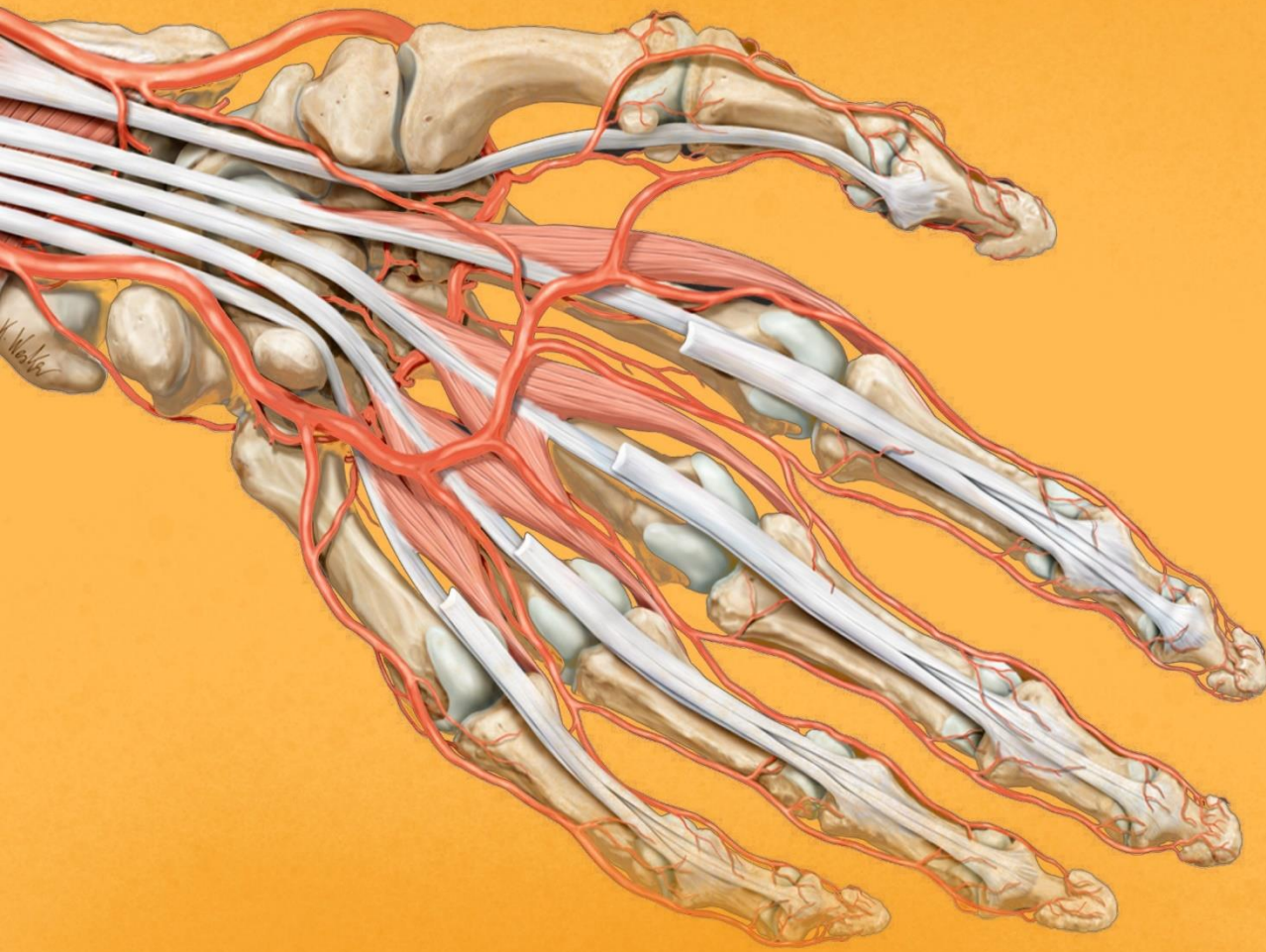


HATAHET ANATOMY



Axial skeleton (V. column & Thoracic cage)

