



Skeletal System-3 Axial Skeleton

Introduction to Anatomy and Embryology

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Skull is formed by 22 bones.The bones of the skull can be divided into1- Cranial bones2- Facial bone

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Cranial Bones (8 bones)





Facial Bones (14 bones)

Zygomatic (2)

Maxilla (2)

Nasal (2)

Lacrimal (2)

Vomer (1)

Palatine (2)

Inferior Conchae (2)

Mandible (1)



Frontal bone



Nasal bone



Maxilla





Zygomatic bone (cheek bone)

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Mandible



Sphenoid





Vomer bone

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Frontal bone



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Parietal bone



Occipital bone



Temporal bone



Mastoid process (Temporal bone)

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External acoustic meatus (Temporal bone)

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Sphenoid bone



Zygomatic bone



Nasal bone







Mandible



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Temporomandibular joint (TMJ)

Between the temporal bone of the skull above and the mandible below

Type of Joint: Synovial hinge joint

Movements

The mandible can be depressed or elevated, protruded or retracted. Rotation can also occur, as in chewing



Occipital bone



Occipital bone

Foramen magnum (Latin: *great hole*) is a large oval opening in the occipital bone of the skull, through which the spinal cord passes

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Lambdoid suture

The junction of the sagittal and coronal sutures is the **Bregma**

The junction of the sagittal and lambdoid sutures is the Lambda

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Pterion

Frontal bone
Parietal bone
Temporal bone

4- Sphenoid bone

Dangerous area (why?)

Fontanel is a soft spot in the skull of an infant, covered with tough, fibrous membrane where ossification is not complete

Fontanelles close between 3 months and 2 years

Fontanelles:

- 1. Allow room for the baby's brain to grow
- 2. Enable the head to be compressed during delivery.

Note: Intramembranous ossification: Formation of bone within a fibrous membrane Example: flat bones of the skull

The Paranasal Sinuses

- The paranasal sinuses are cavities found in the interior of the maxilla, frontal, sphenoid, and ethmoid bones.
- They are lined with mucous membrane and filled with air.
- They communicate with the nasal cavity through relatively small apertures.

Frontal sinus

Maxillary

Functions:

- 1. Resonators of the voice
- 2. They also reduce the skull weight
- 3. Help warm and moisten inhaled air
- 4. Act as shock absorbers in trauma

Functions & Importance

- Protects the spinal cord & spinal nerves
- Supports the head
- Provides flexibility & resilience to the trunk
- Helps in movement

Curvatures of Vertebral Column

Primary Curves:

Concave anteriorly

Occur during fetal development

Atlas (C1)

- <u>Cervical curvature:</u> As the child starts to hold his head up

<u>- Lumbar curvature:</u>
As the child begins to walk & assumes upright posture

Intervertebral Discs

2 parts:

Annulus fibrosus (fibrous):

- ✓ Concentric layers of fibrocartilage
- \checkmark Strengthens the disc & protects the central part

Nucleus pulposus (gelatinous):

- \checkmark Central core of the disc
- ✓ More elastic (↑ water)
- ✓ Shock absorber

The intervertebral foramen is an oval-shaped opening formed between the pedicles of two adjacent vertebrae of the vertebral column. These foramina provide passageways for spinal nerves to carry information to and from the spinal cord

Spinal nerve Nucleus pulposus Annulus fibrosus

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Spinal cord

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Disc Herniation

Protrusion (leakage) of the gelatinous nucleus pulposus through the anulus fibrosus of intervertebral disc

Posterolateral direction:

Thinner annulus fibrosus

POSTERIOR Spinous process of vertebra Spinal cord Spinal nerve Herniation Nucleus pulposus Annulus fibrosus

95% in L4/L5 or L5/S1

ANTERIOR

Superior view

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Structure of Typical Vertebra

Lamina of the vertebral arch

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Pedicle of the vertebral arch

Joints of the vertebral bodies and arches

In order to maintain stability and secure movements of the vertebral column, the vertebrae articulate with each other by connecting their bodies and their arches.

The **intervertebral joints** are the articulations between the adjacent vertebrae of the vertebral column.

Each intervertebral joint is composed of three separate joints: - One intervertebral symphysis (intervertebral disc joint): - Two facet joints

An intervertebral symphysis is the articulation of two contiguous vertebral bodies and the intervening intervertebral disc.

Type: Secondary cartilaginous joint or symphysis (fibrocartilage composition).

Facet joints are between the superior articular process of one vertebra and the inferior articular process of the vertebra directly above it.

