

TOPIC 1: ANATOMY

TOPIC 1.1: THE SKELETAL SYSTEM

1.1.1 Distinguish anatomically between the axial and appendicular skeleton

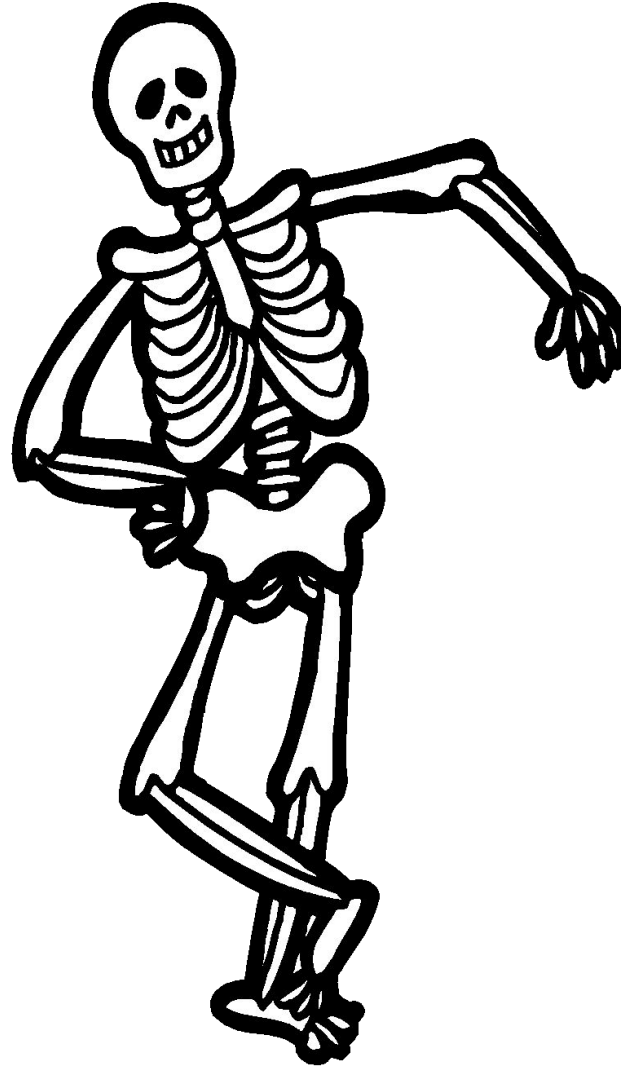
- Activity: Skeleton Observation

Consider the following definitions from the *Collins Concise Dictionary Plus*:

- Axis: a real or imaginary line about which an object, form, composition, or geometrical construction is symmetrical.
- Append: to add as a supplement; to attach; hang on.

How does this relate to your observations of the skeleton? List the features you believe would be classified as axial and appendicular skeleton.

1.1.1 Distinguish anatomically between the axial and appendicular skeleton



1.1.1 Distinguish anatomically between the axial and appendicular skeleton

- The skeleton can be thought of as 2 main divisions.
 - **The axial skeleton** consisting of of those parts near the skeletal axis (the skull, the vertebral column, the ribs and sternum).
 - **The appendicular skeleton** consisting of the upper and lower extremities, the pelvic bone with the exception of the sacrum), and the shoulder girdle.
 - (Solomon and Davis, 1987)

1.1.2 Distinguish between the axial and appendicular skeleton in terms of function

Consider:

what may be the primary function of the axial skeleton. How does this dictate it's structure?

Consider:

what may be the primary function of the appendicular skeleton. How does this dictate it's structure.

1.1.2 Distinguish between the axial and appendicular skeleton in terms of function

Some important functions of the human skeleton include:

- **Attachment** = attachment points for muscles.
- **Protection** = for various body organs.
- **Movement** = attachment of muscles with bones acting as levers.
- **Support** = organs and tissues require structure I.e scaffolding.
- **Blood cell formation** = red and white blood cells.
- **Mineral Reservoir** e.g. phosphorus and calcium

1.1.2 Distinguish between the axial and appendicular skeleton in terms of function

- Axial Skeleton = protection
 - E.g. Skull, ribs & sternum, vertebral column.
- Appendicular = movement
 - Eg: arms, legs, hips, shoulders

1.1.2 Distinguish between the axial and appendicular skeleton in terms of function

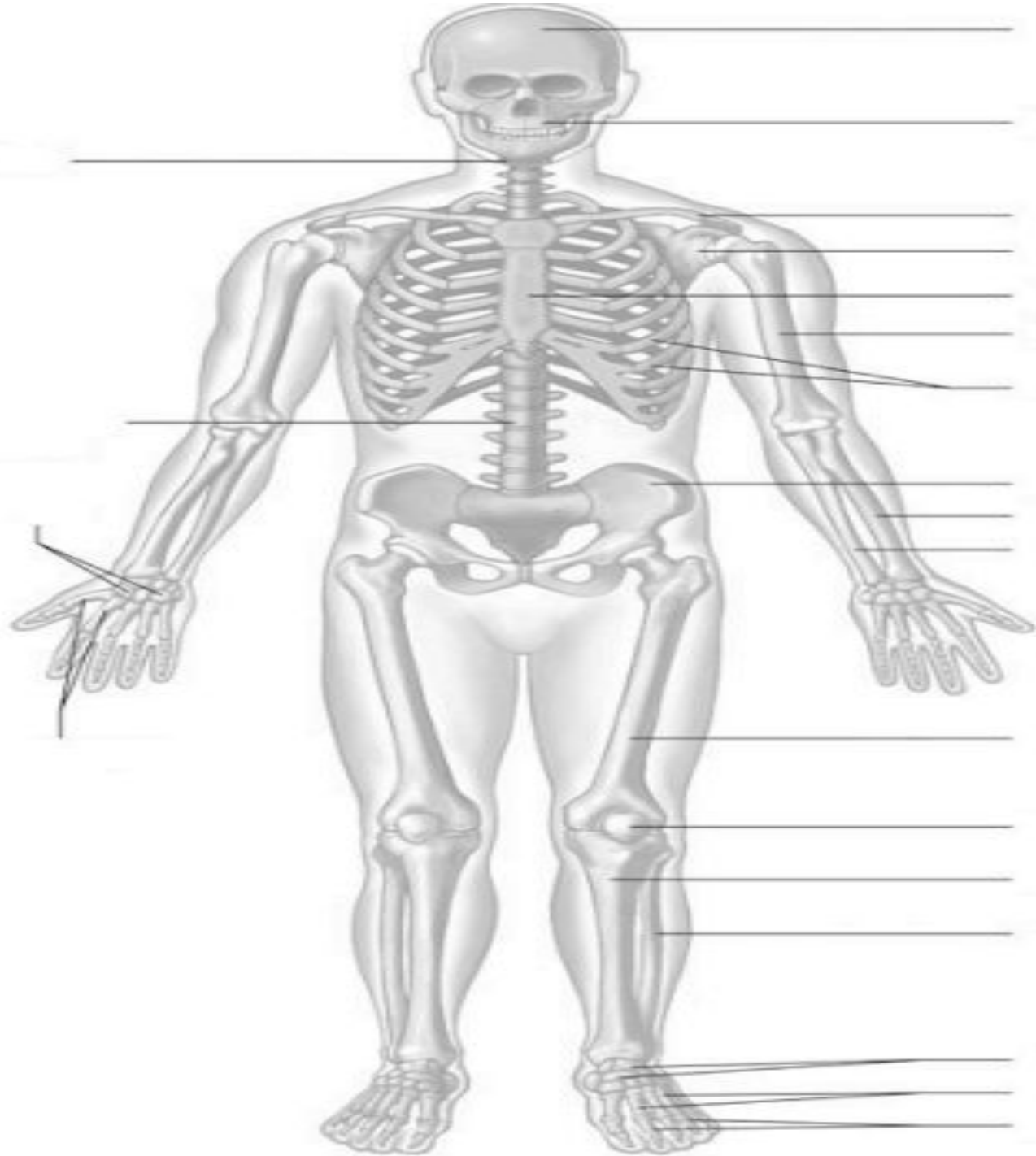
Axial bones to know and identify/locate:

- skull
- ribs
- sternum
- cervical spine (7 bones)
- thoracic spine (12 bones)
- lumbar spine (7 bones)
- sacrum
- coccyx

1.1.2 Distinguish between the axial and appendicular skeleton in terms of function

Appendicular bones to know and identify/locate:

- pectoral girdle
 - scapula
 - clavicles
- humerus
- radius
- ulna
- carpals
- metacarpals
- phalanges
- pelvic girdle
 - ilium
 - ischium
 - pubis
- femur
- patella
- tibia
- fibula
- tarsals
- metatarsals
- phalanges



1.1.3 State the four types of bone.

- **Long Bones:** Length is always greater than width
 - Ex: femur, metatarsals of the feet, clavicle
- **Short Short Bones:** Small and cube shaped. Tend to articulate with other bones
 - Ex: carpals of the hand, tarsals of the foot, patella
- **Flat:** curved surfaces that provide protection and area for muscle attachment
 - Ex: sternum, scapula, ribs, pelvis
- **Irregular:** specialized shapes and functions
 - Ex: vertebrae, sacrum, coccyx

1.1.4 Draw and annotate the structure of a long bone.

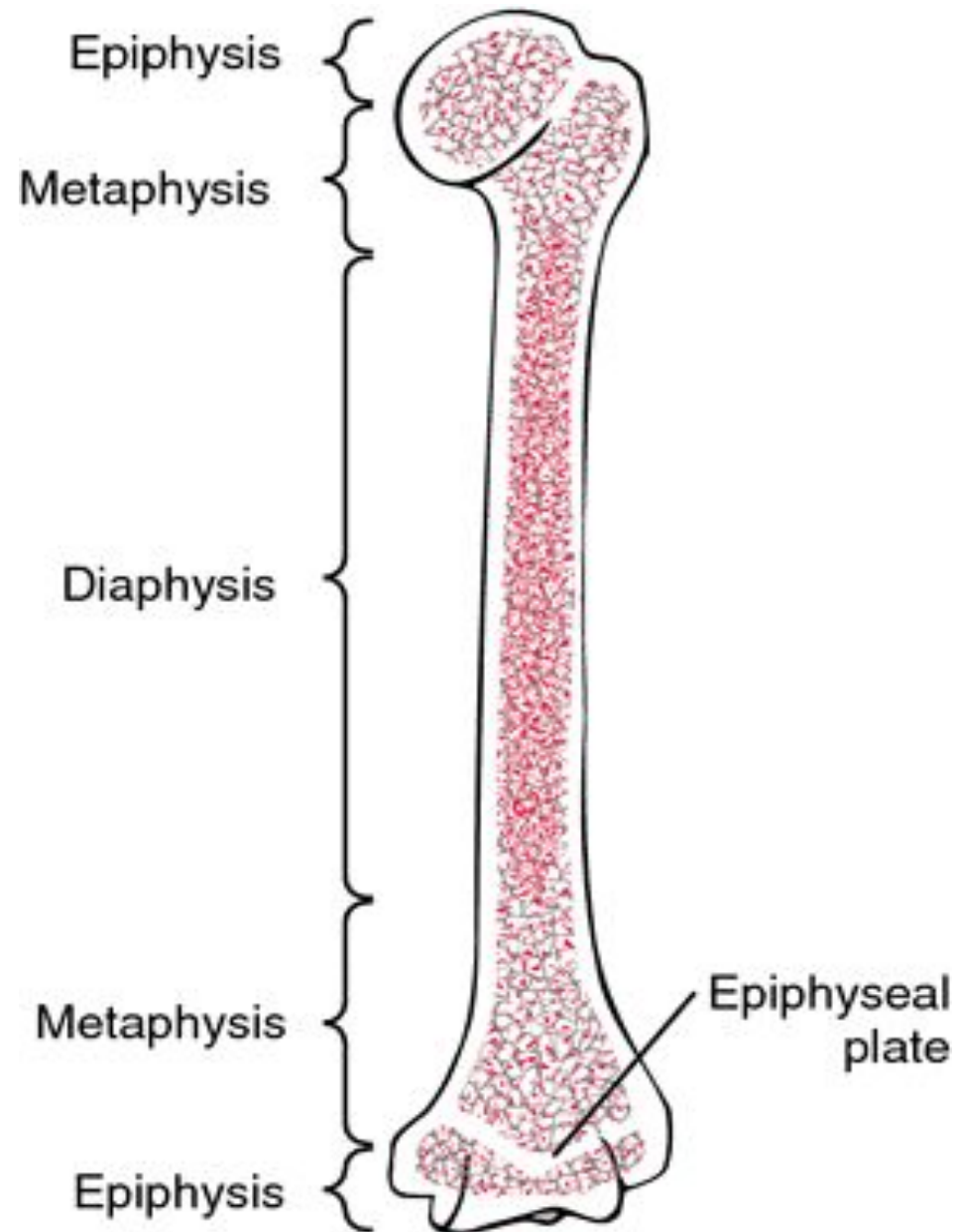
Structure of the bone includes:

