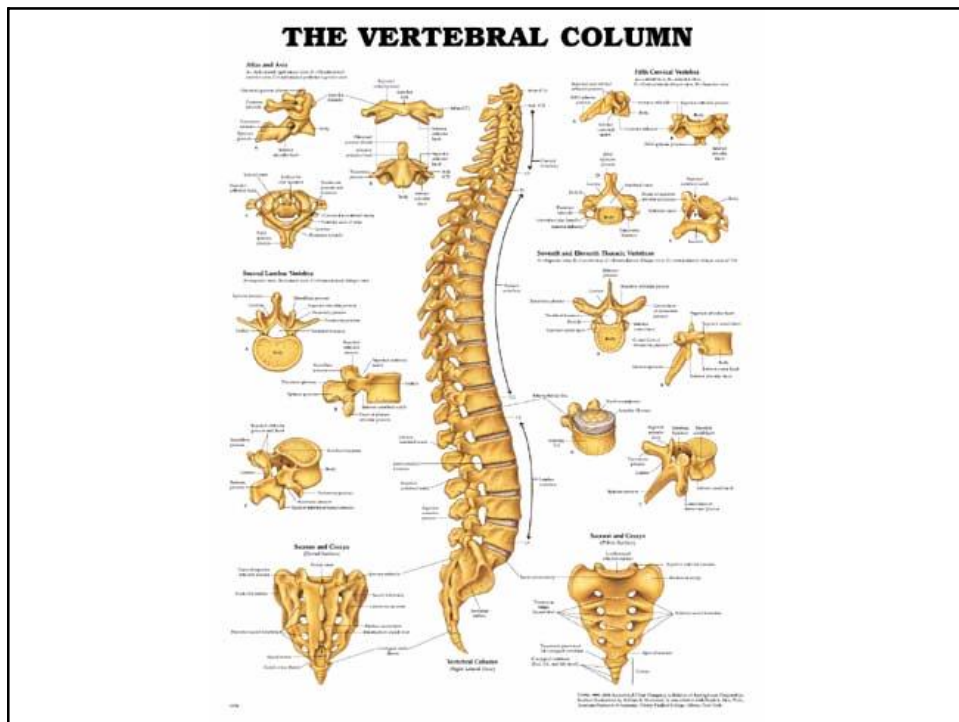
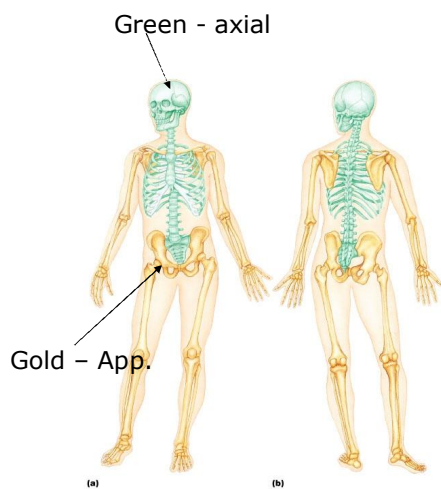


<http://www.getbodysmart.com/ap/skeletalsystem/skeleton/axial/vertebrae/atlas/animation.html>

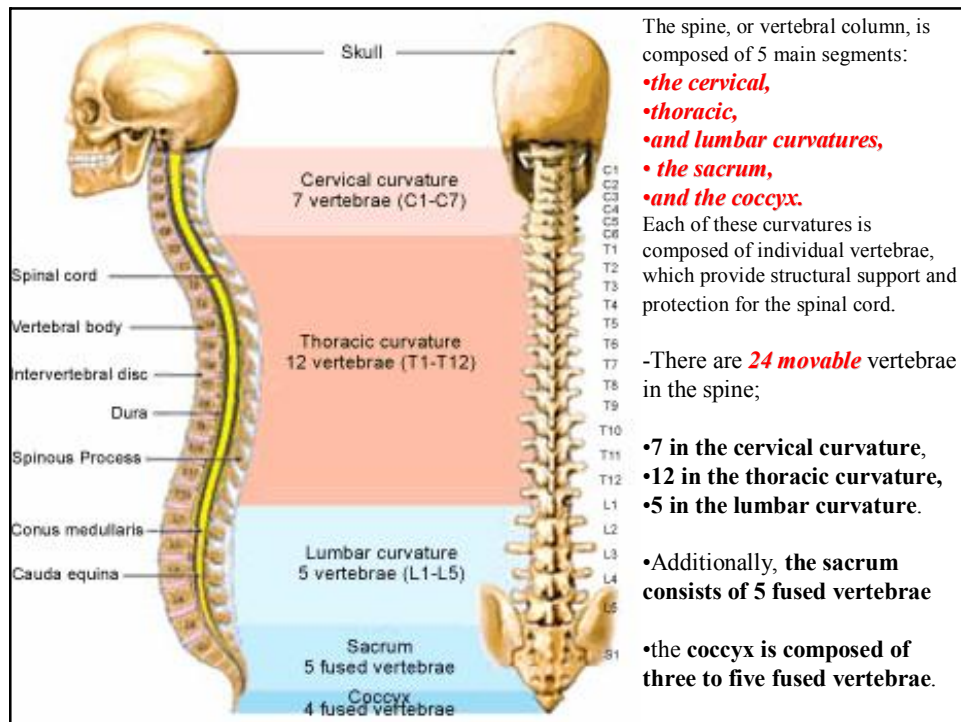


## Axial v. Appendicular Skeleton



- Axial Skeleton
  - Skull
  - Vertebral column
  - Thoracic cage
    - Ribs and sternum
- Appendicular Skeleton
  - Bones of the upper and lower limbs
  - Plus, pectoral and pelvic girdles

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### Regions of Vertebral Column

Cervical	7
Thoracic	12
Lumbar	5
Sacral	5 fused
Coccygeal	4 fused

**Lordosis**

**Kyphosis**

**Lordosis**

**lordosis**

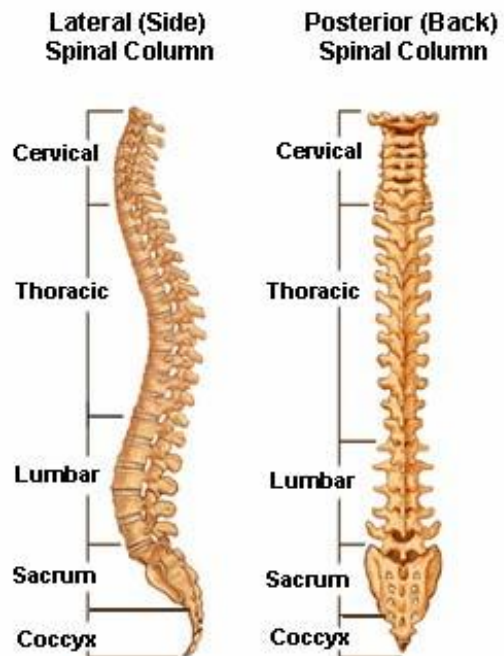
The spine provides attachment for our ribs, muscles and ligaments which make up the trunk.

It is divided into 3 regions:

Neck (cervical)	7 vertebrae
Thoracic	12 vertebrae
Lumbar	5 vertebrae

The four curves function to:

- a.increase the strength of the spine
- b.help maintain balance in the upright position
- c.absorb shocks from walking and jumping
- d.help protect the spine from fracture.



The **vertebral column** (also called the backbone, spine, or spinal column)

consists of a series of 33 irregularly shaped bones, called vertebrae.

These 33 bones are divided into five categories depending on where they are located in the backbone.

The first seven vertebrae are called the cervical vertebrae. Located at the top of the spinal column, these bones form a flexible framework for the neck and support the head.

The first cervical vertebrae is called the atlas and the second is called the axis.

**The atlas' shape allows the head to nod "yes" and the axis' shape allows the head to shake "no".**

The next twelve vertebrae are called the thoracic vertebrae.

These bones move with the ribs to form the rear anchor of the rib cage.

Thoracic vertebrae are larger than cervical vertebrae and increase in size from top to bottom.

After the thoracic vertebrae, come the lumbar vertebrae.

These five bones are the largest vertebrae in the spinal column. These vertebrae support most of the body's weight and are attached to many of the back muscles.

The sacrum is a triangular bone located just below the lumbar vertebrae.

It consists of four or five sacral vertebrae in a child, which become fused into a single bone after age 26.

The sacrum forms the back wall of the pelvic girdle and moves with it.

The bottom of the spinal column is called the coccyx or tailbone.

It consists of 3-5 bones that are fused together in an adult.

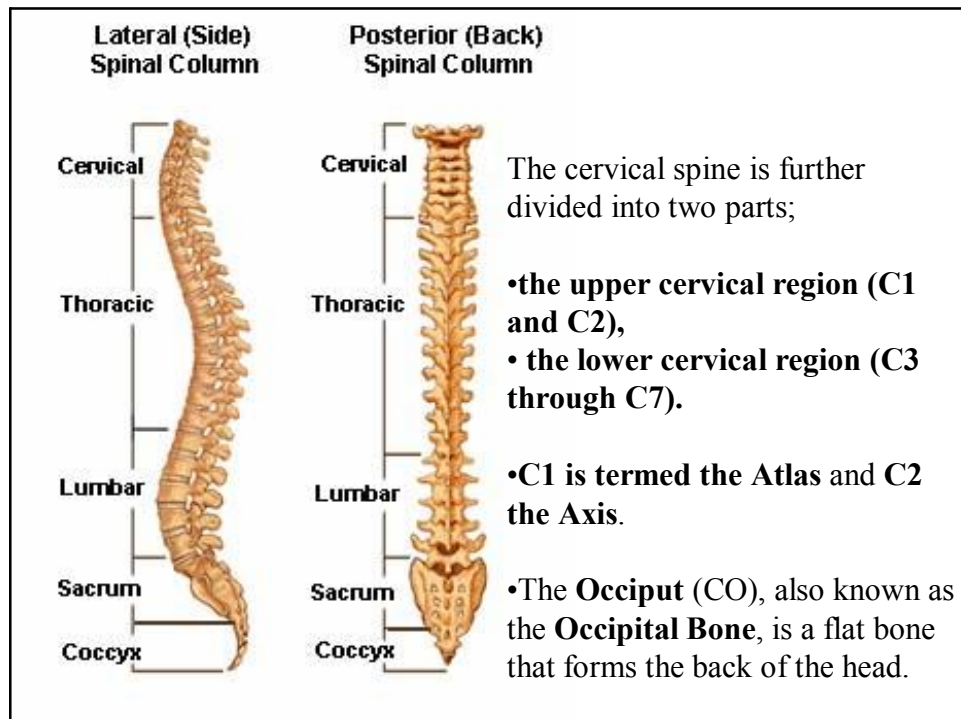
Many muscles connect to the coccyx.

These bones compose the vertebral column, resulting in a total of 26 movable parts in an adult. In between the vertebrae are **intervertebral discs** made of fibrous cartilage that act as shock absorbers and allow the back to move. As a person ages, these discs compress and shrink, resulting in a distinct loss of height (generally between 0.5 and 2.0cm) between the ages of 50 and 55.

When looked at from the side, the spine forms four curves.

- These curves are called the cervical, thoracic, lumbar, and pelvic curves.
- The **cervical curve** is located at the top of the spine and is composed of cervical vertebrae. Next come the **thoracic** and **lumbar curves** composed of thoracic and lumbar vertebrae respectively.
- The final curve called the **pelvic or sacral curve** is formed by the sacrum and coccyx. These curves allow human beings to stand upright and help to maintain the balance of the upper body. The cervical and lumbar curves are not present in an infant. The cervical curves forms around the age of 3 months when an infant begins to hold its head up and the lumbar curve develops when a child begins to walk.

In addition to allowing humans to stand upright and maintain their balance, the vertebral column serves several other important functions. It helps to support the head and arms, while permitting freedom of movement. It also provides attachment for many muscles, the ribs, and some of the organs and protects the spinal cord, which controls most bodily functions.



Functions of the Vertebral or Spinal Column Include:	
<b>Protection</b>	<ul style="list-style-type: none"> <li>•Spinal Cord and Nerve Roots</li> <li>•Many internal organs</li> </ul>
<b>Base for Attachment</b>	<ul style="list-style-type: none"> <li>•Ligaments</li> <li>•Tendons</li> <li>•Muscles</li> </ul>
<b>Structural Support</b>	<ul style="list-style-type: none"> <li>•Head, shoulders, chest</li> <li>•Connects upper and lower body</li> <li>•Balance and weight distribution</li> </ul>
<b>Flexibility and Mobility</b>	Flexion (forward bending) <ul style="list-style-type: none"> <li>•Extension (backward bending)</li> <li>•Side bending (left and right)</li> <li>•Rotation (left and right)</li> <li>•Combination of above</li> </ul>
<b>Other</b>	<ul style="list-style-type: none"> <li>•Bones produce red blood cells</li> <li>•Mineral storage</li> </ul>

A typical vertebra has the following structural features:

- i. **body**
- ii. **vertebral arch**, which consists of:
  - a. two **pedicles**
  - b. two **laminae**
- iii. 7 processes:
  - a. two **transverse processes**
  - b. one **spinous process (spine)**
  - c. two **superior articular processes** with **facets**
  - d. two **inferior articular processes** with **facets**

## Cervical Vertebrae

- Seven vertebrae (C<sub>1</sub>-C<sub>7</sub>) are the smallest, lightest vertebrae
- C<sub>3</sub>-C<sub>7</sub> are distinguished with an oval body, short spinous processes, and large, triangular vertebral foramina
- Each transverse process contains a transverse foramen

## Cervical Vertebrae

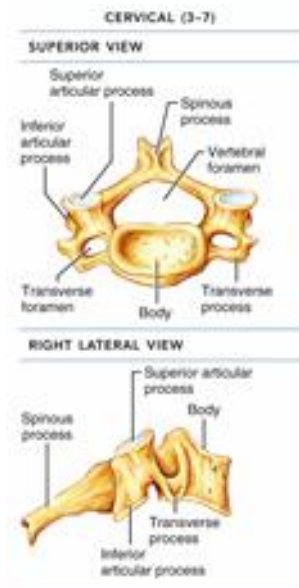


Table 7.2.2



## Cervical Vertebrae: The Atlas (C<sub>1</sub>)

- The atlas has no body and no spinous process
- It consists of anterior and posterior arches, and two lateral masses
- The superior surfaces of lateral masses articulate with the occipital condyles

## Cervical Vertebrae: The Atlas (C<sub>1</sub>)

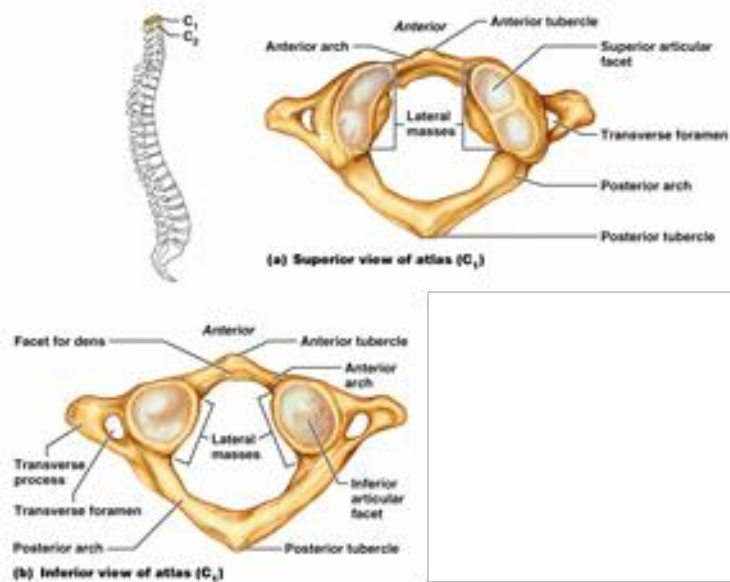


Figure 7.16a, b

## Cervical Vertebrae: The Axis (C<sub>2</sub>)

- The axis has a body, spine, and vertebral arches as do other cervical vertebrae
- Unique to the axis is the dens, or odontoid process, which projects superiorly from the body and is cradled in the anterior arch of the atlas
- The dens is a pivot for the rotation of the atlas