Lecture: 5

Pages: 10

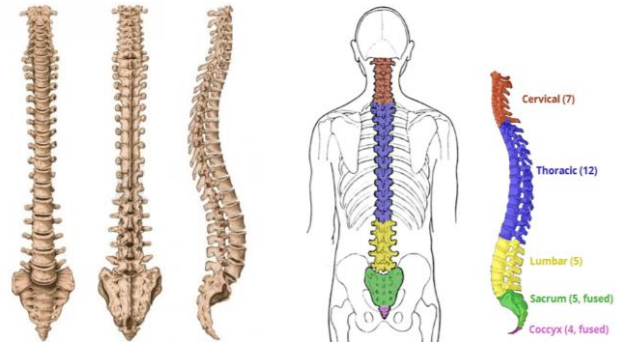
Lecture 5 p1: Vertebral column

➤ The vertebral column is a bony vertical column that houses the spinal cord and the spinal nerves, it consists of:

- ① 33 irregular bones called (Vertebrae - فقرات)
- ② Intervertebral discs
- ③ a bundle of ligaments and joints

➤ Main functions of the vertebral column are:

- ① protects the spinal cord
- ② attaches ribs, pelvic girdles
- ③ supports the head
- ④ provides flexibility and resilience to the trunk



Curves of the vertebral column

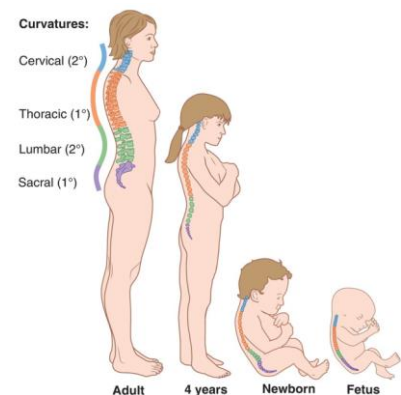
- the vertebral column of a normal adult human is not straightened but rather curved
- when the fetus is inside his mother's womb, his vertebral column will have one curve and it is concave anteriorly
- as the fetus is born and developed, vertebral column will have 4 normal curves, these curves are classified into 2 groups:

1) **Primary curves**, concave anteriorly, they are named "Primary"; because they retain the original fetal curve, these are:

- ① Thoracic curve
- ② Sacral curve

2) **Secondary curves**, convex anteriorly, and named "Secondary"; because they appear as the baby develop and will have a reversed curvature direction, these are:

- ① Cervical curve, appears when the head of the baby gets bigger
- ② Lumbar curve, appears when the baby walks and assumes upright posture

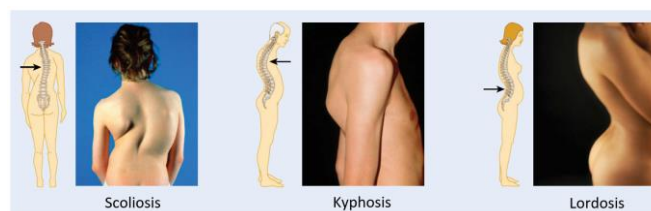


➤ Functions of the vertebral curves:

- ① increase the strength of the vertebral column
- ② maintain balance in the upright position
- ③ helps in absorbing shocks
- ④ protects the vertebrae from fracture

➤ There are also abnormal curves of the vertebral column, which are:

- **Scoliosis**: lateral bending of the vertebral column, can be congenital or due to paralysis of muscles on one side
- **Kyphosis**: an increase in the thoracic curvature, occurs in older people because of the degeneration of the IV discs
- **Lordosis**: an increase in the lumbar curvature, result from increase weight of the abdomen like in pregnancy or obesity



Regions of vertebral column

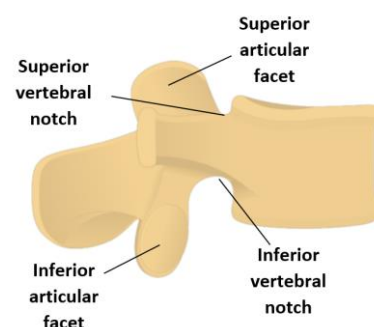
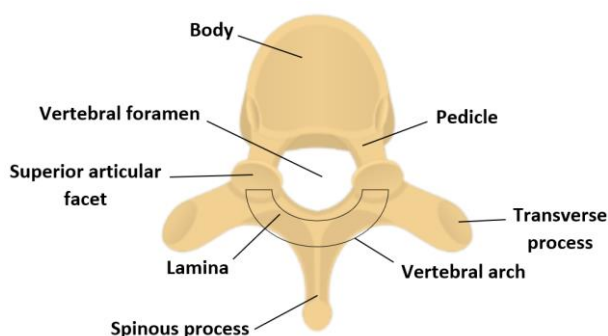
Regions Differences	Cervical	Thoracic	Lumbar	Sacrum	Coccyx (Tailbone)
Location	Neck	Thorax	Abdomen	Between the 2 hip bones	Inferior to the sacrum
Number of vertebrae	C1 - C7	T1 - T12	L1 - L5	S1 - S5 (Fused)	Co1 - Co4 (Fused)
Function	supports the head/skull	holds the ribs posteriorly	carries the most of body's weight	forms the posterior part of the pelvis	weight-bearing while sitting
Curve direction (Anterior view)	Convex	Concave	Convex	Concave	Concave