- **Diaphysis (compact bone)** = a long shaft covered by a membrane called the periosteum.
- **Epiphysis (spongy bone)** = two end portions each covered by articular cartilage.
- **Articular cartilage** = reduce friction and absorb shock.
- **Bone marrow cavity** = contains bone marrow
- **Blood vessel** = supply oxygenated blood.
- **Periosteum** = membrane for protection

1.1.4 Draw and annotate the structure of a long bone.

Diaphysis

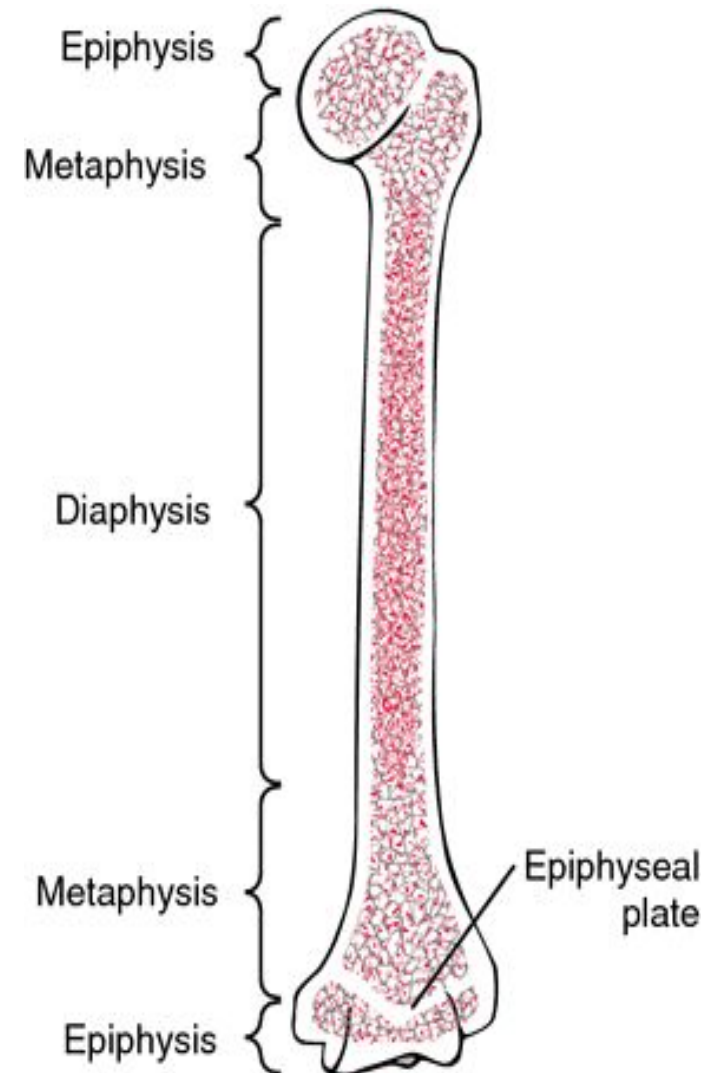
- Shaft/midsection of a long bone consisting of mostly compact/hard bone.
- Compact bone is relatively solid and dense.
- Has few spaces and is also found in the outer layer of most other types of bones.



1.1.4 Draw and annotate the structure of a long bone.

EPIPHYSIS (Proximal & Distal)

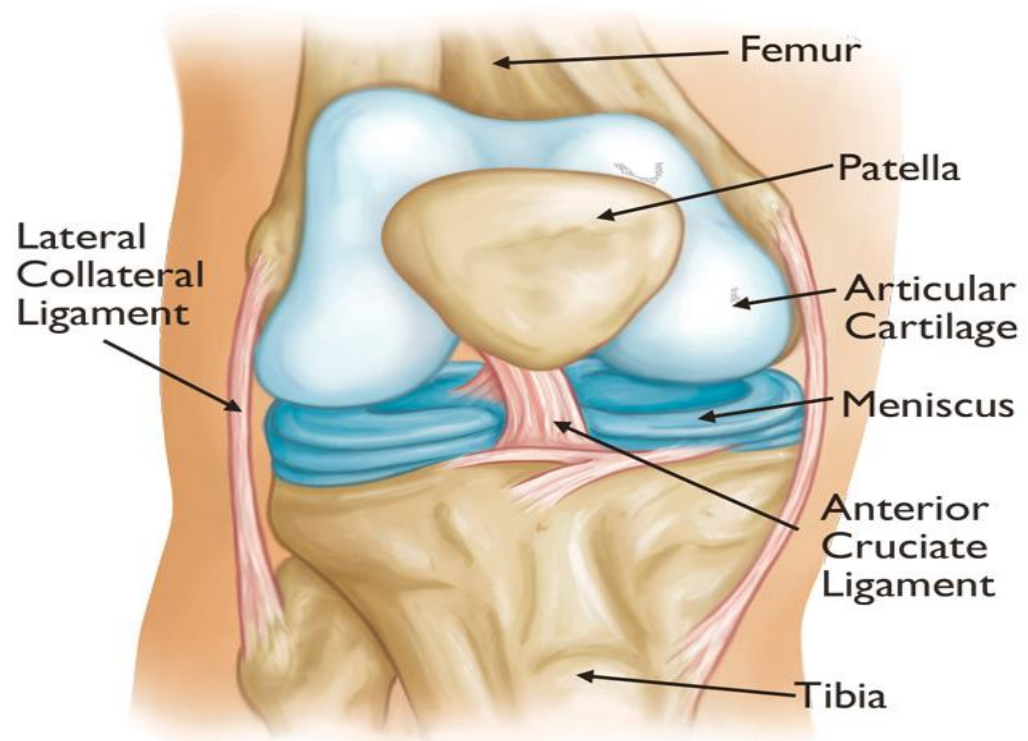
- Made up of cancellous or spongy bone.
- Cancellous/Spongy bone has an irregular latticework structure (like honeycomb) where there are many spaces.
- It is also found in short, flat and irregular bones.
- Red marrow is stored there, blood cell production occurs here.



1.1.4 Draw and annotate the structure of a long bone.

ARTICULAR CARTILAGE

- Thin layer covers the ends of the bone where they articulate with other bones to form joints.
- Main functions are to reduce friction between the bones and absorb shock.
- Red marrow is stored there, blood cell production occurs here.



**Articular Cartilage
Normal**



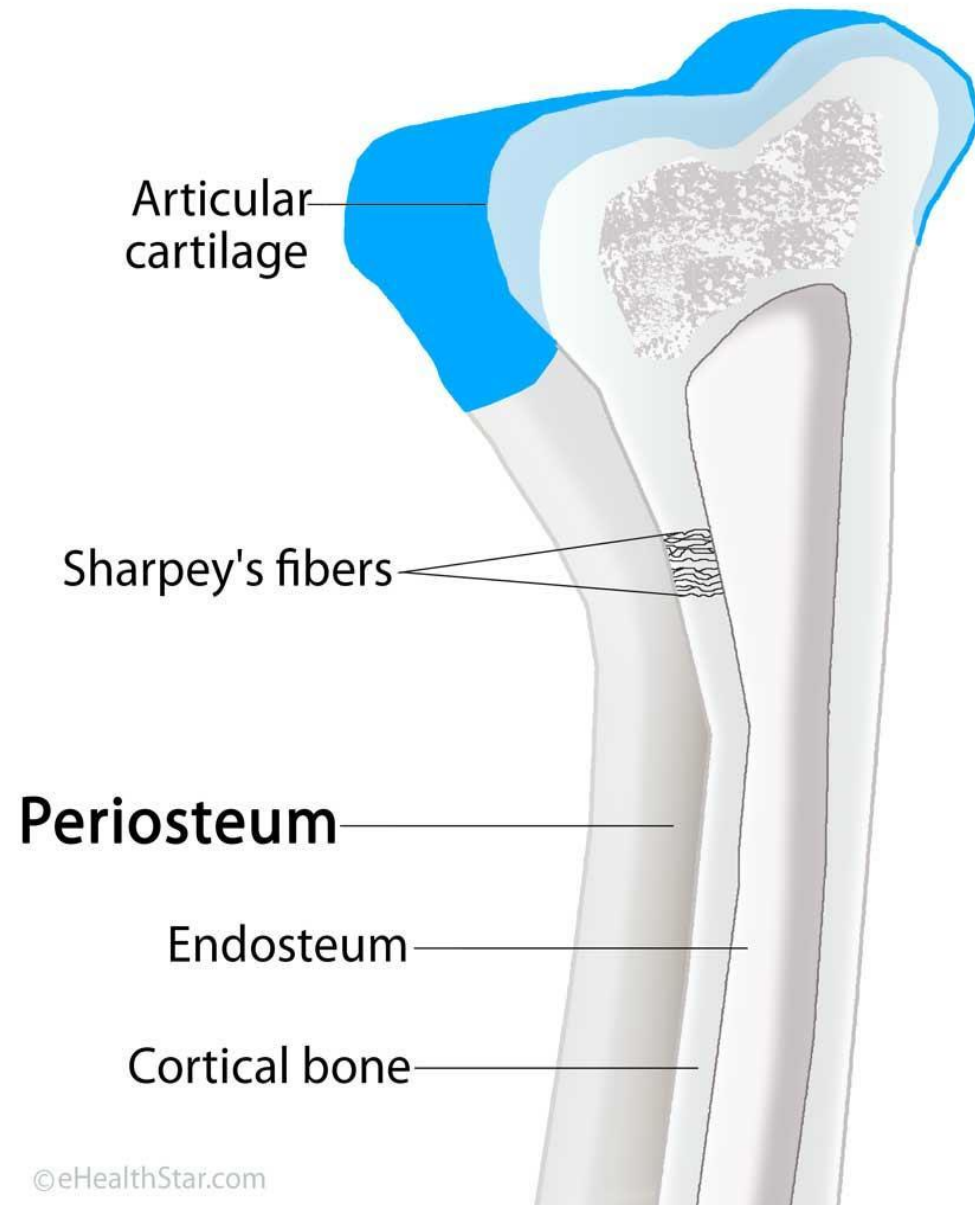
**Articular Cartilage
Damaged**

1.1.4 Draw and annotate the structure of a long bone.

PERIOSTEUM

- The area of the bone not covered by cartilage but instead by a thin, shiny white membrane.
- This forms the outer lining of the bone and is important for bone growth, repair, nutrition and attachment of ligaments and tendons.

