LOCOMOTION

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LOCOMOTION

Locomotion is the movement of the whole organism from one place to another.

Movement is the displacement of part of the body of an organism.

Forms or types of locomotion

- ✓By crawling
- ✓By walking
- ✓By flying
- ✓By creeping

Structures used in locomotion are referred to as limbs and they include;

i) Wings
ii) Fins
iii) Legs
iv) Arms
v) Cilia
vi) Flagella
vii) Pseudopodia

An animal locomotes in order to;

- ✓ Look for food
- ✓ Search for mates
- ✓ Avoid danger and catastrophes.
- ✓ Avoid competition with other animals
- ✓ Colonize new areas.

Requirements for locomotion

Locomotion requires the following.

1. **Energy.** This is obtained from respiration.
2. **Skeleton.** This is a rigid framework for support and attachment of muscles.***(Read and make notes about the 3 types of skeletons i.e. definition, advantages and disadvantages)***
3. **Muscles.** These contract and relax in order to move the skeleton during locomotion.
4. **Medium.** This is the environment in which the organism moves. The medium can be water, land or air

LOCOMOTION IN MAMMALS

Mammals possess **Endoskeleton** on which **muscles** are attached.

The muscles pull on the skeleton to effect movement.

The skeleton is made up **bone** and **cartilage**.

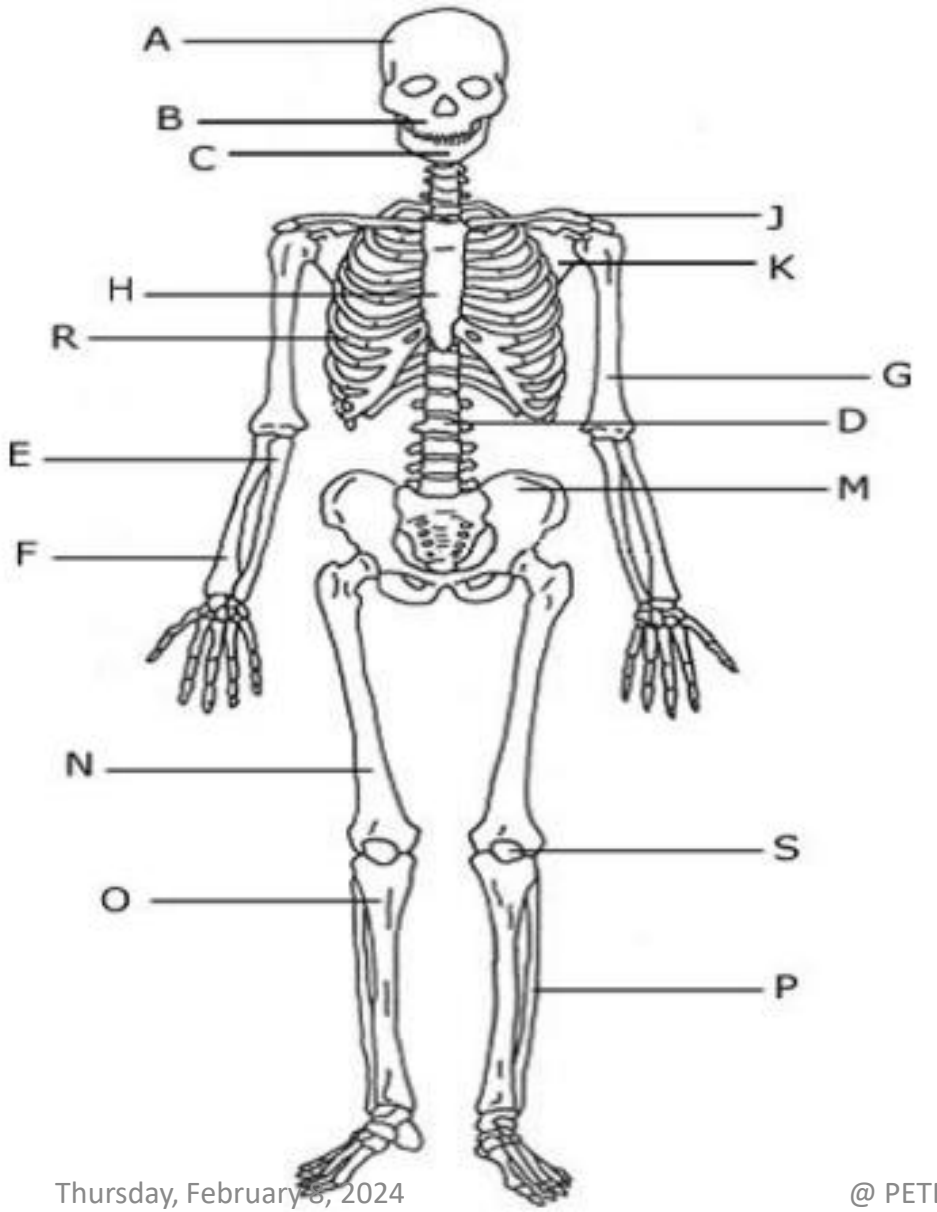
Differences between bone and cartilage

Bone	Cartilage
It is hard and compact due to hard ground tissue called collagen.	This is soft and flexible with chondrin ground tissue.
This consists of calcium and phosphorous salts	This has no salts
Long bones have marrows	No marrows.
Contain nerves	No nerves.
Contain blood vessels	No blood vessels
Occurs in adults	Occurs in fetus and some remain in adults
Bone cells are arranged in concentric layers around nerves and blood vessels	Cartilage cells are usually single or rows scattered in the ground tissue.
Rate of growth is slow	Growth rates are high.

Functions of mammalian skeleton

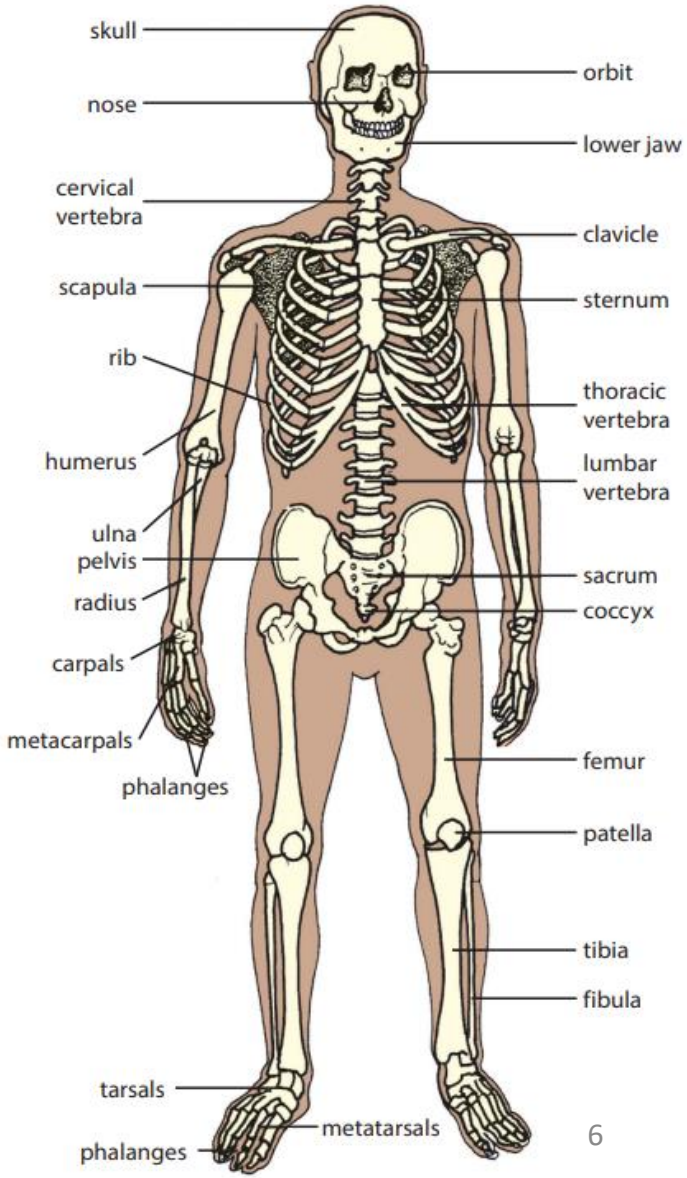
1) **Support.** The skeleton forms a rigid framework over which body organs are suspended e.g. the lungs, heart, intestines, kidney, bladder or else these organs would crush into one another and hence make the body shapeless.
2) **Locomotion.** It provides surfaces for attachment of muscles to allow movement.
3) **Protects delicate organs of the body.** Delicate parts of the body are protected by the skeleton. The skull protects the brain, inner ear and eyes. The vertebral column protects the spinal cord. The rib cage protects the heart, lungs and all organs in the thoracic cavity.
4) **Stores calcium for usage in the body.** Calcium is an element that is added to cartilage to form bone. All bones contain calcium, which makes them strong. When calcium is needed in other areas, it can be obtained from the bones.
5) **It is a site for manufacture of red blood cells and white blood cells.** These cells are made in bone marrows.
6) **It is used in breathing.** The rib cage adjusts the volume of the thoracic cavity during breathing

STRUCTURE OF THE MAMMALIAN SKELETON



Bones of the skeleton

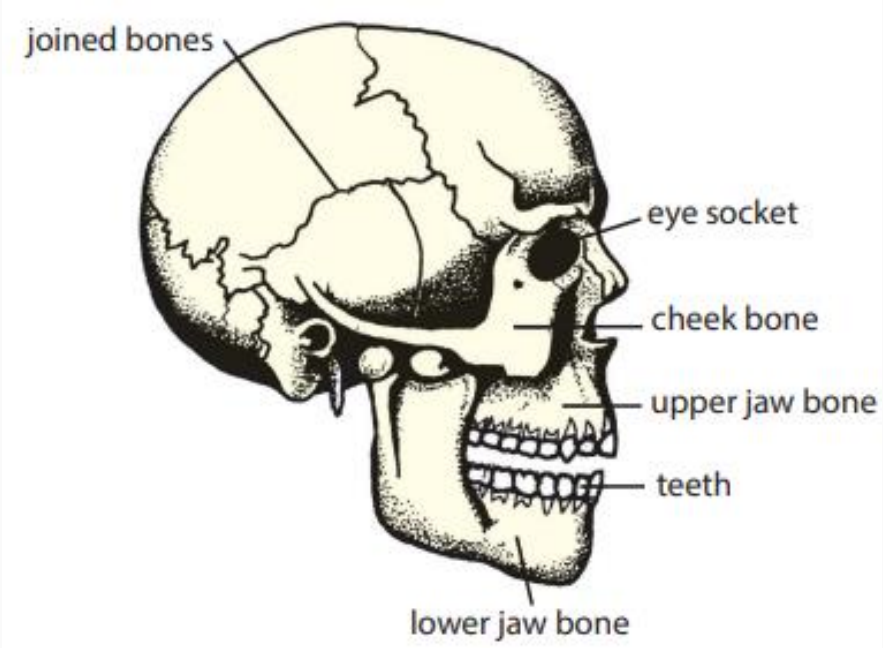
A. Skull
B. Maxillae
C. Mandible
J. Clavicle
K. Scapula
H. Sternum
G. Humerus
D. Vertebra
R. Rib
E. Ulna
F. Radius
M. Pelvic bone
N. Femur
O. Tibia
P. Fibula
S. Patella



PARTS OF THE SKELETON

The skeleton consists of two major parts

1. *Axial skeleton*
2. *The appendicular skeleton*



AXIAL SKELETON

1. **Skull**
   It is made of the brain box (**cranium**) and the upper jaw which together form the upper part. A cranium is made up of several flattened bones joined together by immovable joints called the **suture** joints. A cranium protects the **brain, eyes** and **inner ear.**

2. **Vertebral column**
   The vertebral column is made up of small bones called the **vertebrae**. Their number varies from one organism to the other. They are joined to one another by cartilage called **inter vertebral disks** which allow slight movement of the bark.

