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Physical Education

REVISION GUIDE

For the 9–1 exams

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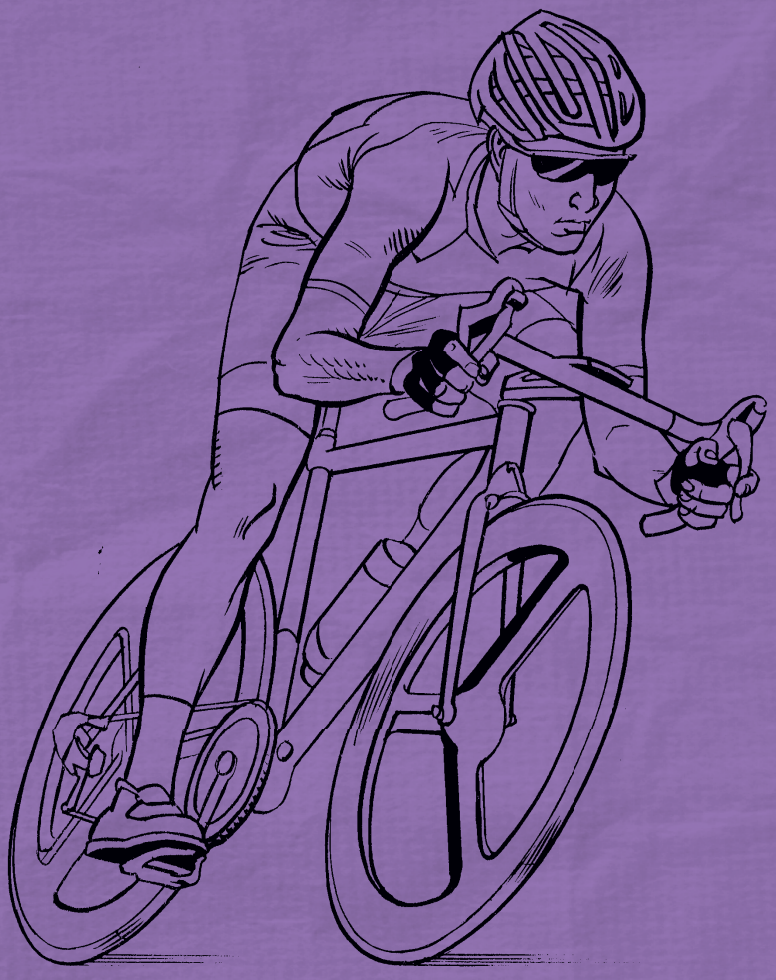

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REVISE AQA GCSE (9–1) Physical Education

REVISION GUIDE

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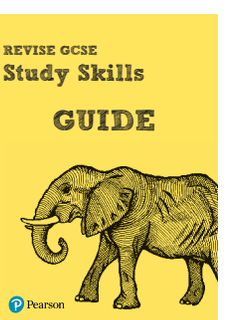

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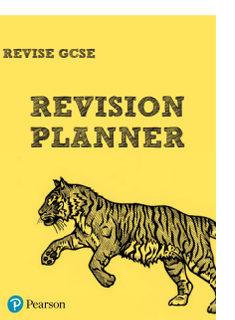

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Contents

1-to-1 page match with the AQA Physical Education Revision Workbook
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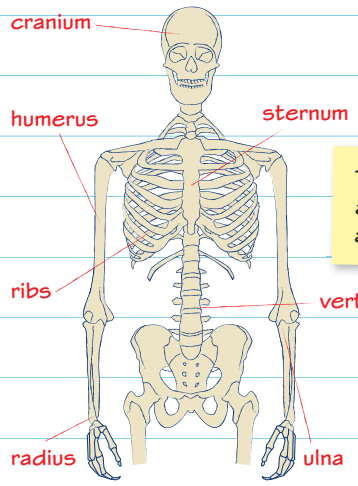
Pearson publishes Sample Assessment Material and the Specification on its website. This is the official content and this book should be used in conjunction with it. The questions and revision tasks in this book have been written to help you revise the skills you may need for your assessment. Remember: the real assessment may not look like this.

Many of the key terms used in this book are explained in a subject-specific vocabulary on page 118.

Bones of the skeleton

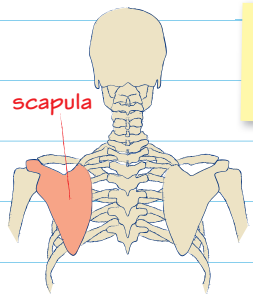
The **skeleton** is made up of many bones. Make sure you know the names of the bones at these locations: head/neck, shoulder, chest, elbow, hip, knee and ankle, and that you can recognise these bones on a variety of diagrams.

Front view of upper skeleton



The humerus, radius and ulna are located at the elbow joint.

Rear view of upper skeleton



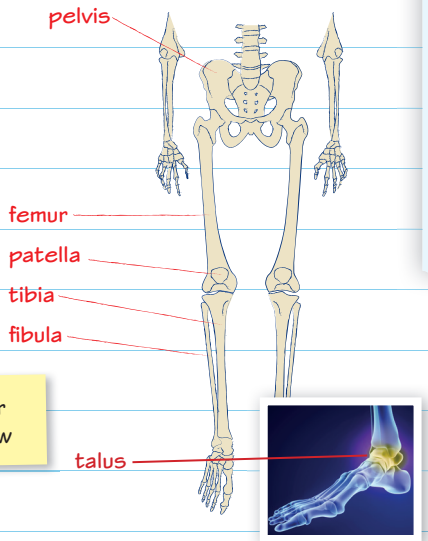
The humerus and the scapula are located at the shoulder joint.

Golden rule

A good way to remember the names and locations of the bones is to practise by labelling blank diagrams of the skeleton.

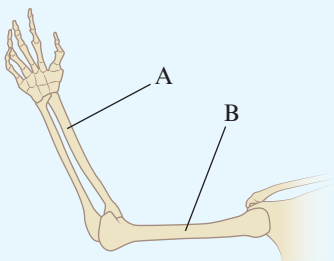
Front view of lower skeleton

- The pelvis and femur are located at the hip joint.
- The femur and the tibia meet at the knee joint and the patella sits in front of the joint.
- The tibia, fibula and talus are located at the ankle joint.



Bones of the lower skeleton, front view

Worked example



Identify the bones at A and B. **(2 marks)**

A: Radius

B: Humerus

Sometimes it is hard to remember which bone is the radius and which is the ulna. Remember: the radius is the bone that is near the thumb.

Now try this

The knee joint makes it possible for the rugby player to run during the game. State **two** bones located at the knee joint that allow the player in **Figure 1** to run. **(2 marks)**

Figure 1

Had a look ☐ Nearly there ☐ Nailed it! ☐

Structure of the skeleton

We classify bones by their shape. Each bone type or classification has a particular function. You need to know the classification type of each bone and its function, and to be able to explain the use of each in physical activity.

Identifying bones

The skeleton:

- provides a framework for muscle attachment
- works together with the muscular system to enable movement at joints.

When muscles contract they pull on the bone, creating movement.

A joint is a place where two or more bones meet. Different types of joints allow different types of movements.

