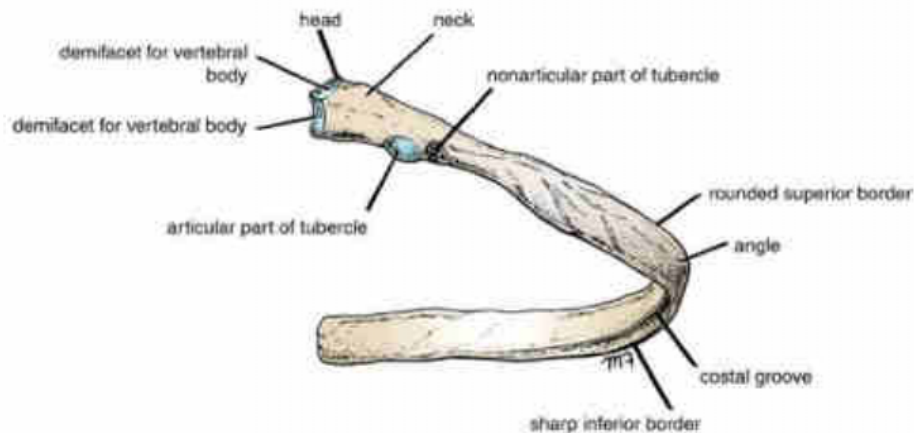
Features of the typical rib:

I-The posterior end:

- ✓ Head which is divided into 2 facets by a transverse ridge. These facets articulate with the costal facets of 2 thoracic vertebrae.
- ✓ Neck: between head and tubercle.
- ✓ Tubercle: Lies anterior to the neck and is divided into articular medial part and non-articular lateral part for attachment of the costal cartilage.

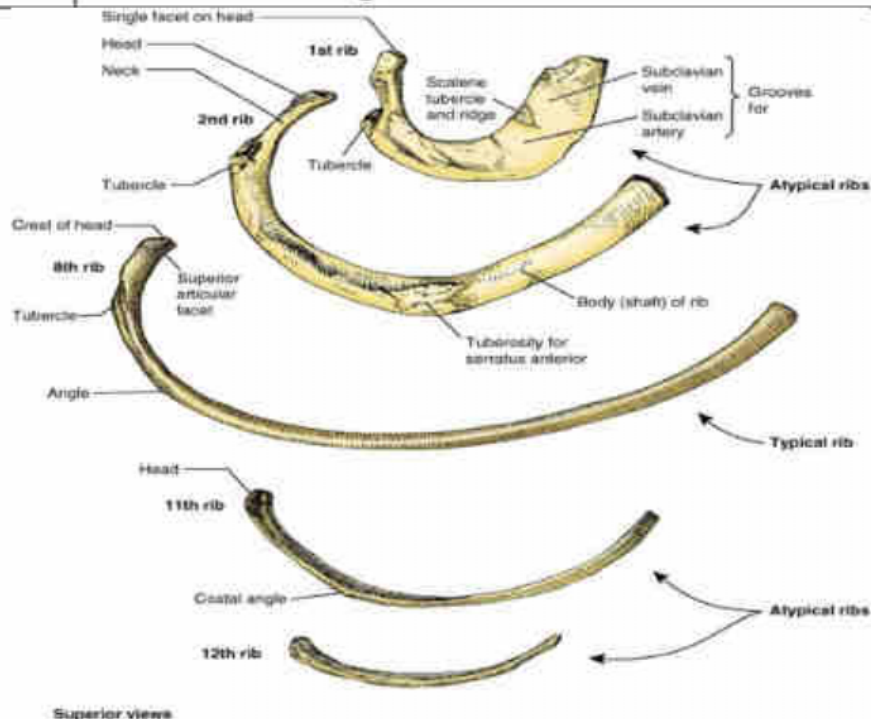
II-The anterior end for attachment of the costal cartilage.

III-The shaft: has an outer convex and inner concave surfaces.



Features of atypical ribs (1st, 2nd, 11th and 12th ribs)

| | |
|------------------|---|
| The first rib | It is the shortest rib. Upper surface marked by rough impressions and two grooves while lower surface is smooth. |
| The second rib | It has no twist in its long axis. |
| The eleventh rib | The head has a single facet. No neck and no tubercle. |
| The twelfth rib | The head has a single facet. No neck and no tubercle. No costal groove |

