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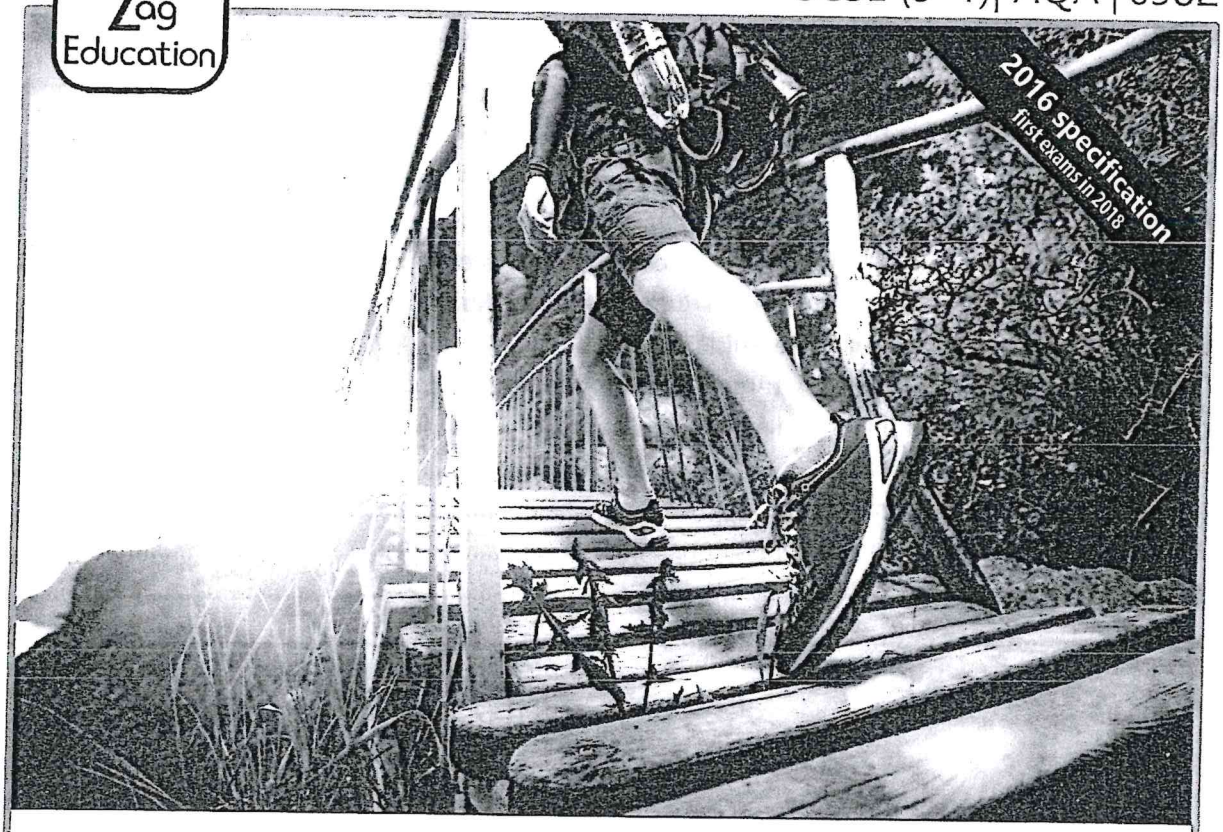

GCSE AQA Revision Guide

Paper 1: The Human Body and Movement in Physical Activity and Sport

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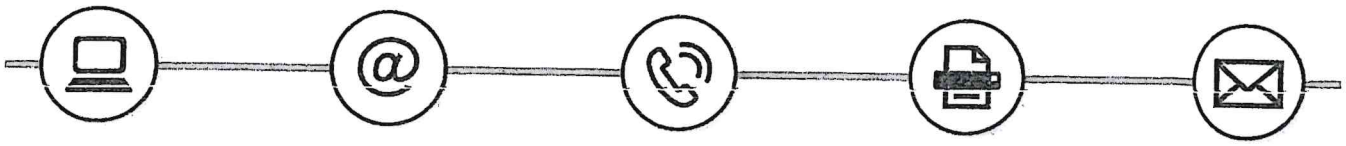

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Teacher's Introduction

This resource has been written to support students' revision for their GCSE AQA Paper 1 exam. Each topic from the specification is covered by concise, student-friendly revision notes and engaging activities in specification order. This resource provides a great opportunity to prepare the students for their examination and will give them the potential to be awarded the full 78 marks available, by covering the full range of the specification. The notes and activities are suitable for self-study and could be handed out to students at the start of their revision period, or after each topic is covered in class. Full answers are included for easy marking.

Remember!
Always check the exam board website for new information, including changes to the specification and sample assessment material.

Each chapter contains:

- A **knowledge checklist**: so students can record their progress and understand exactly what they need to learn for each section.
- **Learning objectives**: to ensure students focus on the correct information and understand the purpose of each chapter.
- Attractively presented and easy to understand **revision notes**, which cover the full specification content concisely.
- **Revision activities**: to support active revision and check students' knowledge and understanding.
- **Exam-style questions**: for students to become accustomed to the exam format and put their knowledge into practice.

By working through each section, the students will develop their understanding and their exam skills, which will allow them to provide evidence of all assessment objectives (AO1–AO3) during their examination.

O Walters, February 2018

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Student's Introduction

Your examination for this unit will involve a 1 hr, 15 min written exam which is worth 78 marks. In order to achieve the full 78 marks, you will need to understand the content covered in this revision guide and also be able to apply your knowledge and demonstrate evidence of the assessment objectives.

During your examination, you will come across a range of questions and it will be important that you understand the type of response that each question requires. Below is a list of the main command words which you can expect to find.

Command word	What you are expected to do
Analyse	Breakdown information and recognise connections
Describe	Give an interpretation of a concept in descriptive words / set out characteristics
Discuss	Provide key points from both sides of an argument / identify an issue through investigation and come to conclusions
Draw	Provide an image or graph
Evaluate	Make a judgement from given information
Explain	Provide a reason for something
Define	State the meaning behind something
Identify	Use information to select important or correct pieces of factual information / name something
Justify	Draw conclusion to the reason for something, using evidence
Label	Identify key points in a graph or image
Outline	Provide a brief description of something
Plot	Add information to a graph by adding data
State	Provide a factual statement in clear terms
Suggest	Propose an idea or concept / provide a solution

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Assessment Objective Checklist

The following table outlines the assessment objectives for your assessment/exam.

- **AO1** – means you can recall information and show knowledge of the important factors in sport and physical activity
- **AO2** – means you can apply your knowledge, information and facts to relevant sporting examples
- **AO3** – analyse and evaluate the factors that underpin performance and involvement in physical activity and sport

Use this table to track your progress and confidence against each assessment objective for each given chapter, and detail what you need to do to achieve this.

CHAPTER	Assessment objective checklist	AO1	AO2	AO3	What you need to do *(add your comments here)*
1 Structure and Functions of the Musculoskeletal System	*I can demonstrate my knowledge of the structure and function of the musculoskeletal system, types of movements and muscle contractions*				
	I can apply types of movement to sporting examples				
	I can discuss how the muscular and skeletal systems work together and analyse the impacts on health, fitness and performance				
2 Structure and Function of the Cardiorespiratory System	*I can demonstrate my knowledge of the cardiorespiratory system including the structure of the heart and lungs, and the muscles used in breathing*				
	I can apply my knowledge of the cardiorespiratory system by explaining how the system changes in response to exercise				
	I can discuss how the cardiovascular and respiratory systems work together at rest and during exercise, and the effects of this on lung volumes and performance				
3 Anaerobic Exercise and Aerobic Exercise	*I can demonstrate my knowledge of types of exercise (aerobic and anaerobic) and recovery in sport*				
	I can apply types of exercise (aerobic and anaerobic) to sporting examples and the recovery strategies different athletes may use				
	I can justify why sports are either aerobic or anaerobic and evaluate and justify the recovery methods athletes of different sports may use				
4 The Short-term and Long-term Effects of Exercise	*I can name and describe the short-term and long-term effects of exercise on the body*				
	I can apply the short-term and long-term effects of exercise to suitable sporting examples				
	I can analyse the short-term and long-term effects of exercise on the body and the effect these have on sporting performance				

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CHAPTER	Assessment objective checklist	AO1	AO2	AO3	What you need to do *(add your comments here)*
5 Lever Systems, Planes and Axis	*I can demonstrate my knowledge of lever systems, planes and axes by identifying and describing lever systems, planes and axes*				
	I can give sporting examples of lever systems in the body and skills that occur in the different planes and axes				
	I can analyse sporting movements by identifying sporting movement, antagonistic pairs, planes of movement and axis of movement				
6 Health and Fitness	*I can demonstrate my knowledge of the relationship between health and fitness, the components of fitness and the tests and protocols used to measure components of fitness*				
	I can give examples of sports that require each component of fitness and the tests that would be used in that sport to measure components of fitness				
	I can discuss reasons for, and limitations of, fitness testing, justify which fitness tests should be used to measure each component of fitness, and understand why normative data is used by researchers, coaches and athletes				
7 Principles of Training	*I can demonstrate my knowledge of SPORT and FITT and types of training*				
	I can apply the use of SPORT and FITT to sporting examples and identify which athletes would use each type of training, and why				
	I can analyse the types of training used by different athletes and discuss the advantages and disadvantages of the different types of training				
8 Optimising Training and Preventing Injury	*I can calculate training thresholds and one-repetition maximum and can name strategies used to prevent injury in sport. I can demonstrate knowledge of altitude training and the seasons of training.*				
	I can calculate training thresholds for different athletes and can provide injury prevention strategies for specific sports. I can apply the seasons of training to sporting examples.				
	I can assess the use of altitude training and its effects on performance				
9 Warm-ups and Cool-downs	*I can identify the components of effective warm-ups and cool-downs*				
	I can give apply the components of effective warm-ups and cool-downs to sporting examples				
	I can assess the benefits of effective warm-ups and cool-downs and their influence on sporting performance				

At the start of each chapter, you'll find a knowledge checklist. Use this to tick-off your progress and make notes on anything you need to work on further.

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Chapter 1: Structure and Functions of the Musculoskeletal System

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

Knowledge Checklist

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

Key Terms

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

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Structure and Functions of the Skeletal System

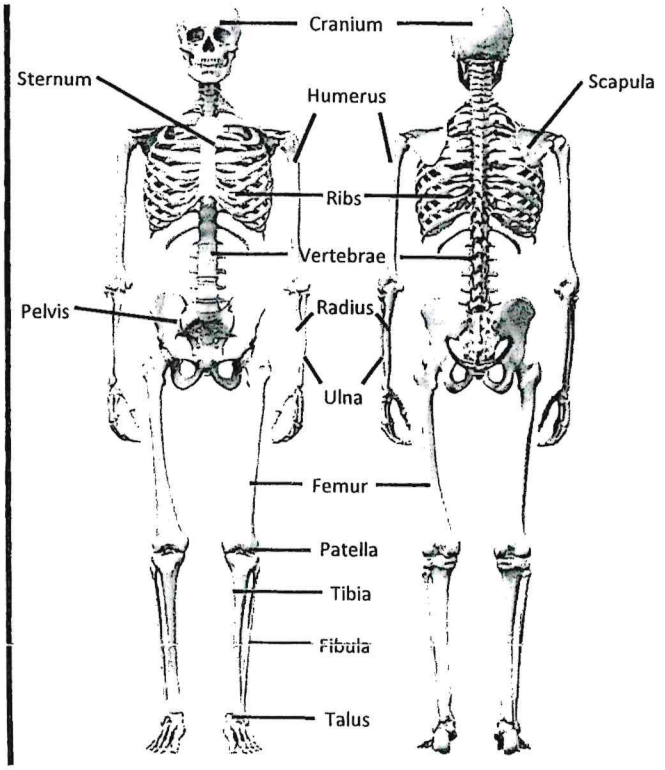
Bones are the framework of our body and allow movement by working with muscle groups. Bones also provide protection for vital organs, and joints allow different types of movement.

Functions of the Skeleton:

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

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

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



Functions of the Skeleton:

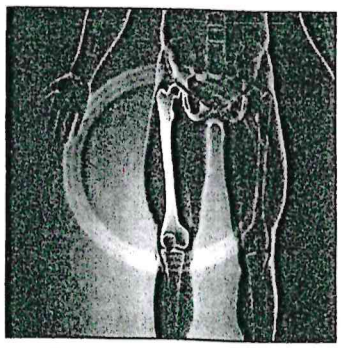
Shape and points for attachment – bones give our body size and shape and provide points for muscles to attach to, e.g. attaching the femur, tibia and fibula to create the knee joint and form the lower limbs

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

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

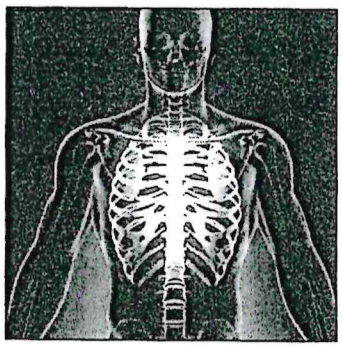
Functions of Different Bone Types

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



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

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



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

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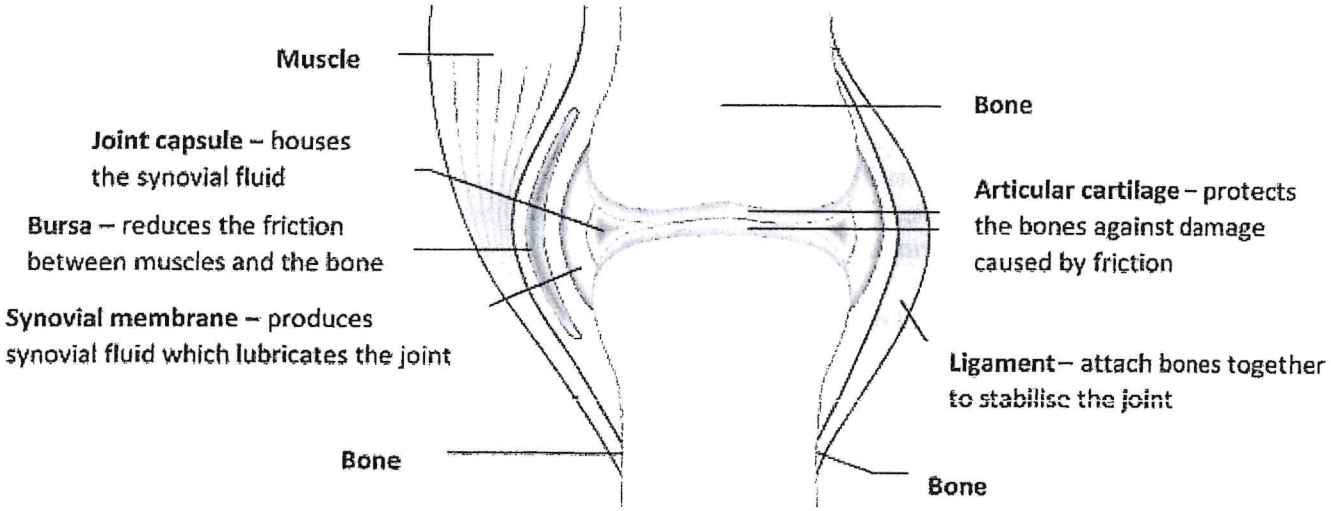
Synovial Joints

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

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

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

The structure of a synovial joint is shown below.



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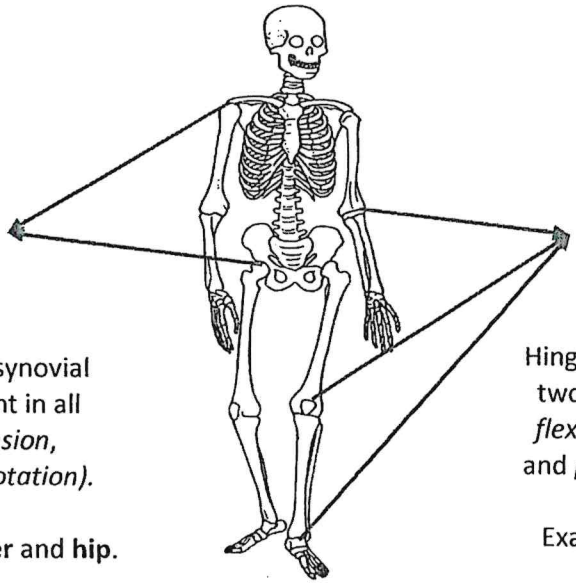
Movement at Joints

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

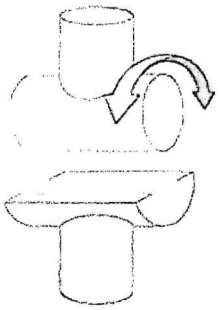
Ball-and-socket

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

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



Hinge



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

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

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

Definitions of Movements

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

Extension – the angle between two bones around a joint increases

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

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

Rotation – turning a bone about its long axis

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

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

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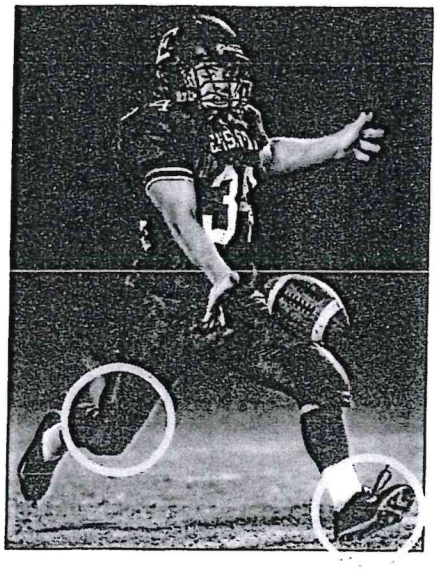
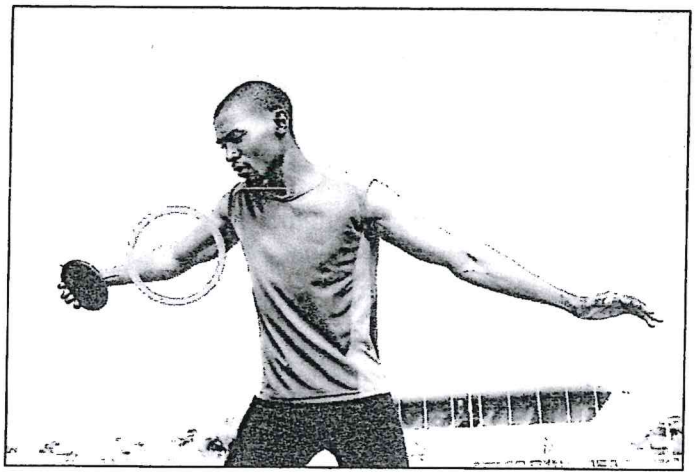
Movements in Action:



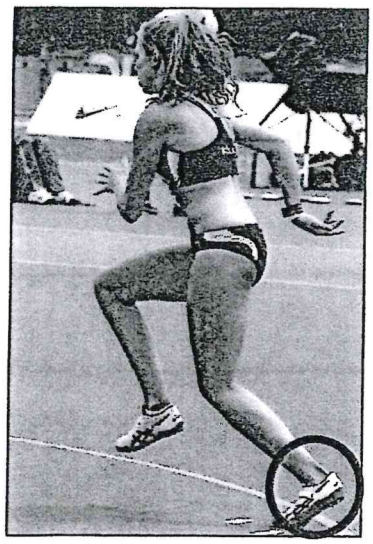
In this example, the American footballer is **flexing** his knee to bring his leg backwards. When he brings his leg forwards to kick the ball, his knee will undergo **extension**.

