

B. Facial Bones

The facial region is made up of 14 skeletal elements which form the front part of the skull along with skeleton of nose, hard palate and lower jaw. The 14 facial bones are the nasal (2), maxillae (2), zygomatic (2), lacrimal (2), palatine (2), inferior nasal conchae (2), vomer, and mandible.

C. Auditory Ossicles

Each middle ear contains three tiny bones - Malleus, Incus and Stapes, collectively called Ear Ossicles.

D. Hyoid

A single U-shaped bone called hyoid is present on the floor of the buccal cavity. It supports the tongue and provides attachment for some muscles of the tongue, the pharynx and neck. The hyoid bone does not articulate with any other bone.

II. Vertebral Column

Our vertebral column is formed of 26 serially arranged units called vertebrae and is dorsally placed. It extends from the base of the skull and constitutes the main framework of the trunk. The vertebral column articulates with skull, pectoral girdle, pelvic girdle and the ribs. The vertebral column protects the spinal cord, supports the head and serves as the point of attachment for the ribs and musculature of the back.

The total number of vertebrae during early development is 33. As a child grows, several vertebrae in the sacral and coccygeal regions fuse. As a result, the adult vertebral column typically contains 26 vertebrae.

A. Regions of the Vertebral Column

The vertebral column is differentiated into cervical (7), thoracic (12), lumbar (5), sacral (5 fused vertebrae) and coccygeal (4 fused vertebrae) regions starting from the skull. It provides strength, support, and balance. (Fig. 17.3.3).

Frontal bone
Zygomatic bone

Sternum

Ribs

Ilium

Pubis

Ischium

(2) nasals
(2) palatines

Corona
Parietal

Lambdoid

Occipital
Temporal

Zygoma

External acoustic
Mastoid
S

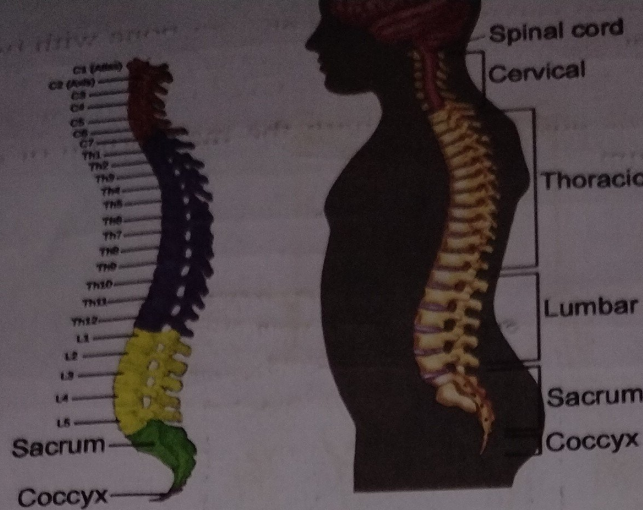


Fig. 17.3.3 Vertebral column

1. Cervical Vertebrae

The number of cervical vertebrae is seven in almost all mammals including human beings. First cervical vertebra (C_1) is the **atlas**. It has two superior articular facets that articulate with the occipital condyles. The second cervical vertebra (C_2) is the **axis**.

2. Thoracic Vertebrae

There are 12 thoracic vertebrae. They articulate with ribs. The vertebral bodies of thoracic vertebrae have **articular surfaces** that form articulations with the heads of the ribs.

3. Lumbar Vertebrae

The five lumbar vertebrae (L1 to L5) are the largest vertebrae. They withstand most of the body weight.

4. The Sacrum

The **sacrum** is a triangular bone formed by the union of five sacral vertebrae (S1–S5). The sacrum serves as a strong foundation for the pelvic girdle.

5. The Coccyx

The **coccyx** is formed by the fusion of usually four coccygeal vertebrae (Co1–Co4). It is considered a vestige of tail.

