Unit 1 Structure and Functions of the Musculoskeletal System

Learning objective: To develop your knowledge and understanding of the musculoskeletal system and how it influences health, fitness, performance and participation

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to name and identify bones and muscles of the human body			
Be able to describe the functions of the skeletal system and link these to the structure of the skeletal system			
Be able to label and describe the roles of different features of a synovial joint			
Be able to identify and describe the movements possible at different joint types			
Understand the roles of antagonistic pairs of muscles in movement			

Key Terms

1. **Long bone** – dense bone which provides strength and structure and acts as a lever to allow movement
2. **Short bone** –small bone which is mainly involved in shock absorption, support and stability
3. **Flat bone** – broad, flat bone which is mainly involved in protection and is the site of muscle attachment
4. **Synovial joint** – the most common joint type found in the body that allows movement to occur
5. **Cartilage** – shock-absorbing tissue between articulating bones
6. **Ligament** – tissue that connects bone to bone
7. **Tendon** – tissue that connects muscle to bone
8. **Isotonic** – the length of a contracting muscle changes (either concentrically or eccentrically)
9. **Isometric** – the length of a muscle undergoing contraction does not change
10. **Concentric contraction** – the shortening of a muscle under contraction
11. **Eccentric contraction** – the lengthening of a muscle under contraction
12. **Agonist** – the main muscle that causes movement
13. **Antagonist** – the opposing muscle of the agonist
14. **Bursae** – a cavity within a synovial joint that acts as a buffer between bones and tendons
15. **Joint capsule** – an articular capsule that surrounds a synovial joint and provides a seal of the joint space and stability to the joint.
16. **Synovial fluid** – lubricating substance found in the joint cavity to reduce friction at joints
17. **Fine movement** – small, intricate musculoskeletal movement that places emphasis on skill rather than power
18. **Gross movement** – large musculoskeletal movement that produces large, powerful movements
19. **Function** – the role or job of something

Structure and Functions of the Skeletal System

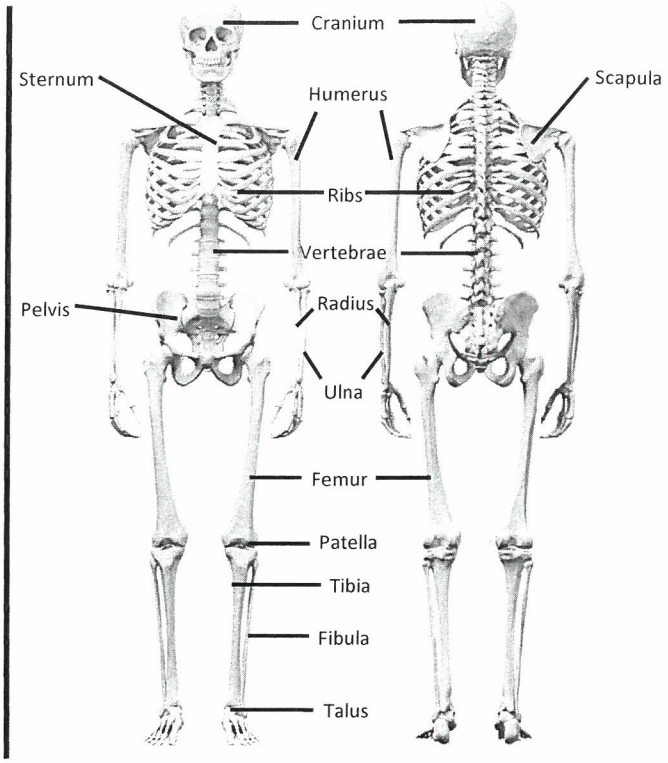
Bones are the framework of our body and allow movement by working with muscle groups. Bones also provide protection for vital organs, and joints allow different types of movement.

