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REVISE BTEC NATIONAL

Sport

UNITS 1 AND 2

REVISION GUIDE

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Pearson

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REVISE BTEC NATIONAL Sport UNITS 1 AND 2

REVISION GUIDE

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Introduction

Which units should you revise?

This Revision Guide has been designed to support you in preparing for the externally assessed units of your course. Remember that you won't necessarily be studying all the units included here – it will depend on the qualification you are taking.

BTEC National Qualification	Externally assessed units
Certificate	1 Anatomy and Physiology
For all: Extended Certificate; Foundation Diploma; Diploma (FS)	1 Anatomy and Physiology 2 Fitness Training and Programming for Health, Sport and Well-being
Diploma	1 Anatomy and Physiology 2 Fitness Training and Programming for Health, Sport and Well-being 22 Investigating Business in Sport and the Active Leisure Industry
Extended Diploma	1 Anatomy and Physiology 2 Fitness Training and Programming for Health, Sport and Well-being 19 Development and Provision of Sport and Physical Activity 22 Investigating Business in Sport and the Active Leisure Industry

You can revise Units 19 and 22 using a separate Revision Guide, also available from Pearson.

- Revise BTEC National Sport Units 19 and 22 (ISBN 9781292221649).

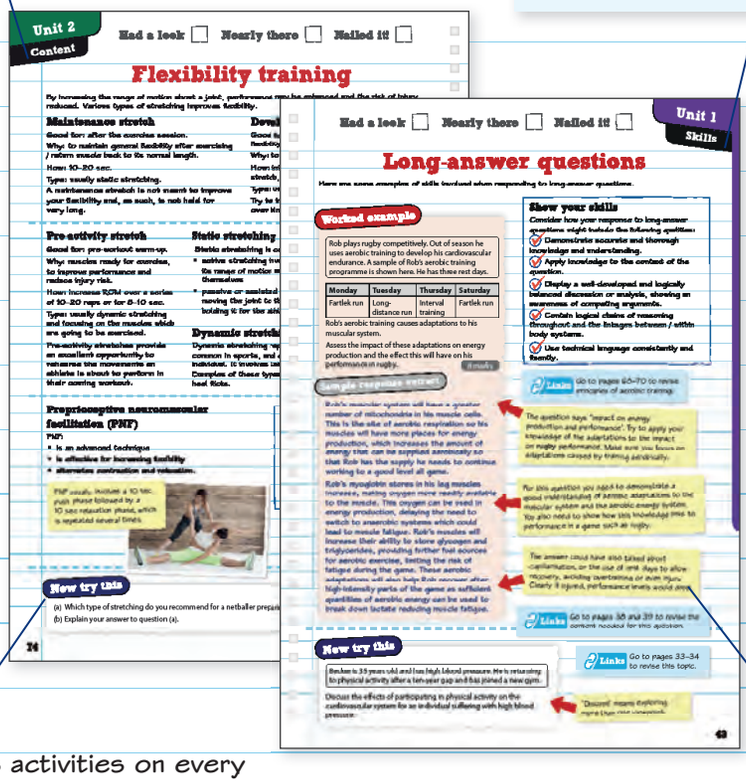
Visit www.pearsonschools.co.uk/revise for more information.

Your Revision Guide

Each unit in this Revision Guide contains two types of pages, shown below.

Content **pages** help you revise the essential content you need to know for each unit.

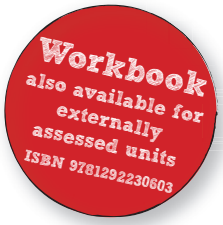
Skills **pages** help you prepare for your exam or assessed task. Skills pages have a coloured edge and are shaded in the table of contents.



Use the **Now try this** activities on every page to help you test your knowledge and practise the relevant skills.

Look out for the **example student responses** to revision questions or tasks on the skills pages. Post-its will explain their strengths and weaknesses.

Contents



Unit 1 Anatomy and Physiology

Unit 2 Fitness Training and Programming for Health, Sport and Well-being

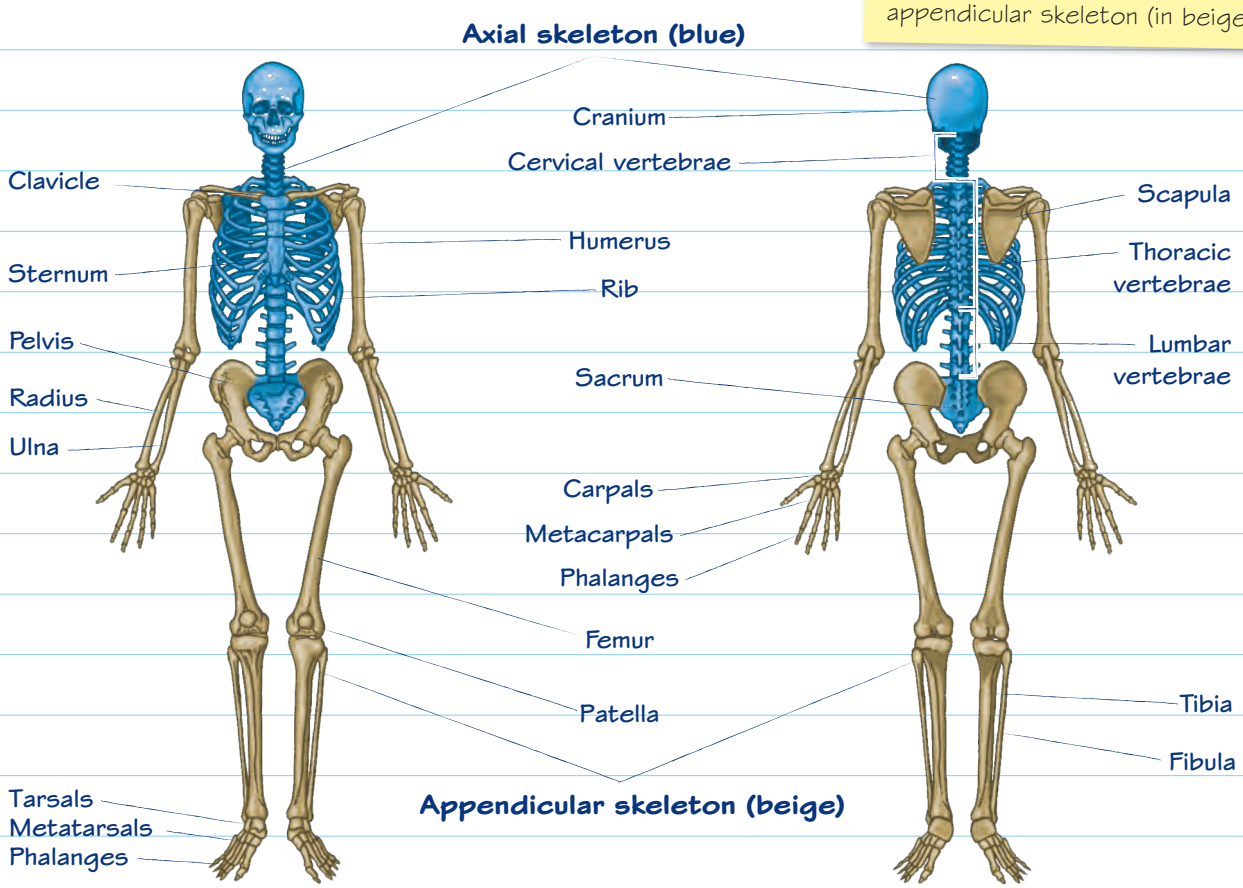
A small bit of small print

Pearson publishes Sample Assessment Material and the Specification on its website. This is the official content and this book should be used in conjunction with it. The questions in *Now try this* have been written to help you test your knowledge and skills. Remember: the real assessment may not look like this.

