Chapter 1.1
The structure and function of the skeletal system

Understanding the Specification

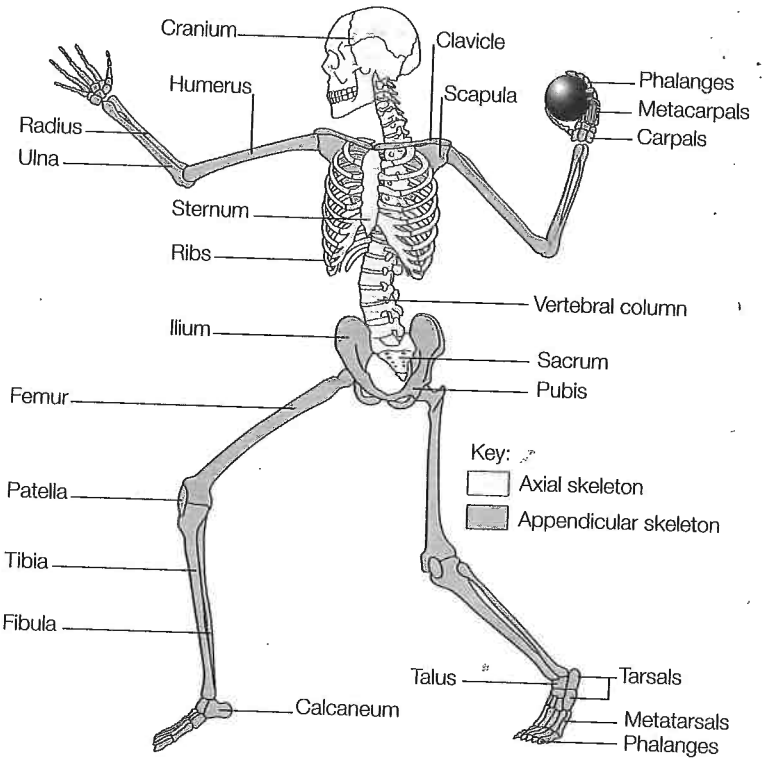
This topic area will help you know and understand the location of the major bones in the body. By the end of the topic you will be able to apply examples to the functions of the skeleton. You should know the major joints and the articulating bones (bones that make up the joint) in the knee, elbow, shoulder and hip. You should also know about types of movements at hinge joints and ball and socket joints and be able to use practical examples to show and analyse different movements.

Activity

Write the names of the major bones of the body on separate Post-it Notes. With a partner, put each Post-it on the appropriate area for the bone.

Location of the major bones

More than 200 bones make up the human skeleton. For us to understand how the body moves effectively in sports activities, it is important to kno the location of the main bones.



▲ Figure 1.1.1 Location of the major bones in the human body

? Extend your knowledge

The **axial skeleton** is the central part of the skeleton and is the main source of support. It includes the cranium (the skull), the vertebral column (bones that make up the spine) and the rib cage, including 12 pairs of ribs and the sternum.
The **appendicular skeleton** consists of the remaining bones and includes the structures that join these bones on to the axial skeleton.

You should know the location of the following bones:

- cranium
- vertebrae
- ribs
- sternum
- clavicle
- scapula
- humerus
- ulna
- radius
- carpals
- metacarpals
- phalanges
- pelvis (ilium)
- femur
- patella
- tibia
- fibula
- tarsals
- metatarsals.

Functions of the skeleton

The skeleton has several major functions:

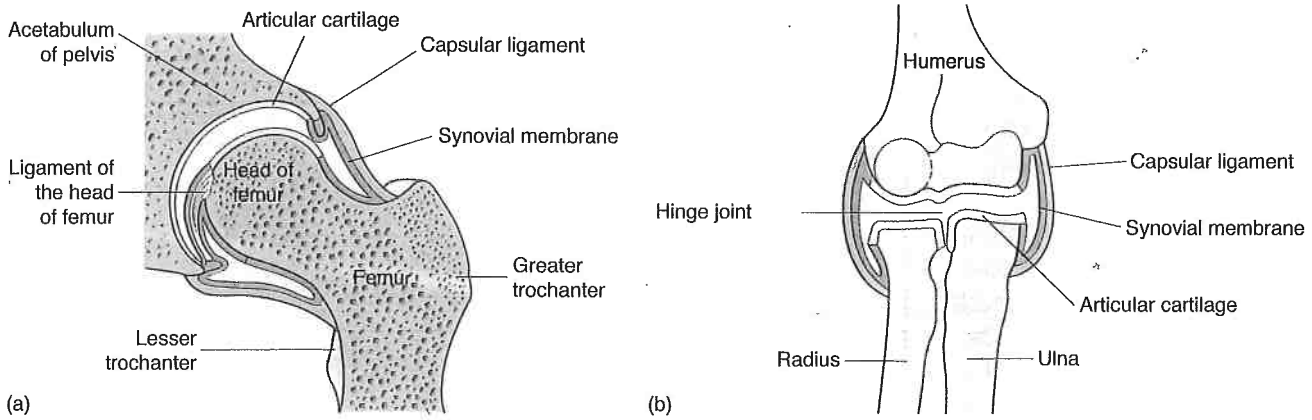
1. To give shape and support to the body – therefore giving the body posture.
2. To allow movement of the body – by providing areas or sites for muscle attachment. This also provides for a system of levers that helps us move.
3. To give protection to the internal organs – such as heart, lungs, spinal cord and the brain. For example, the cranium protects the brain.
4. To produce blood – red and white blood cells.
5. To store minerals – such as phosphorus, calcium, potassium and iron, etc. Iron helps in the transport of oxygen to working muscles and calcium is needed to build and repair bones.

Types of synovial joint

A joint is where two or more bones meet. There are many different types of joint in the human body, including some that do not allow movement, or allow very little. Joints are very important in movements related to sport. The type of joint that we are more concerned with is the **synovial joint**. This is the most common joint and since it allows for a wide range of movement is very important to people playing sports. It consists of a joint capsule, lined with a synovial membrane. There is lubrication provided for the joint in the form of synovial fluid. This is secreted into the joint, e.g. the knee joint, by the synovial membrane.

Key term

Synovial joint This is a freely movable joint in which the bones' surfaces are covered by cartilage, called articular cartilage, and connected by a fibrous connective tissue capsule (joint capsule) lined with synovial fluid.



▲ Figure 1.1.2 Diagram of (a) the hip joint and (b) the elbow joint. These are synovial joints

The articulating bones for the shoulder joint are the:

- humerus
- scapula.

The articulating bones for the hip joint are the:

- pelvis
- femur.

Types of movement at hinge joints and ball and socket joints

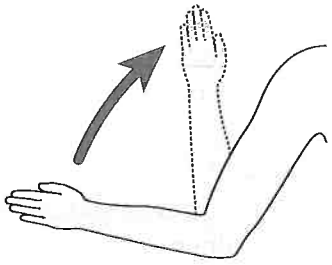
There are different types of movement associated with the joints in our bodies, including:

- flexion
- extension
- rotation
- abduction
- adduction.

Movement at hinge joints

Flexion is a decrease in the angle around a joint.

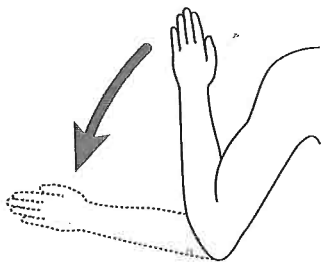
- **At the knee**: for example, bending your leg at the knee when preparing to make a pass in football.
- **At the elbow**: bending your arm at the elbow and touching your shoulder with your hand – for example, when a badminton player prepares to hit an overhead clear, the arm shows flexion at the elbow.



▲ Figure 1.1.5 Flexion at the elbow

Extension is when the angle of the bones that are moving (articulating bones) is increased.

- **At the knee**: from a stooped or squat position you then stand up. The angle between your femur and tibia (upper and lower leg) increases, thus extension has taken place – for example, when a basketball player drives up to the basket from bent legs to straight, extension occurs at the knee joint.
- **At the elbow**: straightening your arm at the elbow joint. The angle between the humerus and the radius/ulna (upper and lower arm) is increased, thus extension takes place – for example, when making a basketball set shot the bent arm moves to a straight arm as you release the ball and extension occurs at the elbow joint.