III. Thoracic Skeleton

Thoracic vertebrae, ribs and sternum together form the rib cage (**Fig. 17.3.4**). The thoracic cage

A. Sternum is situated on the ventral parts of the sternum central body, and process (**Fig. 17.3.4**).

1st thoracic vertebra

Costochondral joint

Costal cartilage

Costal cartilage

B. Ribs

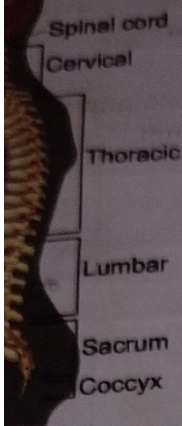
There are 12 pairs of ribs. They are curved, and the vertebral bodies of the ribs increase in size and then decrease in size. At the 10th rib, the vertebral body of the head, the head of the rib contacts the vertebral body. Thus it has a head and is hence called a head rib.

1. True Ribs

The true ribs are the first 10 pairs of ribs. They are connected to the sternum by the costal cartilage.

2. False Ribs

The false ribs are the last two pairs of ribs. They are not connected to the sternum by the costal cartilage.



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protects vital organs in the chest area and upper abdomen.

A. Sternum

Sternum is a flat and dagger-shaped bone situated on the ventral midline of thorax. The three parts of the sternum are the upper **manubrium**, the central **body**, and the lower cartilaginous **xiphoid process** (Fig. 17.3.4).

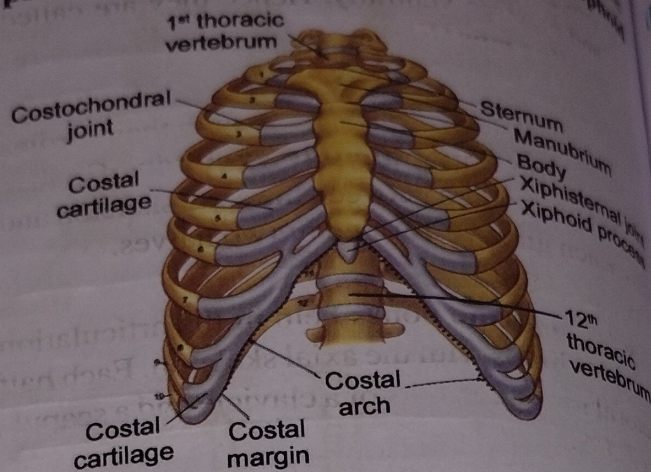


Fig. 17.3.4 Thoracic Cage

B. Ribs

There are 12 pairs of **ribs**. Each rib is an elongate, curved, flat bone connected dorsally to the vertebral column and ventrally to the sternum. The ribs increase in length from the first through seventh and then decrease in length to the twelfth rib (Fig. 17.3.4). A typical rib consists of head, neck and body. The vertebral end of the rib articulates with the vertebral column at the **head**, or **capitulum**. From the head, a short **neck** leads to the **tubercle** that contacts the transverse process of the thoracic vertebra. Thus it has two articulation surfaces on its dorsal end and is hence called **bicephalic** (double headed).

1. True Ribs

The first seven pairs are called **true ribs**, or **vertebrosternal ribs**. They reach the anterior body wall and are connected to the sternum by the **costal cartilages** (hyaline cartilages) (Fig. 17.3.4).

2. False Ribs

The next five pairs of ribs (8–12) are called **false ribs**, because they do not attach directly to the sternum.

Vertebrochondral Ribs:
pairs of ribs do not articulate with the sternum but join to each other at the 7th rib with the help of the **costal cartilages**. These are called **vertebrochondral ribs** (Fig. 17.3.4).

Floating Ribs: Last two pairs of ribs (11 and 12) are not connected to the sternum and are free ventrally. These are called **floating ribs** (Fig. 17.3.4).

17.3.2 Appendicular Skeleton

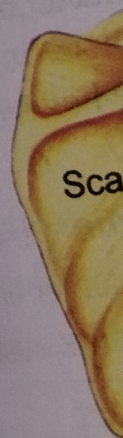
The bones of the limbs constitute the **appendicular skeleton**. They provide a connection between the axial skeleton and the limbs. Each girdle is formed by two bones.

A. Pectoral Girdle

The **pectoral girdle** consists of the upper limbs with the scapula and clavicle. It provides support for the upper limbs and connects them to the axial skeleton (Fig. 17.3.6).