The shape and type of the bone determines the amount of movement that occurs at each joint.

Remember to look at the shape of the bone, to help identify what type of bone it is.

Long bones

Long bones enable gross movement by working as levers.

Examples of long bones are:

- the humerus
- the femur.

Long bones work as a lever to increase the pace of the ball when kicked.

Short bones

Short bones:

- are as wide as they are long
- allow finer, controlled movements.

Examples of short bones include:

- the carpals (in the wrist)
- the tarsals (in the ankle).

Flat bones

Flat bones provide protection of vital organs and a broad surface for muscles to attach to.

Examples of flat bones include:

- the cranium
- the ribs
- the scapula.

Example of use:

- The cranium protects the brain if hit by a cricket ball.

Worked example

Which **type** of bone is the ulna? **(1 mark)**

A Flat bone ○

B Long bone ●

C Irregular bone ○

D Short bone ○

If you are not sure, think about where the ulna is. Then think: does it look similar to any bones you know the classification of? Remember that bones are classified by shape; so if it is the same shape as a bone you *do* know, go for that option.

Now try this

Explain how the bone type at the cranium makes it possible for the player in **Figure 1** to head the ball. **(3 marks)**

Make sure you identify the bone type you are explaining.

Figure 1

Functions of the skeleton

You need to know the functions of the skeleton and how they apply to physical activity and sport.

Key functions

The functions of the skeleton are:

- support
- production of blood cells
- storage of minerals
- protection of vital organs
- structural shape and muscle attachment
- formation of joints for movement.

You need to be able to explain how the skeleton carries out all of these functions by giving examples of each in relation to physical activity.

Blood cell production

The following types of blood cell are produced in bone marrow. They are all beneficial to physical performance.

- Platelets help clotting if you are cut.
- Red blood cells transport oxygen to working muscles.
- White blood cells help fight infection.

Mineral storage

Calcium and phosphorus are stored in bones to help strengthen them.

Support

Your skeleton provides support by providing a structural shape for muscles and tissues to attach to. This keeps the muscles in place and gives you your shape.

Protection

Your skeleton provides protection for your vital organs, including the heart.

For example, your skull protects your brain if an opponent follows through wildly with their hockey stick and it hits you on the head during a game.

Aid to movement

- The bones provide a place for the muscles to **attach** to, so that when the muscles contract they **pull** the bones to cause movement. Movement occurs at the **joints** of the skeleton.
- Bones also act as **levers**. Levers allow the body to increase the force it can generate or increase the speed of the movement. For example, a tennis player with longer levers will generate more force on a serve.

Worked example

Which of the following options is correct to complete the sentence below? **(1 mark)**

The skeletal system protects:

A vital organs, for example, bones, muscles, tendons ○

B by providing a hard structure over the organ needing protection ●

C by providing a structure for support ○

D by producing red blood cells which fight disease ○

Now try this

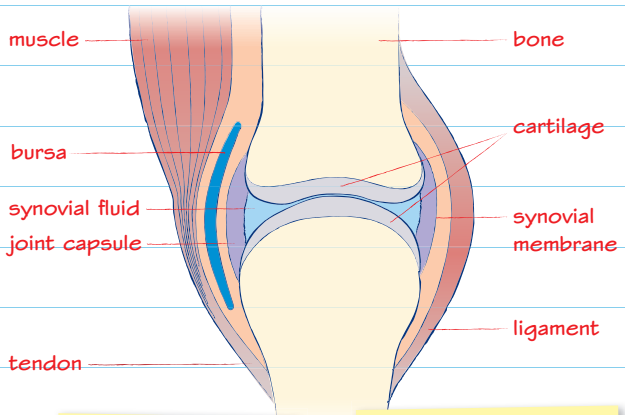
The skeletal system has several functions. Describe how the skeleton aids movement. **(2 marks)**

Had a look ☐ Nearly there ☐ Nailed it! ☐

Structure of a synovial joint

You need to be able to identify the structures that make up a **synovial joint**. You also need to explain the function of each of these structures and how they help to prevent injury.

Components of a synovial joint



General structure of a synovial joint

The plural of bursa is bursae.

Function of each component

Cartilage is a shiny, elastic material that:

- reduces friction
- absorbs shock.

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

The **joint capsule** surrounds the synovial joint. It is attached to the outer layer of the bones forming the joint. It:

- seals the joint
- provides stability to the joint.

The **synovial membrane** secretes synovial fluid.

Synovial fluid:

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

Bursae are in most major synovial joints. They:

- reduce mechanical friction in the joint
- act as a cushion between the bone and another part of the joint, such as the tendons or muscles.

Summary of injury prevention

The components of a synovial joint:

- ✓ reduce any shock on a joint that can occur during physical activity, by cushioning the joint.

The joint lubrication helps to prevent injury during physical activity by:

- ✓ helping to prevent friction, that is the rubbing together of parts of the joint causing wear and tear
- ✓ supporting the removal of tiny particles of waste that could otherwise cause damage to the joint.

Think about the function of the structure labelled A. What is its job? Then think how this structure helps to prevent injury.

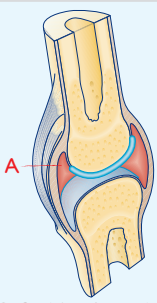
Worked example

1 (a) Identify the structure labelled A. **(1 mark)**

Synovial fluid

(b) Explain how this structure helps to prevent injury. **(2 marks)**

The synovial fluid reduces friction in the joint and therefore stops the wear and tear on the performer's cartilage.



Now try this

How would the bursae aid sporting performance in contact activities such as wrestling or judo? **(3 marks)**

Types of freely movable joints

You need to be able to identify two types of freely moveable joints at their various locations in the body. You also need to know the bones located at each of these joints.

Pages 5–8 contain the content for **3.1.2.1: Analysis of basic movements in sporting examples.**

About joints

- A joint is the place where two or more bones meet. It is where movement can occur.
- Although there are many joints in the human body, you only need to know the joints on this page.
- You should be able to see the similarities between the same types of joints.
- You should be able to give sporting examples of the use of each joint.

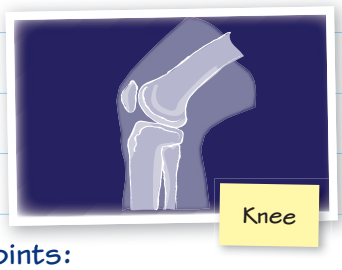
Golden rule

Remember it is the formation of the joint that dictates the type of movement that can occur there.

Hinge joints

Located at the:

- knee
- elbow
- ankle.



Movement at hinge joints:

- flexion
- extension

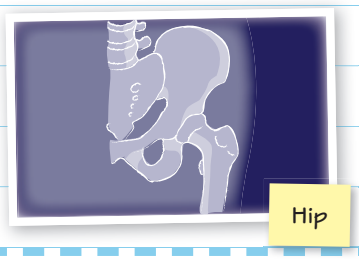
Ball and socket joints

Located at the:

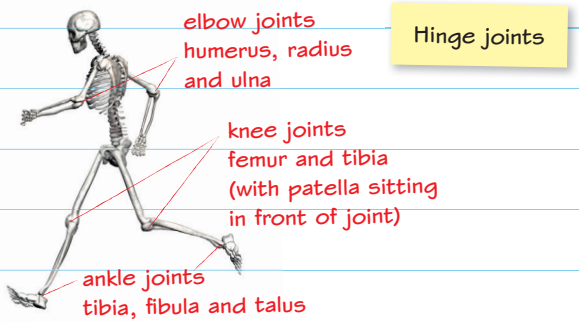
- hip
- shoulder.