## Cervical Vertebrae: The Axis (C<sub>2</sub>)

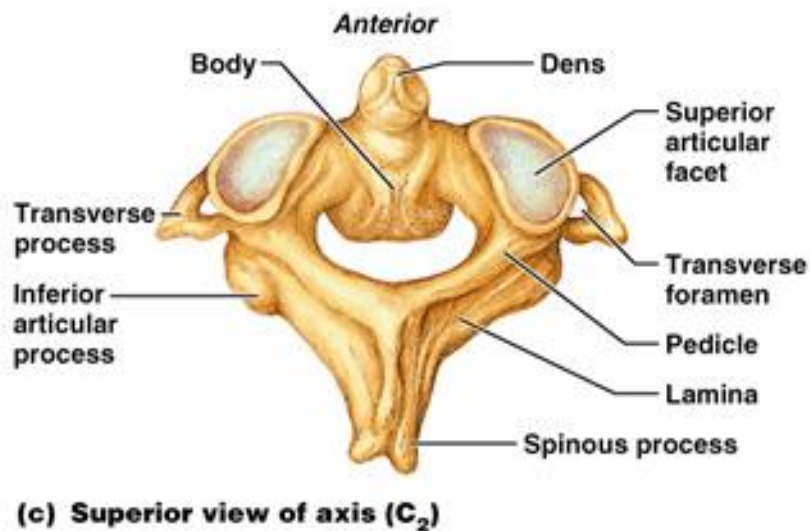
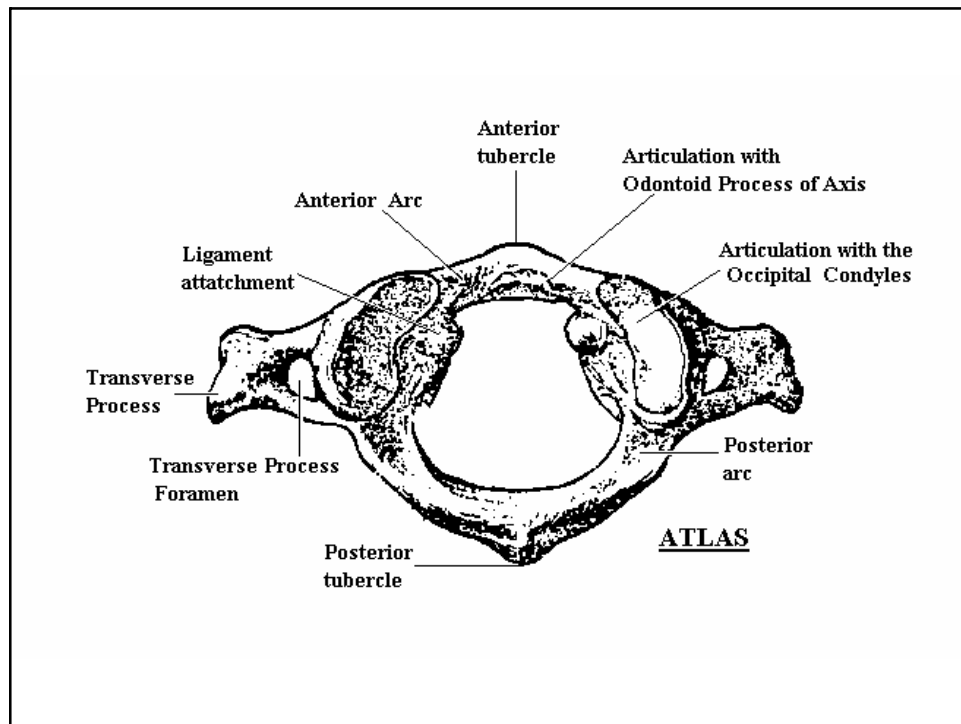


Figure 7.16c



## Cervical Vertebrae: The Atlas (C<sub>2</sub>)

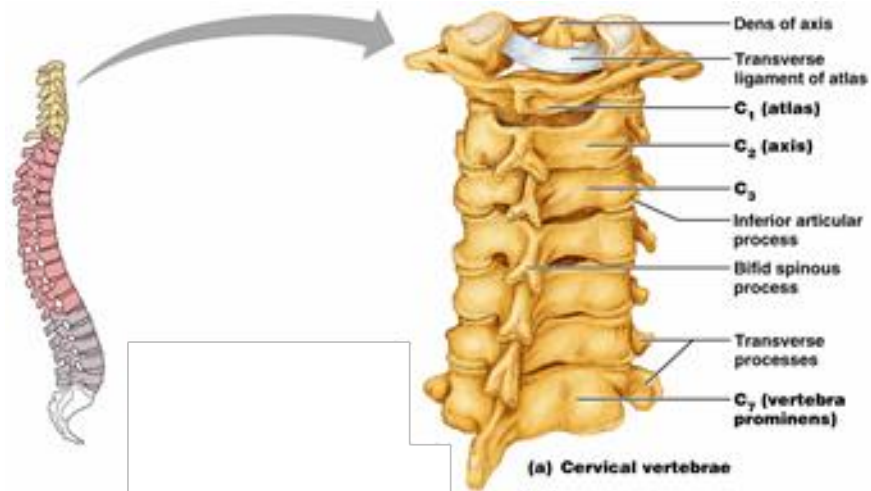
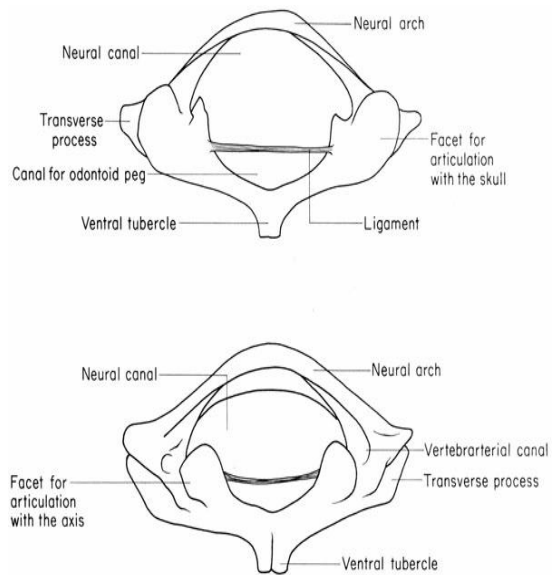
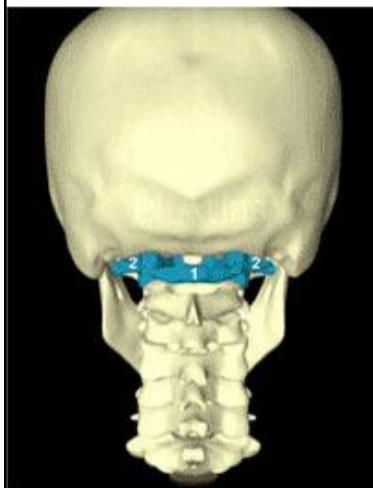
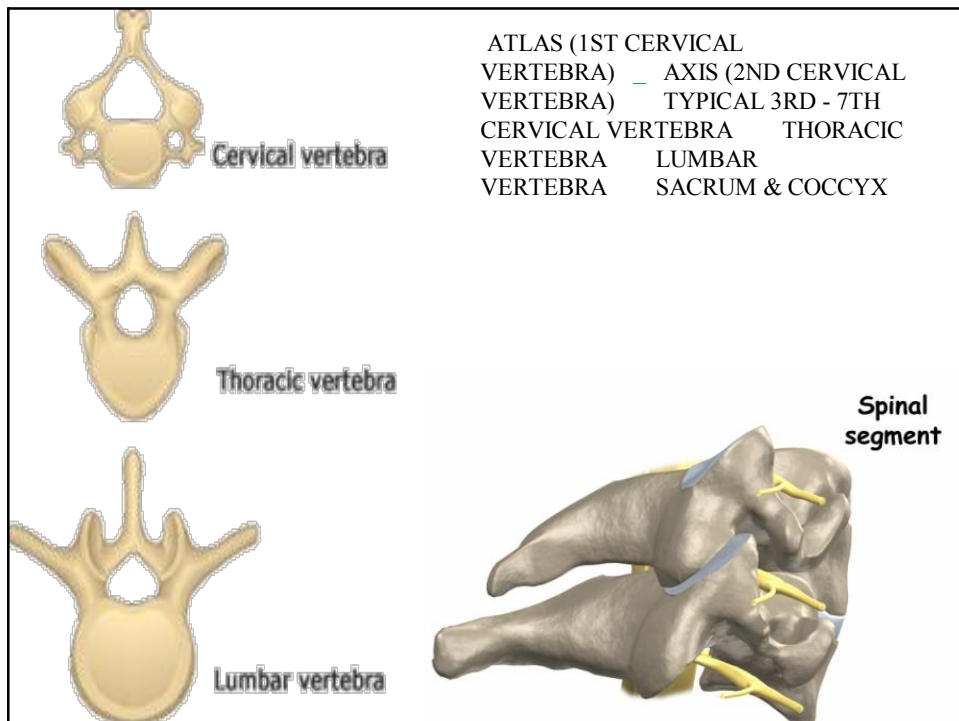
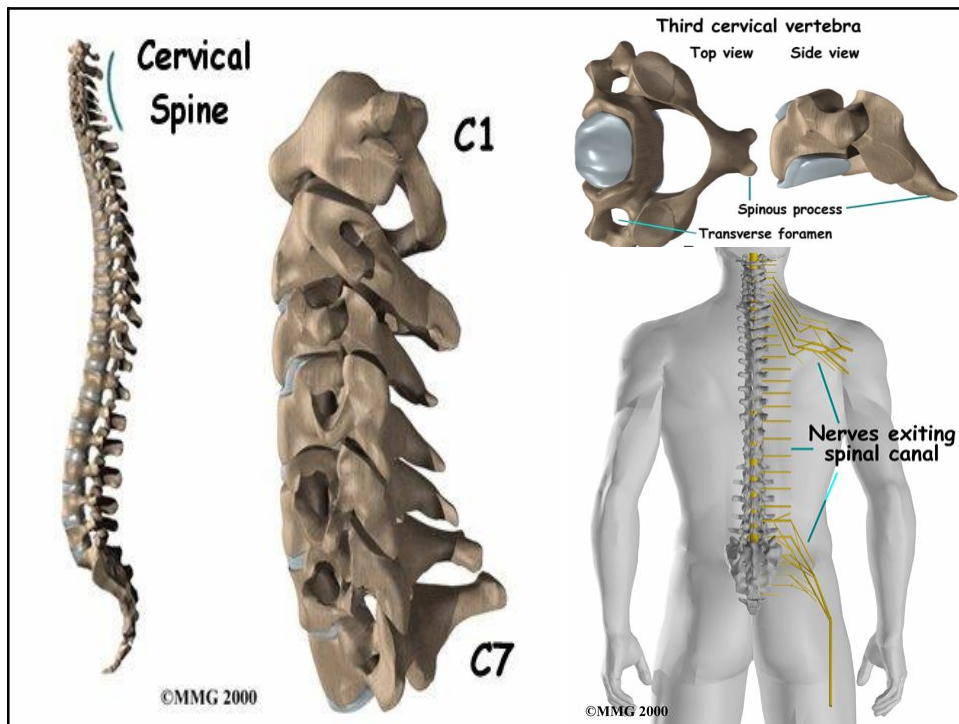
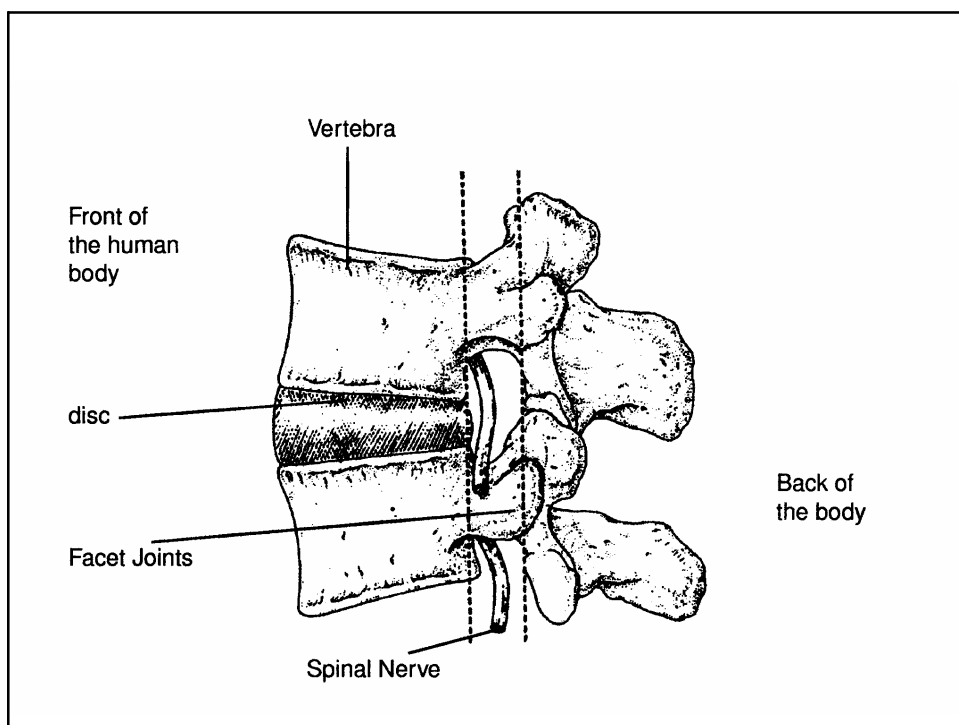


Figure 7.17a

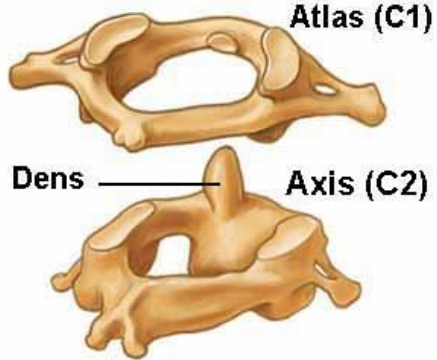
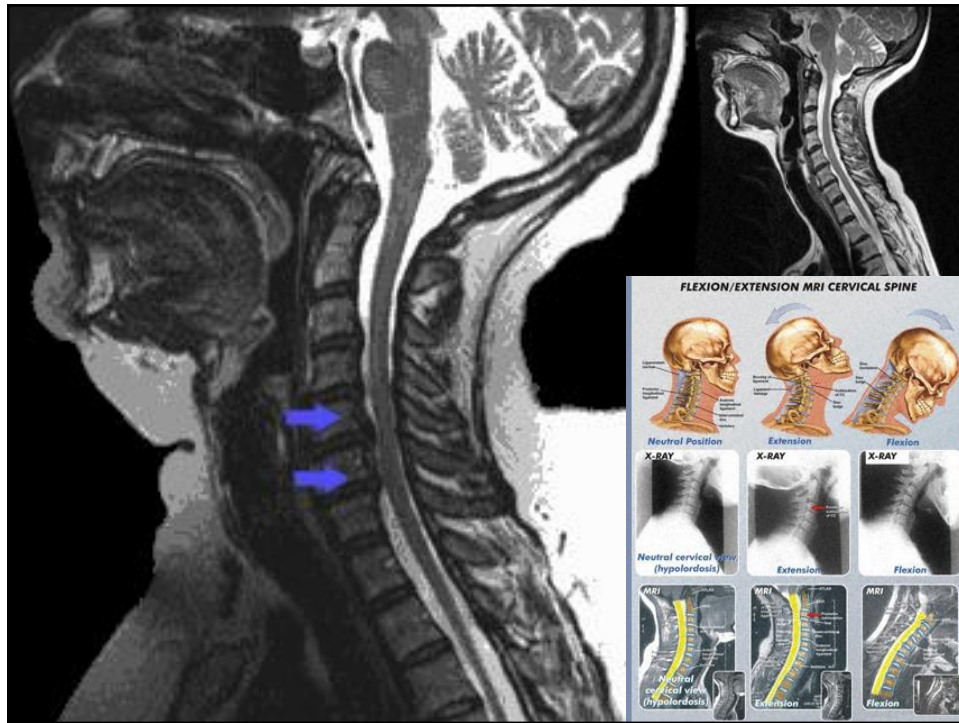
## ATLAS VERTEBRA











### Atlas (C1)

#### Atlas (C1)

The Atlas is the first cervical vertebra and therefore abbreviated C1.

