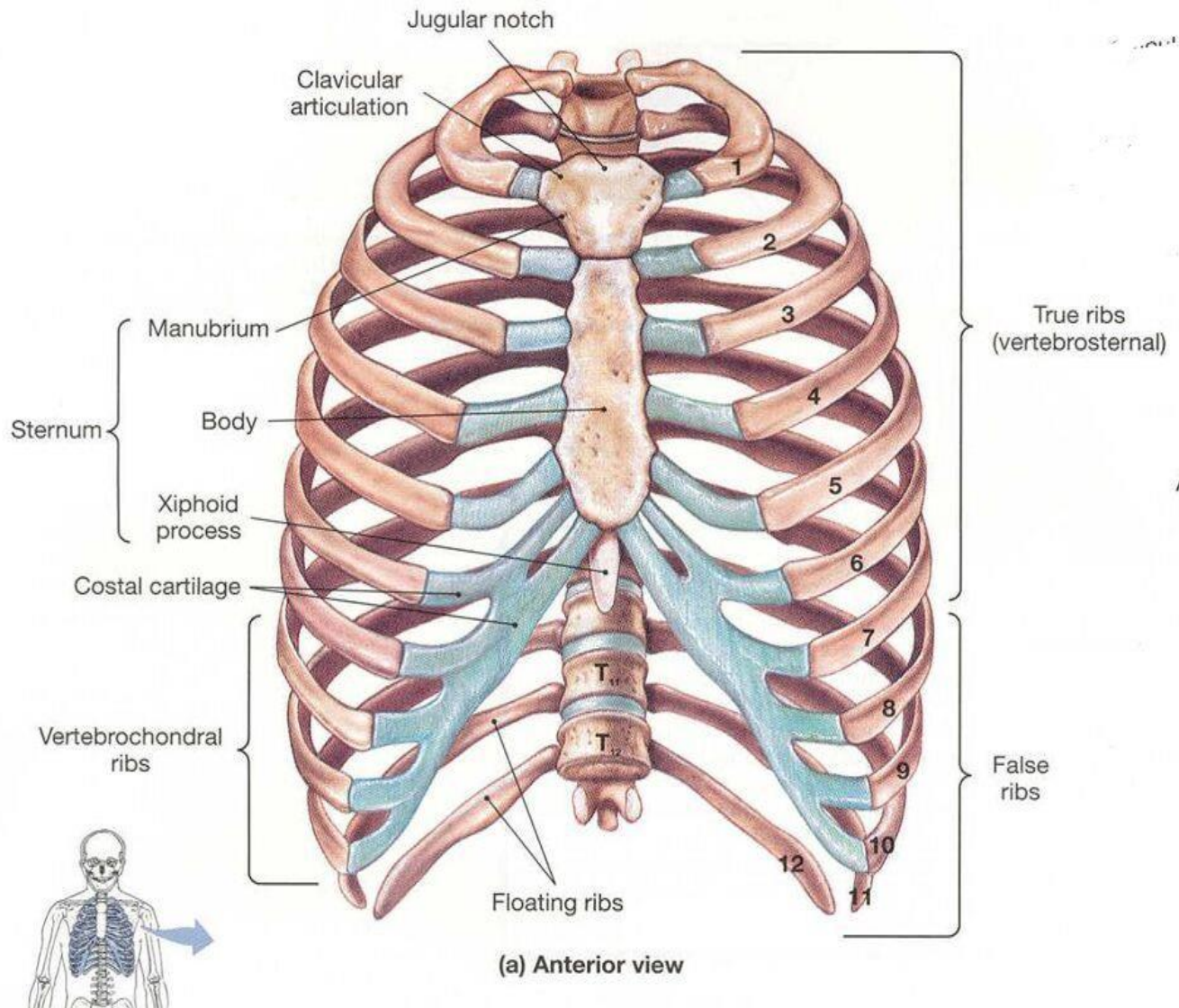
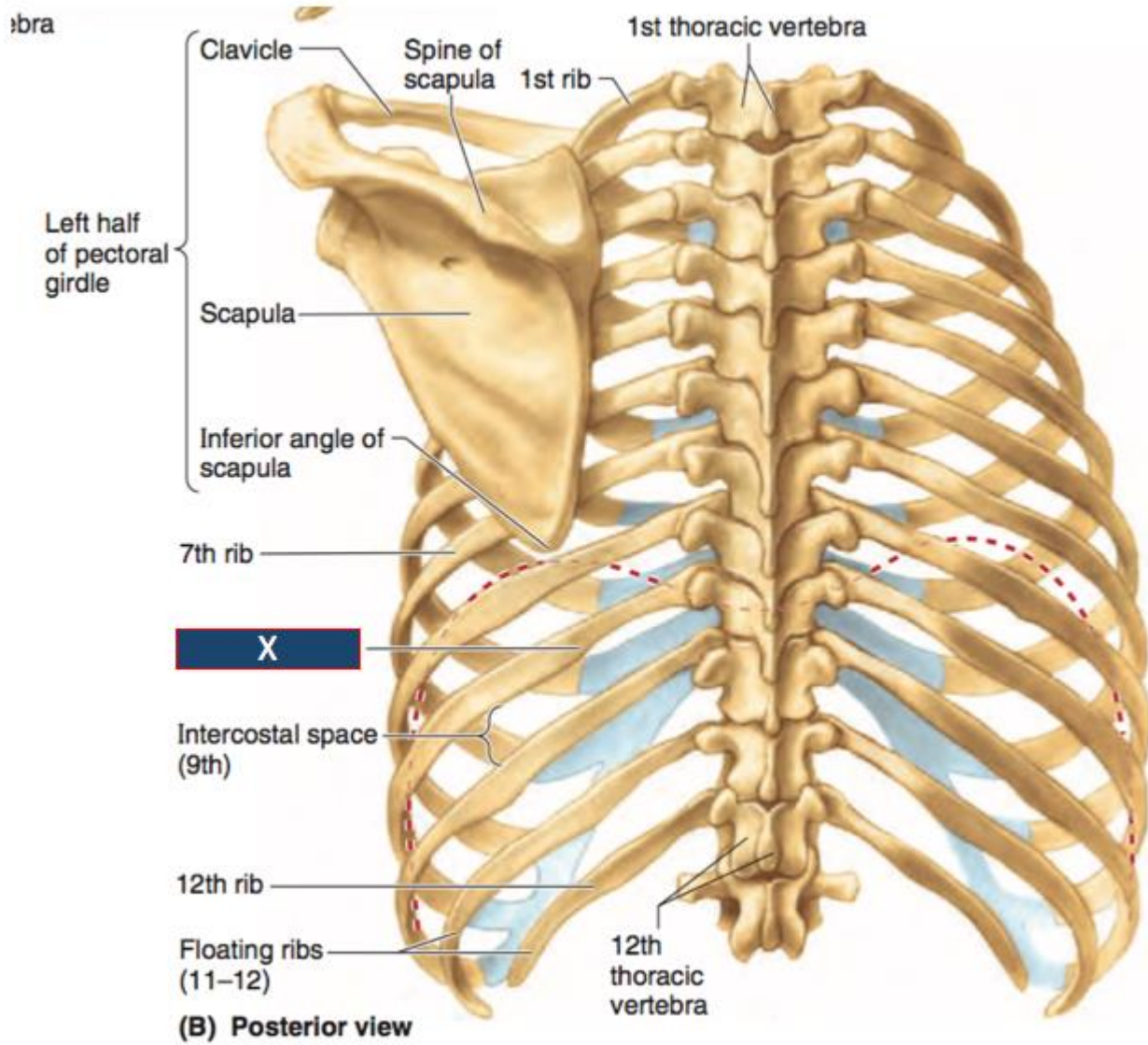


Thoracic Cage

The thoracic cage



Thoracic Cage (anterior view)



Thoracic Cage (posterior view)

- The skeleton of the thorax forms an **osteo-cartilagenous cage** .
- It is **conical** in shape with a narrow inlet and a broad outlet.
- **The thoracic cage is formed of:**
 1. The **sternum**: in front.
 2. Twelve thoracic **vertebrae**: behind
 3. Twelve pairs of **ribs** and their **costal cartilage**: on either side
- **Function:** the thoracic cage **Supports** and **protects** the **thoracic & upper abdominal** viscera.

Thoracic cavity

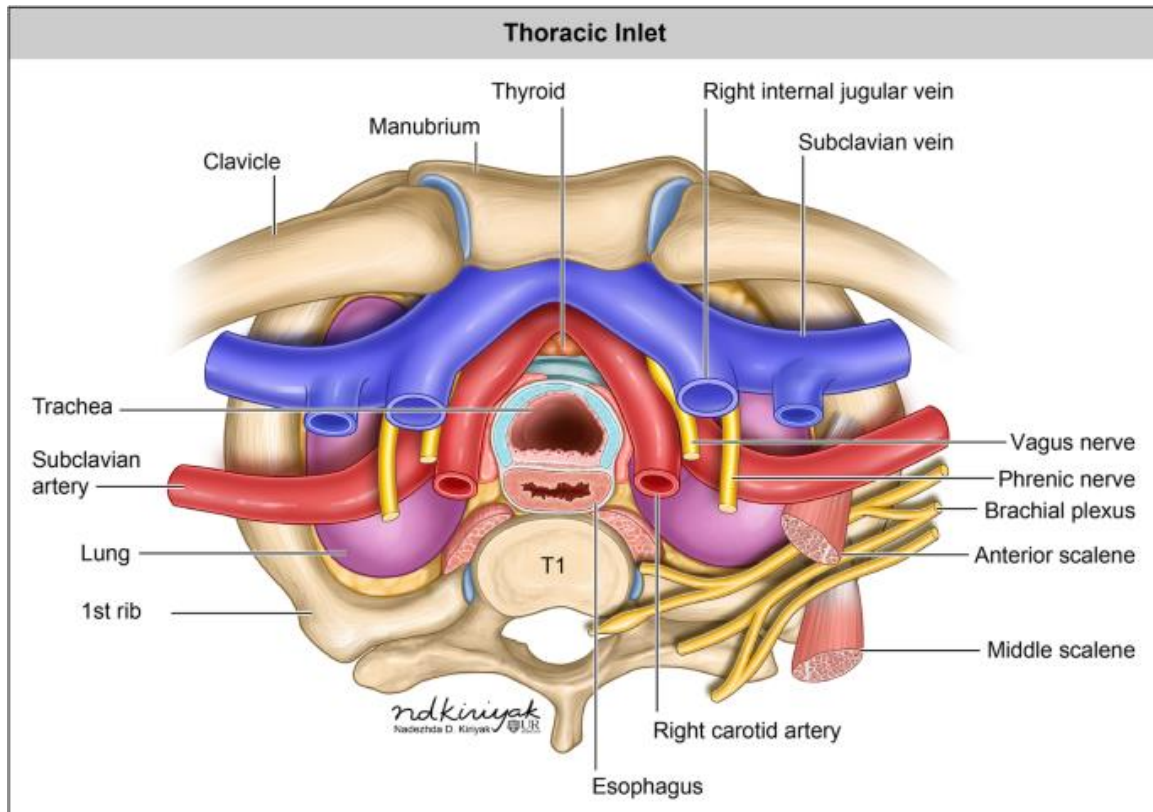
- **The thoracic cavity has:**
 - An inlet [narrow], continuous with the neck.
 - A cavity contains the lungs and mediastinal structures.
 - An outlet [broad], closed by the diaphragm

