Unit 1 - Anatomy and Physiology

Assessment Outcomes

AO1 – Demonstrate knowledge of body systems, structures, functions, characteristics, definitions and other additional factors affecting each body system.

AO2 – Demonstrate understanding of each body system, the short- and long-term effects of sport and exercise on each system and additional factors that can affect body systems in relation to exercise and sporting performance.

AO3 – Analyse exercise and sports movements, how the body responds to short-term and long-term exercise and other additional factors affecting each body system.

AO4 – Evaluate how body systems are used and how they interrelate in order to carry out exercise and sporting movements

AO5 – Make connections between body systems in response to short-term and long-term exercise and sport participation. Make connections between muscular and all other systems, cardiovascular and respiratory systems, energy and cardiovascular systems.

Learning Aim A – The effect of exercise & sports performance on the skeletal system

Learning objectives

A1 – To understand the structure of the skeletal system.

A2 – To be able to explain the functions of the skeletal system.

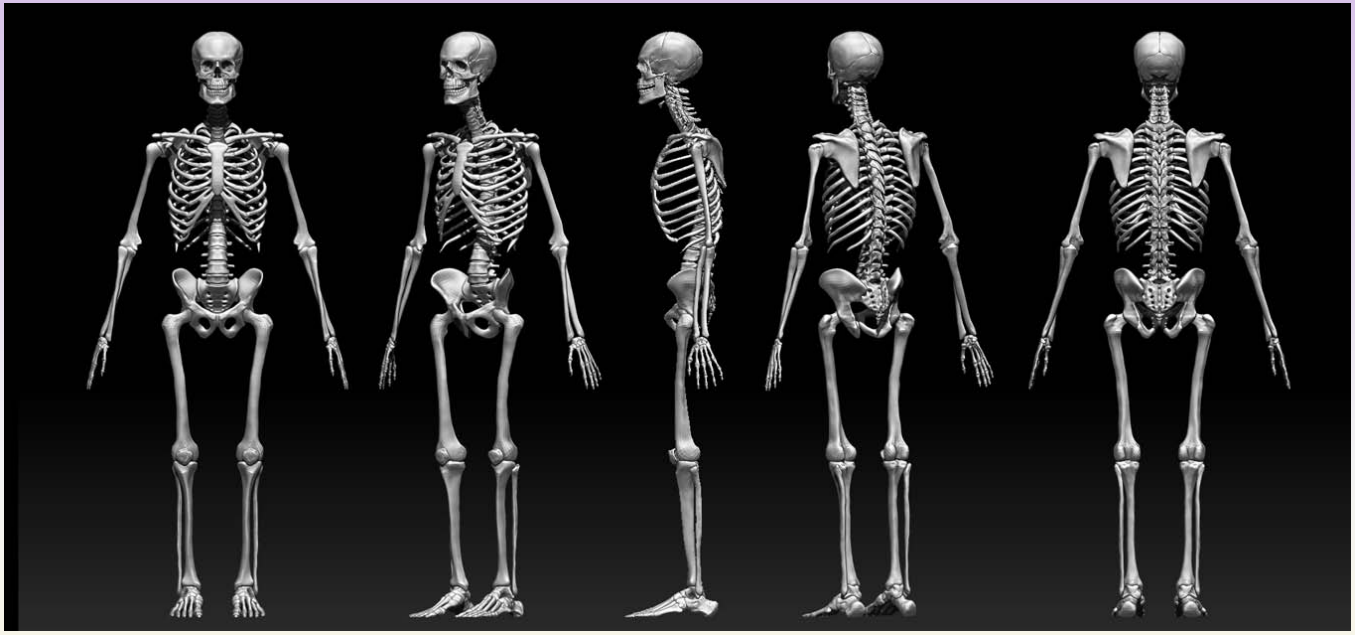
A3 – To identify joints in the body and related synovial joint actions.

A4 + A5 – To understand the responses and adaptations of the skeletal system to sport and exercise.

A6 – To be able to describe factors that affect the skeletal system.

Structure of the skeletal system

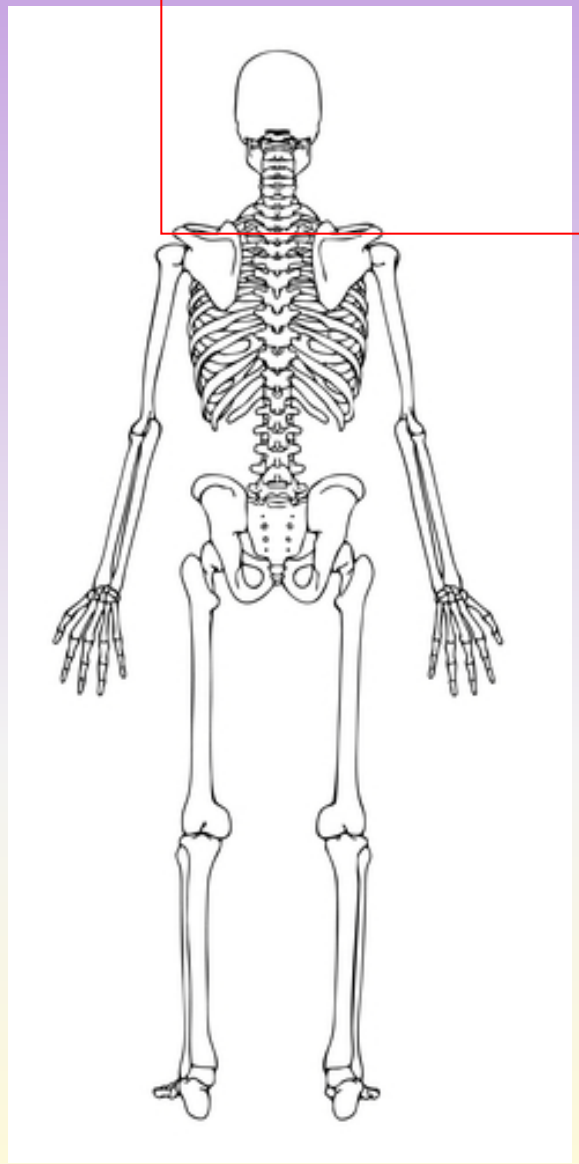
The skeleton is a framework for the body and provides protection, site for muscle attachment and is responsible for blood cell production. There are 206 bones in the body.



Watch me

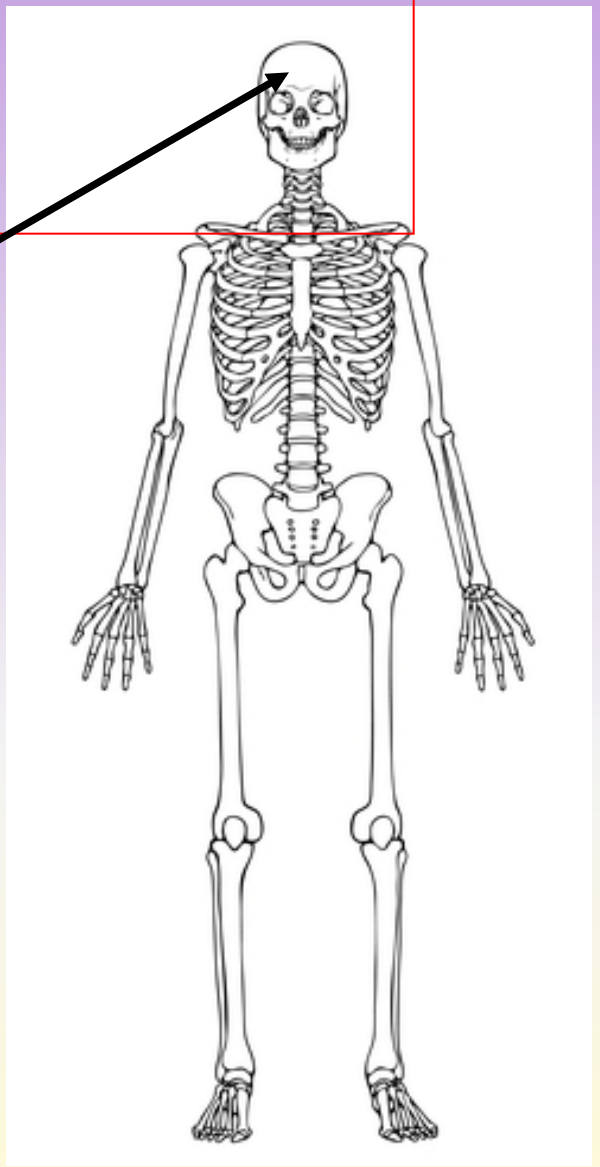
How many bone names do you know already?