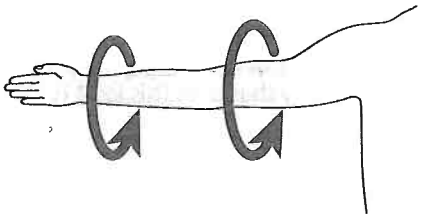
▲ Figure 1.1.6 Extension at the elbow

? Extend your knowledge

Other types of joint:

- **Pivot joint**: this allows rotation only and is therefore also uniaxial, e.g. axis and atlas of the cervical vertebrae. An example of a physical activity that uses this joint is turning the head to find a fellow player to pass to in hockey.
- **Gliding joint**: this is when two flat surfaces glide over one another and can permit movement in most directions, although mainly biaxial, e.g. the carpal bones in the wrist. An example of a physical activity that uses this joint is dribbling the ball by moving the hockey stick over and back.
- **Saddle joint**: this is when a concave surface meets a convex surface and is biaxial, e.g. carpal–metacarpal joint of the thumb. An example of a physical activity that uses this joint is gripping a tennis racket with the thumb.

▲ Figure 1.1.7 A ballet dancer moves into first position and rotates the hip joint laterally



▲ Figure 1.1.8 Rotation at the shoulder

Movement at ball and socket joints

Flexion:

- **At the shoulder**: involves movement of the arm forwards and up overhead – for example, lifting the arms out of the water during the backstroke in swimming.
- **At the hip**: describes the bending motion that brings your thigh towa your chest – for example, in hockey, bending down to ensure that you hockey stick is flat on the floor and can stop the ball.

Extension:

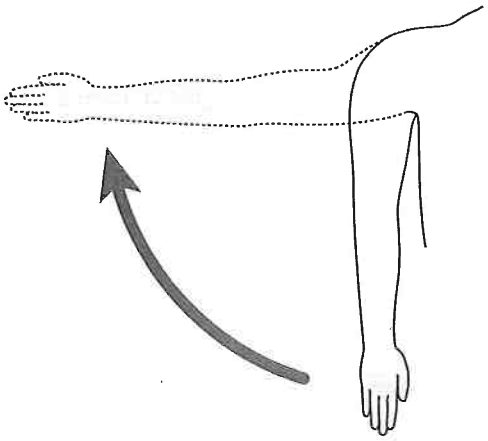
- **At the shoulder**: is the lowering of the arm from in front and taking it back behind you – for example, the execution of a serve in tennis, whe the player takes the arm back before throwing the ball up.
- **At the hip**: moving the leg backwards towards the posterior side of th body – for example, a rugby player extends the hip in preparation for kicking through the ball, to get maximum power.

Rotation is when the bone turns about its longitudinal axis within the join Rotation towards the body is called internal or medial rotation; rotation away from the body is called external or lateral rotation. For example:

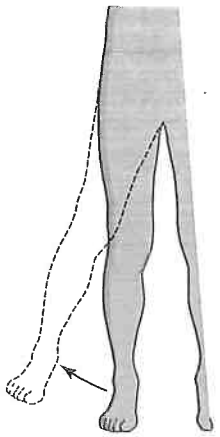
- **Hip**: a ballet dancer moves into first position and rotates the hip joint laterally.
- **Shoulder**: a tennis player uses external rotation at the shoulder joint during the backswing of the serve.

Abduction is the movement of the body away from the middle or the midline of the body – for example:

- **Hip**: a gymnast with her leg lifted to the side of her body shows abduction
- **Shoulder**: a swimmer lifts the arms out to the side during the butterfly stroke.