Dorsiflexion is also occurring at the ankle joint.

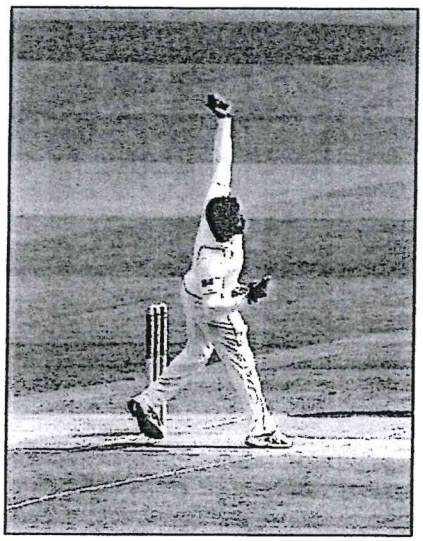


During the discus event, **flexion** and **extension** of the elbow occur.

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



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



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

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

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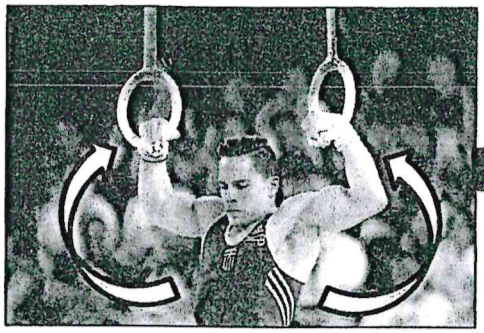

This athlete has completed shoulder **abduction** as his arms have move away from his body

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

Revision Tip!

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

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

Note:

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

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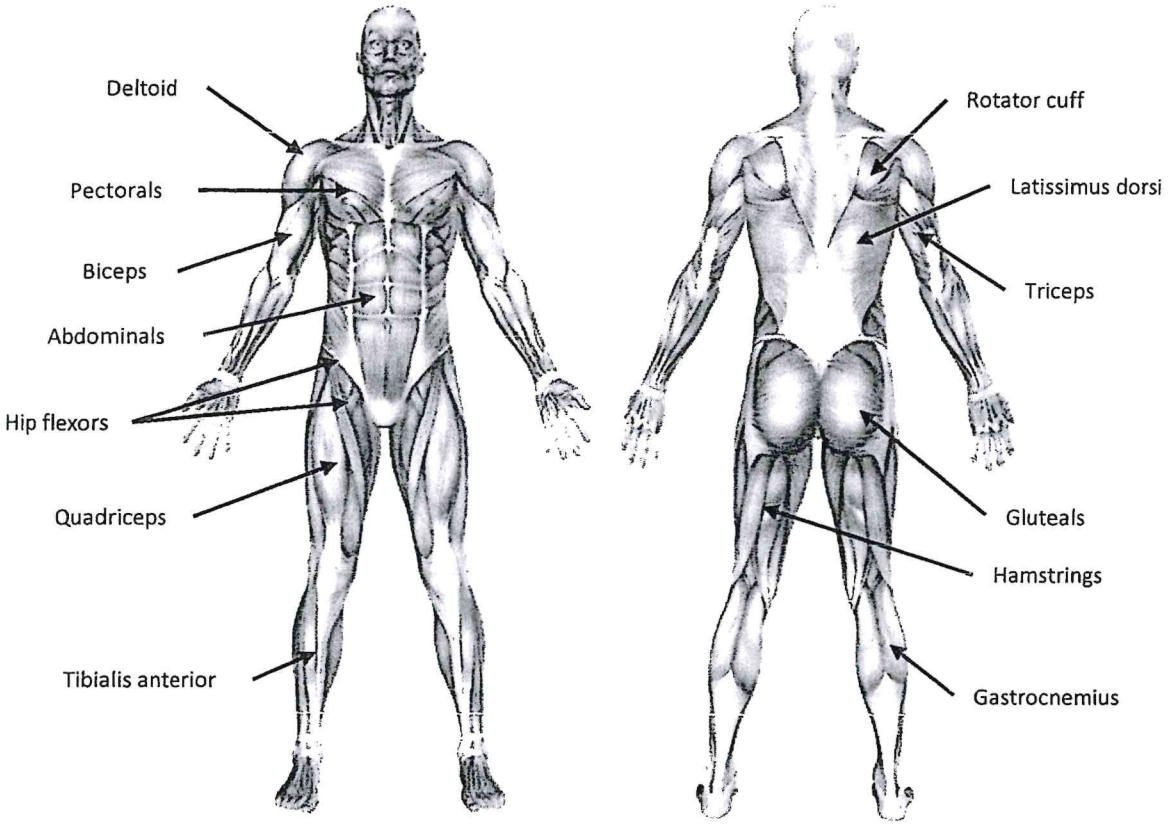
Muscles of the Body and Movement

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



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Antagonistic Pairs

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

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

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

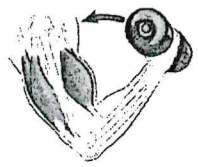
Isotonic Contraction

- Movement occurs
- The length of the muscle changes

Concentric Contraction

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

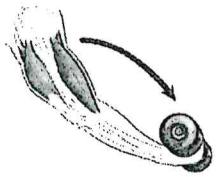
e.g. lifting a weight



Eccentric Contraction

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

e.g. lowering a weight



Isometric Contraction

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

e.g. holding a weight stationary

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Examples of Muscles Working Antagonistically

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

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

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

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Revision Activities – Chapter 1

1. Describe five functions of the skeletal system.

   1. .....
   2. .....
   3. .....
   4. .....
   5. .....

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

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

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

   .....

   .....

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

   .....

   .....

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

   .....

   .....

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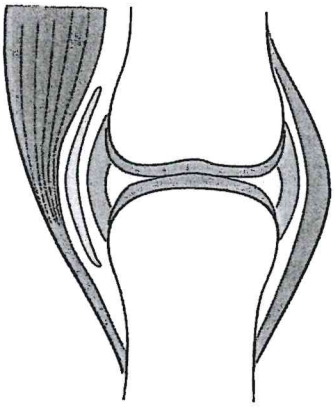
4. Label the following on the diagram of the knee below:
   - Synovial membrane
   - Bursa
   - Synovial fluid
   - Joint capsule
   - Cartilage
   - Ligaments



5. Name the agonist muscle in the following movements.

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

   .....

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

   .....

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

   .....

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

   .....

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

   .....

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

(1 mark)

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

(1 mark)

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

   1. .....

   .....

   .....

   .....

   2. .....

   .....

   .....

   .....

(4 marks)

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Chapter 2: Structure and Function of the Cardiorespiratory System

Learning objective: To develop your knowledge and understanding of the cardiorespiratory system and the influence of the cardiorespiratory system on participation in sport and physical activity

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to describe the pathways of air from the atmosphere to the red blood cells			
Explain the process of gaseous exchange and the factors that aid gaseous exchange			
Describe the functions and structural characteristics of blood vessels			
Be able to label a diagram of the heart and describe the functions of each feature			
Be able to describe the cardiac cycle, including diastole and systole			
Discuss cardiac output and the changes that occur pre, during and post exercise			
Be able to describe the mechanics of breathing and explain the role of features in breathing			
Be able to interpret a spirometry trace and analyse the effects that exercise has on respiratory measurements			

Key Terms

1. **Alveoli** – sacs in the lungs that are the site of gaseous exchange
2. **Artery** – large blood vessel that transports oxygenated blood from the heart to the body
3. **Capillary** – small blood vessel that surrounds body tissues and is the site of gaseous exchange
4. **Gaseous exchange** – the process of gases being transferred from the lungs to the blood, and from the blood to the lungs
5. **Heart rate** – how many times the heart beats in one minute
6. **Diaphragm** – strip of muscle below the lungs that contracts and relaxes to aid breathing
7. **Diffusion** – the movement of substances from a high concentration to a low concentration (gaseous exchange)
8. **Haemoglobin** – protein contained in blood that can bind to molecules (O_2 and CO_2)
9. **Oxyhaemoglobin** – haemoglobin that has bonded with oxygen molecules
10. **Aorta** – artery that takes oxygenated blood from the heart to the body
11. **Pulmonary vein** – vein that carries oxygenated blood from the lungs to the heart
12. **Atria** – chambers of the heart that receive blood from the lungs and the body
13. **Stroke volume** – the volume of blood pumped out of the heart per heartbeat
14. **Vein** – blood vessel that transports deoxygenated blood back to the heart
15. **Vasoconstriction** – the act of narrowing (constricting) blood vessels
16. **Vasodilation** – the act of widening (dilating) blood vessels
17. **Ventricles** – chambers of the heart that hold blood before it is ejected towards the lungs and the body
18. **Cardiac cycle** – name given to a full heartbeat; consists of systole and diastole
19. **Cardiac output** – the volume of blood ejected from the heart in one minute
20. **Thoracic cavity** – the space enclosed by the ribs, found between the diaphragm and the neck, where the lungs and heart are located.
21. **Tidal volume** – the volume of air that is inspired at rest

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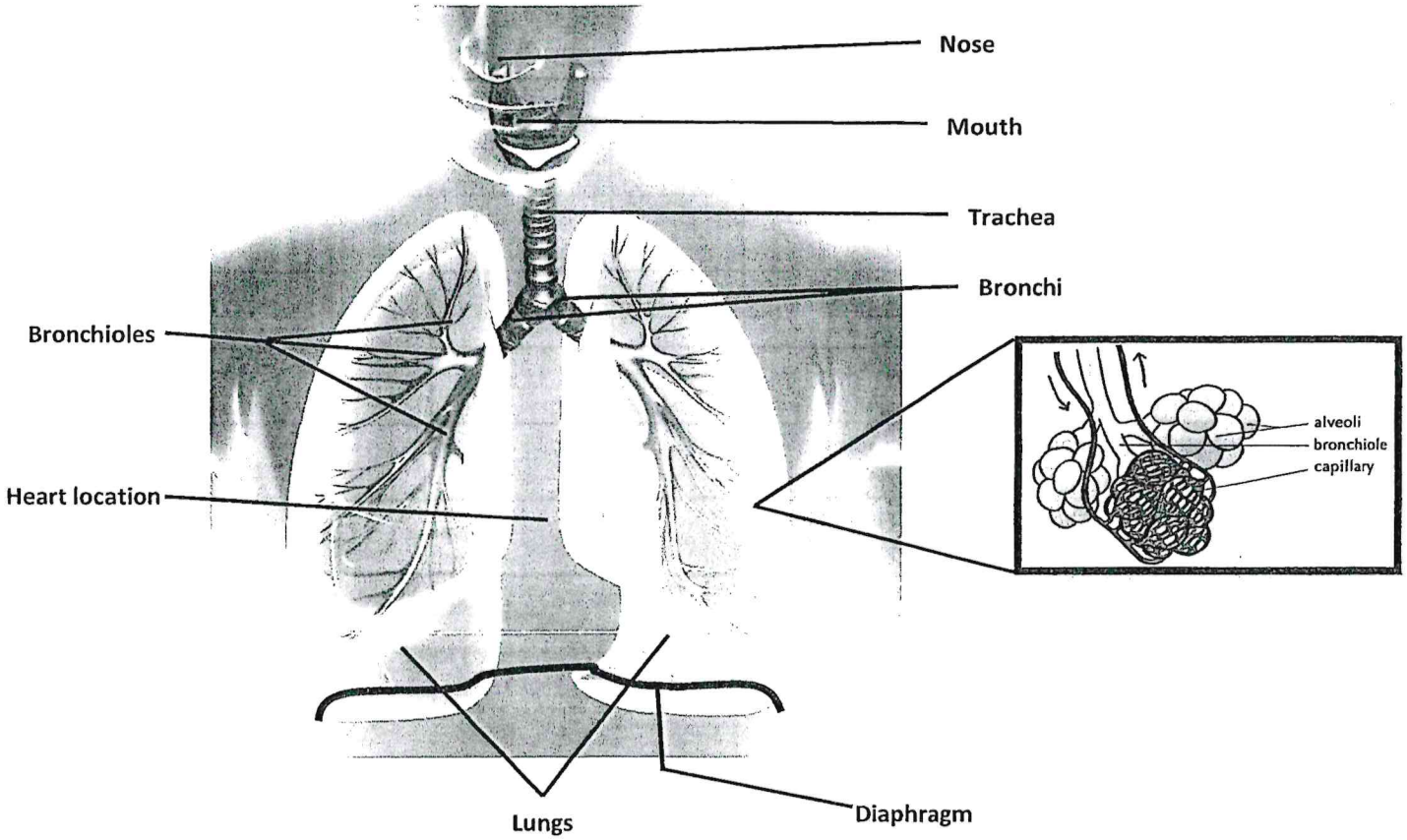
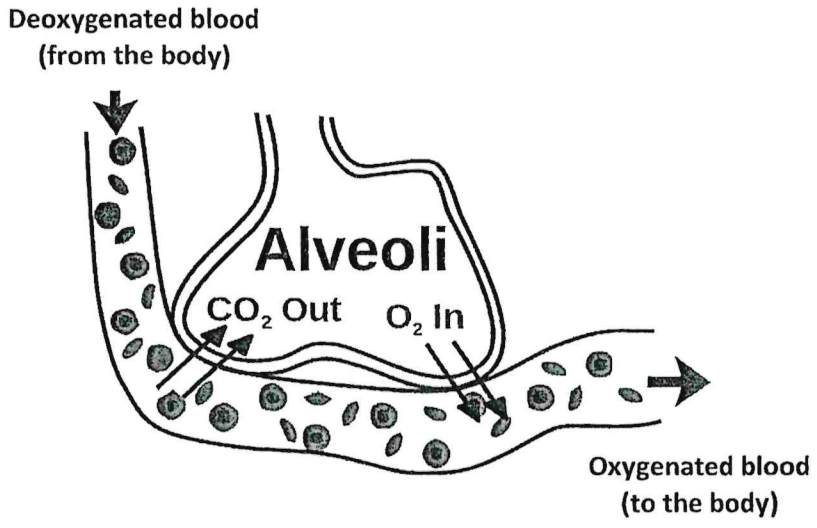
The Pathway of Air and Gaseous Exchange

To live and exercise at varying intensities, humans must breathe in air (oxygen) to supply cells with oxygen – an energy source for the cells. When we breathe, air travels from the environment into our lungs through the respiratory pathway. Air is breathed in through the nose and mouth, through the trachea and into the bronchi, which split into the left and right lungs. Here, air travels through the bronchioles and into the alveoli, where gaseous exchange takes place.



Diffusion at the lungs is the process of gases travelling from the alveoli and into the red blood cells to take oxygen to the cells. Diffusion can also take place from the red blood cells into the lungs, as waste products (carbon dioxide) are expelled from the body. Gases move from a high concentration to a low concentration; therefore, when we breathe in, there is a high concentration of oxygen in the alveoli, which is then diffused to an area of low concentration (the deoxygenated red blood cells). When we breathe out, carbon dioxide moves from an area of high concentration (deoxygenated red blood cells) to an area of low concentration (lungs). This is outlined by the diagram below:



Alveoli

- High concentration of oxygen
- Low concentration of carbon dioxide
- O_2 diffuses into bloodstream

Blood (deoxygenated/blue)

- Low concentration of oxygen
- High concentration of carbon dioxide
- CO_2 diffuses into the alveoli

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Factors That Aid Gaseous Exchange

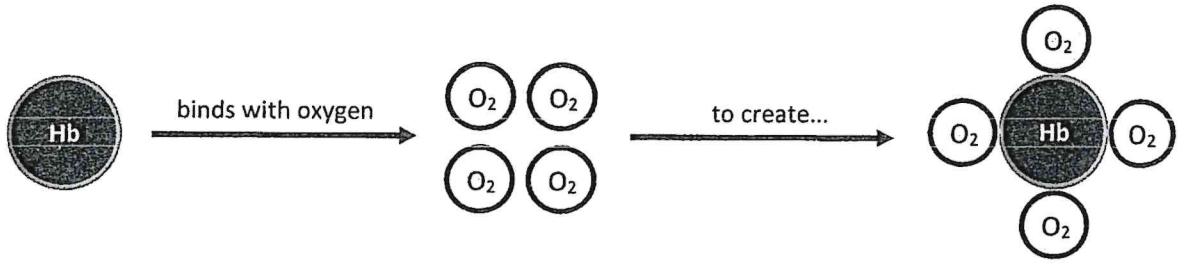
Large surface area of alveoli – although alveoli are small, there is a very large number of them in each lung. This increases the total surface area for diffusion to take place.

Thin, moist walls – the alveoli have moist walls, and the surrounding capillaries are only one cell thick; this aids diffusion.

Short diffusion distance – the distance between the edges of the alveoli and the capillaries is very short, reducing the distance that diffusion occurs over.

Vast amount of capillaries – surrounding the alveoli are whole networks of capillaries carrying blood. These give oxygen and carbon dioxide as much opportunity as possible to diffuse.

Haemoglobin (Hb) in the red blood cells can bind with oxygen to carry it to the working cells.



Haemoglobin **Oxygen** **Oxyhaemoglobin**

Haemoglobin can also bind with carbon dioxide, to transport it out of the body.

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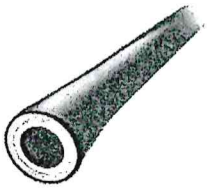
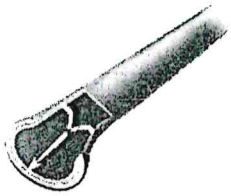
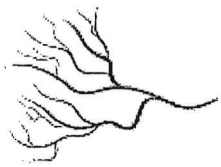
Blood Vessels

Different blood vessels have different roles in the function of the cardiorespiratory system. The characteristics of each blood vessel can help to transport oxygen and waste products around the body.

	Artery	Vein	Capillary
			
Structural characteristics	• Largest diameter of the blood vessels • Thick outer walls • Elastic walls • Muscles to vasoconstrict and vasodilate (changing diameter)	• Thin walls • Large internal diameter	• High number of capillaries in body • Very small in diameter • Thin walls
Role/aid in transportation	• Carries blood away from the heart • High blood pressure • Vasoconstriction/ vasodilation can increase or decrease blood flow to particular areas of the body	• Carries (deoxygenated) blood to the heart • Valves prevent blood travelling in the opposite direction • Low blood pressure	• Join veins and arteries • Thin walls aid gaseous exchange • Can transport nutrients • Very thin diameter increases efficiency of diffusion

It is important for you to be able to name some major blood vessels in the human body and understand their role in the body. Some major blood vessels are:

- **Aorta** – main artery in the human body. Transports blood from the heart to the body.
- **Pulmonary vein** – vein that receives oxygenated blood from the lungs and transports it to the left atrium of the heart
- **Superior vena cava** – returns deoxygenated blood from the body to the right atrium of the heart

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Redistribution of Blood during Exercise

When we exercise, blood must be redistributed, to transport oxygen and nutrients to muscle cells that require energy during exercise. This is achieved through the vasodilation and vasoconstriction of blood vessels. Vasoconstriction is the narrowing of blood vessels and vasodilation is the widening of blood vessels. Take the following example of a baseball player to help you understand this.