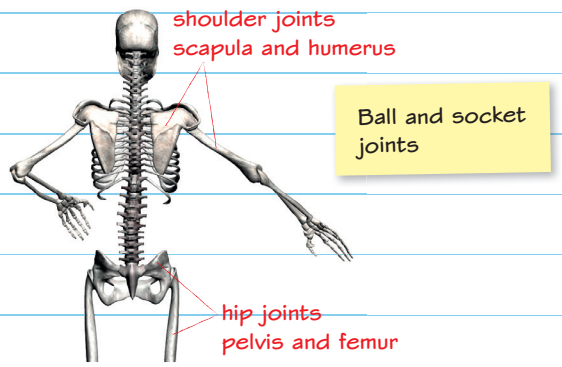
Movement at ball and socket joints:

- flexion
- extension
- rotation
- abduction
- adduction



Identification of joints





Worked example

If you are not sure, use your own body to try to work it out.

Identify the type of movement possible at **both** hinge and ball and socket joints. **(1 mark)**

A Adduction ○
B Rotation ○
C Flexion ●
D Abduction ○

Now try this

What type of joint is formed at the shoulder? **(1 mark)**

A Ball and socket ○
B Ball joint ○
C Dovetail ○
D Hinge ○

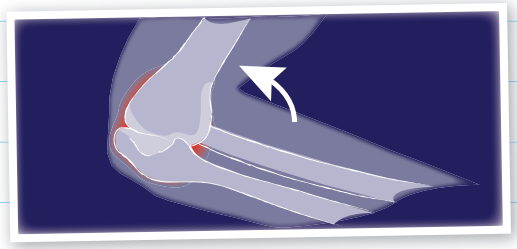
Had a look ☐ Nearly there ☐ Nailed it! ☐

Movement at joints 1

You need to know the different types of movement that are linked to the joint types and be able to apply these movements to specific sporting actions. Pages 5–8 contain the content for 3.1.2.1: Analysis of basic movements in sporting examples.

Joint action: flexion

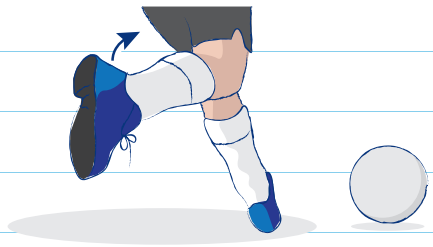
Flexion is the term given when the angle at a joint **decreases**.



This happens when the bones forming the joint move closer together.

Joint type and application

Flexion occurs at hinge and ball and socket joints.

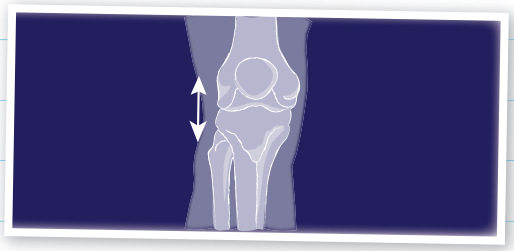


For example, it occurs at the knee when the player is preparing to kick a football.

The lower part of your leg gets closer to the upper part of your leg as the angle at the joint decreases.

Joint action: extension

Extension is the term given when the angle at a joint **increases**.

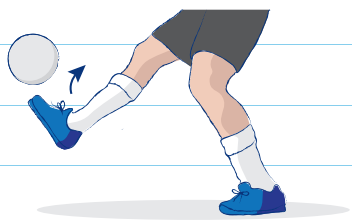


This happens when the bones forming the joint move away from each other.

Flexion and extension occur at the shoulder, elbow, hip and knee.

Joint type and application

Extension occurs at hinge and ball and socket joints.



For example, it occurs at the knee when following through after kicking a football.

The lower part of your leg gets further away from the upper part of your leg as the angle at the joint increases.

Worked example

State the main range of movement possible at the knee joint. **(1 mark)**

The range of movement at the knee joint is flexion to extension.

Flexion and extension could be written in any order but you do need to include both. If a question asks for the range of movement at a joint, you need to put down both parts because the range is the whole movement covered.

Now try this

Identify the joint action necessary to bend the batting (right) arm at the elbow to move into the position shown in **Figure 1**. **(1 mark)**

Figure 1

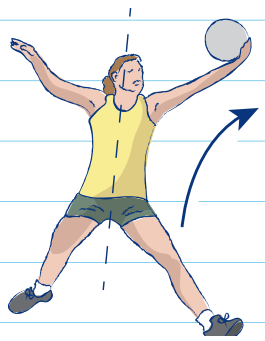
This question asks for the joint action. Watch out for the different terms and make sure you are not confusing joint action with joint type or muscle action.

Movement at joints 2

This page covers the joint actions of abduction, adduction and rotation, which occur at ball and socket joints. Knowledge of these joint actions will allow you to analyse basic movements in sport. Pages 5–8 contain the content for **3.1.2.1: Analysis of basic movements in sporting examples.**

Joint actions

Abduction = the movement of a limb **away** from the midline of the body



Adduction = the movement of a limb towards the midline of the body

Rotation = when the bone at a joint moves around its own **axis**, so making a circular movement

Rotation allows for the biggest range of movement, for example, from when the fingers enter the water all the way round until they enter the water again.

Joint type and application

Abduction occurs at ball and socket joints (hip and shoulder).

For example, there is abduction at the shoulder when reaching out sideways to intercept a netball.

To help you remember:
If something is 'abducted', it is taken away.

Adduction occurs at ball and socket joints (hip and shoulder).

For example, adduction occurs at the hip in the cross-over leg action when throwing a javelin. The leg comes back towards the midline of the body.

To help you remember:
Adduction starts with 'add', so it is when a limb is added to the midline of the body.

Rotation occurs at ball and socket joints (hip and shoulder).

For example, it occurs at the shoulder when swimming front crawl. The arm rotates around in a circular motion.

Worked example

Use the image as a guide – it will have been included to help you.

Which of the following is the correct term for the joint action that occurs when the ski jumper takes their arms away from the midline of the body to achieve the position shown in **Figure 1**? **(1 mark)**

A Abduction ●
B Adduction ○
C Flexion ○
D Extension ○

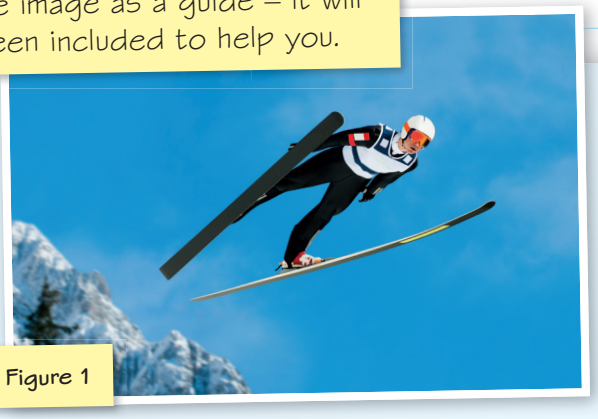


Figure 1

Now try this

The word 'range' means you need to include both the start and finish movement for the action identified.