Functions of the Skeleton:

Support – bones hold up the body, e.g. a rugby prop's bones give stability, support and maintain their shape when they are pushing against the other team's scrum

Protection – bones protect your vital organs, e.g. the skull protects the brain from heavy damage in boxing

Movement – the bones act as levers that muscles attach to, causing movement, e.g. the arm bones are connected by muscular tissue to form the elbow joint. This allows a football to be thrown.



Functions of the Skeleton:

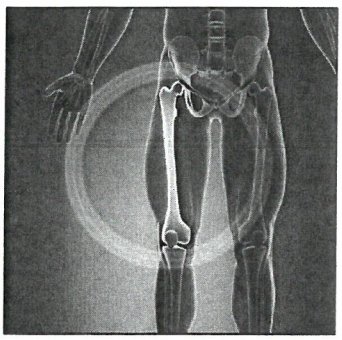
Shape and points for attachment – bones give our body size and shape and provide points for muscles to attach to, e.g. attaching the femur, tibia and fibula to create the knee joint and form the lower limbs

Storage of minerals – calcium and phosphorus – these chemicals are required for the body to be able to contract muscle cells, which in turn cause bodily movement

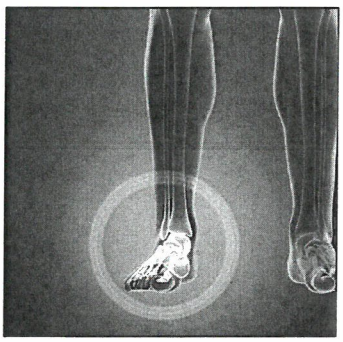
Blood cell production (produced in bone marrow) – red blood cells are oxygen carrying and, therefore, help provide energy to muscles by carrying oxygen to them. White blood cells fight off infection and allow athletes to compete all year round.

Functions of Different Bone Types

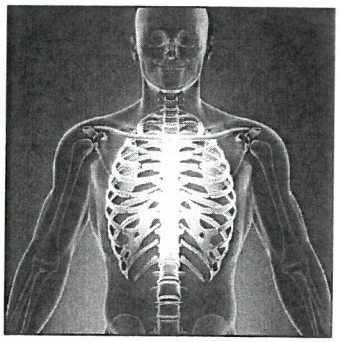
Each of the different types of bone is responsible for certain functions of the skeletal system:



Long bones such as the *femur* are responsible for allowing leverage to occur, causing gross movements, e.g. the femur moving at the hip joint so that a kick-boxer can lift their leg to attack.



Short bones such as the *tarsals* and *metatarsals* are responsible for fine, controlled movements, e.g. a gymnast on the balance beam adjusting their stance to maintain balance.



Flat bones such as the *ribs* are responsible for providing protection to major organs, e.g. the ribcage provides protection for the heart and lungs when playing contact sports such as rugby.

