



# Ratna Sagar

RATNA SAGAR

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**Education, Our Mission**



As per the latest ICSE syllabus

 Ratna Sagar

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Revised and Updated

# LIVING SCIENCE BIOLOGY

D K Rao • J J Kaur

9



EDUCATION, OUR MISSION



# ICSE

## Living Science

# Biology

Class 9

**Chapter 12 Movement and Locomotion**



## LEARNING OBJECTIVES

### The Human Skeletal System

- ❖ Functions of human skeleton
- ❖ The Human Skeleton
- ❖ Axial skeleton
- ❖ Appendicular skeleton

### Joints

- ❖ Classification of joints
- ❖ Functional classification
- ❖ Structural classification
- ❖ Some common disorders associated with skeleton and joints

### Muscle and Movement

### How do we define the skeletal system?

The internal framework of bones and cartilage that protects our organs and helps us in movement is called the **skeletal system**



## Key terms to remember

- ❖ **Skeletal system or skeleton:** The internal framework of bones and cartilage that protects organs and helps in movement.
- ❖ **Axial skeleton:** The part of the skeleton that lies around the body axis. It comprises of skull, vertebral column and ribcage which protect delicate organs like brain, spinal cord, heart and lungs.
- ❖ **Appendicular skeleton:** The part of the skeleton that consists of the bones of the free appendages— upper and lower limbs, and the bones (girdles) which connect the limbs to the axial skeleton, i.e. pectoral and pelvic girdle.
- ❖ **Fibrous joints:** The joints in which there is no synovial cavity and the bones are held together by fibrous connective tissue.
- ❖ **Cartilaginous joints:** A joint in which there is no synovial cavity and the bones are held together by cartilage.
- ❖ **Synovial joints:** The joints in which there is a synovial cavity and bones forming the joint are united by a surrounding articular capsule and accessory ligaments.
- ❖ **Hinge joint:** A joint in which the convex surface of one bone fits into the concave surface of another bone and movement is primarily in one direction or in a single plane only.



- ❖ **Pivot joints:** This type of joints allow rotation around an axis, i.e. neck and forearms.
- ❖ **Gliding joints:** The joints in which articulating surface of the bones are usually flat and one bone slips over the other.
- ❖ **Ball and socket joints:** A joint in which ball-like surface of one bone fits into a cup-like depression of another bone, and movement is primarily in three planes of motion.

### **What are bones and cartilages?**

**Bone:** Bone is a rigid (non-flexible) and hard connective tissue that forms the framework and supports the body. It also supports the muscles and main organs of the body.

**Cartilage:** A white semi-opaque tissue which consists of matrix along with proteins and sugars is called **cartilage**.

### **Functions of human skeleton**

The human skeleton performs many functions such as:

- ❖ **Support:** The skeleton provides an internal framework for the body. The **rigid skeleton supports the weight of the body**, supports many soft tissues, **maintains the shape of the body** and provides a site of attachment for many muscles.



- ❖ **Protection:** The **skeleton protects many internal organs from injury**. For example, the brain, eyes and inner ear are protected by the skull; the spinal cord is protected by the vertebral column and the heart and lungs are protected by the thoracic bones (ribcage).
- ❖ **Movement and locomotion:** Many **bones act as levers**, when muscles pull on the levers, they produce movement. **Locomotion is the coordinated action of muscles on the limb bones to which they are attached by tendons**. When the muscles contract, bones acting as levers and movable joints acting as fulcrums bring about movement.
- ❖ **Blood cell formation (haematopoiesis):** Red bone marrow in several long bones (humerus and femur) produces blood corpuscles, i.e. red blood cells, some white blood cells and blood platelets.
- ❖ **Storage of minerals:** Bones store calcium and phosphorus. These minerals can be distributed to other parts of the body as and when required.