Functions of the vertebral column

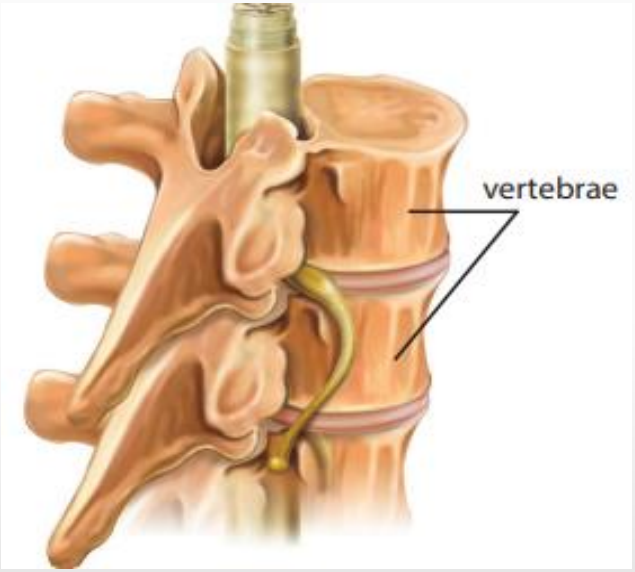
i) It protects the spinal cord and allows for emergence of the spinal nerves.

ii) It provides support to the head.

iii) The joint between atlas and the skull allows slight movement of the head in a vertical plane.

iv) Transverse processes provide points of attachment of tendon muscles, which straighten the back.

v) The caudal vertebrae form the tail.



Types of the vertebrae

The vertebrae include:

Type of vertebra	Region of the vertebral column	Number in the human skeleton
Cervical vertebrae	Neck	7
Thoracic vertebrae	Thoracic region	12
Lumber vertebrae	Abdomen	5
Sacral vertebrae	Lower abdomen	5
Caudal vertebrae	Tail	4

Functions of parts of the vertebrae

1) Centrum. This is the lower part of the vertebra with a thick protective mass. It provides the main support of the backbone and allows articulation with other vertebra.
2) Transverse processes. These are projections on the sides of the neural arch. It provides surface for attachment of muscles. It also helps to articulate with ribs in the thoracic vertebra.
3) Neural arch. It is the ring of bone above the vertebra. It forms a bonny tube that protects the spinal cord.
4) Neural spine. This is a pointed part or extension of the neural arch at the dorsal part.
5) Neural canal. It is the central hole that provides passage for the spinal cord.
6) Facets: for articulation with other vertebra and ribs for the thoracic vertebrae
7) Vertebraterial canal: allows passage of the blood vessels

THE CERVICAL VERTEBRA

These are found in the neck region. They are seven in number.

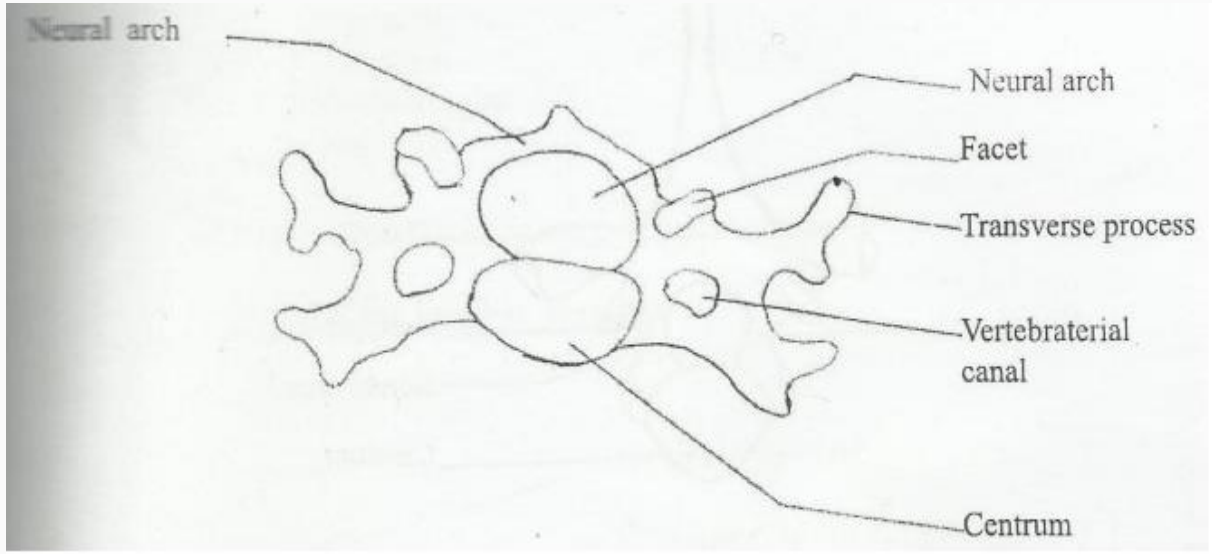
Characteristics of the cervical vertebrae

1. They have a pair of canals (openings) in the neural arch called vertebral canals through which the neck vessels pass.
2. Their transverse processes are flattened and divide into two to form cervical ribs.
3. They have a short neural spine.
4. They have a large neural canal.
5. They have a small Centrum.

General functions of the cervical vertebrae

1. Supports the head region
2. Protects the blood vessels and the nerves that pass through them.
3. Support and protect the spinal cord.
4. Provides attachments to muscles of the head

Drawing of the cervical vertebra (anterior)



Note: The first cervical vertebra is the **atlas** and the second is the **axis**.

1. **Atlas vertebrae**

(characteristics)

- ✓Has no centrum
- ✓Has very large neural canal
- ✓Has a flat broad transverse process for muscle attachment
- ✓Has two large facets for articulation with the skull base to permit the nodding movements of the head.
- ✓Has a small rigid neural spine.

2. Axis

(characteristics)

- ✓Has a relatively small neural canal than the atlas.
- ✓Has a large flat centrum that projects forward to form odontoids process that fixes in the neural canal of the atlas.
- ✓Has a small transverse process
- ✓Has two facets at the posterior part of the vertebrae called post zygapophysis for articulation with the atlas.

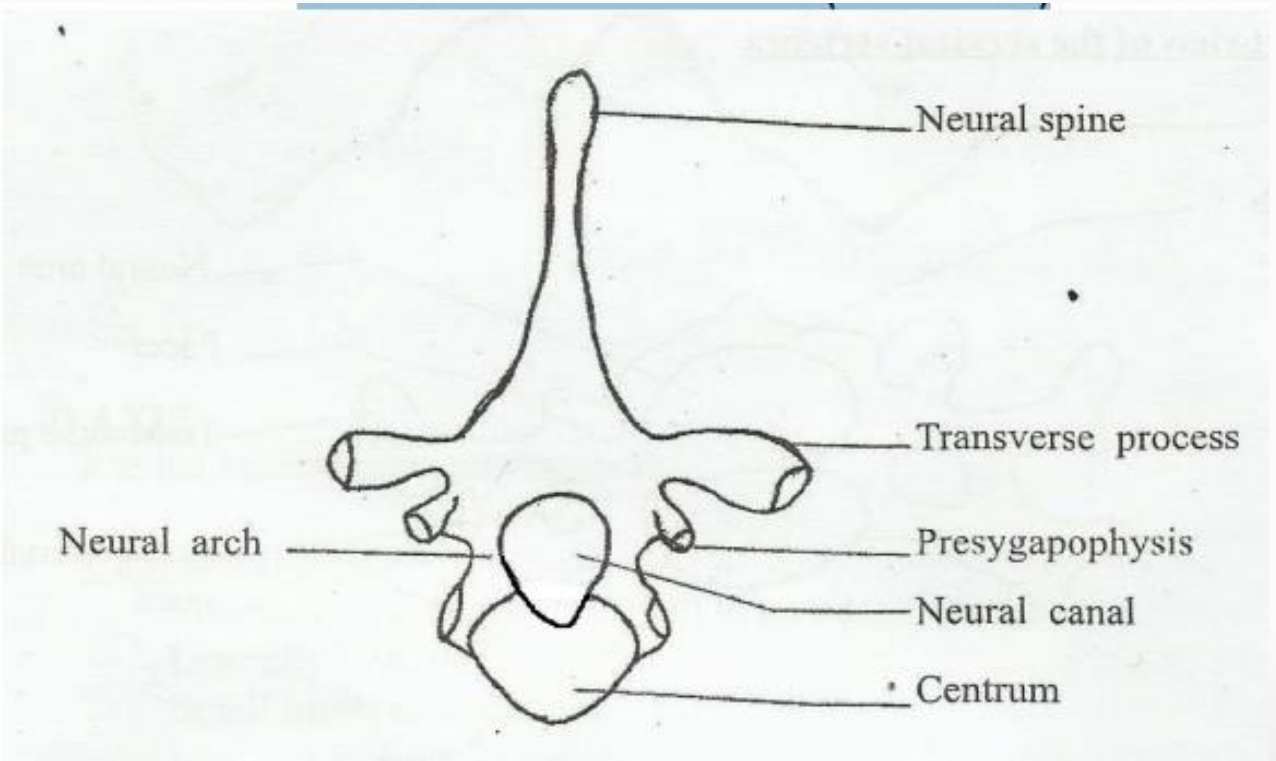
THORACIC VERTEBRAE

These are found in the chest region (thorax)

Characteristics

1. It has a large Centrum for articulation with ribs.
2. It has a large neural canal.
3. It has a long neural spine which projects upwards and backwards.
4. It has a pair of short transverse processes.
5. It has a pair of facets for articulation with other vertebra.
6. It has a large neural arch.
7. Has a pair of pre and post-zygopophysis for articulation with other vertebrae.

Structure of the thoracic vertebra (anterior view)



Adaptations to its functions

- ✓ Has a thick centrum to support upper body weight
- ✓ Has a long neural spine for attachment of thoracic muscles
- ✓ Have extra facets to articulate with the ribs
- ✓ Has a wide neural canal for accommodation of spinal cord.

Similarities between cervical and thoracic

- ✓ Both have a neural spine
- ✓ Both have a centrum
- ✓ Both have a neural canal
- ✓ Both have articulating facets

Differences

Cervical	thoracic
Short neural spine	Long neural spine
Has vertebraterial canal	Lacks vertebraterial canal
Has no notch	Has a notch
Transverse process divided	Transverse process not divided
Has no extra facet	Has extra facet