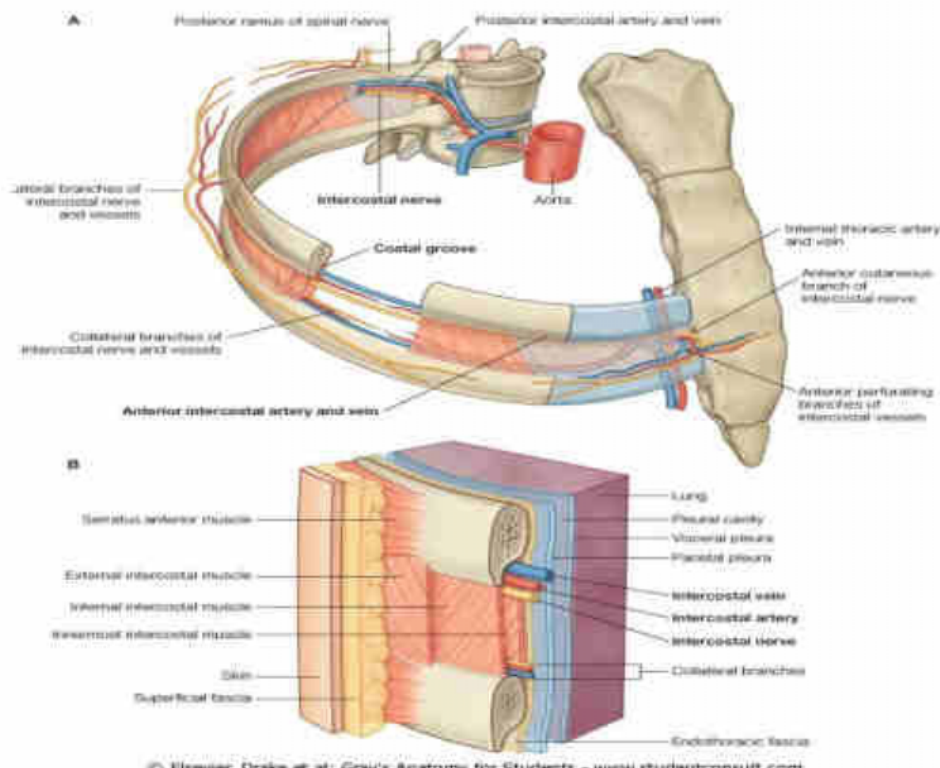


➤ INTRCOSTAL SPACES

- The spaces between the ribs are called intercostal spaces.
- Each space contains three muscles and a neurovascular bundle.

A-Intercostal muscles

| | The external intercostal muscle | The internal intercostal muscle | The transversus thoracis muscle |
|------------|---|---|--|
| Layer | The most superficial layer | The intermediate layer | The deepest layer |
| Fibers | Directed downward and forward | Directed downward and backward. | |
| Attachment | From the inferior border of the rib above to the superior border of the rib below. | From the subcostal groove of the rib above to the upper border of the rib below. | |
| Extension | The muscle extends forward from the rib tubercle behind to the costochondral junction in front. | The muscle extends backward from the sternum in front to the angles of the ribs behind. | |
| End | The muscle is replaced by the anterior intercostal membrane. | The muscle is replaced by the posterior intercostal membrane | |



Nerve supply:

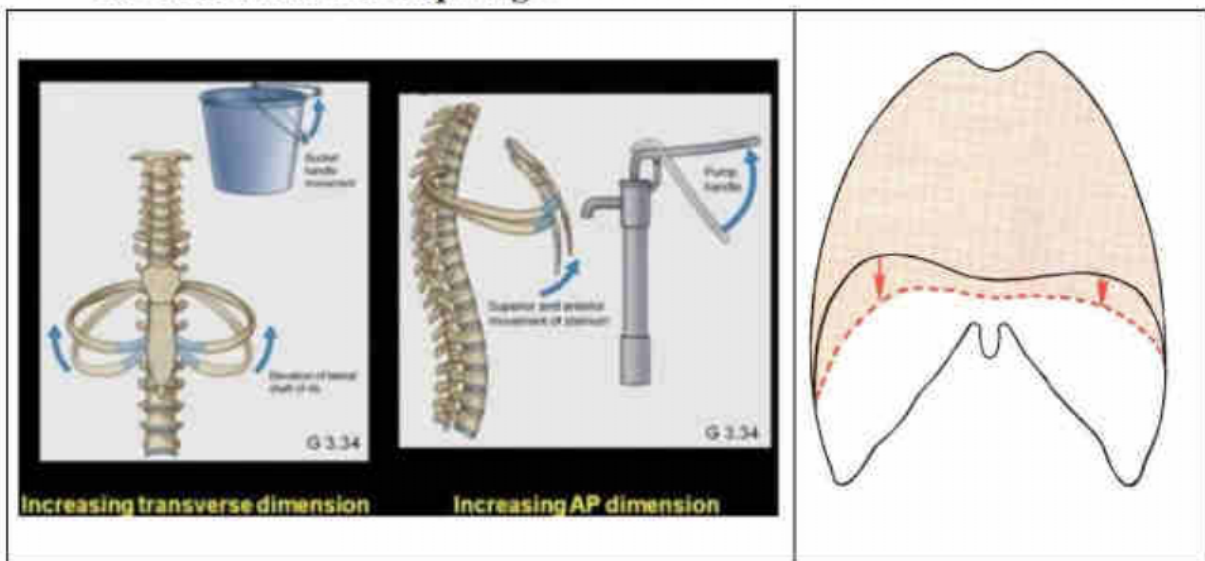
The intercostal muscles are supplied by the corresponding intercostal nerves.