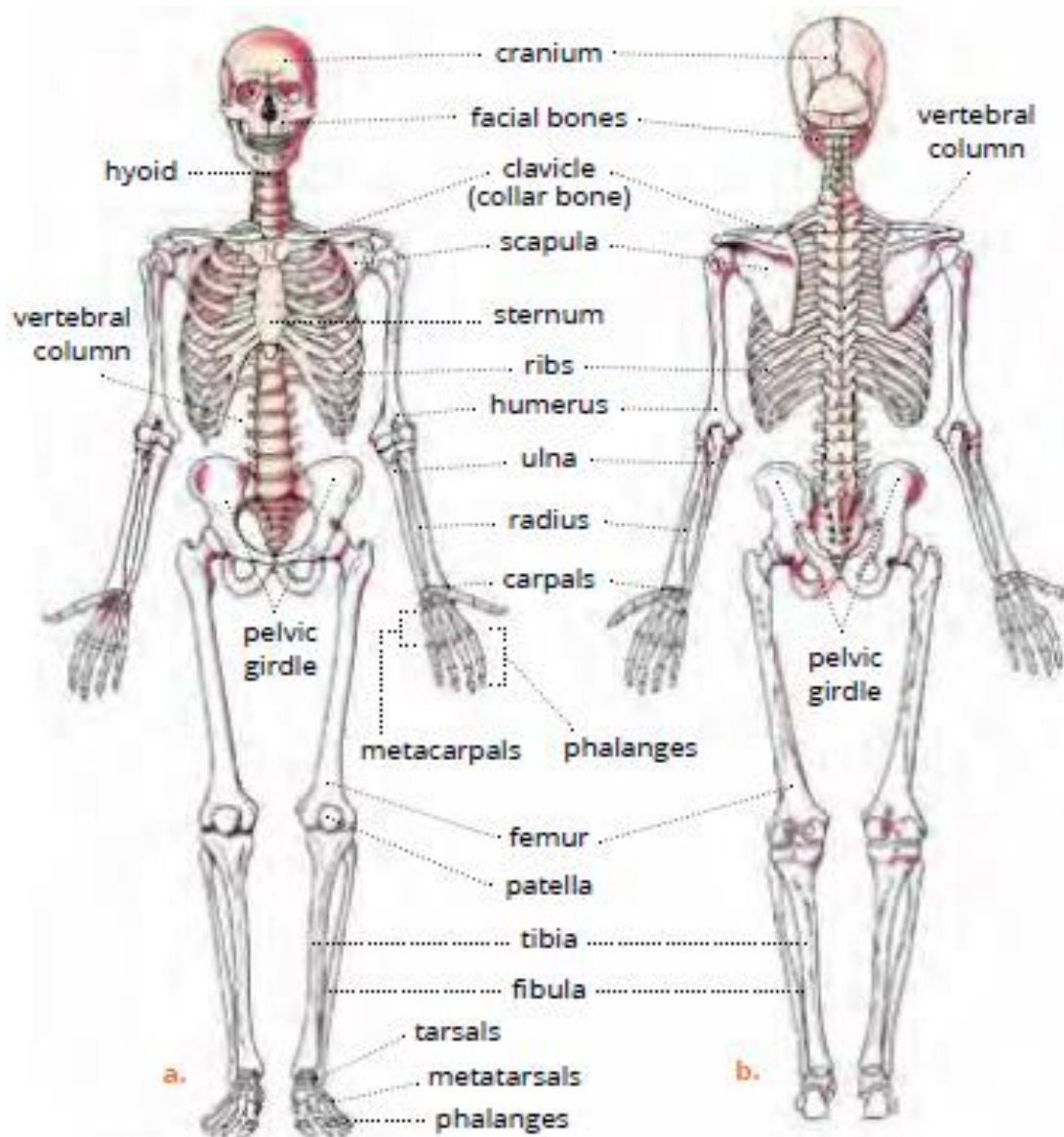
## **The Human Skeleton**

The skeleton of an adult human consists of 206 bones in the form of **long bones (femur, humerus, etc); short bones (wrist and ankle bones); flat bones (skull bones, ribs, shoulder blades); and irregular bones (vertebrae, lower jaw, etc)**. The overall human skeleton consists of two parts:

1. Axial skeleton
2. Appendicular skeleton



There are **80 bones in the axial skeleton** and **126 bones in the appendicular skeleton**.



The human skeleton  
a. anterior view and  
b. posterior view



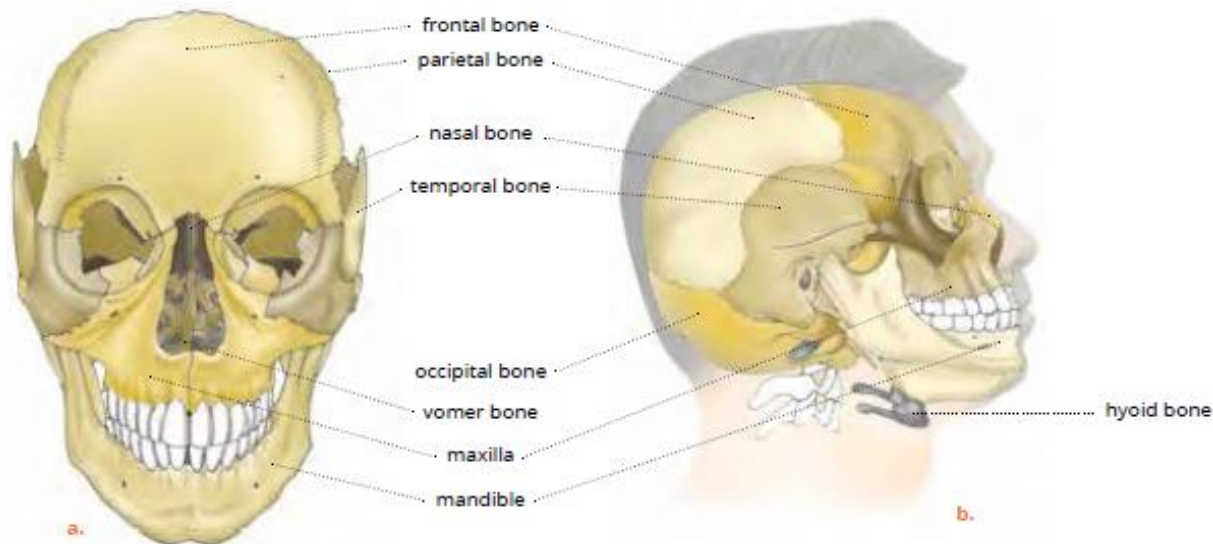


## Axial skeleton

The axial skeleton consists of the bones that form the upright portion or the axis of the body, i.e. skull, ribs, hyoid bone, ear bones, vertebral column (back bones) and sternum are the bones of axial skeleton.