The skeleton

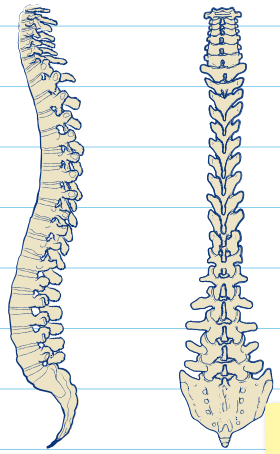
You need to know the names and locations of the major bones of the axial and appendicular skeleton, and the variations of the curvature of the spine.

The bones of the axial (in blue) and appendicular skeleton (in beige)



Neutral spine alignment

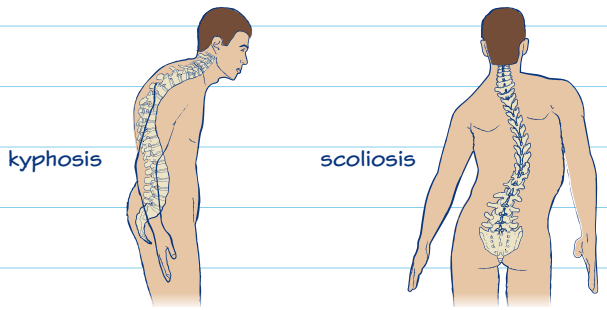
Another name for the vertebral column is the spine.



The spine naturally forms an 'S' shape when viewed from the side (in other words there should be three slight curves). When viewed from the back the spine should be straight.

This is neutral spine alignment.

Postural deviations kyphosis and scoliosis



Kyphosis (hunched back) and scoliosis (abnormal sideways curvature of the spine when viewed from the back).

Now try this

(a) Describe the postural deviation kyphosis.

(b) Explain **one** way that the postural deviation kyphosis could impact on performance in sport.

Had a look ☐ Nearly there ☐ Nailed it! ☐

Bone growth

Strong healthy bones are vital for effective sports performance. You will need to know the process of bone growth and the bone cells that enable it to take place.

Process of bone growth

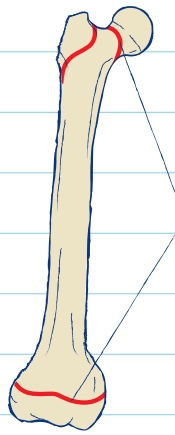
Bone is living tissue. It is formed through a process called **ossification**.

Bone develops in length from infancy to adulthood.

Calcium and phosphate accumulate on the cartilage, trapping it, causing the cells of cartilage to die.

Tiny spaces are left when the cartilage dies. Blood vessels grow in these spaces and transport osteoblasts and nutrients to the developing bone.

The length of your bones can determine your sport. For instance, basketball players are often tall; jockeys, often short.



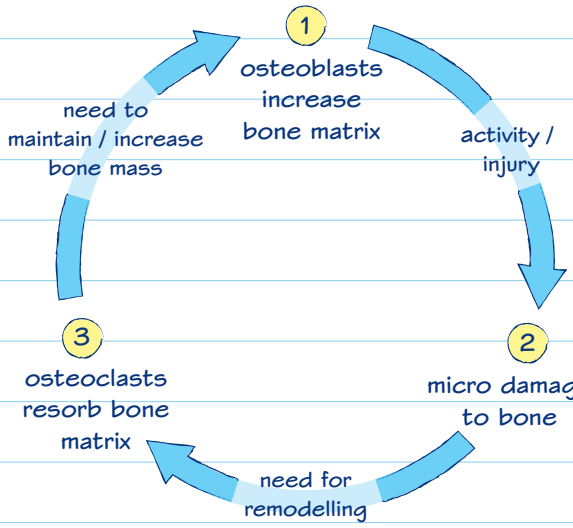
Bone tissue is naturally added at the epiphyseal plate in children and teenagers to increase the length of the bone.

Bone cells

Bone cells comprise:

- **osteoblasts**, which form bone by secreting **collagen**
- **osteoclasts**, which remove bone. Osteoclasts dissolve bone mineral. The degraded bone is then removed.

Growth in diameter of a bone can continue through adulthood.



Bone is continuously being broken down and restructured due to the dynamic relationship between bone cells.

Worked example

Describe how the bone cells maintain bone mass. 4 marks

The command word used is '**Describe**' so the points you make must be linked or related to each other.

Sample response extract

Bone mass is maintained through the action of the osteoblasts and osteoclasts. Osteoblasts are responsible for increasing the bone matrix after the osteoclasts have absorbed bone tissue during growth / repair.

Start by identifying the relevant bone cells before describing the role of each.

Now try this

Karl broke his arm playing rugby.

Explain the role of bone cells in Karl's recovery.

Make sure you read each question carefully. Tailor your answer to the question context. The context is a broken arm, so make sure you link your response.

Functions of the skeleton

You need to know the functions of the skeleton and be able to apply your knowledge to a range of different sport and exercise situations.

Supporting framework and movement

The skeleton:

- allows the body to maintain its shape
- allows you to stand erect due to the vertebral column
- provides a framework for muscle attachment
- allows movement due to muscle attachment and the formation of joints between the bones
- allows a vast range of movement from intricate precise movements of the hand to the large range of movement possible at the shoulder.

Leverage

The length of our bones determines our height and the amount of leverage the bones can exert. This will impact on our performance in a range of activities.

It is an advantage for basketball players to be tall.

A tennis player with long arms will be able to exert more force on the ball; improving their service.

Weight bearing

In order to maintain an erect stature, the bones of the pelvis and leg are strong and thick so that they can take the weight of the entire skeleton.

Some other bones are especially designed for strength to allow weight bearing. For instance, the bones at the gymnast's wrists can support her body weight.

Protection

Vital organs are protected from damage due to their position in relation to the bones of the skeleton.

For example:

- the cranium protects the brain
- the vertebrae protect the spinal cord
- the rib cage and sternum protect the lungs and the heart.

Source of blood cell production

The following blood cells develop in the bone marrow:

- red blood cells – important as they carry oxygen to the muscles
- white blood cells – important as they fight infection to keep the performer healthy.

Store of minerals

The bone matrix stores:

- calcium, essential for muscle contraction and bone repair
- phosphorus; too little phosphorus can cause muscle fatigue and joint pain.

The bone marrow stores iron, essential for red blood cell formation.

Now try this

Explain how **two** different bones of the skeleton are used for protection in physical activity.

Give examples for **two** different bones in the skeleton, such as the cranium and the ribs.

Be clear about how each bone provides protection.

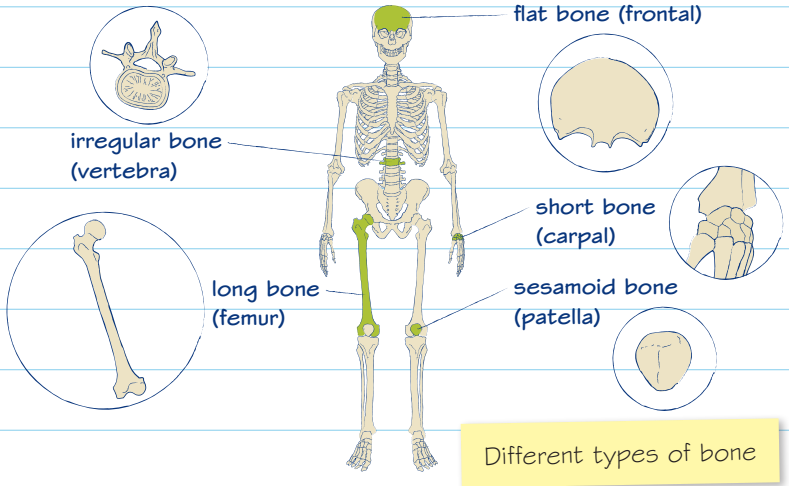
Give a different sporting example for each bone.

Had a look ☐ Nearly there ☐ Nailed it! ☐

Bone types

You need to know and understand how each bone type is related to its function and how these functions aid sporting techniques and actions.