Identify the range of movement at the shoulder during a star jump. **(1 mark)**

Had a look ☐ Nearly there ☐ Nailed it! ☐

Movement at joints 3

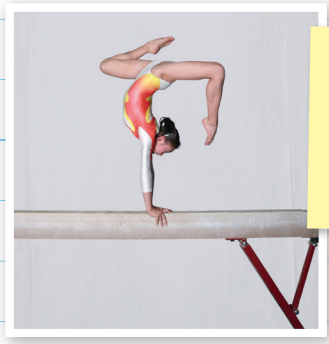
In addition to the joint actions on pages 6–7, there are two other joint actions you need to know: plantar flexion and dorsiflexion. These movements only occur at the hinge joint at the ankle. Pages 5–8 contain the content for **3.1.2.1: Analysis of basic movements in sporting examples.**

Joint action: plantar flexion

- Occurs at the ankle joint.
- Movement of the foot downwards away from the front of the ankle.

For example, plantar flexion occurs when:

- kicking a football with the laces of a boot
- a gymnast points their toes.



Plantar flexion of the ankle occurs as the gymnast points her toes to make the shape more aesthetically pleasing.

Joint action: dorsiflexion

- Occurs at the ankle joint.
- Movement of the foot upwards towards the shin (decreasing the angle at the joint).

Dorsiflexion occurs at the ankle of the leading leg as the athlete jumps the hurdle.

Worked example

State the name of the joint type where plantar flexion takes place and give an example of its use. **(2 marks)**

Hinge joint. Pointing the toes so you can kick a football with the laces of the boot.

Make sure you read the question carefully. This question is asking for the name of a **joint type**, not the name of a **joint**.

Golden rule

Always try to apply your answers to examples in physical activity.

Now try this

Briefly explain how the joint action at the ankle in **Figure 1** shown assists the volleyball player in their sport. **(2 marks)**

The joint action has not been named, so it would be a good idea to name it and then explain how it might help.

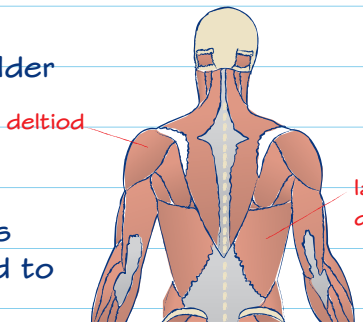
Figure 1

Muscles

You need to know the role of tendons and the names of the muscles identified on pages 9–13, as well as being able to recognise these muscles on a variety of diagrams. These muscles are attached to the bones located at the joints identified on page 5. Turn to page 1 for more on bones and page 5 for more on joints.

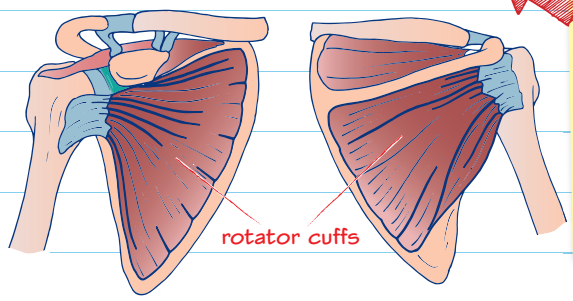
Muscles of the shoulder and back

Name: **Deltoid**
Location: Top of the shoulder
Role: Abducts the arm at the shoulder
Example: Lifting your arms above your head to block the ball in volleyball



Name: **Latissimus dorsi**
Location: Side of back
Role: Adducts the upper arm at the shoulder / rotates the humerus
Example: Bringing arms back to side during a straight jump in trampolining

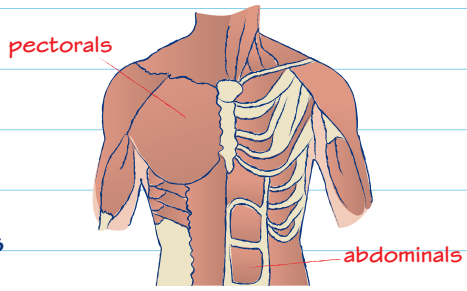
Name: **Rotator cuffs**
Location: On the scapula in the shoulder
Role: Rotation of shoulder
Example: Bowling in cricket



The deltoids and latissimus dorsi work as an **antagonistic pair** to raise and lower the arm at the shoulder. Antagonistic pairs are explained on page 10.

Muscles of the chest and abdomen

Name: **Pectorals**
Location: Front of upper chest
Role: Adducts the arm at the shoulder
Example: Follow-through from a forehand drive in tennis



Name: **Abdominals**
Location: Front of body between pelvis and ribs
Role: Flexion of trunk
Example: Sit-ups

Worked example

Which one of the following muscles is contracting to allow the tennis player in **Figure 1** to adduct his arm at the shoulder?
(1 mark)

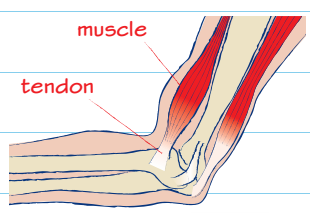
A Triceps ○
B Latissimus dorsi ○
C Abdominals ○
D Pectorals ●

Figure 1

Tendons

The role of the tendons is to join (skeletal) **muscle to bone**. Tendons are formed of a tough connective tissue.

Tendons are relevant to sport and physical activity because they hold the muscle to the bone – when the muscle contracts it pulls on the bone causing movement at joints.



Tendons join muscles to bones.

Now try this

Name the movement that occurs when the deltoids contract **and** give an example of its use in a physical activity of your choice.
(2 marks)

Had a look ☐ Nearly there ☐ Nailed it! ☐

Antagonistic pairs: biceps and triceps

Antagonistic pairs of muscles create opposing movement at joints. You need to know the **four** different pairs covered on the following pages and relate them to sporting techniques.

Antagonistic pairs

Skeletal muscles work together to provide movement of the joints.

While one muscle **contracts**, another **relaxes** to create movement.

Muscles working together like this are called **antagonistic pairs**.

The muscle contracting is the **agonist** (prime mover).

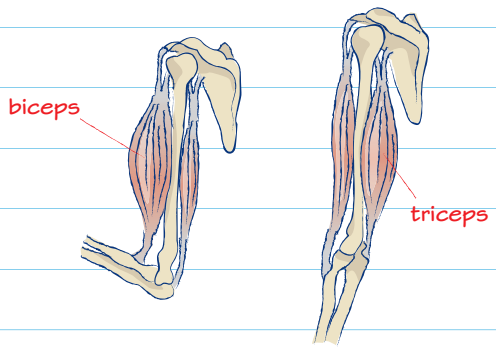
The muscle relaxing is the **antagonist**.