THE PERIOSTEUM

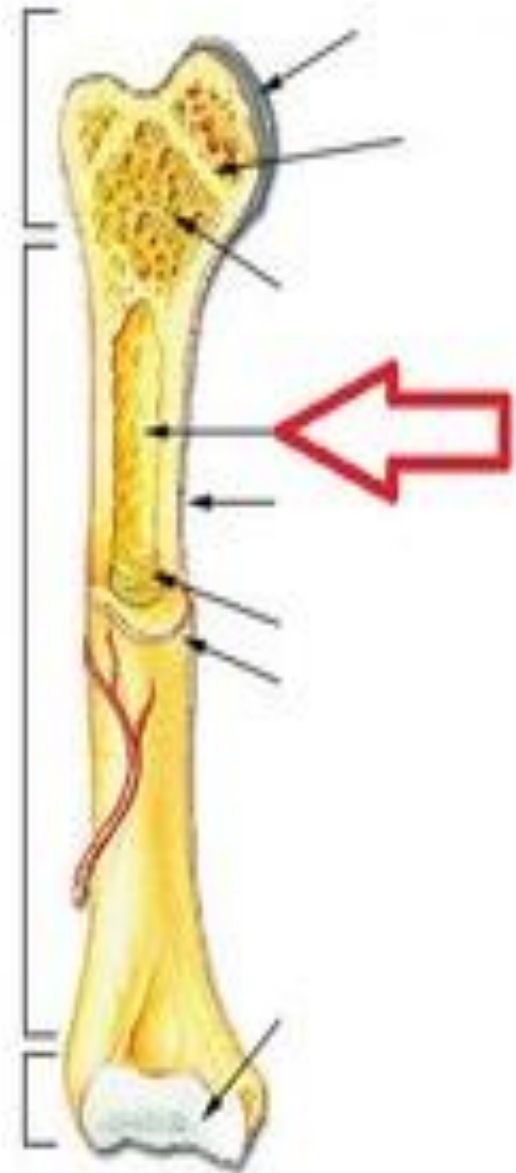


1.1.4 Draw and annotate the structure of a long bone.

MEDULLARY (MARROW) CAVITY

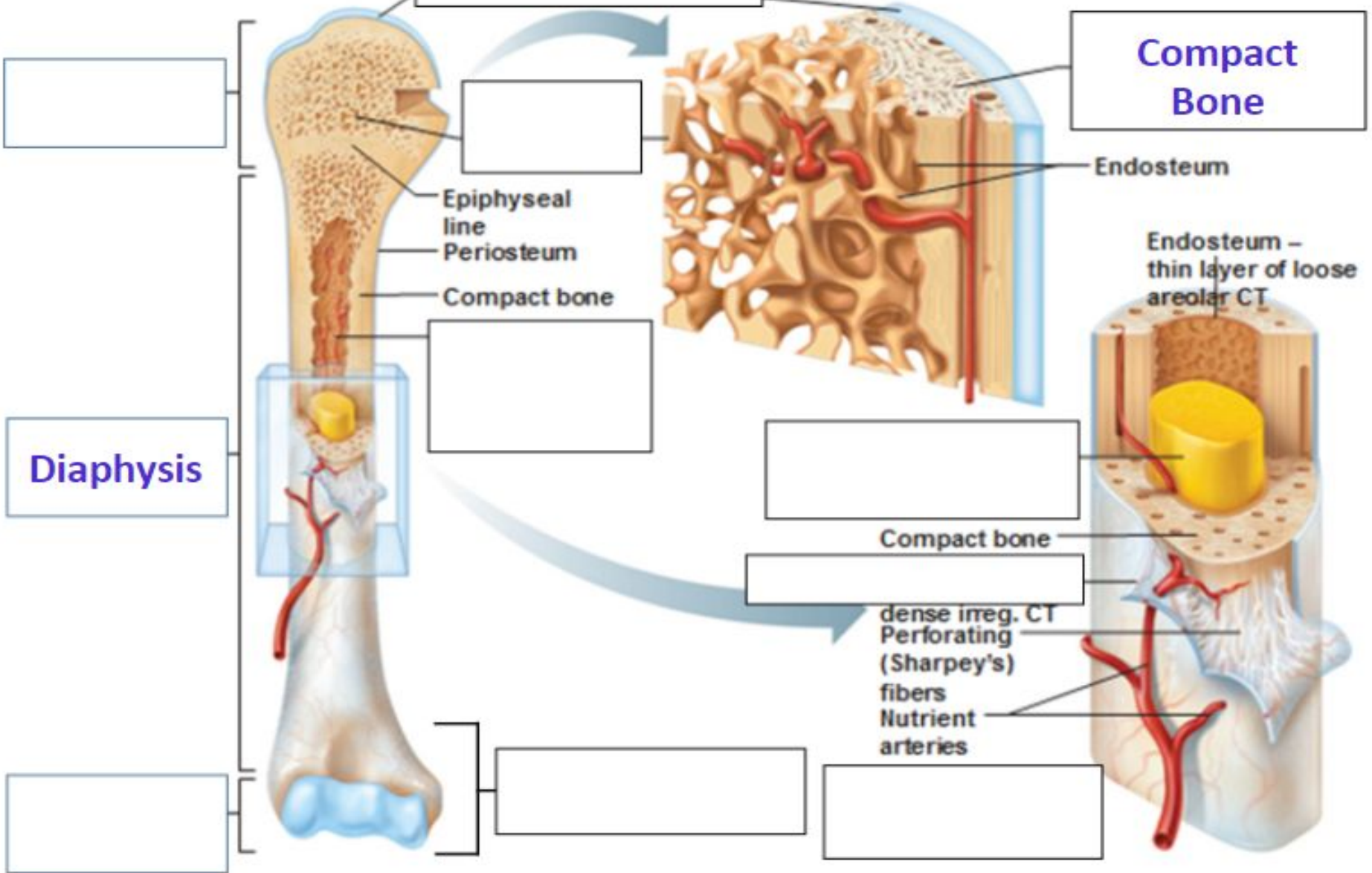
- Space within the diaphysis where yellow bone marrow is stored.
- There is a small opening in the diaphysis called the nutrient foramen.
- Blood vessels pass through here, enter the medullary cavity and provide the marrow and compact bone with blood and nutrients.

Long Bone



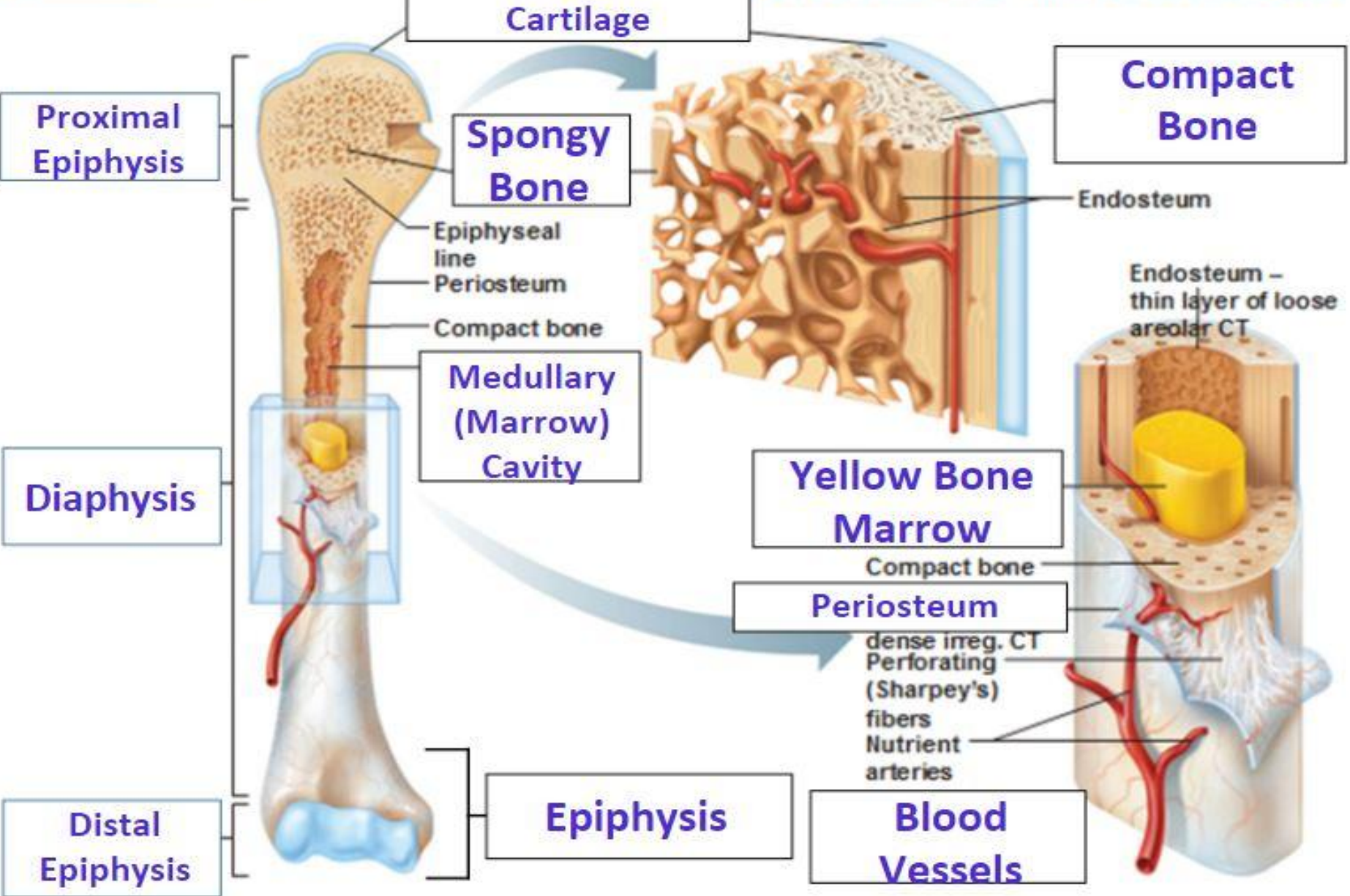
1.1.4 Draw and annotate the structure of a long bone.

Structure of the LONG bone



1.1.4 Draw and annotate the structure of a long bone.

Structure of the LONG bone



1.1.5 Apply anatomical terms to the location of bones

- Superior is a term used to describe a place that is toward the upper part of the body. For example the skull is superior to the shoulders. Superior can also be used to mean above.
- When the lower part of the body (or below is referred to, the term inferior is used.
 - Ex: the knees are inferior to the shoulders.

1.1.5 Apply anatomical terms to the location of bones

- Proximal : closer to the centre of the body.
 - Ex: the shoulder is proximal to the hand.

- Distal: away from the centre of the body.
 - Ex: the hand is distal in relation to the head.

1.1.5 Apply anatomical terms to the location of bones

- Lateral: towards the side of the body or away from the middle imaginary body line (the midline).
 - Ex: the humerus is lateral to the sternum
- Medial describes the part of the body located towards the midline.
 - Ex: coccyx is medial to the carpals.

1.1.5 Apply anatomical terms to the location of bones

- Anterior is used to describe the front or towards the front of the body.
 - Ex: the sternum is anterior to the vertebrae.

- Posterior is used to describe the back of the body.
 - Ex: the vertebral column is posterior to the sternum.

1.1.5 Apply anatomical terms to the location of bones

Activity:

Give 3 examples of the usage of the following terms in relation to bones:

e.g. "the knee bone's _____ to the scapula."