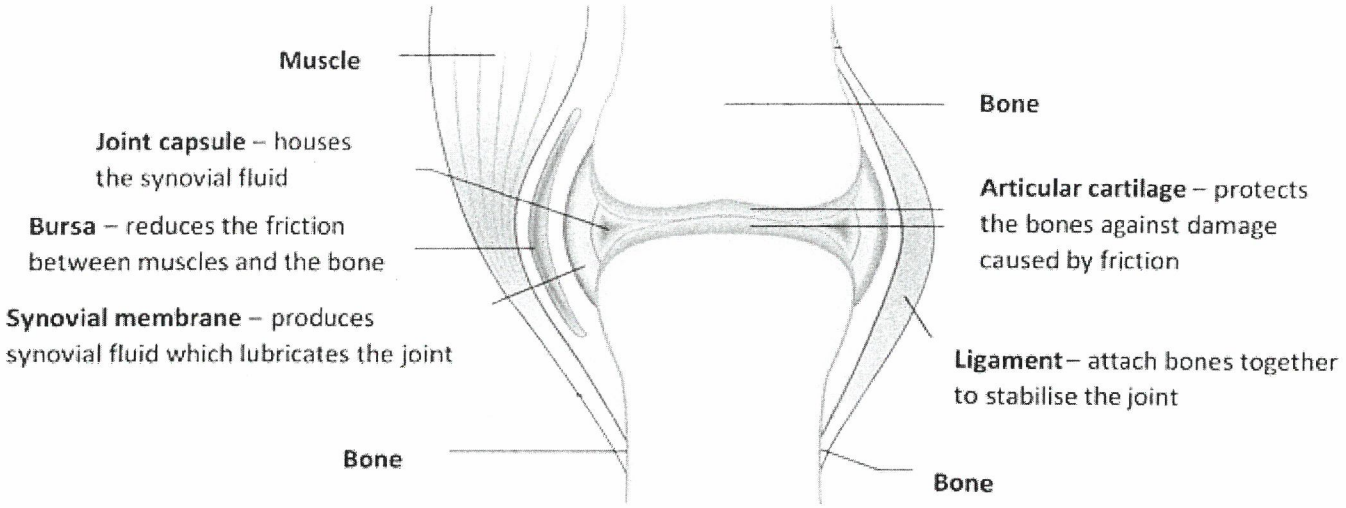
Synovial Joints

Synovial joints are found across the body in lots of locations. They allow for a range of different movements and are designed to help avoid injury.

Connective tissue provides support and connects different parts of the body. There are three different types of connective tissue:

- **Cartilage:** firm, flexible tissue that acts as a shock absorber between bones
- **Ligament:** connective tissue that attaches bone to bone, and prevents injury at the joint
- **Tendon:** tough tissue with limited flexibility that connects muscle to bone

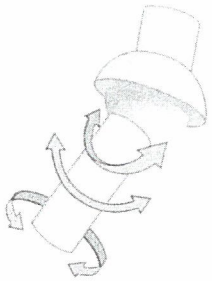
The structure of a synovial joint is shown below.



Movement at Joints

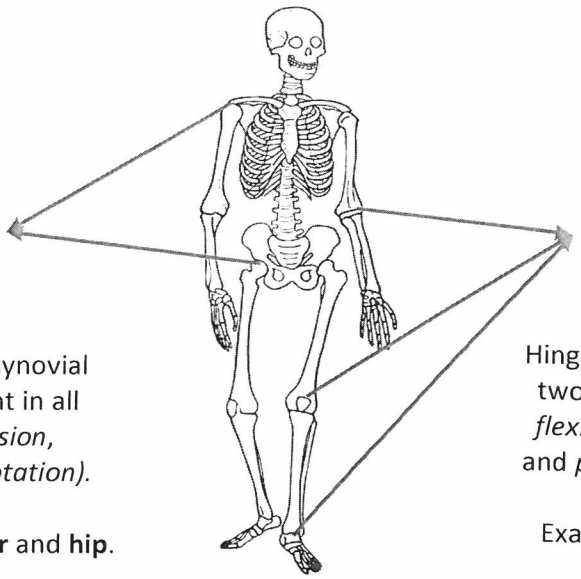
A joint is where two bones meet and where movement occurs. There are different types of joint in the body that allow different types of movement. The important ones to remember are outlined below.

Ball-and-socket

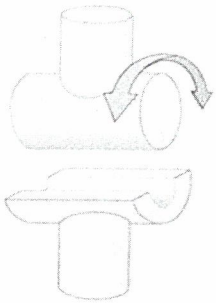


The most freely moveable synovial joint. They allow movement in all directions (*flexion*, *extension*, *abduction*, *adduction* and *rotation*).

Examples include the **shoulder** and **hip**.



Hinge



Hinge joints allow movement in two directions (*extension* and *flexion*) and allow *dorsiflexion* and *plantar flexion* at the ankle.

Examples include the **elbow**, **knee** and **ankle**.