This vertebra supports the skull.

### Axis (C2)

Its appearance is different from the other spinal vertebrae.

The atlas is a ring of bone made up of two lateral masses joined at the front and back by the anterior arch and the posterior arch.

#### Axis (C2)

The Axis is the second cervical vertebra or C2.

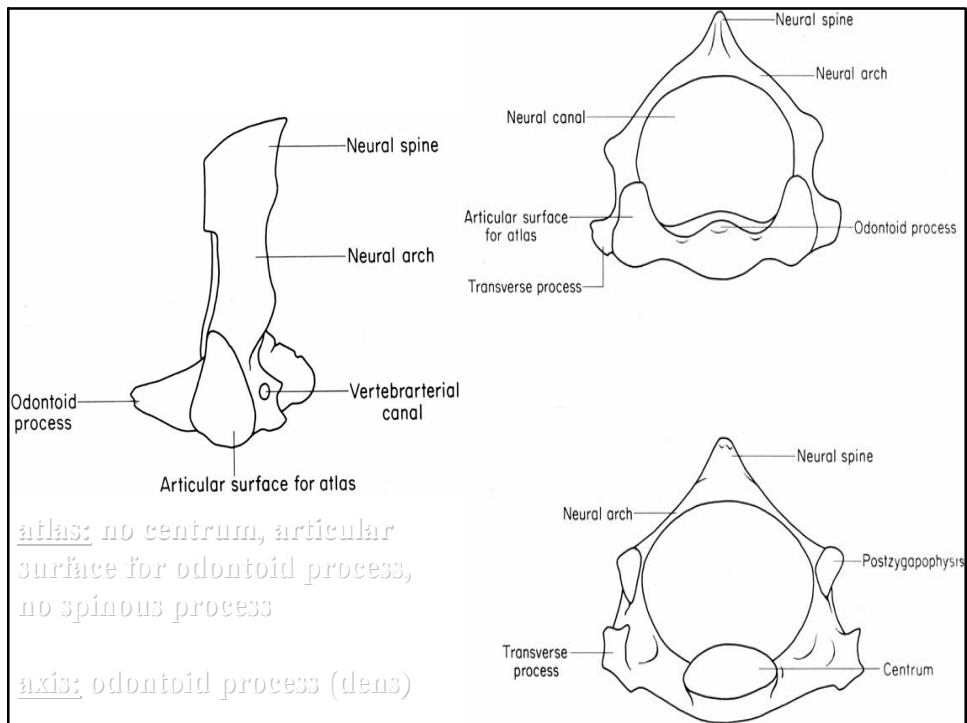
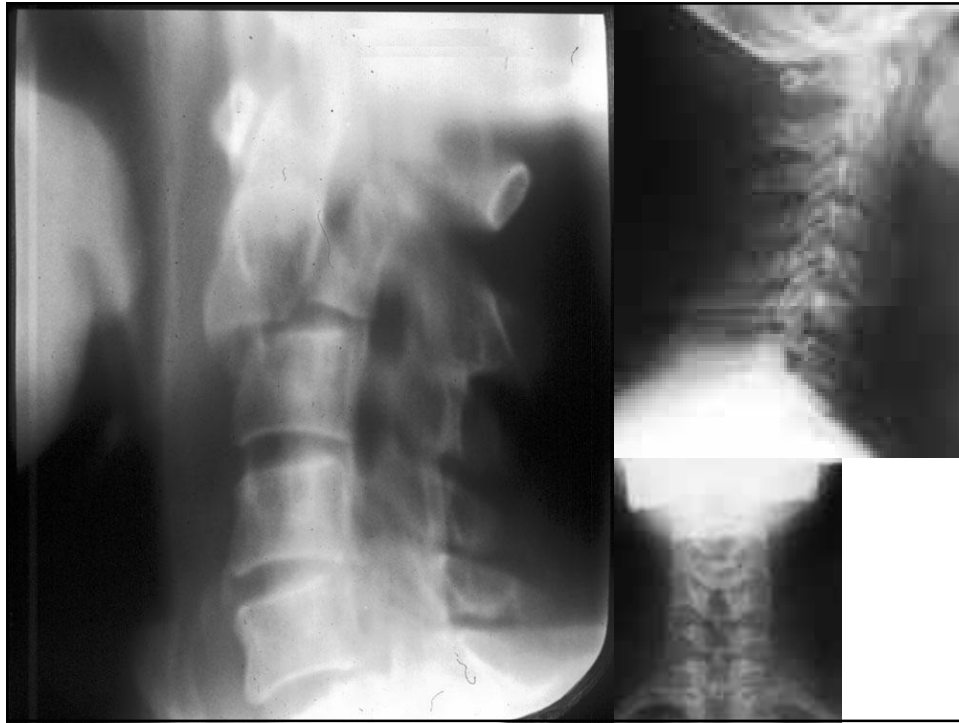
It is a blunt tooth-like process that projects upward.

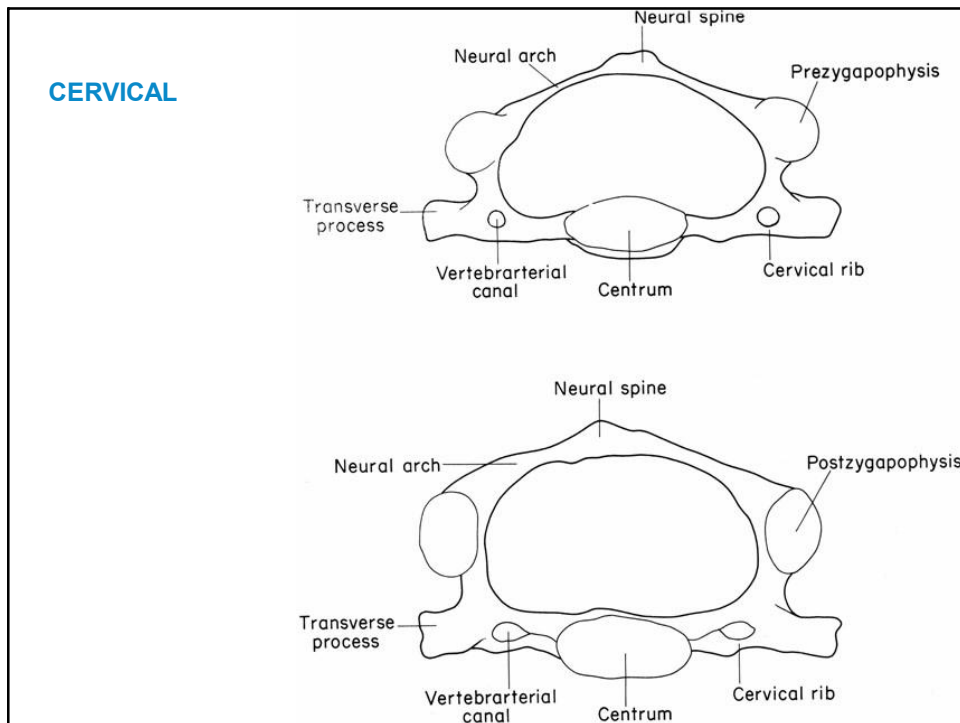
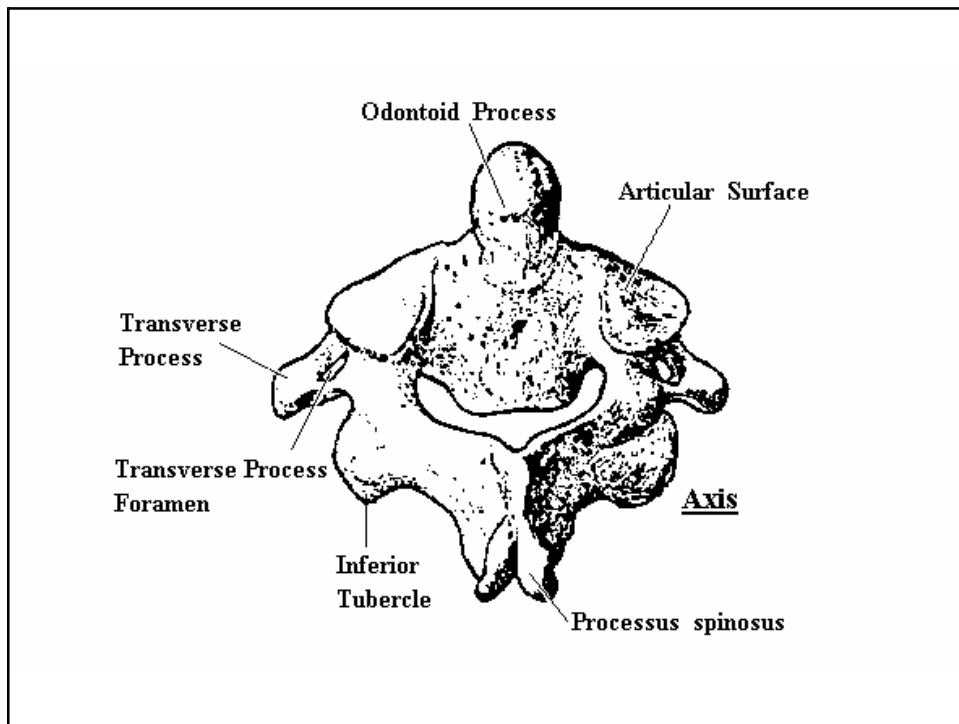
It is also referred to as the 'dens' (Latin for 'tooth') or odontoid process.

The dens provides a type of pivot and collar allowing the head and atlas to rotate around the dens.

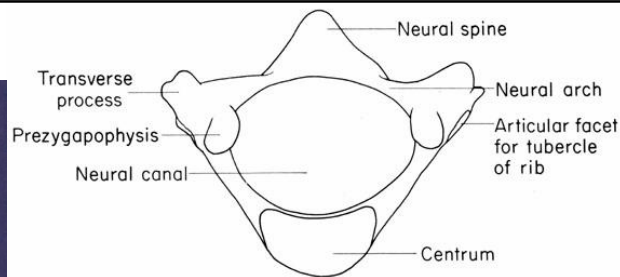




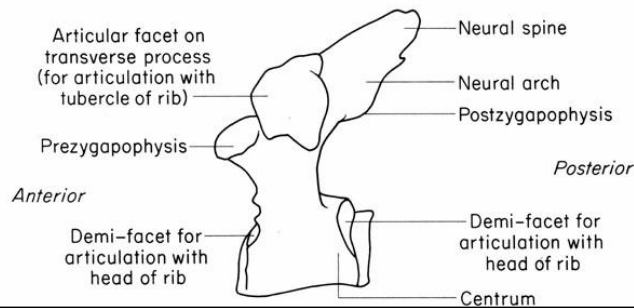




## THORACIC



**Unique thoracic features: demifacets for articulation with rib head, seen from side (except for 11th and 12th.), articular facets on transverse processes (for rib tubercle) and long delicate spinous processes**



## Thoracic Vertebrae

- There are twelve vertebrae ( $T_1$ - $T_{12}$ ) all of which articulate with ribs
- Major markings include two facets and two demifacets on the heart-shaped body, the circular vertebral foramen, transverse processes, and a long spinous process
- The location of the articulate facets prevents flexion and extension, but allows rotation of this area of the spine

## Thoracic Vertebrae

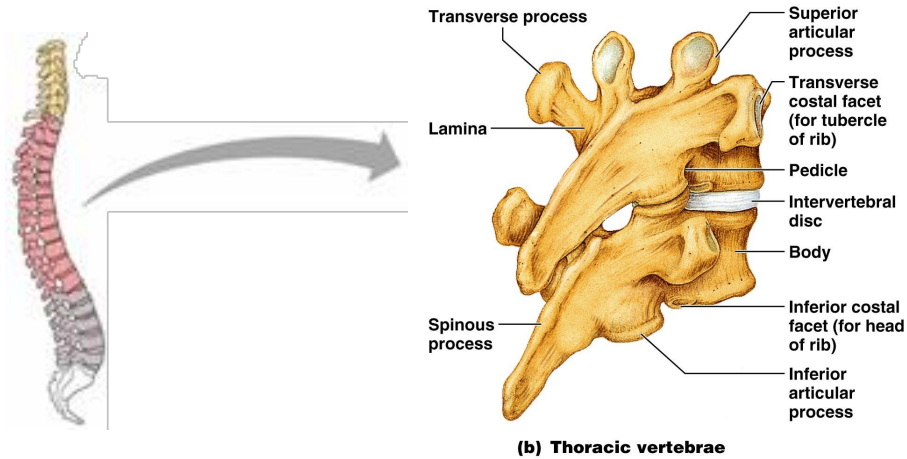
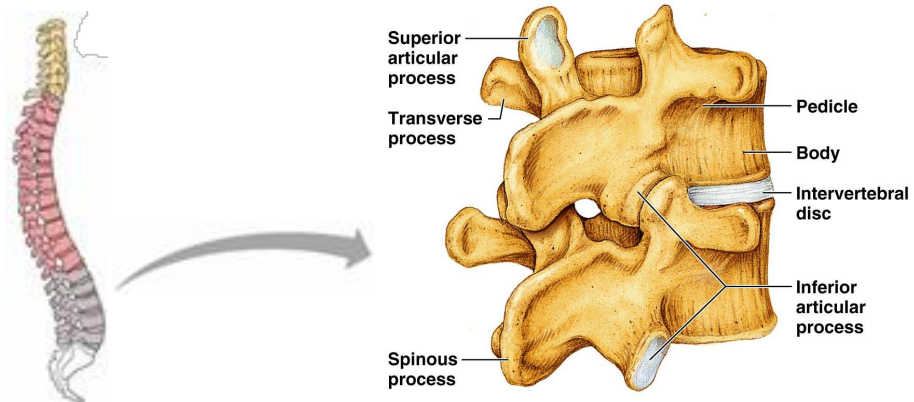


Figure 7.17b

## Lumbar Vertebrae

- The five lumbar vertebrae ( $L_1$ - $L_5$ ) are located in the small of the back and have an enhanced weight-bearing function
- They have short, thick pedicles and laminae, flat hatchet-shaped spinous processes, and a triangular-shaped vertebral foramen
- Orientation of articular facets locks the lumbar vertebrae together to provide stability