A batter warms up to prepare to go out batting. He does some short sprints (ready to run between the bases) and swings his bat a few times to warm up his arms.

The body responds to this increase in physical activity by redistributing blood to where the body needs it the most (arms and legs). This is achieved by vasoconstricting blood vessels that lead to areas of the body that do not require as much oxygen at that moment in time; for example, the digestive system. This is because vasoconstriction narrows the blood vessels, limiting the amount of blood that can go through the vessel.

At the same time, blood vessels that lead directly to the arms and legs vasodilate, allowing more blood to flow through these blood vessels to reach the working muscle cells. This feeds the muscle cells with the nutrients and oxygen required to generate energy at the arms and legs.

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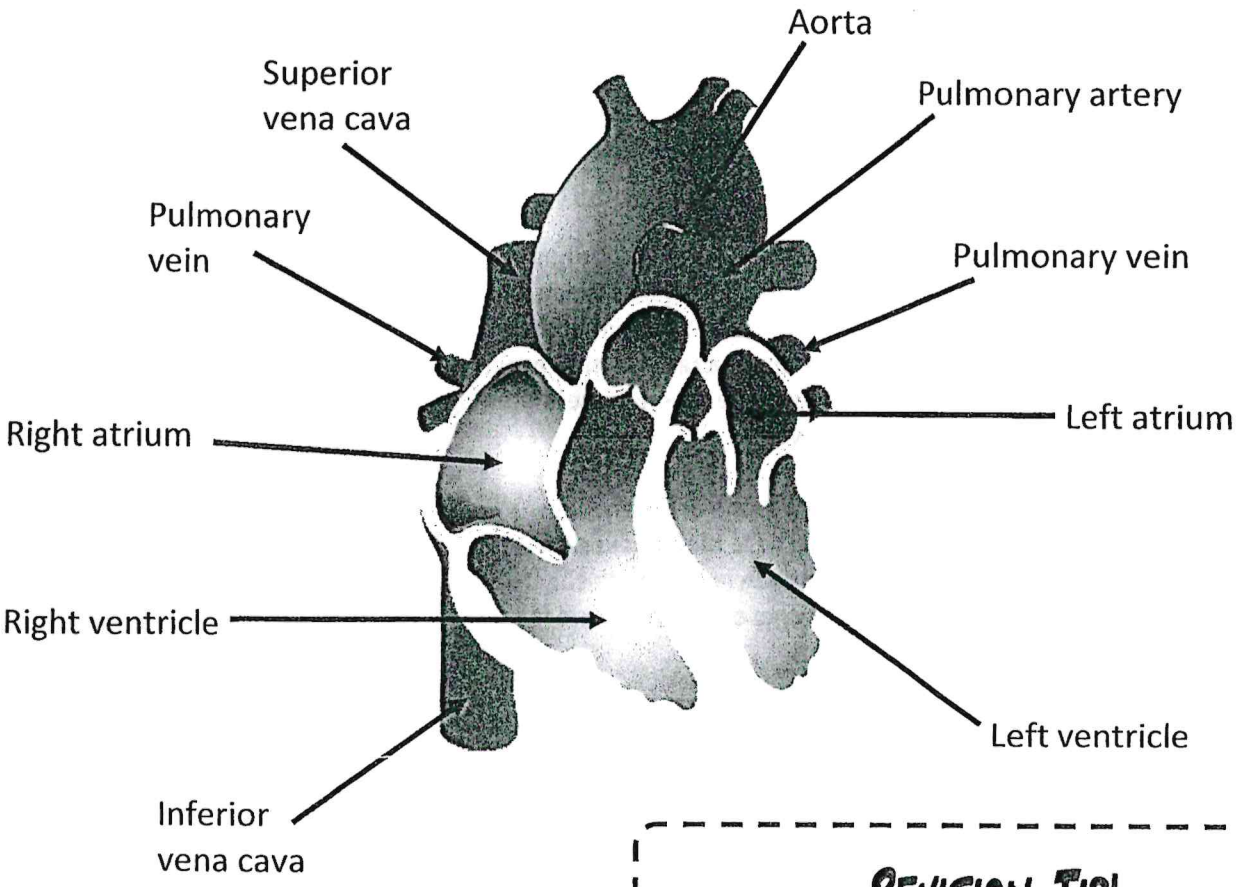
Structure of the Heart, Cardiac Cycles and the Pathway of Blood

There are four main chambers to the heart: the left and right atria and the left and right ventricles. It is also important for you to remember the names and roles of the main arteries and veins that are part of the cardiac cycle.



Revision Tip!

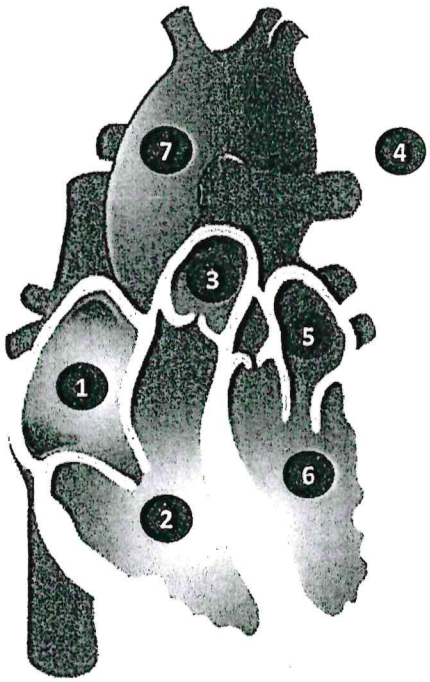
When you look at a diagram of the heart, the right-hand side appears on the left of the diagram, and the left-hand side appears on the right.

Pathway of Blood

❶ Deoxygenated blood from the body travels through the superior vena cava into the right atrium

❷ Blood travels from the right atrium into the right ventricle

❸ Pulmonary artery transports blood to the lungs



❹ Gaseous exchange occurs at the lungs (CO_2 out, O_2 in)

❺ Blood travels through the pulmonary vein into the left atrium

❻ Blood travels from the left atrium into the left ventricle

❼ Blood is ejected from the left ventricle, through the aorta, to the body

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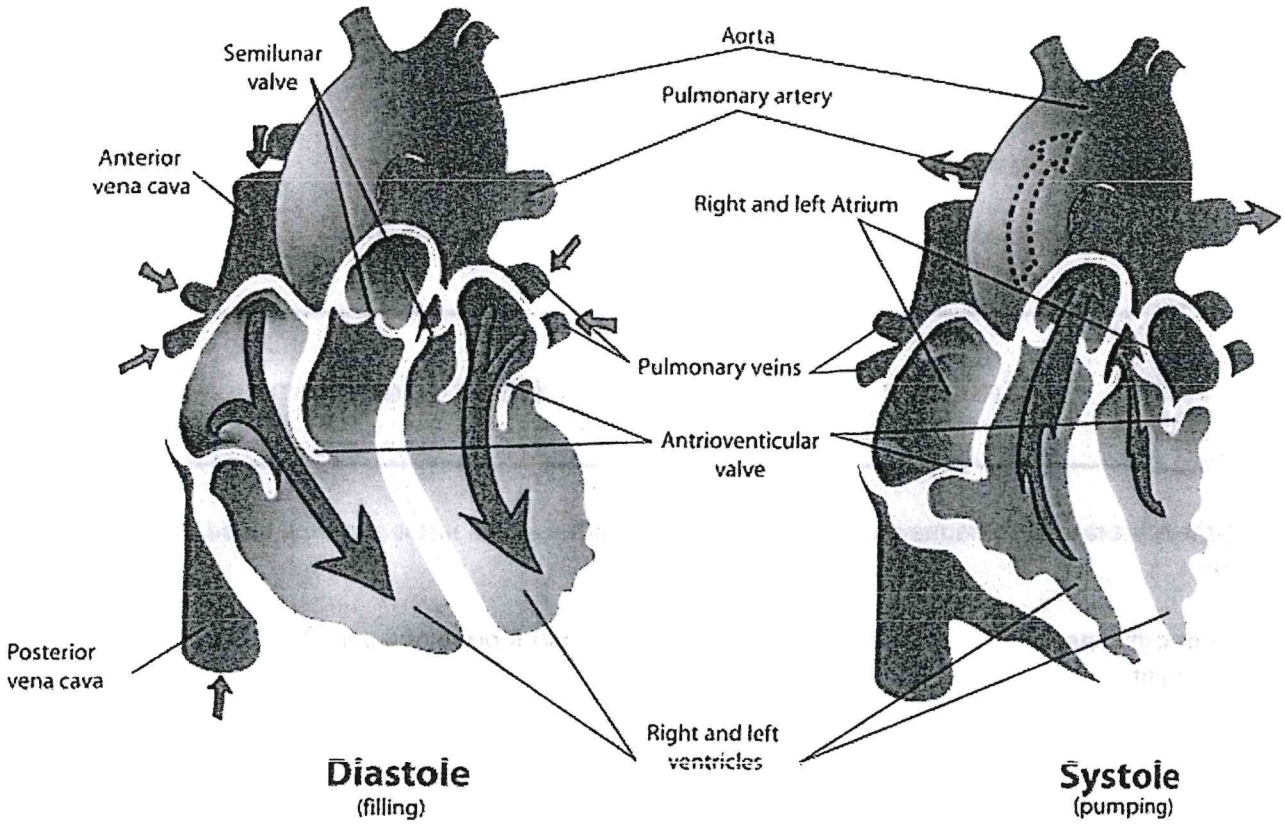
The Cardiac Cycle

As the blood travels its pathway through the cardiac muscle, two phases of the **cardiac cycle** are taking place: **diastole and systole**.



Diastole (filling)

- The ventricles and atria relax and the heart fills with blood
- The semilunar valves are shut to prevent backflow of blood

Systole (pumping)

- The ventricles contract, increasing the pressure inside the ventricles
- The increase in pressure shuts the atrioventricular valves to prevent backflow of blood
- The semilunar valves are forced open, allowing blood to travel through the aorta and pulmonary artery

Revision Tip!

You will not need to learn the names of valves for your exam, but it may be useful to help you remember the pathway of blood through the heart.

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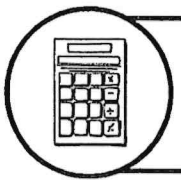
Cardiac Output, Stroke Volume and Heart Rate

It is useful for an athlete to be able to monitor the health and effectiveness of their heart. To do so, numerous measurements of the heart can be made; these are: heart rate, stroke volume and cardiac output. You will need to know how to measure or calculate each of these.

- **Heart rate** – the number of times the heart beats per minute
- **Stroke volume** – the volume of blood ejected from the heart per beat
- **Cardiac output** – the volume of blood ejected from the heart in one minute



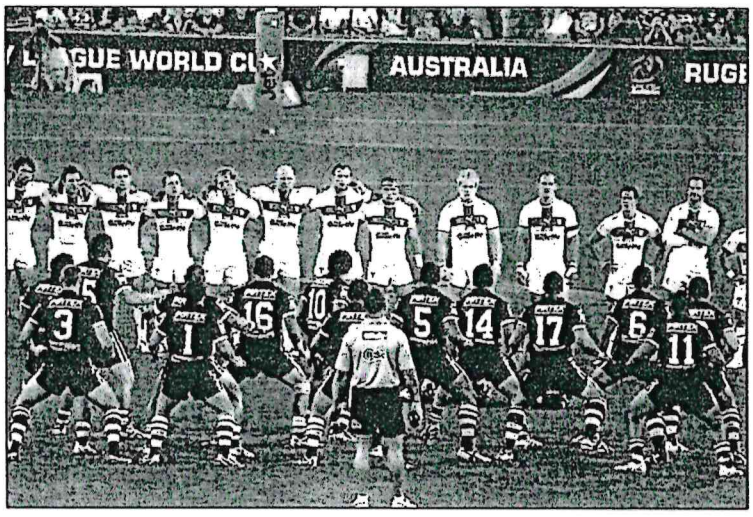
Cardiac output (Q) = heart rate (HR) × stroke volume (SV)

Increasing the heart rate of someone increases the cardiac output as the heart is pumping blood more times in one minute.

Stroke volume can increase by the heart working harder to pump out more blood per beat. This, in turn, increases the cardiac output.

Anticipatory Rise

Cardiac output can also increase as a result of **anticipatory rise**. This is an increase in heart rate as the performer is expecting exercise to happen soon. In elite athletes, this may be a natural, physiological response of their bodies as they are eager to start a match, for example. In beginners, this may be caused by nervousness. During exercise, cardiac output increases to meet the demands of the intensity of exercise.



Rugby players may experience an anticipatory rise as they line up before a match begins; for example, when facing the haka.

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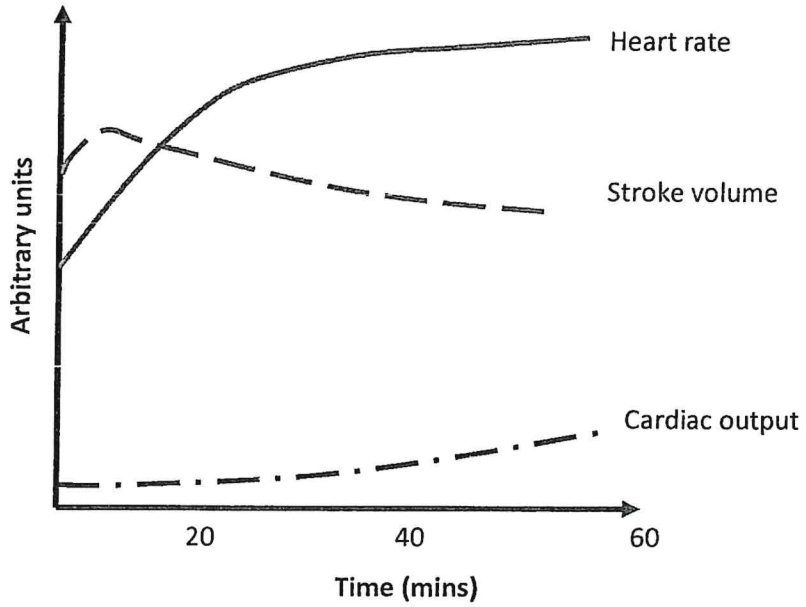
Cardiovascular Drift

During continuous exercise where the intensity of exercise does not change (e.g. a marathon run), the athlete will require an increase in cardiac output to provide the body with a continuous and adequate source of blood, which provides oxygen to the working muscle cells for energy (aerobic respiration). However, stroke volume cannot be maintain during steady-state exercise because:

- it has a maximum upper volume limit so no more blood can be pumped out per heart beat
- maximum stroke volume peaks at approximately 60% maximum intensity of the individual
- it decreases as a result of dehydration or sweating as the volume of blood is decreased (reduced plasma and increase in blood viscosity)

Therefore, to increase cardiac output, the body must instead increase heart rate. Although less blood will be pumped out of the heart per beat (i.e. stroke volume), a significant increase in heart rate will make up for this and lead to an increase in cardiac output, providing the body with the blood required to maintain physical activity. This is outlined by the diagram below.



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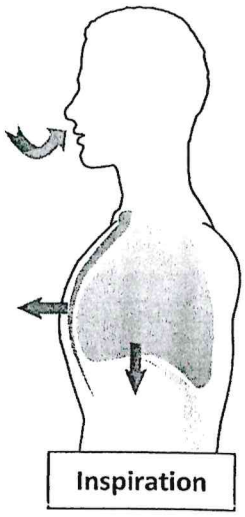
Mechanics of Breathing

Breathing is split into two components: **inspiration** and **expiration**. When we breathe, the body changes its state to cause inspiration and expiration of air. The movement of air between the atmosphere and the body is dependent on air **pressure**. Air will travel from a high pressure to a low pressure; therefore, when you inhale, your body will create a low pressure inside your lungs, forcing air to travel from an area of high pressure (atmosphere) to an area of low pressure (the lungs). During expiration, this is reversed as the body increases the pressure inside the lungs, forcing the air to travel to an area of lower pressure (the atmosphere).

Inhaling and Exhaling at Rest



Intercostals – the intercostal muscles contract, causing the ribs to rise. This increases the thoracic capacity.

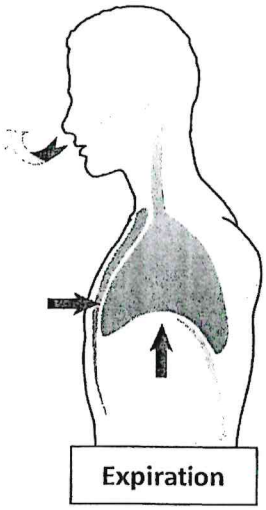
Diaphragm – the diaphragm contracts, causing it to flatten. Flattening the diaphragm increases the thoracic capacity.

Ribcage – the actions of the intercostal muscles and the diaphragm cause the ribs to move upwards and downwards, increasing the thoracic capacity.

Intercostals – the intercostal muscles relax, causing the ribs to move downwards. This decreases the thoracic capacity.

Diaphragm – the diaphragm relaxes, causing it to curve upwards. This decreases the thoracic capacity.

Ribcage – the actions of the intercostal muscles and the diaphragm cause the ribs to move downwards and inwards.

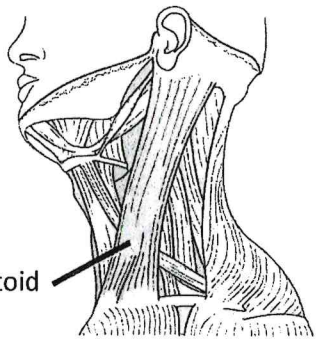


Inhaling and Exhaling during Exercise

During exercise, more oxygen is needed to maintain movement. This means the body must adapt and work harder to maximise the amount of air being inhaled, as well as the amount of waste products being exhaled. To be able to meet the demands of the body (more oxygen), the body uses more muscles to breath during exercise.