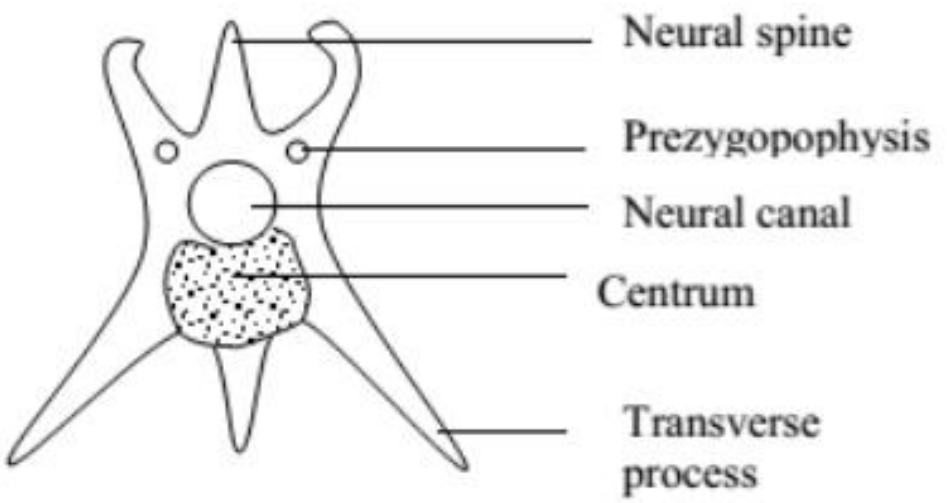
LUMBAR VERTEBRA

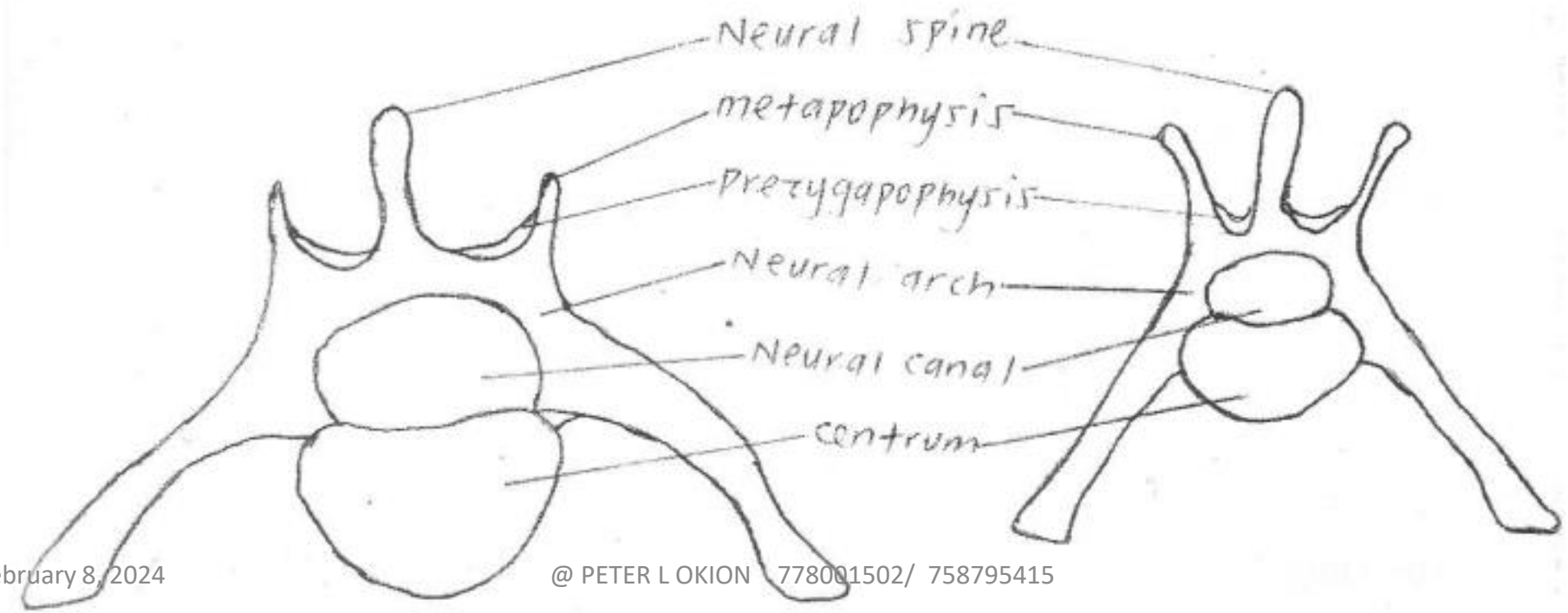
These are found in the abdominal region. They provide the only support for the trunk in the abdominal region. They are **five** in man.

Characteristics

1. They have long transverse processes facing forward for muscle attachment.
2. They have a broad neural spine.
3. Has a short flattened neural spine projecting forward
4. They have a large and thick Centrum than cervical and thoracic.
5. They have extra processes called metapophyses for muscle attachment of abdominal organs.
6. Has a prominent anterior facet.

Structure of the lumbar vertebra (anterior view)





Adaptations to its functions

- ✓ Has a long and broad transverse process to increase surface area for attachment to the abdominal muscles.
- ✓ Has a short and broad neural spine for the attachment of muscles.
- ✓ Has a wide and thick centrum to support weight of abdominal organs.
- ✓ Has a thick neural arch for protection of the spinal cord.

Similarities between lumbar and cervical vertebrae

- ✓ Both have neural spine
- ✓ Both have a transverse process
- ✓ Both have a centrum

Differences:

Lumbar	Cervical
Long neural spine	Short neural spine
Transverse process not divided	Transverse process divided
Has no vertebraterial canals	Has vertebraterial canals
Has metapophysis and prezygapophysis	Lacks metapophysis and prezygapophysis.

ASSIGNMENT: compare and contrast the lumbar and the thoracic.

SACRAL VERTEBRAE

This consists of 5 vertebrae in man and 4 in rabbits. In adult man they fuse together to form the sacrum that forms the base of the pelvis

Characteristics of the sacral vertebra

1. It has a narrow neural canal.
2. It has a small neural spine which is reduced to a small notch.
3. It has a large wing-like transverse process.
4. Each vertebra has a large Centrum.

CAUDAL VERTEBRAE

These decrease in size from the sacrum backwards and gradually lose their transverse processes, neural spine and facets.

In man, the tail consists of four vertebrae called coccyx that do not protrude from the body.

Characteristics:

i) Have no neural arch
ii) Have no neural canal
iii) Have no transverse process
iv) Have no neural spine
v) There entire body consists of the centrum only.

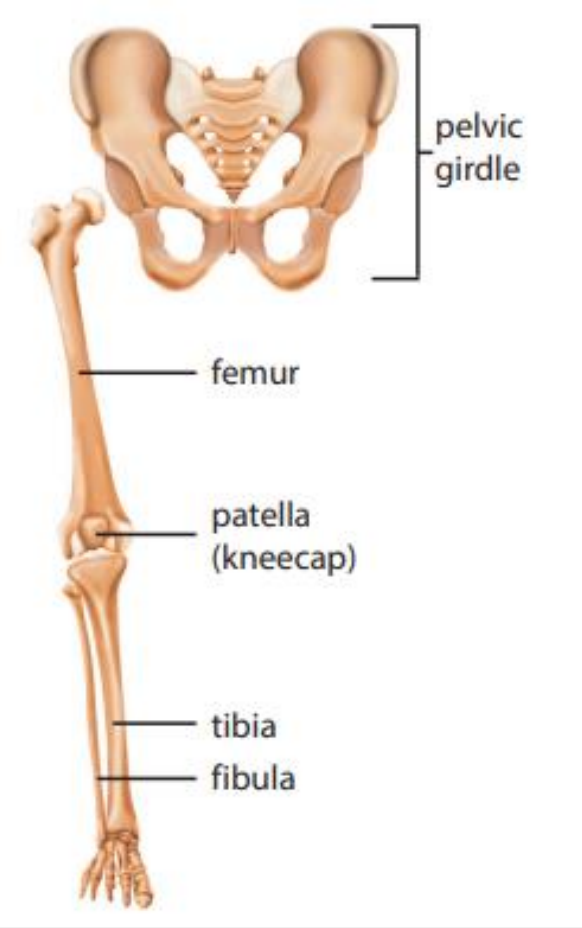
APPENDICULAR SKELETON

This is the skeleton of **limbs** and **limb girdles**.

There are four limbs and two girdles. i.e. *pectoral girdle* (**shoulder**), *pelvic girdle* (**hip**)

Functions of the limb girdles

1. It provides a connection between the Axil and the appendicular skeleton.
2. It provides stability of the body by separating limbs.
3. It provides a suitable surface for attachment of muscles that move the limb.



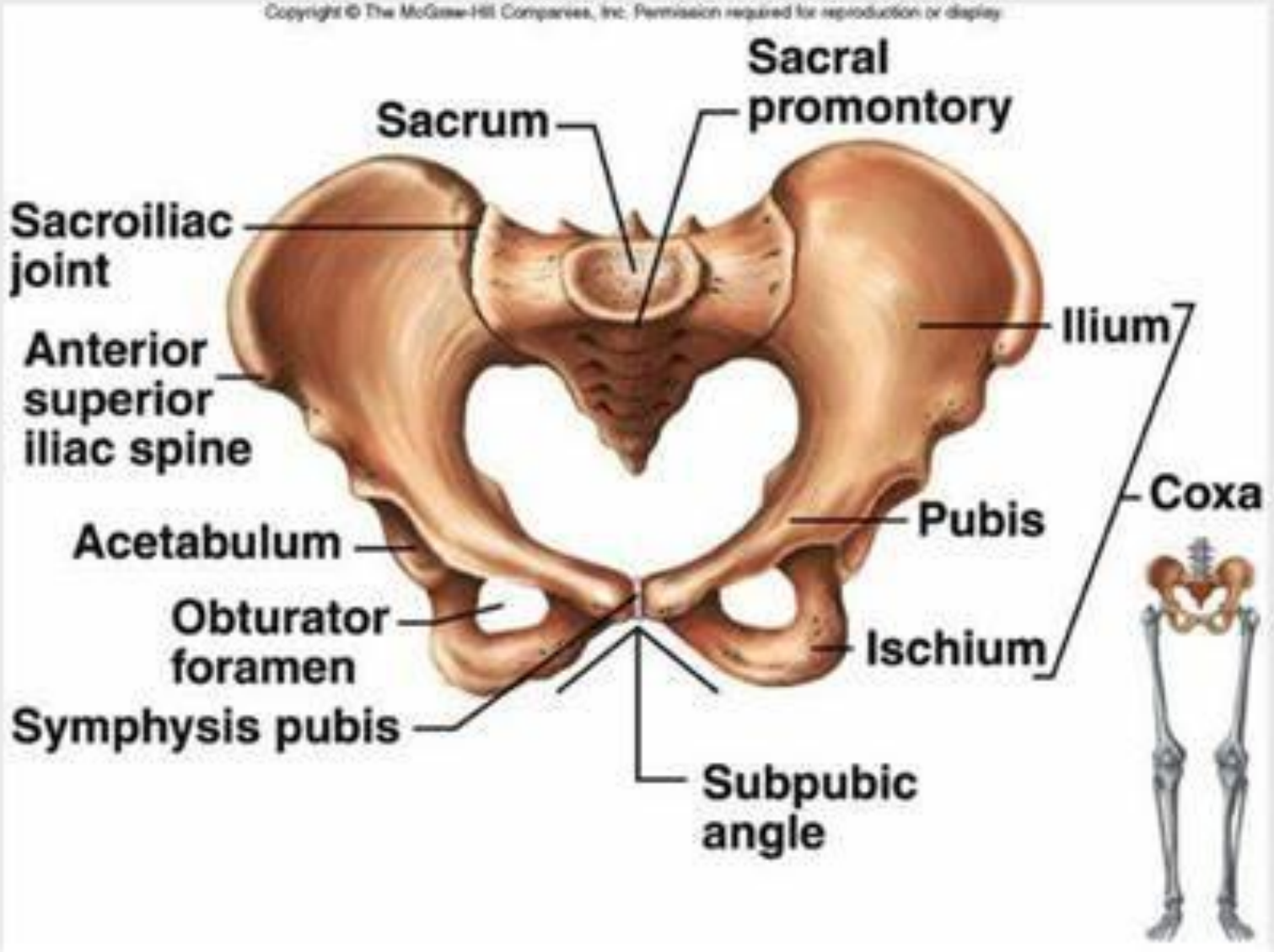
The pelvic girdle

It is made up of bone on either sides namely; Ilium, Ischium and Pubis.

The three bones are fused so tightly that their joints can't easily be observed thus they are collectively known as nominate bones.

NOTE: Draw the Structure of pelvic girdle (biological science pg 631 fig. 18.10)

Pelvic girdle



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Functions of the parts

1. ***Acetabulum:*** It provides a surface where the head of the femur articulates with the pelvic girdle.
2. ***Pubis symphisis:*** It joins the 2 pelvic girdles
3. ***Obturator foramen:*** It provides surface for attachment of muscles and passage for some nerves and blood vessels.