The type of joint at a location of the body allows for specific movements to be performed. For example, the joints at the shoulder, elbow, hip and knee allow for flexion and extension. The joints at the shoulder allow for abduction, adduction and rotation. At the ankle, plantar flexion and dorsiflexion occur.

Definitions of Movements

Flexion – the angle between two bones around a joint is reduced

Extension – the angle between two bones around a joint increases

Abduction – a bone (or limb) moving away from the body

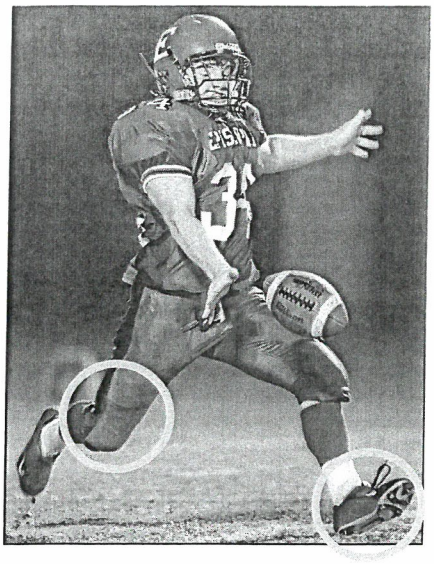
Adduction – a bone (or limb) moving towards the body

Rotation – turning a bone about its long axis

Plantar flexion – flexion of the ankle that causes the toes to point towards the floor

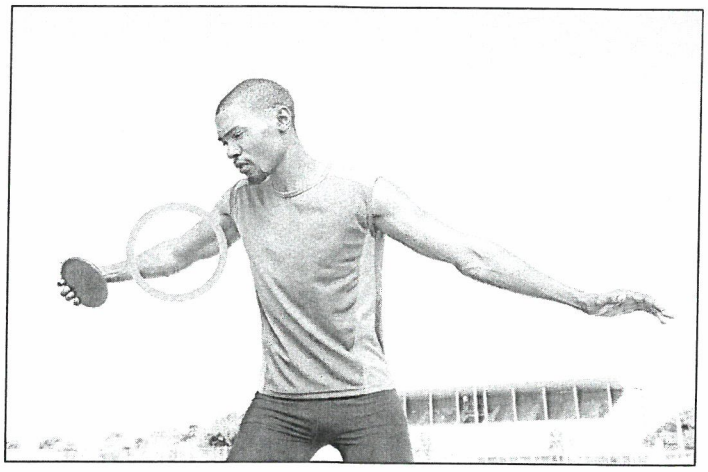
Dorsiflexion – flexion of the ankle that causes the toes to move upwards towards the midline of the body

Movements in Action:



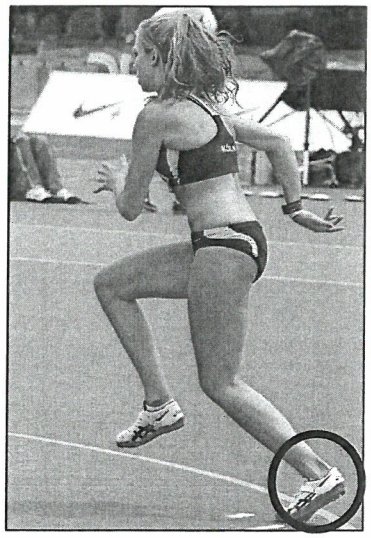
In this example, the American footballer is **flexing** his knee to bring his leg backwards. When he brings his leg forwards to kick the ball, his knee will undergo **extension**.

Dorsiflexion is also occurring at the ankle joint.