The thoracic inlet

*It is the upper opening of the thoracic cage which separating the thoracic cavity from the neck

*** Boundaries:**

1. Anteriorly: upper border of manubrium sterni which is called suprasternal or jugular notch.
2. Posteriorly: the body of first thoracic vertebra.
3. On either side: inner border of the first pair of ribs and their costal cartilage.



Boundaries of the thoracic inlet

*** Structures passing through the thoracic inlet:**

• Organs :

1. Oesophagus.
2. Trachea.
3. Apices of the right and left lungs, pleura and suprapleural membrane.

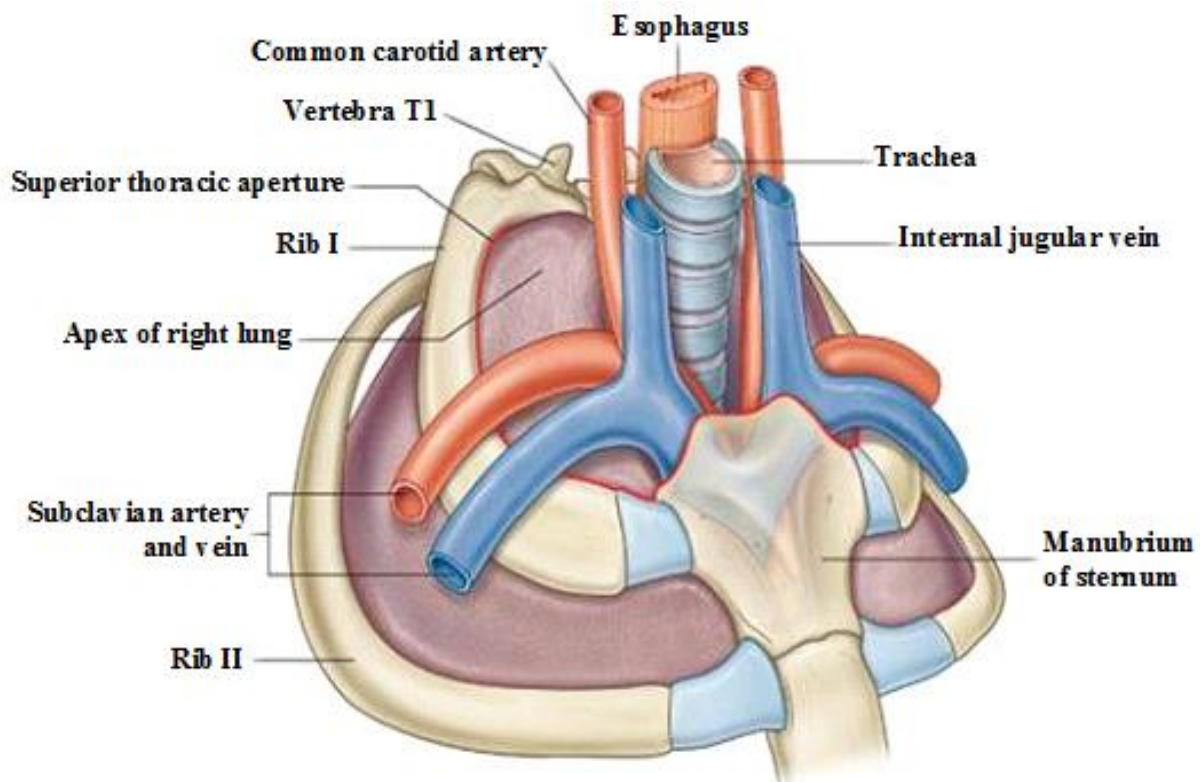
• Vessels

1. Right and left brachiocephalic veins.
2. Brachiocephalic artery.
3. Left common carotid artery.
4. Left subclavian artery.

5. Internal thoracic arteries.
6. Superior intercostal arteries.
7. Thoracic duct.

* Nerves

1. Phrenic nerves (right and left).
2. Vagus nerves (right and left) and their cervical cardiac branches.
3. Sympathetic chains (right and left) and their cervical cardiac branches.
4. Greater part of ventral ramus of T₁.
5. Left recurrent laryngeal nerve.

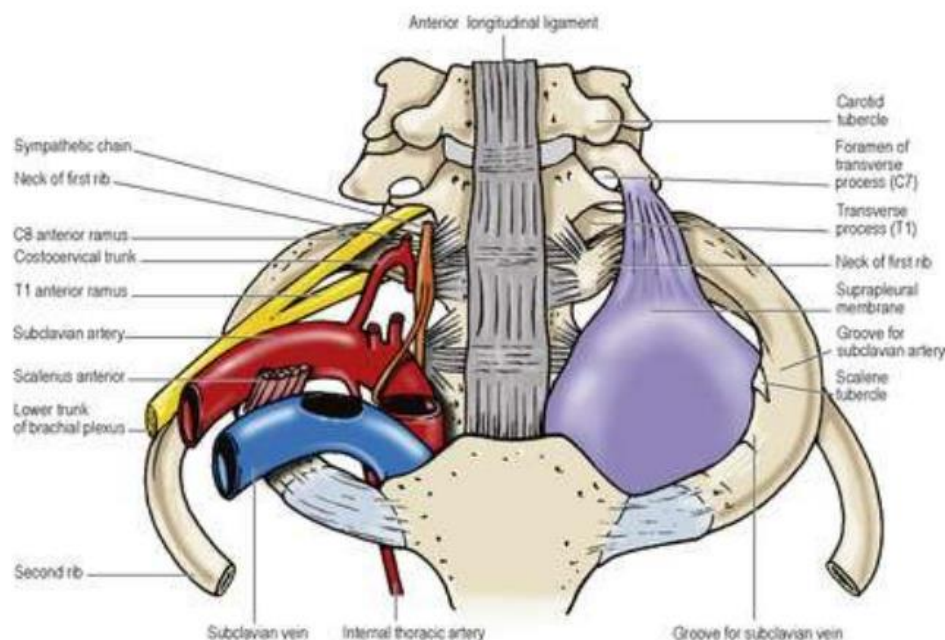


Supra pleural membrane

- Dense layer of fascia which closes the lateral part of thoracic inlet on each side.
- It is triangular in shape having an apex and a base.
- **Attachments:**
 - 1) **The apex:** posteriorly it is attached to transverse process of C7.
 - 2) **The base:** laterally it is attached to the medial border of the first rib and costal cartilage.

* **Function:**

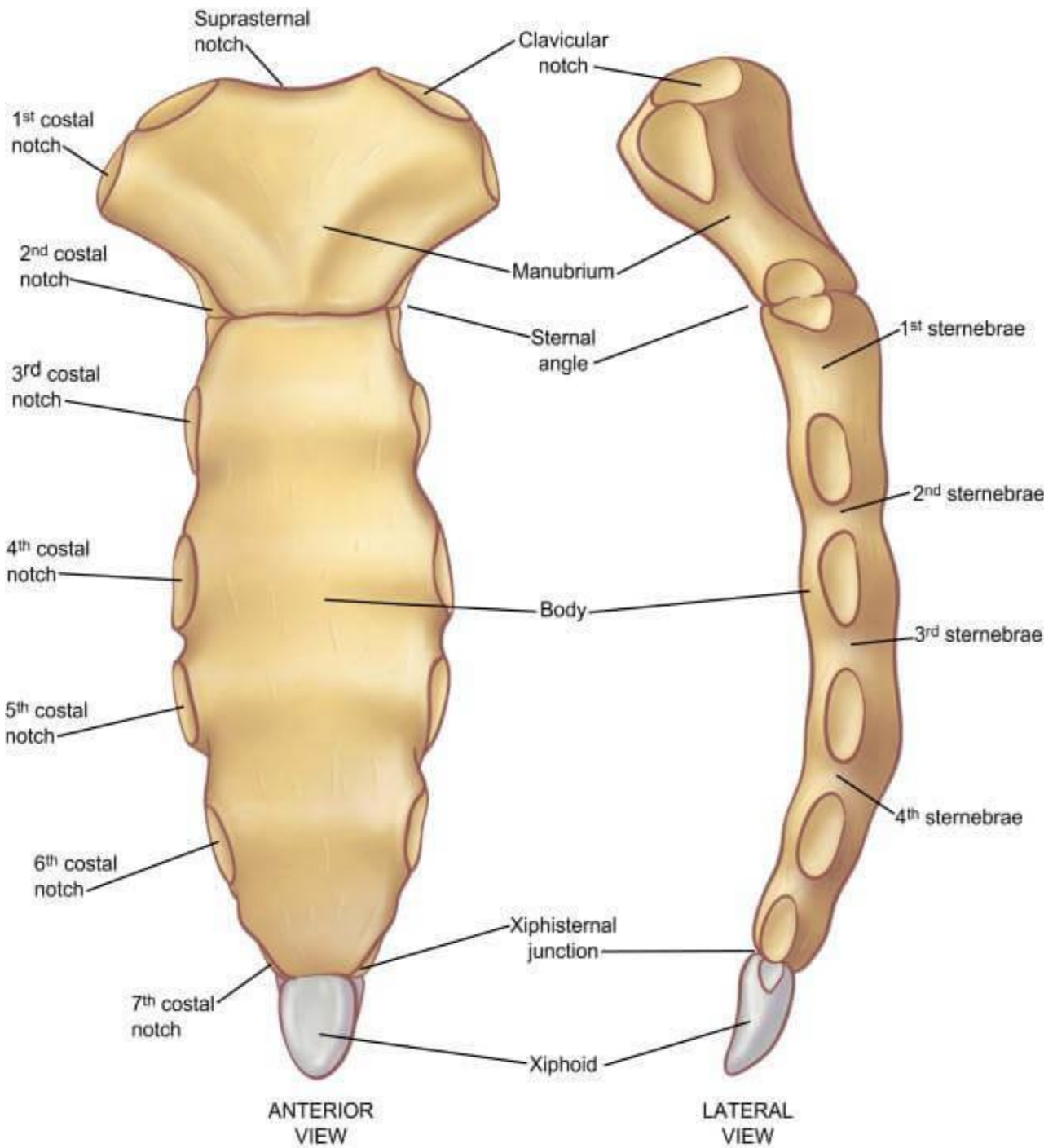
- 1- It **protects** the cervical pleura and apex of the lung.
- 2- It **prevents inward suction** of structures at root of neck during inspiration.
- 3- It **prevents upward bulging** of apex of lung during forcible expulsive expiration.