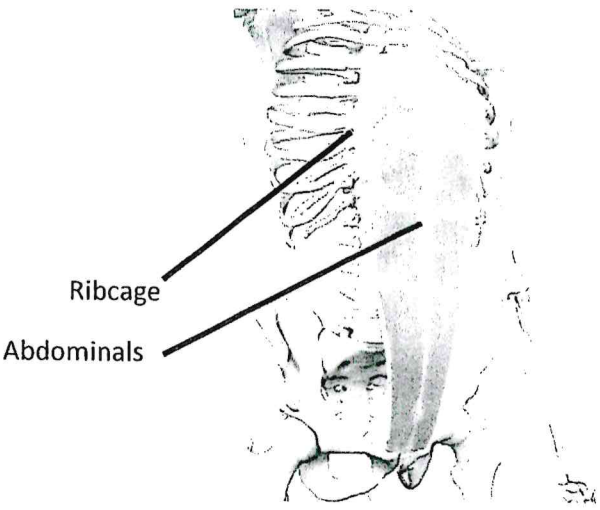
Inspiration

- **Sternocleidomastoid** – contracts, causing the thoracic capacity to increase – allowing a greater volume of air to enter the lungs
- **Pectorals** – contract, causing the thoracic capacity to increase – allowing a greater volume of air to enter the lungs



Expiration

- **Ribcage** – pulled downwards quickly and forcefully by the **abdominal muscles** during expiration, forcing air out of the lungs at a faster rate



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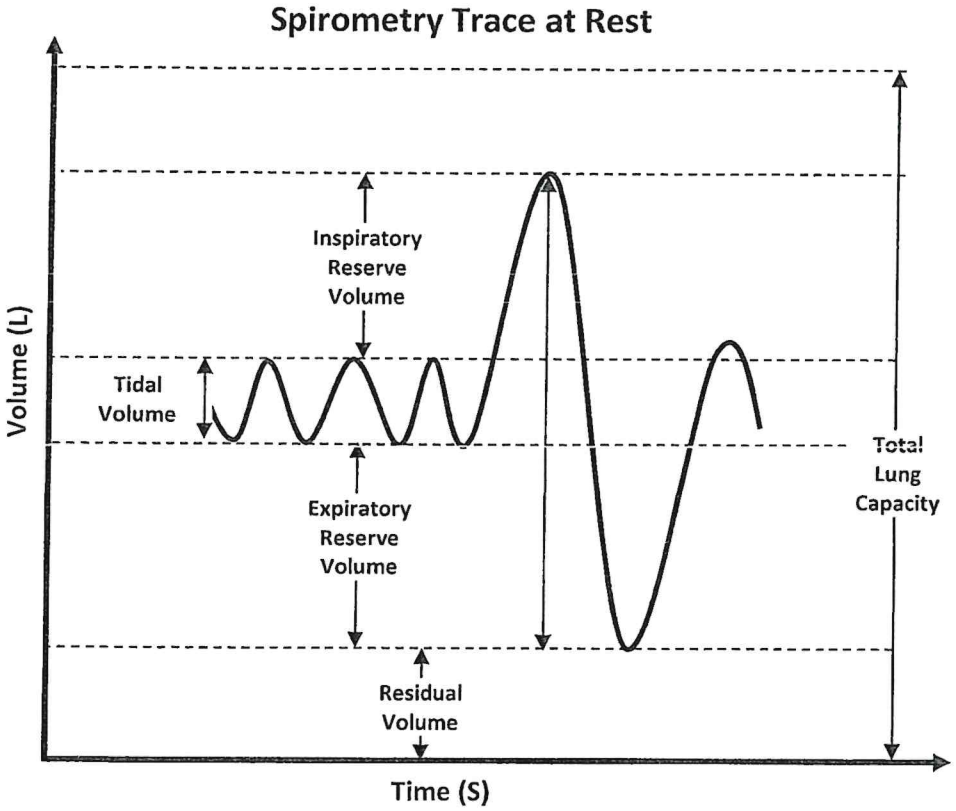
Interpreting Spirometry Traces

Spirometers are pieces of equipment that can record the volume of air that is being inspired and expired by the lungs. There are many different types of spirometer, but each type will mainly focus on recording **tidal volume, inspiratory reserve volume, expiratory reserve volume** and **residual volume.**

- **Tidal volume** – the volume of air that is inspired at rest
- **Inspiratory reserve volume** – the amount of air that can be inhaled during a deep breath (above normal tidal volume)
- **Expiratory reserve volume** – the amount of air that can be exhaled during a deep exhalation (above normal tidal volume)
- **Residual volume** – the amount of air left in the lungs after an individual has expired maximally



During exercise, the values of inspiratory reserve volume, expiratory reserve volume and tidal volume will change, as the body adapts to meet the demands of the exercise taking place.

	Effect of exercise on variable	Why?
Inspiratory reserve volume	Decreases	Inspiratory reserve volume decreases due to the increase in tidal volume, as a result of the increased demand for oxygen at the working muscles.
Expiratory reserve volume	Decreases	Expiratory reserve volume decreases due to the increase in tidal volume, as a result of the increased demand for oxygen at the working muscles.
Tidal volume	Increases	The amount of air inhaled into the lungs (tidal volume) must increase to provide the body with enough oxygen to maintain physical activity.

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Revision Activities – Chapter 2

1. Put the following statements in order to show the pathway of air from the atmosphere to gaseous exchange.

◯ Air moves into the alveoli, where gaseous exchange takes place.	◯ Air moves through the bronchioles.
◯ Air is breathed in through the nose and mouth.	◯ Air travels into the bronchi, which split into the left and right lungs.
◯ Air travels through the trachea.	

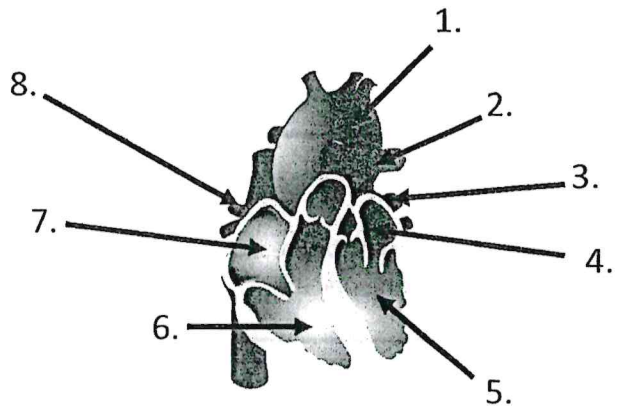
2. Name and describe four factors that aid gaseous exchange.

   1. .....
   2. .....
   3. .....
   4. .....

3. How many oxygen molecules can haemoglobin bind with?

   .....

4. Label the diagram of the heart.



5. Explain the mechanics behind a marathon runner's breathing during the race.

   .....
   .....
   .....
   .....
   .....

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1. Which one of the following statements applies to arteries?

A	Very small in diameter / can transport nutrients	☐
B	Carry blood away from the heart / high blood pressure aids blood flow	☐
C	Thin walls / low blood pressure	☐
D	Thin walls / thin walls aid diffusion (gaseous exchange)	☐

(1 mark)

2. Veins carry blood to the heart from the body.

Name **two** major veins in the body and provide two characteristics of veins that aid their function in blood flow.

1. .....

.....

2. .....

.....

(4 marks)

3. During exercise, the body needs more oxygen to continue working at higher intensities.

Define the terms **cardiac output** and **stroke volume**.

.....

.....

.....

.....

(2 marks)

4. A football player had her respiratory functions tested at rest. The spirometry trace is shown below.

Describe what happens to her inspiratory reserve volume and tidal volume as she increases the amount of exercise she is completing.

.....

.....

.....

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.....

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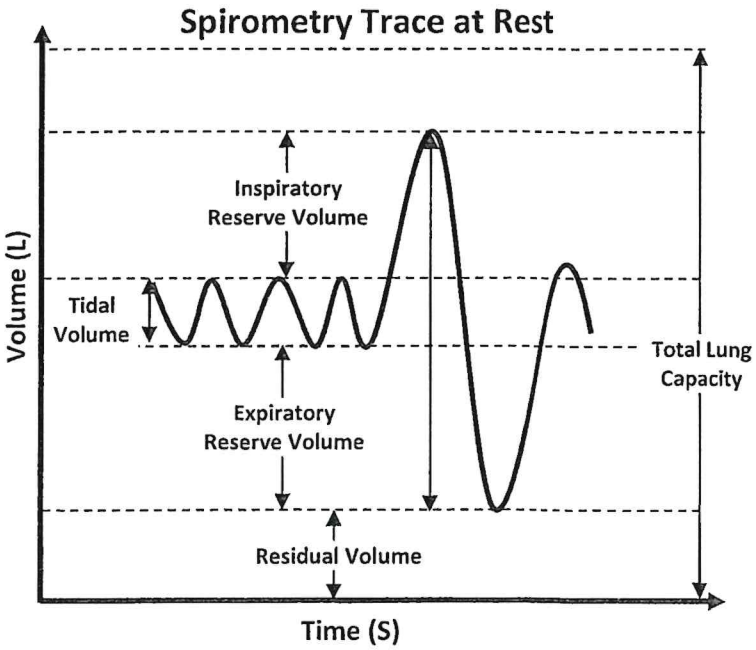
.....

(2 marks)



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Chapter 3: Anaerobic Exercise and Aerobic Exercise

Learning objective: To develop your knowledge and understanding of the use of aerobic exercise and anaerobic exercise in different sports, and your understanding of recovery methods used by athletes

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to define and give examples of aerobic exercise and anaerobic exercise and provide equations to show the process of each			
Define EPOC and explain how this affects an athlete's recovery			
Be able to evaluate the strategies used for recovery after exercise and the benefits of each			

Key Terms

1. **Aerobic exercise** – exercise that requires the presence of oxygen to produce muscular contractions
2. **Anaerobic exercise** – exercise that is completed without the presence of oxygen
3. **Duration** – how long something takes place for
4. **Glucose** – a type of sugar that is used by the body to create energy to move
5. **Intensity** – how physically demanding a task or activity is
6. **Lactic acid** – a waste product of working anaerobically that can cause fatigue
7. **EPOC** – excess post-exercise oxygen consumption
8. **Oxygen debt** – the amount of oxygen 'owed' to the body, needed to replace energy stores used during exercise
9. **DOMS** – delayed onset muscle soreness

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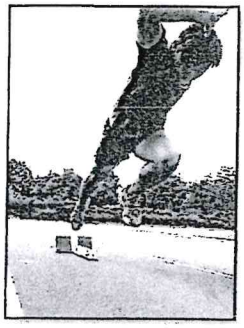
Anaerobic Exercise and Aerobic Exercise

When we exercise, we are working either aerobically or anaerobically. The system used by the body depends on whether the exercise being completed requires oxygen to provide the working muscles with energy. If oxygen isn't needed by the muscles, the body works anaerobically. When the body needs extra oxygen at the muscles, the body works aerobically.

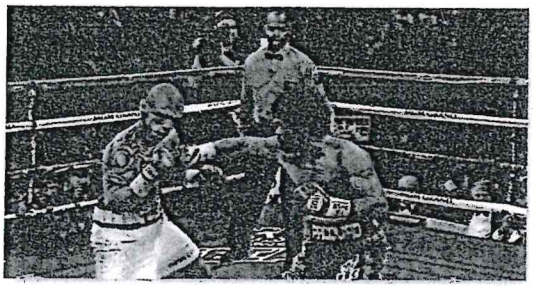
Aerobic exercise – exercise that requires the presence of oxygen to provide the muscles with energy

Activities such as long-distance running require the **aerobic** system. This is because long-distance running is a **low-intensity** exercise carried out over a **long period of time**.

Anaerobic exercise – exercise that is completed without the presence of oxygen. The energy needed at the muscles is already stored in the muscles.



Sprinting events such as the 100 m sprint use the **anaerobic** system. This is because sprinting is a **high-intensity** event over a **short period of time**.



Some sports, such as boxing, require a mixture of both the aerobic and anaerobic systems. This is because boxers require the anaerobic system to provide powerful muscle contractions to throw punches, and the aerobic system to maintain the physical activity over 12 rounds.

Aerobic exercise = glucose + oxygen → energy + carbon dioxide + water

Anaerobic exercise = glucose → energy + lactic acid

Revision Tip!

In the exam, if you are asked to justify whether an activity is aerobic or anaerobic, remember to justify with regard to the activity's **intensity** and **duration**.

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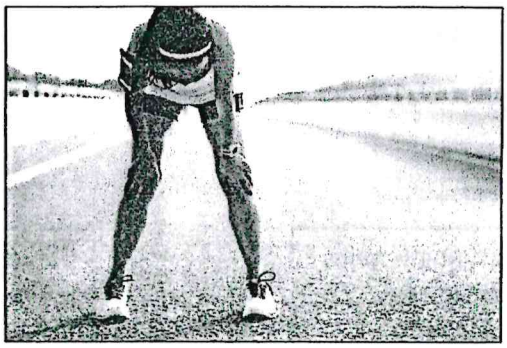
Excess Post-exercise Oxygen Consumption

When the body exercises anaerobically (for example, when sprinting), oxygen is not required to produce muscular contractions because the body uses stores of energy already held in the muscles. However, anaerobic exercise produces lactic acid as a by-product. This is highlighted by the equation for anaerobic exercise.

Anaerobic exercise = glucose → energy + lactic acid

The body will need to remove the lactic acid following high-intensity exercise. The body has an **'oxygen debt'** which it needs to repay. This is called **EPOC – excess post-exercise oxygen consumption**. As a result, the athlete will begin to breathe heavily after high-intensity exercise.



After high intensity exercise, athletes will breathe heavily to repay their oxygen dept. The extra oxygen helps to remove lactic acid from the muscles

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The Recovery Process

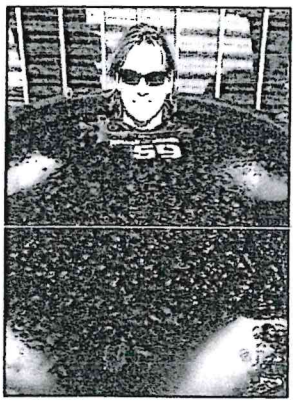
Following vigorous exercise, athletes want to reduce the effects of exercise on their body, such as nausea, light-headiness and sore muscles – the delayed onset of muscle soreness (DOMS). There are numerous strategies that performers use to reduce the effects of exercise to recover as quickly as possible.

Cool-downs

Cool-downs occur following exercise. They aim to gradually decrease heart rate and breathing rate to resting levels. A cool-down provides an opportunity for some of the oxygen debt to be repaid, removing lactic acid from the body. Cool-downs can consist of jogging and stretching. Benefits of a cool-down include:

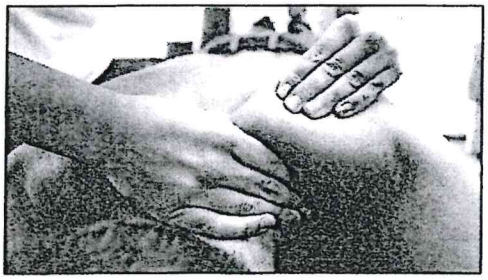
- removal of lactic acid
- reduced likelihood of DOMS occurring
- allows heart rate and breathing rate to gradually reduce (reduces shock on system)
- redistribution of blood that may have pooled at the body's extremities

Ice Baths



Ice baths aim to reduce swelling of muscles following exercise. Intense exercise can cause microtears in muscles, contributing towards DOMS. The cold temperature of ice baths causes blood vessels to vasoconstrict, reducing the flow of blood to the damaged muscle, thereby reducing swelling.

Once the body is removed from the ice bath, the blood vessels start to vasodilate, increasing the blood flow to the muscles, providing the muscles with nutrients and flushing waste products (lactic acid) away from the muscles. Ice baths are commonly used by athletes competing at high intensities (e.g. a 400 m sprinter), but can also be used by athletes who compete for long durations (e.g. following a long cycling stage in a tour).



Massage

Massages target sore muscles following exercise. Tiny tears in the muscles following exercise result in scar tissue forming around the muscle, which causes muscle soreness. Massages help to break down the scar tissue, increasing movement and reducing muscle soreness.

Manipulating the Diet

- Rehydration – athletes need to replace the fluids lost during exercise through sweating. Fluids should include any nutrients lost through exercise too (e.g. sodium). Fluids could contain carbohydrates to replace energy stores used by the body.
- Carbohydrates – any energy stores used by the body during exercise should be replaced during and after exercise.
- Proteins – protein consumption following exercise aids the recovery and growth of muscles.
- Diet manipulation will differ for each athlete; for example, a weightlifter's diet would be very different from a cyclist's diet.

Revision Tip!

You will need to be able to apply each of these recovery methods to different sports. Think about which sports would benefit the most from using each recovery method.

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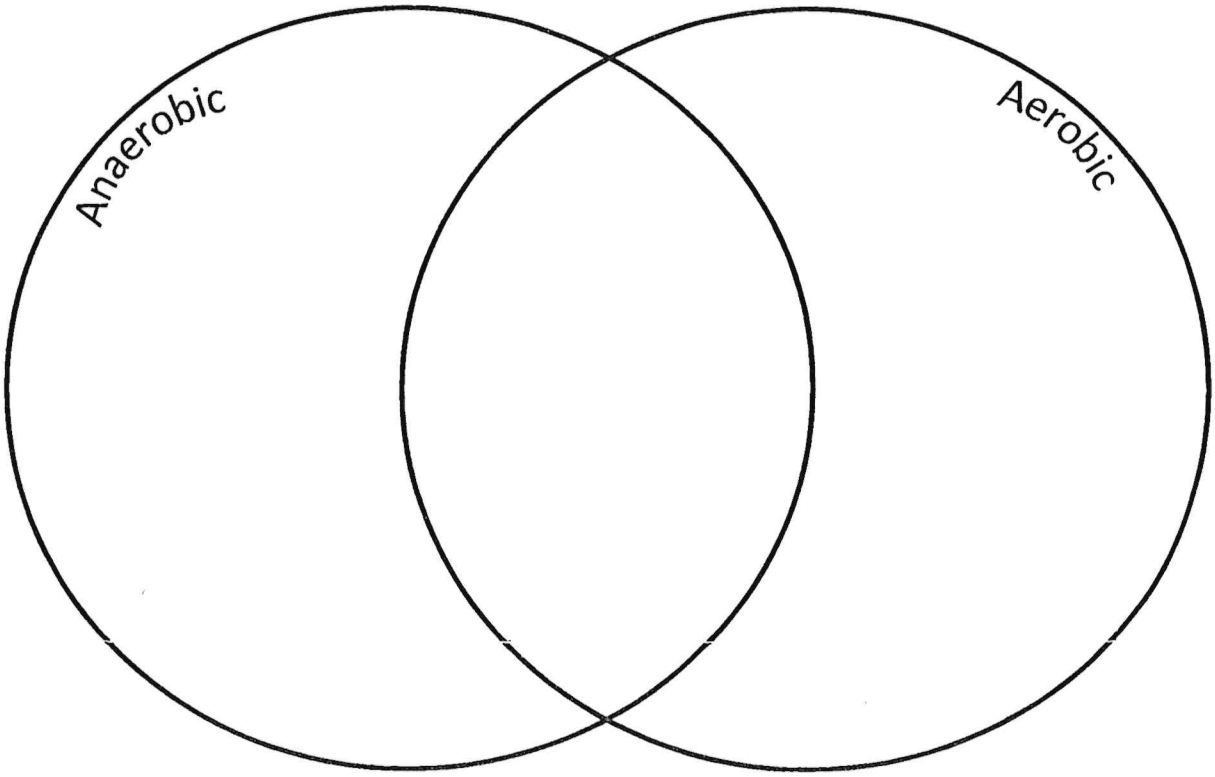
1. Fill in the Venn diagram below, giving as many examples as possible of sports that are anaerobic, aerobic and sports that include elements of both.