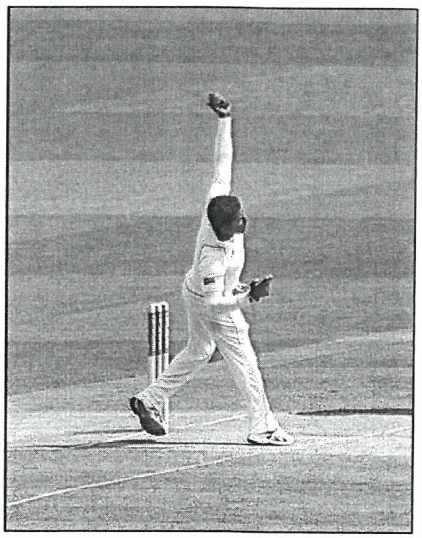


During the discus event, **flexion** and **extension** of the elbow occur

This discus-thrower's shoulders are also undergoing **rotation** as he prepares to throw the discus.

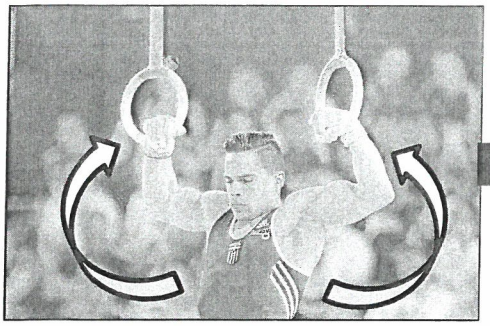


To generate power for a run-up, this high jumper **plantar flexes** her ankle, **extends** her knee and **extends** her hips to move forwards.

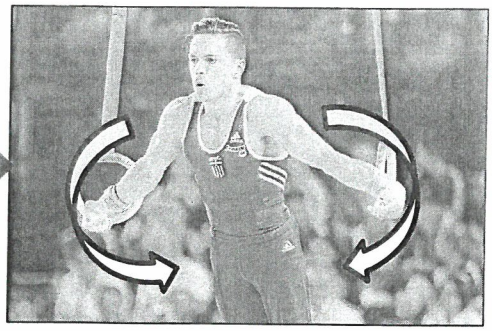


Notice how this bowler has one elbow under **extension** and one arm under **flexion**.

His left shoulder is performing **flexion**. When his arm follows through after the ball, his left shoulder will fully **extend**. His shoulders are also **rotating**.



This athlete has completed shoulder **abduction** as his arms have move away from his body



As this athlete move his arms closer to his body, his shoulders are **adducting**.

Revision Tip!

It's not just hinge joints that cause flexion and extension. Ball-and-socket joints can also cause flexion and extension.