The thoracic outlet

- * It is the level separating the thoracic and abdominal cavities, and it is closed by the diaphragm.
- * **Boundaries :**
 - Xiphoid process in front .
 - Costal margin (lower 6 costal cartilages and 12th rib) on either side.
 - The body of the 12th thoracic vertebra and last pair of ribs behind.

The Sternum



* **Type:** It is a flat **dagger**-shaped bone

* **Function:**

a) Forms part of anterior wall of the thoracic cage.

b) Supports and articulates with the clavicle and upper 7 pairs of costal cartilage.

* **Parts:** it is formed of 3 parts:

I) Manubrium: (the handle of dagger), it has

- **Upper lateral angle** is called **clavicular notch** and it articulates with the medial end of the clavicle (**sterno-clavicular joint**).
- **Upper border:** jugular or suprasternal notch
- **Lower border:** is joined with the body to form manubrosternal angle or sternal angle of Louis [T4/T5]
- **2 lateral border** articulates with 1st costal cartilage and upper half of 2nd costal cartilage .

II) Body : (the largest part of the sternum)

- Lies opposite T₅ to T₉ .
- **Before puberty** It is formed of **4 pieces** [sternebrae] joined together by cartilage they fuse together at puberty.
- Its **posterior surface** is concave and smooth but its **anterior surface** is convex and rough and has three ridges between the four sternebrae.
- **Body articulates with** lower half of 2nd, 3rd, 4th, 5th, 6th, and half of 7th costal cartilages .

III) Xiphoid process: the smallest part of the sternum.

- It remains as cartilage till age of 40 years, then ossifies and fuses with the body.
- Xiphisternal joint: at the level of T₉

* **Posterior relation of the sternum:**

I) Manubrium :

- sternohyoid and sternothyroid muscles.
- Anterior border of pleurae and lungs on both sides.
- The left brachiocephalic vein is behind the **upper half** of manubrium and in front of the branches of aortic arch.
- The aortic arch is behind **lower half** and gives its three branches (Brachiocephalic , left common carotid & left subclavian) .

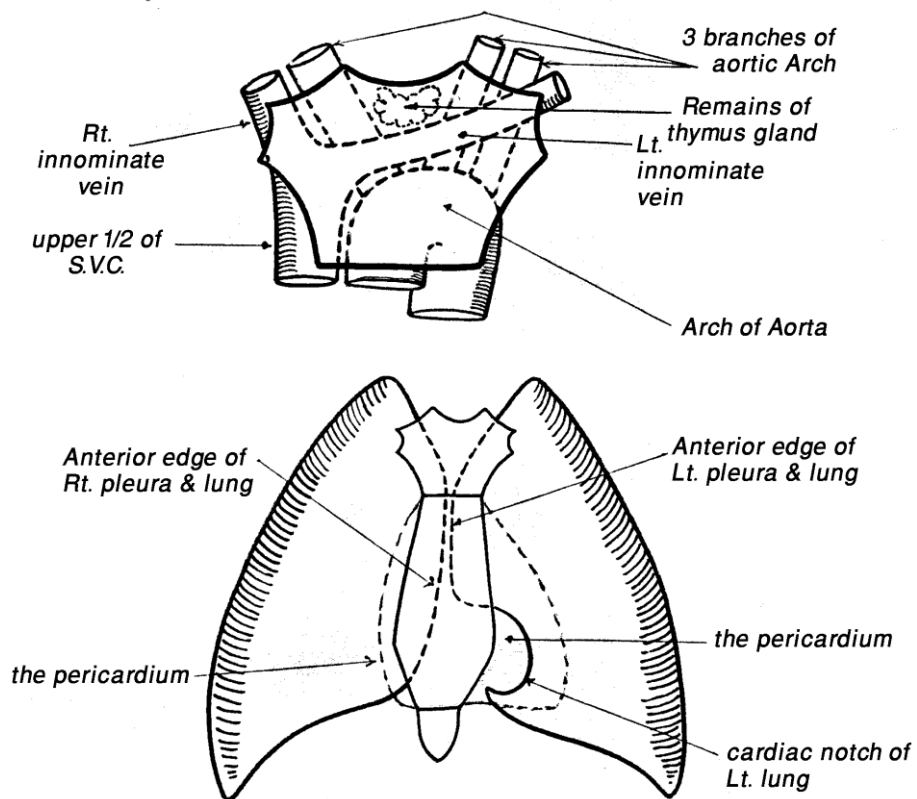
II) Body:

- sternocostalis muscle and sternopericardial ligament.
- Anterior border of pleurae and lungs except the lower half of the left side which is related to pericardium (cardiac notch).
- Remnant of thymus gland.

III) Xiphoid process :

- Sternal origin of diaphragm.
- Liver and falciform ligament.

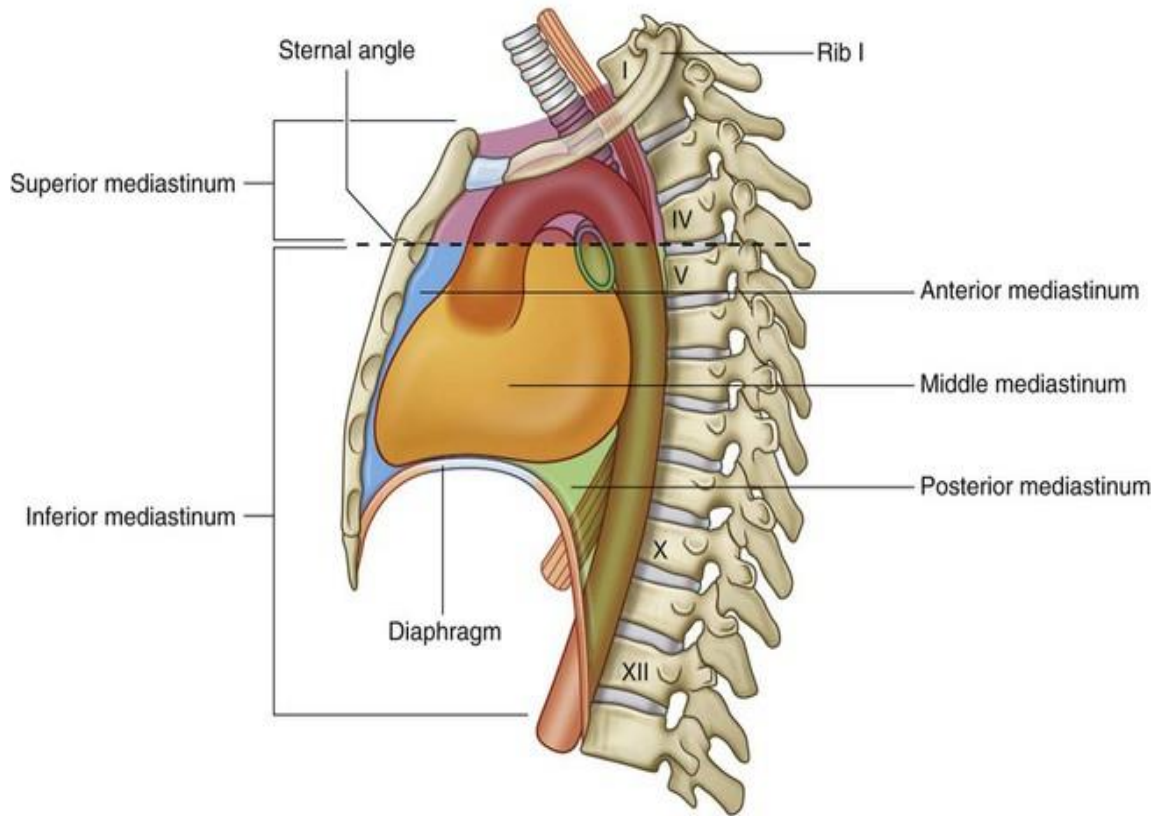
Direct posterior relations of the sternum



* **N.B.**

- In general to get the vertebral level approximately add two to the number of the rib articulating with the sternum .
- **Structures at the level of sternal angle of Louis:**
 - 1) End of ascending aorta
 - 2) Beginning and end of aortic arch
 - 3) Beginning of descending aorta
 - 4) End of trachea where it bifurcates
 - 5) End of pulmonary trunk where it divides.