Action:

1. When the intercostal muscles contract, they all tend to pull the ribs nearer to one another.
2. If the first rib is fixed by the contraction of the muscles in the root of the neck, the intercostal muscles will raise the ribs.

Read only: Mechanisms of respiration

- **Pump handle mechanism**
- **Bucket handle mechanism**
- **Contraction of the diaphragm**

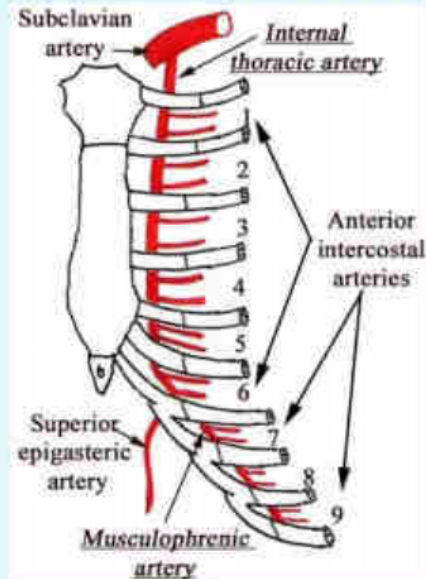


B-Intercostal arteries

Anterior Intercostal Arteries

Each anterior intercostal space contains **two** anterior intercostal arteries (except in the lower two inter-costal spaces).

- a. The upper 6 pairs arise from the **internal thoracic artery**.
- b. The 7th, 8th, and 9th pairs arise from the **musculophrenic artery**.

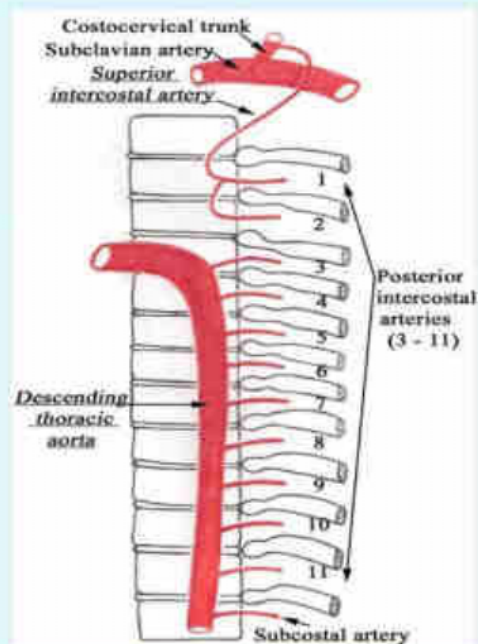


Posterior Intercostal Arteries

- Each posterior intercostal space contains **one** posterior intercostal artery which runs in the costal groove.
- Each artery gives a **collateral branch** which runs over the upper border of the rib *below*.

*The upper **two** posterior intercostal arteries → **superior intercostal artery** (from the *costo-cervical trunk*) → **2nd part of subclavian artery**.

* From **3 - 11** posterior intercostal arteries and subcostal artery → **descending thoracic aorta**.



C-Intercostal veins

✓ Anterior intercostal veins:

The anterior intercostal veins drain forward into the internal thoracic and musculophrenic veins.

✓ Posterior intercostal veins:

-The posterior intercostal veins run with the posterior intercostal arteries and are eleven in number on each side.

-The corresponding posterior intercostal veins drain backward into the azygos or hemiazygos veins.

The azygos vein:

✓ The azygos vein arises from the posterior aspect of the inferior vena cava to join the superior vena cava.

✓ The azygos vein collects from the posterior intercostal veins of the right side except:

1-The first posterior intercostal vein: join right brachiocephalic vein.

2-The second, third and fourth posterior intercostal veins: join the right superior intercostal vein.

✓ It receives also the hemiazygos and accessory hemiazygos veins, several esophageal, mediastinal, and pericardial veins.

The hemiazygos vein:

✓ It ascends on the front of the vertebral column as high as the eighth thoracic vertebra, it passes across the column to end in the azygos.

✓ Its tributaries are the lower three posterior intercostal veins and some oesophageal and mediastinal veins.