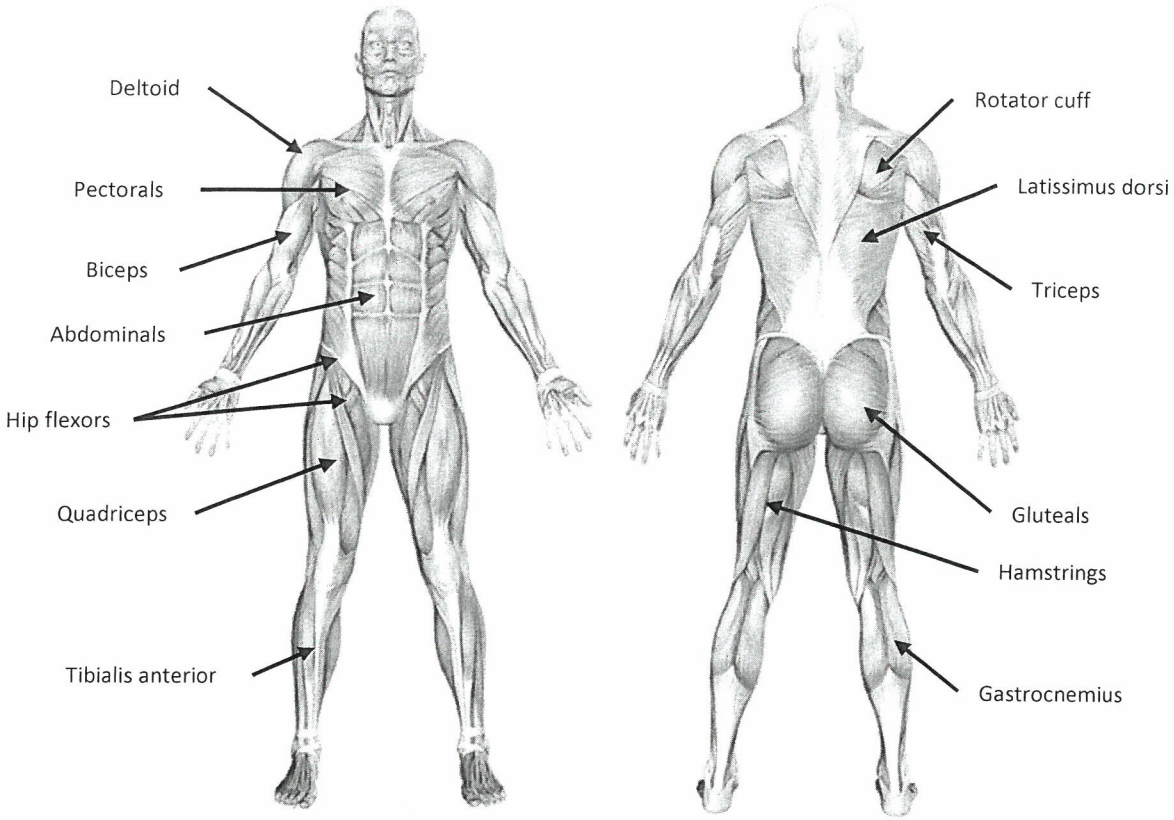
This tennis player has **rotated** his right shoulder to be able to hit this shot, close to his body.

Note:

Detailed movement analysis will be covered later, in Chapter 5.

Muscles of the Body and Movement

The muscles and skeleton work together to produce movement of the body. The muscles that you should know and their locations are given below.



Antagonistic Pairs

Muscles work in groups to move joints. This creates movement of the body. There are different types of muscle contractions that allow this movement – concentric and eccentric.

The make-up of the muscles means that they can only operate in one direction (pulling). They therefore need to work in pairs (**antagonistic pairs**) in order to create movements at a joint in two directions. The **agonist (prime mover)** contracts in order to bring about movement in one direction while the **antagonist** relaxes in order to facilitate the movement of the limb. Then the two muscles switch roles in order to produce movement in the other direction.

The types of muscular contraction are **isotonic (concentric and eccentric)** and **isometric**.

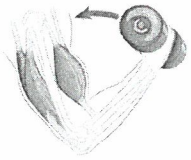
Isotonic Contraction

- Movement occurs
- The length of the muscle changes

Concentric Contraction

- The muscle shortens during a concentric contraction
- The muscle is able to overcome the resistance acting against it
- The most common type of muscle contraction in sport

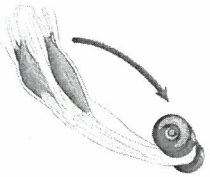
e.g. lifting a weight



Eccentric Contraction

- The muscle lengthens under tension during an eccentric contraction
- The resistance is greater than the force the muscle can create or a weight is being deliberately lowered
- Often used to control or decelerate the movement of a limb

e.g. lowering a weight



Isometric Contraction

- No movement occurs
- The length of the muscle does not change as a result of contraction