Structure of the skeletal system

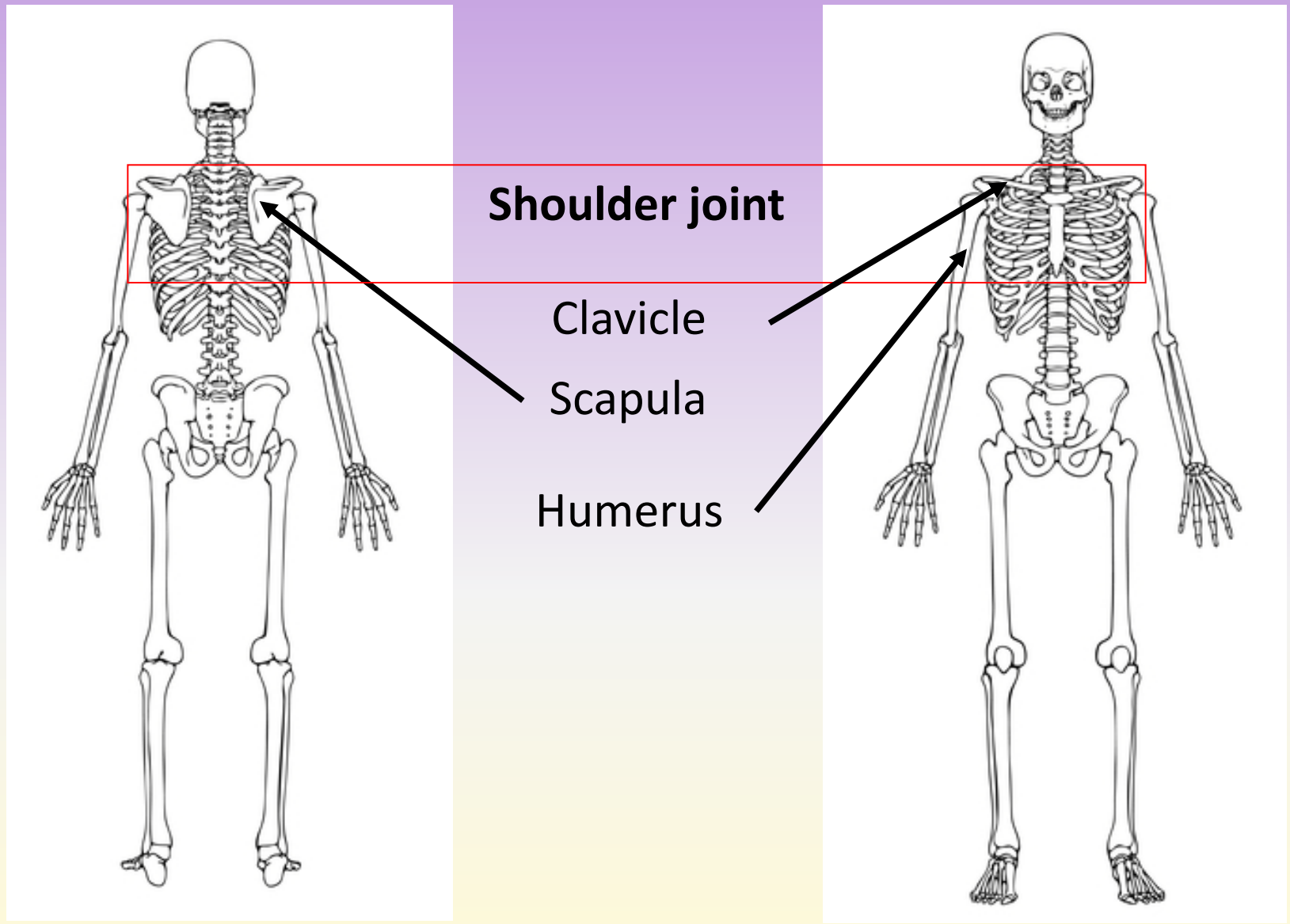


Head/Neck joint

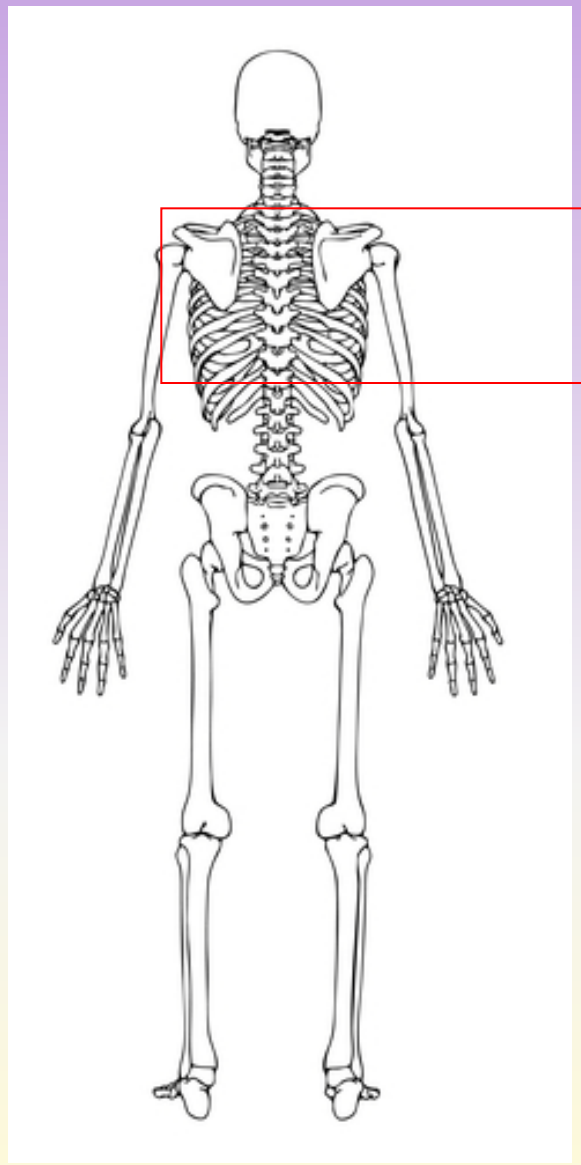
Cranium



Structure of the skeletal system



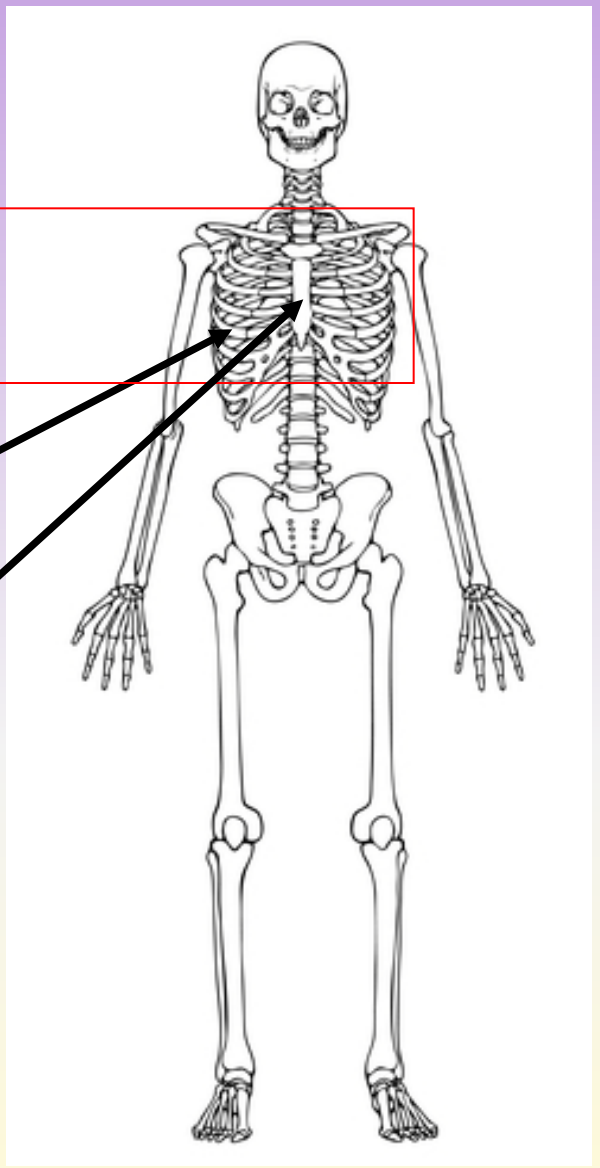
Skeletal System



Chest region

Ribs

Sternum



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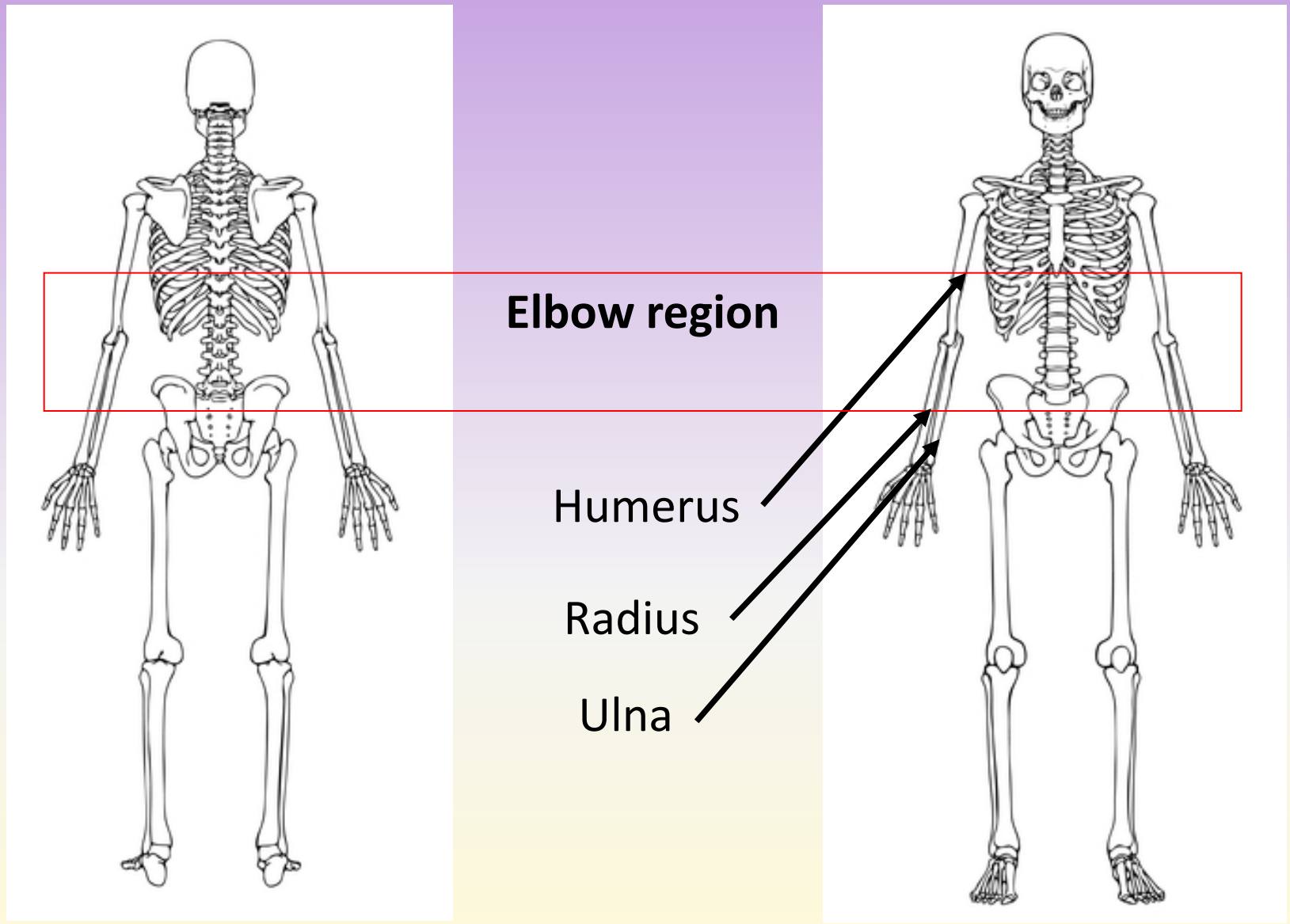