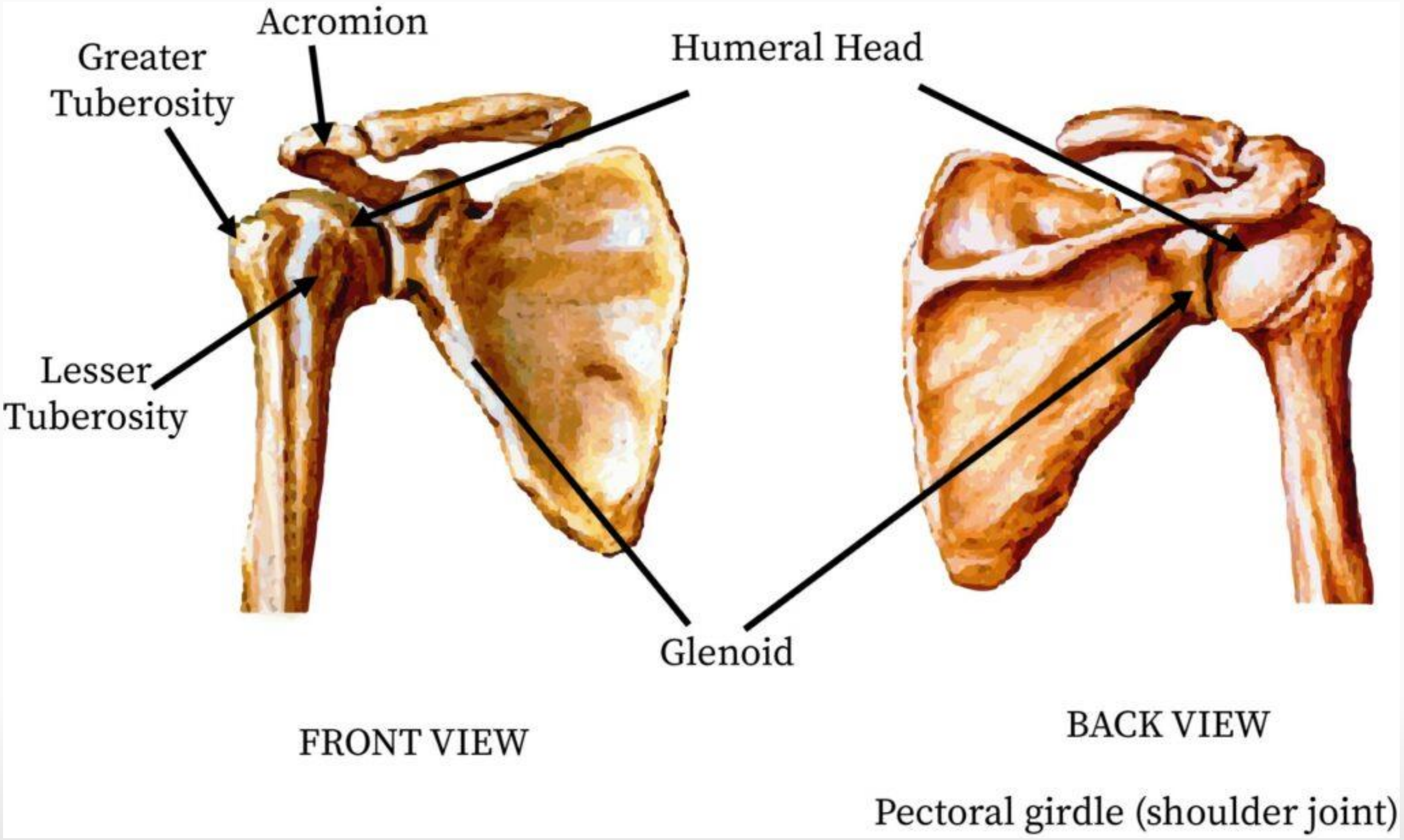
The pectoral girdle

It consists of mainly;

1. **The scapular (shoulder blade)**

This is a flat triangular shaped bone. It's anterior, with a hollow cavity called the **glenoid cavity** which articulates with the head of a humerus.

A scapular ridge spine runs across the outer surface of where powerful muscles are attached to.

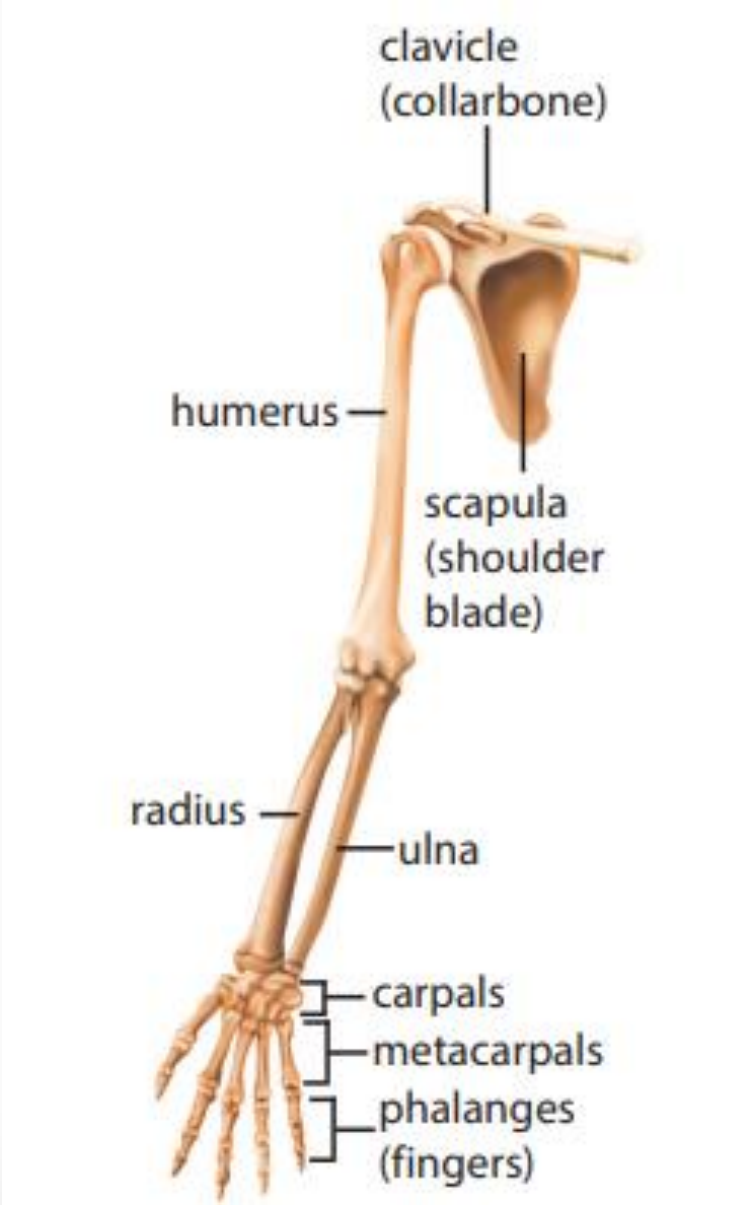


Pectoral girdle (shoulder joint)

Note: DRAW the Structure of the scapular

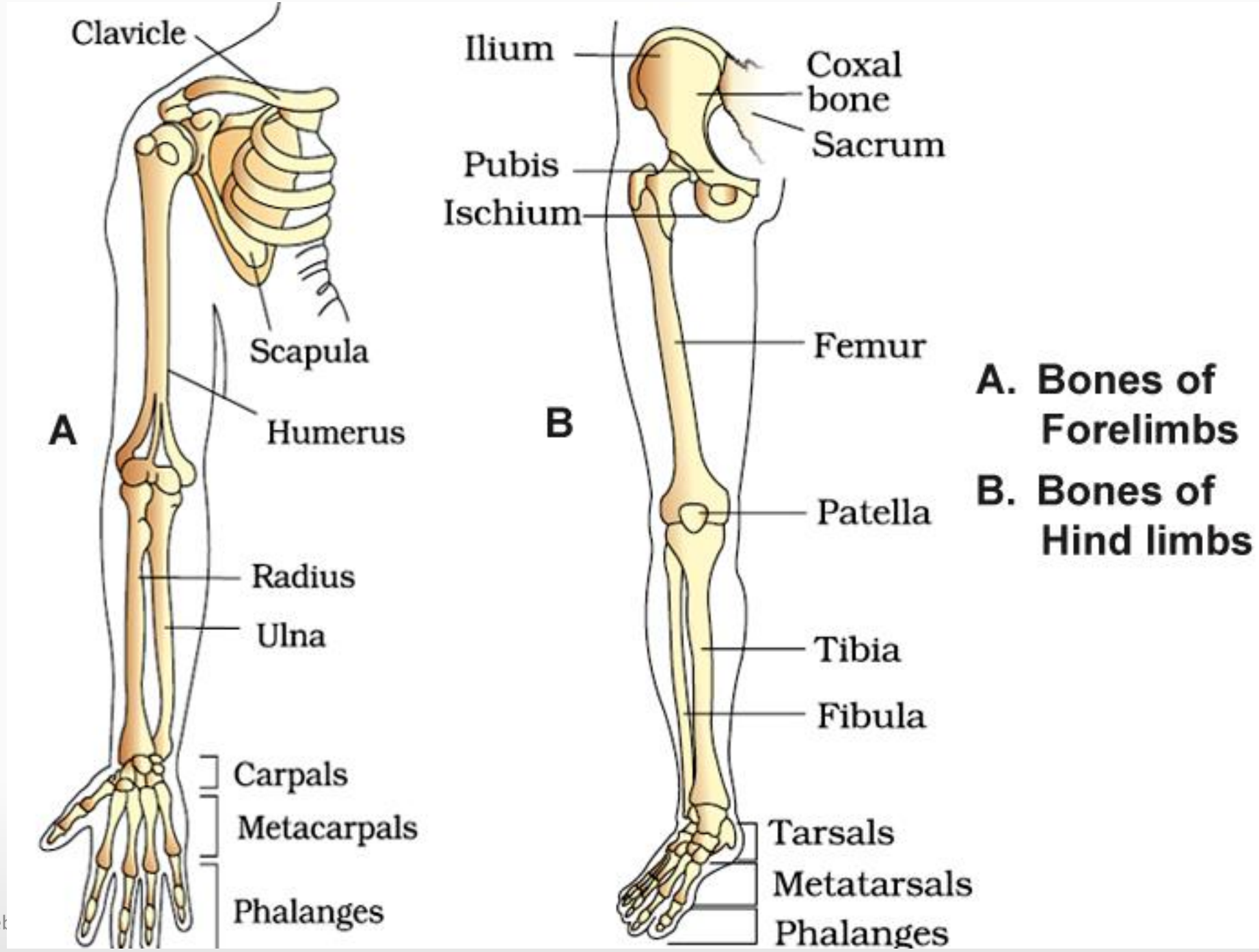
2. Clavicle (colar bone)

It consists of a lot of bones attached to a ligament joining the sternum to the end of the scapular ridge