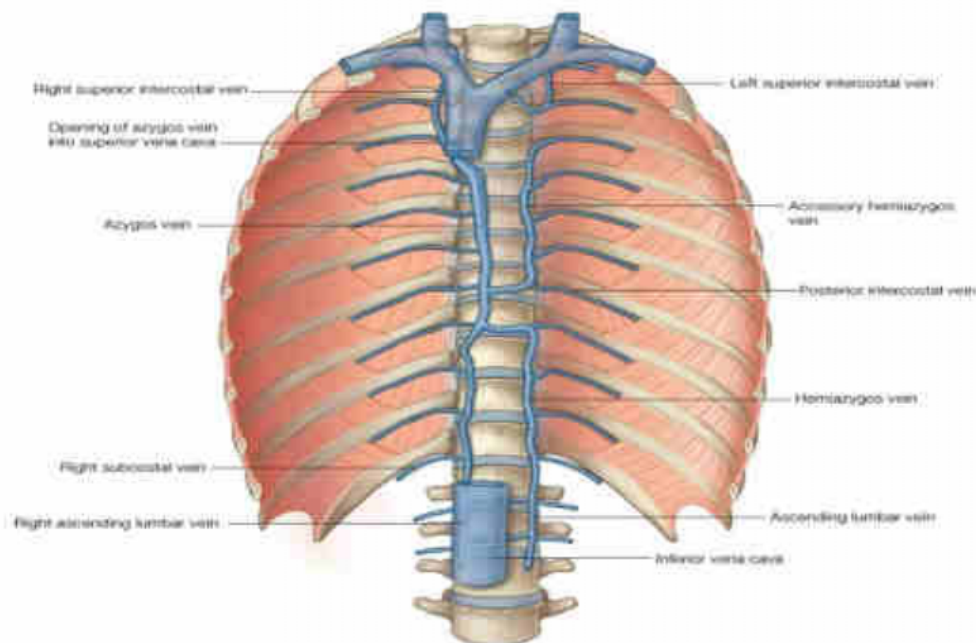
The accessory hemiazygos vein:

✓ It descends on the left side of the vertebral column.

- ✓ It receives the veins from the fifth to the eighth intercostal spaces inclusive of the left side.
- ✓ It crosses the body of the seventh thoracic vertebra and joins the azygos vein.

| Posterior intercostal veins | Right side | Left side |
|--|----------------------------------|---------------------------------|
| 1 st | Right brachiocephalic vein | Left brachiocephalic vein |
| 2 nd , 3 rd , 4 th | Right superior intercostal vein. | Left superior intercostal vein. |
| 5 th , 6 th , 7 th , 8 th | Azygos vein | The hemiazygos vein |
| 9 th , 10 th , 11 th +subcostal vein | | The accessory hemiazygos vein |

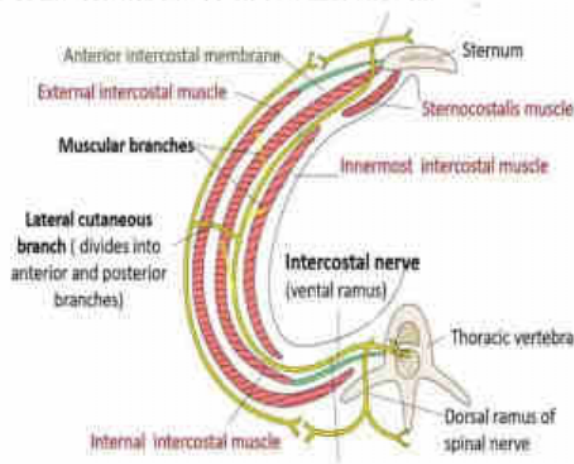
NB: On the right side, the superior intercostal joins the azygos vein, while on the left side, it usually drains into the left brachiocephalic vein.



Azygos system of veins

D-Intercostal nerves

- ✓ The intercostal nerves are the anterior rami of the first eleven thoracic spinal nerves. Each intercostal nerve enters an intercostal space between the parietal pleura and the internal intercostal muscle.
- ✓ It then runs forward inferiorly to the intercostal vessels in the subcostal groove of the corresponding rib, between the transversus thoracis and internal intercostal muscle.



Branches:

1. A collateral branch.
2. A lateral cutaneous branch.
3. An anterior cutaneous branch.
4. Muscular branches.
5. Pleural, peritoneal, Articular branches to the joints of the ribs.

Atypical intercostal nerves:

- ✓ The first intercostal nerve is joined to the brachial plexus.
- ✓ The second intercostal nerve is joined to the medial cutaneous nerve of the arm.
- ✓ The seventh to ninth intercostal nerves leave the anterior ends of their intercostal spaces by passing deep to the costal cartilages, to enter the anterior abdominal wall and supply the skin and the parietal peritoneum and the anterior abdominal muscles.

References:

- Kaplan Medical USMLE Step 1 Lecture Notes anatomy 2021.
- Gray's Anatomy, 40th edition.