2. Fill in the gaps to complete the equations for aerobic and anaerobic exercise.

   a) _____ = glucose + oxygen → energy + _____ _____ + _____

   b) _____ = glucose → energy + _____ _____

3. Describe what is meant by excess post-exercise oxygen consumption (EPOC). Avoid using the following words in your description:
   - exercise
   - fatigue
   - debt

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1. Define 'aerobic exercise'.

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(1 mark)

2. Following exercise, an athlete often performs a cool-down.

State two reasons why a cool-down may be beneficial to the athlete following exercise.

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(2 marks)

3. Outline two reasons why athletes should consume fluids following vigorous exercise.

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(2 marks)

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Chapter 4: The Short-term and Long-term Effects of Exercise

Learning objective: To develop your knowledge and understanding of the short-term and long-term effects of exercise on the body

Knowledge Checklist

	Revised	Understood	What you need to do
Explain the changes in the cardiorespiratory system during exercise			
Be able to describe the short-term effects of exercise on the body			
Be able to describe the long-term effects of exercise on the body			

Key Terms

1. **Fatigue** – a feeling of physical weakness or tiredness
2. **DOMS** – delayed onset muscle soreness – the feeling of soreness in the muscles following vigorous exercise
3. **Hypertrophy** – an increase in the size of cells; normally refers to muscle cells
4. **Bradycardia** – a condition characterised by a heart rate of below 60 beats per minute
5. **Fitness** – an umbrella term for a variety of factors that contribute to overall performance of an individual

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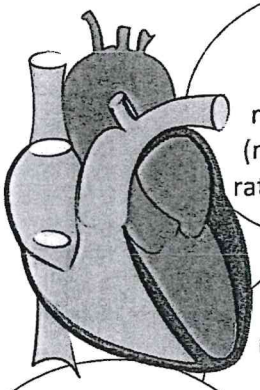
The Immediate Effects of Exercise

When a person begins to exercise, there are numerous changes occurring inside of their body. These changes are happening to allow the body to be able to withstand the exercise taking place. The main requirement of exercising will be the supply of oxygen to the working muscles. The changes occurring in the body that enable an increased supply of oxygen to reach the muscles are outlined below.



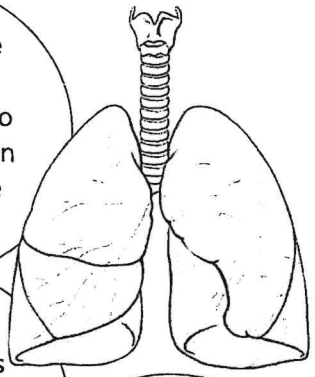
Heart rate increases to required level (maximal heart rate = 220 – age)

More powerful contractions of the heart occur, forcing more blood out with each contraction **(increased stroke volume)**

Increased heart rate and increased stroke volume mean there is a **greater cardiac output**

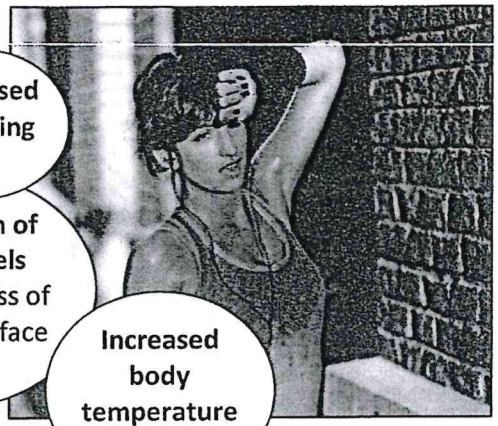
A greater cardiac output means that more oxygenated blood can reach the muscles

Breathing rate increases to required level to meet the oxygen demand of the body



Greater tidal volume means gaseous exchange at the alveoli is more efficient

Depth of breathing increases



Increased sweating

Vasodilation of blood vessels causes redness of the athlete's face

Increased body temperature

Short-term Effects of Exercise

Following exercise, a person may experience several effects of the exercise for up to 36 hours after the exercise has finished. These effects are outlined below.

- **Fatigue or tiredness** – caused by working the muscles hard. When muscles have been worked intensely, they swell and become 'heavy' or lethargic.
- **Delayed onset muscle soreness (DOMS)** – intense exercise can cause small tears in muscle fibres which can feel sore after exercise.
- **Cramping** – fatigue or overusing particular muscles can cause them to involuntary contract which can be painful. It can also be caused by dehydration
- **Nausea** – caused by a lack of nutrients, lack of fluids, or over-exertion.
- **Light-headedness** – caused by a loss of minerals or fluids, or by blood pooling during exercise.

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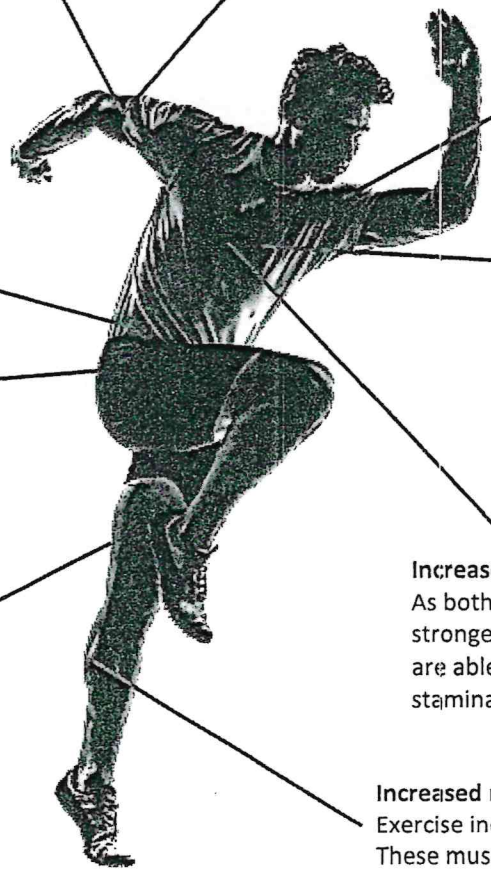
Long-term Effects of Exercise

When exercise is routinely completed for long periods of time (months to years), noticeable changes occur to the body that benefit the health and well-being of someone.



Increased strength
A trained athlete will experience hypertrophy of muscles. These muscles will be able to lift greater weight, for longer periods of time, before fatigue begins.

Hypertrophy of muscles
When worked hard, muscles suffer from microtears. When the body recovers and repairs the microtears, the muscle grows.

Increased flexibility
Specific flexibility training or general exercise increases the range of movement about a joint.

Weight loss
When an athlete consumes less energy (calories) than they are using during the day, they will lose weight. This is called a negative energy balance.

Hypertrophy of the heart / bradycardia
Just like any other muscle, the heart (a cardiac muscle) grows when it is worked hard. An increase in heart size and strength can lead to bradycardia, which is a low resting heart rate (below 60 bpm). This is due to an **increased stroke volume** (the amount of blood that is ejected from the heart per beat).

Change in body shape
Generally, an athlete will experience weight loss (i.e. loss of body fat) and hypertrophy of muscles, making them more toned in shape.

Increased stamina / cardiorespiratory fitness
As both the cardiac and respiratory systems become stronger, more powerful and more efficient, athletes are able to train and compete for longer as their stamina has improved.

Increased speed
After long periods of training, the athlete's muscles become more powerful. They are, therefore, able to cover a distance in a shorter time than before.

Increased muscular endurance
Exercise increases the size and number of muscle cells. These muscle cells will be able to contract and relax (to cause movement) for longer periods of time than before.

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Revision Activities – Chapter 4

1. Name two cardiovascular changes and two respiratory changes that occur **during** exercise.

   Cardiovascular changes

   1. .....

   2. .....

   Respiratory changes

   1. .....

   2. .....

2. What is the name given to the condition with a resting heart rate of less than 60 beats per minute?

   .....

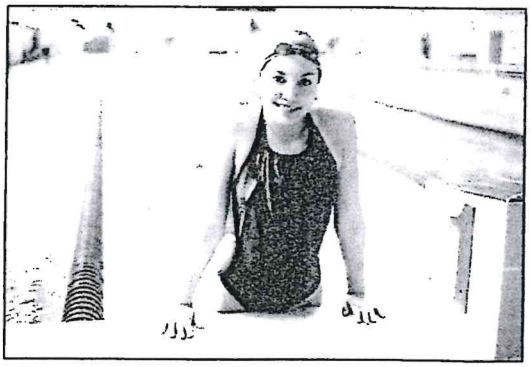
3. Name three components of fitness that can improve as a result of long-term exercise.

   1. .....

   2. .....

   3. .....

4. Identify three long-terms effects of exercise a swimmer would experience, and explain how these would benefit their performance.



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1. A 5,000 m runner would benefit the most from which of the following long-term effects of exercise?
   - A Increased strength ☐
   - B Increased flexibility ☐
   - C Tachycardia ☐
   - D Increased muscular endurance ☐

   (1 mark)

2. Identify **two** effects that exercise has on the body up to 36 hours after exercise. Give reasons why the effects occur.

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   (4 marks)

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Chapter 5: Lever Systems, Planes and Axes

Learning objective: Develop your knowledge and understanding of lever systems, axes and planes of movement in the body and the use of each in different sporting movements

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to label and draw the different components of a lever system			
Be able to identify and describe first-, second- and third-class lever systems			
Be able to identify types of levers in the body during sporting movements and link them to different sporting movements			
Be able to name and describe the planes and axes of movement			
Be able to identify the planes and axes of movement used in specific sporting movements			
Be able to perform a movement analysis			

Key Terms

1. **Fulcrum** – the point at which a lever is balanced, or the point at which a lever rotates
2. **Effort** – the force applied to a lever system
3. **Resistance/load** – the opposing resistance to the effort
4. **Resistance arm** – the distance between the fulcrum and the resistance
5. **Effort arm** – the distance between the fulcrum and the effort
6. **Mechanical advantage** – the advantageous features of a particular lever, based on the type of lever system
7. **Frontal plane** – plane that divides the body into front and rear
8. **Transverse plane** – plane that divides the body into upper and lower
9. **Sagittal plane** – plane that divides the body into right and left
10. **Axis** – a theoretical straight line that the body rotates about
11. **Longitudinal axis** – axis that travels from head to toe
12. **Sagittal axis** – axis that travels through the body from rear to front
13. **Transverse axis** – axis that travels through the body from left to right

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First-, Second- and Third-class Lever Systems

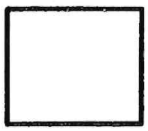
In human bodies, levers are used to create movement around a joint. They are made up of three components:

- **fulcrum**
- **effort**
- **resistance**

The fulcrum is the point at which a lever is balanced, or where rotation occurs around. The effort is the point and direction a force is applied to the lever system. The resistance/load is the force acting against the effort. These three components are usually represented in the following ways:

Fulcrum

Effort
(the direction of the arrow can change)



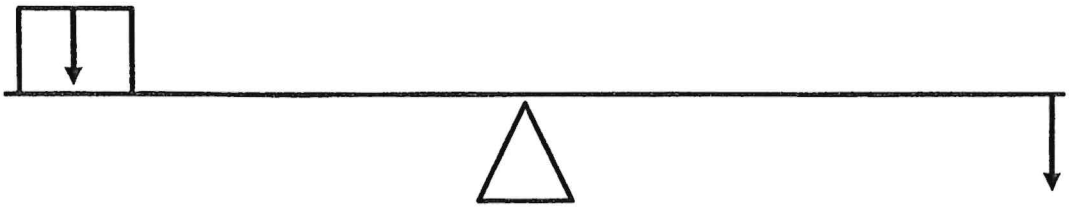
Resistance/Load
(the direction of resistance depends on the type of lever system, but it always works against the effort)

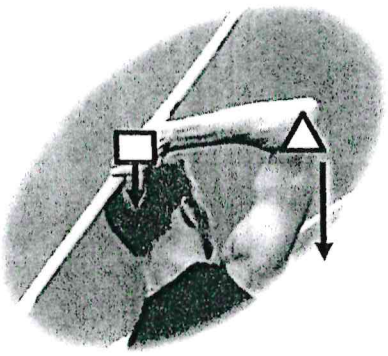
Revision Tip!

Remembering the order of the components of lever systems is as easy as '**123... FLE**'. This tells you what the middle component will be for each lever system (first-class lever system = fulcrum, second-class = load, and third-class = effort).

First-class Levers

First-class levers have the fulcrum placed between the effort and resistance. This is represented as follows:





Take this javelin thrower who is about to extend his elbow. The resistance is his hand and the weight of the javelin. The fulcrum point is his elbow and the effort is his triceps contracting, pulling downwards.

Revision Tip!

In this example, the resistance acts in the same direction as the effort. Think of this lever as a see-saw. Even though the resistance is acting in the same direction as the effort, the location of the fulcrum means that it creates an opposing force to the effort.

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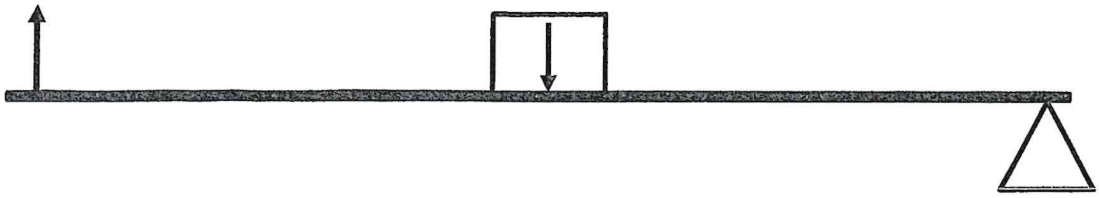
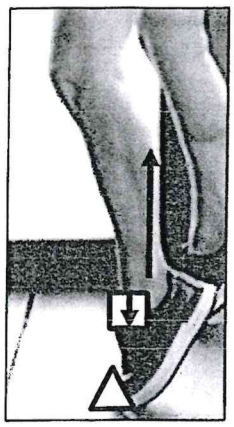
Second-class Levers

Second-class lever systems have the fulcrum at a far end of the lever, then the resistance next closest to it and finally, the effort at the opposite end of the lever:





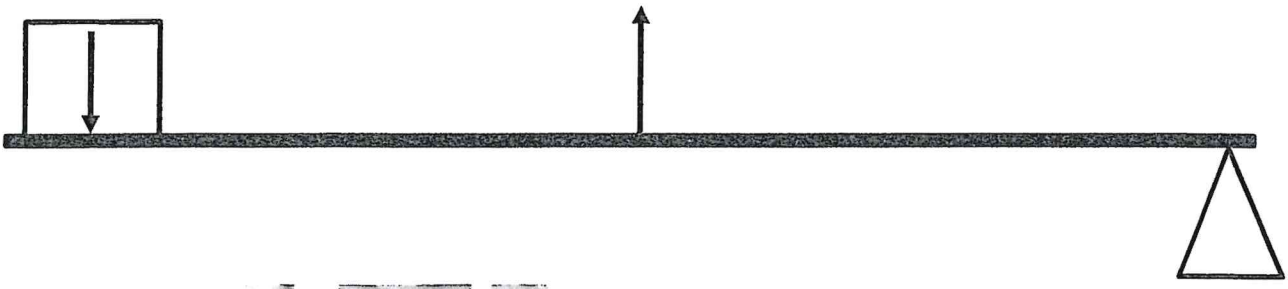
REVISION TIP!

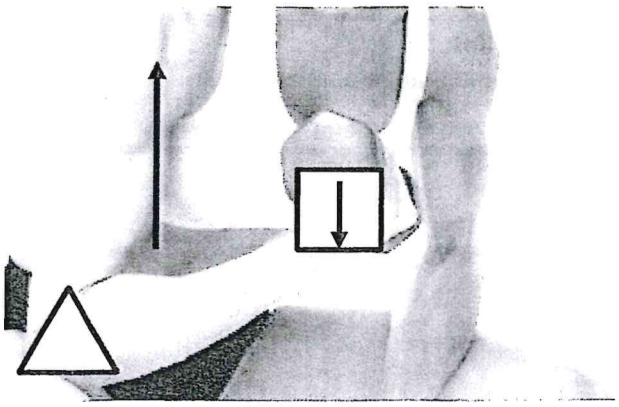
In this example, the resistance acts in the opposite direction to the effort. Think of this lever as a wheelbarrow.

When someone performs dorsiflexion, they are using a second-class lever system. The fulcrum is located at the toes, with the resistance being the mass of the leg and foot pulling downwards. The effort comes from the gastrocnemius, pulling the ankle upwards to go onto tiptoes.

Third-class Levers

Third-class lever systems have the fulcrum at a far end of the lever, then the effort next closest to it and, finally, the load at the opposite end of the lever:





When someone performs a bicep curl, flexing the elbow, they are using a third-class lever system. The fulcrum is at the elbow joint. The resistance is located at the hand/weight and the effort originates at the biceps, lifting the lower arm.

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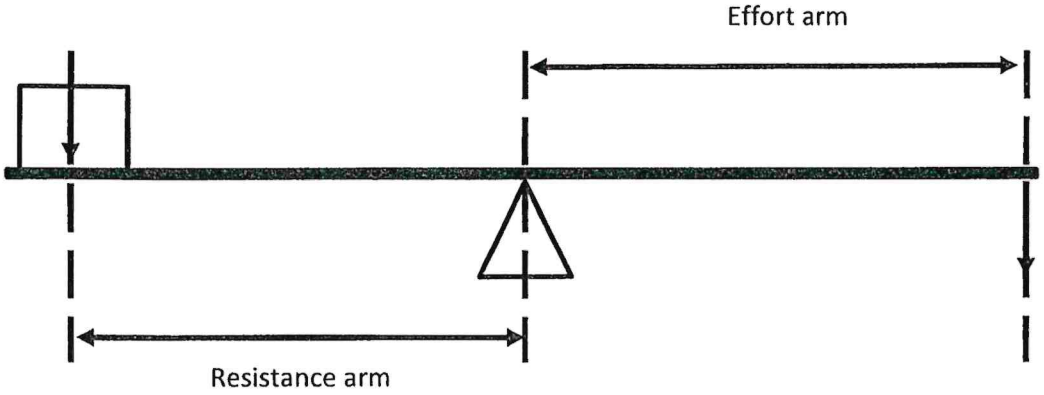
Mechanical Advantages

In levers, different systems have different **mechanical advantages**. The mechanical advantages help an element of movement within that particular lever system. Mechanical advantage can be calculated by dividing the **effort arm** length by the **resistance arm** length.

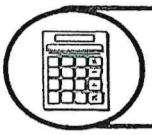
- Resistance arm – the distance between the fulcrum and the resistance/load
- Effort arm – the distance between the fulcrum and the effort

For example, in a first-class lever system:



REVISION TIP!

The resistance arm length and the effort arm length change, depending on the location of the fulcrum, resistance and effort.