Remember, muscles are connected to bones via tendons. When the muscles contract, they pull on the tendon which pulls on the bone. This creates the movement.

Biceps and triceps

These two muscles are an example of an antagonistic muscle pair.

Name:	**Biceps**
Location:	Front of upper arm
Role:	Flexion of the arm at the elbow
Example:	Upwards phase of a biceps curl



Name:	**Triceps**
Location:	Back of upper arm
Role:	Extension of the arm at the elbow
Example:	Straightening the arms in a chest press

During this part of the movement, the triceps is the antagonist – it is relaxing to allow the biceps to contract.

During this movement, the biceps is the antagonist – it is relaxing to allow the triceps to contract.

Worked example

Explain the term 'antagonistic pair' in relation to muscle movement. **(1 mark)**

One muscle contracts while the other relaxes to bring about movement.

EXAM ALERT!

Explain the role of **each** muscle in the antagonistic pair.

Now try this

Complete the blanks by identifying the muscles involved in the movement described, as shown in **Figure 1**. **(2 marks)**

The ..... is the agonist when the goalkeeper extends her arm at the elbow and the ..... is the antagonist.

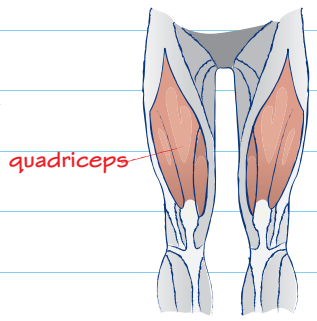
Figure 1

Antagonistic pairs: quadriceps and hamstrings

You need to know which muscles work together to bring about movement and use this knowledge to analyse sporting actions.

The quadriceps and hamstrings are an antagonistic muscle pair.

Name:	**Quadriceps**
Location:	Front of upper leg
Role:	Extension of the leg at the knee
Example:	Straightening the leading leg going over a hurdle



During this part of the movement the hamstrings act as the antagonist. They are relaxing to allow the quadriceps to contract.

Name:	**Hamstrings**
Location:	Back of upper leg
Role:	Flexion of the leg at the knee
Example:	Bending the trailing leg going over a hurdle

During this part of the movement the quadriceps is the antagonist. It is relaxing to allow the hamstrings to contract.

The quadriceps and hamstrings work together so the performer can clear the hurdle.

Golden rules

- ✓ If you are not sure of the correct spelling of muscle names, write them like they sound.
- ✓ Always write the name in full, for example, quadriceps, not quads.

Worked example

Which one of the following muscles is contracting to allow the cyclist in **Figure 1** to flex her leg at the knee? **(1 mark)**

A Latissimus dorsi ○

B Hamstrings ●

☐ **C** Gastrocnemius ○

☐ **D** Quadriceps ○

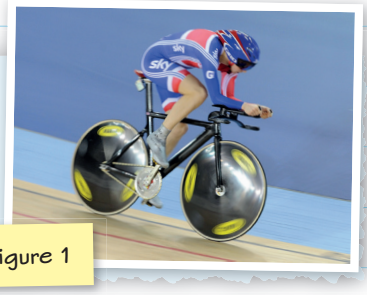


Figure 1

EXAM ALERT!

Make sure you know the actions of the muscles. Questions often have a picture to help you visualise the movement.

Now try this

Name the antagonist that is relaxing to allow the cyclist in the image above to flex her leg at the knee. **(1 mark)**

Had a look ☐ Nearly there ☐ Nailed it! ☐

Antagonistic pairs: gastrocnemius and tibialis anterior

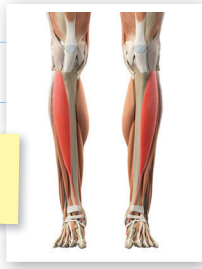
Make sure you know the names and locations of these muscles and can give an example of their use.

Name: **Gastrocnemius**
Location: Back of lower leg
Role: Plantar flexion at the ankle

The **gastrocnemius** muscles are highlighted.

Example: Pointing the toes when performing a pike jump in trampolining

Name: **Tibialis anterior**
Location: Front of lower leg
Role: Dorsiflexion at the ankle



The **tibialis anterior** muscles are highlighted.

Example: Bringing the toes up towards the shins when extending the legs in the long jump

Golden rule

Always use the correct name for the gastrocnemius, not the calf. Also remember it has a 'C' sound in it (gast-ro-C-nemius).

Which action is plantar flexion?

To help you recall which action is plantar flexion, remember:

Pointing toes starts with the letter **P** and so does the action **p**lantar flexion.

Where is the tibialis anterior?

To help you recall where the tibialis anterior muscle is located, remember:

- the word 'anterior' means front
- the word 'tibialis' starts with the name of the bone – the tibia
- the muscle is located on the front of the tibia.

Worked example

What term is being described below? **(1 mark)**
When two muscles work together, one muscle starts to contract to pull the bone, the other starts to relax to aid the movement.

Antagonistic pair

Golden rule

When asked to give an example, always use the most obvious example to make sure it is correct, rather than giving a more obscure answer.

Now try this

Double check whether a question is asking for the agonist or the antagonist.

Name the antagonist supporting the agonist to allow the gymnast in **Figure 1** to point his toes. **(1 mark)**

Figure 1

Antagonistic pairs: hip flexors and gluteals

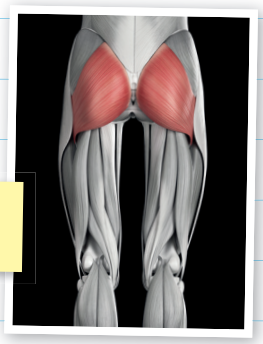
Make sure you know the names and locations of these muscles and can give an example of their use.

Name: **Hip flexors**
Location: Very top of front of upper leg
Role: Flexion of leg at the hip

The **hip flexor** muscles are highlighted.

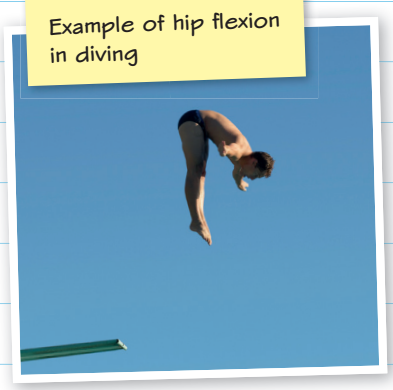
Example: Bringing the legs up in a seat-drop in trampolining

Name: **Gluteals**
Location: Buttocks
Role: Extension of the leg at the hip



The **gluteals** muscles are highlighted.

Example: Lifting the leg back at the hip when running



Example of hip flexion in diving

Golden rules

Notice the words **flexion** and **extension** are used for the action at the hip as well as the knee. The same rules apply.

- ✓ Flexion occurs when the angle at the joint gets smaller.
- ✓ Extension occurs when the angle at the joint gets bigger.

Example of hip extension in basketball

Worked example

Note that the question refers to the hip, not the knee, and asks about extension rather than flexion.