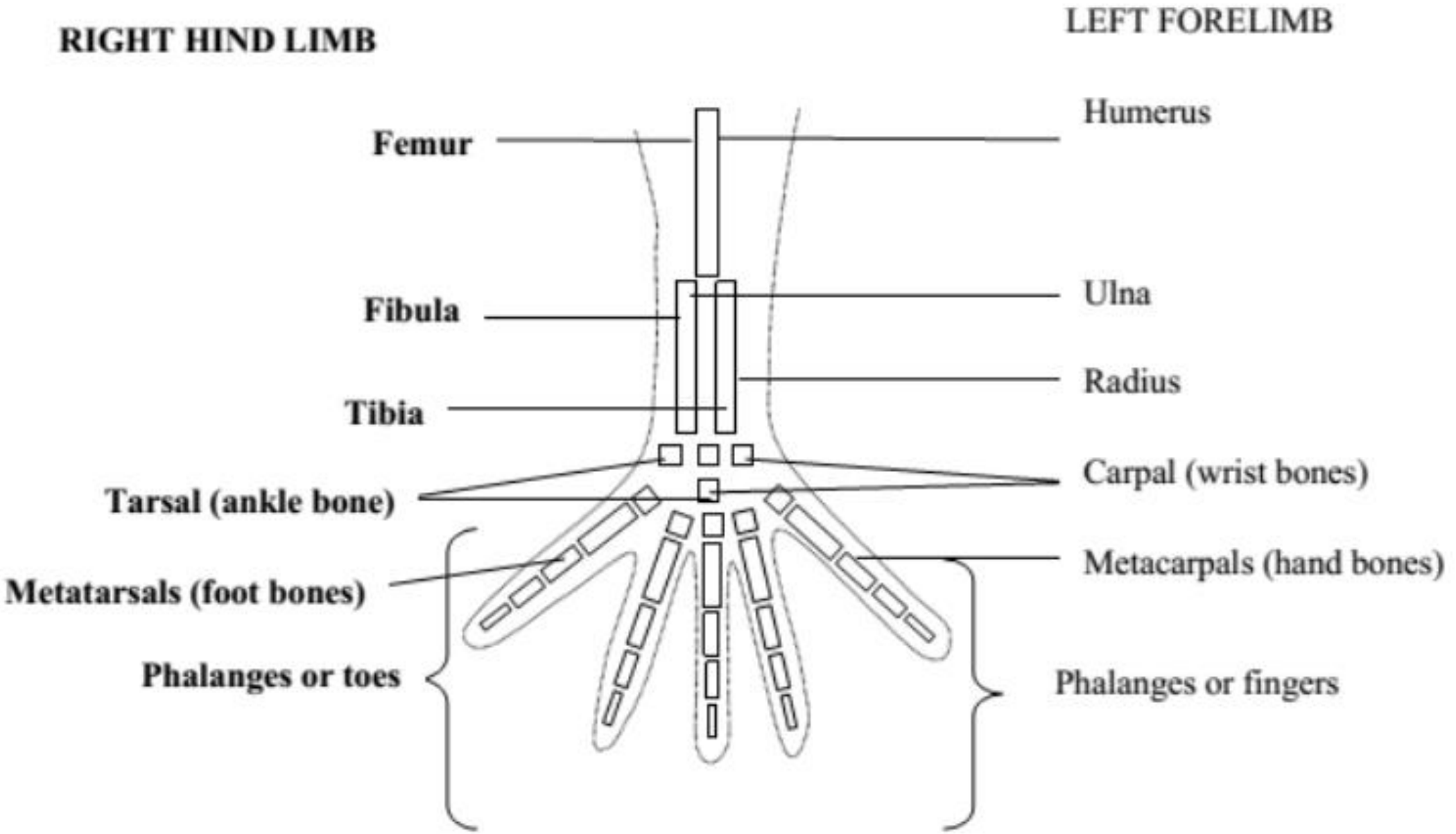


LIMB BONES

- ✓The mammalian skeleton has limb bones; the fore and hind limbs.
- ✓They are constructed with the same plan or arrangement known as the pentadactyl plan.
- ✓The limb consists of an upper long bone followed by a pair of long bones placed side by side and a set of small bones.
- ✓In 3 rows five thin long bones and finally 5 digits


Clavicle
Scapula
A
Humerus
Radius
Ulna
Carpals
Metacarpals
Phalanges
Ilium
Coxal bone
Sacrum
Pubis
Ischium
B
Femur
Patella
Tibia
Fibula
Tarsals
Metatarsals
Phalanges
A. Bones of Forelimbs
B. Bones of Hind limbs

Structure of the pentadactyl limb



THE FORE LIMB

It consists of the upper arm, **fore** arm and the **hand**.

The upper arm consists of a long bone called the **humerus**.

The fore arm consists of the **radius** and **ulna**.

1. **Humerus:** it has a round head which articulates with a glenoid cavity of scapular. Its lower end is grooved to articulate with the radius and ulna.
2. **Radius:** it lies anterior to the ulna.
3. **Ulna:** it is longer than the radius at the elbow. It projects back ward to form olecranon.

The tip of olecranon forms a joint with the humerus and so prevents the joint from being straightened

HIND LIMB

It consists of the thigh, leg and the foot.

The leg is made up of the tibia and fibula.

1. Femur:

The proximal end is **rounded** to form the head which articulates with the acetabulum of the pelvic girdle to form a **ball** and **socket** joint.

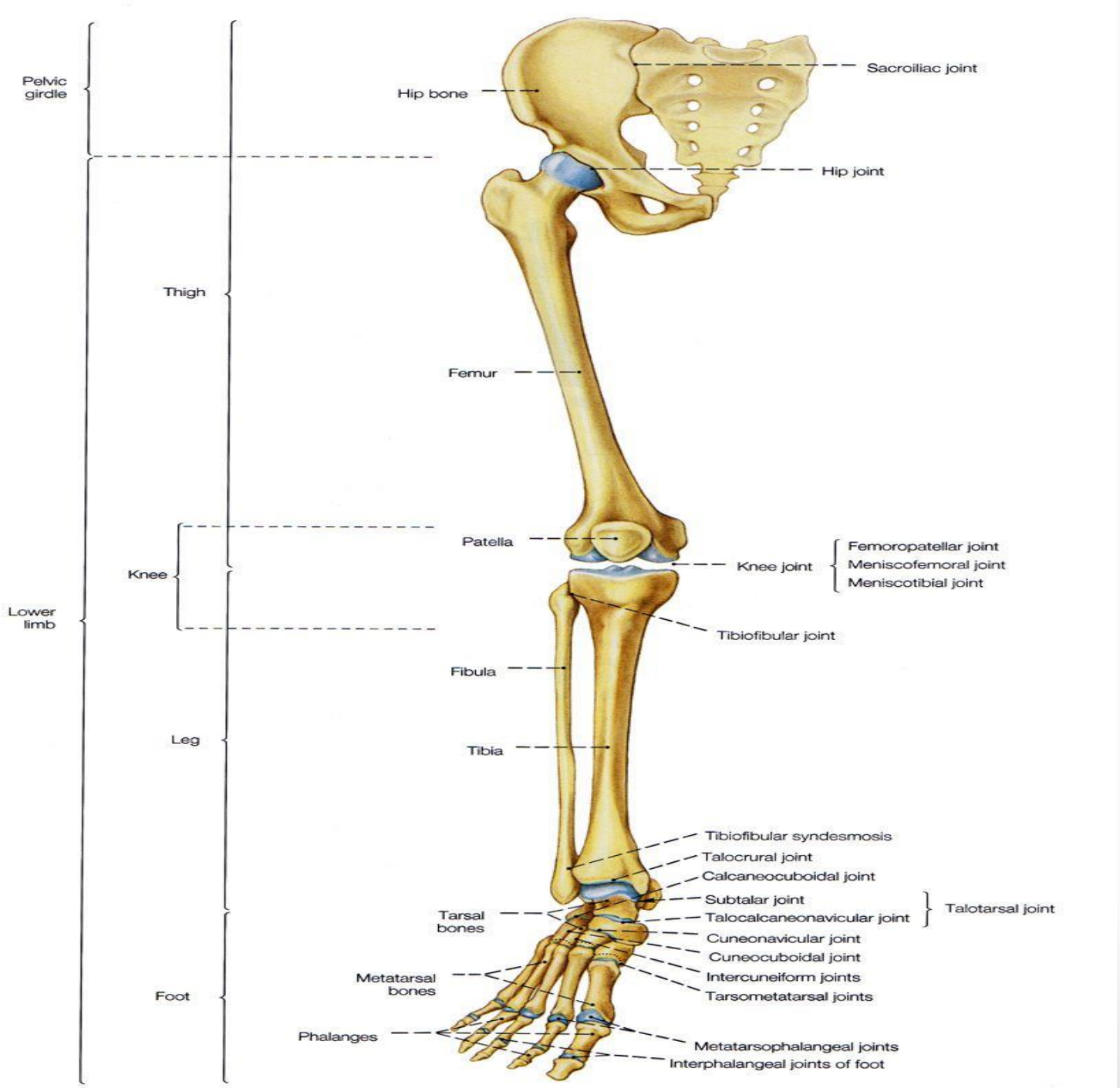
Near the head, there are three projections which are points for attachment of some muscles.

At the distal (lower end) the femur has 2 rounded knobs which articulates with the tibia.

NB: draw the Structure of the femur

2. Tibia: The proximal surface of the tibia is shaped into 2 shallow oval hollows which fit the 2 rounded knobs of the femur.

3. Fibula: This is a small bone which lies outside to the tibia and it's joined to it at the distal end.


Pelvic girdle
Lower limb
Thigh
Knee
Leg
Foot
Hip bone
Sacroiliac joint
Hip joint
Femur
Patella
Knee joint
Femoropatellar joint
Meniscofemoral joint
Meniscotibial joint
Tibiofibular joint
Fibula
Tibia
Tibiofibular syndesmosis
Talocrural joint
Calcaneocuboidal joint
Subtalar joint
Talocalcaneonavicular joint
Talotarsal joint
Tarsal bones
Cuneonavicular joint
Cuneocuboidal joint
Intercuneiform joints
Tarsometatarsal joints
Metatarsal bones
Phalanges
Metatarsophalangeal joints
Interphalangeal joints of foot

JOINTS

A joint is a place where two or more bones meet.

The bones are connected together by ligaments to allow movement.

Types of joints

Joints are classified according to the degree of movement into the following categories.

1. Immovable joints: These are joints where no movement is possible for example the joints in the skull (sutures).
2. Movable joints: These are joints, which allow some degree of movement. They are also called synovial joints. The movable joints are further divided into the following types.

i) Sliding joints. These are joints, which allow bones to slide over one another for example in the *wrist and ankle*.

ii) Pivot joints.

These allow rotation of one bone over the other for example between the *axis and atlas* of the vertebral column.

iii) Saddle joints:

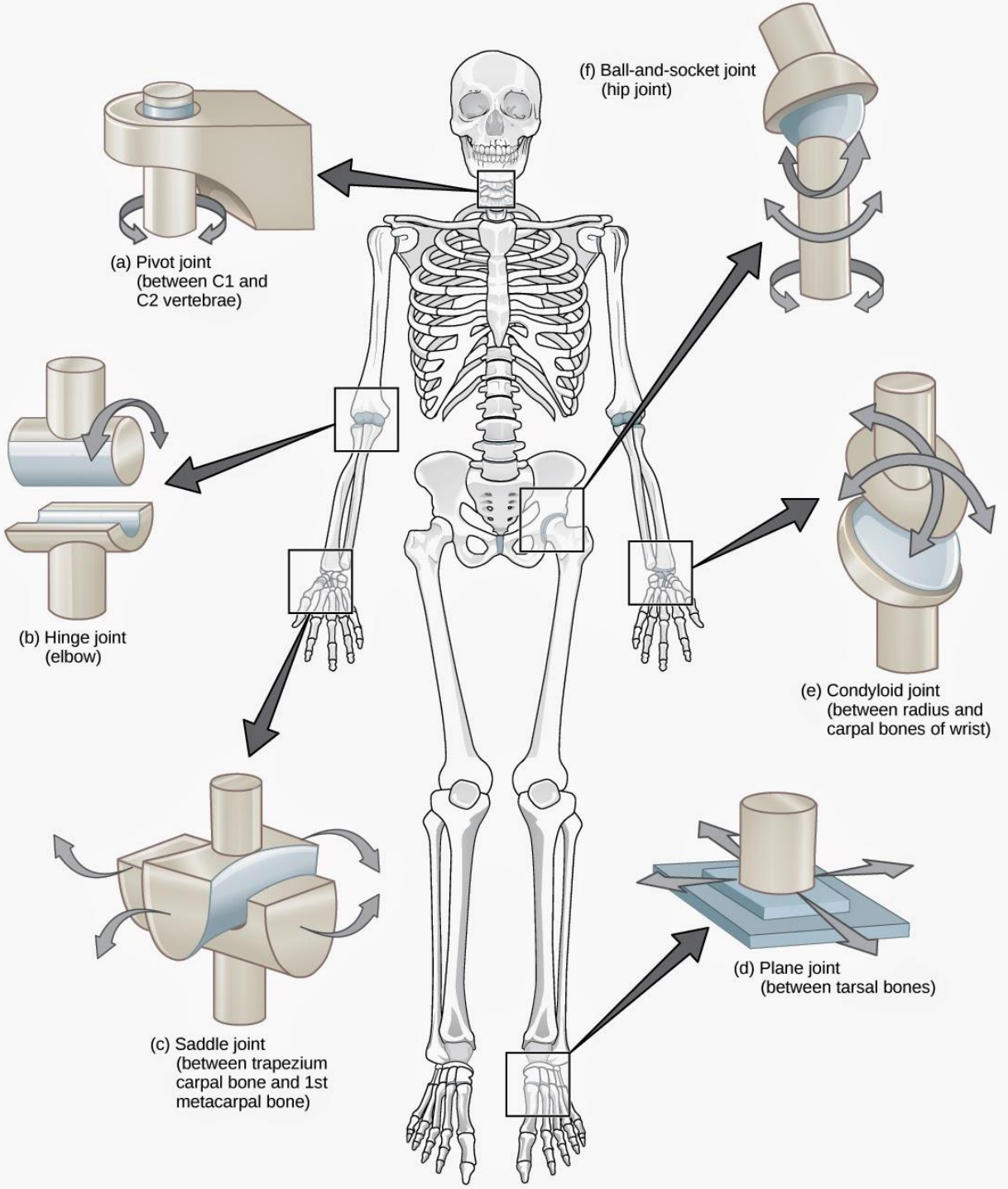
it allows twisting movements i.e. rotation of each bone between 2 axis e.g. the *radius and ulna.*