Mechanical advantage = effort arm ÷ resistance arm

Lever System	Mechanical Advantages
First-class	• Movements can be balanced • Wider range of movement than second-class lever
Second-class	• Can move a large load with a small effort • Can only move the large load over a small range of movement
Third-class	• Movement can be completed quickly over a large range of motion

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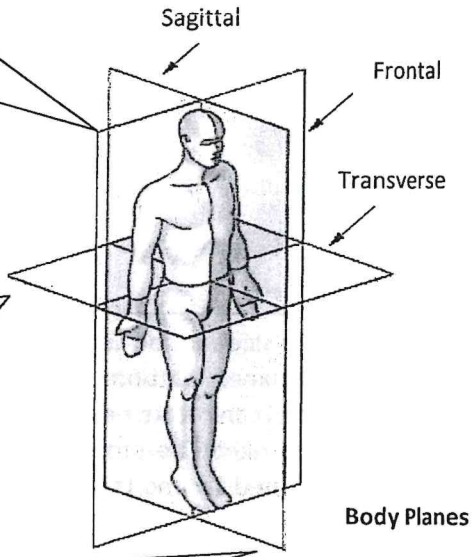
Planes and Axes of Movement

Whenever a movement is being completed by a body, it is acting in one of three **planes**: frontal, transverse or sagittal.

Frontal
The frontal plane divides the body into front and back, which means any **sideways motion** in line with this plane occurs in this plane. Elevation, depression, adduction and abduction are the common movements which take place in this plane, e.g. cartwheel.

Transverse
The transverse plane divides the body into upper and lower parts, which means any **rotational motion** occurs in this plane. Horiztonal extension, horizontal flexion, rotation, pronation and supination are common movements which take place in this plane (e.g. golf drive).

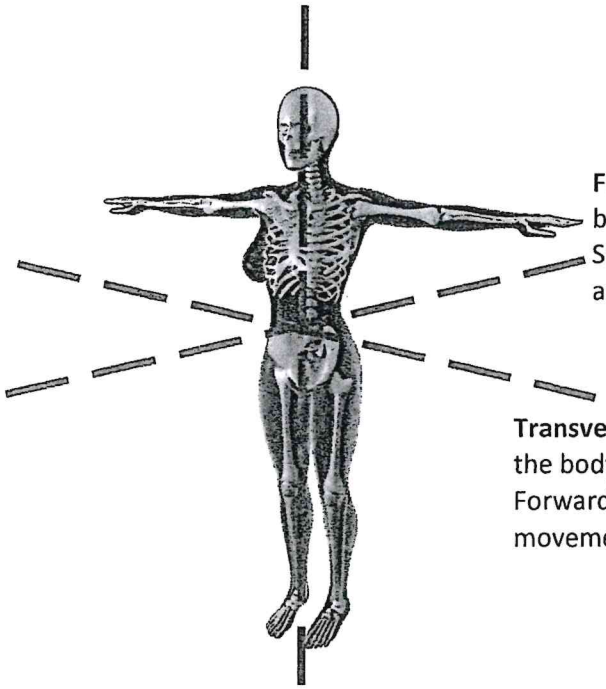
Sagittal
The sagittal plane divides the body into a right side and a left side, with **forwards or backwards motion** in line with this plane occuring in the sagittal plane. Plantar flexion, dorsiflexion, extension and flexion are the movements that take place in this plane (e.g. somersault).



Body Planes

Movements also occur around one of three axes. These are called the **axes of rotation**. There are three axes of rotation: longitudinal, sagittal and transverse.

Longitudinal axis – travels through the head down to the feet. Rotational movements occur around this axis.



Frontal axis – passes through the body from the rear to the front. Side-to-side movements occur around this axis.

Transverse axis –passes through the body from right to left. Forwards and backwards movements occur around this axis.

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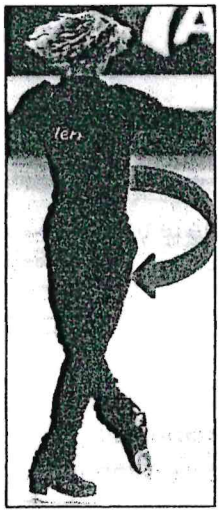
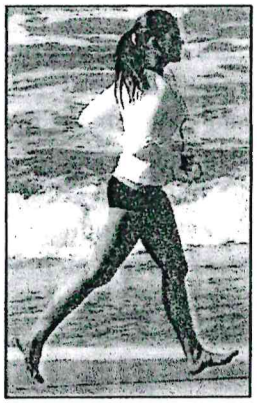
Linking Planes of Movement to Axes of Movement

When a movement is completed by the body, it is acting in both a plane of movement and an axis of movement at the same time. Consider the following examples:

A cartwheel is a side-to-side motion so it is acting in the frontal plane. Rotation is occurring so that the girl can rotate her whole body from left to right. Therefore, the cartwheel is performed around the frontal axis.



When this ice skater is spinning on the spot, he is moving in the transverse plane and around the longitudinal axis.



Running is a forwards motion, so it occurs in the sagittal plane. Running occurs around the transverse axis.

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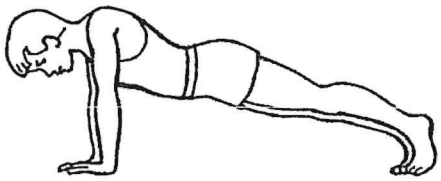
In Chapter 1, you revised the types of movement that can occur at specific joints and the muscles that cause the movements. You should now be able to analyse sporting examples and the types of movement occurring at joints, the planes and axes the movement occurs in, and the type of contraction taking place.



Upwards Phase

Movement at elbow: extension

Agonist: triceps

Type of contraction: concentric

Plane of movement: sagittal

Axis of movement: transverse

Downwards Phase

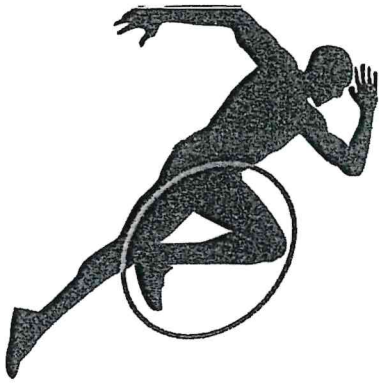
Movement at elbow: flexion

Agonist: triceps

Type of contraction: eccentric

Plane of movement: sagittal

Axis of movement: transverse



Drive Phase

Movement at ankle: plantar flexion
Agonist and contraction: gastrocnemius, concentric

Movement at hip: extension
Agonist and contraction: gluteals, concentric

Movement at knee: extension
Agonist and contraction: quadriceps, concentric

Plane of movement: sagittal

Axis of movement: transverse

Recovery Phase

Movement at ankle: dorsiflexion
Agonist and contraction: tibialis anterior, concentric

Movement at hip: flexion
Agonist and contraction: hip flexors, concentric

Movement at knee: flexion
Agonist and contraction: hamstrings, concentric

Plane of movement: sagittal

Axis of movement: transverse

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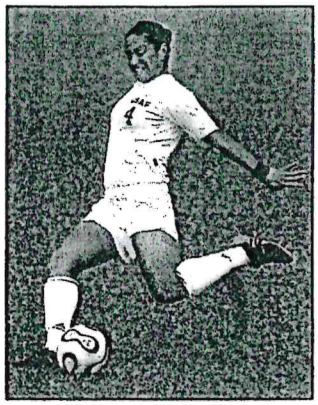


Execution Phase When Kicking (Left Leg)

Movement at ankle: plantar flexion
Agonist and contraction: gastrocnemius, isometric

Movement at hip: flexion
Agonist and contraction: hip flexors, concentric

Movement at knee: extension
Agonist and contraction: quadriceps, concentric

Plane of movement: sagittal

Axis of movement: transverse

Cricket Bowl

Movements at shoulder: rotation and extension
Agonists: rotator cuff muscles and deltoids

Plane of movement: transverse

Axis of movement: longitudinal

Squat – Downwards Phase

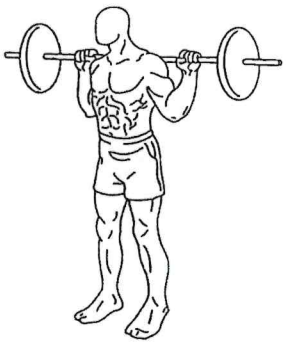
Movement at ankle: dorsiflexion
Agonist and contraction: gastrocnemius, eccentric

Movement at hip: flexion
Agonist and contraction: gluteals, eccentric

Movement at knee: flexion
Agonist and contraction: quadriceps, eccentric

Plane of movement: sagittal

Axis of movement: transverse



Squat – Upwards Phase

Movement at ankle: plantar flexion
Agonist and contraction: gastrocnemius, concentric

Movement at hip: extension
Agonist and contraction: gluteals, concentric

Movement at knee: extension
Agonist and contraction: quadriceps, concentric

Plane of movement: sagittal

Axis of movement: transverse

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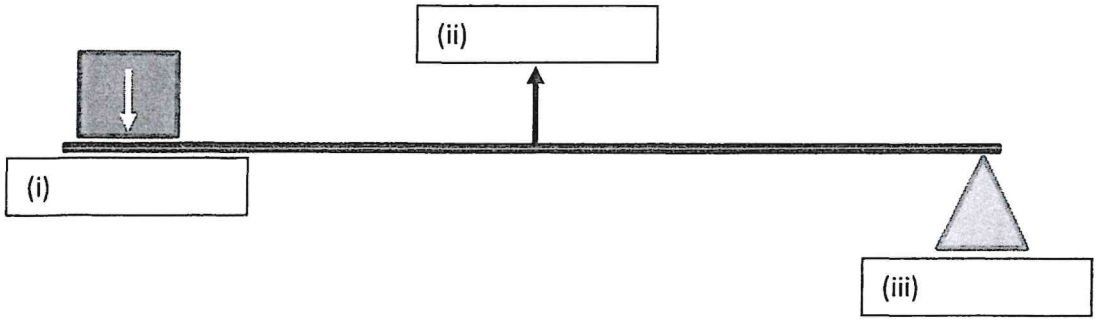
1. Label the following lever systems, identifying the fulcrum, effort and resistance and name the type of lever system. **THIRD-CLASS and FIRST-CLASS**

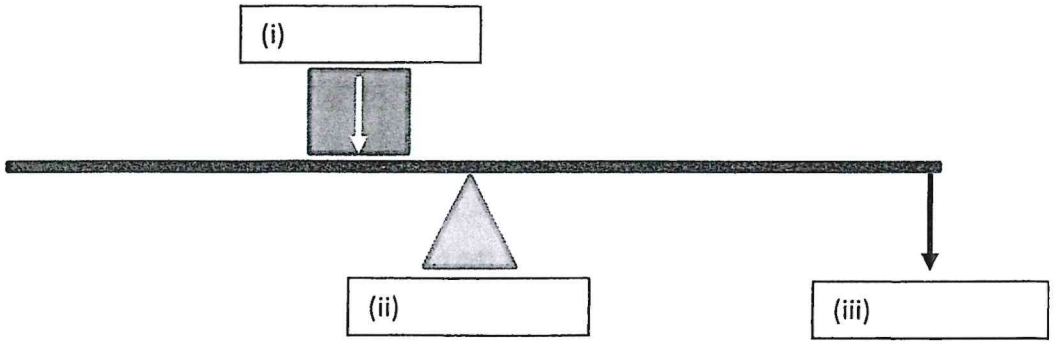
a)

Type of lever system:



b)

Type of lever system:



2. Draw a second-class lever system occurring at the ankle.

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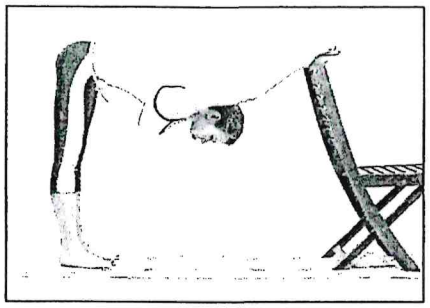
3. Name the mechanical advantage of a second-class lever system.

.....

.....

4. a) A ballerina bends forwards and stretches before practice in the position shown.



What plane and axis of movement is the skill being performed in?

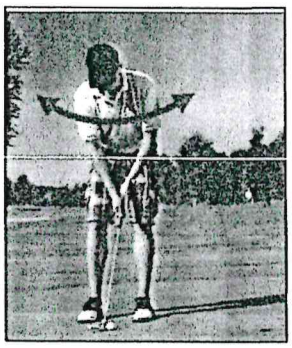
Plane of movement: .....

.....

Axis of movement: .....

.....

b) A golfer is performing a putt.



What plane and axis of movement are the shoulders and arms moving in?

Plane of movement: .....

.....

Axis of movement: .....

.....

c) A cricket batsman twists his upper body to hit the ball away from the fielders.

What plane and axis of movement is the skill being performed in?

Plane of movement: .....

.....

Axis of movement: .....

.....

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1. At the moment of take-off, a high jumper plantar flexes to start their jump.

   Identify the type of lever being used and describe the mechanical advantage of this lever system.

   .....

   .....

   .....

   .....

   .....

   .....

   (2 marks)

2. It is important to know the mechanical advantage a lever system has, to assess the efficiency of movement.

   How is mechanical advantage calculated?

   .....

   (1 mark)

3. Below is an image of an ice skater skating in a straight line.

   Identify the plane of movement and axis of movement that the ice skater is completing her skill in.

   Plane: .....

   Axis: .....

   (2 marks)

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Chapter 6: Health and Fitness

Learning objective: To develop your knowledge and understanding of the terms 'health' and 'fitness', fitness tests used in sport and the importance of fitness components to athletes

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to define 'health' and 'fitness'			
Describe the relationship between health and fitness			
Explain the effects of lifestyle choices on health and fitness			
Be able to name, describe and give a sporting example of the components of fitness			
Be able to analyse the reasons for, and limitations of, fitness testing			
Be able to describe the process of different fitness tests and any drawbacks to the tests			

Key Terms

1. **Health** – a person's social, mental and physical well-being
2. **Fitness** – an individual's ability to cope with the stresses and challenges of their environment
3. **Obesity** – having a BMI of over 30
4. **Components of fitness** – the broad term used to identify the individual elements of fitness; for example, agility, speed and strength
5. **Validity** – the level to which the test being performed is testing what it is supposed to test
6. **Reliability** – whether a test produces the same or similar results if repeated
7. **Qualitative data** – data based on subjective, opinion-based measurements
8. **Quantitative data** – data based on numbered, objective measurements

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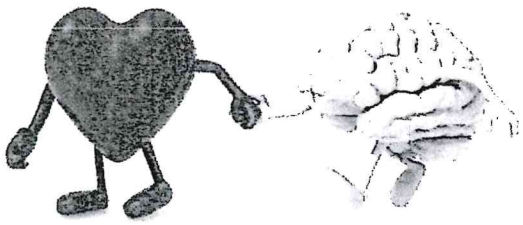
The Relationship between Health and Fitness

Health and fitness are two terms that are often used interchangeably but it is important to know the difference between the two.

- **Health** is defined as a person possessing **social, mental** and **physical** well-being.
- **Fitness** is defined as an individual's ability to cope with the stresses and challenges of their environment.



Linking Health and Fitness

You should know the factors and influences of fitness on a person. However, it is also important to consider the link between health and fitness. For example, poor health can lead to a reduced fitness level because of the inability to train. Also, remember that while a person may have ill-health (e.g. depression), they may still be able to train, increasing fitness levels.

Poor health, such as:

Social

- Limited social life
- Not having many friends
- Not meeting new people
- Not working or interacting with groups

Mental

- Depression
- Anxiety
- Stress

Physical

- Obesity
- Improved heart function
- Improved immune system
- Improved efficiency of body systems (e.g. respiratory, immune and cardiac)

Can lead to decreased fitness levels as you are often unable to train or are demotivated to train!*

On the flipside, you may be unfit, e.g.:

- Not being strong enough to carry out everyday tasks
- Lacking energy and stamina
- Feeling lethargic

However, just because you are unfit, does not mean you cannot train. You are still able to train and increase your overall fitness levels.*

***Note:** Health and fitness are covered in more detail in Paper 2 – see *Physical, emotional and social health, fitness and well-being*.

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Components of Fitness

'Fitness' is made up of many different components that are key to successful performance. The components of fitness of most importance will vary between sports and activities. It is important that you can apply the components of fitness to a relevant sporting example and give reasons why that component of fitness is important to the sporting example.

Component of Fitness	Definition	Sporting Example	Importance of Fitness Component to Sporting Example
Agility	Being able to change direction at speed, maintaining control throughout.	Rugby scrum half performing a 'dummy' and changing direction to make a break	The player is required to fool the opponents before quickly changing direction to make a break.
Balance	The ability to keep the centre of mass over the base of support.	Gymnast performing a routine on the balance beam	The gymnast must have good balance to stay atop the balance beam while performing the skills in the routine.
Cardiovascular endurance	The ability of the cardiovascular system to supply the body with oxygenated blood for a continuous period of time.	Marathon runner	The marathon runner needs a sufficient supply of oxygen to reach the working muscles to maintain performance and minimise fatigue through the long race.
Coordination	The ability to use more than one body part at the same time efficiently.	Tennis player responding to a serve	The tennis player must have the ability to efficiently move their legs to move into position and swing their arm (hand–eye coordination) to return the ball.
Flexibility	The range of movement about a joint.	Gymnastics floor routine	When performing a floor routine, a gymnast must have good flexibility to contort their body into different positions.
Muscular endurance	The ability of muscles to perform continuous contractions without fatigue.	800m freestyle swimmer	The swimmer requires muscular endurance to produce powerful muscular contractions to move through the water as quickly as possible, over a long distance / period of time.
Power / explosive strength	The ability of muscles to produce strength at speed (strength × speed).	Throwing a javelin	The javelin thrower needs power / explosive strength to produce a large force quickly, throwing the javelin at the highest velocity possible.
Strength (maximal, static, dynamic and explosive)	Maximal – largest force created in a single contraction	Weightlifting	Deadlift – the weightlifter needs maximal strength to lift the weight quickly, in a single movement.
	Static – contracting a muscle without changing its length	Rugby scrum	Rugby scrum – in an even rugby scrum, the team must contract their muscles to remain stationary.
	Dynamic – performing repeated contractions over a long period of time	Sprint cycling	Sprint cycling – the cyclist must produce powerful contractions over a long period of time.
Speed	The rate at which a movement is performed over a specific distance (speed = distance / time).	100 m sprinter	A 100 m sprinter needs speed to cover the 100 m in the quickest time possible.
Reaction time	The time taken for a human to respond to a stimulus.	A rugby player who is defending, reacting to a sidestep performed by an opponent	The defender needs good reaction times to identify that a sidestep has taken place and to readjust their body / running line to catch and tackle the opponent.