A. Scapula

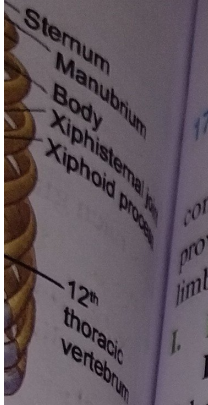
Scapula is a large, flat bone located in the dorsal part of the thorax. It articulates with the seventh rib and the scapula has a spine which projects laterally and is called the **acromion**. Below the acromion is the **glenoid cavity** which articulates with the head of the humerus to form the shoulder joint.



Scapula

chest area and upper

larger-shaped bone of thorax. The thoracic vertebrae are connected by intervertebral discs. The sternum is a cartilaginous structure.



age

is an elongated bone dorsally. The sternum is composed of the manubrium, body, and xiphoid process. The 12th rib is the last rib. The neck and body of the vertebrae articulate with the intervertebral discs. The scapula is a triangular bone.

ribs, for the costal

Vertebrochondral Ribs : The 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum but join to each other, and also with the 7th rib with the help of hyaline cartilage (Fig. 17.3.4). These are called **vertebrochondral ribs**.

Floating Ribs : Last 2 pairs (11th and 12th) of ribs are not connected ventrally to the sternum and are free ventrally. Hence they are called **floating ribs** (Fig. 17.3.4).

17.3.2 Appendicular Skeleton

The bones of the limbs along with their girdles constitute the **appendicular skeleton**. Girdles provide a connection between the axial skeleton and limbs. Each girdle is formed of two halves.

I. Pectoral Girdle

Pectoral girdle bones help in the articulation of the upper limbs with the axial skeleton. Each half of pectoral girdle consists of a clavicle and a scapula (Fig. 17.3.6).

A. Scapula

Scapula is a large triangular flat bone situated in the dorsal part of the thorax between the second and the seventh ribs. The dorsal, flat, triangular body of scapula has a slightly elevated ridge called the **spine** which projects as a flat, expanded process called the **acromion**. The clavicle articulates with this. Below the acromion is a depression called the **glenoid cavity** which articulates with the head of the humerus to form the shoulder joint. (Fig. 17.3.5).

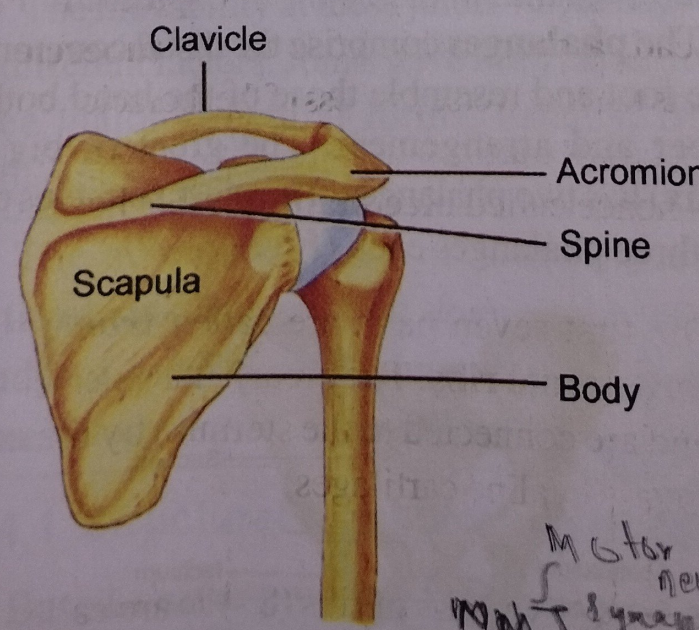


Fig. 17.3.5 Scapula

Motor neuron
synapse
sacrolemma
skeletal muscle

B. Clavicle

Each clavicle is a curved bone. This bone articulates with the scapula and medially with the sternum.

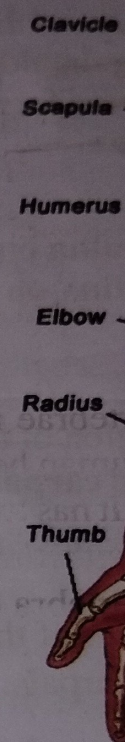


Fig. 17.3.6 U

II. Pelvic Girdle

Pelvic girdle articulates the lower limb. The pelvic girdle consists of three bones. Each consists of fusion of three bones. (Fig. 17.3.8).