Which **one** of the following muscles is contracting to allow the footballer in **Figure 1** to extend her leg at the hip? **(1 mark)**

A Gluteals ●
B Hamstrings ○
C Abdominals ○
D Quadriceps ○

Figure 1

Now try this

Name the agonist that brings the thighs up to the chest in a tuck jump and identify the joint action occurring at the hip. **(2 marks)**

Had a look ☐ Nearly there ☐ Nailed it! ☐

Muscle contractions

You need to know the different types of muscle contraction – **isotonic** and **isometric** – as well as the difference between concentric and eccentric isotonic muscle contractions.

Any physical activity requires movement. All movement is achieved through working the muscles by contracting them. The muscles also need to work to hold the body in a stationary pose.

Muscle contraction

There are two different types of muscle contraction, used for different purposes. You need to know the terms for them and be able to explain the two types.

- **Isotonic** muscle contractions are those that result in movement.
- **Isometric** muscle contractions are where the muscles contract but there is no visible movement.

Always use a stationary example for isometric contractions, and include the word 'stationary'. For example: 'The stationary phase of a rugby scrum is an example of an isometric muscle contraction.'

Examples of muscle contractions

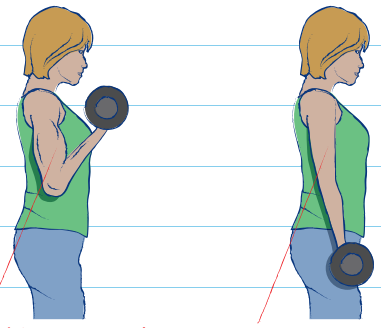
Isotonic contractions provide movement of the limbs.

Isometric contractions hold the whole body in balance and there is no movement.

The difference between concentric and eccentric isotonic contractions

During **isotonic** muscle contractions the type of contraction is either concentric or eccentric.

- **Concentric muscle contraction** is when the muscle shortens during the contraction. Example: biceps muscle contracting to lift a weight during a biceps curl activity.
- **Eccentric muscle contraction** is when the muscle lengthens during the contraction. Example: biceps muscle contracting to lower and control the weight during a biceps curl activity.



the biceps muscle shortens as the weight is raised

the biceps muscle lengthens as the weight is lowered

Concentric and eccentric muscle contractions during the upward and downward phases of a biceps curl

Worked example

The gymnast in **Figure 1** is holding a position on the rings. What type of muscle contraction is taking place to allow the gymnast to hold this position? **(2 marks)**

Isometric muscle contraction

Figure 1

Now try this

Using an example, describe the difference between eccentric and concentric muscle contractions. **(3 marks)**

The pathway of air

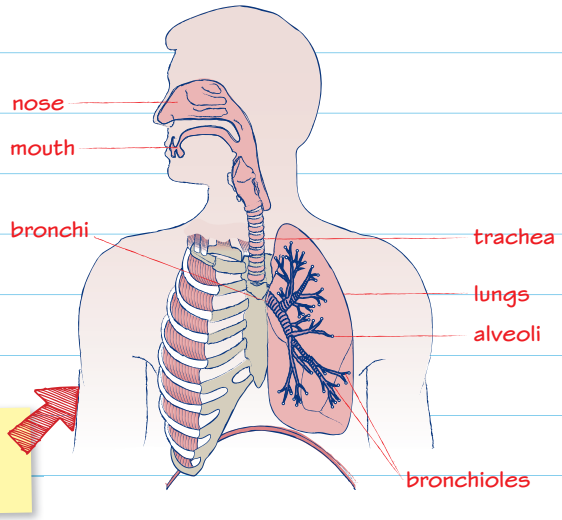
You need to be able to identify several of the structures used in the pathway of air from outside the body to the **alveoli** in the lungs. The actual mechanics of breathing is covered on page 21.

The pathway of air

- Enters the body through the **mouth** and **nose**.
- Then travels down through the **trachea** to the **lungs**.

The trachea

Rings of cartilage surround the trachea. These help the trachea to keep its shape and prevent collapse, so allowing the air to pass through to the lungs.



Structures used in pathway of air

Lungs

- There are two lungs (left and right).
- The lungs allow the movement of air in and out of the body (ventilation).
- Air enters the lungs during inspiration (the process of breathing in).
- Air leaves the lungs during expiration (the process of breathing out).

Bronchi and bronchioles

- The air travels to each of the lungs via the **bronchi** – the term for both the left and right bronchus that take air to each of the lungs.
- The passages that the air travels down get smaller as the bronchi subdivide. The smaller airways from the bronchi are called **bronchioles**.
- Bronchioles branch out throughout the lungs and carry the air from the bronchi to the **alveoli**.

Worked example

Which one of these describes the correct pathway of air? **(1 mark)**

A mouth; nose; trachea; bronchioles; alveoli; lungs ⬭

B nose; mouth; lungs; trachea; bronchi; alveoli ⬭

C mouth; trachea; bronchi; alveoli; bronchioles; lungs ⬭

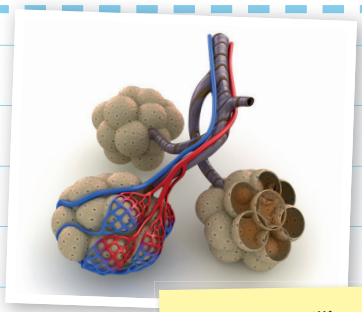
D nose; trachea; bronchi; lungs; bronchioles; alveoli ⬬

Discount the clearly incorrect responses first. Diffusion of oxygen from air takes place in the alveoli. This means the alveoli must be the final part of the pathway, so the answer must be either B or D.

Alveoli

- The alveoli are tiny air sacs.
- They are attached to the branches of the bronchioles throughout the lungs.
- At the alveoli the exchange of oxygen and carbon dioxide occurs.

See page 16 for more on the alveoli.



There are millions of alveoli in the lungs.

Now try this

Describe the pathway of air through the respiratory system from the trachea to the alveoli. **(3 marks)**

Gaseous exchange

You need to know the features that assist with gaseous exchange, including the structure of the alveoli, and how the gases are transported within the blood.

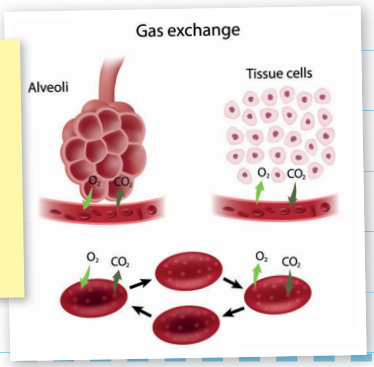
Gaseous exchange

Gases always move from high to low areas of concentration.

- Oxygen diffuses into the bloodstream from the alveoli in the lungs.
- The oxygen then binds (joins) with the **haemoglobin** in the red blood cells, to form oxyhaemoglobin.
- Oxyhaemoglobin is transported to the working muscles, where it is needed for aerobic activity.
- Carbon dioxide produced in the tissue is transported away from the muscles by the haemoglobin.

Golden rule

Remember: gaseous exchange is the exchange of one gas for another gas. It is NOT turning one gas into another.



Gas exchange occurs between the alveoli and the capillaries, and between the capillaries and the muscle tissue.