## Lumbar Vertebrae

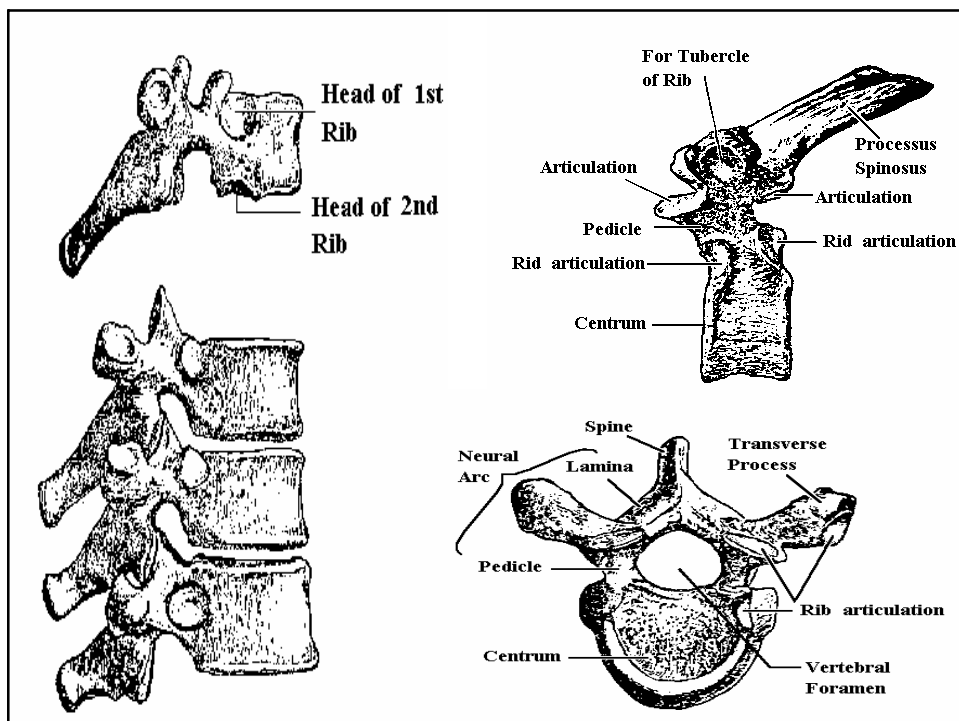
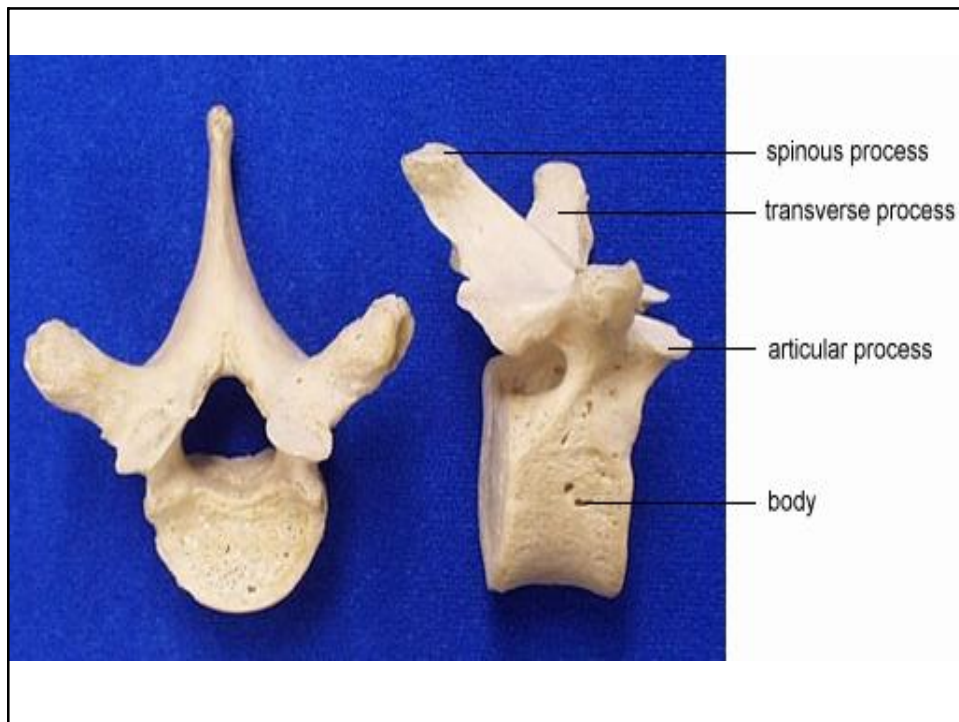


(c) Lumbar vertebrae

Figure 7.17c



1. 1st Lumbar vertebra
2. 2nd Lumbar vertebra
3. 3rd Lumbar vertebra
4. 4th Lumbar vertebra
5. 5th Lumbar vertebra
6. T12
7. Twelfth rib
8. Sacroiliac joint
9. Sacrum
10. Sacral foramen
11. Ilium
12. Pelvic brim
13. Superior ramus of pubic bone
14. Pubic symphysis

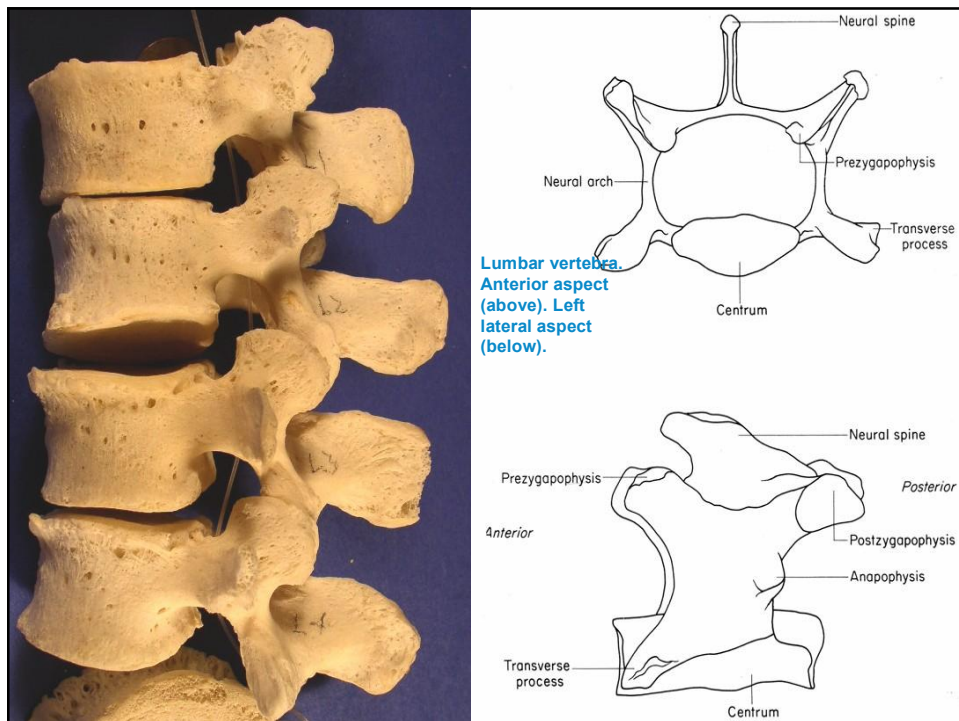
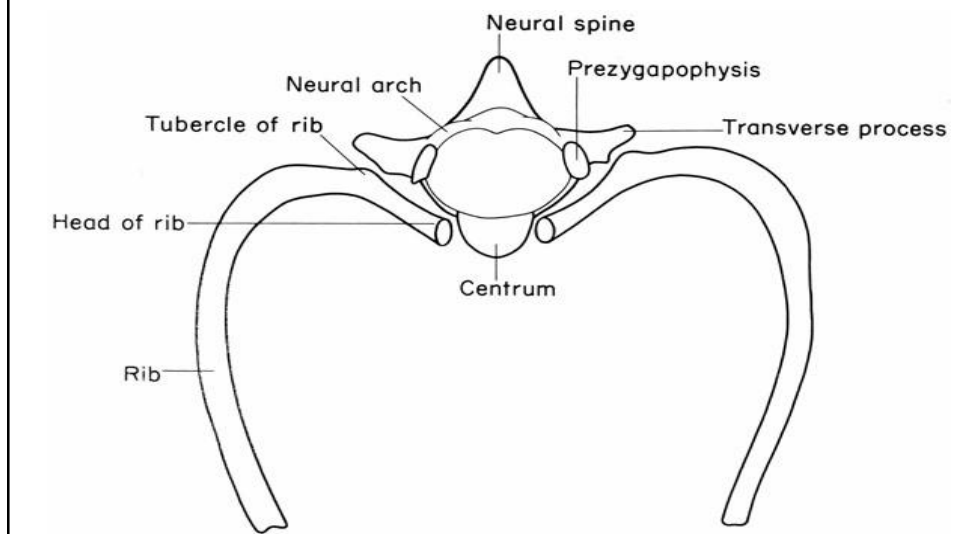




centrum,  
neural arch,  
vertebral  
foramen,  
pedicle,  
spinous  
process,  
lamina,  
superior  
articular  
processes,  
transverse  
process



## 5th thoracic vertebra with rib. Anterior aspect.







heavy centra,  
broad heavy spinous  
process,  
transverse process  
lacks facets

## Regional Characteristics of Vertebrae

**TABLE 7.2** Regional Characteristics of Cervical, Thoracic, and Lumbar Vertebrae

CHARACTERISTIC	CERVICAL (3-7)	THORACIC	LUMBAR
Body	Small, wide side to side	Larger than cervical; heart shaped; bears two costal facets	Massive; kidney shaped
Spinous process	Short; bifid; projects directly posteriorly	Long; sharp; projects inferiorly	Short; blunt; projects directly posteriorly
Vertebral foramen	Triangular	Circular	Triangular
Transverse processes	Contain foramina	Bear facets for ribs (except T <sub>11</sub> and T <sub>12</sub> )	Thin and tapered
Superior and inferior articulating processes	Superior facets directed superoposteriorly Inferior facets directed inferoanteriorly	Superior facets directed posteriorly Inferior facets directed anteriorly	Superior facets directed posteromedially (or medially) Inferior facets directed anterolaterally (or laterally)
Movements allowed	Flexion and extension; lateral flexion; rotation; the spine region with the greatest range of movement	Rotation; lateral flexion possible but limited by ribs; flexion and extension prevented	Flexion and extension; some lateral flexion; rotation prevented

Table 7.2.1

## Regional Characteristics of Vertebrae

TABLE 7.2 Regional Characteristics of Cervical, Thoracic, and Lumbar Vertebrae

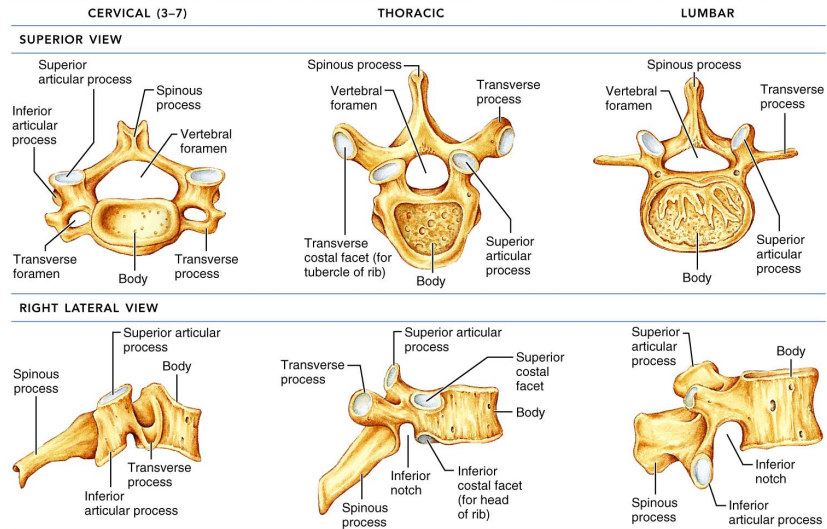


Table 7.2.2

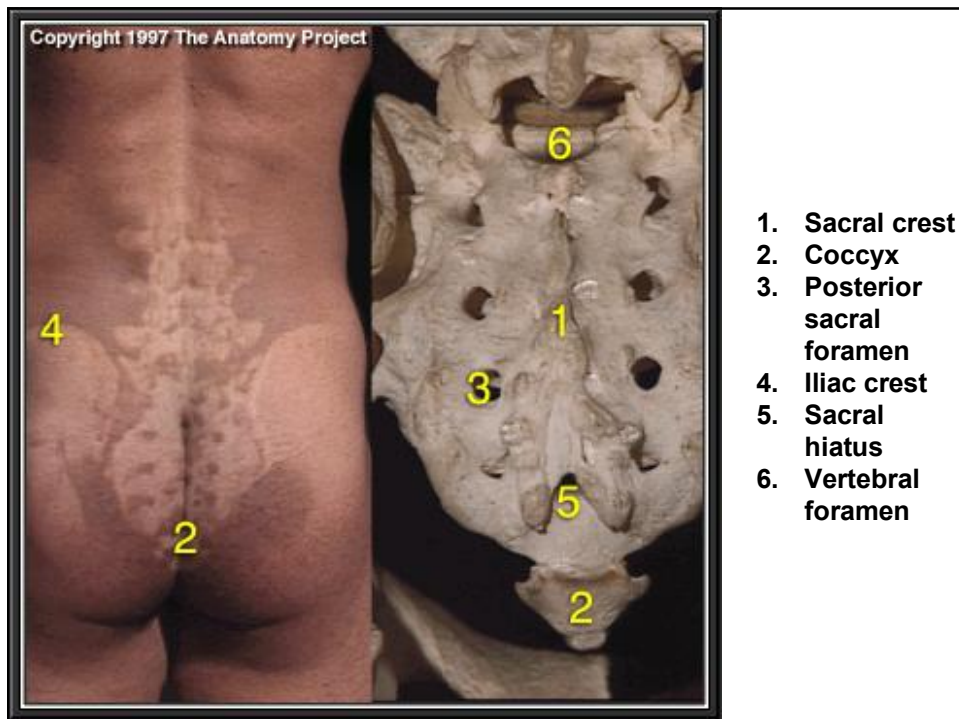
## Sacrum

### ▪ Sacrum

- Consists of five fused vertebrae ( $S_1$ - $S_5$ ), which shape the posterior wall of the pelvis
- It articulates with  $L_5$  superiorly, and with the auricular surfaces of the hip bones
- Major markings include the sacral promontory, transverse lines, alae, dorsal sacral foramina, sacral canal, and sacral hiatus

## Coccyx

- Coccyx (Tailbone)
  - The coccyx is made up of four (in some cases three to five) fused vertebrae that articulate superiorly with the sacrum