At the point of articulation, the acetabulum cavity is formed. The femur articulates with this.

The two halves of the pelvis are joined ventrally (anteriorly) by the pubic symphysis containing fibrocartilage.

The hip bones form the bony framework of the lower limb and pelvic column and provide support to the lower limbs to the

III. Bones of the Upper Limbs

The upper limbs are adapted for freedom of movement. Each upper limb has 30 bones: humerus, radius and ulna, 8 carpals in the wrist, 5 metacarpals in the palm and 14 phalanges in the digits (*Fig. 17.3.6*).

A. Humerus

The **humerus** is the long bone of the upper arm. Proximally, the humerus forms a **shoulder joint** with the scapula. Distally, the humerus forms an **elbow joint** with the ulna of the forearm.

B. Radius and Ulna

The forearm bones are the **ulna** on the medial (little finger) side and the **radius** on the lateral (thumb) side.

C. Carpals

The wrist is the proximal region of the hand. It consists of eight small bones called **carpals** arranged in two rows.

D. Metacarpals

Palm is the intermediate region of the hand. It consists of five bones called metacarpals.

E. Phalanges

The **phalanges** (singular: phalanx) are the bones of the digits, the distal part of the hand. There are 14 phalanges in the five digits of each hand. The thumb (**pollex**) has two phalanges, and there are three phalanges in each of the other four digits (*Fig. 17.3.7*).



Fig. 17.3.7 Skeleton of the Hand

IV. Bones of the Lower Limbs
The lower limbs are adapted for locomotion. Each lower limb has 30 bones: femur, tibia and fibula, 7 tarsals in the ankle and 14 phalanges in the digits.

A. Femur

The femur is the long bone of the thigh. It articulates with the pelvis at the hip joint and with the tibia and patella at the knee joint (*Fig. 17.3.8*).

B. Patella

A small triangular bone, the patella (kneecap), is located anterior to the knee joint (*Fig. 17.3.8*).

C. Tibia

The tibia is the large bone of the lower leg. It articulates with the femur at the knee joint and with the talus bone at the ankle joint. The fibula is the smaller bone of the lower leg, located lateral to the tibia.

D. Talus

The talus is a small bone located between the tibia and the calcaneus. It articulates with the distal ends of the tibia and fibula and with the calcaneus.

E. Metatarsals

The metatarsals are the five long bones of the foot. They articulate with the tarsals at the ankle and with the phalanges of the toes.

F. Phalanges

The phalanges are the bones of the toes. The thumb (hallux) has two phalanges, and the other four toes have three phalanges each.

IV. Bones of the Lower Limbs

The lower limbs (legs) are adapted for locomotion and support. Each lower limb has 30 bones: femur (thigh bone), patella, tibia and fibula, 7 tarsals in the ankle, 5 metatarsals and 14 phalanges in the digits (**Fig. 17.3.9**).

A. Femur

Femur is the longest and heaviest bone of the body. The proximal end of the femur consists of a rounded head that articulates with the acetabulum of the hip bone to form the **hip (coxal) joint**. Distally, femur articulates with the tibia of the leg at the **knee joint** (**Fig. 20.3.9**).

B. Patella

A small cup shaped (triangular) bone called **patella** (knee cap) covers the knee joint anteriorly (**Fig. 17.3.9**). It is a **sesamoid bone**.

C. Tibia and Fibula

Tibia and fibula bones together support the shank of the leg (**Fig. 17.3.9**). The **tibia**, or **shin bone**, is the larger, medial, weight-bearing bone of the leg. The **fibula** is a slender bone that lies parallel and lateral to tibia.

D. Tarsals

The **ankle** is the proximal region of the foot. It consists of seven tarsal bones. (**Fig. 17.3.9**).

E. Metatarsals

The intermediate region of the foot consists of five **metatarsal bones**. They distally articulate with the phalanges of the leg (**Fig. 17.3.9**).

F. Phalanges

The **phalanges** comprise the distal component of the foot and resemble those of the hand both in number and arrangement. The great or big toe (**hallux**) has two phalanges. The other four toes each have three phalanges each (**Fig. 17.3.9**).