Characteristics and examples of bone types



Different types of bone

- Long – longer than they are wide, such as the femur, ulna and phalanges
- Short – as short as they are wide, such as the carpals and tarsals
- Flat – broad, flat and normally thin bones, such as the pelvis, sternum and ribs
- Sesamoid – held within tendons, covered in cartilage, such as the patella
- Irregular – irregular shape, such as the vertebrae

Function of long bones

- Source of red blood cells production, essential for oxygen delivery
- Enable large movements, allowing increased speed or range in which an object can be moved
- Act as levers to generate more force on an object

Function of short bones

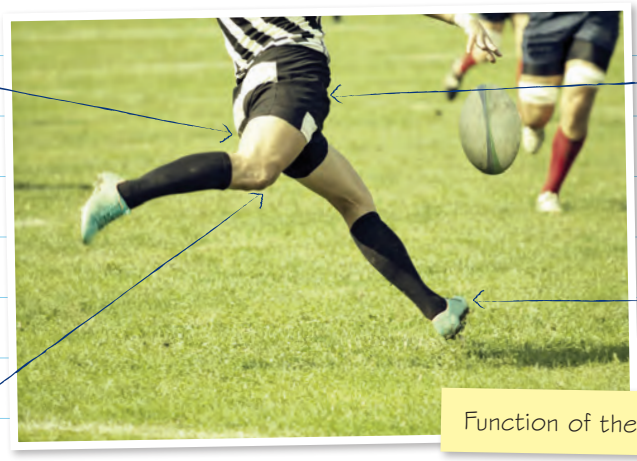
- Increase stability and reduce unwanted movement
- Are weight bearing, helping the body to remain upright or hold balance
- Absorb shock, such as when running

Function of sesamoid bones

- Ease joint movement, meaning more fluid
- Resist friction so movement is not slowed down

Function of flat bones

- Protect vital organs to reduce injury
- Enable muscle attachment to create movement
- Produce blood cells in adults



Function of the bone types applied to sport.

Now try this

Analyse the role of **one** bone type during a game of badminton.

Think of the roles of the different bone types. For example, a long bone acts a lever – how does this help? What will happen to the speed of the racket? What is the impact of this?

Joint classification

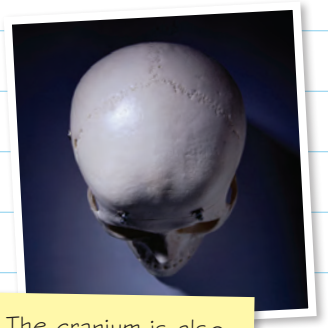
The first thing you need to know is that there are different types of joints in the body.

Types of joints

A joint is formed where two or more bones meet. We classify joints according to the amount of movement they allow.

1 Fibrous

These joints are fixed and allow no movement, such as the sacrum and coccyx.



The cranium is also a fibrous joint.

2 Cartilaginous

These joints are slightly moveable joints, such as between the lumbar vertebrae.

The joints between the cervical and thoracic vertebrae also form cartilaginous joints.

3 Synovial

These are freely moveable joints.

They are important in sport because they provide the greatest range of movement.

The shape of the bones at the joint determines the range of movement. For example, due to the shape of the bones forming the knee, we can only bend and straighten the leg at the knee.

Synovial joints

Synovial joints are divided into six groups based on the amount of movement at each joint.

Condyloid joint

This joint allows movement in two planes.

It allows flexion, extension, adduction, abduction, and circumduction.

Pivot joint

There is a pivot joint at the elbow and between the first and second vertebrae. These joints allow twisting or rotation.

Hinge joint

Examples of these are found at the elbow, knee and ankle.

They allow flexion and extension.

Gliding joint

This joint is formed between the bones of the wrist and foot. The bones glide over each other to allow sliding or twisting movements. For example, the hand action in hockey as you dribble the ball.

Saddle joint

This joint is formed between the carpals and metacarpals at the base of the thumb. The movements are the same as the condyloid joint.

The elbow

Classified as a pivot and hinge joint. This is because there are actually two joints in the area of the elbow. Make sure you know which bones form each joint:

- **pivot** – between the radius and the ulna
- **hinge** – between the radius and the humerus and the ulna and the humerus.

Ball and socket joint

These joints give the greatest range of movement.

Ball and socket joints at the hip and shoulder allow flexion, extension, adduction, abduction and rotation.

Now try this

Go back to page 1 to identify the joints of the upper and lower skeleton.

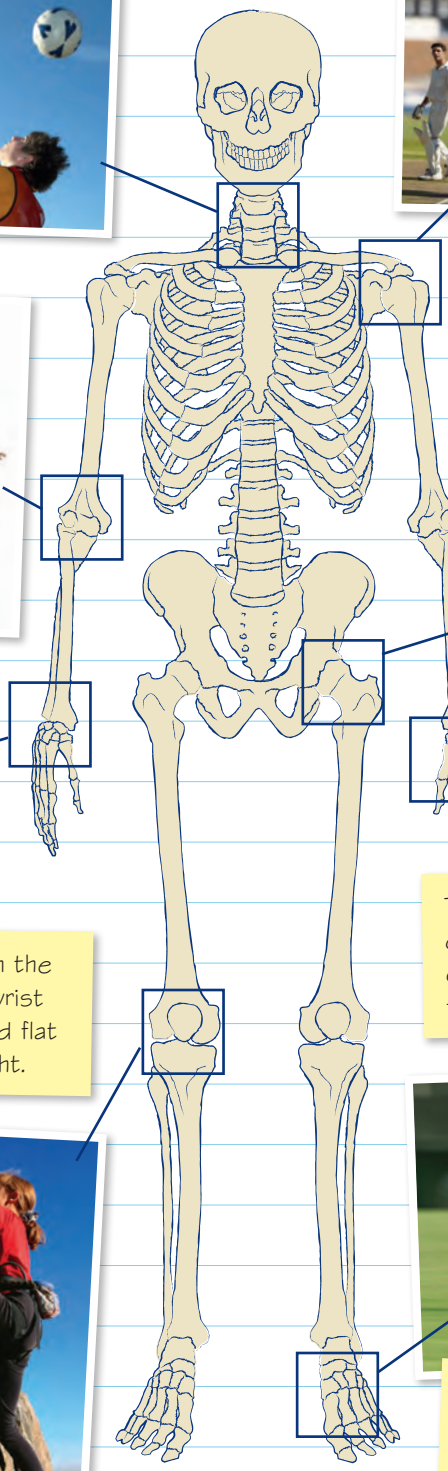
Analyse how the synovial joints from the upper skeleton allow a player to serve the ball in a game of tennis.

Joints use in sport

You need to understand how the joints of the upper and lower skeleton are used in sporting techniques and actions.

The pivot joint formed between the first and second vertebrae at the neck allows the player to tilt the head back to watch the ball.

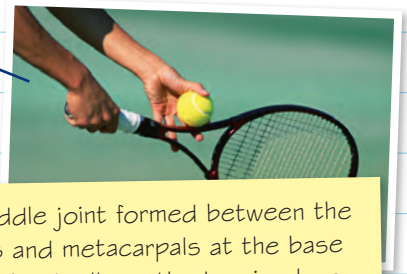
The ball and socket joint formed between the scapula and humerus at the shoulder allows the bowler to bowl the cricket ball.



The hinge joint formed between the humerus and the radius and ulna at the elbow allows the volleyball player to bend the arm to serve the ball.

The ball and socket joint formed between the femur and pelvis at the hip allows the hurdlers to lift the leg to clear the hurdle.

The condyloid joint formed between the radius, ulna and the carpals at the wrist allows the gymnast to put their hand flat on to the bar to maintain their weight.



The saddle joint formed between the carpals and metacarpals at the base of the thumb allows the tennis player to grip the racquet and the ball.