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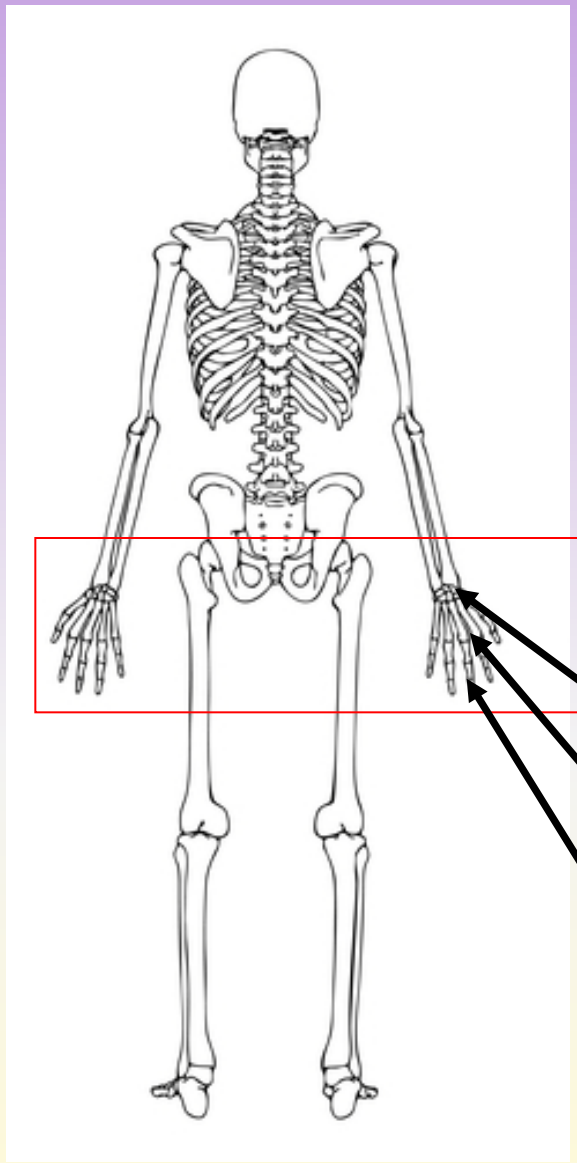
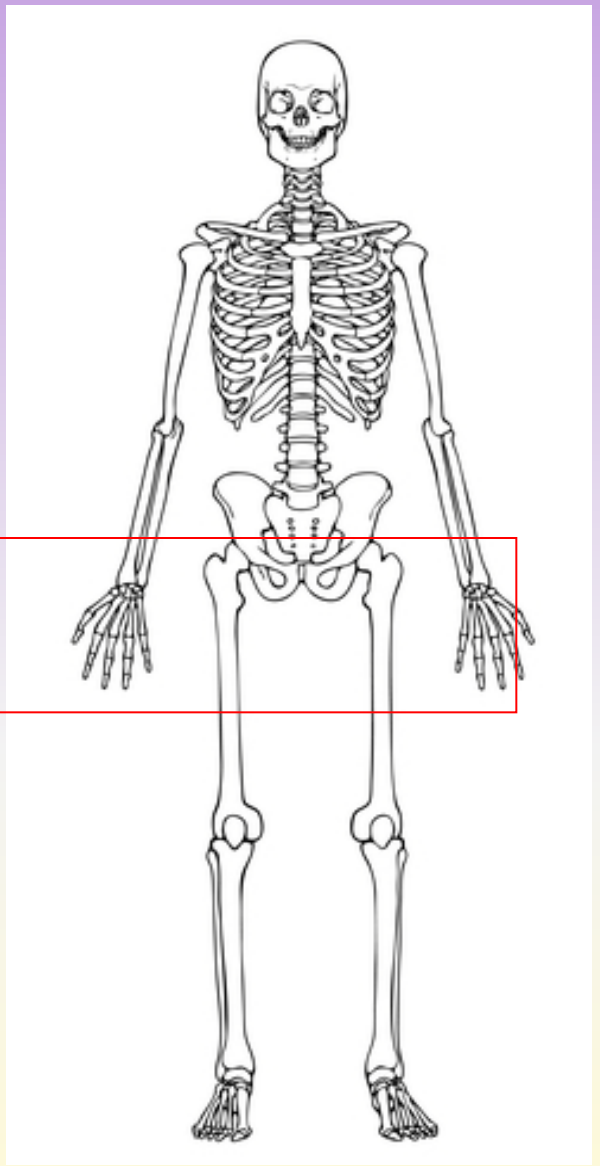