Features that assist in gaseous exchange

- The alveoli are tiny air sacs with moist, thin walls (only one-cell thick).
- The combined surface area of the alveoli is very large, allowing plenty of opportunity for gases to pass through.
- There are lots of capillaries very close to the alveoli, so there is only a short distance for the gases to diffuse through (short diffusion pathway) and a large blood supply.

Gas exchange – alveoli to capillaries

- The alveoli have a high oxygen concentration.
- The capillaries surrounding the alveoli have a low concentration of oxygen.
- Oxygen moves from high concentration to low, through the thin walls of the alveoli and capillaries. In this way the capillaries gain oxygen to transport around the body.

Gas exchange – capillaries to alveoli

The reverse happens with the movement of carbon dioxide.

- Capillaries surrounding the alveoli have a high pressure/concentration of CO_2 (from muscles).
- Alveoli have a low pressure/concentration of CO_2.
- Movement of CO_2 from high pressure to low.
- CO_2 is moved out of the blood into the alveoli to be breathed out.

Exercise intensities

Gas exchange varies with the intensity of exercise.

- ✓ **During aerobic activity** there is an increase in breathing rate and an increase in gas exchange to meet the demands of the working muscles for more oxygen.
- ✓ **After anaerobic activity** there is an elevated breathing rate, allowing greater gas exchange to aid recovery.

Worked example

Explain one reason why carbon dioxide can diffuse from a capillary to the alveoli. **(2 marks)**

There will be high levels of carbon dioxide in the capillaries and lower levels in the alveoli, therefore the carbon dioxide will move from high pressure in the capillaries to the alveoli to try to even out the concentration of CO_2.

Now try this

(a) What will the concentration of oxygen in the blood be just after it leaves the alveoli?

(b) Give a reason for your answer to (a). **(2 marks)**

Blood vessels

You need to know both the structure and function of the blood vessels and how this is relevant in terms of **blood pressure**, carrying oxygenated blood and deoxygenated blood, and gas exchange. Turn to page 16 for more on gaseous exchange, for more on the redistribution of blood during exercise turn to page 18, revise the names of the arteries and veins around the heart on page 19.

Arteries

Structure

- Thick muscular and elastic walls
- Small internal diameter (lumen)

Functions

- Carry blood at high pressure **away** from the heart
- Mainly carry **oxygenated** blood (exception: pulmonary artery carries **deoxygenated** blood to lungs from heart)

Relevance

Blood pressure increases during exercise as the working muscles demand more oxygen, increasing blood flow. The muscles in the artery walls contract and relax automatically. When the muscle relaxes, the arteries dilate so there is more room for the blood to travel through, helping regulate blood pressure.

Capillaries

Structure

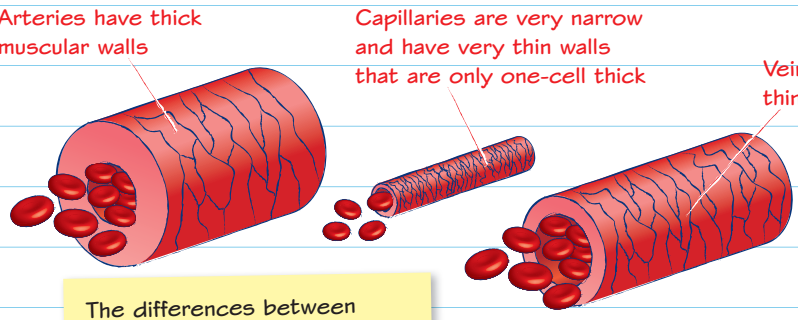
- Very thin walls (only one-cell thick)
- Small internal diameter

Functions

- Link smaller arteries with smaller veins
- Carry blood at very low pressure

Relevance

Capillaries allow **gaseous exchange**. Walls are very thin to allow gases and nutrients to pass through them, therefore getting oxygen to the muscles and removing carbon dioxide.



The differences between arteries, capillaries and veins

Golden rule

Remember: all arteries carry blood **away** from the heart and all veins carry blood **towards** the heart.

Veins

Structure

- Thin walls
- Contain valves
- Large internal diameter

Functions

- Carry blood at low pressure **towards** heart
- Mainly carry **deoxygenated** blood (exception: pulmonary vein carries **oxygenated** blood from lungs to heart)

Relevance

Veins carry deoxygenated blood from the muscles. The wide internal diameter allows blood to pass through more easily and the valves help return the blood to the heart by preventing backflow due to low pressure.

Worked example

Which one of the following is a characteristic of capillaries? **(1 mark)**

A Has valves ○
B Thick muscular wall ○
C One-cell thick ●
D Carries blood under high pressure ○

Think about the function of capillaries. The capillaries need to be thin to allow the gases to move in and out of them easily.

Now try this

State the type of blood vessel that holds blood at high pressure. **(1 mark)**

Had a look ☐ Nearly there ☐ Nailed it! ☐

Redistribution of blood

You need to know the role of the blood vessels in the redistribution of blood during exercise and be able to use the terms **vasoconstriction** and **vasodilation**.

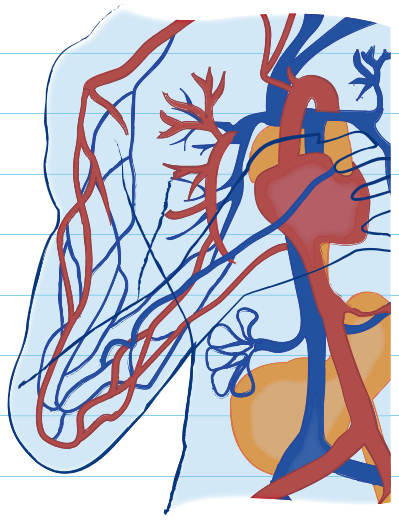
Redistribution of blood flow

When you exercise your working muscles need more oxygen. Oxygen is attached to the red blood cells in the blood and carried to your active muscles.

Your heart rate and stroke volume increase so more blood is circulating every minute. For more on heart rate and stroke volume, turn to page 20.

Blood is diverted away from inactive areas to the working muscles. This is called **redistribution of blood flow**.

Blood can be redistributed away from the stomach. This is why it is important that digestion is complete before exercise begins.



Vasoconstriction

- Vasoconstriction means that the blood vessels are constricted (squeezed) to make them smaller.
- When you start to exercise, chemical changes trigger signals from your nervous system.
- These signals cause the blood vessels that supply the **inactive** areas (for example, the digestive system) to **constrict**, reducing blood flow to these areas.

Vasodilation

- Vasodilation means that the blood vessels are dilated to make them bigger.
- When you start to exercise, chemical changes trigger signals from your nervous system.
- These signals cause the blood vessels that supply the **active** areas (the working muscles) to **dilate**, increasing blood flow to these areas. This means that these muscles receive more oxygen and nutrients.

Worked example

You could use alternative words to 'greater' and 'lower', such as 'more' or 'less', but always re-read your answer to make sure the meaning is clear.