The hinge joint formed between the femur, tibia and patella at the knee allows the climber to bend the leg to get a foothold.

The gliding joint formed between the tarsals and metatarsals of the foot increases the flexibility of the foot, allowing the player to turn the foot to kick the ball.

Now try this

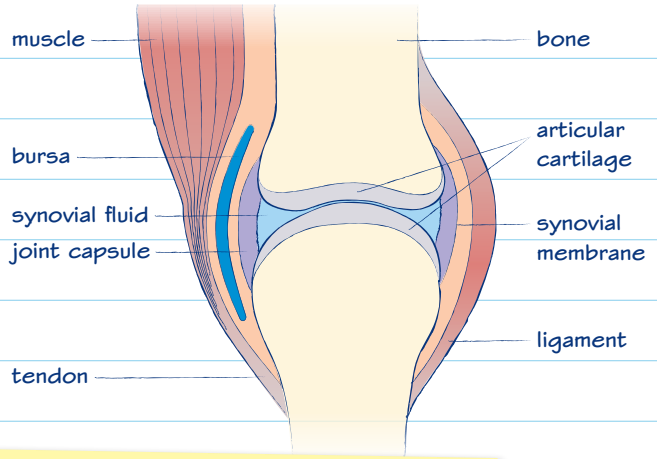
(a) How would the joints between the vertebrae be used in high jump?

(b) The pictures show sporting examples of the use of each type of joint. How else might each of the identified joints be used in sport?

Joint structure

You need to be able to link the function of each component of a synovial joint with its use in sporting techniques and actions.

Components of synovial joints



The general structure of a synovial joint

Function of each component

A joint is formed where two or more **bones** meet. In this example, two bones are meeting to form the synovial joint.

Articular cartilage is a shiny, elastic material, which is designed to reduce friction and absorb shock.

Ligaments connect bone to bone, holding the bones in the correct position. They stabilise the joint.

The **synovial membrane** secretes synovial fluid.

Bursa are found in most major synovial joints. They reduce mechanical friction in the joint. They act as a cushion between bone and another part of the joint, such as tendons or muscles.

Function of each component

The **joint capsule** surrounds the synovial joint. It is attached to the outer layer of the bones forming the joint. It seals the joint and provides stability to the joint.

Synovial fluid:

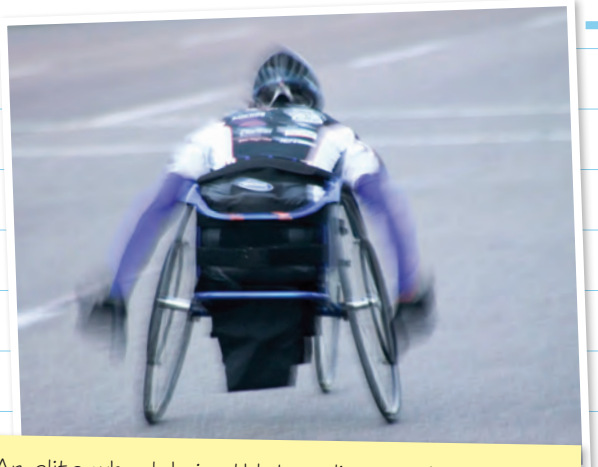
- lubricates and reduces friction in the joint
- supplies nutrients to the joint
- removes waste products from the joint.

Muscles and tendons

Muscles and tendons are part of the muscular system rather than the skeletal system. They are included on the joint diagram to show they must be present at a joint. Otherwise, there would be no way to move the bones at the joint. The tendon attaches the muscle to the bone and the muscle contracts to bring about movement.

Applied to sporting techniques

The components of the joint aim to keep the joint healthy so that it can continue to function, and you can continue to play sport. The role of the articular cartilage is to protect the bones from wearing out. The bone will be at increased risk of wearing the more you use it. For example, think of the potential wear on the articulating bones at the knee of elite long distance runners who run up to 135 miles in training. Or the importance of the ligaments to maintain the stability of the joint in contact sports such as rugby. The importance of synovial fluid to transport nutrients and lubricate the elbow, (reducing friction at the joint), wrist and shoulder joints of the elite wheelchair athlete who completes 10 miles of road distance training each morning, and sprint training later the same day, is another good example to think about.



An elite wheelchair athlete relies on the components of the elbow joint to maintain its health, so they can continue to put additional stress on it to allow them to train and compete.

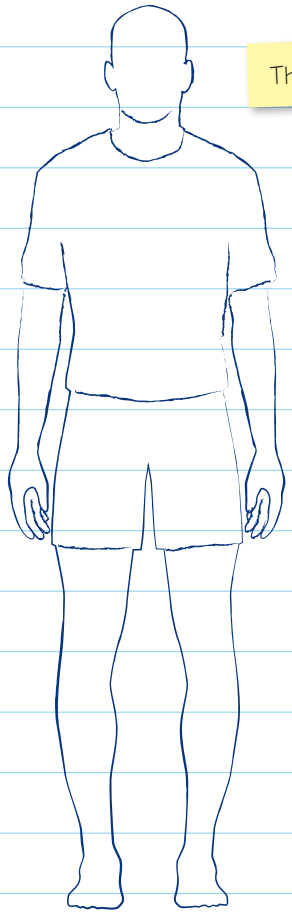
Now try this

How would the bursa aid sporting performance in contact activities such as wrestling or judo?

Had a look ☐ Nearly there ☐ Nailed it! ☐

Anatomical position

You need to know about the ranges of movement possible at joints. When describing any movement, it helps to consider the anatomical position. All ranges of movement start at, or return to, this position.

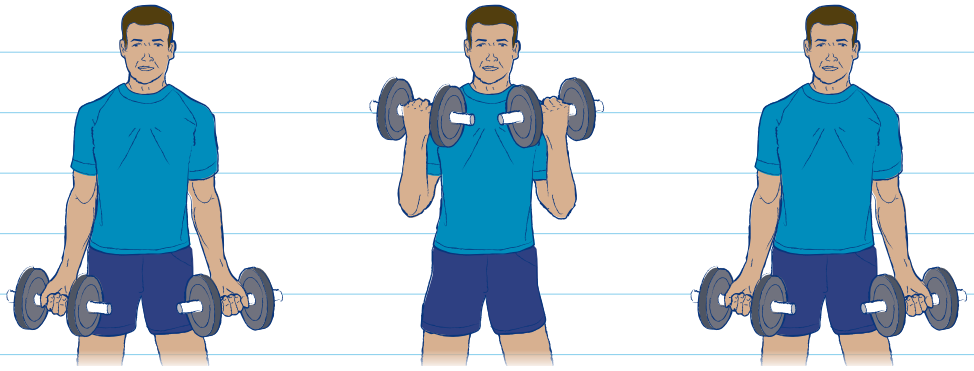


The anatomical position

Flexion, extension

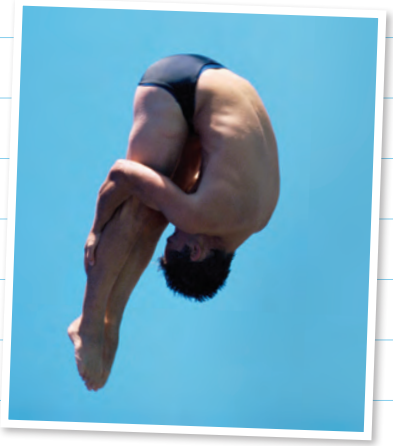
Flexion means reducing the angle of the bones forming the joint (for example, during a bicep curl there is flexion at the elbow to lift or curl the weights). To lower the weights there is extension at the elbow. This means the angle between the bones at the joint increases and the arm is returned to the anatomical position.

Each range of movement has an 'opposite' to allow the limb to move from the anatomical position and then back towards it.