## Skull

The skull which rests on the superior (upper) end of the vertebral column is the body's most complex bony structure. It is made of two sets of bones, namely the **cranial bones** and **facial bones**. There are total **22 bones in the skull**, out of which 8 are **cranial bones** and **14 are facial bones**. These bones protect the brain and sensory organs. **All bones of the skull are firmly united by interlocking joints called sutures.**



The human skull showing various bones a. front view and b. side view



## Vertebral column

It forms the central axis of the body with the skull resting on it. **Vertebral column consists of 33 irregular bones called vertebrae.** Between the vertebrae, a fibrocartilaginous disc called **intervertebral disc** is found. The vertebral column is divided into the following five regions :

**1. Cervical region:** It consists of seven vertebrae. The first vertebra is called **atlas**, second is **axis**, and rest are called typical cervical vertebrae.

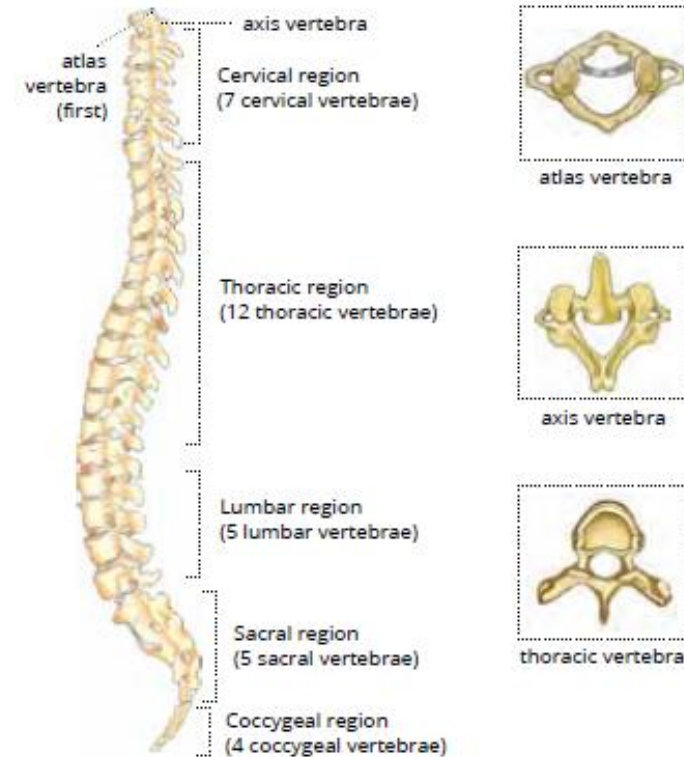
*Functions:* Cervical vertebrae allow movement of head, and bending and twisting of neck.

**2. Thoracic region:** There are twelve thoracic vertebrae. The neural spine of these vertebrae is long and pointed, and provides a surface for muscle attachment.

*Functions:* Thoracic vertebrae support the ribcage and allow some bending and rotation of the trunk.

**3. Lumbar region:** It has five lumbar vertebrae in this region.

*Functions:* Lumbar vertebrae allow bending and rotation of trunk.





**4. Sacral region:** It has five sacral vertebrae, fused together. These are present on both sides of pelvic girdle and form a joint with it.

*Functions:* Sacral vertebrae transmit weight of the body to hips and legs.

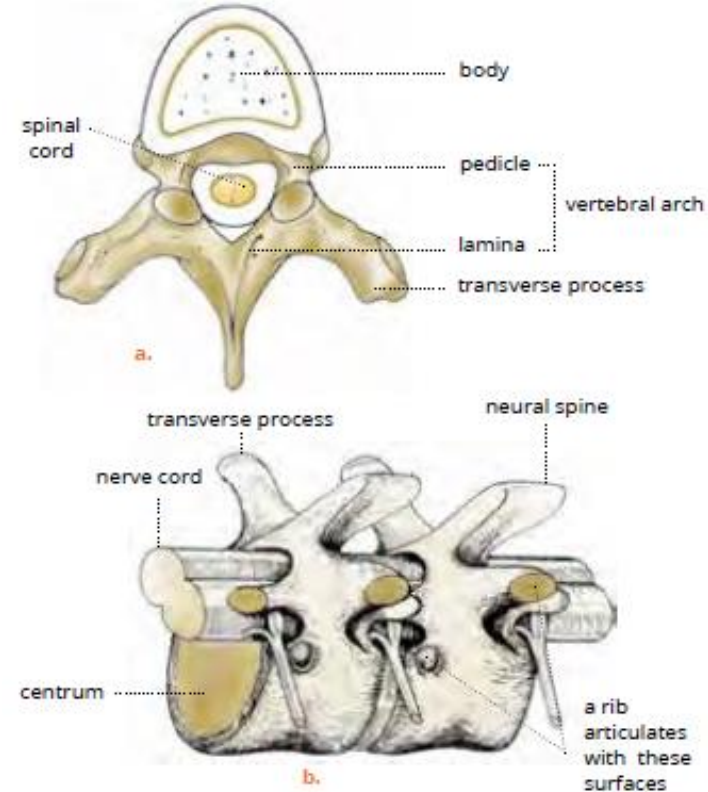
**5. Coccygeal (caudal) region:** It has four coccygeal vertebrae. These vertebrae are fused together to form a coccyx.