Anatomy of vertebral column

Typical vertebra

All vertebrae share many features and structures, listed below:

- **Body (Centrum)**, the largest and the most anterior part of the vertebra, it's the main weight-bearing part of a vertebra
- **Pedicles**, the two extensions of the lateral sides of the body which make the anterior portion of the vertebral arch
- **Laminae**, two plates that extend from the pedicles and make the posterior portion of the vertebral arch
- **Superior articular process**, a superior process near the point where lamina and pedicle are met, it has a facet that articulates with the inferior articular facet of the vertebra above
- **Inferior articular process**, a process that extends inferiorly from the superior articular process and it articulates with the superior articular facet of the vertebra below
- **Transverse process**, two processes that arise laterally from the junction of the pedicles and laminae and help as an attachment point for several structures, and each transverse process has a facet that aids in that attachment
- **Vertebral arch (Neural arch)**, the posterior portion of a vertebra, it is made of both laminae
- **Spinous process**, a posterior projection from the vertebral arch, serves as attachment point for muscles and ligaments
- **Superior & Inferior vertebral notch**
- **Intervertebral foramen (Neural foramen)**, a lateral foramen between each 2 vertebrae where the spinal nerves exit the spinal cord, consists of superior & inferior vertebral notches
- **Vertebral foramen (Spinal foramen)**, a foramen intermediate to the body and the vertebral arch, the aggregation of the vertebral foramina of all the vertebrae make the vertebral canal where the spinal cord runs through



Cervical vertebrae

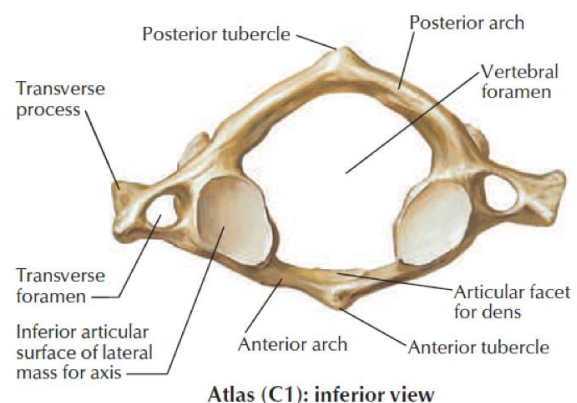
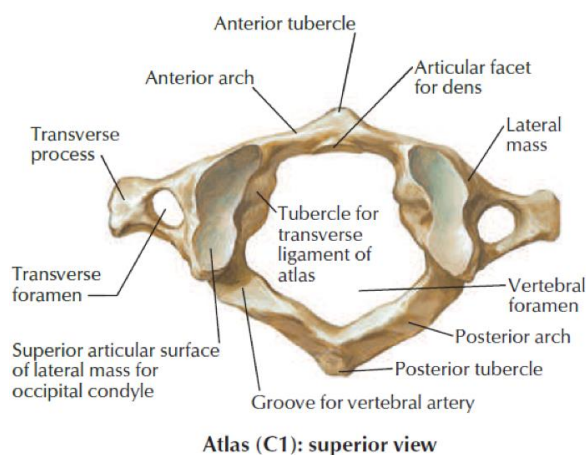
➤ Main characteristics of all cervical vertebrae:

- ❶ the transverse process contains transverse foramen (**Key feature**)
- ❷ the transverse process is **bifid**
- ❸ the spinous process is **bifid**; there is a depression in the middle of the spinous process that divides it into 2 sides
- ❹ superior articular facet is facing **superiorly** & inferior articular facet is facing **inferiorly**
- ❺ cervical vertebrae have the largest vertebral foramina

➤ Atypical cervical vertebrae:

[1] **Atlas (C1)**, the first vertebra in the spinal cord and in the cervical region and it has the suitable structures to receive the skull, and it has many unique features:

- **Lateral masses**, the two thickest parts of the atlas, the atlas has no body but instead these 2 lateral masses
- **Superior articular facet**, a facet in each lateral mass, and it articulates with the condyles of the occipital bone
- **Inferior articular facet**, the facet in each lateral mass, and it articulates with the superior articular facet of the (C2)
- **Anterior arch**, arch extending anteriorly from the transverse processes & encloses the vertebral foramen anteriorly
- **Posterior arch**, arch extending posteriorly from the transverse processes & encloses the vertebral foramen posteriorly
- **Anterior tubercle**, elevation at the apex of the anterior arch, and serves as an attachment point for a muscle
- **Posterior tubercle**, elevation at the apex of the posterior arch, and serves as an attachment point for a muscle
- **Articular facet of dens (Median facet)**, an anterior facet where the axis attaches to the atlas

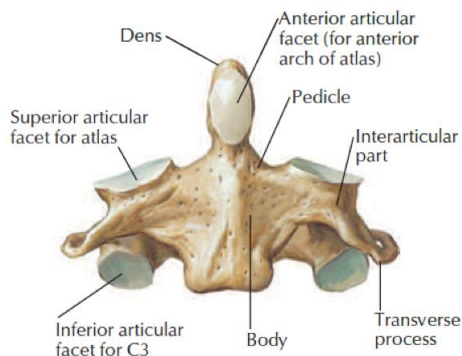


[2] **Axis (C2)**

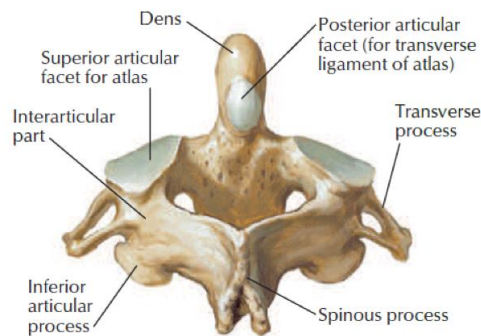
- **Odontoid process (The dens)**, a tooth-like process that connects the atlas with the axis by the articulation between this process and the articular facet of dens (median facet) to make a pivot joint that allows us to rotate the head left and right as if we are giving the gesture of saying "NO"

*****Note:** There are 2 articulations between the Atlas & the Axis:

- **Medial articulation** → between the odontoid process of the axis and the median facet of the atlas
- **Lateral articulation** → between the inferior articular facets of the atlas and the superior articular facets of the axis



Axis (C2): anterior view



Axis (C2): posterosuperior view

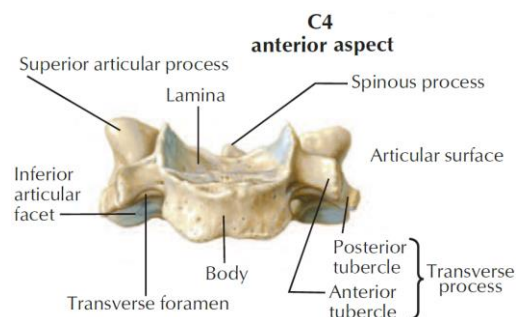
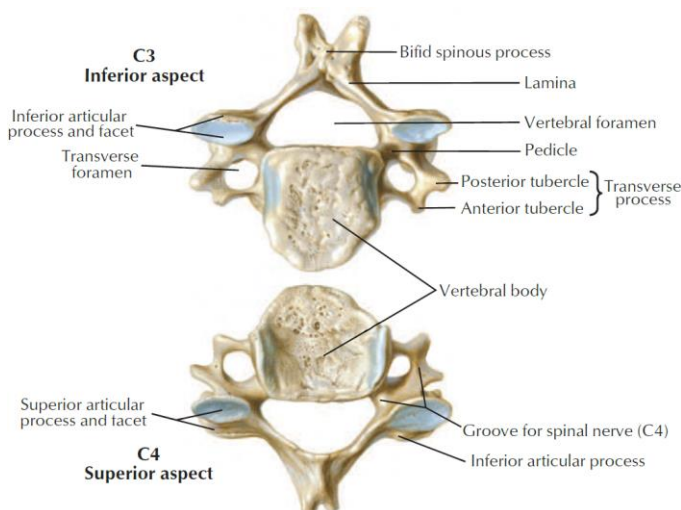
[3] **7th Cervical vertebra**, it has 2 features that makes it unique than the other cervical vertebrae, these are:

- the spinous process is not bifid
- the spinous process is more prominent (**subcutaneous**)

➤ Typical cervical vertebrae (C3 - C6):

- **Transverse foramen**, one foramen the edge of each transverse process, it is where the vertebral vessels pass through
- **Transverse tubercles**, 2 small tubercles at the edge of each transverse process

The prominent spinous process of C7



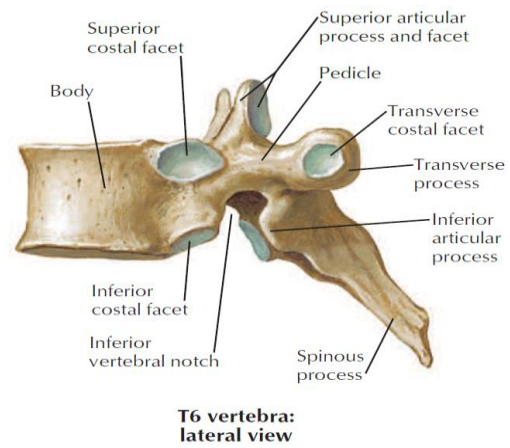
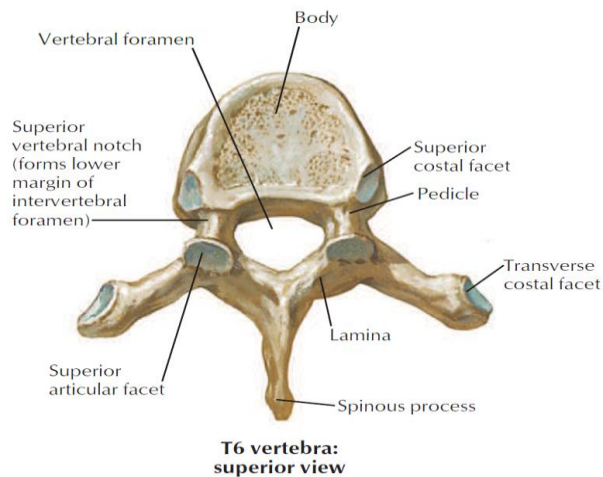
Thoracic vertebrae

➤ Main characteristics of all thoracic vertebrae:

- 1 the spinous process is directed downward (**Key feature**)
- 2 the body of the thoracic vertebrae has 2 (superior / inferior) facets called (**Costal facets**)
- 3 superior articular facet is facing **posteriorly** & inferior articular facet is facing **anteriorly**

➤ Thoracic vertebrae (T1 - T12):

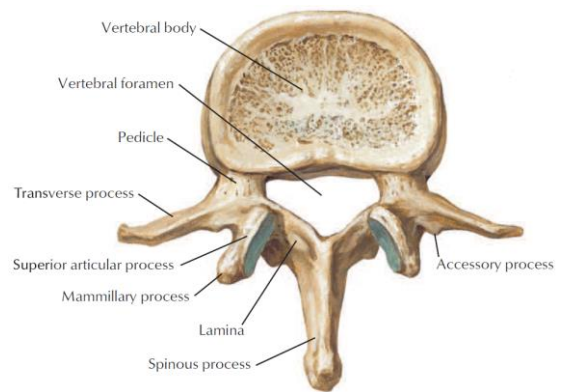
- **Costal facets**, flat facets on the thoracic vertebrae that aid in (Rib - Vertebral) articulation



Lumbar vertebrae

➤ Main characteristics of all lumbar vertebrae:

- 1 the body of a lumbar vertebra is **kidney-shaped and is the thickest and biggest of all the vertebrae**; because the weight bearing in the vertebral column & the size of vertebrae are increased as we go inferiorly
- 2 all the vertebra's processes are thick and short
- 3 Superior articular facet is facing **medially** & inferior articular facet is facing **laterally**
- 4 its superior articular process has a bump called (**Mamillary process**)
- 5 the facets of the transverse processes of the lumbar vertebrae are facing posteriorly



Comparison of Major Structural Features of Cervical, Thoracic, and Lumbar Vertebrae