Plantarflexion and dorsiflexion

This range of movement only occurs at the ankle. During dorsiflexion at the ankle the toes are pulled nearer to the lower leg. To move back to the anatomical position, the ankle plantarflexes. The ankle can plantarflex beyond the anatomical position, such as when pointing the toes in a trampolining routine.



The footballer uses dorsiflexion at the ankle to help control the ball, whilst the diver uses plantarflexion to produce a better dive.

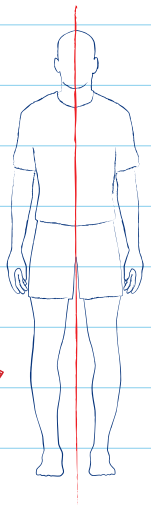
Now try this

Name **three** other movements in sport or physical activity that use flexion and extension.

Abduction and adduction

Abduction

Think of a vertical line passing directly through the body from top to bottom. This is known as the midline of the body. A sideways (lateral) movement of the arms at the shoulder, or a sideways movement of the legs at the hip away from the midline is called abduction.



The midline of the anatomical position

The volleyball player is abducting the arm at the shoulder in preparation to serve as he takes the arm sideways away from the body. He is also abducting the leg at the hip as the limb moves away, sideways, from the anatomical position and the midline of the body.

Adduction

Adduction means bringing the bone at the joint closer to the midline of the body, such as returning to a standing position after a martial art kick out to the side of the body, or the recovery phase of the breaststroke leg action.

The gymnast has adducted the legs at the hip to move to a handstand position on the pommel horse.

Horizontal abduction and adduction

Where the word horizontal is added, it simply gives more detail about the movement taking place. Horizontal means from side to side at shoulder height, so **horizontal abduction** means movement away from the midline of the body but horizontally (parallel to the floor) rather than vertically. For instance, when taking a racket back in the preparatory phase of playing a forehand shot in tennis. Horizontal adduction can occur at the hip and the shoulder.

Horizontal adduction occurs at the shoulder as the tennis player moves the arm forward to play the shot. Note how the elbow is facing downwards.

Now try this

(a) What is the difference between adduction and abduction?

(b) Use an example to explain how horizontal abduction differs from abduction.

If someone is abducted they are kidnapped or taken away. Use this meaning of the word to remind you what the range of movement is.

Other ranges of movement

These are the remaining ranges of movement you need to know and recognise when used in sporting actions.

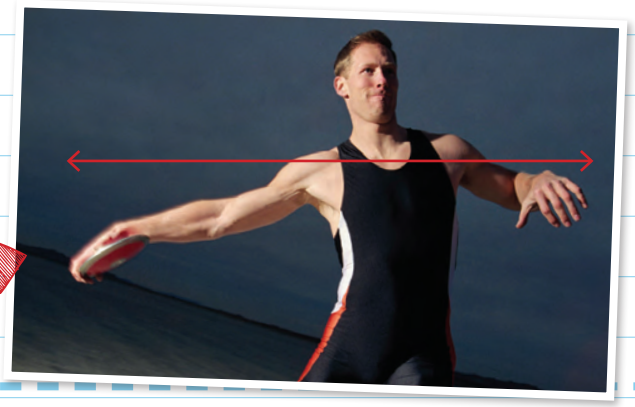
Horizontal flexion at the shoulder

This is a very similar movement to horizontal adduction **except** the elbows face out to the sides (forcing the palms to face downwards) as the arms are moved to the midline of the body horizontally. For instance, as a discus thrower brings the arm through to release the discus.

Links Go to page 9 to revise horizontal abduction and horizontal adduction.

Horizontal extension at the shoulder

Lateral movement away from the midline of the body horizontally, moving the upper arm away from the chest with elbows at the side. The difference between this movement and horizontal abduction is the position of the upper arm – if the elbow is turned out, it is horizontal extension.



The discus thrower has horizontally extended the arm at the shoulder in preparation to throw the discus. Note the elbow is out to the side.

Hyperextension of the spine

Extension of the spine is movement back to the anatomical position. Hyperextension is a continuation of this movement so that the neck moves further away from the chest (cervical vertebrae) or the spine moves away from the pelvis (thoracic and lumbar vertebrae).

Hyperextension of the spine

Lateral flexion of the spine

This is movement away from the midline of the body so the spine moves from side to side. This can occur at the:

- cervical vertebrae, such as moving the neck sideways towards the shoulder as part of a warm-up routine
- thoracic and lumbar vertebrae, such as moving the upper body sideways towards the pelvis when performing a cartwheel.

Circumduction

This is a conical movement. That is, when circumduction occurs at the shoulder the hand will describe a circle, such as the butterfly arm action as the arms leave the water the hands complete a circular action.

Circumduction can occur at the shoulder, wrist, hip and ankle.

Rotation

This is a circular movement that occurs when the bone at the joint turns around an axis. For example, at the elbow and wrist when playing a topspin forehand drive in tennis, or the rotation at the hip during a golf drive.

Now try this

How can you recognise the difference between horizontal flexion and horizontal adduction?

Responses and adaptations

You need to know the short-term responses of the skeletal system to exercise and the resulting long-term adaptions if regular exercise is carried out.

Responses

These are the **immediate, short-term** ways that the skeletal system reacts when you exercise. The reactions are **short lived**. In other words, when you stop exercising the skeletal system has no need to continue to react in this way and therefore stops.

Responses of the skeletal system to exercise

- Stimulates increase of mineral uptake (calcium) within the bones.
- Stimulates production of collagen due to increased stress on bones as a result of exercise.

Responses of the skeletal system to exercise within the joint

Increased range of movement due to:

- reduction in viscosity of the synovial fluid
- increased pliability of the ligaments.

Increased production of synovial fluid to ensure the articular cartilage does not dry out.

Viscosity – how thick liquid is

Adaptations

These are the **long-term** ways that the skeletal system changes due to regular training. These changes are lasting, provided you do not stop **regular** training. In other words, when you stop exercising, the skeletal system does not immediately change back to how it was before the exercise session.

Adaptations of the skeletal system

- Increased bone density and strength due to increased mineral content and bone cell activity make the bones less susceptible to fractures or breaks.
- Increased ligament strength reduce the risk of dislocation at a joint.
- Increased thickness of articular cartilage protects the ends of the bones from wear and tear.

These adaptations reduce the risk of injury making it possible to continue to train or train harder, provided there is adequate rest built in to the programme.

Regular weight-bearing or weight-training exercise makes the areas of the skeleton that are working work harder as they work against gravity, increasing bone strength.

Links Go to page 2 to revise bone cells and bone growth.

Now try this

Use an example to explain why a warm-up is important to the skeletal system before a hockey match.

When answering a question, make sure you pay attention to the question context and tailor your answer to this, rather than just giving a general response.

Additional factors

You need to understand the potential positive impact of exercise on limiting skeletal disease and the importance to bone growth of waiting until the skeleton has sufficiently matured before taking part in resistance training.

Arthritis

This is a common disease of the skeleton and can affect people of all ages. There are two common types:

- osteoarthritis – mainly develops in those over 40, but can occur at any age
- rheumatoid arthritis – normally develops between the ages of 40–50; women are more susceptible than men to this condition.

However, exercise can delay these conditions by helping the individual maintain a healthy weight and healthy joints.

Types of arthritis

Osteoarthritis causes the articular cartilage to thin, which will cause pain and lack of mobility at the joint. This would make it difficult to continue to exercise.

Rheumatoid arthritis causes inflammation of the joints so they become painful and swollen. The synovial membrane of the joint becomes inflamed, due to a build-up of fluid. Although the inflammation can reduce, the joint capsule has been stretched making the joint less stable. Pain at the joint and, later, the increased risk of deformity at the joint will make activity difficult.

Osteoporosis

This is a reduction in bone density. It can be caused by a lack of calcium, vitamin D and a sedentary lifestyle.

The reduction in bone mass makes the bones more brittle, with increased risk of fracturing a bone from even a minor bump or fall.