Wrist region

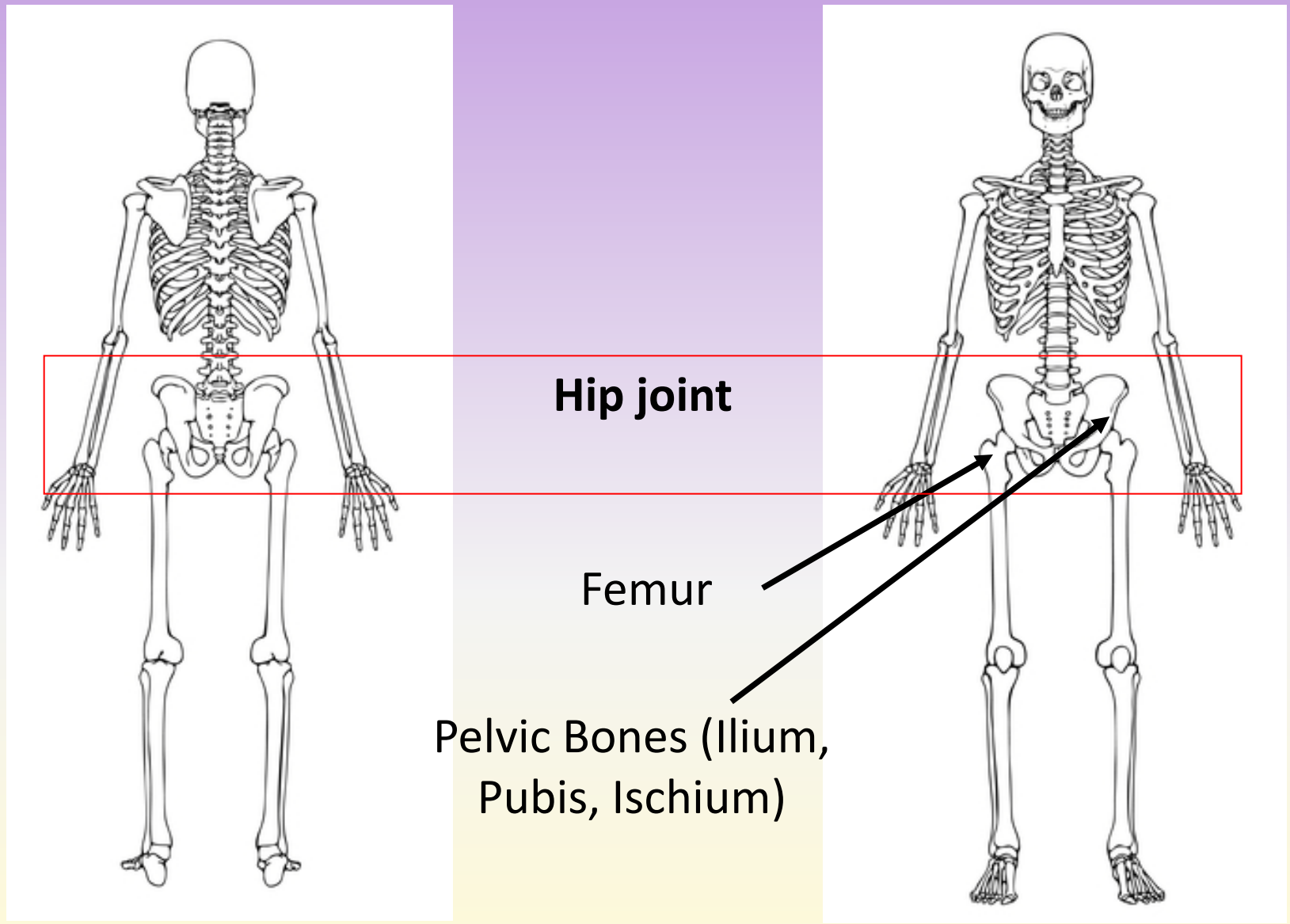
Carpals

Metacarpals

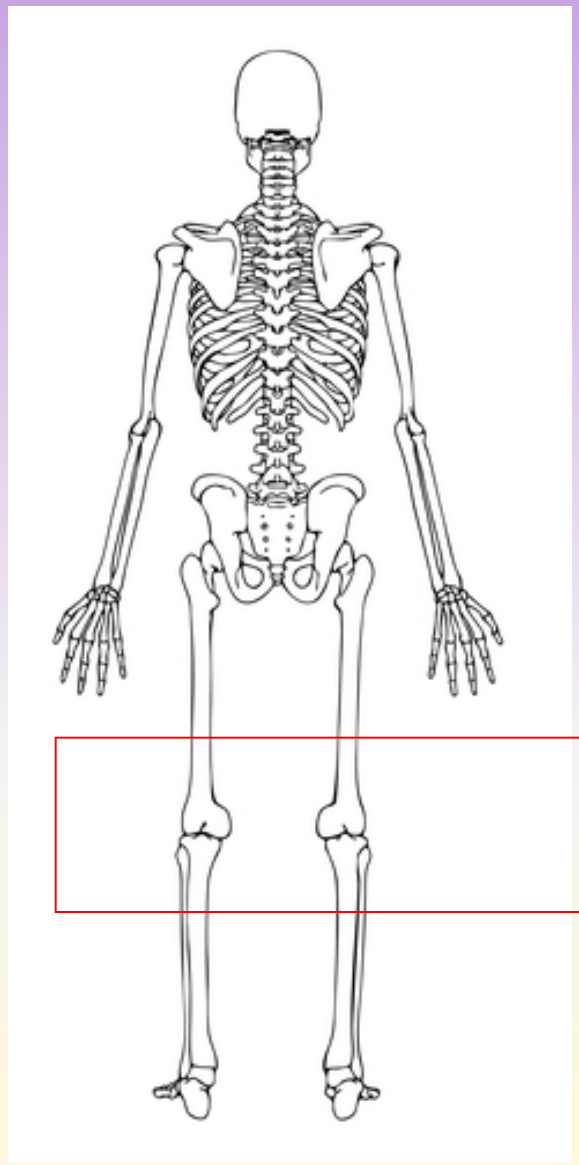
Phalanges

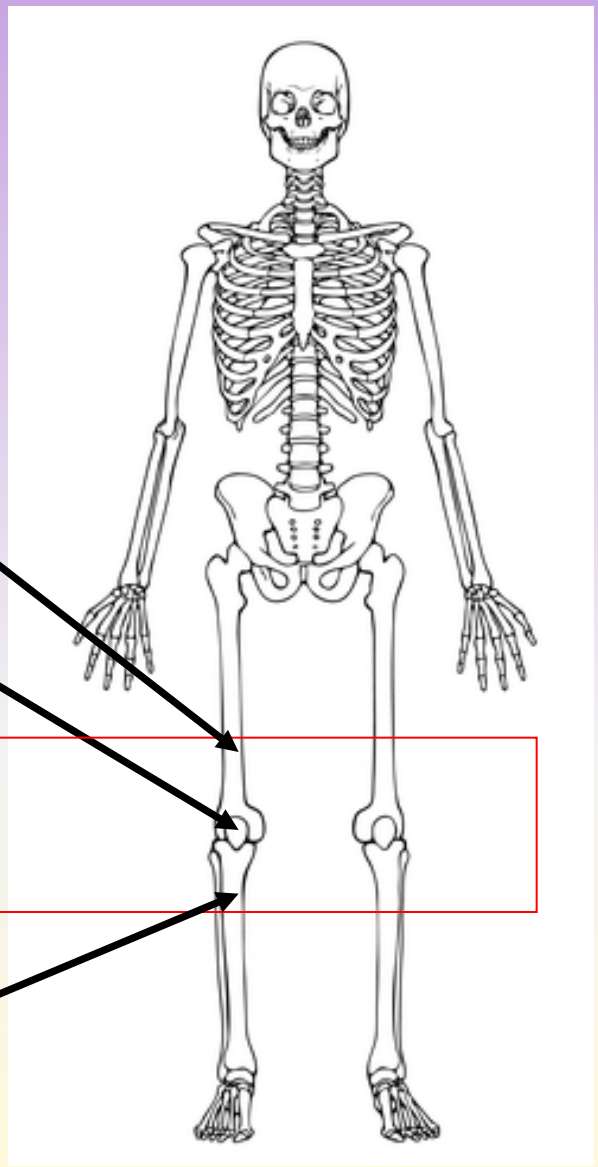


Structure of the skeletal system



Structure of the skeletal system





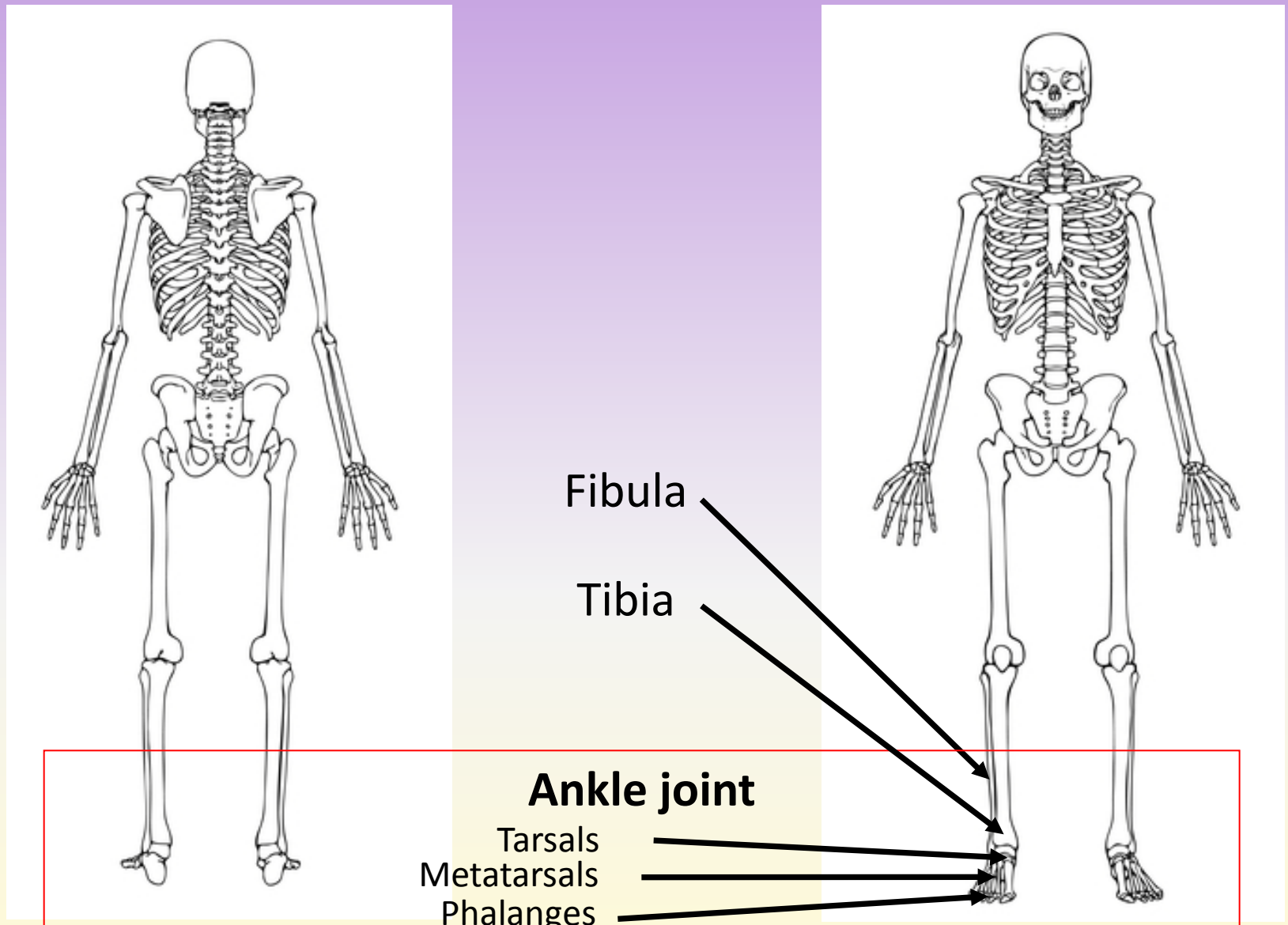
Femur

Patella

Knee joint

Tibia

Structure of the skeletal system

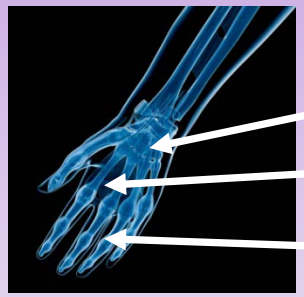


Structure of the skeletal system

Foot

Tarsals
Metatarsals
Phalanges

Hand



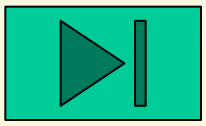
Carpals
Metacarpals
Phalanges

Anatomical terms to describe bone locations

The location of bones can be referred to by the following terms:

Term	Description
Anterior	To the front/in front
Posterior	To the back/behind
Medial	Towards the midline of the body
Lateral	Away from the midline of the body
Proximal	Near the root or origin
Distal	Away from the root or origin
Superior	Above
Inferior	Below

Watch me



How many of the 8 anatomical terms can you remember?

Anatomical terms to describe bone locations

List 5 to 10 statements using the anatomical terms and the skeletal system structures.

i.e. The proximal end of the humerus meets the clavicle and scapula to form the shoulder joint.

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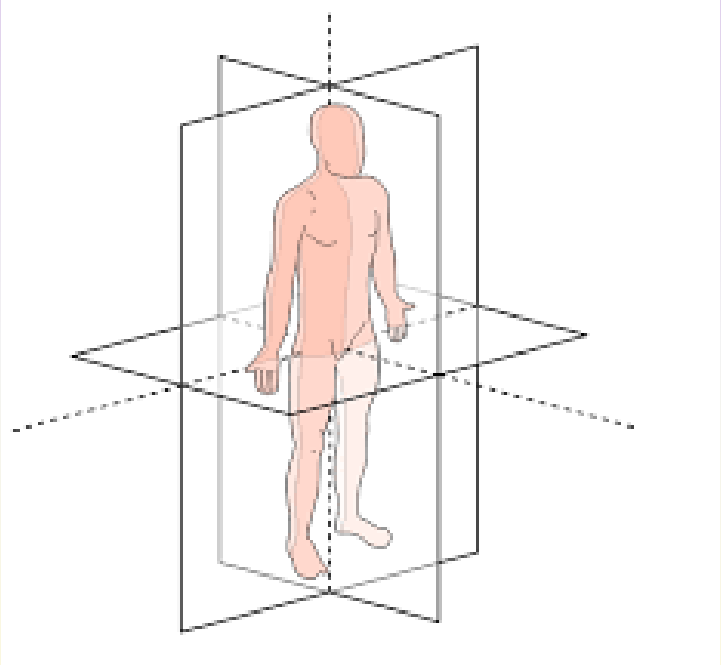


Types of bones

Bones are divided into a number of different categories according to their shape and size.

1. Long bones

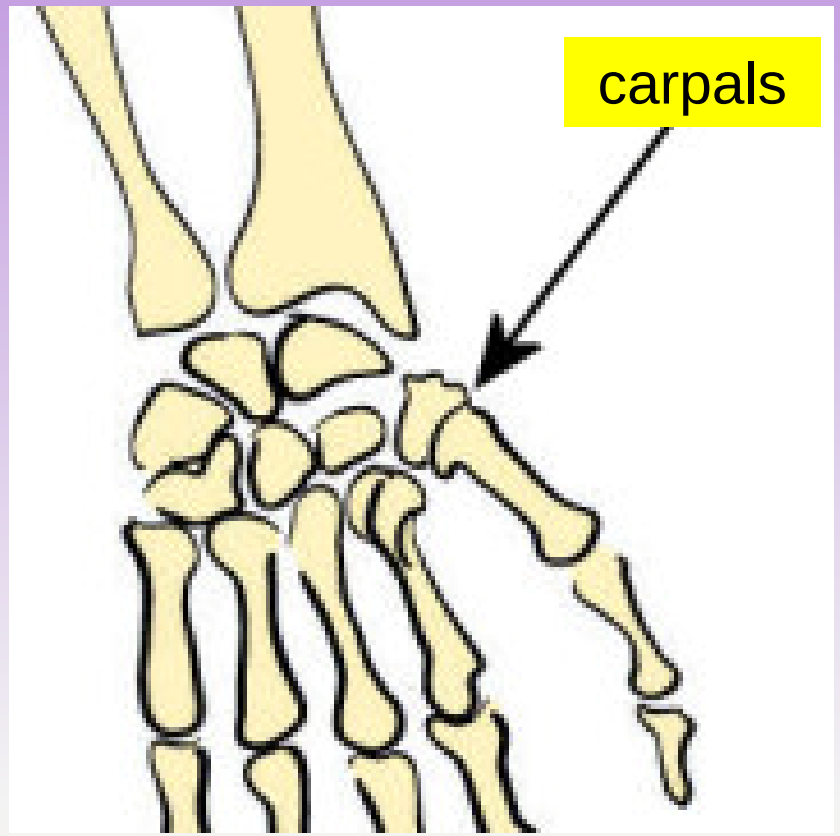
Long bones have a **shaft** known as the **diaphysis** and two **ends** known as the **epiphysis**. These are responsible for **movement** and act as **levers**. This is how sporting actions are created.

Long bones in the body include the **femur, humerus, tibia, fibula, metatarsals, metacarpals and phalanges**.

2. Short bones

Short bones are light, small and very strong. The bones are made up of **cancellous bone**, a **porous** material that has a spongy appearance. The primary function is to support the weight of the body.

The carpals in the wrist and the tarsals in the foot are examples of short bones.

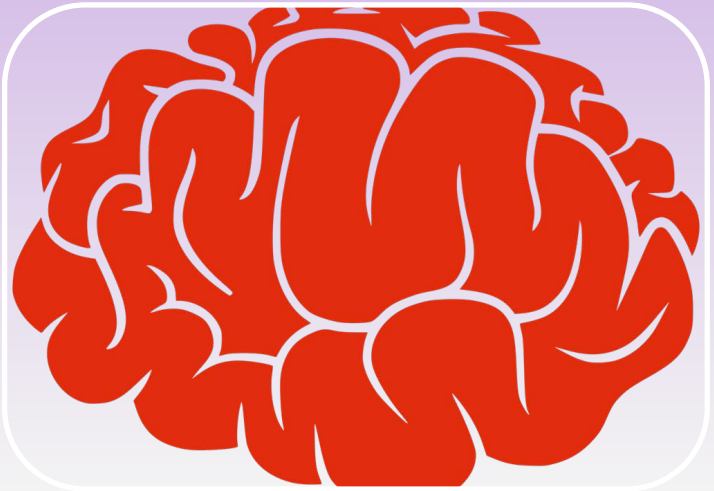


Think. Pair. Share - How does this aid sportspeople in an event?

Gymnasts used these bones to support movements such as a handstand.

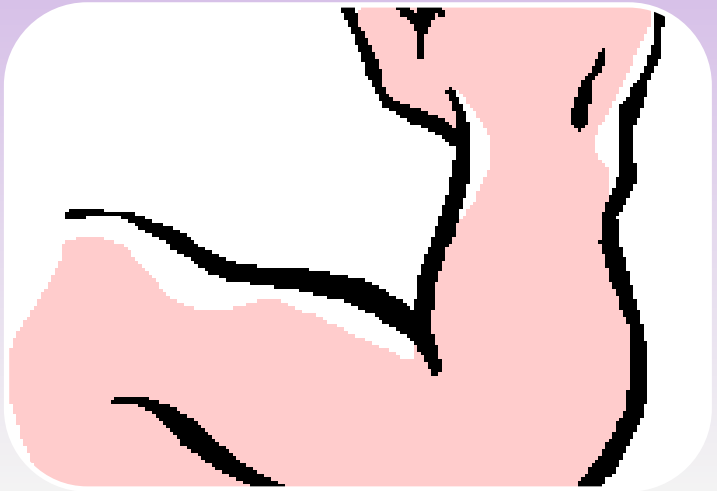
3. Flat bones

Flat bones perform a number of functions and are thin, flattened and have a larger surface area.