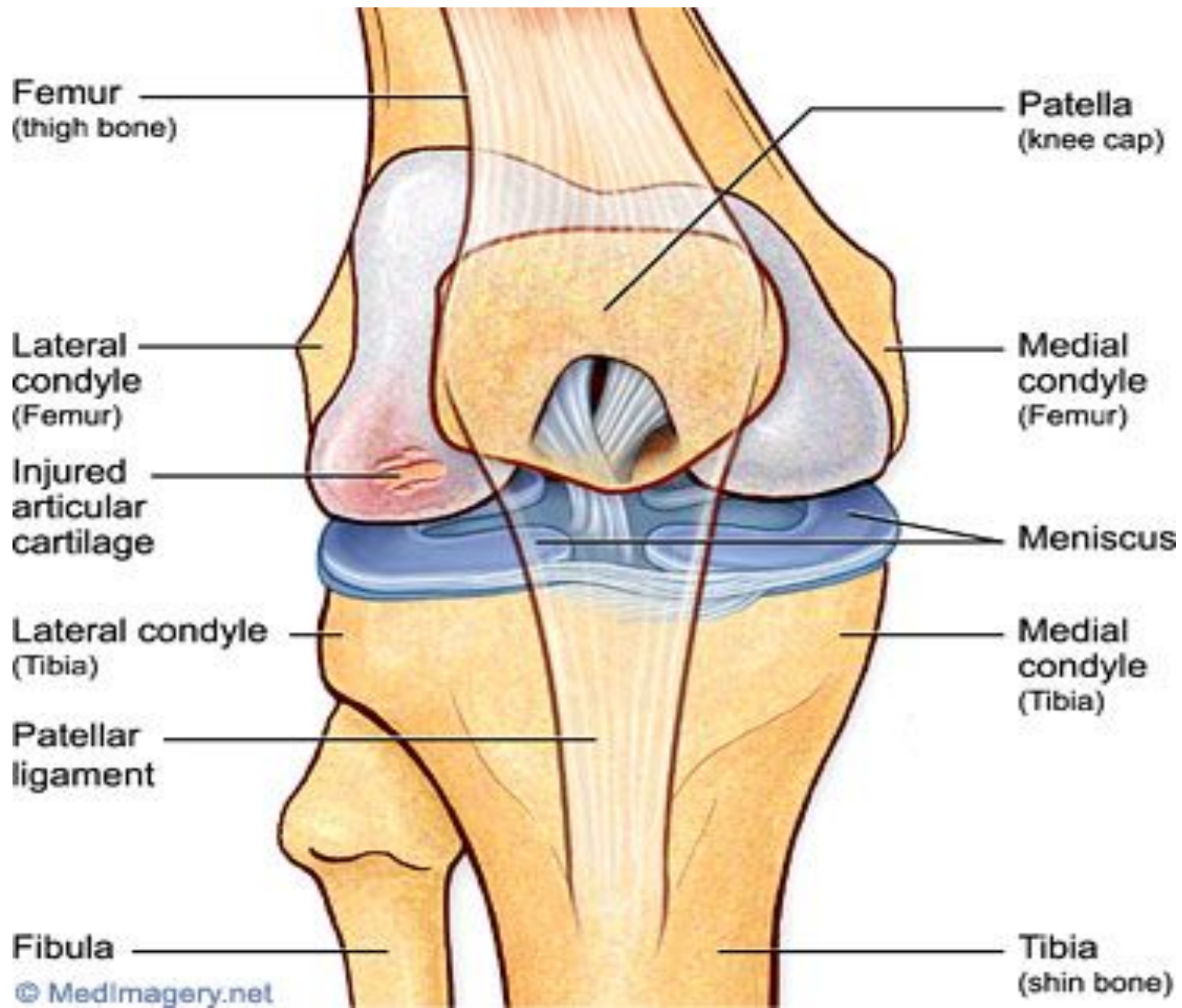
- Inferior/Superior
- Proximal/Distal
- Medial/Lateral
- Posterior/Anterior

1.1.6 Outline the function of connective tissue

- **Cartilage:** hard, strong connective tissue that provides support for some soft tissues and forms a sliding area for joints so that bones can move easily.
- During fetal development cartilage forms most of the skeleton.
It is gradually replaced by bone. In a mature individual it is found mainly at the end of bones, in the nose, trachea, and in association with the ribs and vertebrae.

1.1.6 Outline the function of connective tissue

Cartilage



1.1.6 Outline the function of connective tissue

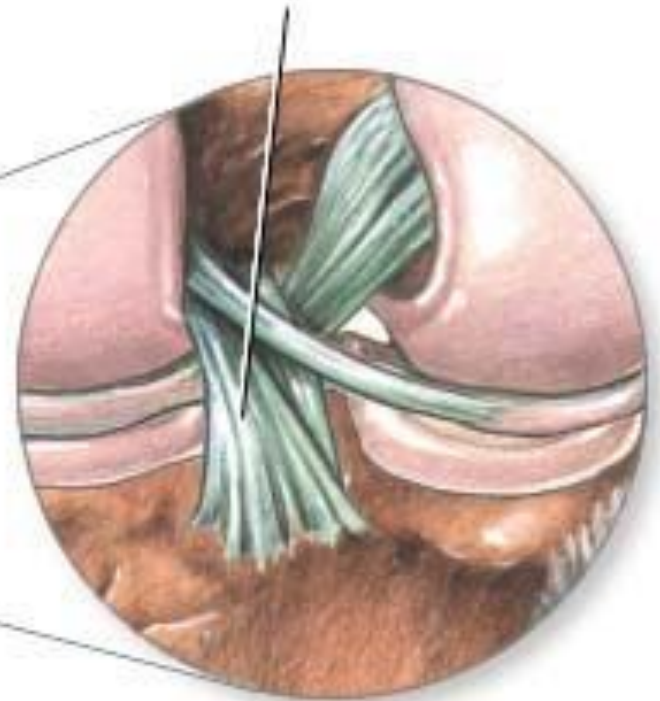
- **Ligament**: band of tough fibrous connective tissue that connects one bone to another, serving to support and strengthen a joint.

(Solomon & Davis)

Back of right knee



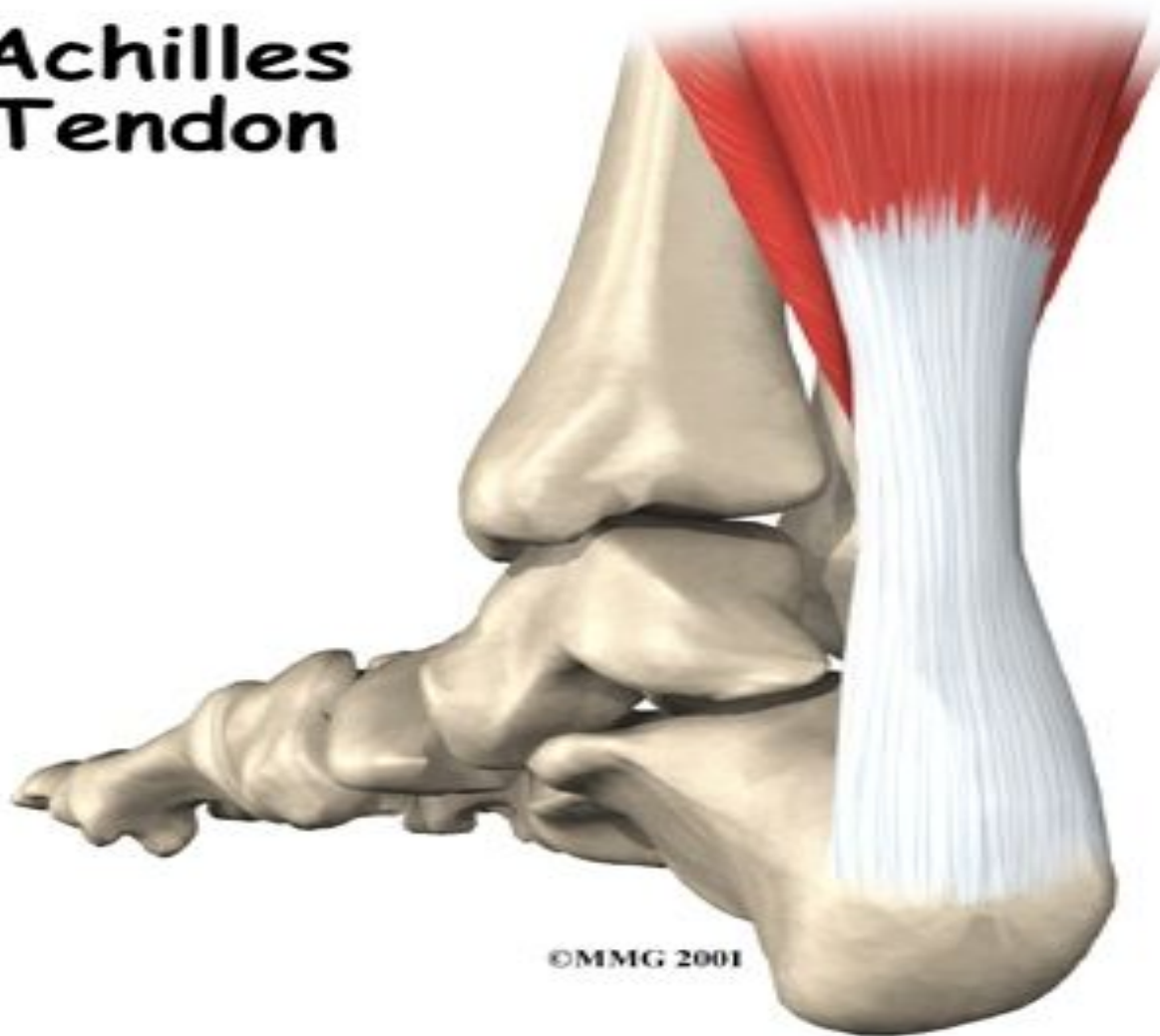
Posterior cruciate ligament (PCL)



1.1.6 Outline the function of connective tissue

- **Tendons** : connect muscles to bones. They are specialised skeletal structures that generally transmit muscular pull to bones.

**Achilles
Tendon**



(Solomon & Davis)

JOINTS

1.1.7-1.1.10

STARTER – Flexion tests to assess range of joint movement

Shoulder joint -inwards



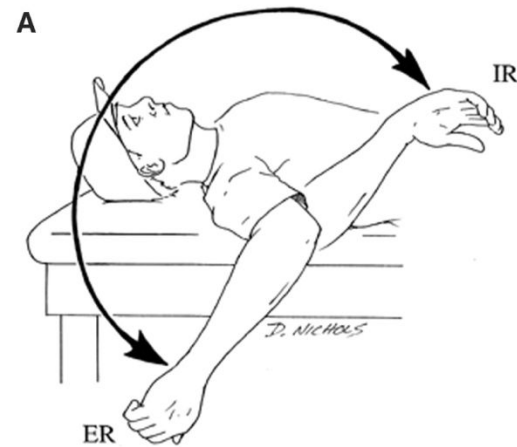
Excellent = Fingers overlap

Good = Fingers touch

Average = Fingers are less than two inches apart

Poor = Fingers are more than two inches apart

Shoulder joint -outwards



- Lie on your back on a firm surface. Knees bent, feet flat.
- Move your right arm out to the side to shoulder level.
- Bend your right elbow, keeping your upper arm in contact with the floor.
- Allow your hand and forearm to fall to the floor towards your head.
- Repeat this process with your left arm
- Normal flexibility will allow your forearm to fall flat on the floor

Learning Objectives

Everyone should

Define the term joint.