## Sacrum and Coccyx: Anterior View

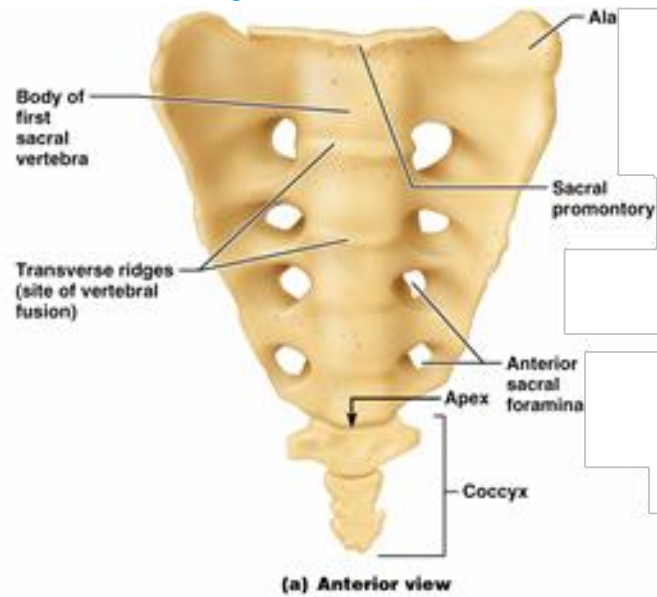


Figure 7.18a

## Sacrum and Coccyx: Posterior View

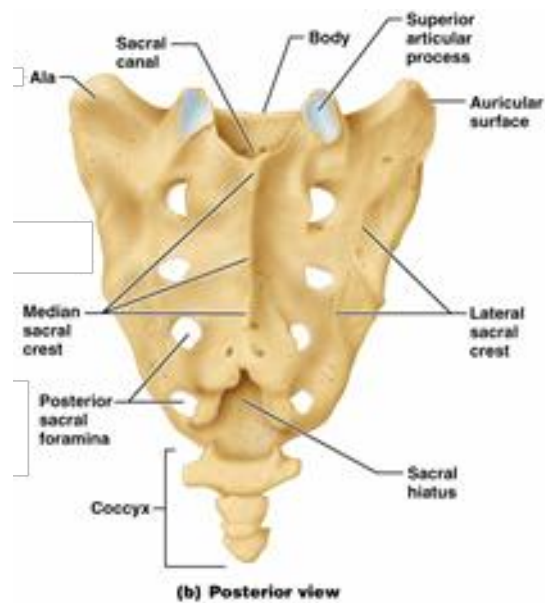
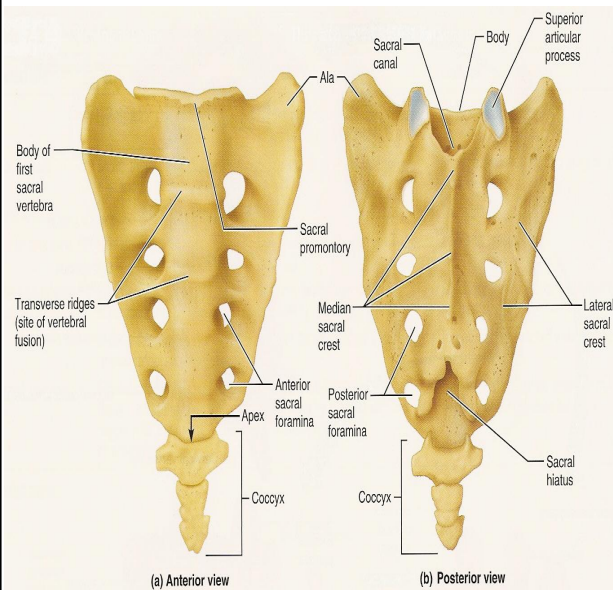


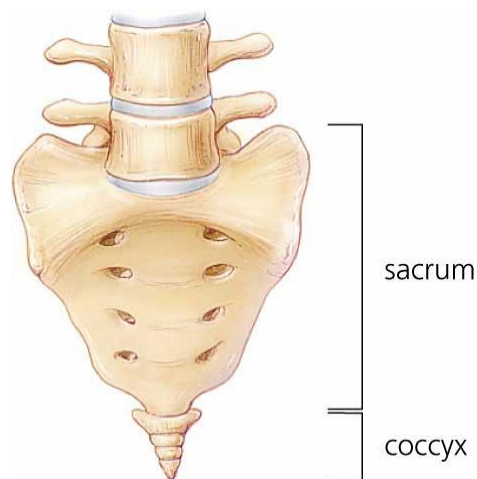
Figure 7.18b

## Sacrum



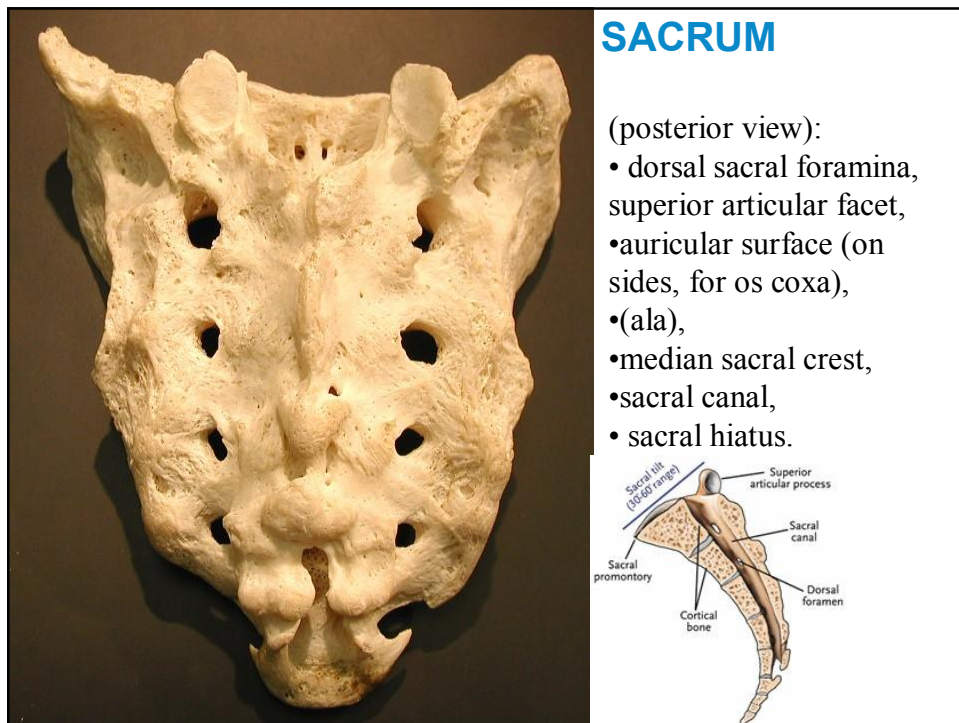
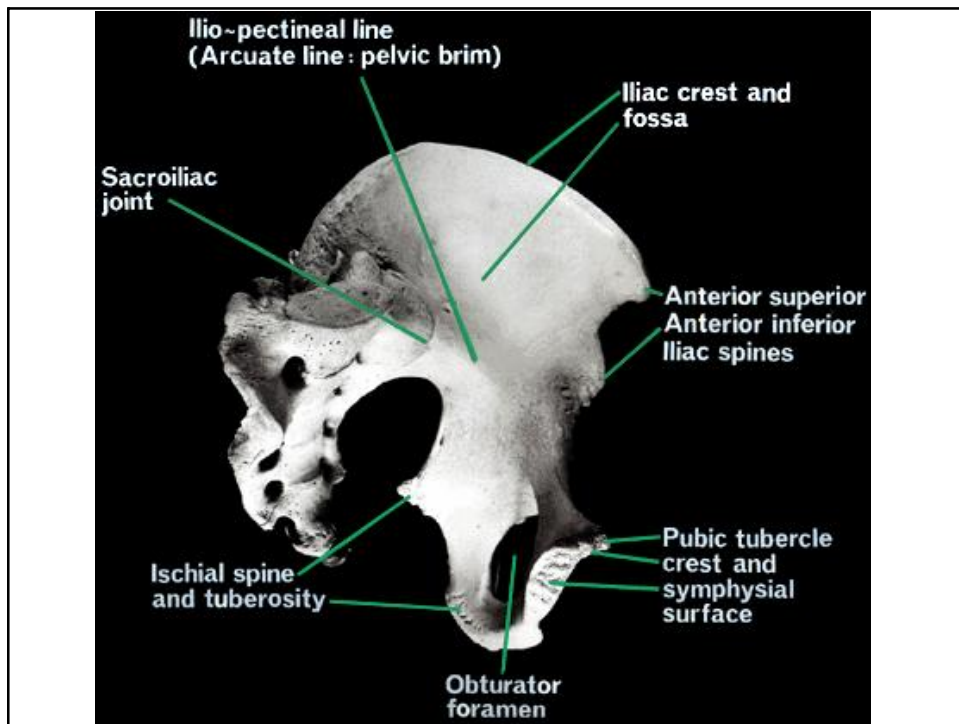
- 5 vertebrae fuse together to form a single bone
- Articulates with:
  - L5 (through SAP)
  - Coccyx
- Functions in weight transfer
- Anterior surface
  - Sacral promontory
  - Transverse ridges
  - Anterior sacral foramina
- Posterior surface
  - Median and lateral sacral crest
  - Posterior sacral foramen

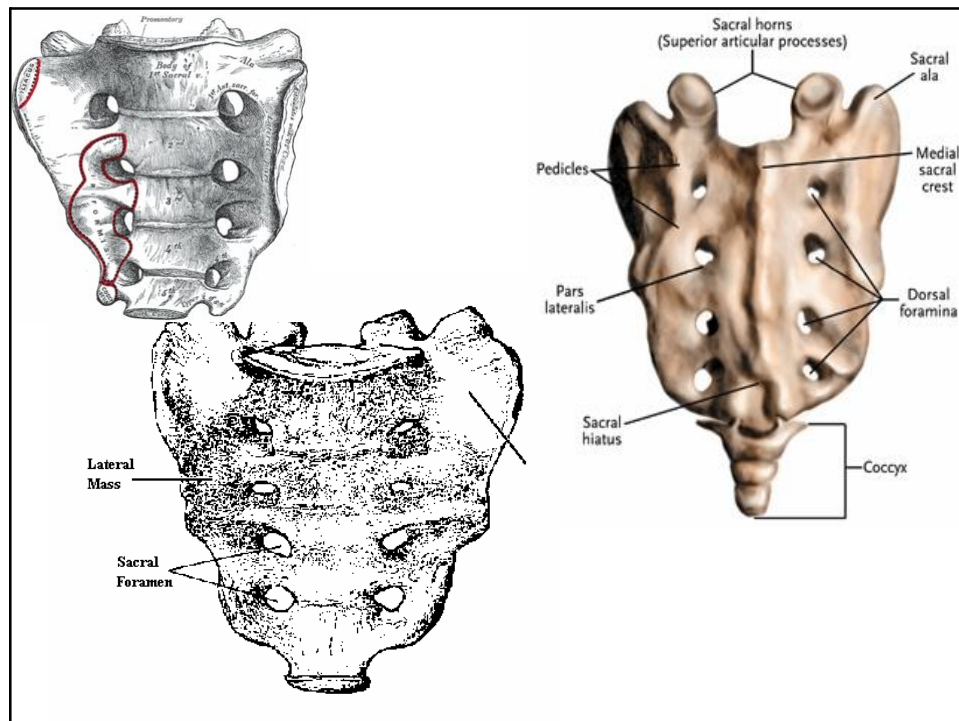
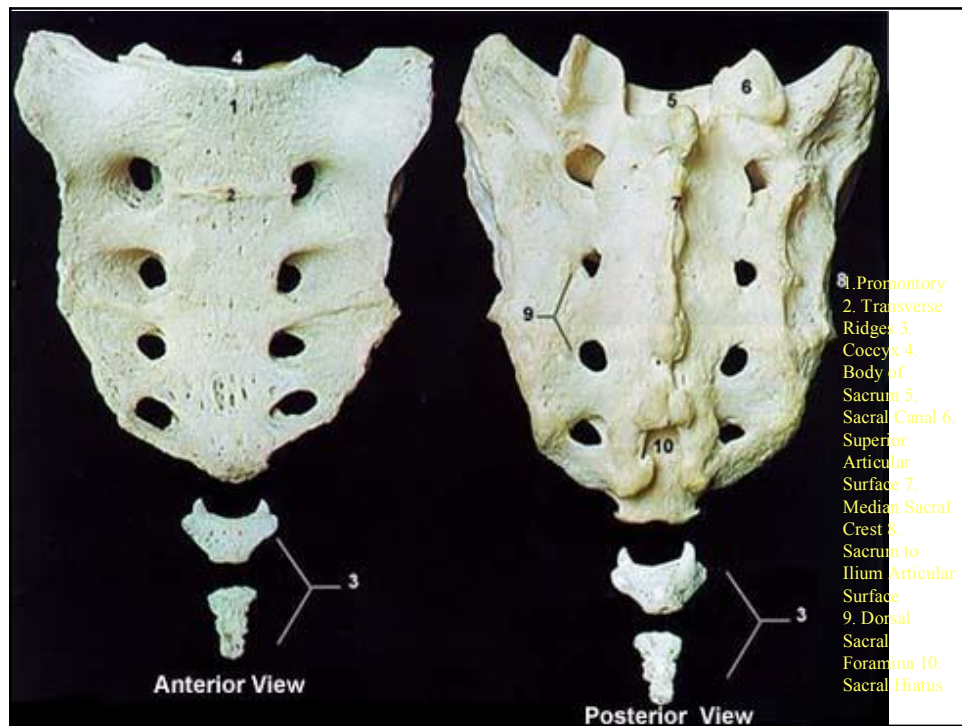
## SACRUM COCCYX

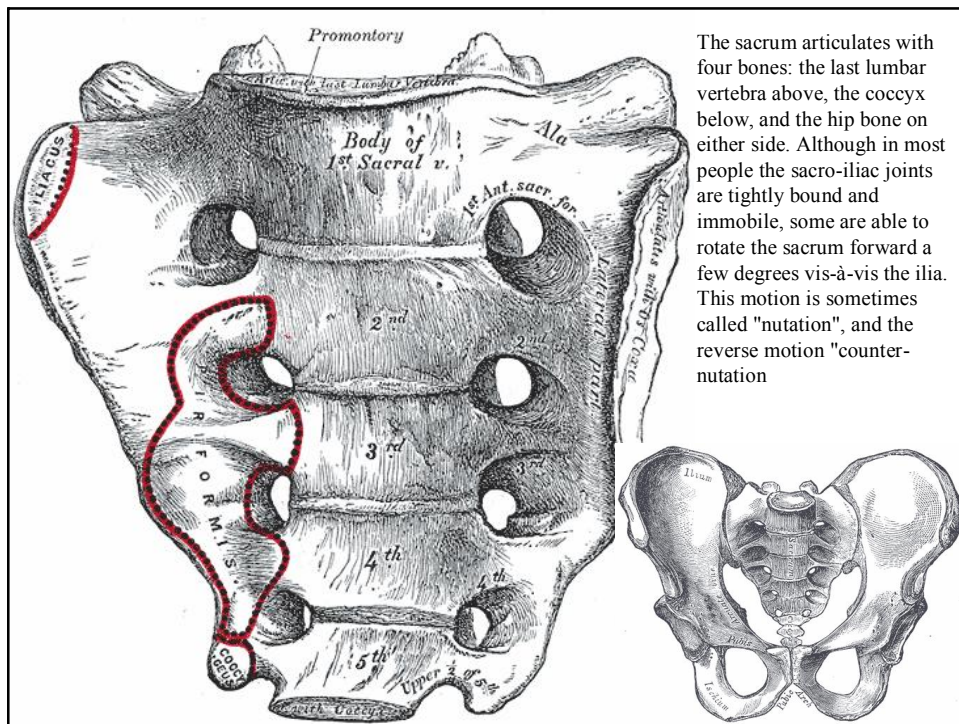


Carlyn Iverson









- The pelvic surface of sacrum is concave from above downward, and slightly so from side to side.
- The dorsal surface of sacrum is convex and narrower than the pelvic.
- The lateral surface of sacrum is broad above, but narrowed into a thin edge below.
- The base of the sacrum, which is broad and expanded, is directed upward and forward.



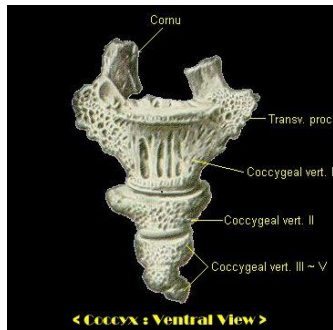
The apex (*apex oss. sacri*) is directed downward, and presents an oval facet for articulation with the coccyx.