1. Protection for delicate areas.

i.e. the cranium protects the brain.



2. Provides a broad surface area for muscle attachment.

i.e. muscles in the back attach to the pelvis.

4. Irregular bones

Irregular bones are complex shapes that do not fall into any of the other categories.

*An example of an irregular bone in the body is the **vertebrae**.*

5. Sesamoid

These types of bone are specially shaped to perform a **particular function** and usually **embedded** within a **tendon** or a **muscle**.

Sesamoids act like pulleys, providing a smooth surface for tendons to slide over and increase muscular force.

*An example in the body includes the **patella.***

Areas of the skeleton

The skeleton is divided into two parts. The **axial skeleton** is the main long axis of the body while the **appendicular skeleton** refers to the bones that are attached to the axis.

Axial Skeleton – This is the main core of the skeleton and consists of

1. The Cranium and facial bones

2. The thoracic cage area – (Sternum and ribs)

3. The vertebral column

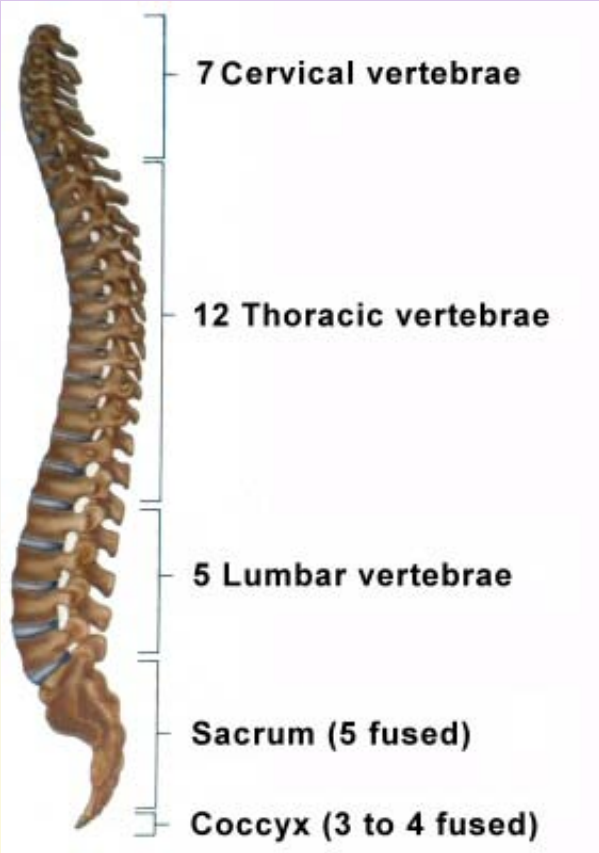
Appendicular Skeleton – This consists of the bones that are attached to the axis.

1. Bones of the upper limbs
2. Bones of the lower limbs
3. Bones of the shoulder region
4. Bones of the pelvic region

The spine or vertebral column

The vertebral column is made up of irregularly shaped bones called **vertebrae**. The vertebral column is divided into **5 sections** and protects the **spinal cord** and **supports** the **ribcage**.

Between each vertebra there is a pad of **cartilage** which allows movement and prevents friction.

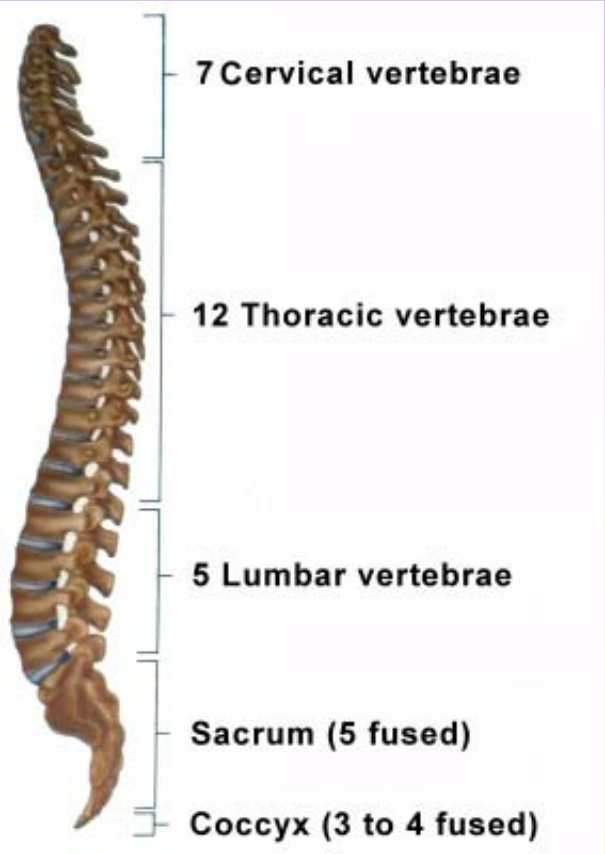


The spine or vertebral column

Cervical vertebrae – The first two bones are the atlas and axis. This forms the pivot joint in the neck and allows the head to move freely.

Thoracic vertebrae – This is the mid spine and move with the ribs

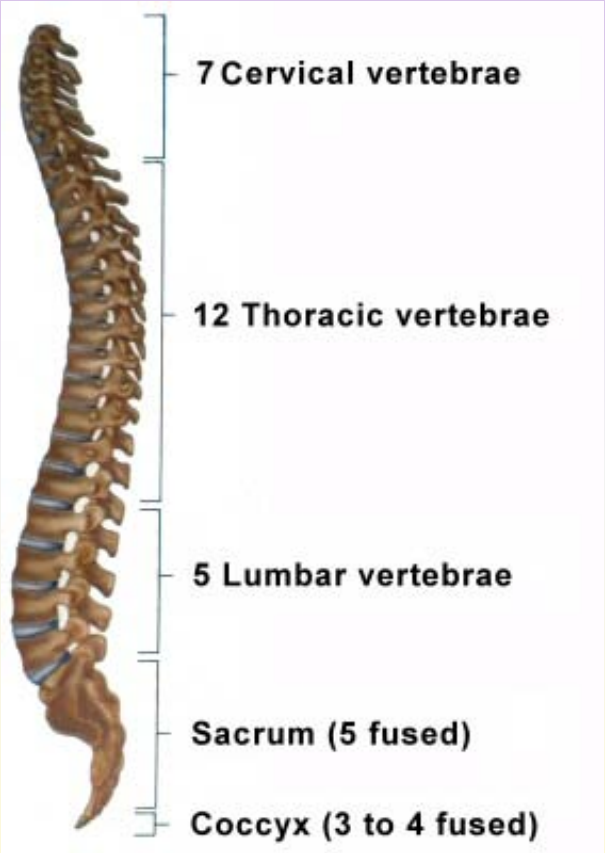
Lumbar vertebrae – This part of the vertebral column provides a large area for muscle attachment and can support more weight than the other regions. The discs produce a **concave** appearance.



The spine or vertebral column

Sacral vertebrae – The 5 bones in the sacral vertebrae are fused to form the **sacrum**. It forms the back section of the pelvic girdle.

Coccygeal vertebrae – There are four coccygeal vertebrae which form the **coccyx**.



Postural deviations

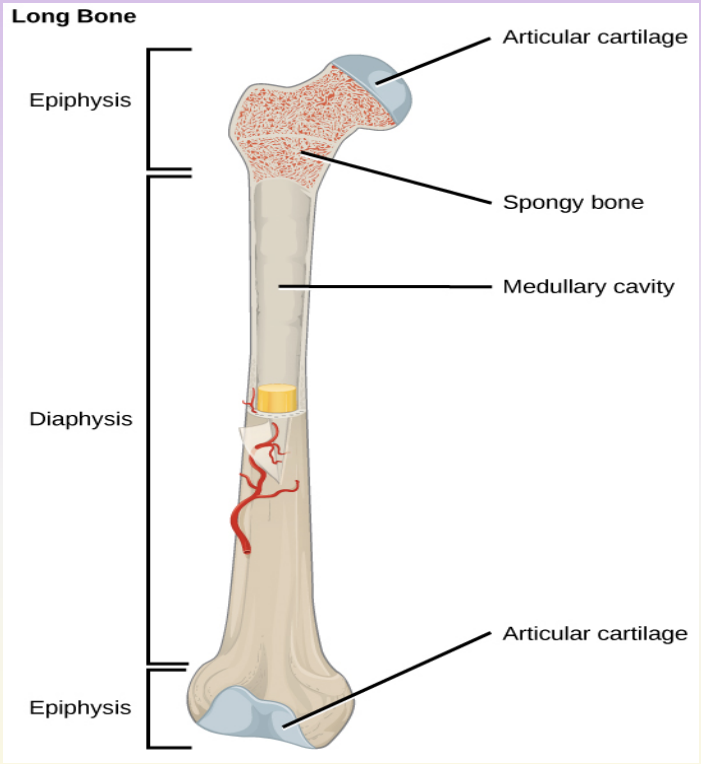
A neutral spine refers to a **good posture** with the correct curves of the **cervical, thoracic and lumbar regions** of the vertebral column.

The spine can suffer from disorders that means the spine is not completely vertical when looking in anterior view. This is known as **Kyphosis** (hunchback) and **Scoliosis** (curvature of the thoracic region left or right often found in children).

Process of bone growth

Ossification is the process in which the bones are formed. This process relies on **osteoclasts** absorbing bone tissue during growth and healing phase.

Cells that supply calcium to developing bones are known as **osteoblasts**. Osteoblast activity can be stimulated through physical exercise. Stronger bones can also reduce the risk of **osteoporosis**.



Process of bone growth

The end of every long bone contains a growing area called an **epiphyseal plate**. These areas are responsible for the increase in the bone length during childhood. Once maturated the head fuses with the shaft to form a **epiphyseal line**.

Functions of the skeleton

The skeleton performs many functions in the body.

1. Support – The skeleton supports the muscles.

2. Protection – The skeleton protects delicate parts of the body like the brain.

3. Leverage – Muscles are attached to the bones and once contracting allows movement.

4. Muscle attachment – The skeleton gives us our shape/size and creates levers.

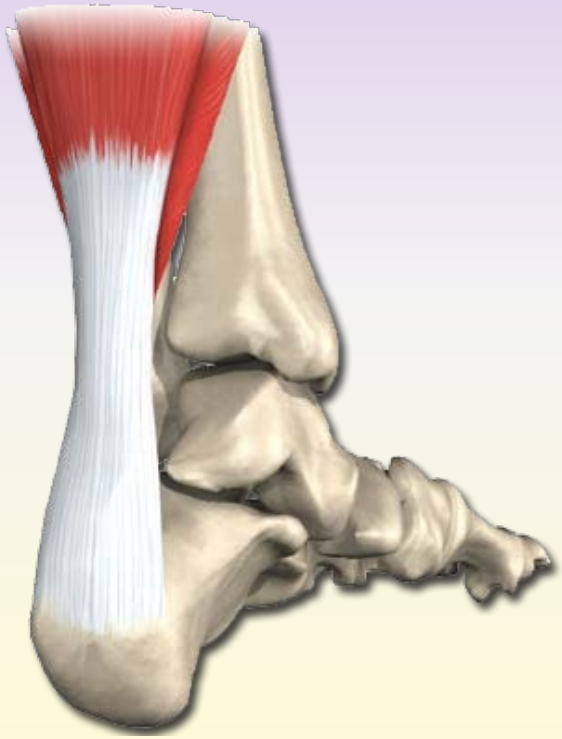
5. Mineral storage – vital minerals such as Calcium and Phosphorus are stored in bones.