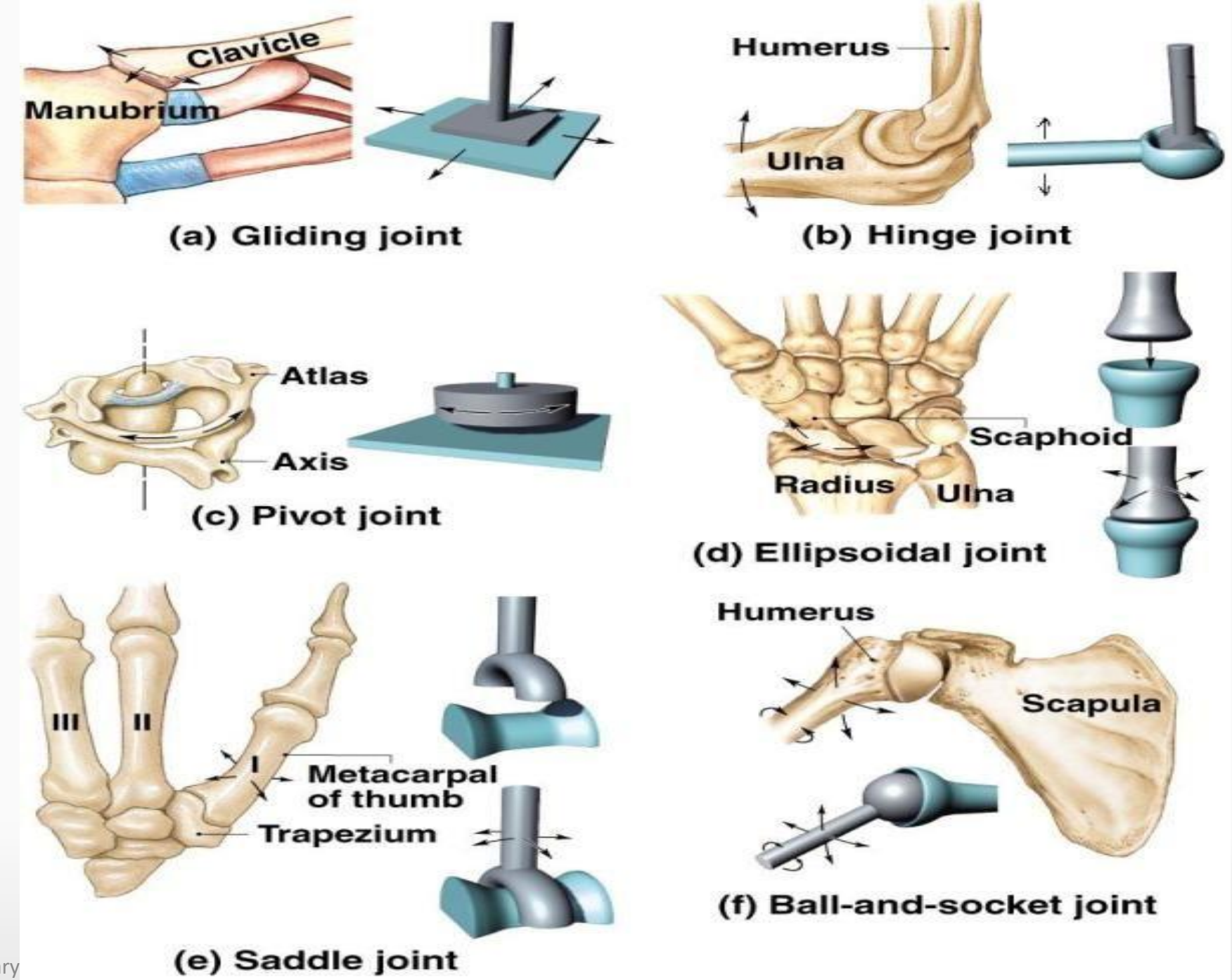
iv) Hinge joint.

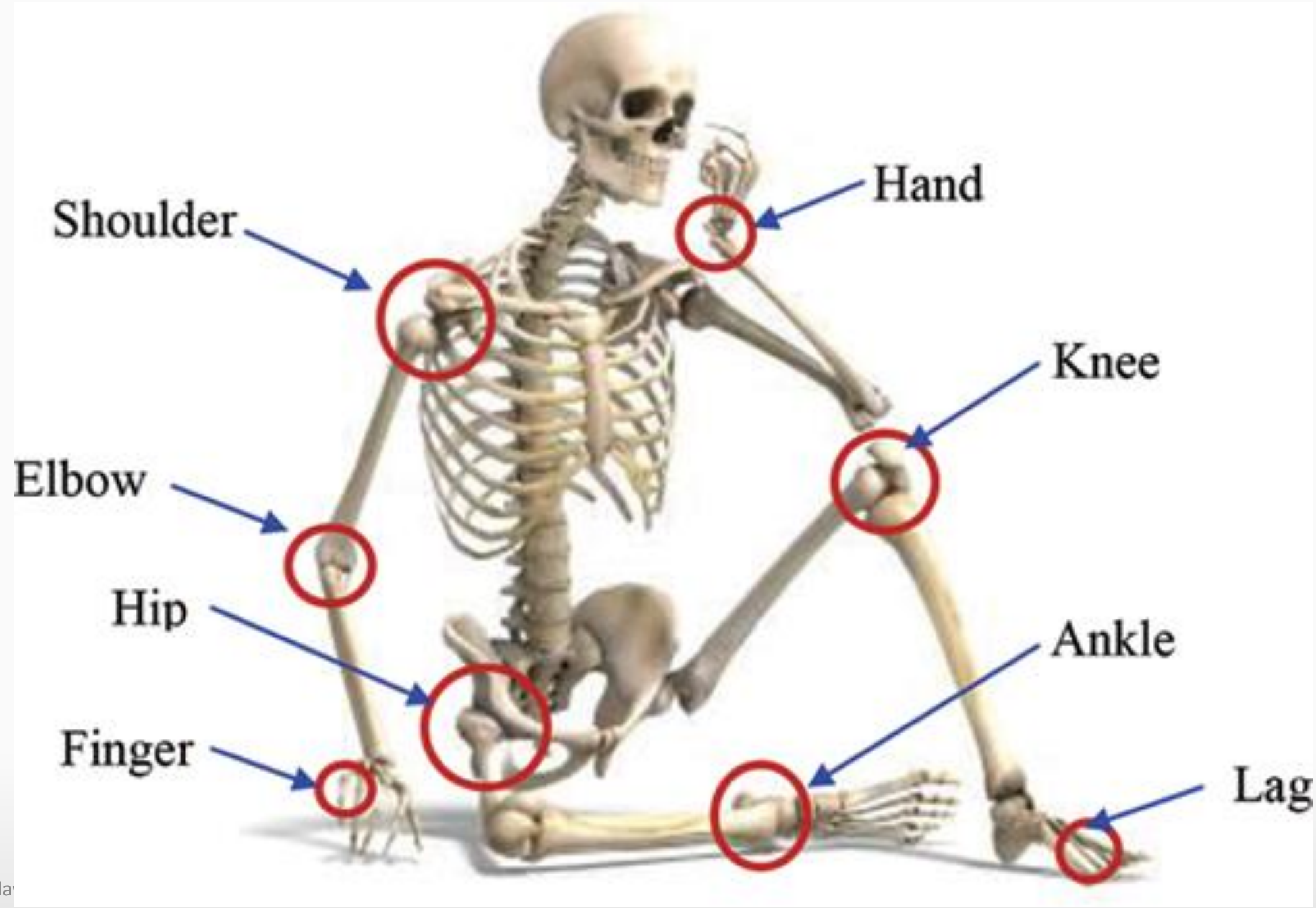
This allows movement in one plane for example in the *elbow of the hand*, in the *knee*, fingers and between the jaw and skull.

v) Ball and socket joint:

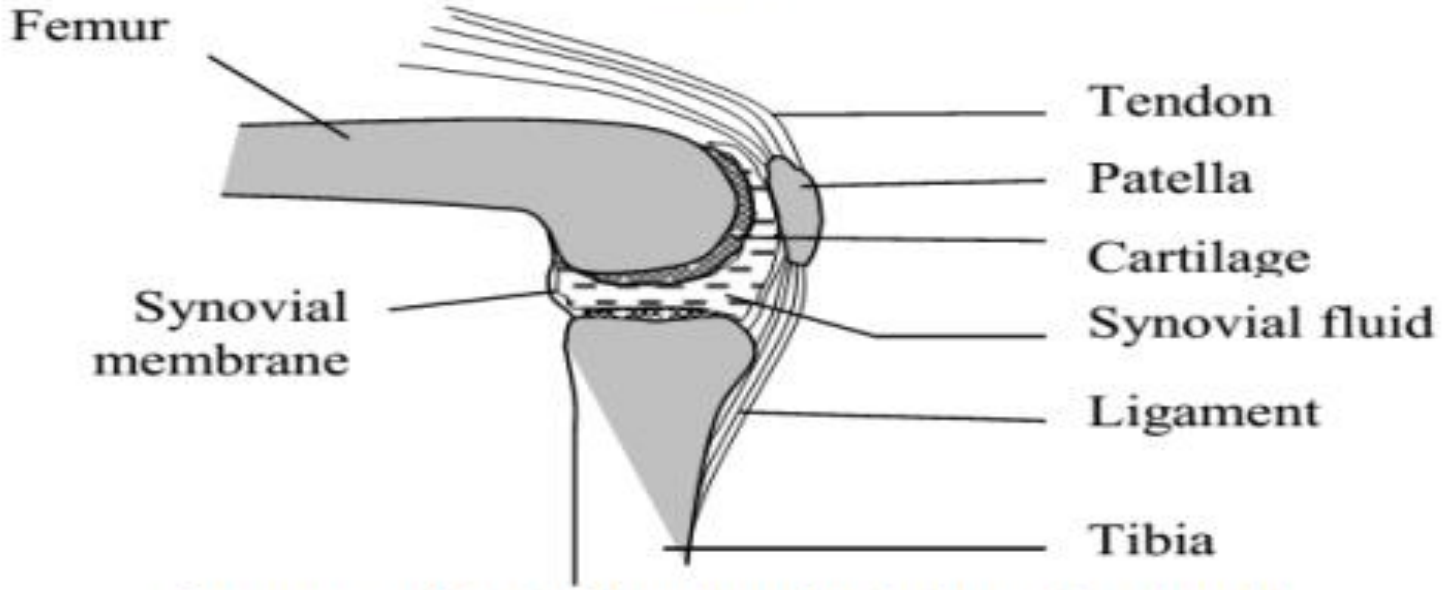
this allows movement in all directions. The *hip and shoulder joints* are ball and socket joints.