Identify the three different types of joint

Most will

Distinguish between the different types of joint in relation to movement permitted

Key terms

Term	Definition
joint	-the physical point of connection between two bones -the point at which two or more bones <i>articulate</i>
ligament	-connect bone to bone and help to stabilize joints they surround. -composed mostly of long, stringy collagen fibers that create bands of tough, fibrous connective tissue -slightly elastic, so they can be stretched and gradually lengthen, increasing flexibility. -can become overstretched and compromise the integrity of the joint they are supposed to be stabilizing
tendon	-tough and flexible bands of fibrous tissue that attach skeletal muscles to bone
to articulate	-to form a joint
motility	movement

Introduction to joints

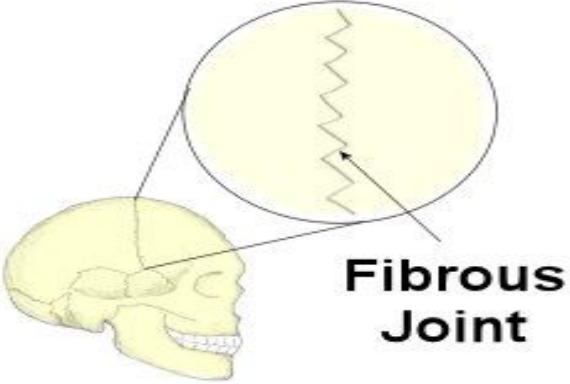
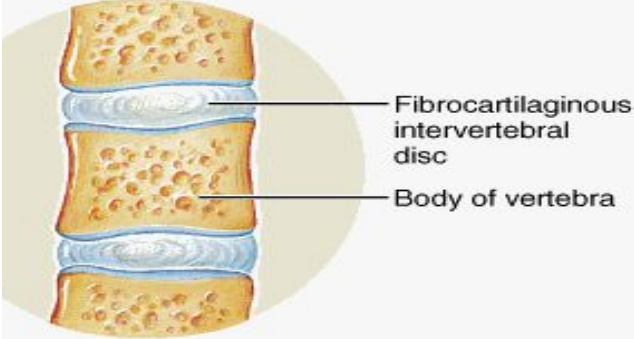
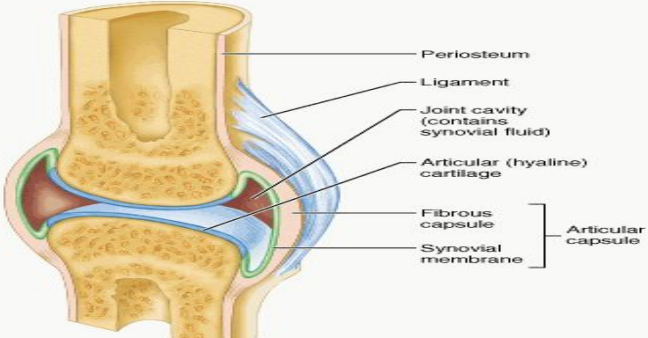
- When two or more bones come into contact or articulate with each other

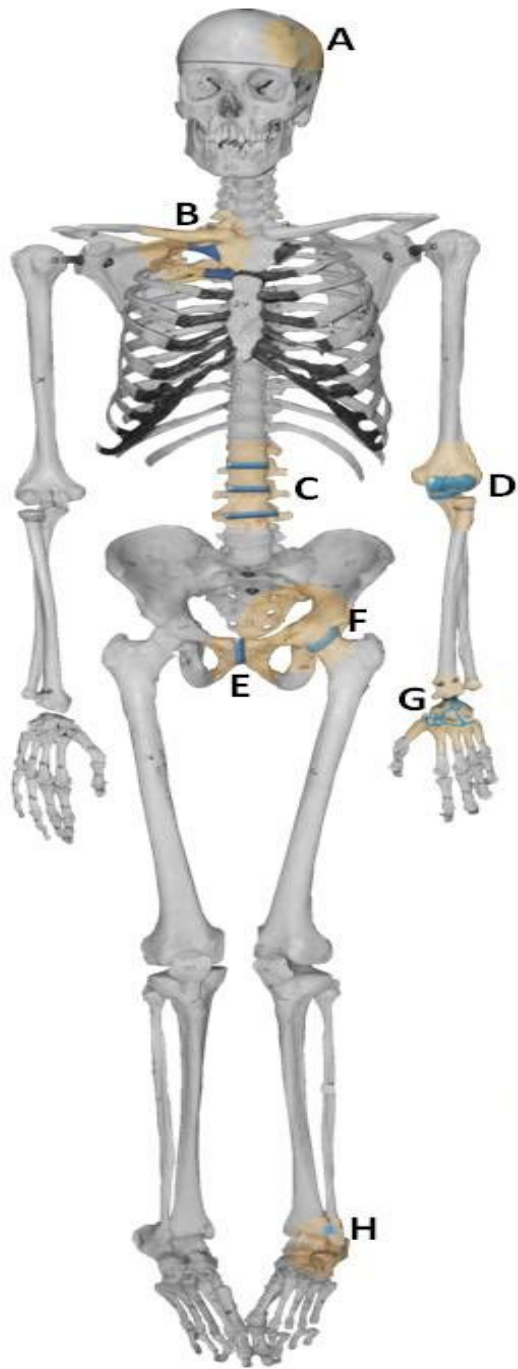
To articulate: to form a joint

Classified by:

- Presence or absence of joint cavity (gap between articulating bones)
- Shape of articulating bones
- Types of tissue that connect bones together

Types of joints

Joint type	Description	Example
Fibrous	<ul style="list-style-type: none"> -Thin layer of fibrous tissue connecting the edges of two bones -continuous with periosteum -no movement allowed at these joints 	 <p>The diagram shows a lateral view of a human skull. A circular callout provides a magnified view of a fibrous joint, which is a suture between two skull bones. The joint is characterized by a zigzag line of fibrous tissue connecting the edges of the bones. The text 'Fibrous Joint' is written below the callout.</p>
Cartilaginous	<ul style="list-style-type: none"> -bones separated by fibrocartilage disc or thick layer of <i>hyaline</i> cartilage -limited movement allowed 	 <p>The diagram shows a cross-section of two vertebrae from the spine. Between the two vertebral bodies is a fibrocartilaginous intervertebral disc. Labels with leader lines point to the 'Fibrocartilaginous intervertebral disc' and the 'Body of vertebra'.</p>
Synovial	<ul style="list-style-type: none"> -most commonly occurring joints -most important for <i>motility</i> 	 <p>The diagram shows a cross-section of a synovial joint between two bones. Labels with leader lines identify the following structures: Periosteum, Ligament, Joint cavity (contains synovial fluid), Articular (hyaline) cartilage, Fibrous capsule, and Synovial membrane. A bracket on the right side groups the fibrous capsule and synovial membrane together, labeling them as the 'Articular capsule'.</p>