The vertebral canal (*canalis sacralis*; sacral canal) runs throughout the greater part of the bone; above, it is triangular in form; below, its posterior wall is incomplete, from the non-development of the laminae and spinous processes.

It lodges the sacral nerves, and its walls are perforated by the anterior and posterior sacral foramina through which these nerves pass out.

For Hindus and Sahaja Yogis the kundalini resides in the sacrum bone in a dormant state.





## Coccyx (3-5 fused)

- “Tailbone”
- Useless bone.....
  - But painful!
- Slight support to pelvic organs and ligament attachment
- Articulates superiorly with sacrum
- Anterior concave
- Posterior convex

## Bony Thorax (Thoracic Cage)

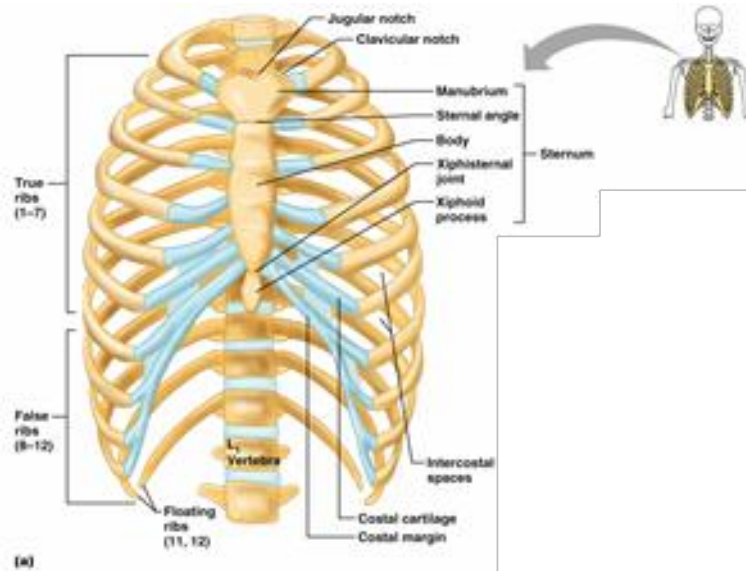
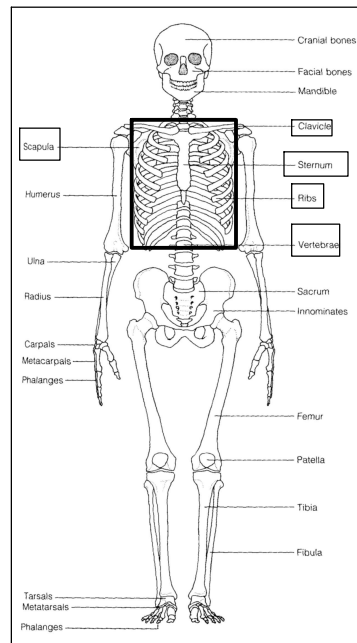


Figure 7.19a

## The Bony Thorax

- Sternum (3 parts)
- Ribs
- Clavicle
- Scapula
- Vertebrae (5 parts)



## Bony Thorax (Thoracic Cage)

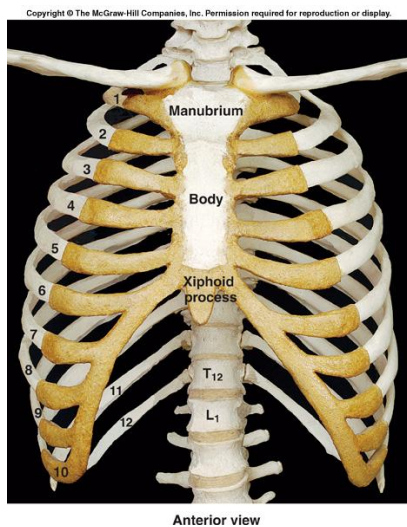
- The thoracic cage is composed of the
  - thoracic vertebrae dorsally,
  - the ribs laterally,
  - and the sternum and costal cartilages anteriorly

## Bony Thorax (Thoracic Cage)

### ▪ Functions

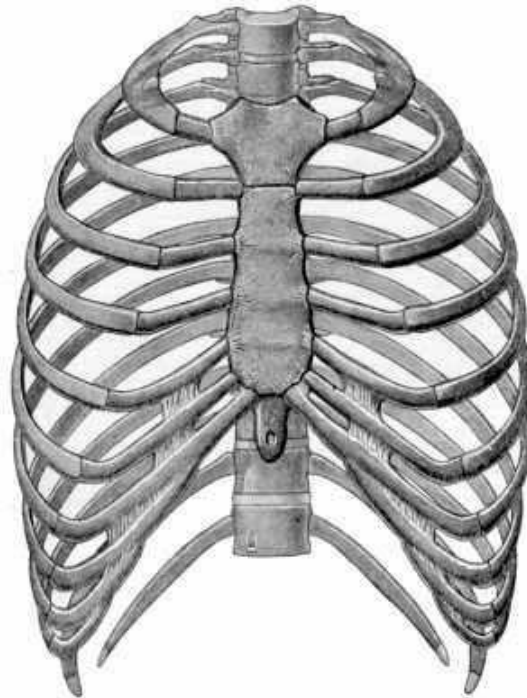
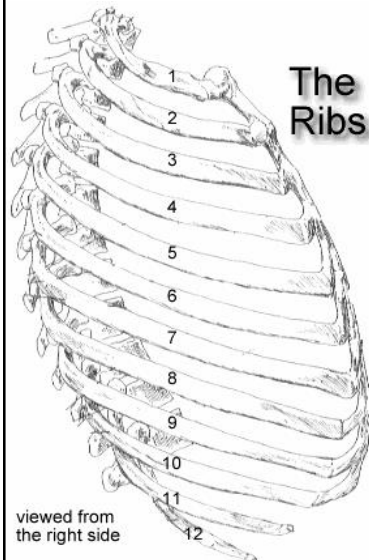
- Forms a protective cage around the heart, lungs, and great blood vessels
- Supports the shoulder girdles and upper limbs
- Provides attachment for many neck, back, chest, and shoulder muscles
- Uses intercostal muscles to lift and depress the thorax during breathing

## 2. Thoracic Cage



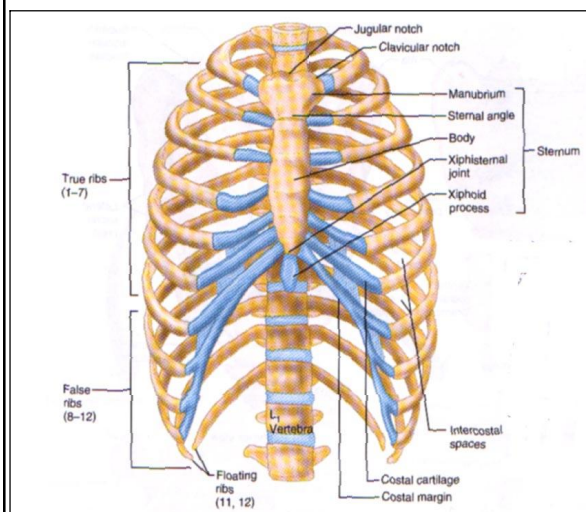
- Borders:
  - Thoracic vertebrae posteriorly
  - Ribs laterally
  - Sternum and costal cartilages anteriorly
- Forms protective cage @ heart, lungs, and other organs
- Composed of:
  - Sternum
  - Ribs

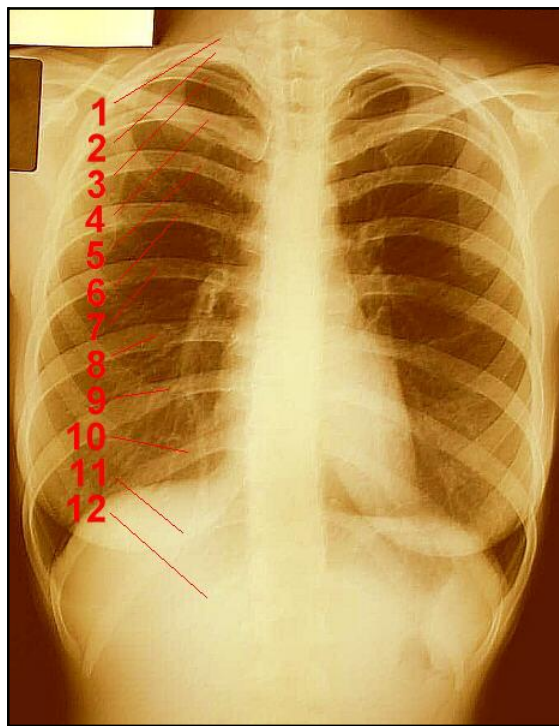
## RIBS



## Thoracic Cage - Ribs

- 12 pairs
  - True ribs
    - Superior 7 pairs that attach directly to sternum by CC
  - False ribs (8-12)
    - Inferior 4 pairs (8-10) and attach indirectly to sternum
    - Floating ribs
      - Ribs 11 and 12 and have no anterior attachments (muscles)





## Ribs

- Typical ribs
  - # 2-9
- Atypical ribs
  - # 1, 10-12
- Increase in length from 1-7
- Decrease in length from 8-12
- Costal margin

## Rib Anatomy – Typical Ribs

- Shaft
  - costal groove at inferior border
- Head
  - Articulates with 2 demifacets
- Neck
- Tubercle
- Angle
- Subcostal groove



## Ribs

- There are twelve pair of ribs forming the flaring sides of the thoracic cage
- All ribs attach posteriorly to the thoracic vertebrae
- The superior 7 pair (true, or vertebrosteral ribs) attach directly to the sternum via costal cartilages
- Ribs 8-10 (false, or vertebrocondral ribs) attach indirectly to the sternum via costal cartilage
- Ribs 11-12 (floating, or vertebral ribs) have no anterior attachment

## Ribs

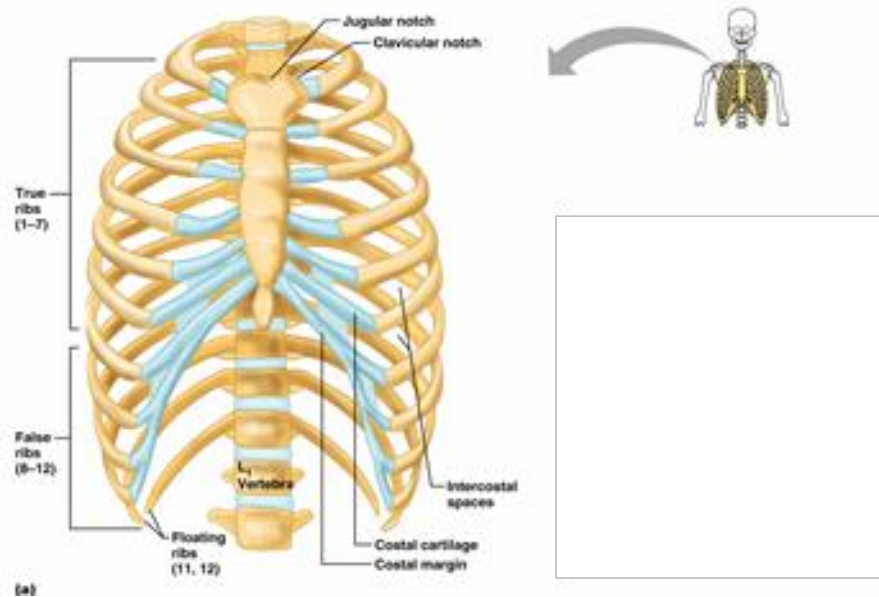


Figure 7.19a

## Structure of a Typical True Rib

- Bowed, flat bone consisting of a head, neck, tubercle, and shaft

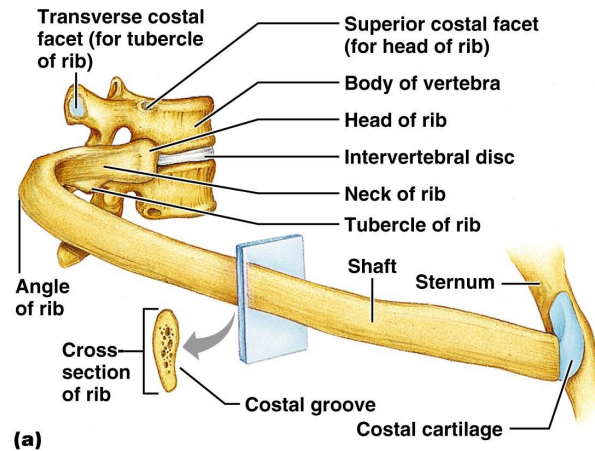


Figure 7.20a

## Structure of a Typical True Rib

- Bowed, flat bone consisting of a head, neck, tubercle, and shaft

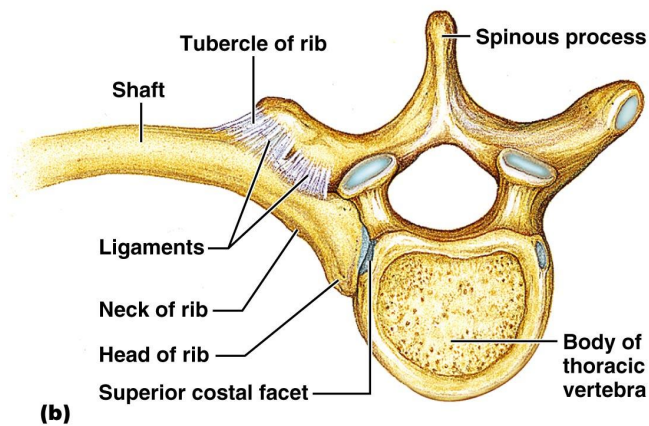
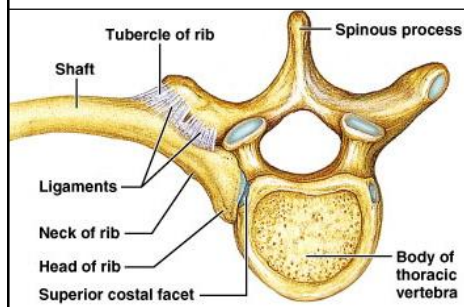
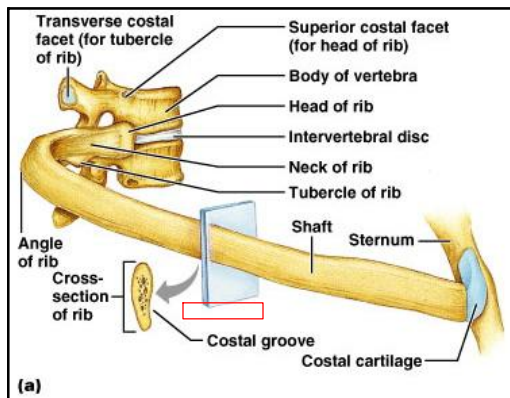


Figure 7.20b



## Rib Anatomy – Typical Ribs

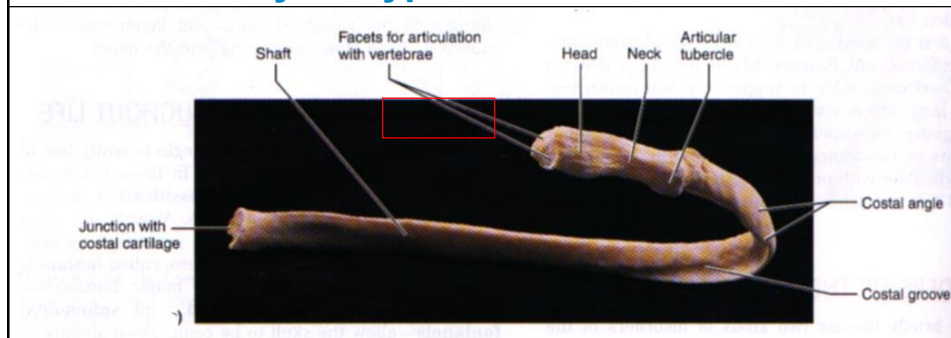
### • Dorsal attachment

- Head of Rib → 2 Demifacets
  - Superior demifacet
  - Inferior demifacet of vertebra above it
  - Intervertebral disc
- Tubercle of Rib
  - Articulates with Transverse Costal Facet (Thoracic vertebra)
- Ex. Rib #4 articulates with Superior Demifacet and Transverse Costal Facet of T4 & Inferior demifacet of T3