Benefits of regular exercise

Higher levels of weight-bearing physical activity can reduce age-related bone loss by putting gentle stress on the bones; not too much that they fracture, but enough so that new bone growth is encouraged.

Links Go to page 2 to revise bone growth.

Strength training

Whilst strength training can be appropriate for all ages, young children should not engage in weight lifting as it can negatively affect bone growth.

Now try this

(a) Why is arthritis likely to stop you from playing sport?
(b) How can exercise improve bone health?
(c) Why shouldn't young children take part in weight training?

Read every question carefully. Part (c) is about weight training; this is different from strength training.

Muscle types

You need to know the characteristics and functions of the three muscle types and their relevance to sport and physical activity.

1 Cardiac muscle

Location:

- only found in the walls of the heart.

Function:

- to circulate blood through and out of the heart.

Characteristics:

- unconsciously controlled by the nervous system
- myogenic (has a set rhythm of contraction)
- does not fatigue.

Relevance to sport

The heart keeps the blood circulating, picking up oxygen from the lungs and dropping off waste products. At rest, approximately 5 litres of blood is pumped out of the heart per minute. When we exercise, we have a much greater demand for oxygen and so need to circulate more blood. The cardiac muscle of the heart achieves this by contracting at a quicker rate. Elite endurance athletes can circulate more than 30 litres of blood a minute during exercise. The heart ensures increased oxygen delivery to allow the performer to continue.

2 Skeletal muscle

Location:

- attached to the bones of the skeletal system.

Function:

- movement plus support and posture.

Characteristics:

- consciously controlled
- contract by impulse from brain
- muscle fibres work together in motor units.

Relevance to sport

Without skeletal muscle we would be unable to move our skeleton and therefore unable to participate in sport.

Skeletal muscle is responsible for large body movements such as running, but also precision movements such as a short putt in golf or releasing an arrow in archery.

3 Smooth muscle

Location:

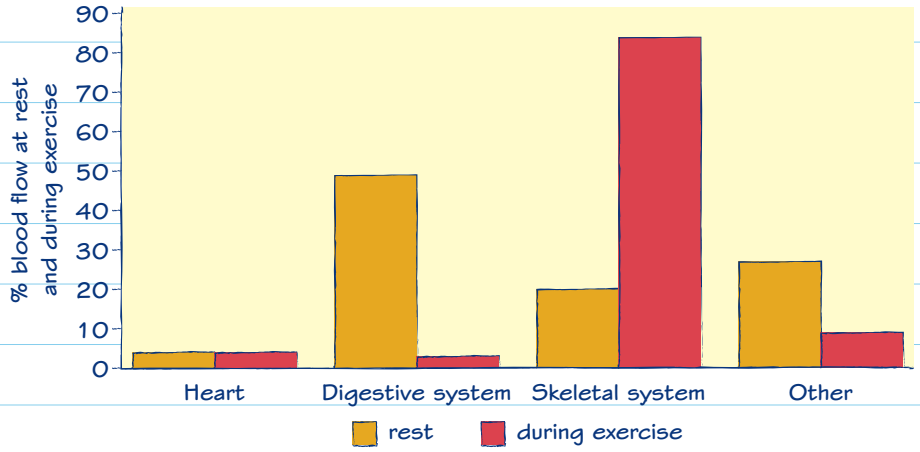
- found in the walls of hollow organs, such as in the digestive and circulatory system.

Function:

- controls body functions, such as movement of food through the body, the passage of urine from the bladder and the movement of blood through the circulatory system.

Characteristics:

- unconsciously controlled by the nervous system.



During exercise, the smooth muscle in the blood vessels can restrict or increase blood flow through the blood vessel so that more blood carrying oxygen can go to the skeletal muscle. Therefore performers get the oxygen their muscles need whilst exercising.

Now try this

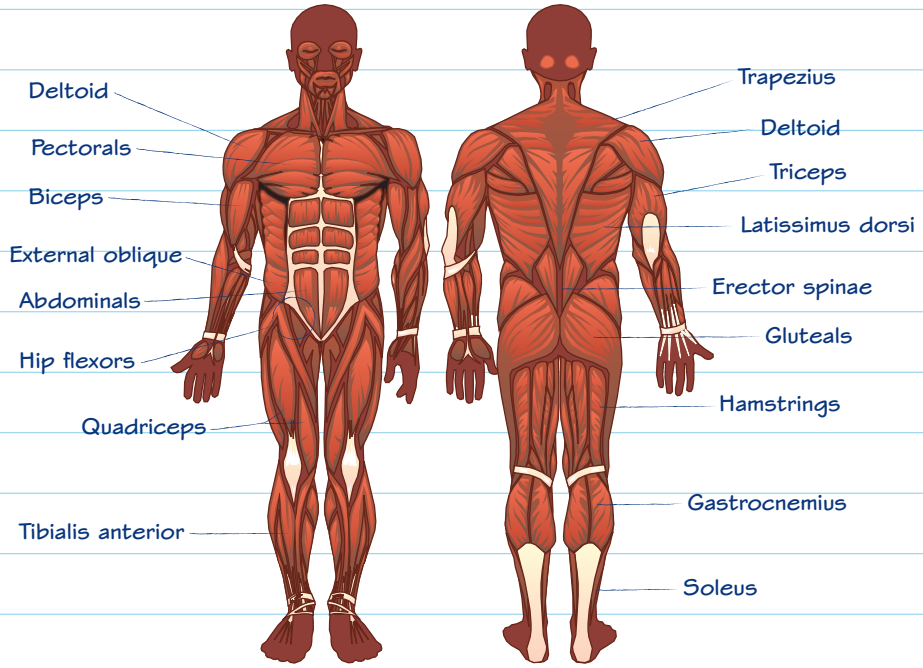
How does each muscle type aid performance?

Make sure you know about each muscle type.

Had a look ☐ Nearly there ☐ Nailed it! ☐

The muscular system

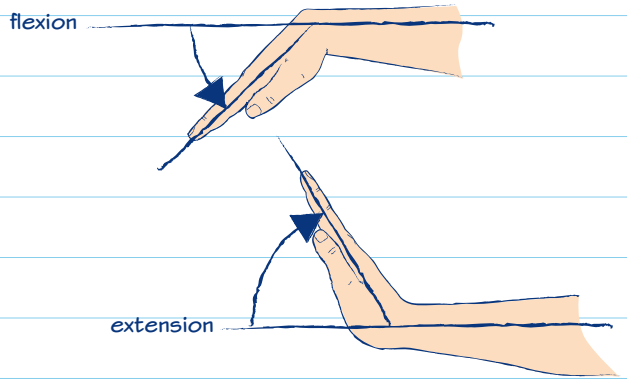
You need to know the names and locations of the major skeletal muscles.



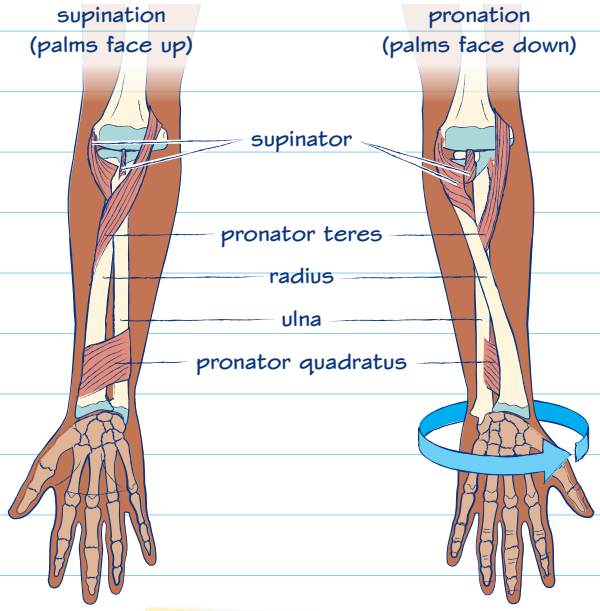
The names and locations of the major skeletal muscles

Movement of the hand at the wrist

Many different muscles control the movement of the wrist. Some are grouped together based on their action. You need to know the collective names of these muscle groups.