Fibrous joints



Fibrous connective tissue

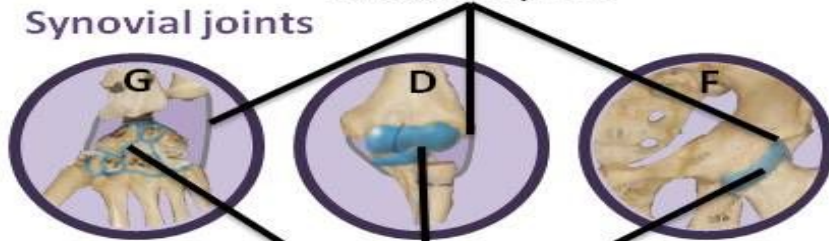
Cartilaginous joints



Hyaline cartilage

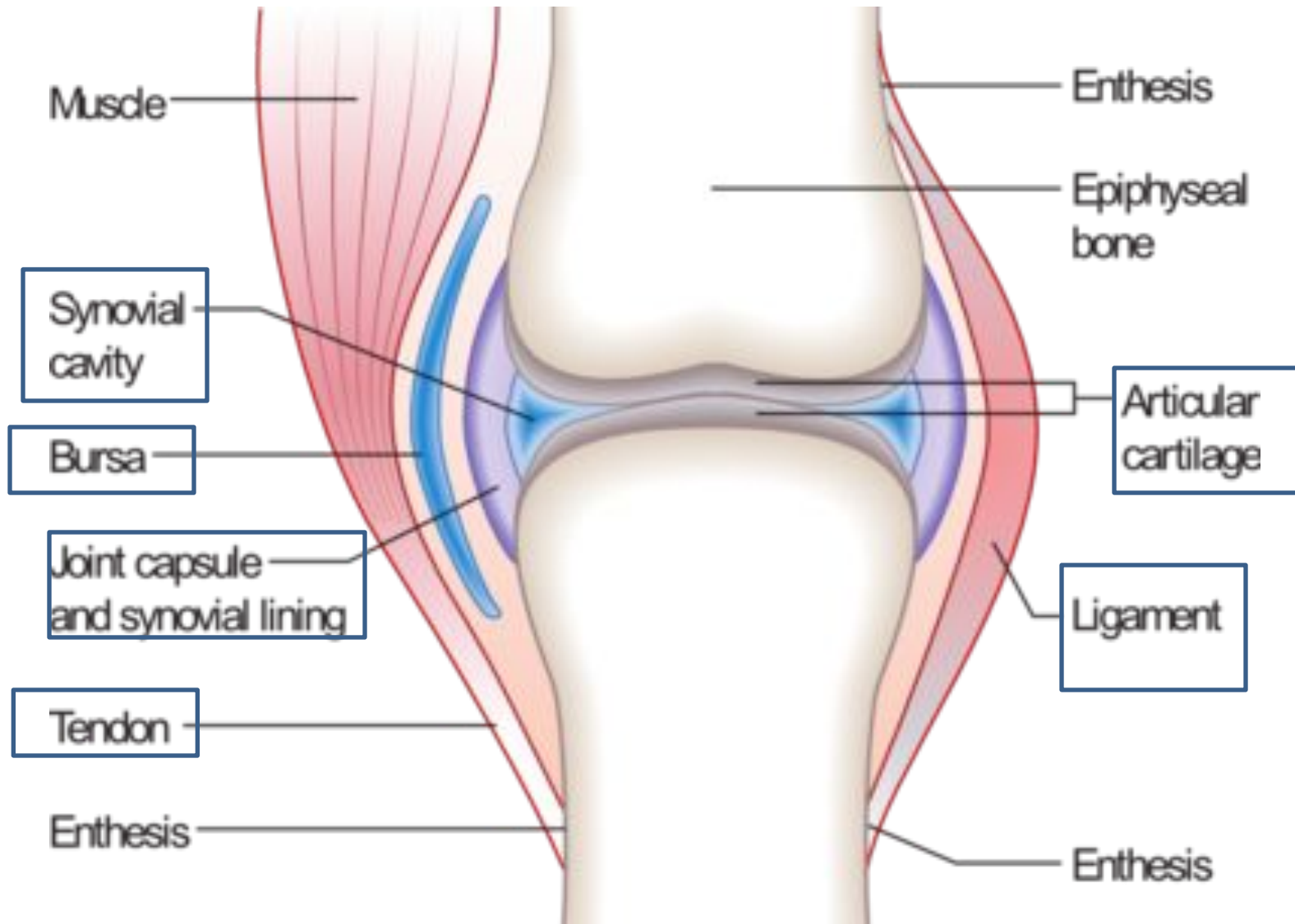
Fibrocartilage

Synovial joints



Articular (hyaline) cartilage

Structure of a synovial joint



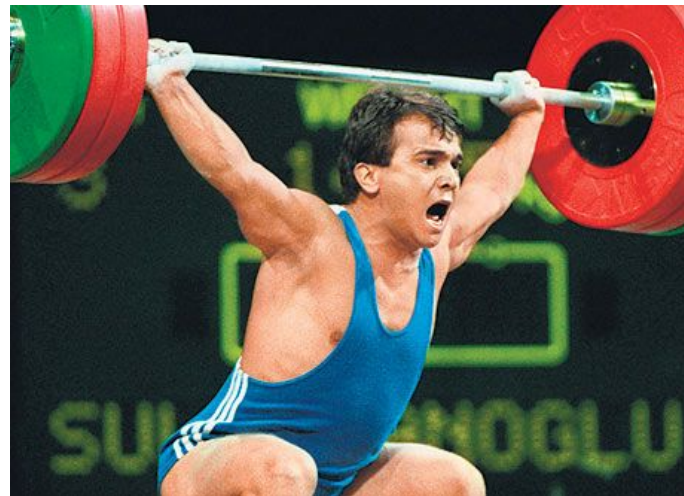
Structure	Function
Synovial (joint) cavity	Space between the bones
Bursa	Small fluid-filled sacs found in areas of high stress Found where two structures rub against each other e.g ligament and bone, tendon and bone Lined by synovial membrane which provide lubrication thereby reducing friction
Joint (articular) capsule	Flexible to allow joint movements to take place Tensile strength prevents joint from dislocation
Synovial (membrane) lining	Secretes synovial fluid
Tendon	Attaches muscle to bone
Ligament	Attaches bone to bone
Articular cartilage	A smooth white layer that covers the articulating surface of bones Reduces friction, absorbs shock and protects bones Thickness depends on the amount of stress it is exposed to
Synovial fluid	Viscous fluid with the consistency and appearance of uncooked egg whites Becomes more fluid with movement Lubricates joint cavity thereby reducing friction Provides nutrients to cartilage

Individual task

- Which of the sports below would cause the greatest *thickening* of articular cartilage? You might want to look it up!



Lionel Messi



Naim Suleymanoglu



Frankie Dettori

Learning Objectives

Everyone should

Identify the different ligaments in the knee

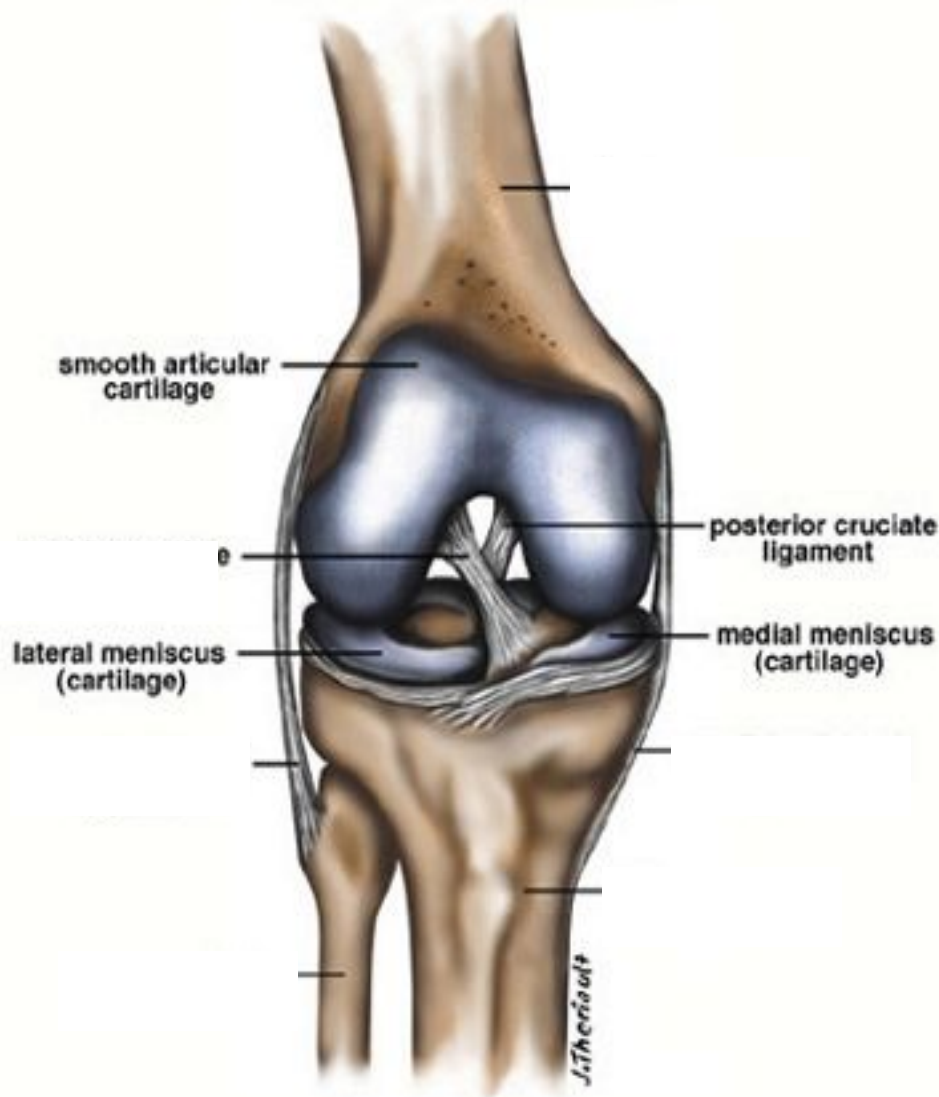
Most will

Describe how different injuries can occur to the knee

Some might

Outline steps that can be taken to help prevent knee damage

Ligaments of the knee



There are four major ligaments that surround the knee joint, keeping it in place when the leg is bent or straight:

- the anterior cruciate ligament (**ACL**) (center of knee)
- the posterior cruciate ligament (**PCL**) (center of knee)
- the lateral collateral ligament (**LCL**) (outer knee)
- the medial collateral ligament (**MCL**) (inner knee)

Meniscus – semi-lunar discs of fibrocartilage that allow bones to fit more tightly together. This provides greater cushioning and stability to the joint

ACL Injuries

**American Academy of
Orthopaedic Surgeons*

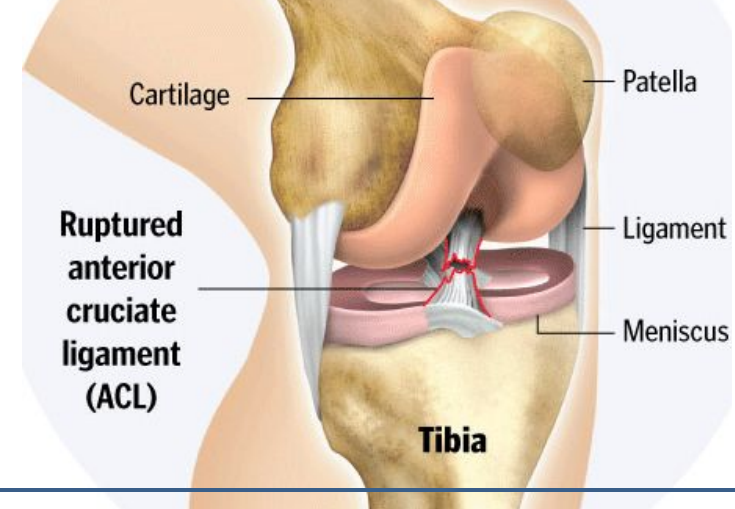
The anterior cruciate ligament is crucial in keeping the tibia from sliding beneath the femur; it is frequently injured among athletes who take part in skiing, basketball and football.

It can be torn or injured in a variety of ways:

- quickly twisting or changing direction
- slowing down while running
- direct hit (like a football tackle)
- landing after a jump

Men and women alike can suffer from sports related injuries like ACL tears, but according to data collected* since 1995 there is a difference between men and women in the same sport.

ACL injuries among women basketball players are twice that of their male counterparts. Women who play soccer are four times more likely to suffer from an ACL tear than men who play the same sport.



Part of the problem is the way many women jump, turn and pivot. They don't usually bend their knees as much as men do when landing from a jump. That puts increased pressure on the knee joint.

Many women also are in a more erect position when turning and pivoting. That also can strain the ACL. Learning to crouch and bend at the knees and hips, could take some of the stress off the ACL.

If you suffer from an ACL injury, you may not even realize it right away. You may just hear a popping noise and feel your knee give out from under you. Two to twelve hours later, there will be swelling accompanied by pain.

PCL injuries

If you suffer from a PCL injury, the tibia can sag backwards, disrupting the stability of the knee joint.

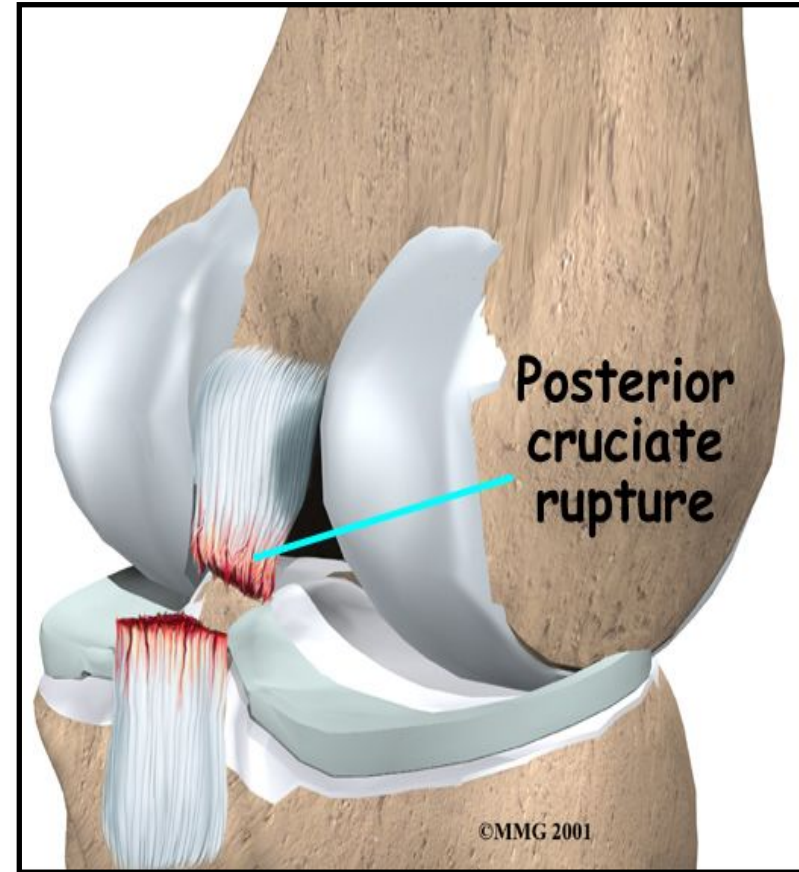
The ends of the femur and tibia will then rub directly against one another, weakening cartilage. This abrasion can lead to arthritis of the knee.

Once again, athletes are susceptible to PCL injuries though the PCL is not injured as frequently as the ACL.

PCL sprains usually occur because of:

- blow to the front of the knee
- misstep
- ligament was pulled or stretched too far

The PCL is the one injured most often by blows such as football tackles or auto accidents.



MCL injury



The medial collateral ligament (MCL) attaches the femur to the shinbone. This makes the inner side of the knee stable.

Those taking part in contact sports, like hockey and football, are most likely to suffer from an MCL injury.

The MCL is most often injured because of a blow to the outer side of the knee. That kind of hit can stretch and tear the ligament, on the inner side of the knee. So even though the hit is on one side the injury occurs on the opposite side of the knee.