- 6) Azygos vein joins the superior vena cava.
- 7) Thoracic duct reaches left side of the oesophagus.



* **Applied anatomy:**

- **Sternal puncture:** Under local anesthesia, a biopsy of bone marrow can be taken from the sternum using a wide bore needle [it is easy because the sternum is subcutaneous, has thin cortical bone and contains red marrow].

- Operation on the heart can be done by splitting the sternum in midline (**Sternotomy**).
- The manubrium can be split in the middle to reach the superior mediastinum in operations on **retrosternal goiter** .

Ribs (costo)

* **Number: 12 pairs** of ribs articulating with 12 thoracic vertebrae.

* **Classification**

A. According to their articulation with the sternum :

1. **True ribs:** vertebrosteral ribs: **upper 7 ribs.**

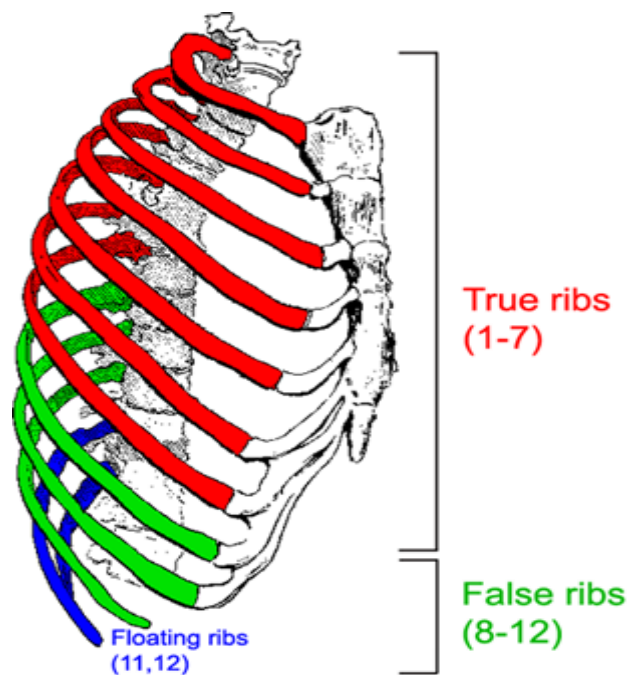
- Their costal cartilage articulates with the **sternum.**

2. **False ribs: lower 5 ribs**

- Their costal cartilage **don't articulate with the sternum** and they are 2 types:

a) **Vertebrochondral ribs** : the **8th, 9th and 10th**, their costal cartilage joins the **costal cartilage** of the rib above them.

b) **Floating** (vertebral) ribs: the **11th and 12th** [ribs] their costal cartilage ends in **abdominal** muscles.



B. According to their features:

1. **Typical ribs: 3rd to 9th** ribs have the **same features** and each **articulates** with **2** succeeding vertebrae .
2. **Atypical ribs: 1st, 2nd, 10th, 11th and 12th** ribs **differ** in one or more of their features .

Typical ribs (3rd to 9th)

* Each typical rib consists of **3 parts**:

a) Anterior or sternal end:

- **Cup-shaped** and articulates with costal **cartilage**.

b) Shaft: formed of

- Two **borders**: **upper** rounded and **lower** sharp.
- Two **surfaces**: **outer** convex and **inner** concave.
- A **costal groove**: present in the lower part of the **inner** surface and **contains** intercostal vein, artery and nerve.
- **The angle**: divides the shaft into **anterior 3/4** (flat from side to side) and **posterior 1/4** (cylinder).

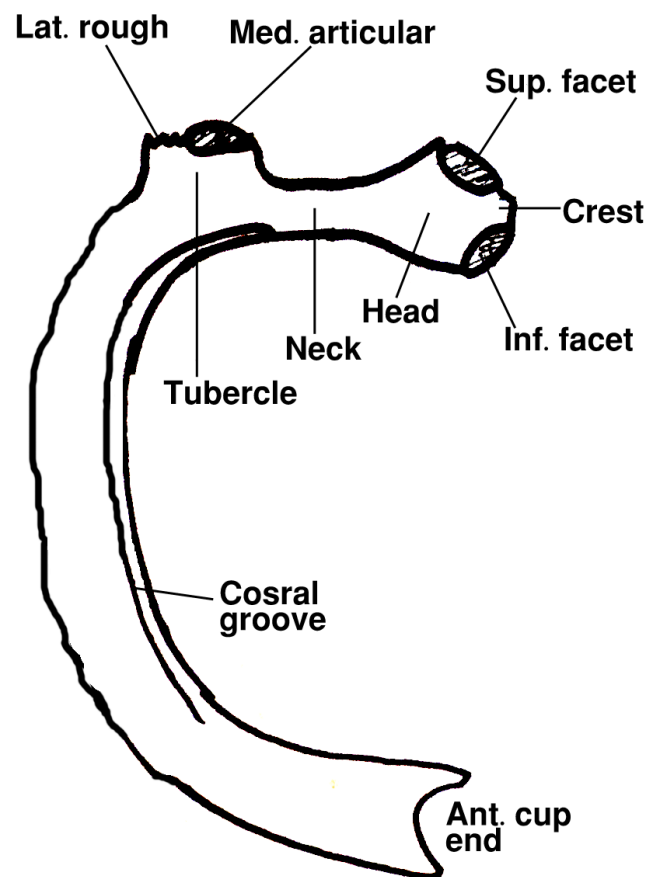
c) Posterior or vertebral end: formed of head, neck and tubercle:

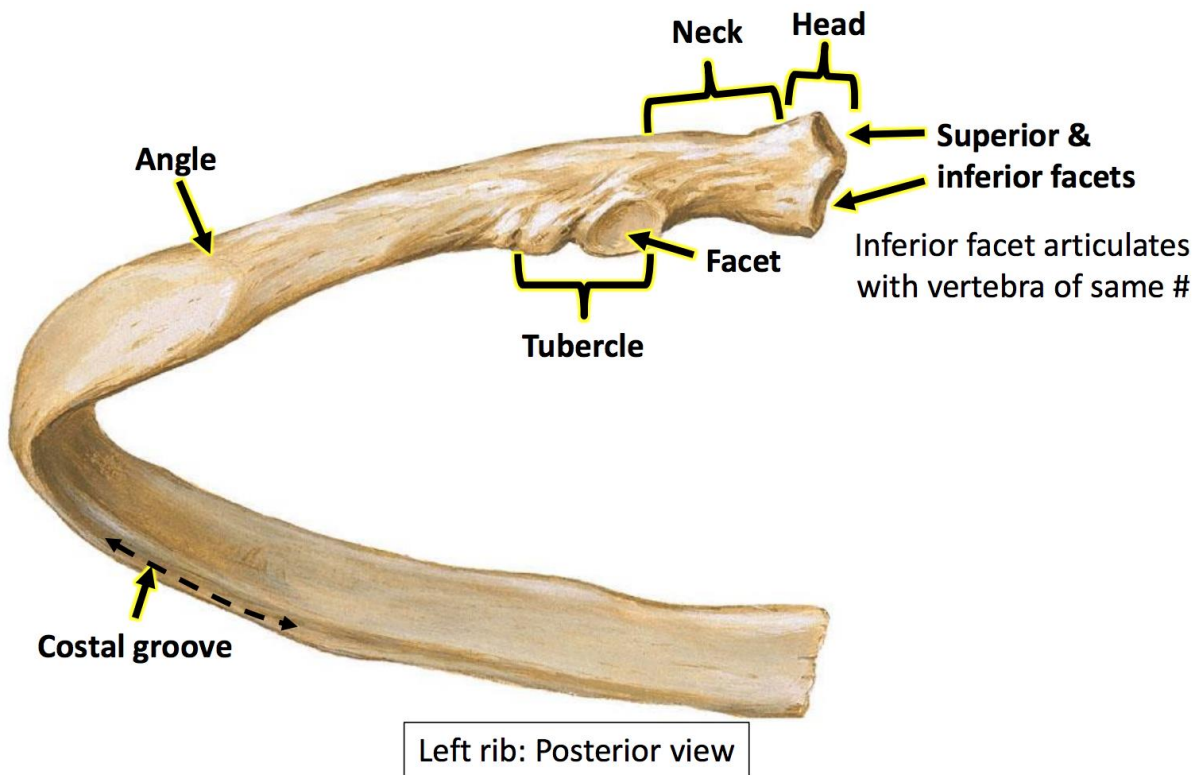
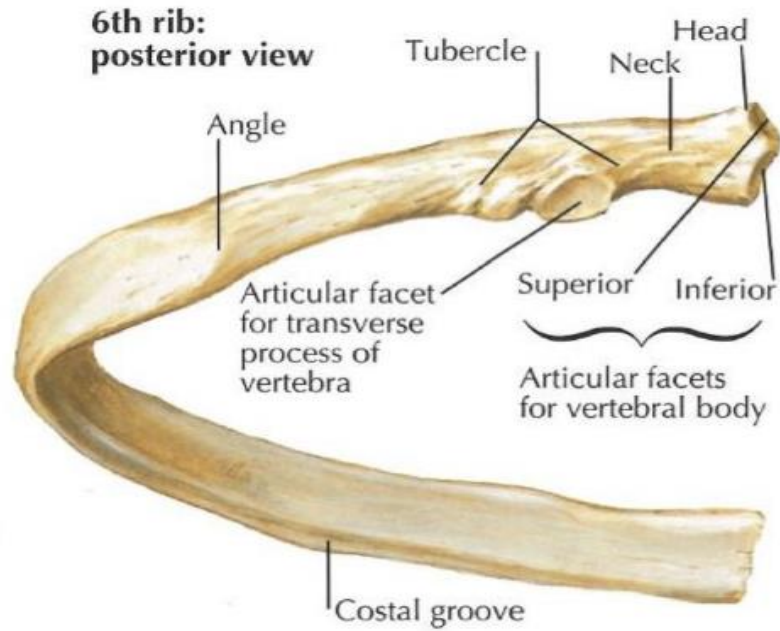
1. **Head**: has 2 facets separated by a crest.