*Functions:* No function in humans.

## Structure of a vertebra

All vertebrae have a common structural plan  
Each vertebra is an irregular ring-like bone which has a **main body or centrum**, and a **vertebral arch** posteriorly.

The **centrum** is the thick, disc-shaped anterior portion which is **weight bearing part of the vertebra**. The **vertebral (or neural) arch** extends posteriorly from the body of the vertebra. It has a canal called **neural canal** that runs in the centre of the neural arch. The **spinal cord runs through this vertebral or neural canal**.





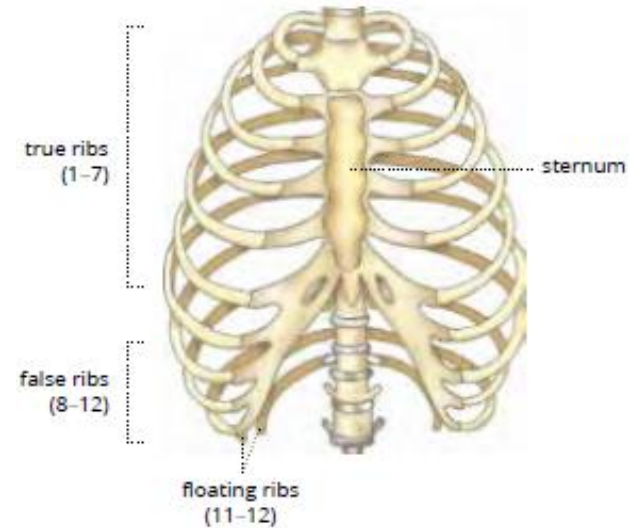
## Sternum

The sternum or breastbone is a flat, narrow bone located in the median line of the front part of chest. **Most of the ribs are attached to the sternum.**

## Ribs

There are **twelve pairs of ribs** which make-up the sides of the thoracic cavity . The ribs along with breastbone and thoracic vertebrae form the bony ribcage. The **first to seventh ribs have a direct anterior attachment to the sternum** by a strip of hyaline cartilage. **These ribs are called true ribs.** The remaining five pairs of ribs do not attach directly to the sternum. Hence, they are called **false ribs.**

Out of these, the last two pairs (eleventh and twelfth) are called **floating ribs** because their anterior ends do not attach even indirectly to the sternum, they attach only posteriorly to the thoracic vertebrae.



## Appendicular skeleton

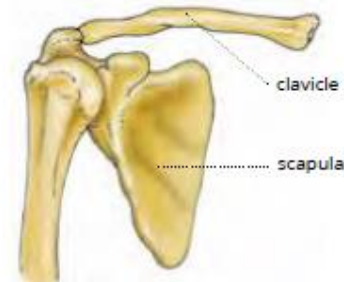
The appendicular skeleton is so named because the bones of appendicular skeleton are appended (attached) to the axial skeleton.



The appendicular skeleton consists of bones of free appendages – upper and lower limbs, pectoral girdle and pelvic girdle. The **appendicular skeleton in humans consists of 126 bones**, i.e. those of pectoral girdle (four bones), pelvic girdle (two bones), forelimbs (arms) (60 bones) and hindlimbs (legs) (60 bones).

### The pectoral (shoulder) girdle

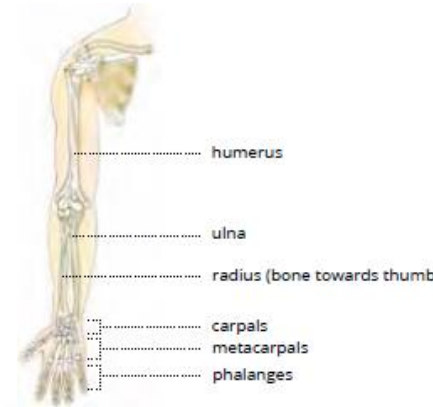
The **pectoral or shoulder girdle consists of two bones**, the **anterior clavicle** and the **posterior scapula**. The paired pectoral girdle and associated muscles form our shoulders.