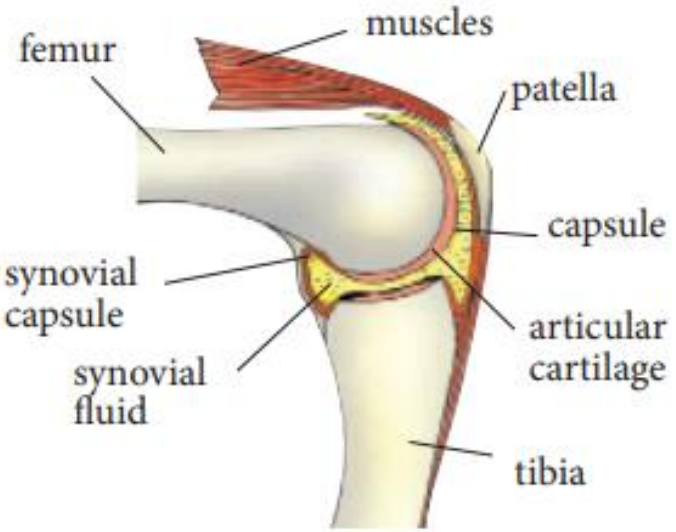

(f) Ball-and-socket joint
(hip joint)
(a) Pivot joint
(between C1 and
C2 vertebrae)
(b) Hinge joint
(elbow)
(e) Condyloid joint
(between radius and
carpal bones of wrist)
(c) Saddle joint
(between trapezium
carpal bone and 1st
metacarpal bone)
(d) Plane joint
(between tarsal bones)



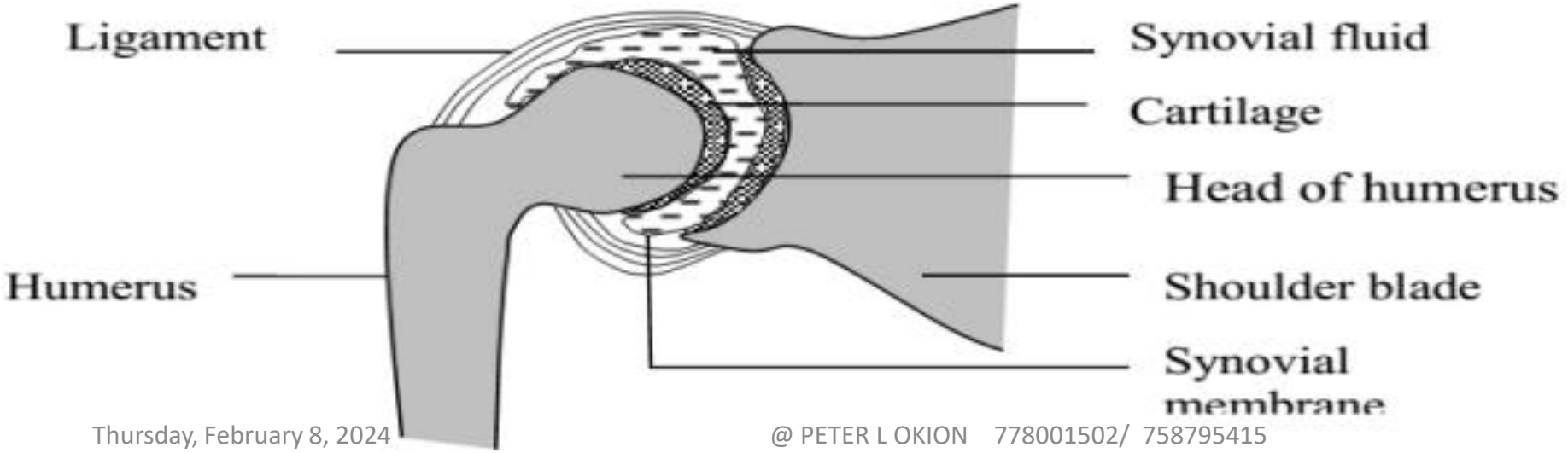

Shoulder
Hand
Knee
Elbow
Hip
Ankle
Finger
Lag

Structure of a hinge joint at the knee





Structure of the ball and socket joint at the shoulder



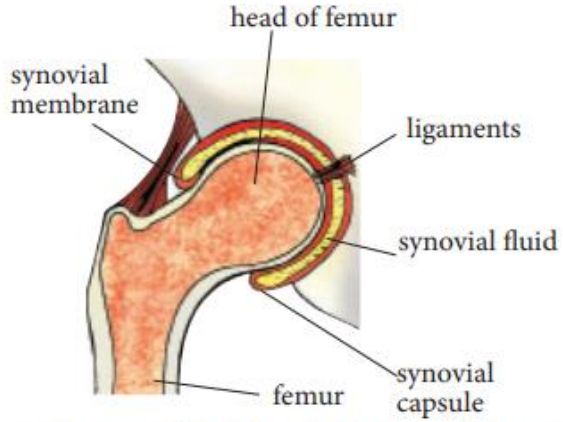


Fig 11.6: Ball and socket joint at the hip

Parts of the joint

1. *Ligament.* This is a tissue that connects a bone to another bone.
2. *Tendon.* This is a tissue that connects a muscle to a bone.
3. *Cartilage.* This is a tissue that encloses the ends of bones at the joints. It prevents articulating bones from wearing out due to friction. It also acts as a shock absorber.
4. *Synovial cavity.* This is located between two surfaces of articulating cartilage. It is surrounded by a synovial membrane that encloses the synovial fluid.
5. *Synovial fluid.* This acts as a lubricant during movement. Damage of a joint causes excess synovial fluid to be formed and the synovial cavity bulges causing a swelling in the joint.

MUSCLES

Muscles are bundles of elongated cells enclosed in a sheath of connective tissue.

When stimulated, the muscles *contract* to shorten e.g. during locomotion or peristalsis.

NOTE: Most muscle cells are arranged in pairs where one moves in opposite direction to the other. When one contracts, the other relaxes. These muscles contract *antagonistically*.

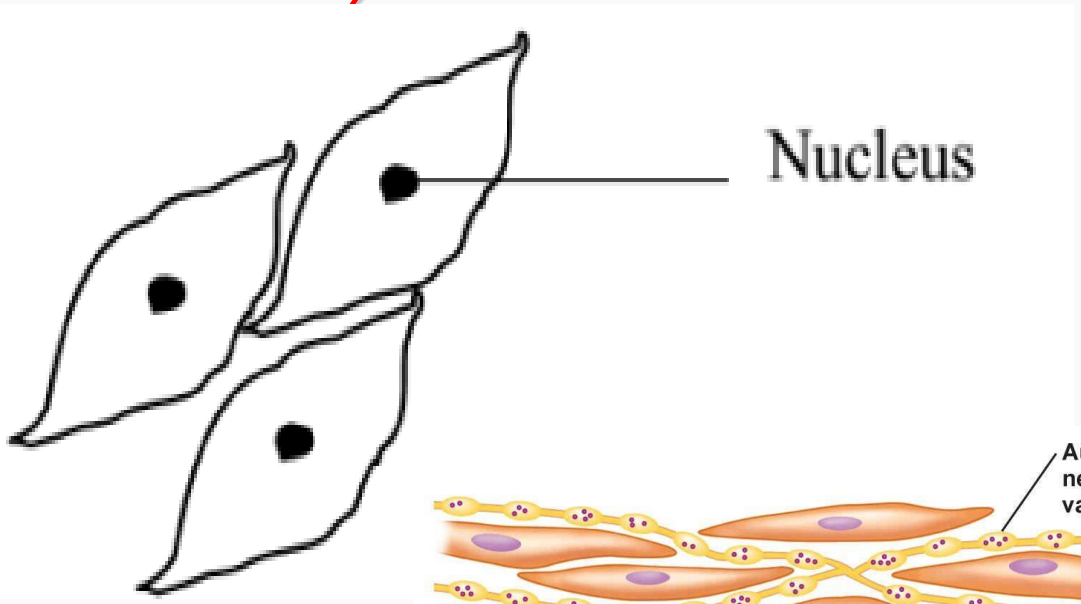
Types of muscles

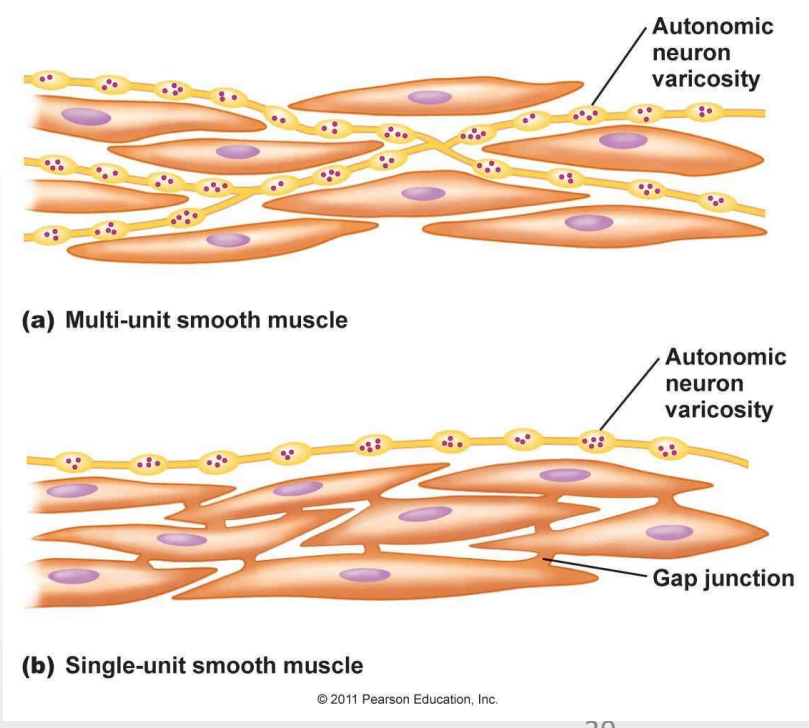
Smooth muscle/involuntary muscle.

This has spindle shaped cells held together by connective tissue.

They are called involuntary muscles because the individual cannot have conscious control over them.

The cells have one nucleus each. This muscle is located in the alimentally canal, reproductive organs, among other areas.





Cardiac muscle.

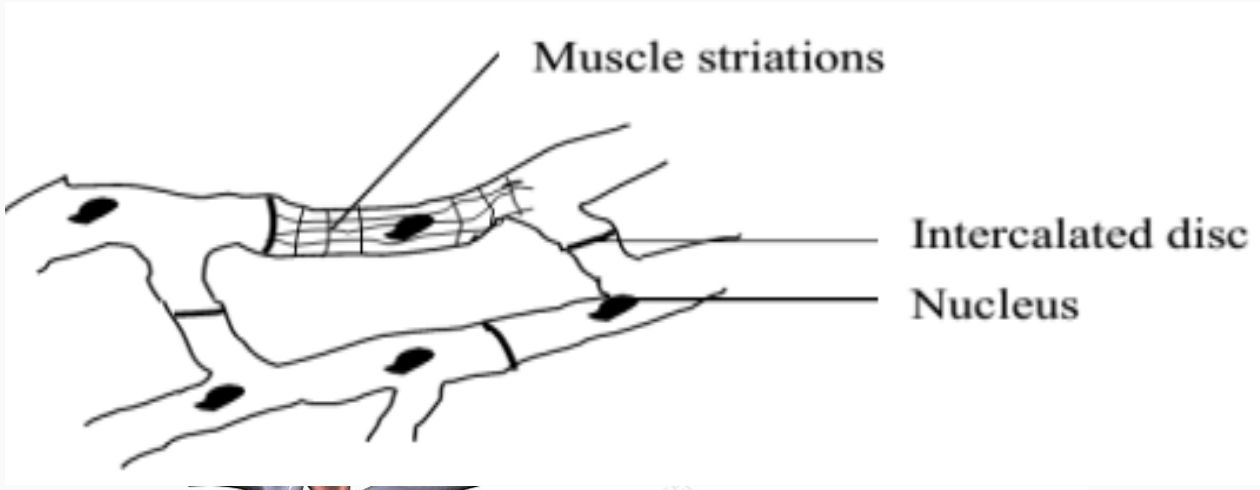
This is located in the walls of the heart.

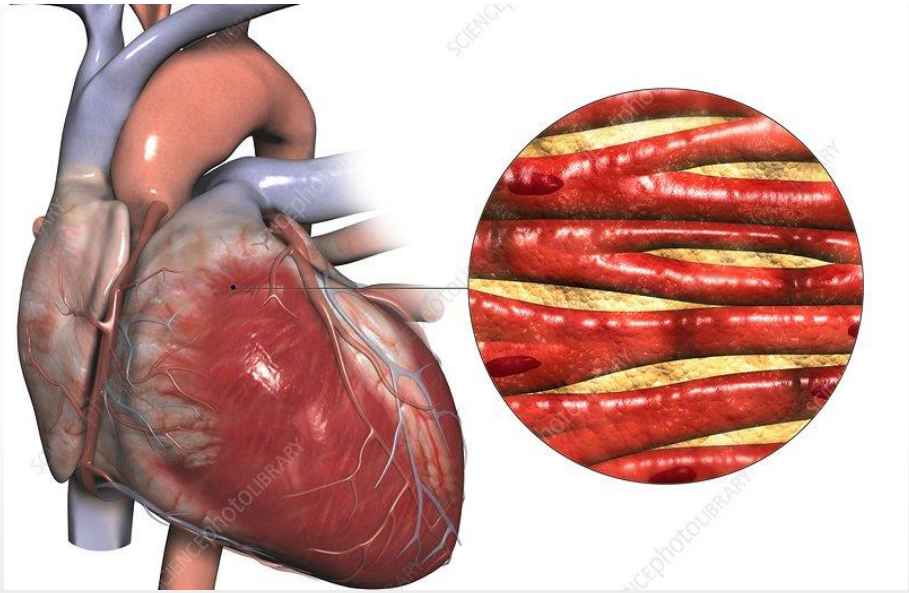
*The cardiac muscle **contracts without fatigue** and its contractions are not initiated by the nervous system.*

*Their contractions are described as **myogenic** that is the contractions arise from the heart muscle itself.*

*The cardiac muscle has **striations** (strips).*

*One cardiac muscle is connected to another via a strip of cartilage called **intercalated disc***





The skeletal muscle.