- The **superior facet** articulates with **inferior demifacet** on the side of the body of the **vertebra above** it.
- The **inferior** facet articulates with the **superior demifacet** on the side of the body of the **corresponding** vertebra.

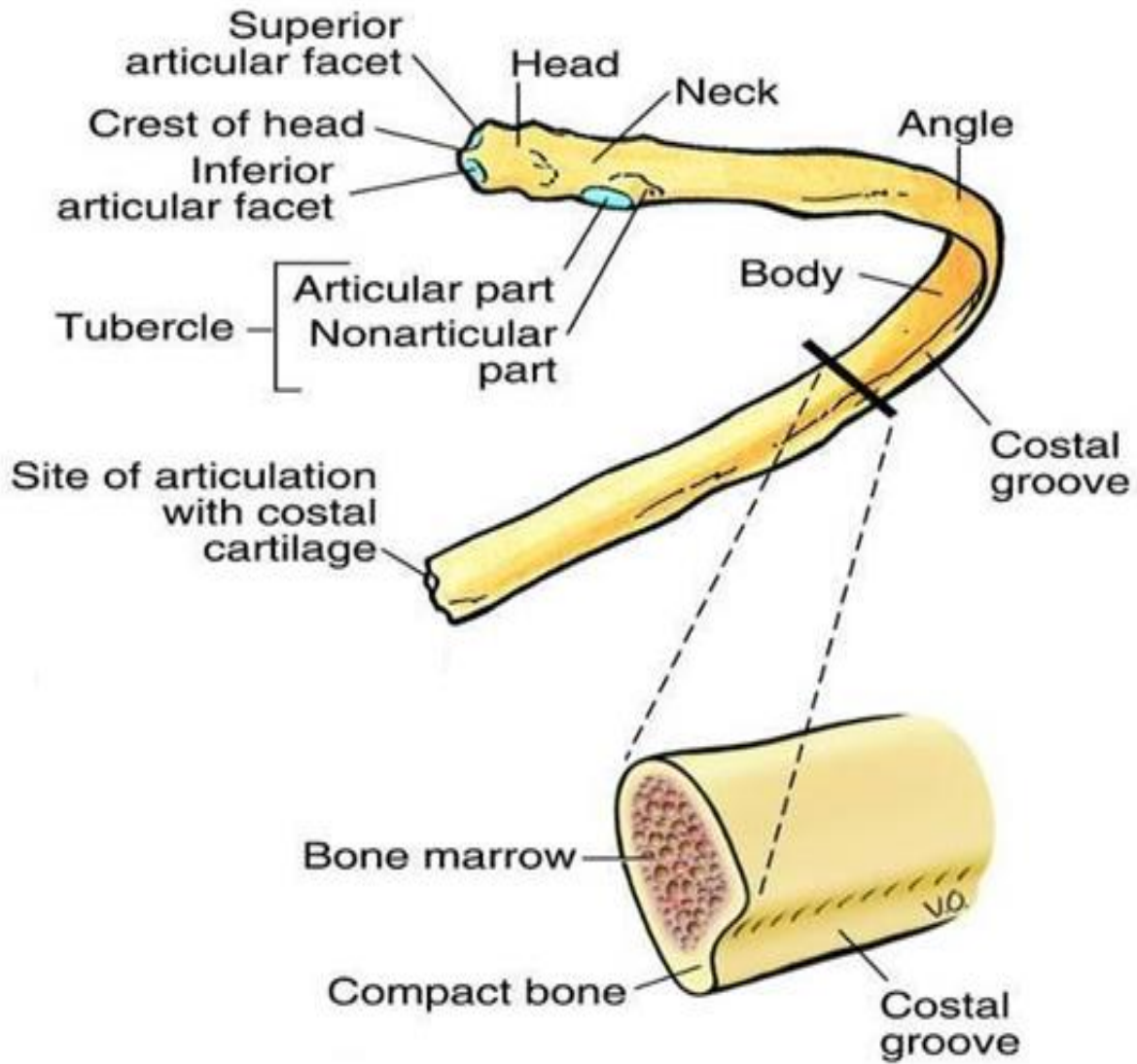
- The **crest** articulates with the intervertebral **disc**.
- 2. **Neck:** constricted part following the head.
- 3. **Tubercle:** formed of 2 parts :
 - A rough **lateral** non-articular part.
 - A smooth **medial** part, which **articulates** with the facet on the **transverse process** of the corresponding vertebra .

Typical ribs





General features of typical rib



* **Joints related to the rib:**

A) Joints of the anterior end:

1. **Sterno-costal joints** between sternum and upper 7 costal cartilages .
2. **Costochondral joints** between ribs and costal cartilages .
3. **Interchondral joints** between costal cartilages .

B) Joints of the posterior end:

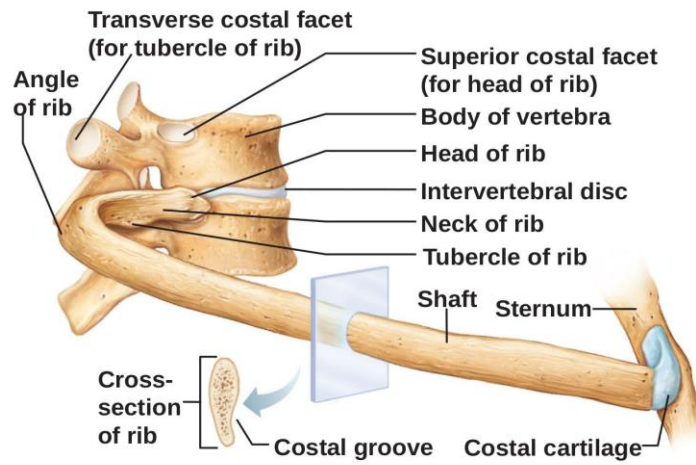
1. Costo-vertebral joints

- Between head of a typical rib and the corresponding vertebra and in the vertebra above and their intervertebral disc.
- The head of 1st, 10th , 11th and 12th ribs carries only one facet to articulate with the body of the corresponding vertebra only.

2. Costo- transverse joint:

- The smooth articular part of the **tubercle** of the rib articulates with the articular facet on the **transverse process** of the corresponding vertebra.
- The **11th and 12th** ribs carry **no** tubercles and therefore have no costo-transverse joints.