### • Ventral attachment

- Costal cartilage

## Rib Anatomy – Atypical Ribs

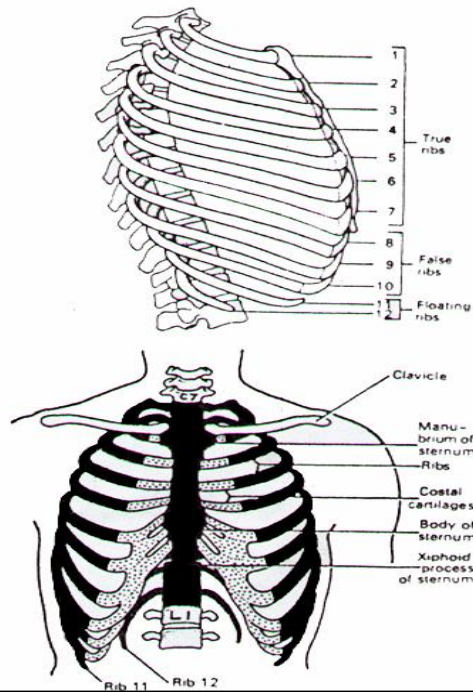


- #1 – flat and broad, supports subclavian vessels
- #1, and 10-12 – articulate with only 1 vertebral body
- #11 and 12 – do not articulate with a vertebral transverse process

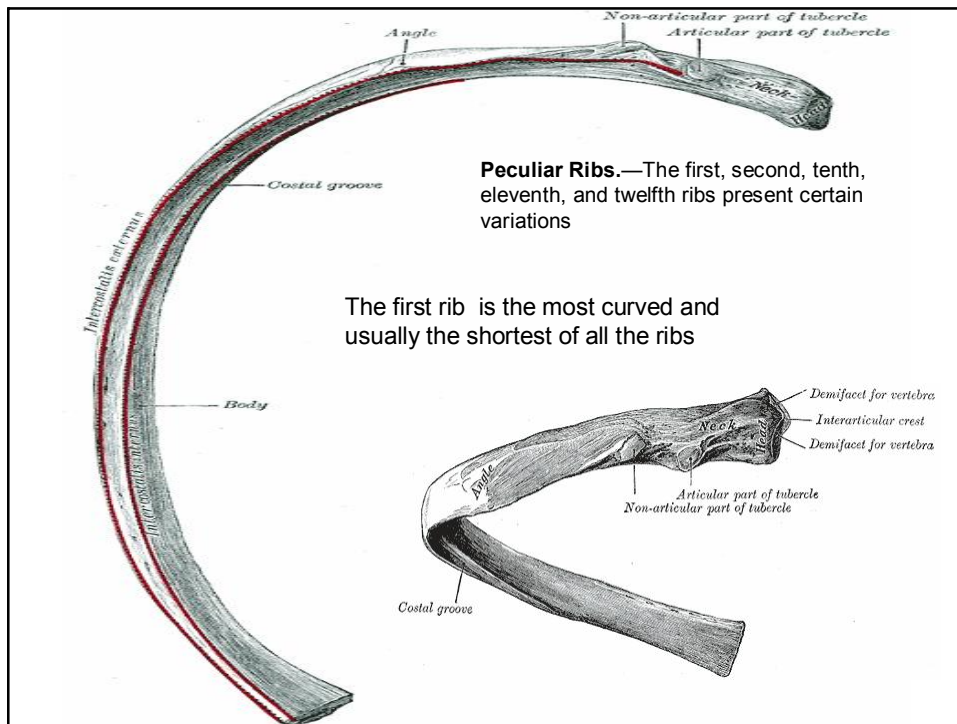
The rib cage is joined to the tl vertebrae.

At T11 and T12, the ribs do n and are so are called "floating

The thoracic spine's range of is limited due to the many rib/vertebrae connections and spinous processes.



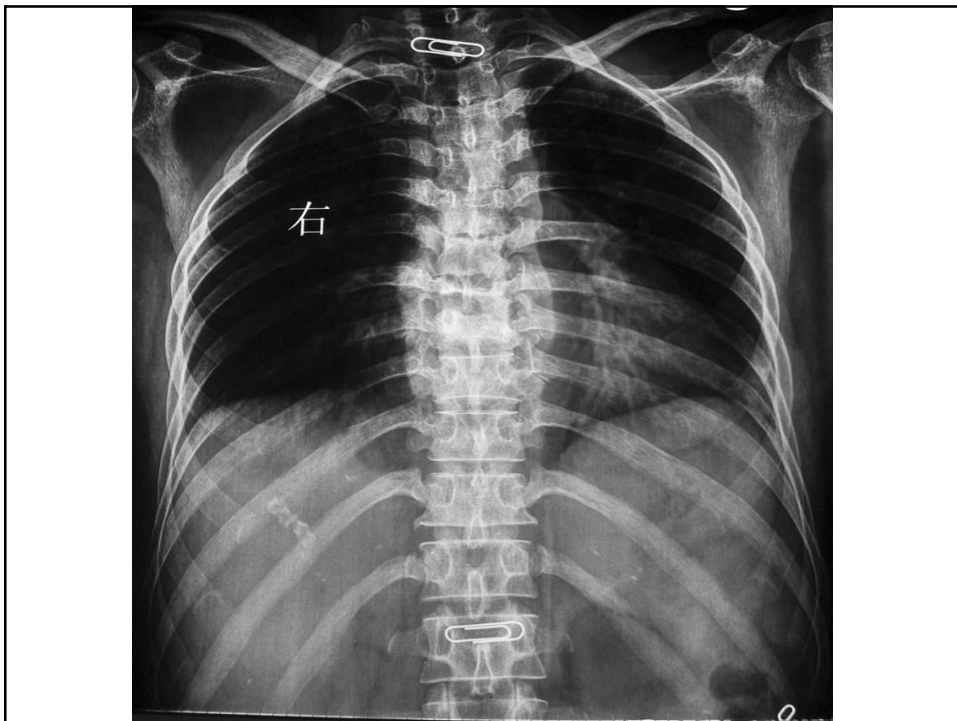
RIBS	
1.	Articular Facet of Rib
2.	Interarticular Crest
3.	Neck
4.	Articular Portion of Tubercle
5.	Nonarticular Portion of Tubercle
6.	Angle of Rib
7.	Costal Groove
8.	Body of Rib
9.	Articular Facet of Transverse Process
10.	Transverse Process
11.	Spinous Process
12.	Lamina
13.	Vertebral Foramen



The **ribs** are thin, flat, curved bones that form a protective cage around the organs in the upper body. They are comprised 24 bones arranged in 12 pairs.

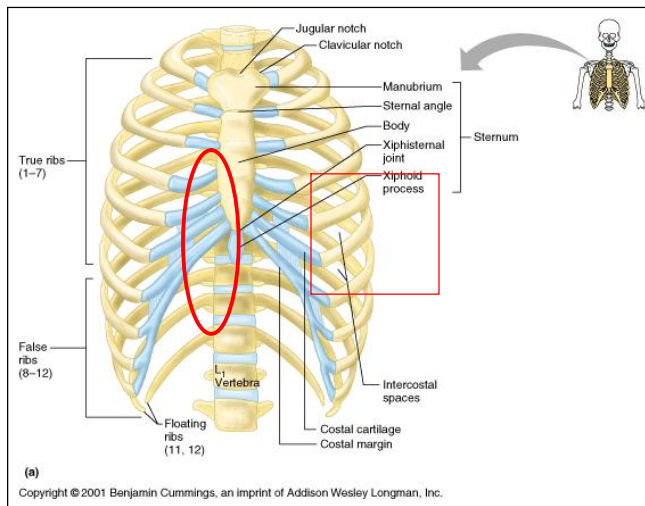
These bones are divided into three categories:

- **The first seven bones are called the true ribs.** These bones are connected to the spine (the backbone) in back. In the front, the true ribs are connected directly to the breastbone or sternum by a strips of cartilage called the **costal cartilage**.
- **The next three pairs of bones are called false ribs.** These bones are slightly shorter than the true ribs and are connected to the spine in back. However, instead of being attached directly to the sternum in front, the false ribs are attached to the lowest true rib.
- **The last two sets of rib bones are called floating ribs.** Floating ribs are smaller than both the true ribs and the false ribs. They are attached to the spine at the back, but are not connected to anything in the front.
- The ribs form a kind of cage the encloses the upper body. They give the chest its familiar shape.
- The ribs serve several important purposes. They protect the heart and lungs from injuries and shocks that might damage them. Ribs also protect parts of the stomach, spleen, and kidneys. The ribs help you to breathe. As you inhale, the muscles in between the ribs lift the rib cage up, allowing the lungs to expand. When you exhale, the rib cage moves down again, squeezing the air out of your lungs.





## Thoracic Cage - Sternum

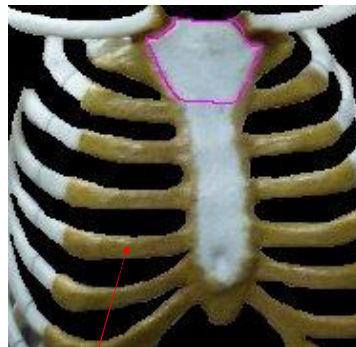


Lies in the anterior midline of the thorax

Consists of 3 fused sternebrae (sections):

- The manubrium
- The body
- The xiphoid process

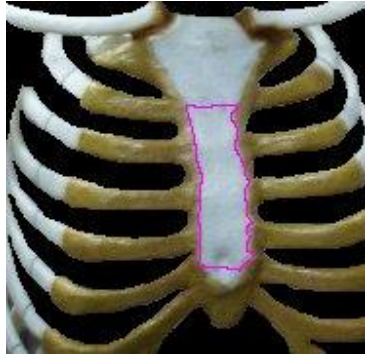
## Sternum - Manubrium



Costal Cartilage

- “Handle”
- Connected to the first 2 ribs
- Clavicular notches articulate with clavicles (collarbone)
- Clavicular Articular facets

## Sternum - Body

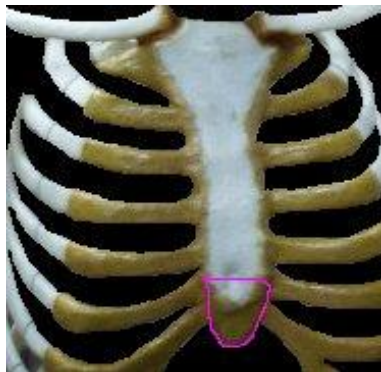


- “Blade” or “gladiolus”
- Connects with ribs 2-7

Sides are notched where it articulates with the costal cartilages

4 separate parts until after puberty

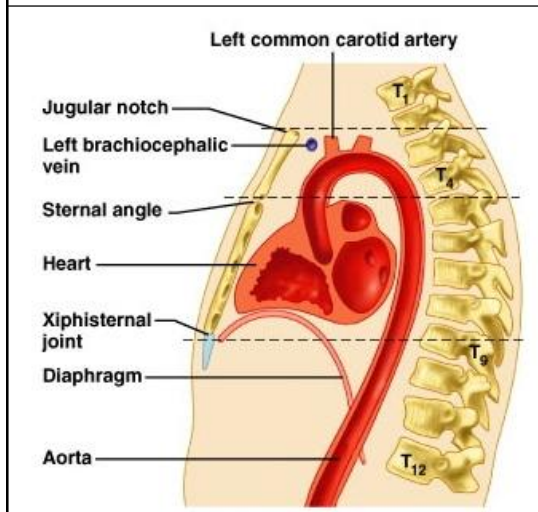
## Sternum – Xiphoid Process



- “Tip”
- Cartilaginous (hyaline) that becomes bony over the years (@40)

Partial attachment of many muscles

## Sternum



- 3 major anatomical landmarks:
  - 1. Jugular notch
    - Central indentation in manubrium
  - 2. Sternal angle
    - Manubrium joins the body
  - 3. Xiphisternal joint
    - Cartilaginous union between xiphoid process and body



1.	Jugular Notch
2.	Manubrium
3.	Sternal Angle
4.	Body (Gladiolus)
5.	Xiphoid Process

•The **sternum** or **breastbone** is a long, flat bone located in the center of the thorax (chest).

• It connects to the rib bones via cartilage, forming the rib cage with them, and thus helps to protect the lungs, heart and major blood vessels from physical trauma.

•The sternum is sometimes cut open (a median sternotomy) to gain access to the thoracic contents when performing cardiothoracic surgery.

The sternum is composed of three parts:

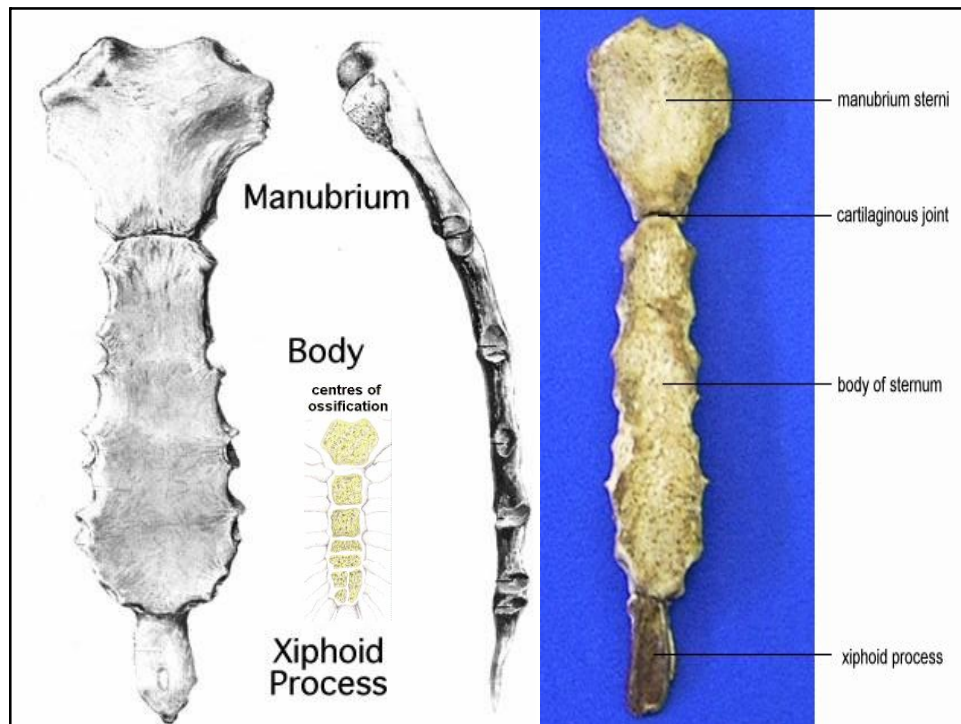
•The **manubrium**, also called the "handle", is located at the top of the sternum and moves slightly. It is connected to the first two ribs.

•The **body**, also called the "blade" or the "gladiolus", is located in the middle of the sternum and connects the third to seventh ribs directly and the eighth through tenth ribs indirectly.

•The **xiphoid process**, also called the "tip", is located on the bottom of the sternum. It is often cartilaginous (cartilage), but does become bony in later years.

These three segments of bone are usually fused in adults.