The symptoms of an MCL injury include a popping and buckling sideways of the knee. Swelling and pain are also common.

Cartilage injuries

Cartilage cushions your knee, and acts to absorb shock during movement. Torn cartilage is experienced by many people.

When people talk about torn knee cartilage, they are usually talking about a meniscal tear. The meniscus is a wedge-like rubbery cushion where the major bones of your legs connect. The meniscus helps the knee carry weight, glide and turn.

Athletes who are involved in contact sports are at risk for this tear because of the amount of twisting, turning and decelerating involved.

The tear often happens in connection with other injuries like a torn ligament (ACL). The elderly are also at risk due to wear and tear of the cartilage over time.

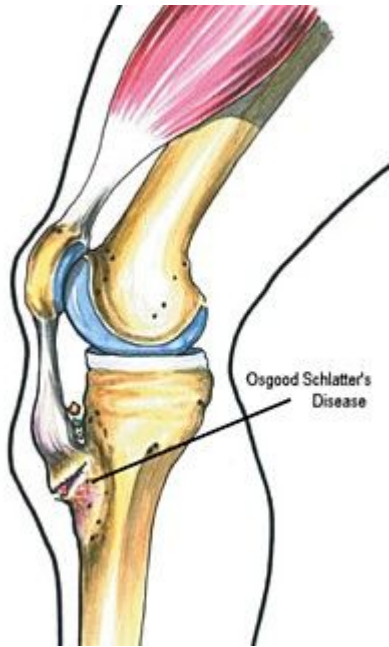


A meniscal tear could begin with a popping sensation. When inflammation sets in you might feel:

- stiffness and swelling
- fluid (water on the knee)
- tenderness in the joint

Without treatment, part of the meniscus may loosen and drift into the joint causing your knee to lock.

Osgood-Schlatter Disease



Repetitive stress or tension on part of the growth area of the upper tibia can cause Osgood-Schlatter disease in growing children.

The disease may also be linked to an injury, in which a tendon is stretched so much that it tears from the tibia taking a bone fragment with it.

The disease most commonly affects active boys who are about 10 to 15 years of age.

People who have the disease may experience:

- **pain below the knee joint that worsens with activity**
- **a painful bony bump below the knee cap**
- **a few months of pain which may recur**

Motion of the knee is usually not affected and the disease almost always disappears without treatment.

Tendon injuries

Tendons are like rubber bands that can become worn and fragile when stretched too far.

Jumper's Knee (Patellar Tendonitis)



Knee injuries involving tendons range from an inflammation of the tendons called tendinitis, to a ruptured tendon.

Athletes and older people whose tendons are weaker are more prone to these injuries.

People with tendinitis often have tenderness and pain while running or jumping.

A ruptured tendon could result in difficulty bending, extending or lifting the leg and swelling.

Treatment of knee injuries

Immediate treatment of injury

RICE - which stands for rest, ice, compression, elevation

Resting the knee gives it time to heal. If you have to walk, use crutches.

Ice, two to three times a day for about 20 minutes each time. It can control swelling.

Compressing the injury reduces swelling. You may have to do this with an elastic bandage or brace that fits snugly, but loose enough so that it doesn't hurt.

Elevate the knee whenever possible

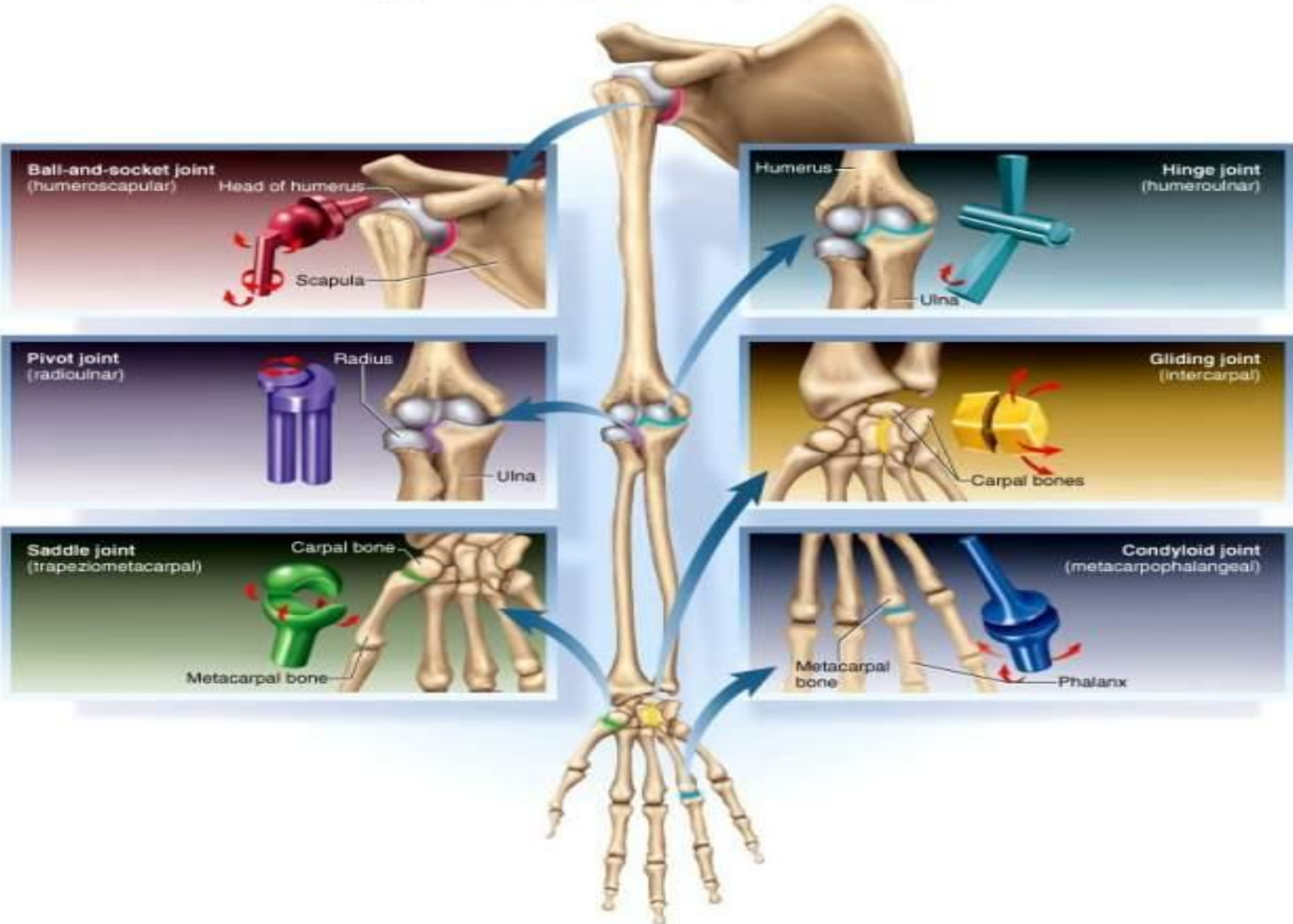
Long term treatment of injury

Physical therapy can help people either avoid surgery or recover following surgery. It is made up of the following stages:

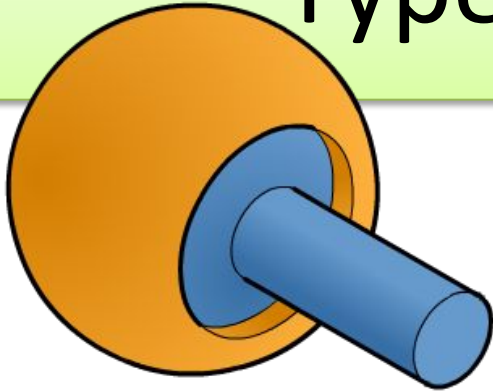
- **Evaluation** - identifying your condition and the factors that contributed to your injury.
- **Therapy** - an individual plan designed to restore motion and muscle performance.
- **Education** - your therapist might want to teach you some new habits to avoid another injury and overcome the one you have.
- **Aftercare** - Physical therapy is aimed at getting you back on your feet with the knowledge of how to prevent reinjury so you won't need to visit your therapist again.

A treatment plan may include a series of exercises like swimming, water walking, strengthening exercises and leg presses designed to help motion.

Different types of synovial joint



Types of synovial joints



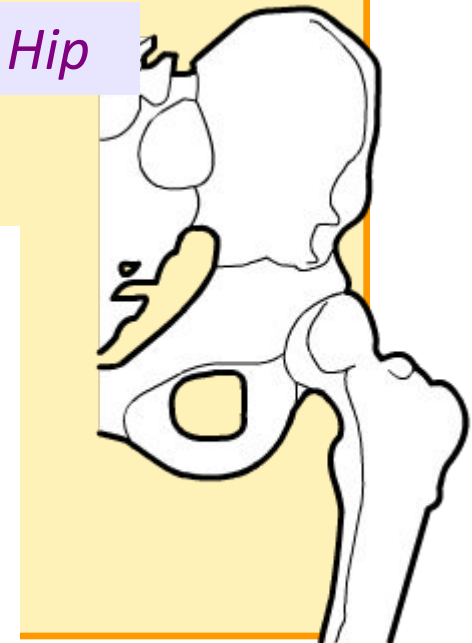
In **ball and socket joints**, the rounded end of one bone fits inside a cup-shaped ending on another bone.

Ball and socket joints allow movement in **all directions** and also **rotation**.

The most mobile joints in the body are ball and socket joints.

Examples: Shoulders and hips.

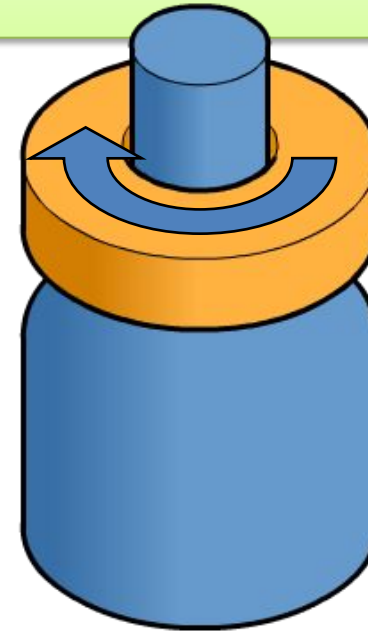
Hip



Types of synovial joints

Pivot joints have a ring of bone that fits over a bone protrusion, around which it can rotate.

These joints only allow **rotation**.



Atlas

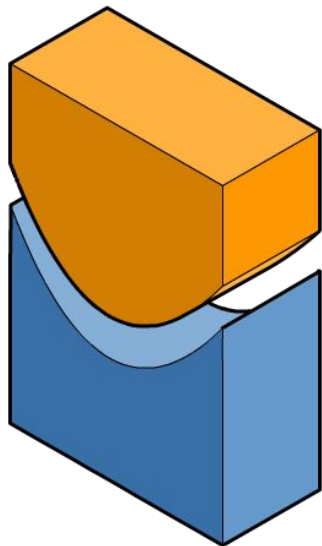
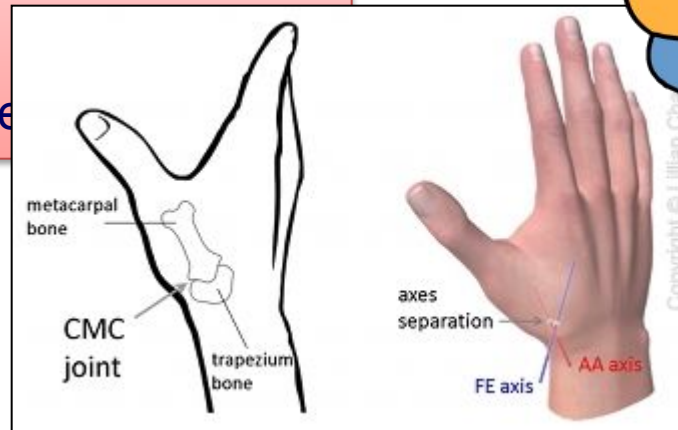
Axis

Examples: The joint between the atlas and axis in the neck which allows you to shake your head.