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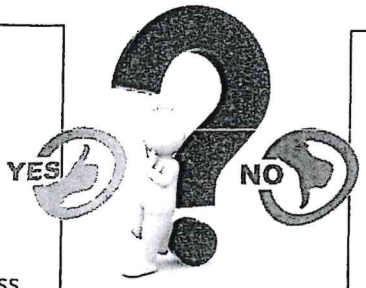
Reasons for and Limitations of Fitness Testing

Components of fitness should be carefully monitored and measured to assess progress, health and fitness of an individual. This can be important for recreational athletes as well as professional athletes.

Reasons for Fitness Testing

- Identifying strength and weaknesses in performance
- Assessing the influence of a training programme
- To establish starting levels of fitness
- The establish end level of fitness (following a training programme)
- To adapt training programmes to the athlete's needs
- To compare fitness levels to national averages
- To aid goal-setting
- To motivate an individual



Limitations of Fitness Testing

- Many tests are not sport-specific and so do not represent the actual skills being performed in the sport
- Test may not replicate the movements involved in the sport
- Do not replicate the conditions faced when in a competitive situation
- Validity of tests is dependent on correct procedures and knowledge of the tester
- Validity and reliability of submaximal and indirect measurement methods unknown or questionable

Validity and Reliability

Validity – the level to which the test being performed is testing what it is supposed to test. For example, using shoe size to estimate the height of a person is not a valid test. However, using a tape measure to measure height is a valid measurement.

Reliability – the 'repeatability' of the test, i.e. if the test was repeated, whether it would produce the same or similar results.

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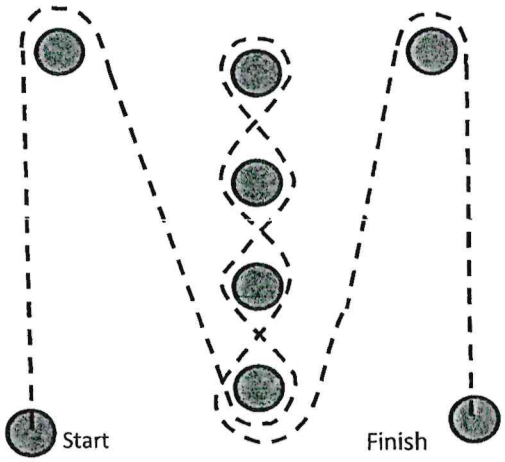
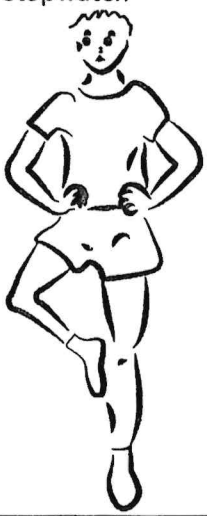
Measuring Components of Fitness

As fitness is a key component of success in sport at all levels, it is important to be able to measure components of fitness to track progress of athletes. For example, if a player has just been signed to a new football club, the new club will perform baseline fitness tests when they arrive. Periodically following periods of training, the same fitness tests will be performed to see whether the player has improved or not and to give them targets to become better players. The main fitness tests used in sport are outlined below. Remember, not all athletes will perform all of these tests – it depends on what components of fitness are important in their sport. For example, a weightlifter will not perform agility tests as agility does benefit their performance.

Agility – Illinois Agility Test

Equipment and Set-up	Protocol
• Cones, measuring tape, stopwatch • Four 'external' cones make up a 5 × 10 m rectangle • Four 'internal' cones are placed in a straight line within the rectangle 	1. Performer begins lying face down on the floor 2. Performer must run to the far end of the rectangle and back 3. Performer must then run around all four of the internal cones 4. Performer runs back to finishing cone

Balance – Stork Test

Equipment and Set-up	Protocol
• Stopwatch 	1. Performer stands upright with two feet firmly on the ground, with their hands on their hips 2. One leg is lifted with the foot placed on the inside of the 'standing' leg 3. The performer balances in this position for as long as possible 4. The time that they are able to hold the pose for is their score

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Cardiovascular Endurance – Multistage Fitness Test / Bleep Test

Equipment and Set-up	Protocol
• Cones, tape measure, CD instructions • Start and end cones placed opposite each other at a 20 m distance 	1. The performer must run the 20 m distance in the set time given by the 'bleeps' of the CD instructions 2. The time between the bleeps gets shorter so the performer will have to get faster to cover the distance in time 3. The performer continues until they cannot keep up with the pace of the bleeps 4. The 'level' (e.g. speed 5, round 6) that the athlete reaches before not being able to continue further is their score

Coordination – Wall Toss Test

Equipment and Set-up	Protocol
• Ball, flat wall, stopwatch and observer • Performer stands with two feet on the floor, 2 m away from the wall	1. The performer throws the ball against the wall using one hand 2. The ball is caught with the opposite hand 3. This is repeated for 30 seconds 4. The amount of times the ball is thrown and caught is counted

Flexibility – Sit-and-Reach test

Equipment and Set-up	Protocol
• Box with distance (in cm and/or inches) measured out on top of it • Performer starts with their feet flat against the side of the box, sitting upright 	1. The performer gradually moves forward while sitting with their arms outstretched 2. They try to reach as far along the top edge of the box as possible, alongside the measurement marks 3. The distance that the performer reaches (in cm or inches) is recorded

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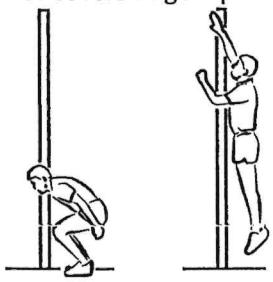
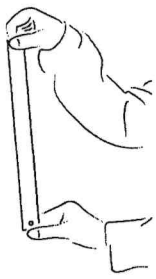
Muscular Endurance – Sit-up Bleep Test

Equipment and Set-up	Protocol
• Working in pairs, gym mat, CD instructions	1. One person is completing the sit-ups, the other is supporting the performer's ankles 2. The CD bleeps twice – once for the upwards phase of the sit-up and once for the downwards phase 3. The performer must keep in time with the bleeps 4. The bleeps get faster and so the performer must complete the sit-ups faster 5. The number of sit-ups completed in one minute is recorded

Power / Explosive Strength – Vertical Jump Test

Equipment and Set-up	Protocol
• Flat wall with distance marked up it, chalk • Performer covers fingertips with chalk 	1. The performer starts with their side to the wall 2. With their feet flat on the ground, they reach up and mark the wall – this is their standing reach height 3. The performer completes a maximal vertical jump and marks the wall at the peak height of their jump, with their arm outstretched 4. The distance (in cm or inches) between the standing reach height and the peak height is the jump height of the performer

Reaction Time – Ruler Drop Test

Equipment and Set-up	Protocol
• Metre ruler 	1. An assessor holds the ruler vertically, starting above the performer's hand 2. The performer has their hands open in front of them, ready to catch the ruler 3. The assessor drops the ruler and the performer must catch it as quickly as they can 4. The distance (cm) along the ruler that the performer catches the ruler is recorded

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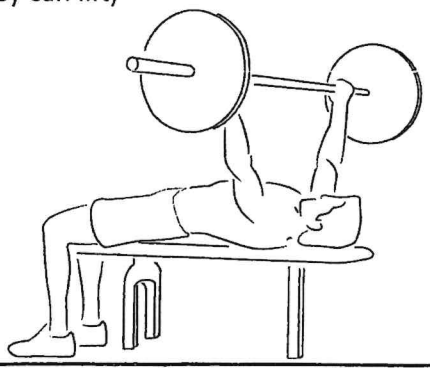
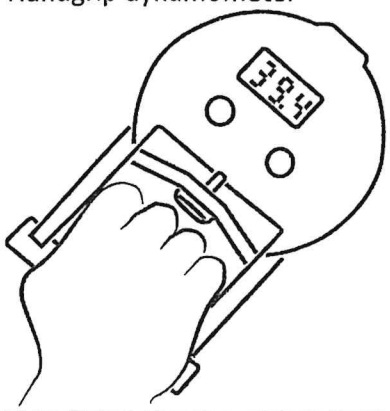
Maximal Strength – One-rep Max Test

Equipment and Set-up	Protocol
• Weights, bench press machine • Performer must know, or work out, their maximum one-rep max (the maximum amount they can lift) 	1. The mass of the one-rep max is divided by body weight to give a score 2. Score is compared to previous research data 3. Maximal strength test = mass (kg) ÷ body mass (kg)

Speed – 30 m Sprint

Equipment and Set-up	Protocol
• Cones, tape measure, stopwatch • Two cones placed 30 m apart to mark start and end of sprint 	1. Performer is timed from a flying start (they get a run-up before the starting cone) 2. Time is recorded for the performer to run 30 m

Strength – Handgrip Dynamometry

Equipment and Set-up	Protocol
• Handgrip dynamometer 	1. Dynamometer held in dominant hand 2. Arm should be at 90 degrees with the elbow held against the body 3. Hand needs to squeeze the dynamometer as hard as possible 4. Score is recorded in kilograms (kg) and pounds (lbs) of force

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Test Measurements and Considerations

When completing fitness tests it is important to know what you are measuring (e.g. distance, force, size) as well as what type of data you are collecting. Some key terms to know are:

- **Qualitative data** – measurements based on opinions, thoughts and observations. Subjective, rather than objective.
- **Quantitative data** – measurements based on numbered measurements. Factual evidence with no opinions given. Objective data.
- **Time** – how long something takes place for, measured in seconds or minutes
- **Distance** – the space between two points, e.g. measured in centimetres and metres
- **Mass** – how much matter or 'stuff' is within something, measured in kilograms
- **Weight** – the force that gravity places on an object due to its mass (weight = mass × acceleration due to gravity)

Normative Data

As previously mentioned, scores from fitness tests can be compared to old scores achieved by the athlete, to see whether they have improved or declined in performance. Another way that scores can be assessed is to compare scores to **normative data**. Normative data is data collected by researchers that is representative of a particular population. It can be grouped into categories such as age, gender and playing ability. This allows someone to complete a fitness test and compare their result to someone in a similar situation as them. For example, an average male aged 69 could complete handgrip dynamometry and compare their score to other males in the over 65 normative data table. This would allow them to see whether they are stronger or weaker than the majority of people their age.

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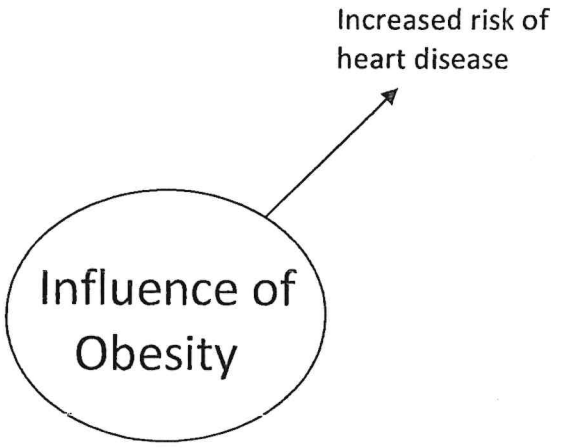
1. Name the three components of health.

   1. .....

   2. .....

   3. .....

2. Complete the mind map by naming the influences of obesity on physical health and well-being.



3. Give a definition of **agility** and **speed**, and then give a sporting example of an athlete who needs both agility and speed to perform successfully in their sport.

   Agility: .....

   .....

   Speed: .....

   .....

   Sporting example: .....

   .....

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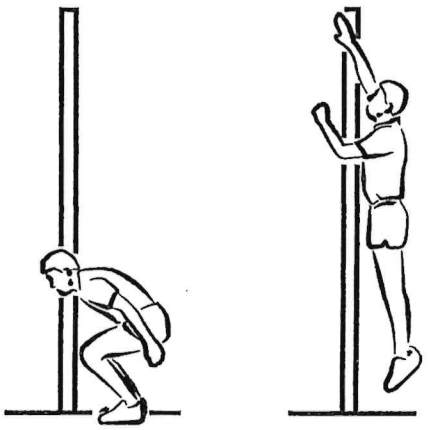
4. Identify the test represented by the image below. Describe the protocol and the equipment needed.



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1. Which **one** of the following tests is most suitable for assessing the coordination of a diver?

   A. Wall toss test ☐
   B. Vertical jump test ☐
   C. Sit-up bleep test ☐
   D. 30 m sprint ☐

(1 mark)

2. Athletes in sport regularly monitor their fitness levels using a variety of tests.

   Outline two reasons why fitness tests can be limited.

   1. .....

   2. .....

(2 marks)

3. Using a sport of your choice, outline the fitness tests used to measure muscular endurance and coordination, and justify their usefulness for athletes in your chosen sport.

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(9 marks)

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Chapter 7. Principles of Training

Learning objective: To develop your knowledge and understanding of the principles of training and the application of training principles to different athletes' training programmes

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to name, describe and apply the principles of training (SPORT)			
Be able to name, describe and apply the principles of overload (FITT)			
Be able to name and describe the different types of training, the purpose of each training method, training thresholds and rest periods required between sessions			
Be able to analyse types of training			

Key Terms

1. **Specificity** – how relevant training methods are to the sport or goal
2. **Progressive overload** – making training gradually harder in intensity or longer in duration to encourage positive adaptions from training
3. **Reversibility** – term given to explain that positive effects of training will be lost if training is not maintained
4. **Tedium** – being bored or uninterested
5. **Overload** – training should push the body harder each time, to maximise the benefits of training
6. **Frequency** – the number of times a person completes training
7. **Intensity** – how hard a performer works during training
8. **Time** – how long training takes place for
9. **Type** – the method or type of training used and its relevance to the sport or goal being trained for
10. **Circuit training** – training that consists of numerous stations, each targeting a specific component of fitness
11. **Continuous training** – exercise completed for a prolonged period of time, at a constant pace, without rest
12. **Fartlek training** – a mixture of continuous and interval training – the speed of exercise is manipulated
13. **Interval training** – high-intensity activities followed by periods of rest or low-intensity exercise
14. **Static stretching** – stretching a limb to its maximum range of movement and holding the stretch for a prolonged period of time
15. **Weight training** – the use of free weights to improve elements of strength and power
16. **Sets** – made up of reps; a specified number of reps constitutes a set
17. **Recovery** – the amount of time given to allow the body to replenish energy
18. **Repetitions/reps** – the number of times a skill or activity is carried out (in weight training it is the number of times a weight is lifted)
19. **Plyometric training** – high-intensity exercise involving hopping and bouncing movements
20. **Training zone** – the workload in which an athlete trains to improve a particular fitness component

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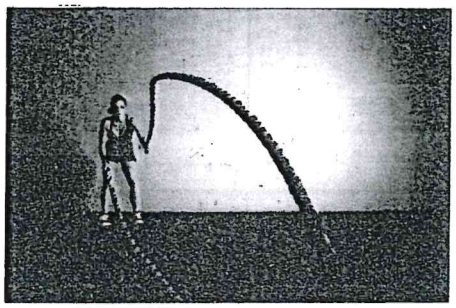
Principles of Training and Overload

When planning a training programme the key principles of training and overload should be considered to maximise the positive effects of training.

Principles of Training (SPORT)

Principle	Description	Example
Specificity	The training should be specific to the sporting event that is being trained for.	A 100 m sprinter wouldn't find long-distance running beneficial to their sport.
Progressive **O**verload	The training should gradually progress in difficulty in either difficulty or intensity. This helps to prevent the performer plateauing in their progress. This can be achieved by using the principles of overload when training. This involves pushing the body past its normal level of intensity	A tennis player working at high intensities each session to allow them to work anaerobically for longer during a rally.
Reversibility	Regular training ensures positive adaptions due to training won't be lost (reversed)	A long-distance runner's muscular endurance will decrease if they cease to train due to an injury.
Tedium	Training should be varied with different activities to prevent boredom of the athlete	A golfer should not practise just putting for hours every day. They should vary activities to include different shots, different locations, different clubs, etc.



Principles of Overload (FITT)

The principle of overload in training is that training should constantly push the body further than last time. To do this efficiently, the following principles of overload should be followed:

Principle	Description	Example
Frequency	The number of times an individual participates in training.	This can vary depending on the training type, but involves how often they train, e.g. three times a week.
Intensity	How hard the performer is working during the training regime.	This can vary according to training type, but could include the weight they are lifting, or the aerobic/anaerobic capacity within which they are working.
Time	The duration of the training session.	One hour for continuous low-intensity training may be fine, but 20 minutes is sufficient for high-intensity interval training.
Type	Refers to the type of exercise being completed. Activities should be specific to the sport the performer participates in.	Whether it's aerobic or anaerobic and the type, e.g. continuous training for marathon runners (see next page).

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Types of Training

Different types of athlete must use the correct type of training to improve specific elements of their performance. Each type of training is suited to a specific type of athlete or to specific training goals.