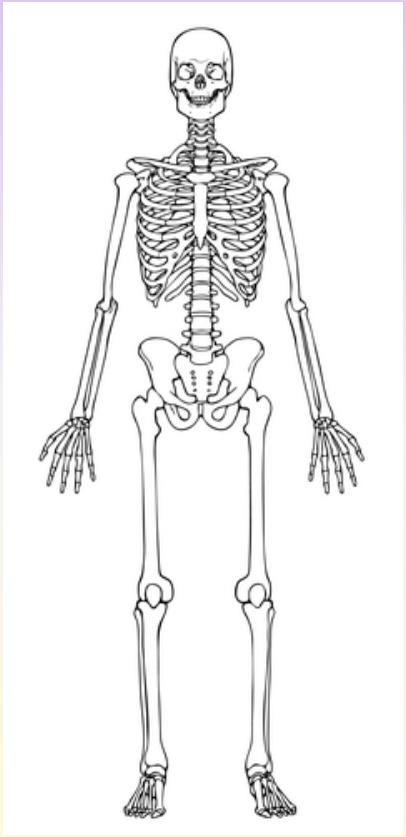
6. Blood cell production – blood cells are made in the bone marrow.

1. Support

It gives the body **support**, enabling us to stand. The bones of the body are held together by **ligaments**.

The skeleton provides a framework for the muscles, which are attached to bones by **tendons**.





2. Protection

Some of our body parts, such as the brain, are very delicate and need **protection**.

Bones can protect body parts from **impacts** and **injuries**.

- 1. What vital organ does the Cranium protect?

Answer:

- 2. What vital organ does the Rib Cage protect?

Answer:

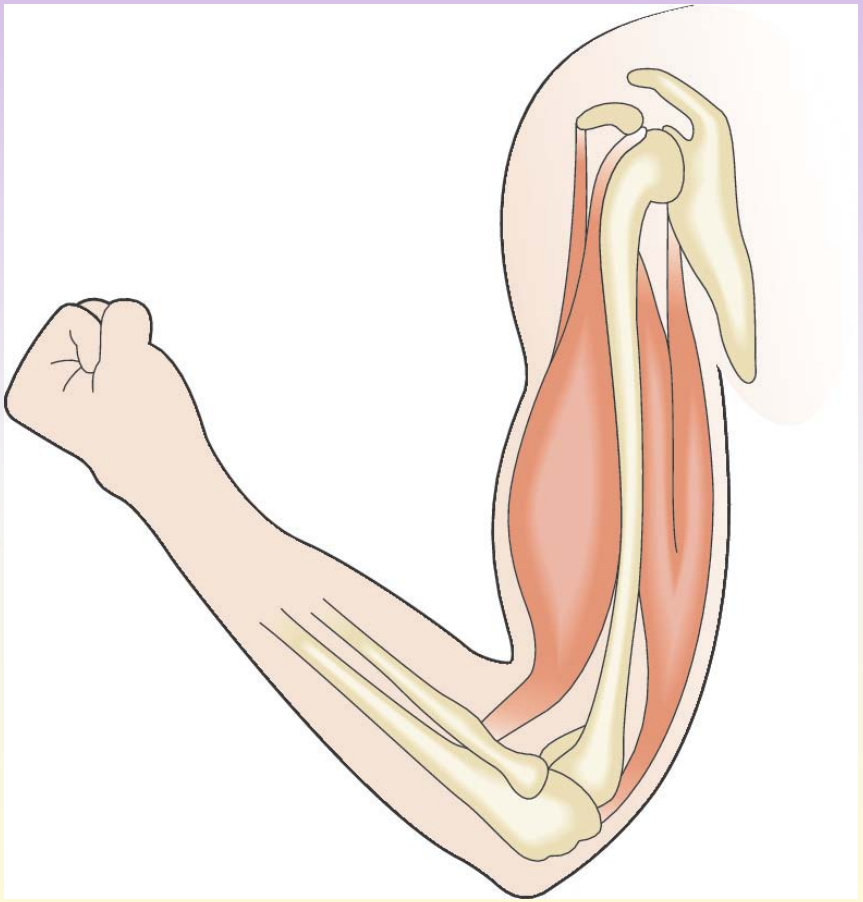
3. Leverage

Muscles are firmly attached to bones forming levers to allow for sporting movements.

4. Muscle Attachment

The skeleton acts as a framework.

Muscles are firmly attached to bones forming levers to allow for sporting movements.



5. Mineral Storage

The minerals in your bones serve two main functions. Minerals transform spongy bone matrix into a rigid structure and in turn increase density and strength.

Your bones also function as a mineral storage depot, releasing dissolved calcium, phosphorus and magnesium into your bloodstream if needed.

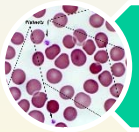
6. Blood cell production

The ends of long bones and some other bones including the ribs, humerus, femur and even vertebrae bones, contain **red bone marrow**.

This is where the red blood cells are produced which carry oxygen.

<u>Other functions include:</u>

White blood cells to combat illness



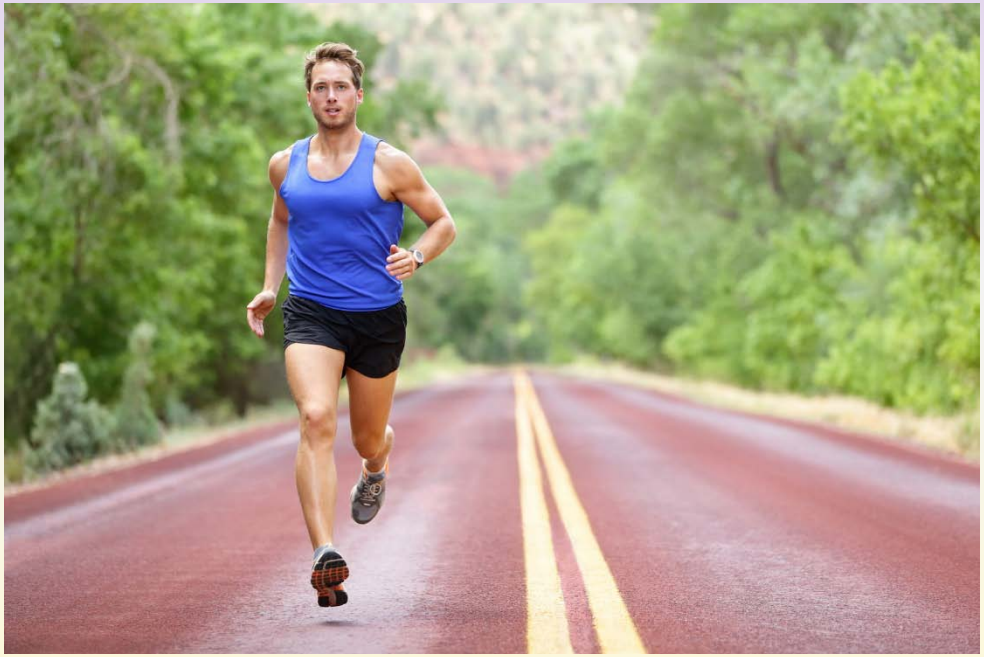
Platelets for clotting and healing.

Storage of Calcium and Phosphorus

Functions of the skeleton

Two additional functions include:

Weight bearing:
Bones will support the weight of your tissue mass. The skeleton provides structural strength to prevent injury.



Reducing friction:
The skeleton makes up many different joints in the body and it is the synovial fluid secreted between a joint that prevents friction.

Functions of different bone types

All bones have different functions depending on their shape and location.

Bone type	Function
Long	Movement, support and red blood cell production.
Short	Stability and weight bearing
Flat	Attachment for muscles and protection.
Irregular	Protection and movement
Sesamoid	Protection and reducing friction across a joint.

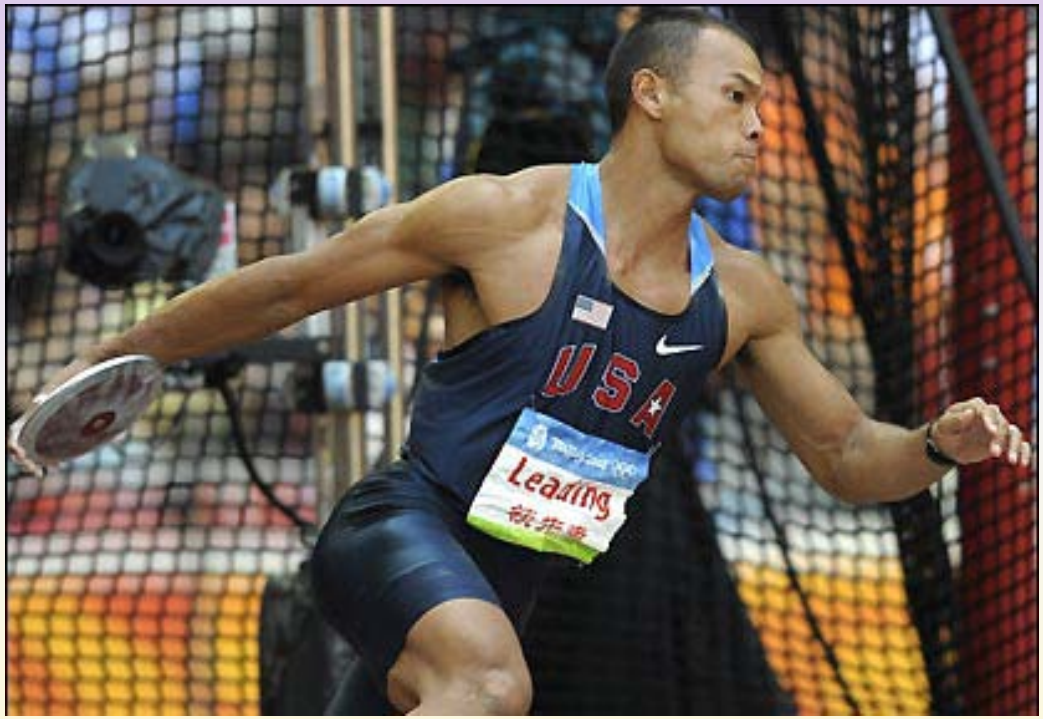
Joints

Definition:

‘A joint is a place where two or more bones meet’ This is known as **articulation.**

The skeleton is a framework connected by joints.

Joints are necessary for muscles to lever bones and create movement.