Types of synovial joints

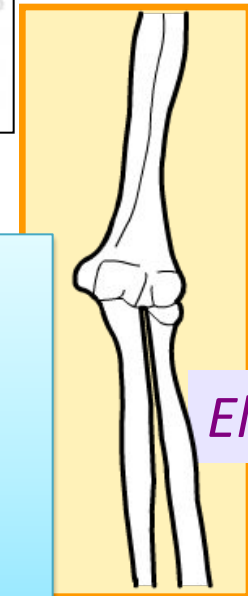
In **saddle joints**, the ends of the two bones fit together in a special way, allowing movement **forwards and backwards** and **left to right**, but not rotation.

Examples: The thumb is the only one



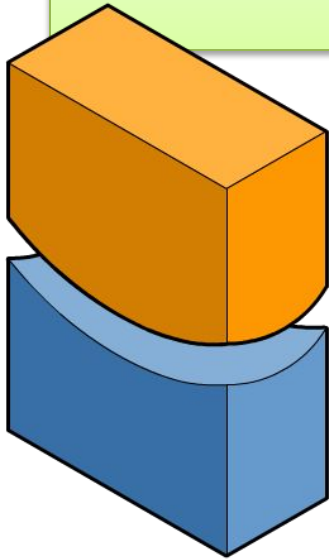
Hinge joints – as their name suggests – only allow **forwards and backwards** movement.

Examples: The knee and elbow.



Elbow

Types of synovial joints

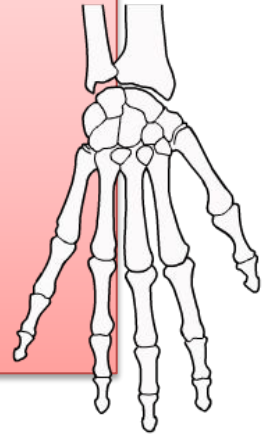


Condyloid joints have an

oval-shaped bone end which fits into a correspondingly shaped bone end.

They allow **forwards**, **backwards**, **left** and **right** movement, but not rotation.

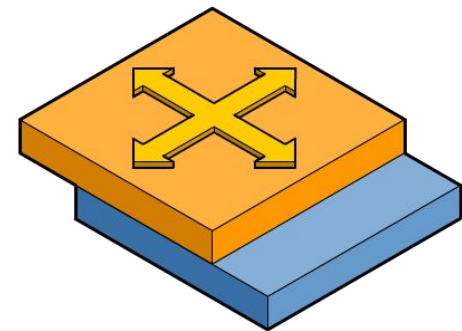
Examples: between the metacarpals and phalanges in the hand.



Gliding joints have two flat

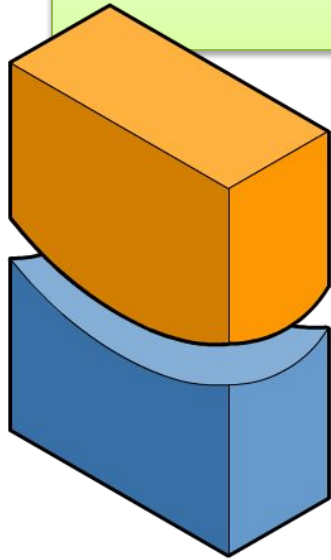
faces of bone that slide over one another.

They allow a **tiny** bit of movement in **all directions**.



Examples: between the tarsals in the ankle.

Types of synovial joints

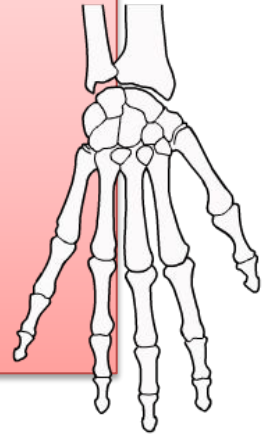


Condyloid joints have an

oval-shaped bone end which fits into a correspondingly shaped bone end.

They allow **forwards**, **backwards**, **left** and **right** movement, but not rotation.

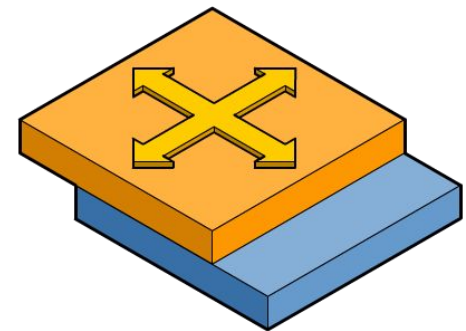
Examples: between the metacarpals and phalanges in the hand.



Gliding joints have two flat

faces of bone that slide over one another.

They allow a **tiny** bit of movement in **all directions**.



Examples: between the tarsals in the ankle.

Starter – Pop Quiz!

Answer the following questions **individually** without using your notes

1. The _____ is frequently injured when an athlete receives a blow to the outside of the knee
2. Give two ways an athlete might damage the ACL and an example of a sport that carries a high risk for this
3. What are the steps for immediate treatment of a knee injury?

ANSWERS— Pop Quiz!

Answer the following questions without using your notes

1. The **LCL** is frequently injured when an athlete receives a blow to the outside of the knee
2. Give two ways an athlete might damage the ACL and an example of a sport that carries a high risk for this
 - **quickly twisting or changing direction**
 - **slowing down while running**
 - **direct hit (like a football tackle)**
 - **landing after a jump**

Skiing, basketball, football

3. What are the steps for immediate treatment of a knee injury?
 - **Resting**
 - **Ice**
 - **Compression**
 - **Elevation**

Learning Objectives

Everyone should

List the different types of joint

Most will

Describe the structure of each joint is related to its mobility

Group activity

Synovial joints – sporting examples

During the butterfly stroke, the **ball and socket** joint of the shoulder allows the swimmer's arm to rotate.



You might head a football using the **pivot** joint in your neck, which allows your head to rotate.

What type of joint allows a handball player's fingers to spread apart so that they can control the ball with one hand?



Answer:

The condyloid joints between the metacarpals and phalanges.

Movement analysis task

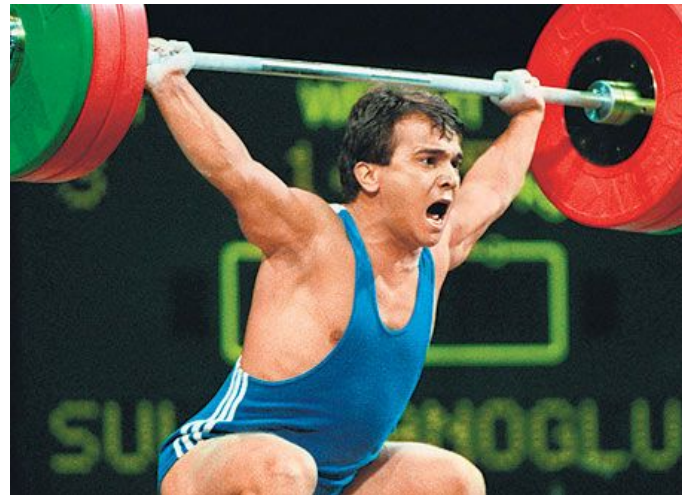
1. Each group member will carry out the motions associated with the following movements
 - a penalty kick in football
 - throwing a baseball
 - serving a tennis ball
 - skipping
2. Discuss the movements occurring at each **synovial joint** during four different types of physical activity **with your partner**

Starter: Individual task

- Which of the sports below would cause the greatest *thickening* of articular cartilage?
(remember Wolff's Law?)



Lionel Messi



Naim Suleymanoglu

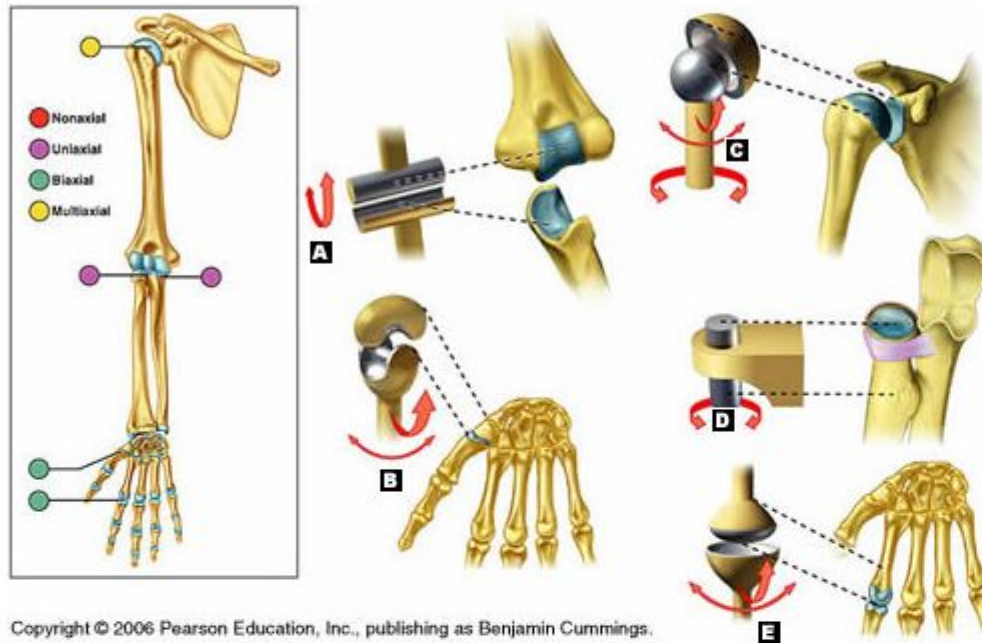


Frankie Dettori

Movement analysis task

1. Each group member will carry out the motions associated with the following movements
 - a penalty kick in football
 - throwing a baseball
 - serving a tennis ball
 - skipping
2. Discuss the movements occurring at each **synovial joint** during four different types of physical activity **with your partner**
3. Try the Joints review **individually** when you have finished

STARTER – Joints Pop Quiz



For each item below, use the pull-down menu to select the letter that labels the correct part of the image.

- 5.1 Pivot joint D
- 5.2 Condyloid joint E
- 5.3 Ball and socket joint C
- 5.4 Hinge joint A
- 5.5 Saddle joint B

Which joint is missing?

Learning Objectives

Everyone should

Identify the different parts of a synovial joint

Most will

Describe how each structure within the joint is related to its mobility

PAIRS ACTIVITY

Dissecting a chicken leg lab

- Follow the instructions in your workbook
- Make sure you complete all questions **individually**

Extension

Try the Joints review questions in your workbook

1.1.7 Define the term joint / 1.1.8 Distinguish between the different types of joint in relation to movement permitted.

- A joint is where two bones meet.
- Joints can be classified as:
 - Fibrous
 - Cartilaginous
 - Synovial

1.1.9 Outline the features of a synovial joint.

- Features of a synovial joint include:
 - Articular cartilage
 - Synovial membrane
 - Synovial fluid
 - Bursae
 - Ligaments
 - Articular capsule

1.1.10 List the different types of synovial joint

- The types of synovial joint are:
 - Ball and socket
 - Hinge
 - Pivot
 - Gliding
 - Condyloid
 - Saddle