**The pectoral girdle attach the bones of the upper extremities to the axial skeleton.** The **clavicles** or **collarbones** are slender, doubly curved long bones, which articulate with the sternum. The scapula articulates with the clavicle and humerus.

### Bones of the limbs

**Upper extremity or forearm or forelimb** The forelimbs consist of 30 bones each, i.e. a total of 60 bones. Each forelimb consists of single long bone, the humerus, ulna and the radius on the sides of the thumb.

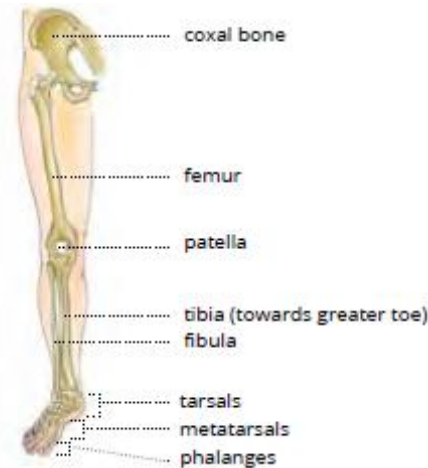




There are eight carpals (wrist bones), five metacarpals (palm bones) and fourteen phalanges in the fingers of the hand.

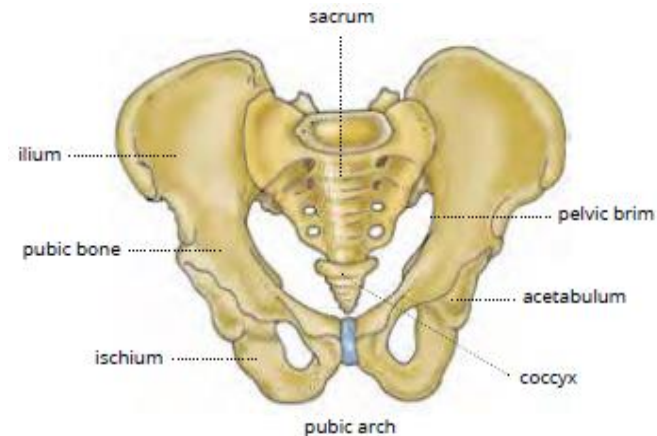
## Lower extremity or hindlimb

Each lower extremity, the leg, is composed of 30 bones, i.e. the two legs consist of a total of 60 bones. Each leg includes the long bone femur in the thigh, patella (knee cap) which is joined to the lower end of the femur, two long bones fibula and tibia in the shank, seven tarsals (ankle bones) in the ankle,



## Pelvic (hip) girdle

The pelvic or hip girdle consists of two bones, namely coxal bones or hip bones joined medially to the sacrum. The pelvic girdle attaches the lower limbs to the axial skeleton, transmits the weight of the upper body to the lower limbs and supports the visceral organs of **the pelvis**. It **provides surface for articulation of hindlimbs and also for joining of muscles**.





## Joint

A **joint** is a point of contact by flexible connective tissue between bones, between cartilage and bone, or between teeth and bones.

### Classification of joints

#### Functional classification

**On the basis of degree of movement they allow**, joints can be classified into immovable, slightly movable and freely movable joints.

❖ **Immovable joints:** The joints in which the bones are bound firmly together by tough fibres so that **no movement is possible** are called **immovable joints**. For example, **joints between the bones of skull** are immovable joints.

❖ **Slightly or partially movable joints:** The joints in which **bones can move a little** against a pad of cartilage situated between them are known as **slightly movable joints**. For example, vertebrae in vertebral column can move slightly against the cartilage discs between them.

❖ **Freely movable joints:** The joints which allow **free movement of bones** are known as **freely movable joints**. There are about 70 freely movable joints. The portion of bones of freely movable joints which rub together are covered with shiny **slippery cartilage**. These joints are lubricated with **synovial fluid**. Thus, these are also called **synovial joints**. For example, the joints of shoulder, knee and elbow.



## Structural classification

Structurally, joints are classified **on the basis of presence or absence of synovial (joint) cavity** (a space between the articulating bones) and the kind of connective tissue that binds the bones together. Thus, structurally the joints are classified as **fibrous, cartilaginous** and **synovial joints**. In general fibrous joints are immovable, and synovial joints are freely movable. However, cartilaginous joints are either immovable or slightly movable.