Type: Synovial plane joints

Atlas (1st cervical vertebra)

Characteristics:

- 1. no body
- 2. no spinous process
- 3. ant. & post. arches
- 4. 2 lateral masses
- 5. 2 transverse foramina

Typical cervical vertebra

Specific to the **cervical vertebra** is the **transverse foramen**

(foramen transversarium).

is an opening on each of the **transverse processes** which gives passage to the **vertebral artery**

Atlas (1st cervical vertebra)

Communicates:

Superiorly: base of skull (atlantooccipital joint) Flexion and extension: nodding of the *head (the YES movement)*

Type: Synovial condyloid (ellipsoid) joint.

Inferiorly: axis (atlanto-axial joint) Rotation: allows us to turn our head to look towards the left or towards the right

Type: Synovial pivot joint.

TABLE 7.5 Comparison of Major Structural Features of Cervical, Thoracic, and Lumbar Vertebrae CHARACTERISTIC CERVICAL THORACIC LUMBAR **Overall structure** Read only Small Larger Largest Size One vertebral and two transverse One vertebral One vertebral Foramina Slender and often bifid (C2-C6) Short and blunt (project posteriorly Spinous processes Long and fairly thick (most project inferiorly) rather than inferiorly) Small Fairly large Large and blunt Transverse processes Absent Present Absent Articular facets for ribs Direction of articular facets Posterosuperior Posterolateral Medial Superior Anteromedial Anteroinferior Inferior Latera Thick relative to size of Thin relative to vertebral Massive Size of intervertebral discs vertebral bodies bodies

Thoracic Cage

- Sternum (*G*, *sternon*= *chest bone*)
- 12 pairs of ribs & costal cartilages
- 12 thoracic vertebrae

Costal Cartilages

Costal cartilages are bars of cartilage connecting the upper seven ribs to the lateral edge of the sternum and the 8th, 9th, and 10th ribs to the cartilage immediately above. The cartilages of the 11th and 12th ribs end in the abdominal musculature.

The costal cartilages contribute significantly to the elasticity and mobility of the thoracic walls. In old age, the costal cartilages tend to lose some of their flexibility as the result of superficial calcification.

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Sternum

It lies in the midline of the anterior chest wall.

It is a flat bone that can be divided into three parts: manubrium sterni, body of the sternum, and xiphoid process.

The manubrium is the upper part of the sternum. It articulates with the body of the sternum at *the manubriosternal joint*, and it also articulates with the clavicles and with the first costal cartilage and the upper part of the second costal cartilages on each side. It lies opposite the third and fourth thoracic vertebrae.

The body of the sternum articulates above with the manubrium at the *manubriosternal joint* and below with the xiphoid process at the *xiphisternal joint*. On each side it articulates with the second to the seventh costal cartilages.

Xiphoid process

The xiphoid process is a thin plate of cartilage that becomes ossified at its proximal end during adult life. No ribs or costal cartilages are attached to it.

Cartilaginous joints

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Manubriosternal joint (Sternal angle)

lies opposite the intervertebral disc between the fourth and fifth thoracic vertebrae.

Manubriosternal Joint:

- ✓ Sternal angle (Angle of louis)
- ✓ Easily palpated
- ✓ Opposite to T4-T5 disc
- ✓ At 2nd costal cartilage:

The sternal angle is a palpable clinical landmark in surface anatomy

Counting the ribs & intercostal spaces

Clinical application: Sternum and Marrow Biopsy Since the sternum possesses red hematopoietic marrow throughout life, it is a common site for marrow biopsy. Under a local anesthetic, a wide-bore needle is introduced into the marrow cavity through the anterior surface of the bone. The sternum may also be split at operation to allow the surgeon to gain easy access to the heart, great vessels, and thymus.

Ribs

Flat curved bones

- ✓ There are 12 pairs of ribs, all of which are attached posteriorly to the thoracic vertebrae.
- ✓ The ribs are divided into three categories:
- True ribs $(1^{st} 7^{th})$: The upper seven pairs are attached anteriorly to the sternum by their costal cartilages.
- False ribs (8th 10th): are attached anteriorly to each other and to the 7th rib by means of their costal cartilages and small synovial joints.

Floating ribs (11th & 12th): have no anterior attachment.

True ribs $(1^{st} - 7^{th})$

Floating ribs (11th & 12th)

Features of typical rib

1. Head: has two facets for articulation with the numerically corresponding vertebral body and that of the vertebra immediately above.