▲ Figure 1.1.9 Abduction at the shoulder

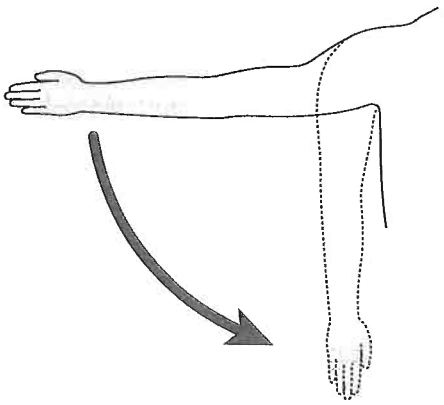


▲ Figure 1.1.10 Abduction of the leg at the hip

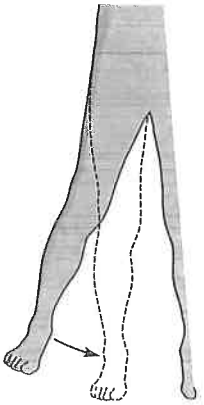
Adduction is the opposite of abduction and is the movement towards the midline of the body, e.g. lowering your lifted leg that you have abducted towards the middle of your body – for example:

- **Hip**: in swimming the recovery of the legs from the breaststroke leg kick involves adduction.

- **Shoulder**: a rugby player tackling another player will hold on to the player by adducting her arms as she tackles.



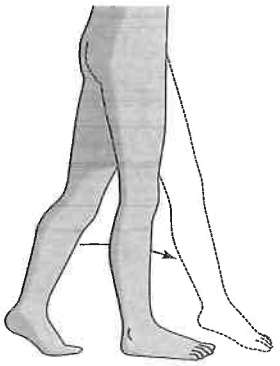
▲ Figure 1.1.11 Adduction at the shoulder



▲ Figure 1.1.12 Adduction at the hip

Circumduction is a combination of abduction, adduction, extension or flexion and rotation. It describes a continuous circular movement of a limb around a joint:

- **Hip**: a gymnast on the beam takes her back leg off the beam and moves it out and round to place her foot ahead of her front foot.
- **Shoulder**: a swimmer during the front crawl arm action will take their arm out and round and back into the water, showing circumduction at the shoulder joint.



▲ Figure 1.1.13 Circumduction at the hip

Activity

Sketch a simple diagram of the knee joint and label the bones that move around this joint.

Name a physical activity that involves both flexion and extension of the knee joint.

Draw the hip joint and label the bones that move around this joint.

Describe a skill in a physical activity that involves both abduction and adduction of the hip joint.

Other components of joints

There are three other main components of joints that it is helpful for budding athletes to know about. These are:

- ligaments
- cartilage
- tendons.

In the same way that joints link the various bones in our body, these tissue-based components help to reduce wear and tear in a variety of ways, for example by absorbing shock or reducing friction.

Ligaments

These are found between bones and attach bone to bone. They are bands of connective tissue that are very tough and resilient.

- **Function**: the role of ligaments is to help join bones together and keep the joints stable during movement.

Some ligaments lie within the synovial capsule, others are outside the capsule. The ligaments prevent movements that are extreme and help dislocation.