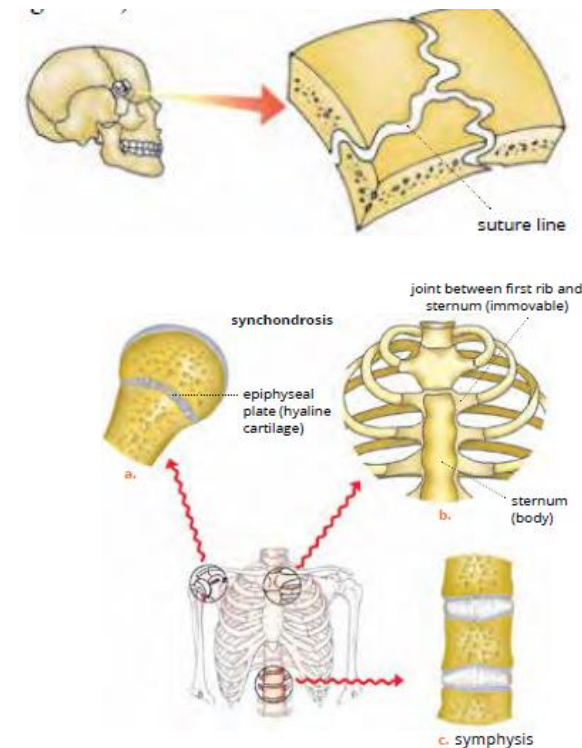
### Fibrous joints – immovable joints

The joints in which there is **no synovial cavity** and the **bones are held together by fibrous connective tissue** are called **fibrous joints**.

These joints are immovable or slightly movable joints. There are three types of fibrous joints – sutures, syndesmosis and gomphosis

### Cartilaginous joints – slight or no movement

A joint in which there is **no synovial cavity** and the **bones are held together by cartilage** is called **cartilaginous joint**. Like fibrous joints, they allow little or no movement.

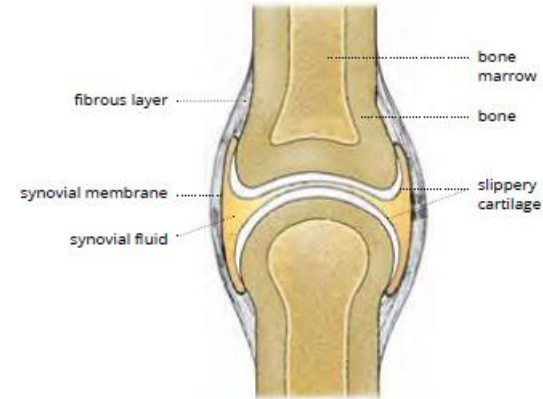






## Synovial joints – freely movable joints

The joints in which **there is a synovial cavity** and **bones forming the joint are united by a surrounding articular capsule and accessory ligaments** are called **synovial joints**. Synovial joints are freely movable joints.



Synovial joints also contain **synovial fluid** which occupies all free spaces within the joint capsule. **The bones of a freely movable synovial joint are held in place by bands of fibres called ligaments.** The joints of limbs are examples of synovial joints.

*Types of synovial joints:* Synovial joints can be classified into following main types:

❖ **Hinge joint:** A joint in which **the convex surface of one bone fits into the concave surface of another bone** and **movement is primarily in one direction** or in a single plane is called a **hinge joint**. *Examples:* Elbow joint, ankle joint, knee joint, joints at end of phalanges.

❖ **Ball and socket joint:** A joint in which the **ball-like surface of one bone fits into a cup-like depression of another bone**, and **movement is primarily in three planes of motion** is called **ball and socket joint**.



*Examples:* Shoulder joint and hip joint.

In shoulder joint, humerus bone articulates at glenoid cavity.

❖ **Gliding joints:** The joints in which **articulating surface of the bones are usually flat and one bone slips over the other** are called **gliding joints**. In gliding joints **only side to side and back and forth movements take place**. No angular movements take place in gliding joints.