Wrist flexors and **wrist extensors** are responsible for flexing and extending the wrist.



Supinators turn the palm upwards.
Pronators turn the palm face down.

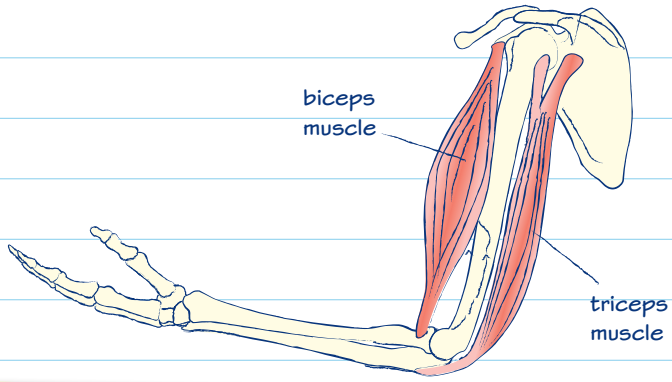
Now try this

What is the collective name given to the muscles that enable a cricketer to 'cup' their hands (palms up) to catch a ball?

Antagonistic muscle pairs

Muscles work together to bring about movement by taking on different roles, depending on the movement required. You need to know the roles of the muscles and their combined use in a variety of sporting actions.

Muscles work in **antagonistic pairs**. When one muscle in the pair is contracting, the other muscle is relaxing. This is so the full range of movement can be achieved at a joint. The contracting muscle is called the **agonist**, and the relaxing muscle, the **antagonist**. When the movement at the joint needs to be reversed the muscles switch roles, the agonist becomes the antagonist, the antagonist becomes the agonist.



The antagonist (triceps) must relax to allow the agonist (biceps) to contract and flex the arm at the elbow. When the arm needs to extend at the elbow, the bicep becomes the antagonist and relaxes, allowing the tricep (now the agonist) to contract.

Synergists

A **synergist** cooperates with the agonist in two ways:

1. Supporting its action by neutralising any undesired action at the joint so that the force generated by the agonist works to bring about the desired action. For example, the latissimus dorsi acts as a synergist for the pectorals when the upper arm is adducted at the shoulder.
2. Assisting the agonist muscle to perform the desired type of movement. For example, the soleus acts as a synergist to the gastrocnemius in dorsiflexion of the ankle.

Fixators

Fixators are muscles that stabilise a joint by eliminating unwanted movement. For example, some of the muscles at the ankle work to stabilise the joint as we stand so that we can balance effectively. During a biceps curl the trapezius will stabilise the movement by preventing the scapula from moving.

The anterior and posterior deltoids work antagonistically to adduct and abduct the arm at the shoulder.

The quadriceps and the hamstrings work antagonistically to allow flexion and extension of the leg at the knee.

The hip flexors and gluteals work antagonistically to allow flexion and extension of the hip.

The tibialis anterior and the gastrocnemius work antagonistically to allow the foot to move from dorsiflexion to plantarflexion.

Now try this

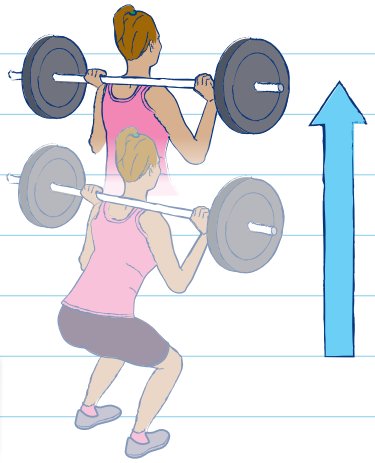
Review the muscles shown on page 14. Identify **five** different antagonistic muscle pairs.

Muscle contraction

You need to know about three different types of muscle contractions. When a muscle contracts, it is working: it is either supporting or moving a load or resistance, or is static under tension.

Concentric contraction

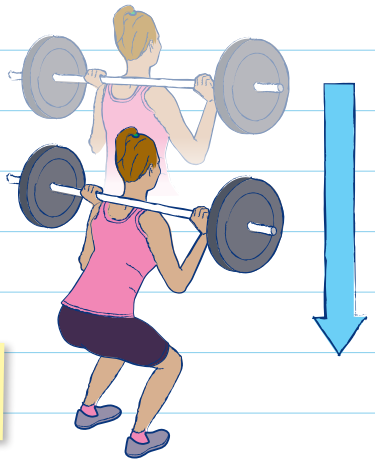
When a muscle contracts and **shortens** it is called a concentric contraction. Concentric contractions are common in power sports or sports where you need explosive force. They cause movement at the joint as the force exerted by the muscle is greater than the resistance. For example, when serving a ball in tennis, the triceps contracts and shortens when you extend the arm to bring the racket through quickly to add pace to the ball.



The quadriceps contract concentrically during the **upward** phase of the squat.

Eccentric contraction

When a muscle contracts it can also **lengthen** under a load or tension. This is often when the muscle is working against gravity, trying to control a movement. For example, running down hill or when lowering the body in a press-up the triceps muscle is still working hard to control the rate of descent so that the body doesn't fall to the floor. In this example, the triceps are contracting but lengthening; therefore they are working eccentrically.



The quadriceps contract eccentrically during the **downward** phase of the squat.

Isometric contraction

When a muscle works isometrically there is little or **no movement** in the muscle or joint. The muscle doesn't shorten or lengthen. For instance, when holding the 'set' position at a sprint start or when weightlifters hold the weights still above their heads for a qualifying lift in the clean and jerk. The muscles are working but there is no movement.

Gymnasts rely on isometric muscle contractions to maintain strength positions on the rings. Their muscles are working but are not shortening or lengthening.

Now try this

Give an example of an exercise activity or technique that would use each type of muscle contraction.
Give **one** example for each type of muscle contraction.

Fibre types

You need to know about the different muscle fibre types and their recruitment for a range of exercises and sports.

All or none law

The muscular system works with the nervous system to bring about muscle contraction. Impulses are sent to the muscle via **motor neurones** (nerves). The motor neurone is attached to a number of muscle fibres in the muscle. Together, these are called a **motor unit**. The muscle fibres within a motor unit will be of the same type. When the motor neurone receives the signal to contract, **all** the muscle fibres attached to that neurone will contract (all or none law). The force the muscle produces is altered by adjusting the number of motor units stimulated to contract.

Type I (slow twitch)

Characteristics:

- utilise the aerobic energy system due to dense capillary network and high levels of myoglobin
- contract slowly
- exert the least amount of force of the fibre types
- have the highest resistance to fatigue; allowing the muscles to continue to contract for long periods of time.

Type I fibres are ideal for endurance activities, such as long distance running.

Links Go to page 35 to revise energy systems.

Type IIa (fast twitch)

Although these are classified as fast twitch fibres, they can develop type I characteristics through endurance training. Therefore, they can utilise either aerobic or anaerobic energy systems depending on the training the performer undertakes. Type IIa fibres have a greater resistance to fatigue than type IIx fibres, but less resistance than type I. They can produce a medium force of contraction. They are ideal for middle distance events.