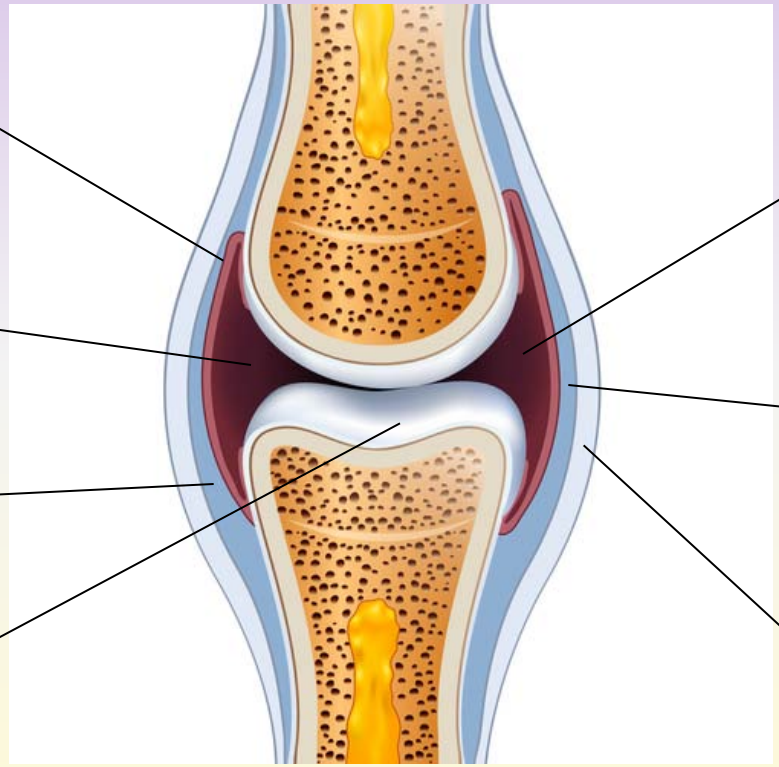
Types of Joints

There are 3 types of joints in the body according to the amount of movement possible:

1. **Fixed joint (fibrous or immovable joint):** These joints do not move. *i.e. the plates in the cranium.*
2. **Slightly moveable joint (cartilaginous joint):** These allow slight movement and are often surrounded by cartilage. *i.e. vertebrae.*
3. **Synovial joint (freely moveable joint):** These joints are the most moveable and are vital to sporting actions. *i.e. the knee joint*

Synovial Joints

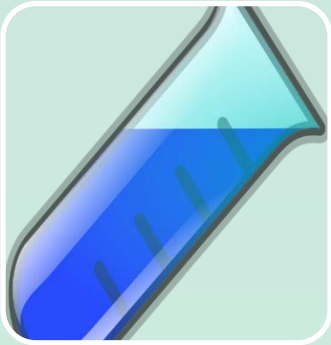
Synovial joints are the most common type of joint in the body. These joints vary in structure for example, the shoulder is a ball-and-socket joint and the knee is a hinge joint. All synovial joints have the following structures.



Synovial Joints

The following structures help prevent injury.

Cartilage prevents the ends of bones rubbing together at joints.



Synovial fluid – lubricates the joint allowing the parts to move freely.

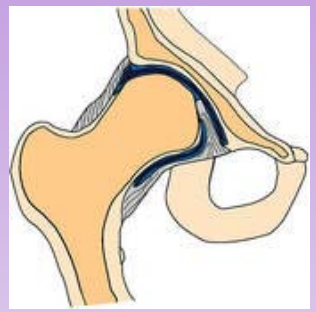
Ligaments – these are tough, elastic fibres that link bones to bones.

Tendons – These connect muscles to bones.

Types of Synovial Joints

1. Ball and socket joints allow movement in **all directions** and is the most mobile joint in the body.

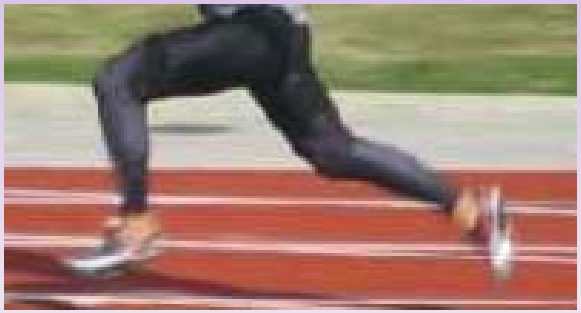
Example: Shoulders and hips used in a tennis serve.



Think. Pair. Share – Using examples, how are these joints used in sport?

Types of Synovial Joints

2. **Hinge joints -** only allow **forwards and backwards** movement like the hinge on a door.



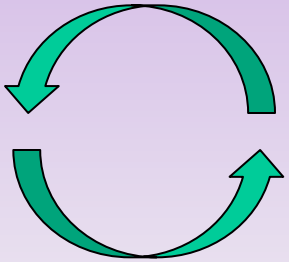
Examples found in the body: The knee and elbow.

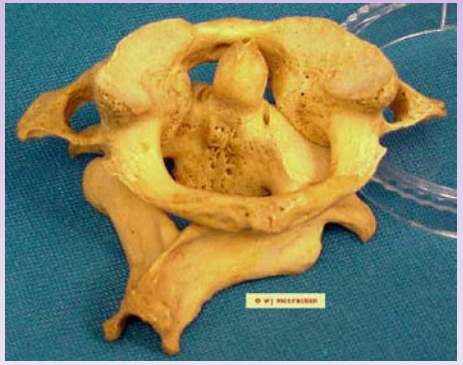
Why are these joints important for sport?

These joint are extremely powerful and in conjunction with surrounding muscles can produce power and speed
i.e. Knee drive during a 100m sprint

Types of Synovial Joints

3. Pivot joints have a ring of bone that fits over a bone sticking out. Pivot joints allow **rotation only**.





Examples found in the body: The joint between the **atlas and axis** in the **neck** which allows turning and nodding of head

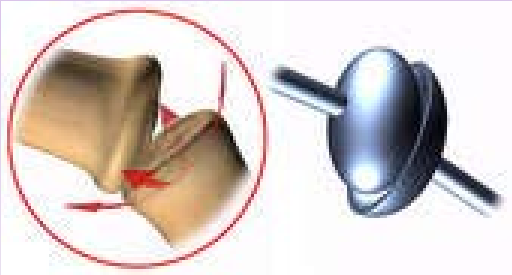
Why are these joints important for sport?

This joint allows for small movements that assist a larger sporting action

i.e. breathing during a swimming stroke

Types of Synovial Joints

4. Condyloid joints have an oval-shaped bone end which fits into a similar shape. They allow small movement in all directions.



Examples found in the body: Found between the carpals and metacarpals in the wrist joint.

Why are these joints important for sport?

These joint are extremely useful when a sport involves gripping a ball.
i.e. handball throw

Types of Synovial Joints

5. Gliding joints occur between the surfaces of two flat bones that are held together by ligaments.

Examples found in the body: The bones in your wrists and ankles as well as the spine.

Why are these joints important for sport?

These joints are used to allow flexibility and movement in the hands, feet and back regions.
i.e. a kicking or catching action or a boxing slip

Types of Synovial Joints

6. Saddle joints are similar to condyloid joints but the surfaces are **concave** and **convex**.

Examples found in the body: The bones at the base of the thumb.

Why are these joints important for sport?

These joints are used to grip a sporting implement.
i.e. gripping a badminton racket.

Range of movement at synovial joints

Flexion involves a **decrease** in the angle that occurs around a joint. Muscles contract to move the joint into a bent position.
i.e. bicep curl or preparation for a kicking action

Range of movement at synovial joints

Extension involves an **increase** in the angle that occurs around a joint or straightening a limb.

i.e. straightening the elbow during the download phase of a bicep curl or the contact point for a forehand.

Range of movement at synovial joints

Planter Flexion is a term used solely for the ankle joint. It involves bending the foot downwards, away from the tibia.

i.e. action of moving up onto toes or pointing toes.

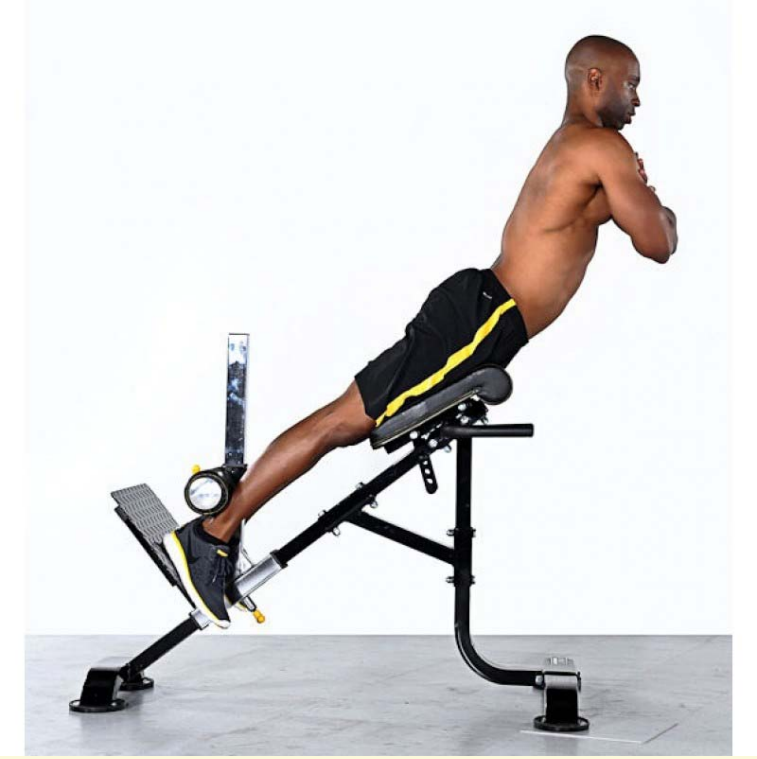
Range of movement at synovial joints

Dorsi Flexion is bending the foot upwards towards the Tibia.

i.e. - Action of pulling up toes towards the body.

Range of movement at synovial joints

Lateral flexion:
Movement of the body bending sideways.



Hyper-extension:
This involves moving the limb beyond its normal position in the direction opposite to flexion.