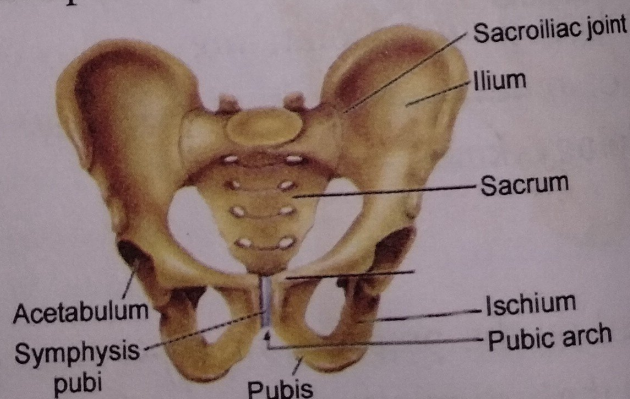


Fig. 17.3.8 Pelvic Girdle

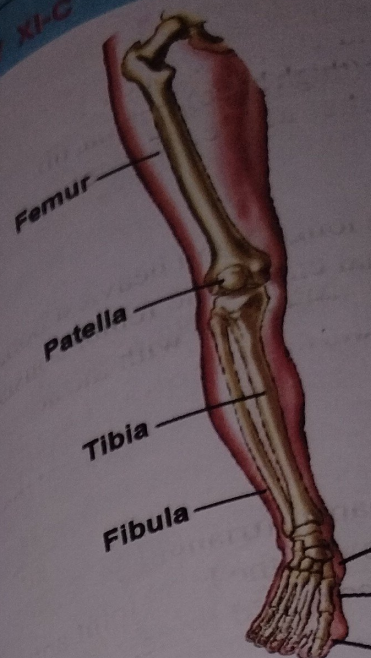


Fig. 17.3.9 Lo

17.4 JOINTS

A **joint**, or **articulation**, is the contact between two bones. Joints are essential for locomotory movements involving the force generated by the movement through joint fulcrum.

The movability at joints depends on different factors. Joints are classified into three major structural types: fibrous, cartilaginous and synovial.

The scientific study of motion is called **kinesiology** (kin + nosis).

17.4.1 Structural

Based on the structure of the joint, it is classified into three types: fibrous, cartilaginous and synovial.

B. Clavicle

Each clavicle is a long slender bone with two curvatures. This bone is commonly called the **collar bone**. Each clavicle articulates laterally with a scapula and medially with the manubrium of the sternum.

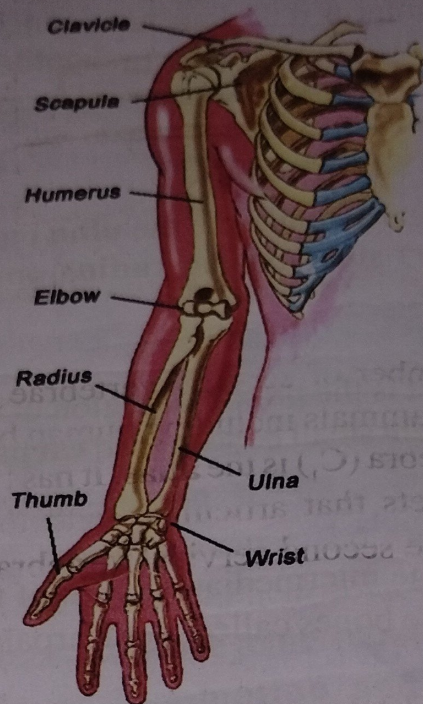


Fig. 17.3.6 Upper limb and pectoral girdle

II. Pelvic Girdle

Pelvic girdle bones help in the articulation of the lower limbs with the axial skeleton. Pelvic girdle consists of two **coxal bones**, or **innominate bones**. Each coxal bone (hip bone) is formed by the fusion of three bones – ilium, ischium and pubis (**Fig. 17.3.8**).

At the point of fusion of the above bones is a cavity called **acetabulum** to which the thigh bone articulates.

The two halves of the pelvic girdle meet ventrally (anteriorly) to form the **pubic symphysis** containing fibrous cartilage.

The hip bones, sacrum, and pubic symphysis form the **bony pelvis**. It supports the vertebral column and pelvic viscera and attaches the free lower limbs to the axial skeleton.