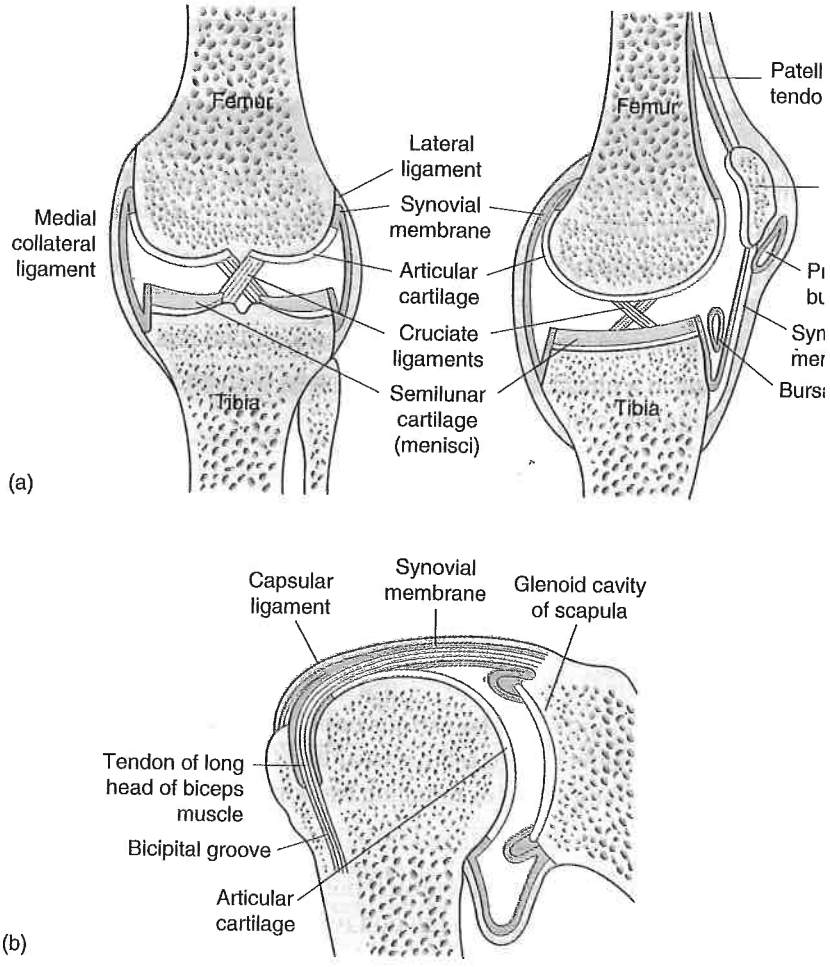
Cartilage

This is soft connective tissue.

- **Function**: the role of cartilage is to reduce friction and act as a shock absorber for the joint.

Newly born babies have a skeleton consisting of cartilage and as they get older this cartilage is mostly replaced by bone, a process known as ossification. Bones have a blood supply, but cartilage has no blood supply. There are three basic types of cartilage:

- **Yellow elastic cartilage**: flexible tissue, e.g. part of the ear lobe.
- **Hyaline or blue articular cartilage**: found on the articulating surfaces of bones, it protects and allows movement between bones with little friction and therefore more flexibility. Hyaline cartilage can thicken as a result of exercise.
- **White fibro-cartilage**: consists of tough tissue that acts as a shock absorber. It is found in parts of the body where there is a great amount of stress, for example the semi-lunar cartilage in the knee joint. It also allows bones to fit together properly; for example, as discs between the vertebrae.



▲ Figure 1.1.14 (a) The knee joint viewed from the rear (left) and the side (right) and (b) the shoulder j

You may tear a cartilage with a forceful knee movement. For example, a footballer may twist the knee while their foot is still on the ground, perhaps while dribbling round a defender. Or a tennis player may twist to hit a ball hard but keep their foot in the same position.
Sometimes a tear develops due to repeated small injuries to the cartilage, or to degeneration ('wear and tear') of the **meniscus cartilage** in older people. In severe injuries, other parts of the knee may be damaged in addition to a meniscus tear – for example, you may also sprain or tear a ligament.
The cartilage does not heal very well once it is torn. This is mainly because it does not have a good blood supply. So, some small outer tears may heal in time, but larger tears, or a tear in the middle of the knee cartilage, tend not to heal properly.

Key term

Meniscus cartilage In the knee, these are areas of cartilage tissue that act like shock absorbers in the joint.

Tendons

Muscles are attached to bones via tendons. These are strong and can be a little flexible.

- **Function:** As well as their attachment role, they help to transmit the power needed to move bones. When a muscle shortens, it pulls on the tendons; this pulls on the bones to which the tendons are attached and causes movement.

IN THE NEWS

Achilles tendons play a critical role in human running ability, the Festival of Science in York has been told. A new computer model confirms that skeletons need to store energy in their tendons to be able to run efficiently.

Extend your knowledge

If contraction is excessively strong then tendons can be damaged. For example, the Achilles tendon is found in the lower leg and can be damaged. If the tendon is damaged below the knee, often caused by over training, then **Osgood-Schlatter's disease** could be experienced.

Key term

Osgood-Schlatter's disease This is a common cause of knee pain in children and is linked to bone and muscle growth.

An active, healthy lifestyle that is balanced in the amount and type of exercise undertaken can limit the damage that may be caused to tendons. Exercise can strengthen tendons and make them less prone to injury.