2. Neck: is a constricted portion situated between the head and the tubercle.

3. Tubercle: is a prominence on the outer surface of the rib at the junction of the neck with the shaft. It has a facet for articulation with the transverse process of the numerically corresponding vertebra (articular & non articular parts)

4. Angle: where the shaft of the rib bends sharply forward.

5. Shaft (Body): is thin and flattened and twisted on its long axis.

Atypical ribs

- 1st rib: Flat, shortest, broadest, <u>one</u> facet on the head, scalene tubercle & grooves for subclavian vein and artery.
- 2nd rib: Rough tuberosity for serratus anterior muscle.
- **10th rib:** <u>One facet on the head.</u>
- 11th & 12th: <u>One</u> facet on the head & <u>no</u> neck or tubercle

Intercostal vein

Intercostal artery

Interco<u>stal</u> nerve A typical rib has a smooth superior border and a sharp, thin inferior border.

The inferior border of the rib contains a groove called the **costal groove**. The costal groove protects the neurovascular bundle.

They are arranged in the following order from above downward: intercostal vein, intercostal artery, and intercostal nerve (mnemonic: VAN).

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Note: Fifth right rib as it articulates with the vertebral column posteriorly and the sternum anteriorly. Note that the rib head articulates with the vertebral body of its own number and that of the vertebra immediately above

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Head of rib

Neck of rib

Tubercle of rib

Body of rib

Angle of rib

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1st rib

One facet on the head

Groove for subclavian vein

Scalene tubercle of first rib

The brachial plexus is a network of nerves that originates from the spinal cord in the neck and extends into the upper limb. It controls the motor and sensory functions of the upper limb.

The first rib is important clinically because of its close relationship to the lower nerves of the brachial plexus and the main vessels to the arm, namely, the subclavian artery and vein. The scalenus anterior muscle is attached to its upper surface and inner border.

Anterior to the scalenus anterior, the subclavian vein crosses the rib; posterior to the muscle attachment, the subclavian artery and the lower trunk of the brachial plexus cross the rib and lie in contact with the bone.

Clinical application: A cervical rib (i.e., an extra rib that forms above the first rib, extending from the seventh cervical vertebra) occurs in about 0.5% of humans.

Usually asymptomatic, but it can lead to issues such as pain, weakness, or numbness in the arm due to compression of nearby nerves and blood vessels, a condition known as thoracic outlet syndrome.

<image>

Groove for subclavian artery

11th & 12th ribs

One facet on the head & no neck or tubercle

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Joints of the Thoracic Wall

Summary 🙂

Joints of the Sternum

- ✓ The manubriosternal joint is a cartilaginous joint between the manubrium and the body of the sternum. A small amount of angular movement is possible during respiration.
- ✓ The xiphisternal joint is a cartilaginous joint between the xiphoid process (cartilage) and the body of the sternum. The xiphoid process usually fuses with the body of the sternum during middle age.

Manubriosternal joint

Xiphisternal joint

Costovertebral joints

1- Joints of the Heads of the Ribs (Costocorporeal joints)

The first rib and the three lowest ribs have a single synovial joint with their corresponding vertebral body. For the second to the ninth ribs, the head articulates by means of a synovial joint with the corresponding vertebral body and that of the vertebra above it. 2- Joints of the Tubercles of the Ribs (Costotransverse joints) The tubercle of a rib articulates by means of a synovial joint with the transverse process of the corresponding vertebra.

(This joint is absent on the 11th and 12th ribs.)

The movements on these joints are called 'pump-handle' or 'bucket-handle' movements, and are limited to a small degree of gliding and rotation of the rib head. The function of these movements is to enable lifting of the ribs upwards and outwards during breathing. The end result is the increase of the lateral diameter of the thorax and subsequent expansion of the lung as the air is being inhaled.

Joints of the Costal Cartilages with the Sternum

1- The first costal cartilages articulate with the manubrium, by cartilaginous joints that permit no movement (Sternochondral synchondrosis of 1st rib).

2- The 2nd to the 7th costal cartilages articulate with the lateral border of the sternum by synovial joints (Sternochondral joints).

3- The 6th, 7th, 8th, 9th, and 10th costal cartilages articulate with one another along their borders by small synovial joints (Interchondral joints).

Note: The cartilages of the 11th and 12th ribs are embedded in the abdominal musculature.

Joints of the Ribs and Costal Cartilages (Costochondral joints) These joints are cartilaginous joints. No movement is possible.

The hyoid bone

- \checkmark Is a U-shaped bone.
- ✓ The bone has a central body (forming the center of the "U") with two smaller protruding structures on the superior surface (lesser horns) and two larger bony protrusions from the body (greater horns).

Unlike other bony structures, the hyoid bone does not directly articulate with other bones. Instead, it is connected to neighbouring bones by muscular and ligamentous attachments.

Muscles that insert on the upper surface of the bone are known as **suprahyoid muscles**, while those attached to the lower surface are **infrahyoid muscles**.