Using the words in the table below, complete the following statements about blood flow while at rest and during physical activity.

unchanged	equal
lower	greater

Blood flow to the digestive system is ..... greater ..... at rest than when exercising. **(1 mark)**

Blood flow to the muscular system is ..... lower ..... at rest than when exercising. **(1 mark)**

Now try this

Using the words in the table below, complete the statements that follow.

redistribution of blood	digestion
cardiac output	increased blood flow

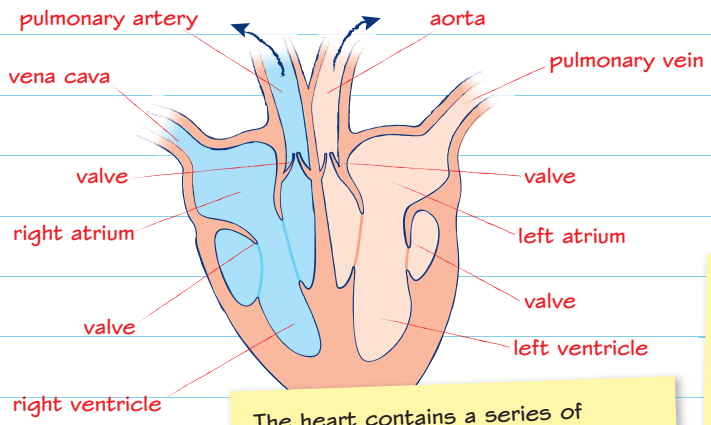
Reduced blood flow to specific areas of the body is achieved through .....

There is a need for ..... to the muscles during exercise. **(2 marks)**

Heart structure and the cardiac cycle

You need to know some of the components that make up the heart and the order of the **cardiac cycle** and pathway of blood, including diastole (filling) and systole (ejection) of the **chambers**.

Structure of the heart



The heart contains a series of chambers, valves and blood vessels.

Golden rule

When looking at a diagram of the heart remember that it is a cross-section, viewed from the front. This is why the right-hand side is actually on the left of the diagram! Imagine your heart to check the sides.

Remember: valves help to keep blood moving forward. They open owing to the pressure of the blood. They shut after the blood has passed through, to prevent **backflow** (the blood flowing back again).

The cardiac cycle

The cardiac cycle is the repeated contraction and relaxation of the heart.

When the heart beats, blood passes through the vessels and chambers in a specific order. Both the right side of the heart and the left side contract and relax at the same time.

There are two phases:

- **Diastole** is when the chamber relaxes and fills with blood.
- **Systole** is when the chamber contracts, ejecting the blood within it.

The pathway of blood

- The **right atrium** contracts (systole) ejecting deoxygenated blood through a valve in to the **right ventricle**: the right ventricle relaxes and fills (diastole) with the **deoxygenated blood**.
- The **right ventricle** then contracts (systole) pushing the deoxygenated blood through valves to the **pulmonary artery**.
- The **pulmonary artery** carries deoxygenated blood **away** from the heart to the lungs to receive oxygen via gas exchange.
- The **pulmonary vein** transports **oxygenated blood** from the lungs to the **left atrium**, which relaxes and fills (diastole).
- The left ventricle then contracts (systole) ejecting the oxygenated blood through valves to the **aorta**.
- The **aorta** is the main artery and carries oxygenated blood away from the **left ventricle** to take oxygen to the working muscles.
- The **vena cava** is the main vein bringing deoxygenated blood back to the **right atrium** so it can be pumped to the lungs to collect oxygen.

Worked example

Explain the function of the pulmonary artery.

(2 marks)

The pulmonary artery carries deoxygenated blood from the heart to the lungs so the blood can get oxygen, which is eventually pumped to the working muscles.

Now try this

Complete the diagram to show the missing components assisting the flow of deoxygenated blood to the lungs.

(2 marks)

vena cava → [ ] → valve → right ventricle → [ ] → pulmonary artery

Cardiac output

You need to know about **cardiac output** and its components (**stroke volume** and **heart rate**). You also need to know how to interpret graphs showing heart rates.

Key terms

Heart rate (HR): the number of times the heart beats per minute.

Stroke volume (SV): the amount of blood ejected from the heart with each beat.

Cardiac output (Q): the amount of blood leaving the heart per minute.

Cardiac output (Q) = SV × HR.

Anticipatory rise: a rise in HR prior to exercise.

Changes in heart rate before and during exercise

Immediately before exercise starts:

- there is an increase in HR (anticipatory rise) due to the release of the hormone **adrenaline**. The body detects this change and increases the HR to increase oxygen delivery in preparation for exercise.

When you start to exercise:

- your muscles demand more oxygen, and the blood transports this oxygen
- to increase delivery of oxygen, cardiac output increases by increasing HR and/or SV.

Interpreting heart rate graphs

A. At rest the HR is at its lowest.

B. Immediately before exercise there is an increase in HR (anticipatory rise).

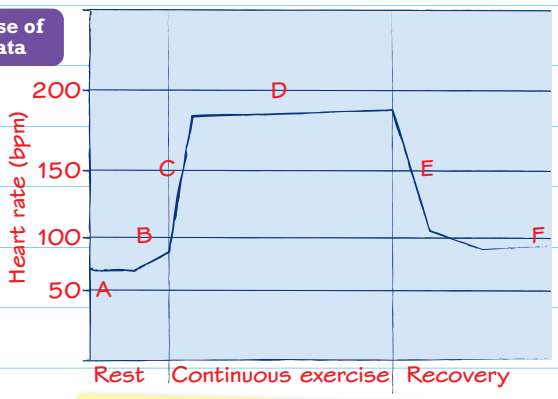
C. At the start of physical activity, as the intensity increases, there is a sharp increase in heart rate.

D. During continuous exercise the HR levels out.

E. Immediately after exercise there is a sharp drop in HR.

F. HR levels out and is slowly returning to resting HR.

Use of data



Resting, working and recovery heart rates, before, during and after exercise

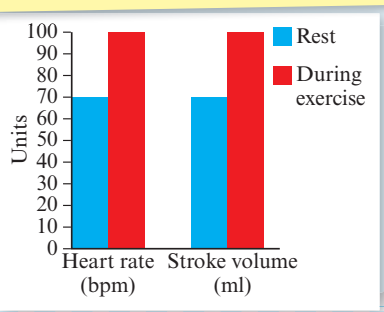
Worked example

Use of data

Use the information you are given: HR × SV = cardiac output

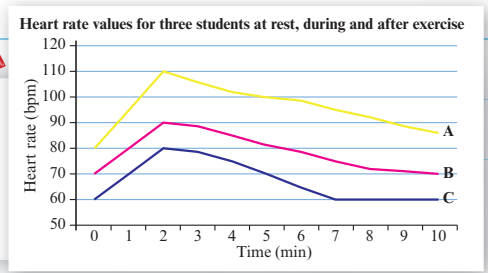
Analyse the graph to determine the effect of exercise on cardiac output. **(3 marks)**

The graph shows an increase in heart rate and stroke volume. As heart rate multiplied by stroke volume equals cardiac output, if they have both increased cardiac output must also increase as a result of exercise.



Now try this

Use the information in the graph to guide you.



(a) Which student had the lowest resting heart rate?

(b) Whose pulse rate increased the most during exercise?

(c) Which student recovered from exercise the quickest? **(3 marks)**