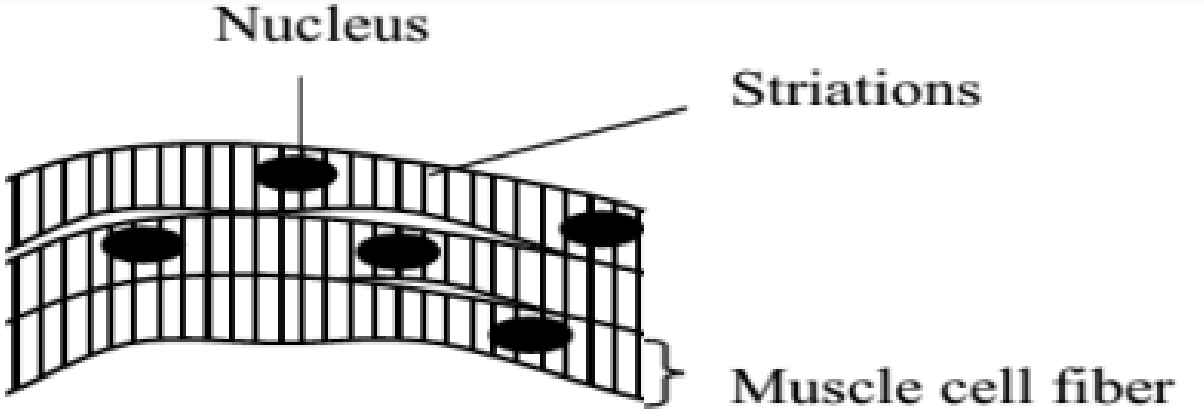
This consists of elongated cylindrical and striated (striped) cells.

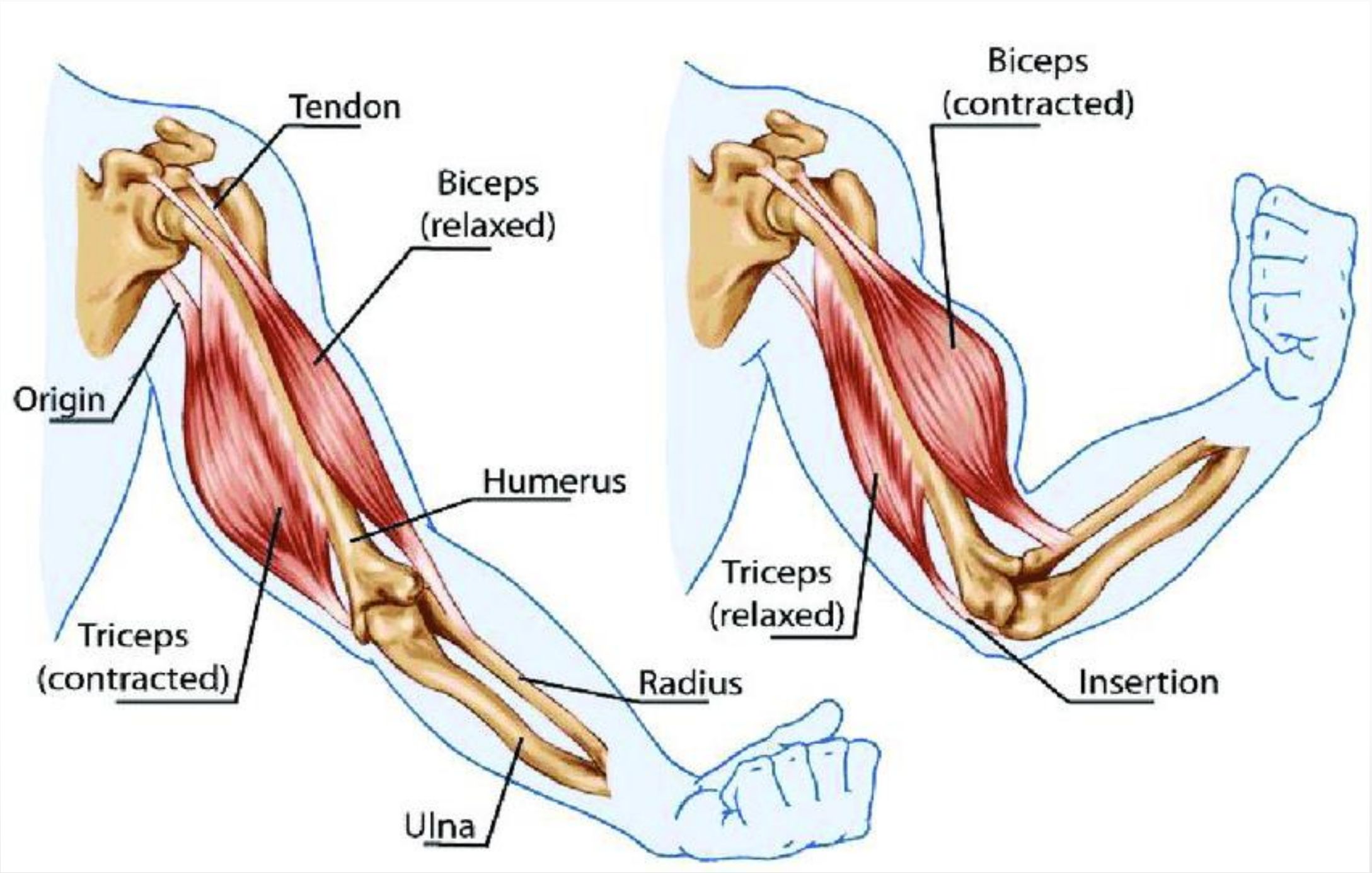
It is attached to the skeleton by tendons and is responsible for voluntary movements.

The cells occur in bundles surrounded by a connective tissue.

Many bundles are enclosed by a tough connective tissue to form muscles such as biceps and triceps.

The cells in the skeletal muscle are made up of more than one nucleus that is they are multinucleated.




Tendon
Biceps
(relaxed)
Origin
Humerus
Triceps
(contracted)
Radius
Ulna
Biceps
(contracted)
Triceps
(relaxed)
Insertion

Movement of the arm at the elbow

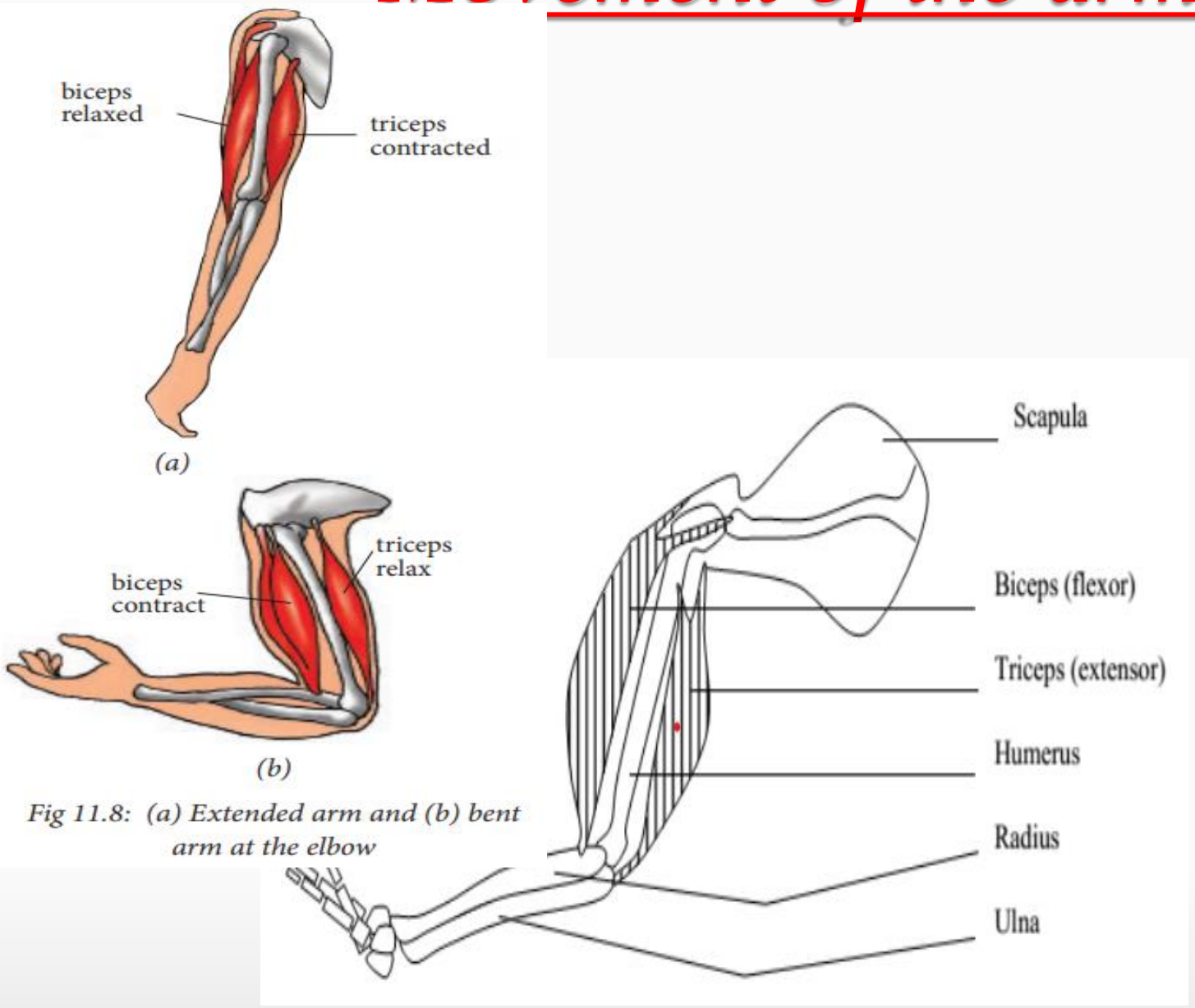


Fig 11.8: (a) Extended arm and (b) bent arm at the elbow

The contraction of the biceps (flexor) muscle pulls the radius, which causes the arm to be raised.

This causes the elbow to bend (flex) hence the bending of the whole arm.

When the triceps (extensor) muscle contracts, it pulls the ulna thus straightening the arm.

Muscle cramps

These are painful, involuntary contractions of muscles.

Causes

The exact cause of muscle cramp is not known, but risk factors may include;

1. Tight, inflexible muscles
2. Poor physical condition
3. Poor muscle tone
4. Inadequate diet
5. Muscle injury
6. Muscle fatigue
7. Dehydration
8. Wearing high-heeled shoes for long periods

Effects

- ✓They are often associated with *muscle strain*, but they can also be a sign of medical conditions e.g. *circulation problems* and *liver disease*.
- ✓Muscle cramps can interfere with your daily activities.
- ✓Because they often happen at night, they can affect your sleep. As a result, they may reduce your quality of life.

Prevention strategies

1. *Increase your level of physical fitness*
2. *Incorporate regular stretching into your fitness routine*
3. *Drink plenty of water before, during and after exercise*
4. *Regular massage to reduce muscle tension*
5. *Wear properly fitted shoes and avoid high heels*
6. *Include fruits and vegetables in your diet*

END

BIOLOGY IS LIFE

SLIDES PREPARED BY TR. PETER L OKION