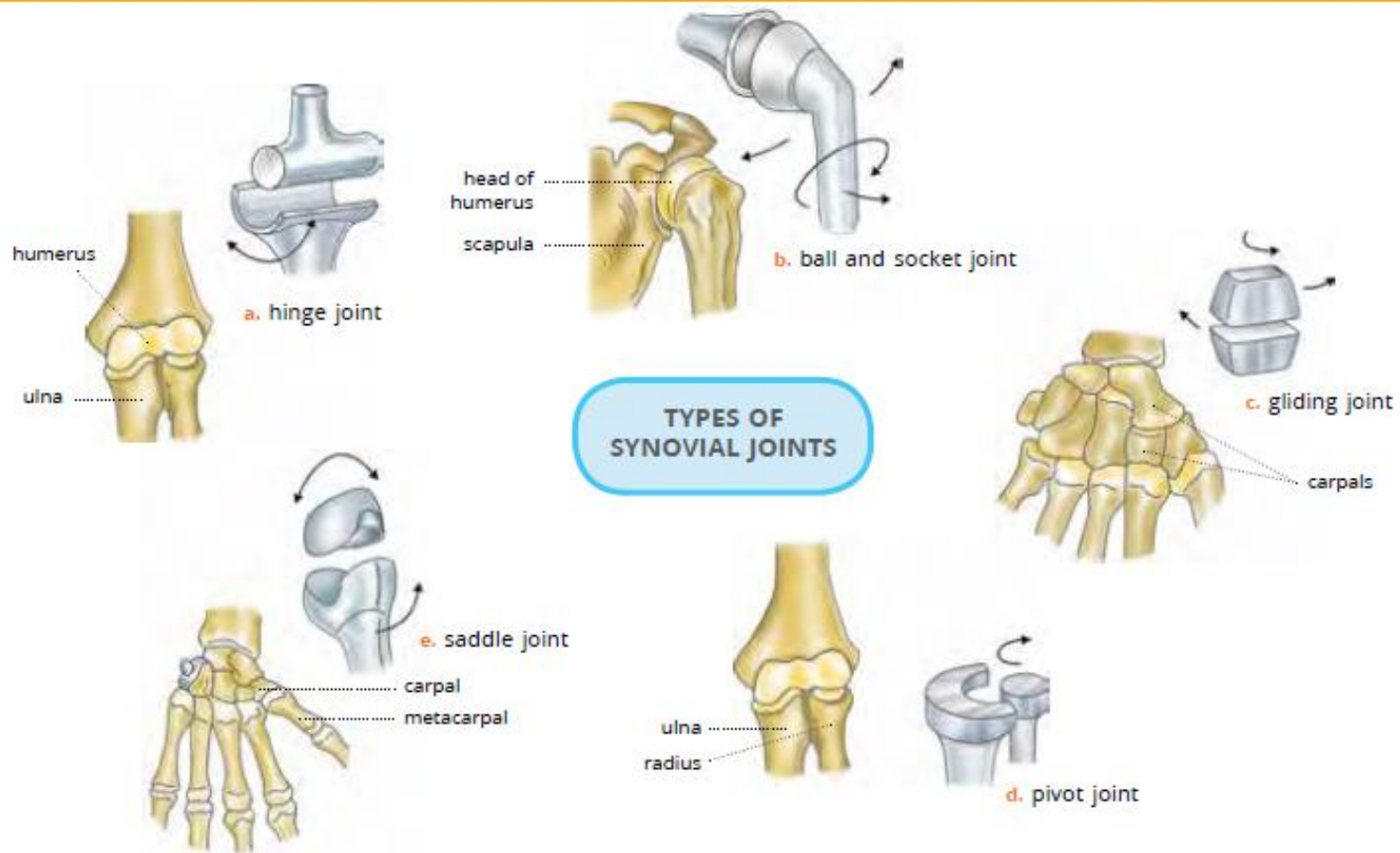
*Examples:* Joints between carpal bones, tarsal bones, the sternum and clavicle, and scapula and clavicle

❖ **Pivot joints:** The joints in which **a rounded, pointed or conical surface of one bone articulates within a ring formed partly by another bone and partly by a ligament**, and the **movement is primarily rotational** are called **pivot joints**.

*Examples:* Joint between axis and atlas vertebra; joints between radius and ulna

❖ **Saddle joints:** The joint in which **the articular surfaces of both bones is saddle shaped** with one slightly convex and the other slightly concave is called a **saddle joint**. The movements at a saddle joint are side to side or back and forth.

*Example:* Joint between metacarpal of thumb and carpal



## Some common disorders associated with skeleton and joints

❖ **Arthritis:** The term arthritis means many different joint diseases. All diseases are characterized by inflammation, in one or more joints. The inflammation, stiffness and pain may also be present in other adjacent parts of the body such as muscles near the joints.



- ❖ **Sprain and strain:** Strain is the overstretching of a muscle while sprain is the forcible twisting of a joint which results in partial rupture or injury to its attachment. It occurs when joints are stretched beyond their normal capacity.
- ❖ **Dislocation:** Dislocation is the displacement of a bone from a joint with tearing of ligaments, tendons and articular capsule. The most common dislocation are those of a finger, shoulder or knee while playing games.
- ❖ **Fractures:** By certain accidents a bone can fracture, and fissures can be formed in it. Rib fracture and fracture of legs or arms are common injuries. With age our bones become more prone to fractures.

## **Muscle and Movement**

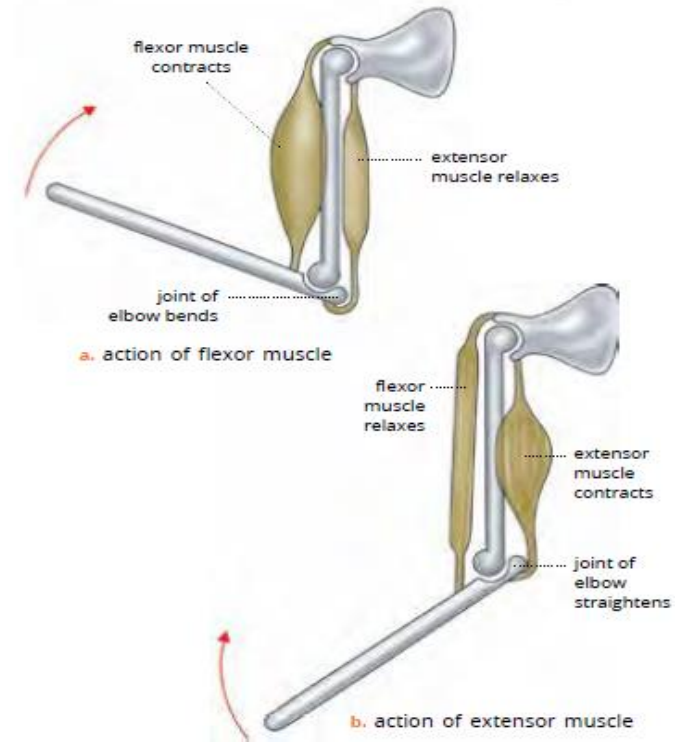
The **muscles which move the body are known as voluntary or skeletal muscles**. They are at our control and attached to both ends of a bone. The **point of attachment between a muscle and a bone is called tendon**.