Range of movement at synovial joints

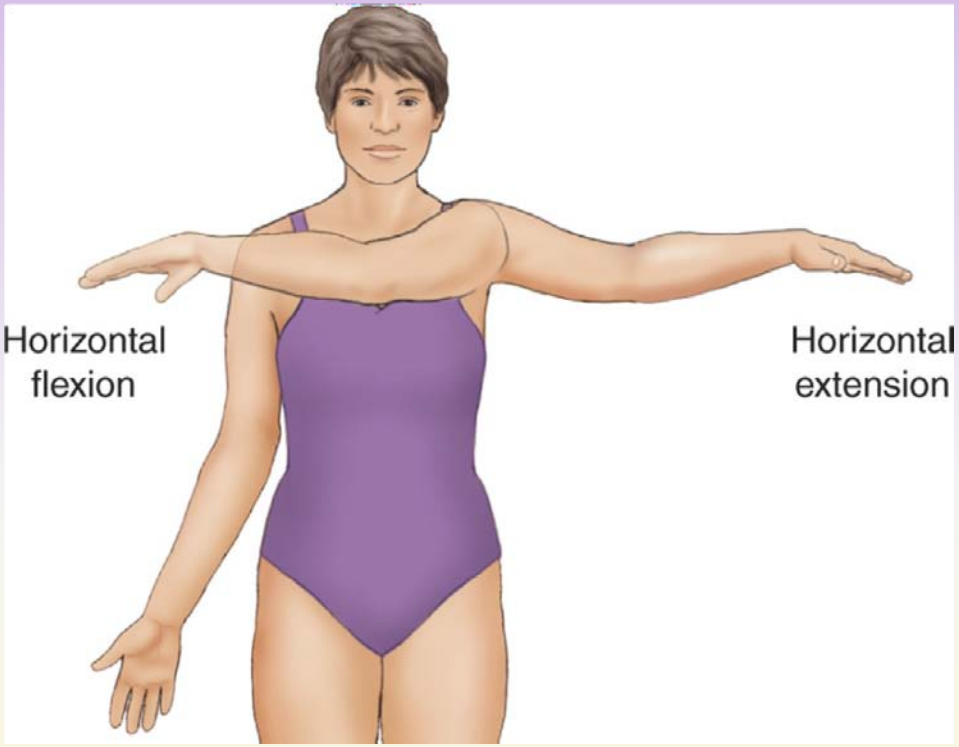
Adduction - Movement towards midline of the body

Abduction - Movement away from midline of the body

Range of movement at synovial joints

Horizontal flexion:
Bending the arm while held horizontally in front of the body.

Horizontal extension:
Extending the arm while held horizontally in front of the body.



Range of movement at synovial joints

Horizontal adduction:

Movement of the arm across the body in the horizontal plane.

Range of movement at synovial joints

Horizontal abduction:

Movement of the arm away from the body in the horizontal plane

Range of movement at synovial joints

Rotation:

The joint moves in a circular motion. *i.e. bowling action.*

Lateral rotation – turning motion away from the mid line.

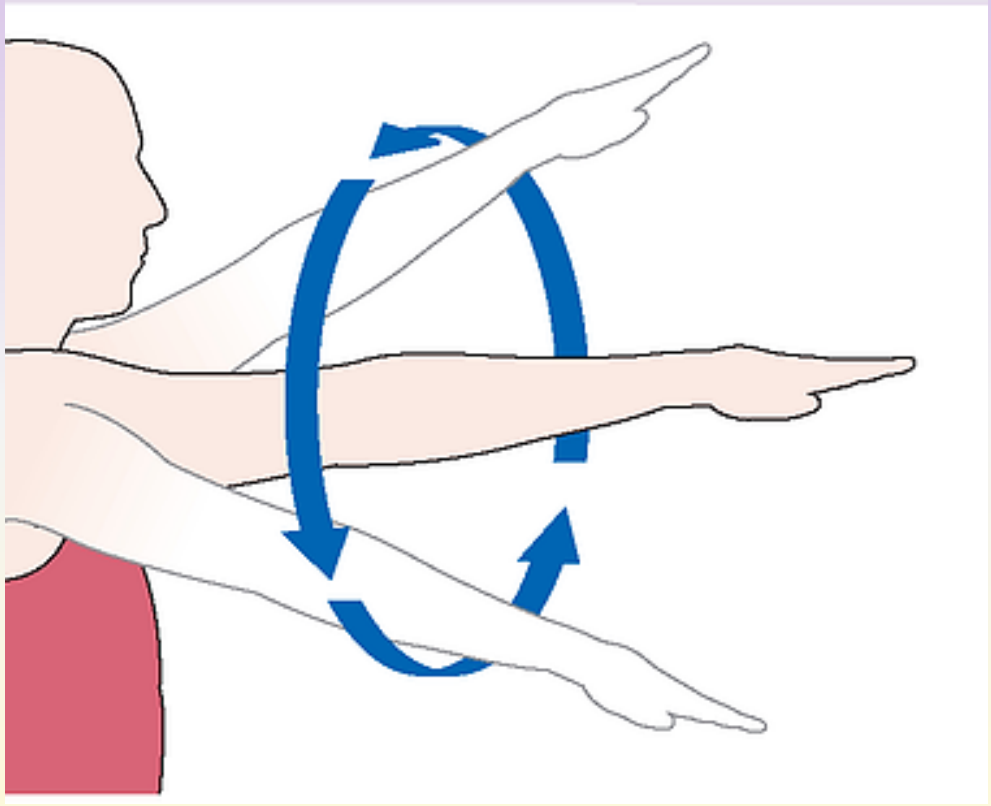
Medial rotation – turning motion towards the mid line.

Range of movement at synovial joints

Circumduction:

This is a circular movement in a conical motion.

i.e. moving the arm in a circular motion in front of the body.



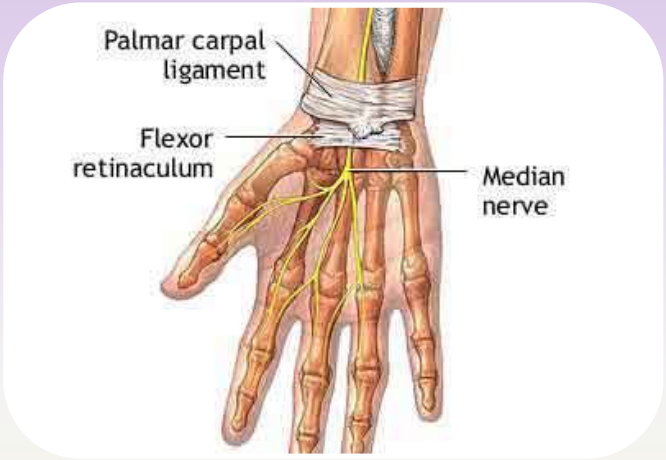
Response of the skeletal system to exercise

The skeletal system responds to exercise in the short term (acute) by:

1. **Increasing production of synovial fluid:** This lubricates the joints and protects the bones during the increased demand place on them. It also increases the range of movement at a joint.
2. **Increasing uptake of minerals:** The body will more readily absorb minerals such as calcium to increase bone density. The more stress placed on bones the better they are able to cope with the stresses of exercise.

Chronic response of the skeletal system to exercise

The skeletal system adapts in the following ways after sustained training:



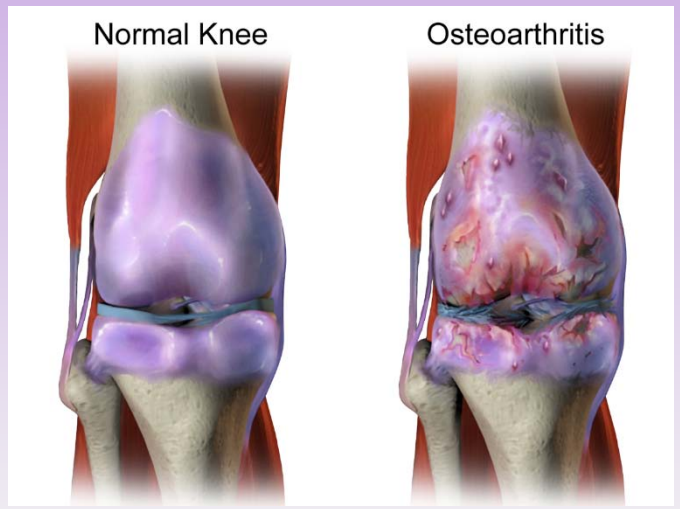
Increase strength in the tendons and ligaments around a joint.

Increase in bone density which will result in stronger bones.

Additional factors affecting the skeletal system

Regular exercise can help common skeletal diseases such as:

1. **Arthritis:** This is a condition where there is a inflammation within the synovial joint. This causes stiffness and pain. Often cartilage tissue is worn down over time as the ends of the bones rub against each other.



Regular exercise prevents arthritis as physical activity produces more **synovial fluid** which **lubricates** the joint, reducing friction levels between bones.

Additional factors affecting the skeletal system

Regular exercise can help common skeletal diseases such as:

2. **Osteoporosis:** This is the weakening of bones due to a lack of calcium of vitamin D. Increases in age cause bones to slowly lose mineral density and naturally become brittle and prone to breaks. Physical activity promotes the increased uptake of minerals.

3. **Age:** Exercise and sport will benefit all ages with the exception of resistance/weight training in young children. Young bones that are still growing should not be exposed to excess force being placed on them. Damage to epiphyseal plates can stunt bone growth.

Apply it!

What has stuck with you?

Name 5 bones in the body and the type of bone category each fall into.

Explain the movement possible at the shoulder during a tennis serve.

Skeletal System

Highlight the difference between the 6 types of synovial joint. *(think movement, location and sporting actions)*

Describe the role of ligaments, synovial fluid and the synovial membrane in a synovial joint in the body.

Practice it!

Exam questions

1. State the function of the following three types of bone. (3)

Long

.....

.....

Short

.....

.....

Flat

.....

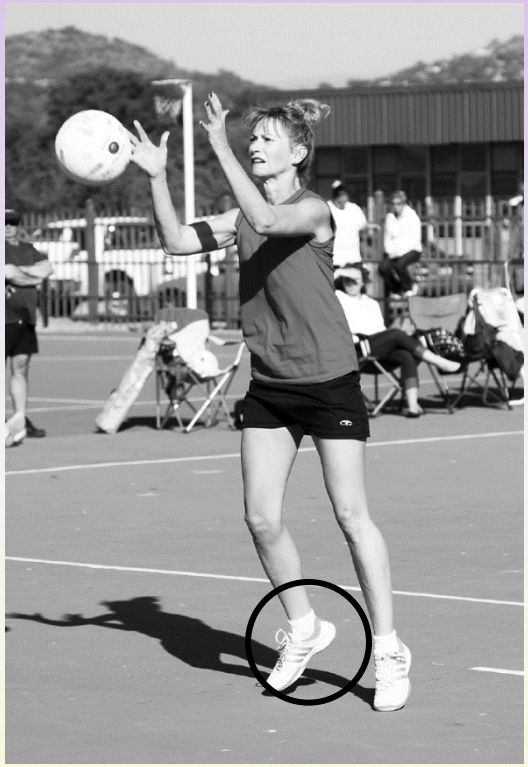
.....

Practice it!

Exam questions

2 (a) Identify the movement occurring at Eve's ankle when she is jumping/taking off in

Figure 1.



Practice it!

Exam questions

2 (b) The ankle is an example of a synovial joint. State two functions of ligaments within Eve's ankle. (2)

1

.....

.....

2

.....

.....

3. Analyse the impact of participation in netball on Eve's skeletal system. (6)

Practice it!

Marks Scheme:

1.

- Long Bones – provide leverage for movement / provide strength structure and movement / red blood cell production
- Short Bones – weight bearing
- Flat Bones – protection and/or provide large surface for muscle attachment

2. (a) Plantar flexion

2. (b) Attaches articulating bones to form a joint & Provides stability at a joint

Practice it!

Marks Scheme:

3. Positive Effects

- Stronger and healthier bones due to increase in bone density
- Reduced risk of osteoporosis.
- Healthier joints due to increase in the thickness of articular cartilage.
- Reduced chance of injury because of greater ability to shock absorb.
- Reduced risk of developing arthritis in later life.
- Stronger ligaments which increases the stability of a joint and therefore less risk of injury.
- Better lubrication of joints with synovial fluid.
- Decreased strain on joints due to weight management from participation.