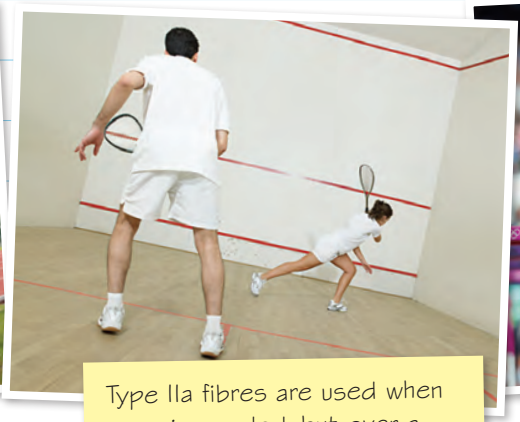
Type IIx (fast twitch, formerly type IIb)

Characteristics:

- utilise the anaerobic energy system
- produce a strong force of contraction
- consist of larger motor neurones
- the motor units normally have more muscle fibres in them compared to slow twitch motor units
- the muscle fibres tend to be larger and thicker than other fibre types.

These fibre types are ideal for power activities, such as sprinting.

Type I fibres are used in marathon running



Type IIa fibres are used when pace is needed, but over a sustained period of time, such as in squash.

Type IIx fibres are used to generate force to achieve a greater height.

Now try this

How does having a range of muscle fibre types allow 10 000 m runners to perform well in their sport?

Responses

You need to know these five short-term responses of the muscular system to exercise.

Responses

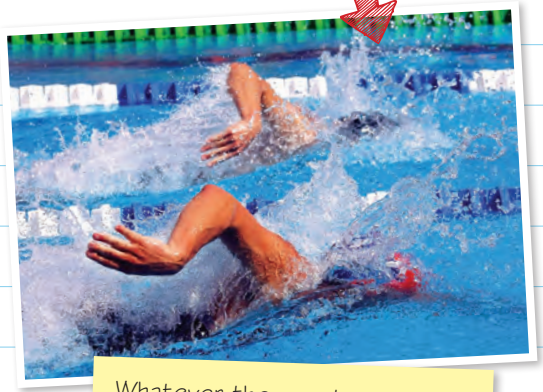
These are the **immediate, short-term** ways that the muscular system reacts when you exercise. The reactions are **short lived**. When you stop exercising, the muscular system has no need to continue to react to exercise, and therefore stops and slowly recovers back to its pre-exercise state.

1 Increased blood supply

During exercise there is an increased need for oxygen to be transported to the working muscles so that energy production is high enough. Oxygen is carried via the red blood cells. The blood supply to the muscles increases by a process called **vascular shunting**. The lumen of the arterioles in the muscles **vasodilates**, to allow an increased passage of blood to the muscles, whilst the arterioles in areas such as the digestive system **vasoconstrict** to reduce blood flow.

Links Go to page 32 to revise redistribution of blood flow.

Vascular shunting provides the oxygen for exercise.



Whatever the sport, exercise will cause temporary changes to the muscular system.

2 Increased muscle temperature

When we exercise heat is given off as a by-product of energy production. The more intense the level of exercise, the greater the heat produced.

3 Increased muscle pliability

As muscle temperature increases with exercise the muscle becomes more pliable. It has more 'give' so reduces the chance of injury.

4 Lactate accumulation

Lactate is a by-product of energy production. If enough oxygen is available lactate can be broken down as it is produced. However, as exercise intensity increases lactate builds in the muscles as it is being produced faster than it can be broken down due to insufficient oxygen.

5 Microtears

Each muscle is made up of bundles of muscle fibres. Each muscle fibre is made up of bundles of myofibrils. As a result of resistance exercise these myofibrils can sustain microscopic tears, which will need time to repair before exercising the muscle again. These microtears are thought to be the reason for delayed onset of muscle soreness (DOMS).

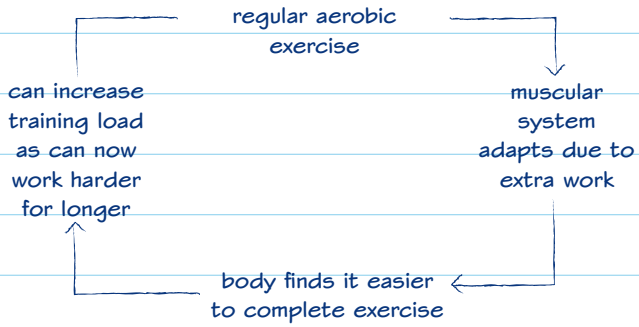
Now try this

Jermaine is a middle distance runner and Jill is a weightlifter. How would their muscular systems respond to exercise?

Aerobic adaptations

You need to know the **long-term** changes to the muscular system due to regular aerobic training. These changes are lasting, provided you do not stop **regular** aerobic training.

Regular aerobic training includes activities that involve the use of large muscle groups, for example jogging, swimming, cycling, dancing and cross-country skiing.



As the muscular system adapts, the aerobic training load can be increased.

Mitochondria

Mitochondria are found in the muscle cells and, with the use of oxygen, generate energy. Regular aerobic training increases the size and number of mitochondria. This means that even more energy can be produced aerobically, allowing the performer to sustain exercise for longer.

Improved use of energy sources

Greater amounts of energy can be released to the muscles for physical work due to increased:

- activity of enzymes that break down our food
- use of glycogen
- use of fat
- stores of glycogen
- stores of triglycerides.

Increased myoglobin content

Myoglobin is similar to haemoglobin, but rather than in the blood it is found in the muscle cells. Its job is to act as an oxygen store in the muscle. With more myoglobin, more oxygen can be transported to the mitochondria, improving aerobic energy production.

Function of adaptations

Most of these adaptations increase the muscles' ability to produce and utilise energy aerobically, in other words, the adaptations allow the performer to work harder, for longer, improving their performance in aerobic, endurance-based activities.

Links You can revise energy systems on page 35.

Now try this

Becky is often substituted in the final quarter when she plays netball. Explain **one** way aerobic training could reduce the likelihood of Becky being substituted in a netball match.

Anaerobic adaptations

You need to know these five **long-term** changes to the muscular system. These changes are lasting, provided you do not stop **regular** anaerobic training.

Anaerobic training

Adaptations as a result of anaerobic training will target the fast twitch muscle fibres:

- type IIa
- type IIx.

This is because these will be the fibres being used to complete the training. Slow twitch muscle fibres would remain unchanged.

Muscle hypertrophy of fast twitch fibres can be brought about by resistance training using heavy loads and few repetitions.

Links You can revise fast twitch fibres on page 17.

1 Hypertrophy of fast twitch muscle fibres

As the muscle is stressed during exercise, microtears form in the myofibrils. This stimulates specialised muscle cells called satellite cells to multiply and to fuse with the existing myofibril, helping to repair the damage. As these cells fuse to the existing cells the fibre increases in size rather than generating new fibres. The increased size of the muscle means it becomes stronger and able to apply greater force.

2 Increased tendon strength

As the muscles become larger and stronger, the tendons that attach the muscle to the bone also have to adapt so that they can manage the increased force of the contraction of the larger muscle, otherwise the player will become injured. This is achieved by an increase in collagen, adding to the existing collagen fibres that make up the tendon.

3 Increased tolerance to lactate

Lactate threshold is the point at which lactate starts to accumulate in the blood – the moment that the body switches from working aerobically to anaerobically. Therefore, the longer you can remain under this threshold the longer you can use the aerobic energy system. Anaerobic training at about 85 to 90 per cent of maximum heart rate for 30 minutes will improve your body's ability to tolerate lactic acid / lactate (enhancing aerobic performance).

4 Increased energy stores

Increased levels within the muscles of:

- ATP
- PC.

ATP is our way of storing small amounts of energy in the muscle so that it can contract when we need it to. We can break down PC to rebuild ATP once it has been used. By increasing the stores of these, we increase the muscles' ability to work quickly.

5 Improved use of energy sources

The muscles get better at breaking down glycogen (even without oxygen) so they can exercise at a high intensity for longer. This is helped by their ability to **buffer** (neutralise) lactic acid more effectively.

Note the references to energy. The muscular and energy systems work together; the training causes adaptations to both of these systems.

Now try this

Igor uses interval training to improve his time in the 200 metres sprint. Explain **one** way Igor's muscle adaptations to this type of training could help him increase his speed.