CHARACTERISTIC	CERVICAL	THORACIC	LUMBAR
Overall structure			
Size	Small	Larger	Largest
Foramina	One vertebral and two transverse	One vertebral	One vertebral
Spinous processes	Slender and often bifid (C2–C6)	Long and fairly thick (most project inferiorly)	Short and blunt (project posteriorly rather than inferiorly)
Transverse processes	Small	Fairly large	Large and blunt
Articular facets for ribs	Absent	Present	Absent
Direction of articular facets			
Superior	Posterosuperior	Posterolateral	Medial
Inferior	Anteroinferior	Anteromedial	Lateral
Size of intervertebral discs	Thick relative to size of vertebral bodies	Thin relative to vertebral bodies	Massive

Intervertebral discs

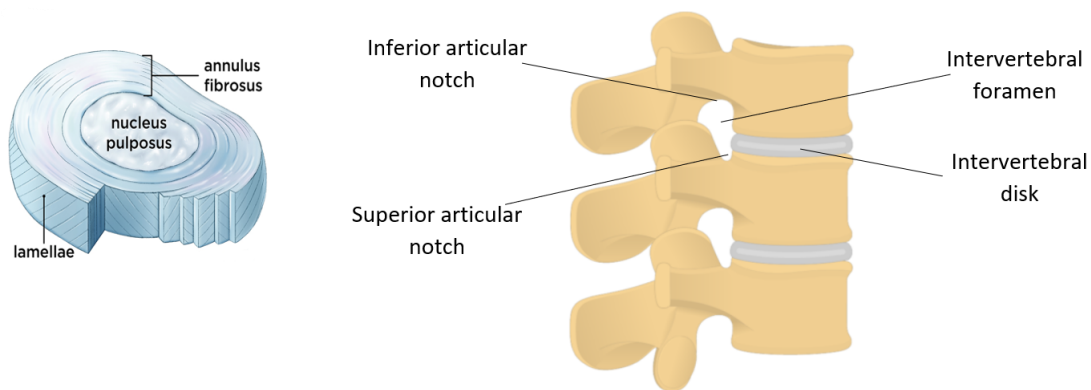
▪ **Intervertebral discs:** thick pads of CT between adjacent vertebrae, they acts as a shock absorber. An intervertebral disc consists of:

- **Annulus fibrosis**

- the outer layer, made up of several rings called (**lamellae**)
- the anterior pads are thicker than the posterior pads, so any injury to the annulus fibrosus will initially be suspected in the posterior pads

- **Nucleus pulposus**

- the inner gel-like soft substance that absorbs pressure directed on the spinal cord
- the gelatinous material forming the nucleus pulposus will lose some of its water content with aging



***Notes:

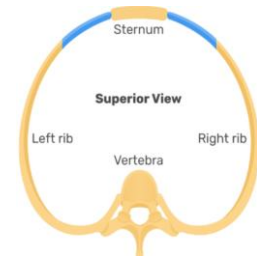
- If the intervertebral disc is damaged, it will collapse, exerting pressure on the spinal nerve that comes out from the intervertebral foramen near it
- With increasing in age, the nucleus pulposus becomes less hydrated and converts gradually into fibrocartilage, which results the intervertebral disc to lose its flexibility
- There is no intervertebral disc between:
 - The atlas (C1) and the axis (C2); because the atlas lacks its body
 - The sacral and coccygeal vertebrae; because the vertebrae of each one of them are fused

Lecture 5 p2: Thoracic cage

The thoracic cage is a part of the axial skeleton, why?

because the ribs of the thoracic cage originate from the thoracic vertebrae and grow anteriorly to reach the sternum, and both sternum and vertebral column are parts of axial skeleton

Ribs don't run horizontally, they run obliquely downwards until they reach the (**Costochondral junction**) between a rib and costal cartilage, then they go upwards



The Sternum

▪ **Sternum (Breastbone)**: a flat bone in the anterior aspect of the thoracic cage and it is subcutaneous, it articulates with the clavicles and the ribs, and protects the heart

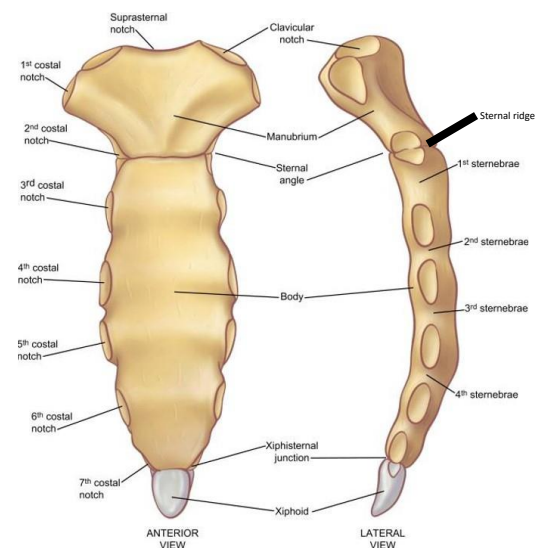
Anatomy of Sternum

• **Manubrium sterni (Upper end)**, the upper quadrangular portion of sternum, contains the following:

- **Jugular notch (Suprasternal notch)**, depression between the clavicular notches, contains the interclavicular ligament
- **Clavicular notch**, depression on each superolateral side of the manubrium sterni, they serve as articulation points for the medial end of the clavicles to make the (**Sternoclavicular joint**)
- **Sternal angle (Angle of Louis)**, transverse subcutaneous line between manubrium sterni and body of the sternum, located at the level of T4-T5 IV disc, it divides the articulation of the 2nd rib between manubrium sterni and body

• **Body**, articulates with the lower half of the 2nd rib, (3rd - 6th) ribs and the upper half of the 7th rib

• **Xyphoid process (Lower end)**, a cartilage that articulates with the lower half of the 7th rib. The xyphoid process remains as a cartilage until it is completely ossified at the age of 40. The xyphoid process articulates with the sternum in the (**Xiphisternal junction**)



The Rib cage

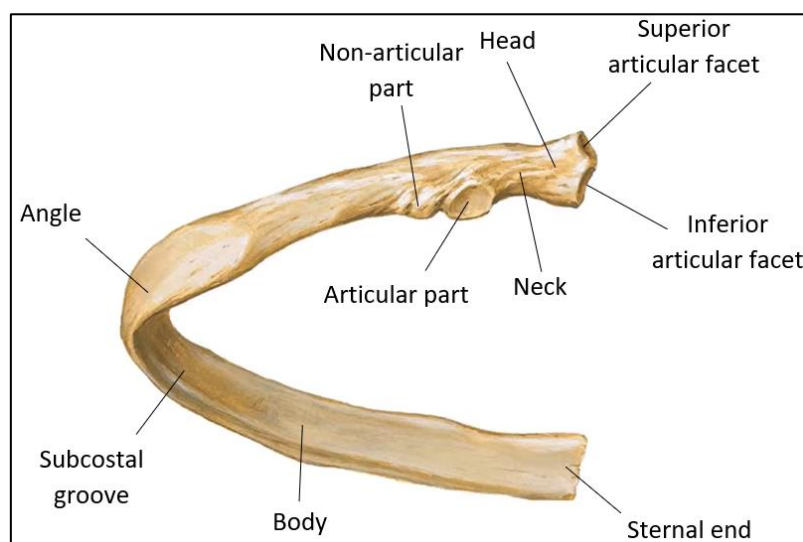
Types of the ribs

Ribs are classified into 3 types according to their **ANTERIOR articulation with the sternum**, as listed here:

Types of ribs	Illustration
True ribs <ul style="list-style-type: none"> - aka (Vertebro-sternal ribs) - 1st - 7th ribs - articulate with the sternum - each rib has its own costal cartilage 	
False ribs <ul style="list-style-type: none"> - aka (Vertebro-chondral ribs) - 8th - 10th ribs - articulate with the costal cartilage of the 7th rib, so indirect articulation with the sternum 	
Floating ribs <ul style="list-style-type: none"> - aka (Vertebral ribs) - 11th & 12th ribs - grow from T11 & T12 and stop anteriorly - have ill-developed costal cartilage that appears as a cap 	