The sternum serves an important function in the body. The ribs are connected to it by the costal cartilage. Without the sternum, there would be a hole in the bone structure in the middle of your chest, right above your heart and lungs. The sternum protects this vital area and completes the circle of the rib cage.

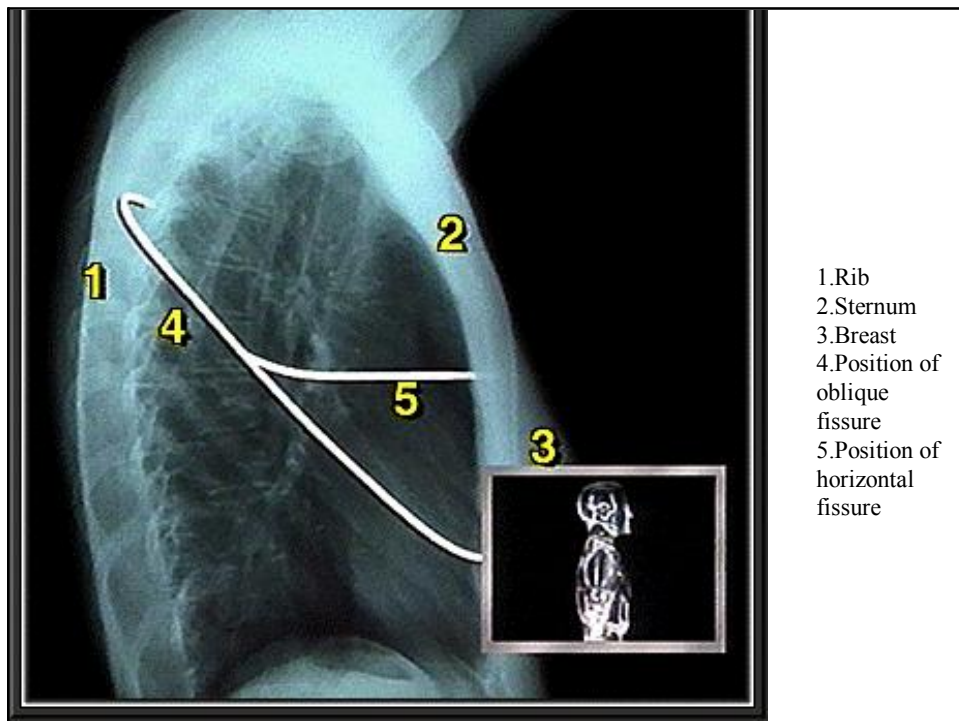
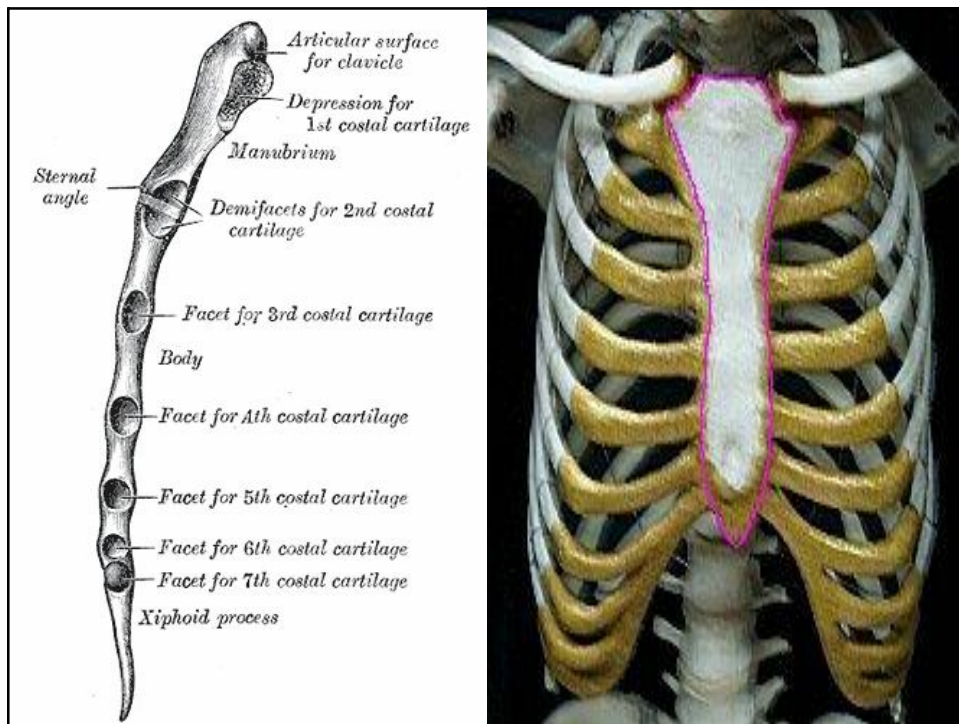


## Sternum (Breastbone)

- A dagger-shaped, flat bone that lies in the anterior midline of the thorax
- Results from the fusion of three bones – the superior manubrium, the body, and the inferior xiphoid process
- Anatomical landmarks include the jugular (suprasternal) notch, the sternal angle, and the xiphisternal joint









## **Pectoral Girdles (Shoulder Girdles)**

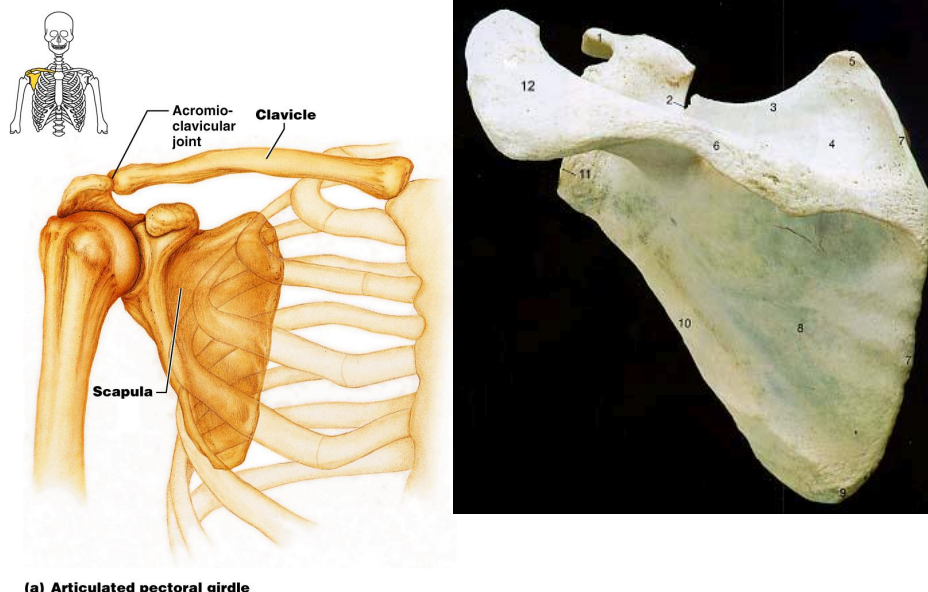
### **Appendicular Skeleton**

- The appendicular skeleton is made up of the bones of the limbs and their girdles
- Pectoral girdles attach the upper limbs to the body trunk
- Pelvic girdle secures the lower limbs

## Pectoral Girdles (Shoulder Girdles)

- The pectoral girdles consist of the anterior clavicles and the posterior scapulae
- They attach the upper limbs to the axial skeleton in a manner that allows for maximum movement
- They provide attachment points for muscles that move the upper limbs

## Pectoral Girdles (Shoulder Girdles)

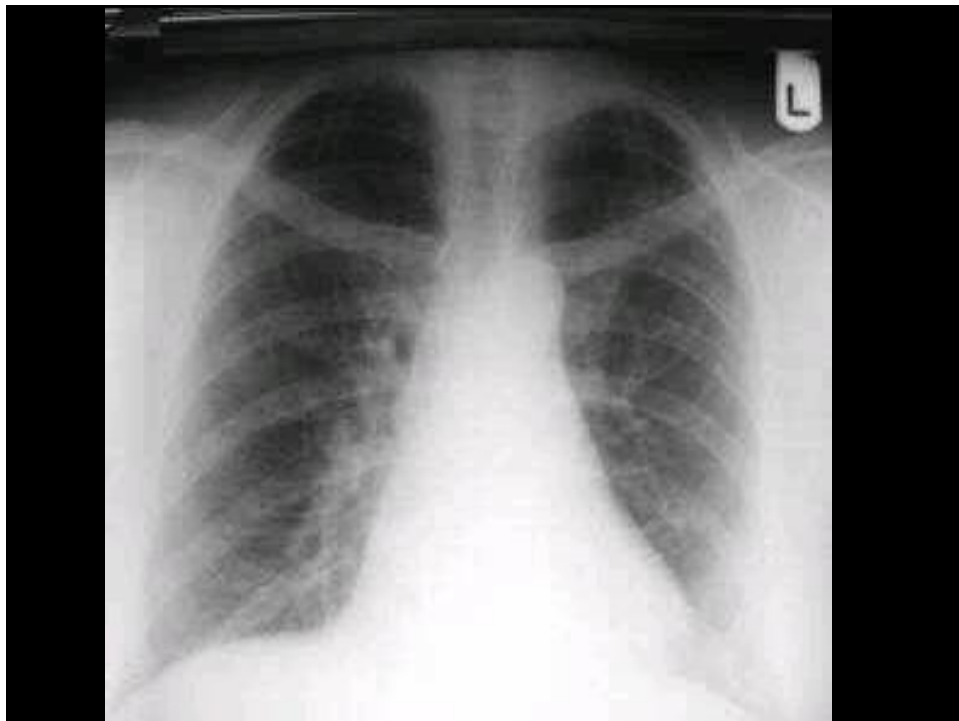


(a) Articulated pectoral girdle

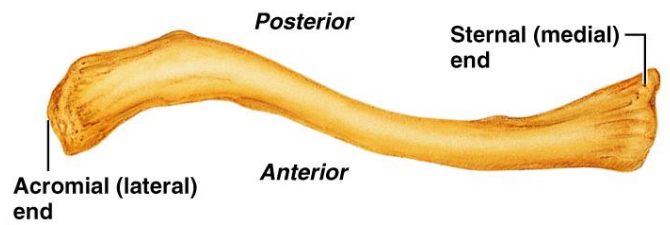
Figure 7.22a

## Clavicles (Collarbones)

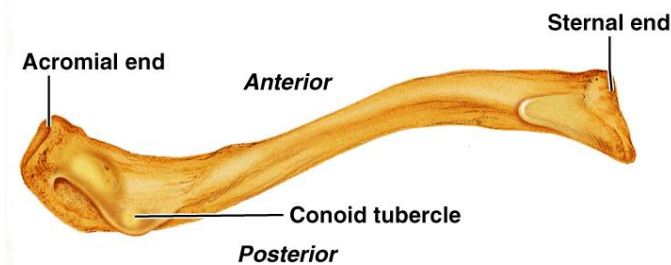
- Slender, doubly curved long bones lying across the superior thorax
- The acromial (lateral) end articulates with the scapula, and the sternal (medial) end articulates with the sternum
- Provide attachment points for numerous muscles, and act as braces to hold the scapulae and arms out laterally away from the body



## Clavicles (Collarbones)



**(b) Right clavicle, superior view**



**(c) Right clavicle, inferior view**

Figure 7.22b, c

## Scapulae (Shoulder Blades)

- Triangular, flat bones lying on the dorsal surface of the rib cage, between the second and seventh ribs
- Scapulae have three borders and three angles
- Major markings include the suprascapular notch, the supraspinous and infraspinous fossae, the spine, the acromion, and the coracoid process

## Scapulae (Shoulder Blades)

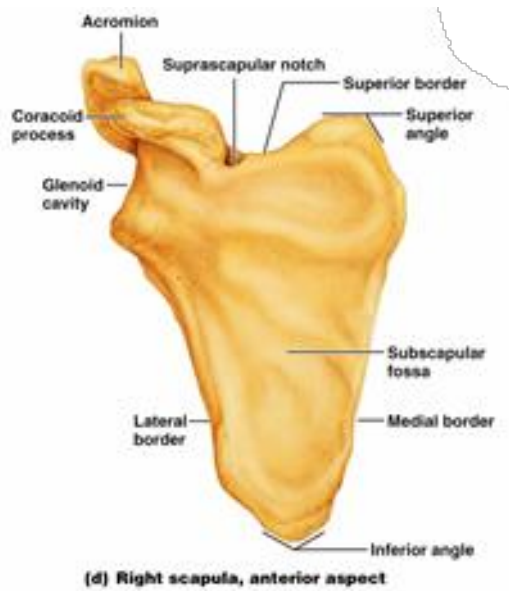


Figure 7.22d

1. Coracoid Process
2. Scapular Notch
3. Superior Margin
4. Supraspinatus Fossa
5. Superior Angle
6. Scapular Spine
7. Vertebral Margin
8. Infraspinatus Fossa
9. Inferior Angle
10. Axillary Margin
11. Glenoid Cavity Margin
12. Acromion Process



### **Left Scapula (Lateral Aspect)**

1. Coracoid Process
2. Glenoid Cavity
3. Scapular Spine
4. Acromion Process
5. Infraspinatus Fossa
6. Inferior Angle
7. Axillary Margin



### **Scapulae (Shoulder Blades)**

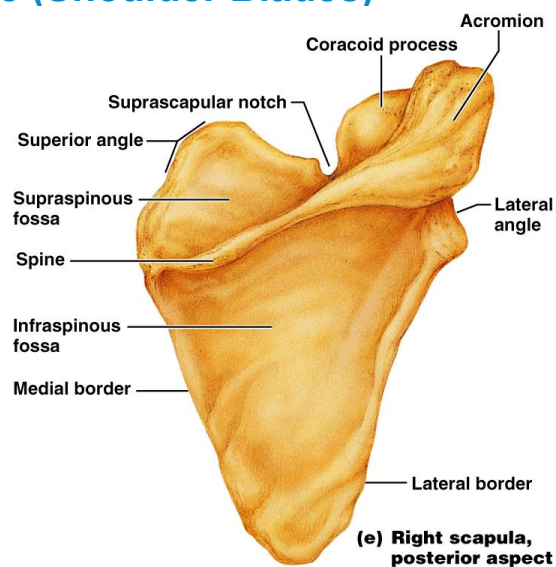
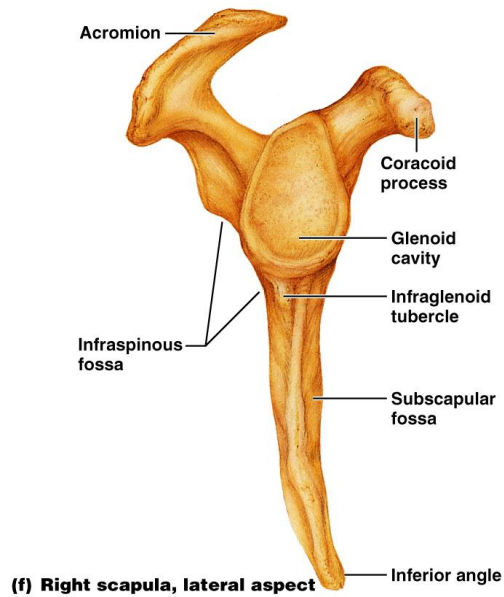
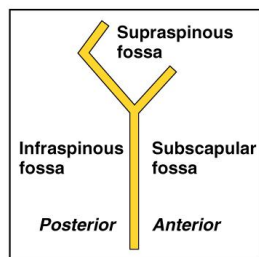
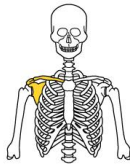


Figure 7.22e



## Scapulae (Shoulder Blades)



(f) Right scapula, lateral aspect

Figure 7.22f