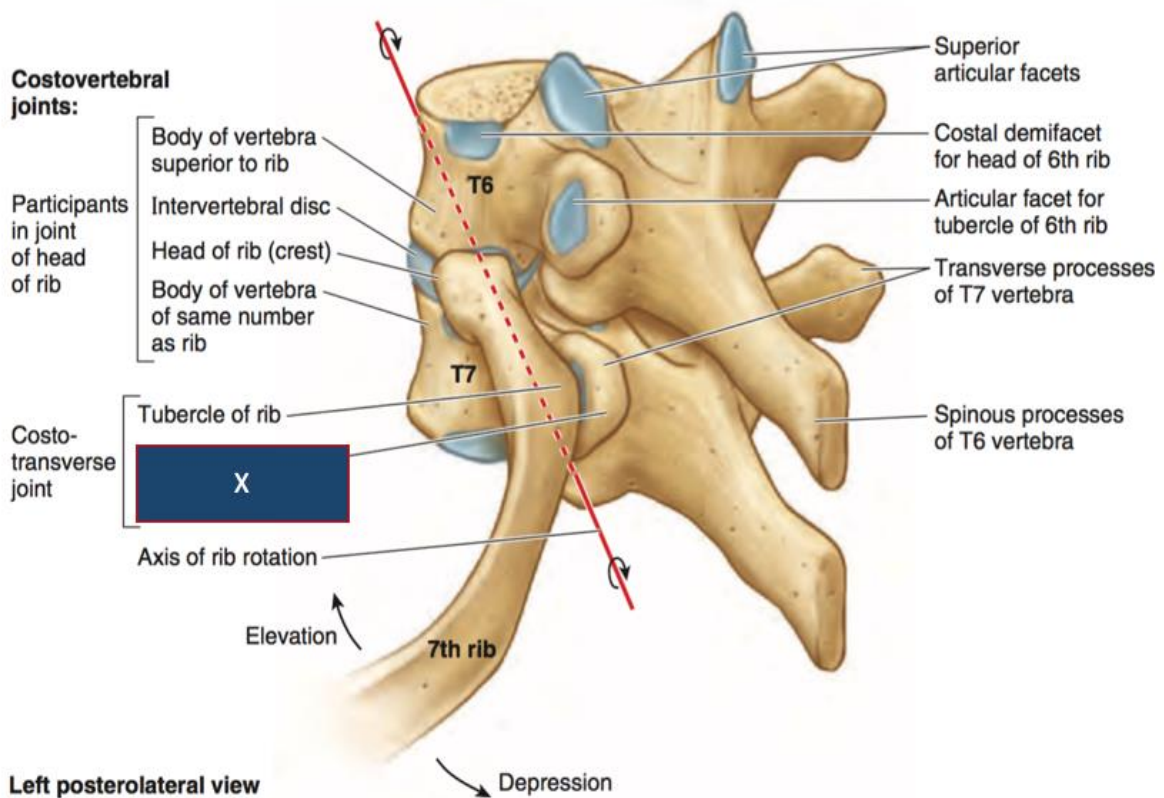
Articulations of typical rib



(a) Vertebral and sternal articulations of a typical true rib

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Figure 7.23a



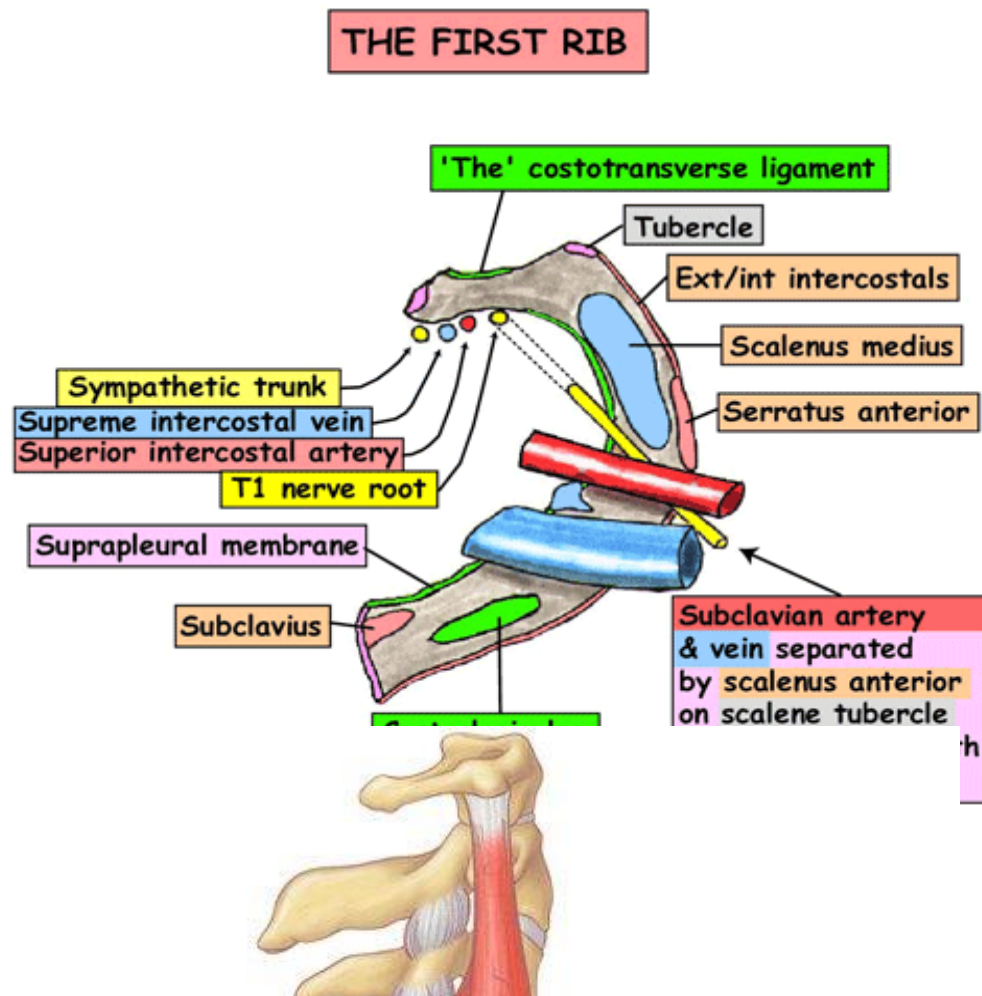
Joints of the posterior end of ribs

Atypical Ribs

(1,2 ,10,11& 12 ribs)

* 1st rib :

- It is the **highest**, strongest, flattest, most curved and most fixed.
- **Anterior end**: larger than any other ribs
- **Posterior end**:
 - Head has **one facet** for body of T₁.
 - **No angle**
 - The tubercle **coincides** with the angle
- The shaft has **two borders**; inner and outer and **two surfaces**; lower and upper, the lower surface is smooth.
- If the 1st rib is **correctly** placed on a table, both anterior end and head will **touch** its surface.



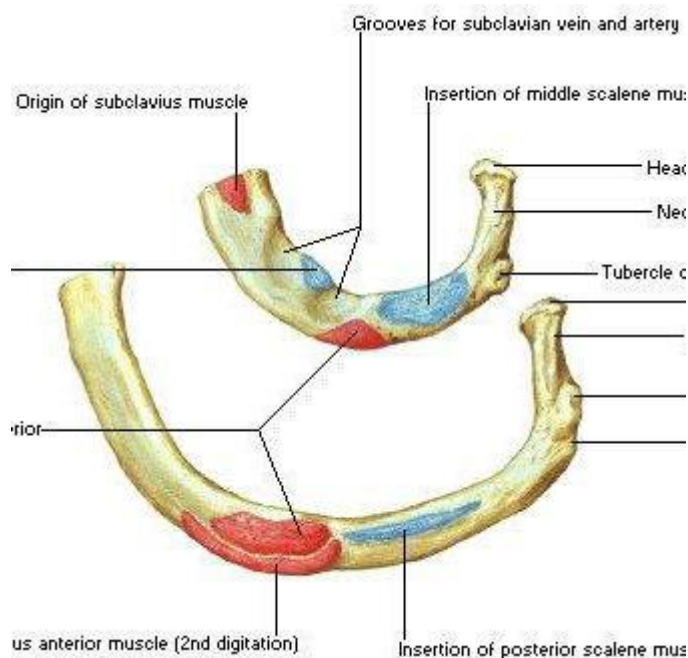
- The **upper surface** of the shaft presents:
 - 1) **Scalene tubercle** on the inner border for the insertion of the scalenus anterior muscle.
 - 2) Groove for **subclavian vein**, in front of the tubercle.
 - 3) Groove for **subclavian artery**, behind the tubercle, separated from the bone by the lower trunk of brachial plexus.
 - 4) An impression near the posterior part of the upper surface for the insertion of **scalenus medius** muscle.
 - 5) Origin of **subclavius muscle** near its costal cartilage.

- **Structures passing in front of the neck of the 1st rib:** arranged from medial to lateral:

- 1) Sympathetic chain
- 2) Superior intercostal vessels .
- 3) Anterior 1^{ry} ramus of T₁ nerve.

* **2nd rib:**

- Its **head** has two facets and a crest in between **as typical ribs**.
- **Twice** the length of the 1st rib.
- Its **costal groove** isn't well developed.
- In the **middle** of its outer surface is a **rough tubercle** for serratus anterior muscle, **behind it** scalenus posterior muscle is inserted.
- The **shaft** is not twisted. Its surfaces are not outer and inner, or upper and lower but **in an intermediate position**.



* **10th rib:**

- Usually have only **one facet** i.e. Like 11th rib.
- Its **tubercle** is small and may or may not have an articular facet.

* **11th rib:**

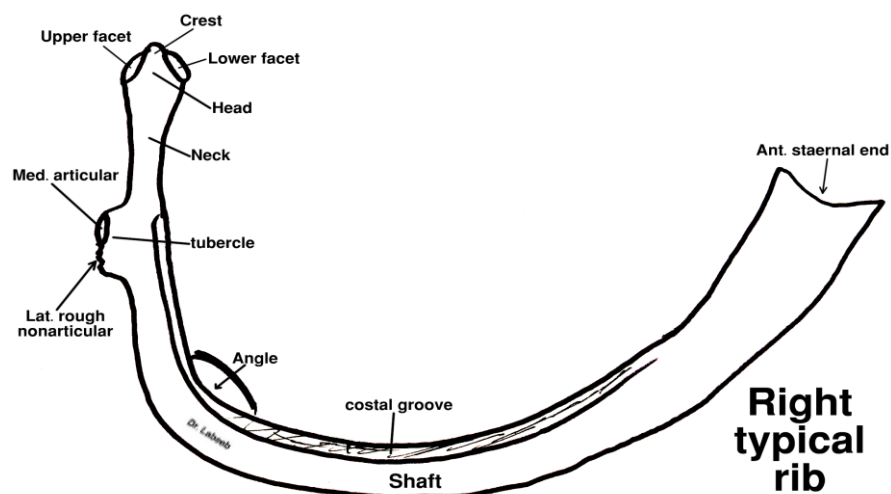
- **Head** is large, rounded, has one facet [for the pedicle of T₁₁]
- Longer than 12th. rib .
- **No** neck, no tubercle, **slight** angle and costal groove is poorly developed.

* **12th rib:**

- Short and has narrow pointed **anterior end**.
- **Head** is large, rounded, has one facet [for the pedicle of T₁₂]
- **No** neck, no tubercle, no angle and no costal groove.