e.g. holding a weight stationary

Examples of Muscles Working Antagonistically

Joint	Articulating Bones of the Joint	Movements	Main Agonist	Antagonist	Sport Example
Knee	Femur, tibia, fibula and patella	Flexion	Hamstrings	Quadriceps	Preparing to kick a football
		Extension	Quadriceps	Hamstrings	Executing a kick in football
Elbow	Humerus, radius and ulna	Flexion	Biceps	Triceps	Pulling ball behind head in football throw-in
		Extension	Triceps	Biceps	Extension of elbow in upward phase of a push-up
Ankle	Tibia, fibula and talus	Plantar flexion	Gastrocnemius	Tibialis anterior	Take-off when performing the high jump
		Dorsiflexion	Tibialis anterior	Gastrocnemius	Landing a vertical jump (e.g. speed skiers)
Shoulder**	Clavicle, scapula and humerus	Abduction	Deltoids	Pectorals and Latissimus dorsi	Performing a star jump in (adduction) and out (abduction)
		Adduction	Pectorals and Latissimus dorsi	Deltoids	
		Flexion	Pectorals and deltoids	Latissimus dorsi and deltoids	Throwing underarm (pulling arm forwards)
		Extension	Latissimus dorsi and deltoids	Pectorals and deltoids	Preparing to throw ball underarm (pulling arm backwards)
Hip**	Pelvis and femur	Abduction	Gluteals	*Hip adductors**	A ballet dancer taking their leg out and away, sideways from their body
		Adduction	Hip flexors	*Hip abductors**	A footballer widening their stance to get ready to defend the goal
		Flexion	Hip flexors	Gluteals	Follow through when kicking a conversion in rugby
		Extension	Gluteals	Hip flexors	Drive phase (extending the knee) when running

* These muscles are not on the specification but allow you to further your knowledge.

** Furthermore, rotation has not been included in the table as the rotation is caused by a combination of all muscles and movements at each joint.

1. Describe five functions of the skeletal system.

   1. .....

   2. .....

   3. .....

   4. .....

   5. .....

2. Match up the following types of bone with their correct description.

Long bones	The bones that are primarily involved in providing protection for the vital organs
Short bones	Bones that are used for stability and fine movements
Flat bones	Bones that provide strength and structure, and are used for gross movements

3. a) What function does the cranium have during a rugby match?

   .....

   .....

   b) What function do short bones, such as the tarsals, have for a marathon runner?

   .....

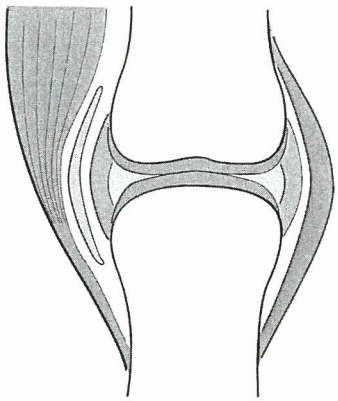
   .....

   c) What function do long bones, such as the humerus, have for a javelin thrower?

   .....

   .....

4. Label the following on the diagram of the knee below:
   - Synovial membrane
   - Bursa
   - Synovial fluid
   - Joint capsule
   - Cartilage
   - Ligaments



5. Name the agonist muscle in the following movements.

   a) Extension of the elbow when throwing a free throw in basketball

   .....

   b) Flexion of the elbow when pulling the arm backwards to throw a javelin (preparation phase)

   .....

   c) Dorsiflexion of the ankle when the foot lands in running

   .....

   d) Abduction of the shoulder during a rugby tackle, when the tackler wraps their arms around an opponent

   .....

   e) Extension of the hips when a footballer pulls their foot backwards (preparation phase) to kick a football

   .....

Exam-style Questions - Unit 1

1. Which bones are found at the knee joint?
   A. Radius and ulna ☐
   B. Humerus and radius ☐
   C. Femur, tibia and fibula ☐
   D. Humerus and ulna ☐

(1 mark)

2. Which muscle causes extension at the knee?
   A. Quadriceps ☐
   B. Gastrocnemius ☐
   C. Hamstrings ☐
   D. Tibialis anterior ☐

(1 mark)

3. Using a sporting example, identify two types of movement that can occur at the shoulder joint.

   1. .....

   .....

   .....

   .....

   2. .....

   .....

   .....

   .....

(4 marks)