Anatomy of typical ribs

- **Head**, has articular facets and it articulates with the costal facets of 1 or 2 thoracic vertebrae
- **Superior articular facet**, the facet that articulates with the **inferior costal facet** in the body of the thoracic vertebrae
- **Inferior articular facet**, the facet that articulates with the **superior costal facet** in the body of the thoracic vertebrae
- **Neck**, a constriction beyond the head
- **Costal tubercle (Articular tubercle)**, an elevation on the posterior surface of the rib at the junction of the head and neck, it has 2 parts:
 - ♦ **Articular part**, the facet part of the tubercle that articulate with the transverse process in the (Costotransverse joint)
 - ♦ **Non-articular part**, the bumpy part of the tubercle that doesn't make any articulation with the thoracic vertebrae, but serve as an attachment point for the (Costotransverse ligament)
- **Costal angle**, the area where the shaft bends/curves anteriorly
- **Subcostal groove**, elongated depression along the inferior/medial surface of the rib for the blood vessels and nerves to pass under the rib, this aggregation of the arteries, veins and nerves is called (**Intercostal neurovascular junction**)
- **Shaft (Body)**, the long, curved part of the rib
- **Sternal end**, the anterior end of the rib that attaches to the to the costal cartilage
- **Costal cartilage**, the hyaline cartilage that links the rib with its appropriate site, the costal cartilage's function is to allow the little movement of the expansion of the chest and to prevent the ribs from fracturing the sternum

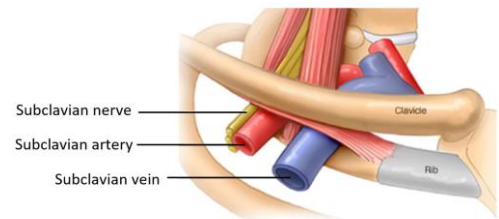


Atypical ribs

[1] 1st rib

- **Head**, has 1 articular facet that articulates with the manubrium sterni
- **Scalene tubercle**, an attachment point for **Scalenus anterior** muscle
- **2 grooves at the superior surface of the 1st rib**:

- ♦ **Anterior groove** → passes the **Subclavian vein**
- ♦ **Posterior groove** → passes the **Subclavian artery** & **Subclavian Nerve**



[2] 2nd rib, has a rough tuberosity for **Serratus anterior** muscle

[3] 10th rib, the head has 1 facet instead of 2

[4] 11th & 12th ribs, the head has 1 facet instead of 2 & no neck or tubercle

*****Note:** Ribs are not the same, they differ in length, thickness and structure. The 1st rib is the smallest and the most curved, and as we go down the ribs become larger until the 7th rib, then start to decrease in length

Questions

1) All of the following are true regarding the spinal cord, EXCEPT:

- A. composed of 33 vertebrae, 23 IV discs, and a bunch of ligaments
- B. the vertebral column is attached to the appendicular skeleton by the pectoral girdle
- C. it houses and protects the spinal cord
- D. composed of 5 main regions: cervical, thoracic, lumbar, sacral, and coccygeal

2) Which of the following pairs are mis-matched, regarding the vertebral column curves?

- A. the cervical curve – secondary curve
- B. the thoracic curve – primary curve
- C. human fetus vertebral column – straight rather than curved
- D. Lumbar curve – convex anteriorly

3) The vertebra that holds a part of ribs of the following vertebrae is:

- A. T6
- B. C3
- C. L1
- D. Co3

4) A typical vertebra has a structure called (Vertebral arch), it is made up of:

- A. superior articular processes + laminae
- B. pedicles + laminae
- C. inferior articular processes + pedicles
- D. superior articular processes + inferior articular processes

5) The main/key characteristic of all cervical vertebrae is that:

- A. they lack the vertebral body
- B. the spinous process is directed upward/superiorly
- C. there are no IV discs between the cervical vertebrae
- D. their transverse processes contain transverse foramina

6) The U-shaped opening at the inferior end of the sacrum between the 2 sacral cornua is called the:

- A. Coccygeal cornua
- B. Sacral canal
- C. Sacral hiatus
- D. None of the listed are correct

7) Which of the following pair/s are missing their IV discs?

- A. C2-C3
- B. Two answers are correct
- C. S5-Co1
- D. L5-S1

8) The thoracic cage is considered a part of the axial skeleton; because:

- A. it doesn't articulate with the appendicular skeleton
- B. it is composed of irregular bones
- C. both the origin (thoracic vertebrae) and the insertion (sternum) of the ribs are parts of the axial skeleton
- D. the ribs are external to the organs occupied in the thoracic cavity

9) The most superficial/subcutaneous part of the sternum is the:

- A. Manubrium sterni
- B. Sternal angle
- C. Xiphoid process
- D. Clavicular notch

10) If a rib originates posteriorly from the thoracic vertebral column, and articulates with the costal cartilage of the 7th rib, this rib is classified as:

- A. True rib
- B. False rib
- C. Floating rib
- D. Vertebrosteral rib

Answers

1	2	3	4	5	6	7	8	9	10
B	C	A	B	D	C	C	C	B	B