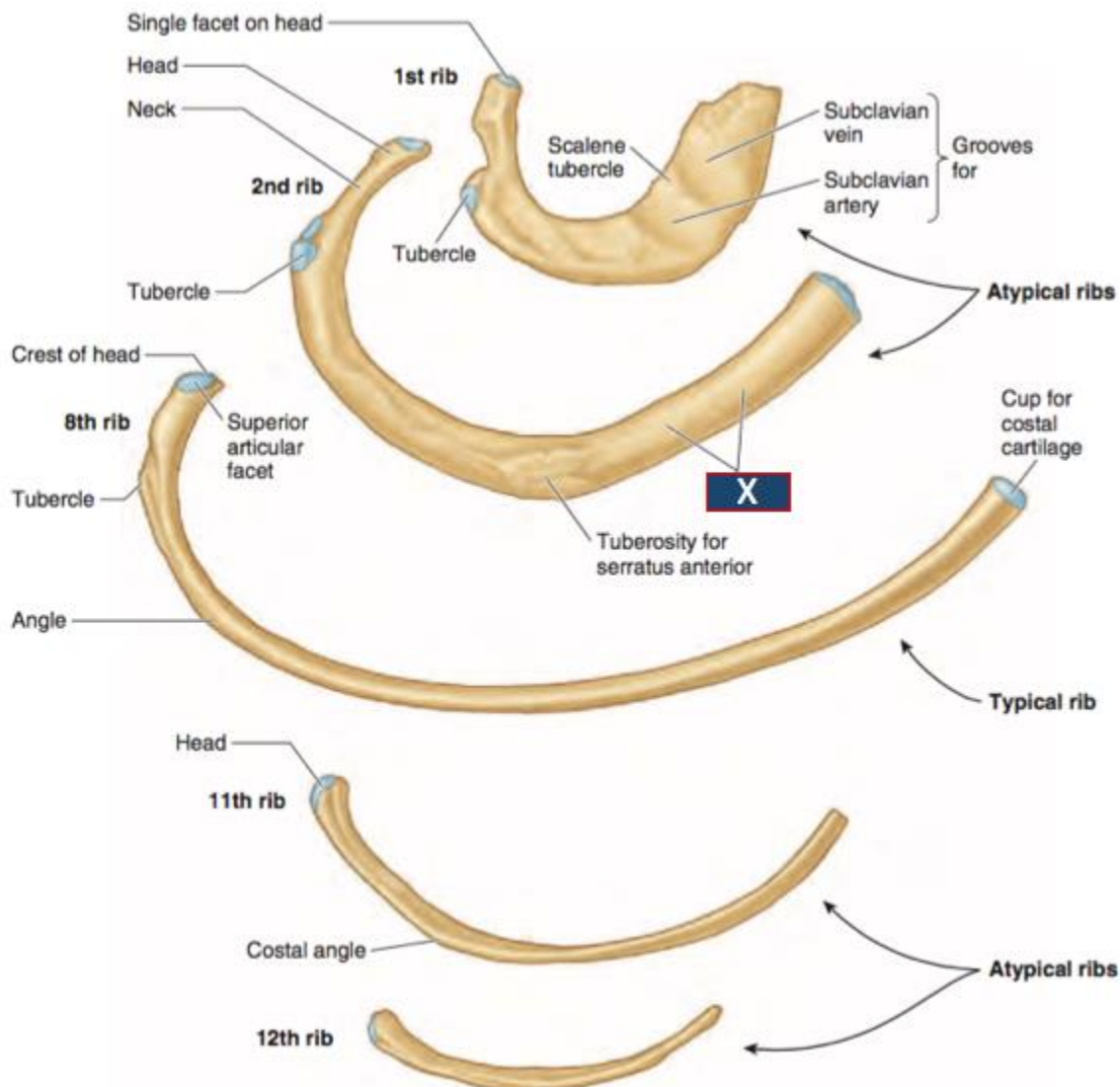
* **Identification of the side of the rib (right or left):**

- Head located **posteriorly** and costal cartilage located **anteriorly**.
- Shaft is convex **laterally** and concave **medially**.
- **Upper border** is rounded and the **lower border** is sharp.
- **Intercostal groove** lies near the lower border on the inner surface.



* **Identification of the number of a given rib:**

- **Exclude** the 1st, 11th and 12th ribs by their particular features.
- If it isn't one of the above, **put the inferior border** of the rib on a flat surface, if it **rests** → **2nd rib**.
- If it **doesn't rest** it's either **typical rib** or the **10th** to differentiate look for the **facets on the head**:
 - If **one** → 10th rib
 - If **two** → typical rib.



* **Important points:**

- The 1st and last ribs are **difficult to palpate**.
- To **count the ribs**, we begin from the 2nd rib at its attachment to the **sternal angle** of Louis.
- Each **intercostal space** lies below its corresponding rib.
- The **anterior end** of each rib is lower than its posterior end.
- **Direction of costal cartilages:**
 - The 1st, 11th and 12th are directed **downward**.
 - 2nd costal cartilage is **horizontal**.
 - The other costal cartilages are directed **up**.
- **Length:** ribs increase in length from 1st to 7th . (The longest rib and costal cartilage is the 7th)
- The **8th** rib is the **most lateral** i.e. the transverse diameter of thorax increases from 1st to 8th rib.
- The **9th** rib is the **most oblique** i.e. Obliquity increases from 1st to 9th rib.
- The **10th** rib is the **lowest rib** when we look anteriorly.
- The tip of **11th** costal cartilage is the **lowest costal cartilage**.

* **Applied anatomy:**

1) Cervical rib:

- It's an abnormal additional rib attached to the 7th cervical vertebra.

- It's important clinically because it may cause compression of the neurovascular bundle supplying the upper limb .

2) Fracture of ribs:

- **In children:** rare because the ribs are elastic.
- **In adults:**
 - The **upper two and lower two** ribs are difficult to fracture; the upper two being protected by the clavicle and the lower two being floating.
 - In **indirect trauma** , the ribs fracture at their **angles**.
 - **Direct trauma** to the ribs leading to fracture at the site of trauma.
 - Fracture rib may lead to injury of the intercostal vessels and nerve leading to severe pain .
 - **Flail chest:** if multiple ribs are fractured, at two sites, the flail segment show paradoxical movements during respiration leading to **respiratory failure** and death. **Immediate fixation** of the flail segment is essential to save life of the patient.

3) Subperiosteal rib resection:

- Stripping of the outer periosteum of the rib with excision of a segment of the rib to enter the cavity of the thorax .
- After the operation , the missing piece of the rib regenerate from the intact periosteum .

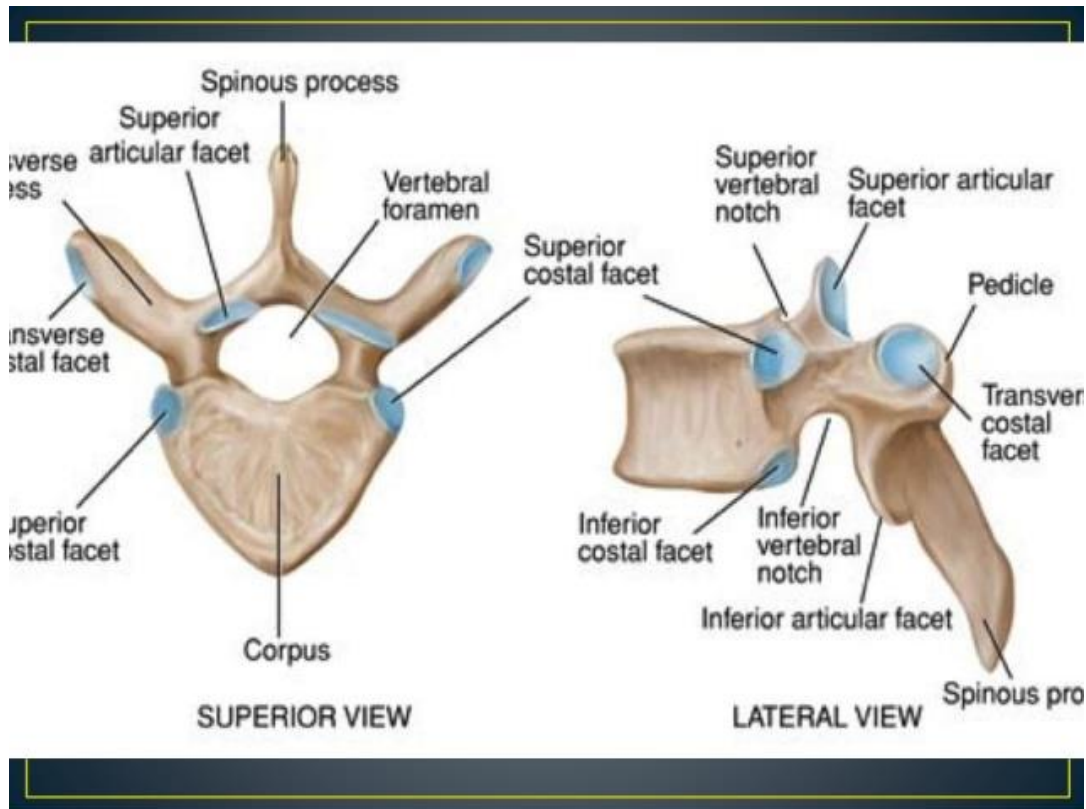
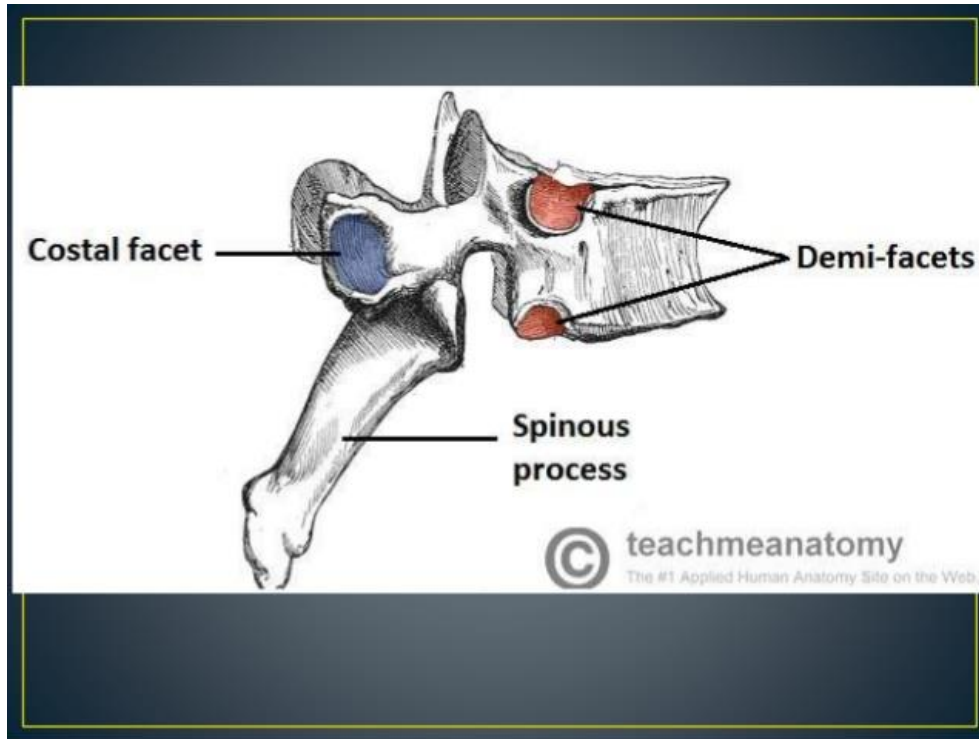
Thoracic vertebrae