Muscles work in pairs. They work opposite to each other. When one relaxes, the other contracts, such a pair of muscles are called antagonistic muscles.



There are following types of antagonistic muscles:

- ❖ **Flexor muscles:** These muscles cause bending of a joint.
- ❖ **Extensor muscles:** These muscles work in opposite direction to straighten the joint.
- ❖ **Abductors:** These muscles move the limb away from the body.
- ❖ **Adductors:** These muscles move the limb towards the body.





## SUMMARY...

- ❖ The internal framework of bones and cartilage that protects our organs and allows us to move is called skeleton.
- ❖ The human skeleton performs many functions such as support, protection, movement and locomotion, blood cell formation, storage of minerals and storage of energy.
- ❖ The human skeleton in an adult consists of 206 bones.
- ❖ The human skeleton is divisible into two parts – axial skeleton and appendicular skeleton.
- ❖ The axial skeleton consists of the bones that form the upright portion or axis of the body, i.e. skull, hyoid bone, ear bones, vertebral column and sternum. There are 80 bones in axial skeleton.
- ❖ The appendicular skeleton consists of bones of free appendages, pectoral girdle and pelvic girdle. There are 126 bones in the appendicular skeleton.
- ❖ A joint is a point of contact between bones; cartilage and bones; and teeth and bones.
- ❖ On the basis of functions, joints can be classified as immovable, slightly movable and freely movable. On the basis of structure, the joints can be classified as fibrous joints, cartilaginous joints and synovial joints.
- ❖ Synovial joints can further be classified into hinge joints, pivot joints, gliding joints, ball and socket joints and saddle joints.

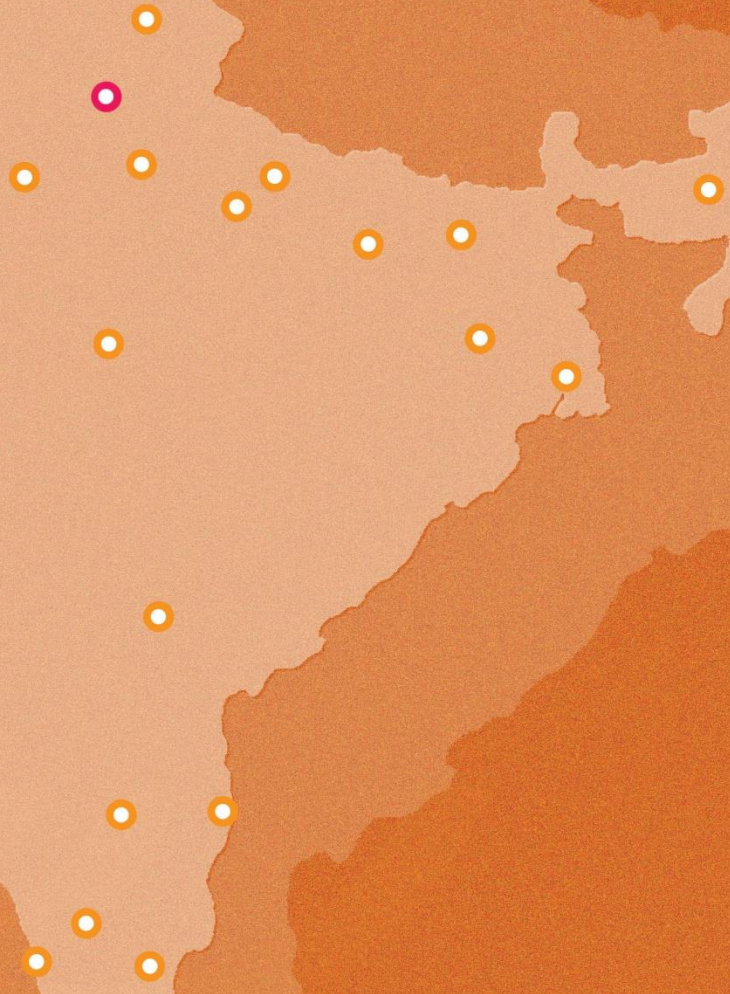
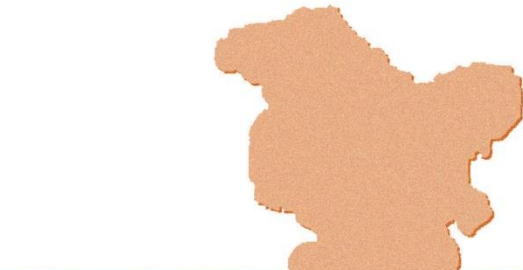


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