- * They are 12 vertebrae articulate with 12 pairs of ribs.
- * **Classification: they are classified into:**
 1. **Typical thoracic vertebrae:** which have the same features (2-8 thoracic vertebrae)
 2. **Atypical thoracic vertebrae:** This differs from typical vertebrae in one or more features (1, 9,10, 11 and 12 thoracic vertebrae)

Typical thoracic vertebrae

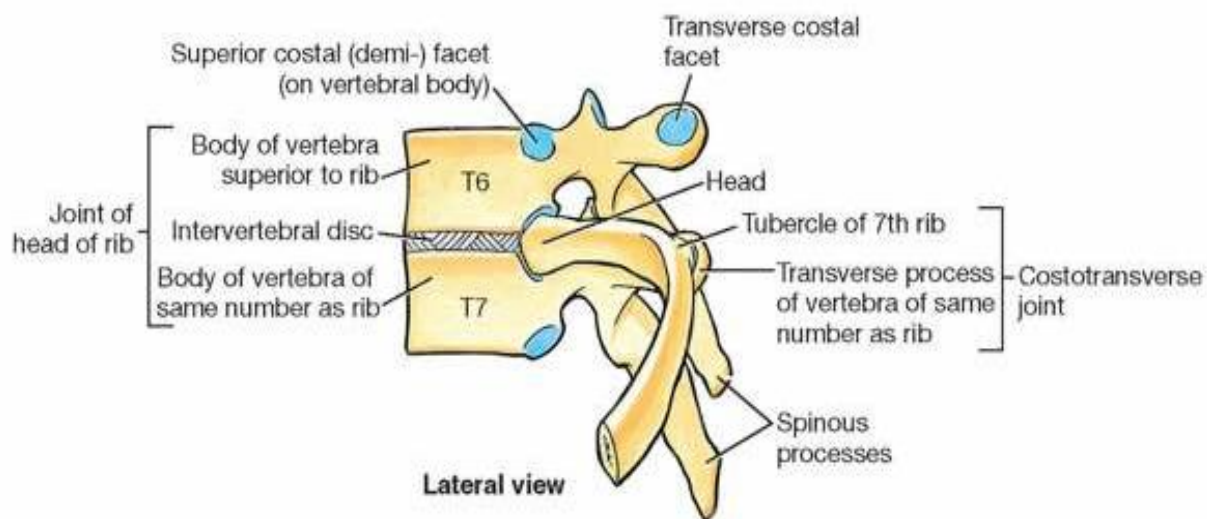
(from 2nd to 8th)

- * **Characteristics:**
 - a. **Body:**
 - Medium sized & heart-shaped .
 - It carries superior and inferior costal demifacets for articulation with heads of ribs.
 - b. **Transverse processes:**
 - Have no foramina (like the cervical vertebrae), carries costal facets for articulation with tubercle of corresponding ribs.
 - c. **Spine:**
 - Long, pointed and directed downwards & backwards.
 - d. **Vertebral canal:**
 - Small and circular.



Typical thoracic vertebrae (2-8)

Articulation of the rib with the thoracic vertebrae



Atypical thoracic vertebrae

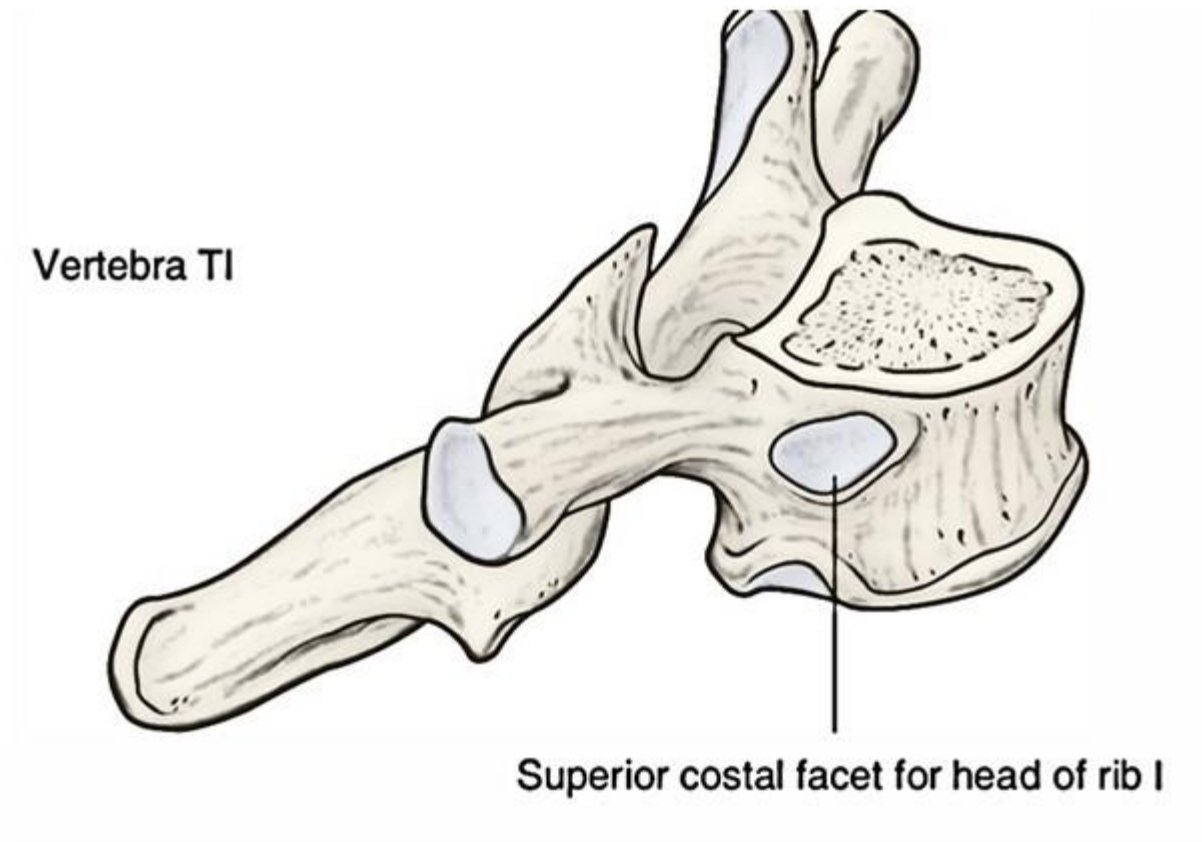
(1st, 9th, 10th, 11th and 12th)

* **The 1st thoracic vertebra (T₁)** has:

1. **One complete superior** circular facet on the body for the head of the **1st rib**.
2. One very **small inferior demi-facet** on the body for the **2nd rib**.
3. The **spine** is **long** and nearly **horizontal**.
4. A costal facet on **transverse process** for the tubercle of the 1st rib.

* **The 9th thoracic vertebra (T₉)** :

- It has one **superior demifacet** for the inferior facet on the head of the **9th rib** .
- It has no inferior demifacet .

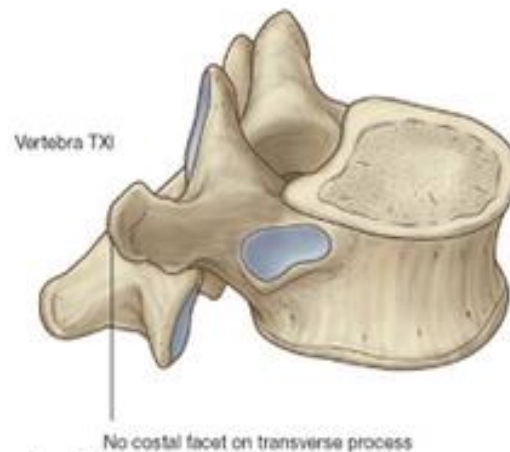
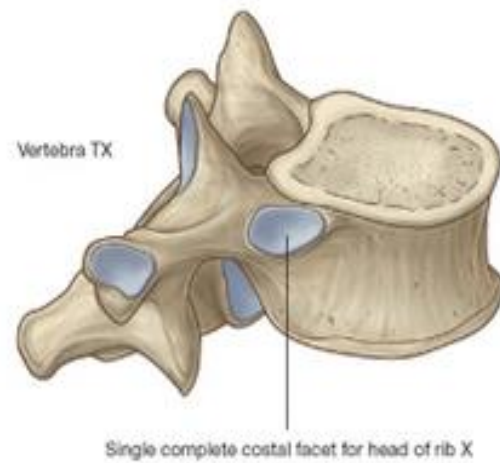
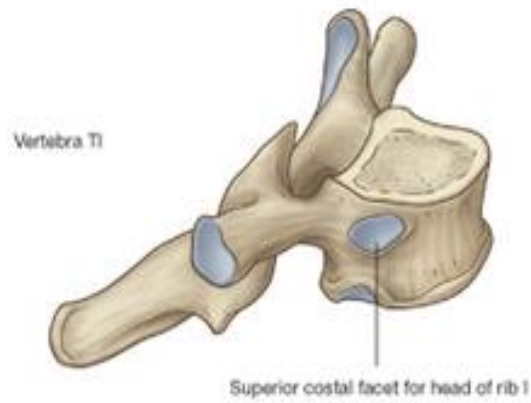


* **The 10th thoracic vertebra (T₁₀) has:**

1. One **complete facet on the body** for the head of the 10th rib.
2. **No inferior demi-facet** on the body.
3. **Small costal facet** usually present on **transverse process**.

* **The 11th thoracic vertebra (T₁₁) has:**

1. One **complete circular facet** on the **side of the body** for head of the 11th rib.
2. **No costal facet** on the **transverse process**.



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Typical thoracic vertebrae.

* The 12th thoracic vertebra (T₁₂) has:

1. **Broad body and lamina and short spine.**
2. One **complete facet** on the side of the body and **encroaching on the pedicle** for articulation with the head of the 12th rib.
3. **No costal facet on transverse process.**
4. The **inferior articular** processes face **laterally** (as the lumbar vertebrae).

Atypical thoracic vertebrae