Training Type	Outline	Training Purpose	Considerations	Training Threshold	Rest/Recovery
Circuit	Numerous stations that can be adapted to the training needs. Commonly formed of numerous stations.	Target different muscle groups or components of fitness (e.g. strength/endurance)	• Space needed/available • Equipment needed/available • Number of stations	Can be adapted to suit specific components of fitness	• 30-minute sessions • 30 seconds rest between each station • 3 complete circuits to be completed
Continuous	Exercise completed continuously without rest breaks at a constant level of intensity	Improve cardiovascular and respiratory endurance	• Should be at an intensity that pushes the athlete, but which is still maintainable over a long period of time • Should be specific to sport	• Calculated as a percentage of maximum heart rate • Aerobic exercise → 60 – 80% maximum heart rate	• ~ 3 times a week • 20-minute sessions • Days off (~ 4 days a week)
Fartlek	A mixture of continuous and interval training. Fartlek training varies the intensity of exercise.	Improve cardiovascular and respiratory endurance	• Intensity should vary • Exercises should be sport-specific (e.g. games players running, then jogging, then running again) • Ensure both aerobic and anaerobic systems are worked	• Dependent on aerobic/anaerobic system and training goals	• Dependant on intensity / duration of training
Interval	High-intensity activities followed by periods of rest or low-intensity exercise	Muscular endurance	• Work-to-rest ratio • Intensity of exercise for beginners	Depending on training aim: • Aerobic exercise → 60 – 80% maximum heart rate • Anaerobic exercise → 80% – 100% maximum heart rate	• 2:1 work-to-rest ratio
Static (stretching)	A type of stretching that involves a muscle contraction remaining at the same length (isometric contraction). Stretching to the muscle's limit for approximately 30 seconds.	Increase flexibility	• Do not 'bounce' when stretching • Do not overstretch muscles (injury risk)	N/A	• Stretches to be held for 30 seconds

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Training Type	Outline	Training Purpose	Considerations	Training Threshold	Rest/Recovery
Weight	Using free weights to target and improve specific muscles or muscle groups. Made up of 'sets' and 'reps'	Increase strength	• Correct technique avoids injury • Spotters should be used at all times	• Dependent on aim of training • One-rep max = maximum weight that can be lifted in a single contraction • Increased strength = low reps, high weight (~70% 1RM, 4–8 reps) • Increased muscular endurance = low weight, high reps (<70% 1RM, 12–15 reps)	• Period of rest following each set
Plyometric	High-intensity jumping/hopping activities. Eccentric contraction – large concentric contraction.	Increase power	• Injury risk higher than other forms of training	• High intensity • Short duration	N/A

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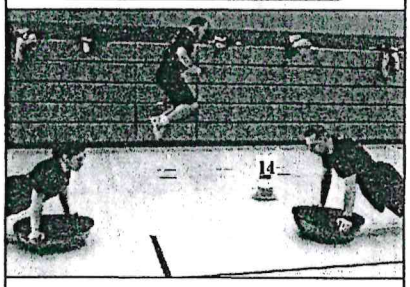
Advantages and Disadvantages of Training Types

Circuit Training



Advantages

- Training can be adapted to make activities simple or complex and different in intensity
- Adaptable for training different components of fitness
- Can be adapted to suit age and fitness levels
- Easy to monitor progress

Disadvantages

- Large space required to make circuit
- May require specialist equipment for certain activities
- May be difficult to appropriately set work:-to-rest ratio

Continuous Training

Advantages

- Little or no equipment required
- Running can be completed nearly everywhere
- Simple and cheap to do

Disadvantages

- Can become tedious
- Injury due to repetitive overuse of limbs and muscles (e.g. shin splints)
- Can take a long time to complete
- Only 100% suitable for continuous sports (e.g. running and swimming)

Fartlek Training

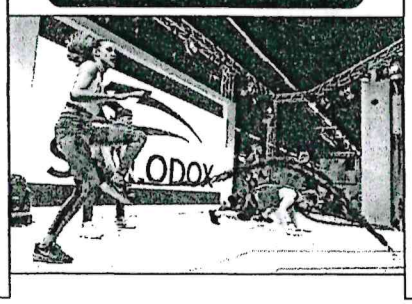
Advantages

- Is more varied than continuous training – reduces tedium
- Can be tailored to suit more 'game' sports (e.g. football, hockey, basketball)

Disadvantages

- Not suitable for all sports/athletes

Interval Training



Advantages

- Burns off body fat (weight loss)
- Can be adapted easily to suit athlete
- Can be quick to complete
- Can be used to improve both the aerobic and anaerobic systems

Disadvantages

- Overtraining / high intensities can lead to injury
- High motivation levels are required by the athlete
- Exercise intensities too high can lead to nausea

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Static Stretching

Advantages

- Increased flexibility
- Can be completed by anyone
- Limited risk of injury

Disadvantages

- Overstretching can lead to injury
- Time-consuming

Weight Training

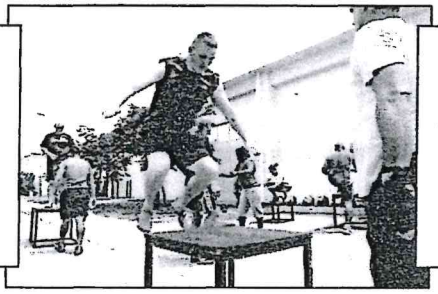
Advantages

- Can be adapted to suit different components of fitness
- Relevant to any sport
- Relatively simple to complete
- Limited equipment required

Disadvantages

- High risk of injury (weight too heavy or incorrect technique)
- High levels of motivation required

Plyometric Training



Advantages

- Improves power, speed and strength
- Relatively little equipment required

Disadvantages

- High risk of injury

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1. Match the principles of training to the correct statements.

Specificity	*'I was recently picked to join the British squash team. My coach is making training sessions harder every week so I am at the right fitness levels to compete at the highest levels.'*
Progressive overload	*'I am a 200 m sprinter for my local athletics club. My coach has changed by training plan because before I included long jogs and agility training as part of my routine.'*
Reversibility	*'Sometimes I complete circuit training because it gives me a variety of activities to complete such as press-ups, skipping and lunges.'*
Tedium	*'I often vary my training routine by using different training methods, so that I don't get bored. This helps maintain my motivation levels.'*
	'I recently broke my leg in a rugby match so I cannot train or compete until it has healed.'
	'Sometimes I complete circuit training because it gives me a variety of activities to complete such as press-ups, skipping and lunges.'

2. Explain how the principles of overload should be used to improve the fitness and skills of a football player.

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3. For each of the following training types, name a sport or an athlete that would benefit from the training method, and justify why you picked that sport.

	Fartlek Training	Weight Training	Continuous Training	Static Stretching
Sport/ Athlete				
Justification				

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1. Continuous training is a popular training method.

   Discuss the suitability of continuous training for a football player.

   .....

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   .....

   (3 marks)

2. Training should be correctly tailored to the athlete taking part to maximise performance.

   Outline **two** principles of training that should be considered when planning a training session.

   1. .....

   2. .....

   (2 marks)

3. A hockey player is looking to apply the principles of overload in their training session. Evaluate the importance of this principle for training in hockey.

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   (6 marks)

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Chapter 8: Optimising Training and Preventing Injury

Learning objective: To develop your knowledge and understanding of injury prevention and methods used to optimise training. To develop knowledge of altitude training and seasonal training.

Knowledge Checklist

	Revised	Understood	What you need to do
Understand how to calculate and use training thresholds (weights and heart rates)			
Explain how training thresholds are used to train different fitness components			
Be able to describe strategies used to prevent injury			
Explain altitude training: how it is completed and the effects on the body			
Be able to describe the three seasons of training and what fitness components are trained in each season			

Key Terms

1. **Training threshold** – a performance threshold that an athlete exercises in (either by weight or heart rate)
2. **Maximal heart rate** – the maximum number of heartbeats per minute of an individual
3. **Aerobic training zone** – training aerobically, commonly exercising at 60–80% of maximal heart rate
4. **Anaerobic training zone** – training anaerobically at 80–90% of maximal heart rate
5. **One-repetition maximum** – the maximum weight an individual can lift in a single contraction
6. **Altitude** – the height of an object or area above sea level
7. **Pre-season** – period of time in an athlete's calendar following post-season and preceding competition season
8. **Competition season** – season in which athletes compete competitively (follows pre-season and precedes post-season)
9. **Post-season** – the rest period for athletes following competition season

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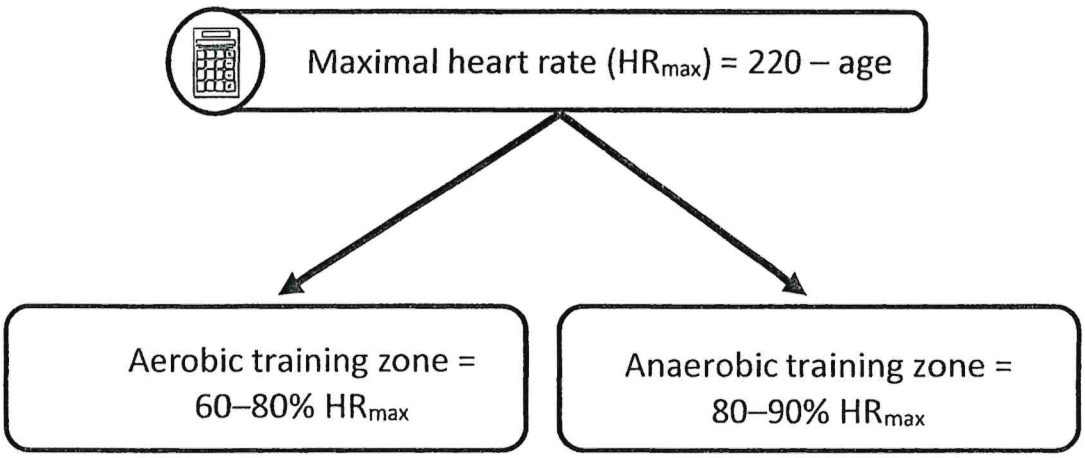
Optimising Training Effectiveness

When training, it is important to exercise at the correct intensity to effectively work a particular component of fitness. This is called a **training threshold**. Training types can also be adapted to benefit particular fitness aims; for example, circuit training can be altered by changing the activities at each station and the time-to-rest ratio between stations.

Calculating Training Thresholds/Zones

Training zones are used to control whether an athlete is working anaerobically or aerobically when exercising. To monitor whether an athlete is working aerobically or anaerobically, the athlete is instructed to work at a particular percentage of their maximal heart rate.



One-repetition Maximum (1RM)

When using weights, or when weight training, it is important for the athlete to know their one-repetition maximum (1RM). 1RM is the maximum weight an athlete can lift in a single contraction. This allows them to work at varying intensities of their 1RM, changing the type of training they are completing. In Chapter 6, the test to measure 1RM was outlined.

Equipment and Setup	Protocol
• Weights, bench press machine • Performer must know, or work out their maximum one-rep max (the maximum amount they can lift)	• The mass of the one-rep max is divided by body weight to give a score • Score is compared to previous research data • Maximal strength test = mass (kg) ÷ body mass (kg)

Strength/Power Training

70% of 1RM

Muscular Endurance

<70% of 1RM

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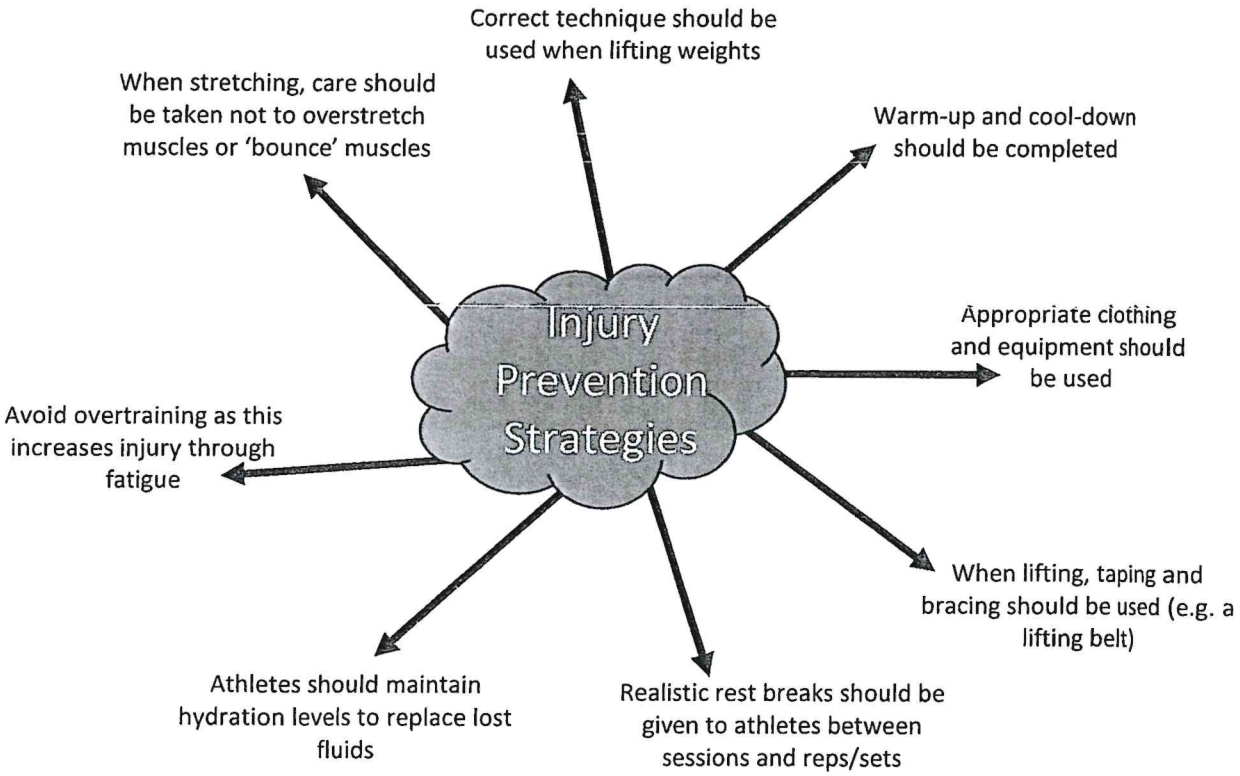
Sets and Reps

As strength/power training and muscular endurance training target very different fitness components, weight training must be adjusted to match this. This is achieved by altering the sets and reps an athlete completes. **Set** is the name given to a group of repetitions that will be completed one after another (e.g. one set may be comprised of 15 repetitions). A **repetition** is completing the movement once (e.g. lifting a weight once = 1 rep, lifting a weight five times = 5 reps).

- Strength/power training sets should use high weights and low reps – three sets of 4 to 8 reps
- Muscular endurance training sets should use lower weights but higher reps – three sets of 15 reps

Considerations in Preventing Injury

Training can benefit the performer in a wide range of ways, depending on the type of training they are completing. However, it is important to always complete training safely to avoid injury. If injury occurs, any benefits from training may be lost, as the performer cannot carry on training until they have recovered.



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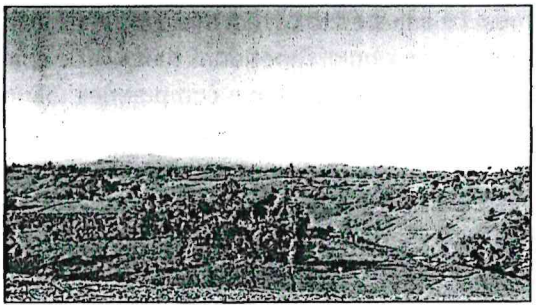
Altitude Training

Athletes who take part in aerobic events such as marathon running often resort to altitude training in order to maximise the adaptations that they experience during their training programme. Altitude training is the process of training in terrains high above sea level. At high altitude, there is less oxygen in the atmospheric air, reducing the capacity of blood being carried to the working muscle cells. This initially leads to a reduction in performance as an athlete finds it hard to breathe in enough oxygen to fuel their normal aerobic capacity. However, after acclimatising to the atmosphere, the athlete's body begins to produce more red blood cells. Having more red blood cells means more oxygen can be taken from the limited supply in the atmospheric air, and transported to the muscles.



Kenya is a popular place for runners to train. This is because Kenya has very high areas to train in. At its highest, the Kenyan landscape can reach up to 5,000 m – although runners wouldn't train this high!

Benefits of Altitude Training	Limitations of Altitude Training
• Benefits aerobic athletes, e.g. marathon runners, cyclists • Increased red blood cell count in the body • Increased aerobic efficiency once the athlete returns to sea level	• Effects of altitude training are not permanent • Some athletes will get altitude sickness • Training at altitude is hard – some athletes may not be able to complete training

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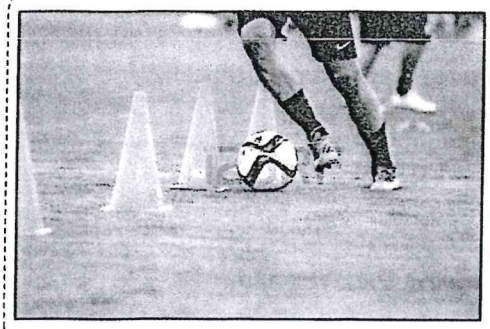
Seasons of Training

Within a year, or sporting calendar, athletes will go through three different 'seasons' of training. This is because it would not be possible for an athlete to be performing at 100% for the whole of the year. Therefore, athletes tailor their training around competitions and major events. The three seasons of training are **pre-season**, **competition** and **post-season**.

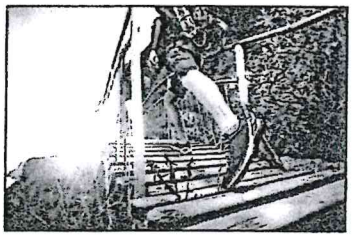


Pre-season (preparation)

The athlete will be at base levels of fitness. In this stage the primary aim will be to improve general fitness levels. Normally, this is the aerobic fitness of the athlete. By the end of pre-season, athletes should be at a competitive level of performance. Individual skills can also be worked on in pre-season.

Competition (peak/playing) season

Fitness levels (carried over from pre-season) need to be maintained throughout the competition season to compete at the highest levels. Skill sets will be continually trained.



Post-season (transition)

Athletes are allowed to rest and recover following the competitive season. Some exercise should still be undertaken to retain some fitness levels in preparation for pre-season.

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1. a. Calculate the maximal heart rate of a female marathon runner who is aged 33.

.....

b. As a marathon runner, what percentage of her maximal heart rate would she need to train in?

.....

c. Calculate the maximum heart rate the marathon runner should train at, to train aerobically.

.....

2. A weightlifter has a bench press 1RM of 168 kg.

Calculate the minimum weight the weightlifter should be lifting to improve their strength.

.....

.....

3. Give three examples of athletes who would want to train at altitude. What do they all have in common?

1. .....

2. .....

3. .....

4. Using a sport of your choice, name and describe the three training seasons.

1. .....

.....

2. .....

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3. .....

.....

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1. Define the terms 'aerobic training zone' and 'anaerobic training zone'.

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(2 marks)

2. Outline **two** injury prevention strategies used by a weightlifter when training.

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(2 marks)

3. Outline **two** benefits of altitude training to an elite marathon runner.

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(2 marks)

4. Athletes must plan each year to ensure that they are at full fitness in time for major competitions.

Identify two characteristics of pre-season training.

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(2 marks)

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Chapter 9: Warm-ups and Cool-downs

Learning objective: To develop your knowledge of effective warm-ups and cool-downs and the effect these have on the body and performance

Knowledge Checklist

	Revised	Understood	What you need to do
Be able to identify the key components of a good warm-up			
Explain the effects of a good warm-up on the body			
Be able to identify the key components of a good cool-down			
Explain the effects of a good cool-down on the body			

Key Terms

1. **Stretching** – the process of increasing flexibility by lengthening (stretching) the muscles about a limb or joint
2. **Mental preparation** – the umbrella term used to describe the processes of increasing focus and motivation used for sport
3. **Lactic acid** – a waste product of anaerobic processes. This acid causes fatigue in the muscles.
4. **DOMS** – (delayed onset muscle soreness) the fatigue and soreness felt by muscles hours to days following exercise

Constituents of a Good Warm-Up

Warm-ups are an important consideration for athletes. Warm-ups can increase performance through stretching, increasing the range of motion (flexibility) of an athlete as well as reducing the likelihood of injury.

Components of an effective warm-up	Benefits of an effective warm-up
Pulse should be raised gradually	• Body temperature is gradually increased, preparing the body for exercise • Increased amount of oxygen to the working muscles • Gradual preparation of the body for exercise reduces the shock exercise that will have on the body
Stretching	• Stretching increases the range of movement about a joint • Reduced likelihood of injury
Sport-specific skill-based drills	• Athlete is able to practise sport-specific skills in preparation for exercise
Mental preparation	• The athlete will be physiologically and psychologically prepared

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Constituents of a Good Cool-Down

Cool-downs are used by athletes to gradually bring their bodies back to their resting states. They are also used to reduce the effects of fatigue on the athlete in the hours and days following exercise.

Components of an effective cool-down	Benefits of an effective cool-down
Maintain breathing rate and heart rate	• Reduced shock of stopping exercise on the body • Allows the body to recover
Gradually reduce the intensity of exercise being undertaken (gradually reducing breathing rate and heart rate	• Removal of lactic acid, carbon dioxide and other waste products from the body • Reduced likelihood of injury/fatigue
Stretching	• Helps to prevent delayed onset muscle soreness (DOMS)

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Answers

Chapter 1 – Revision Activities

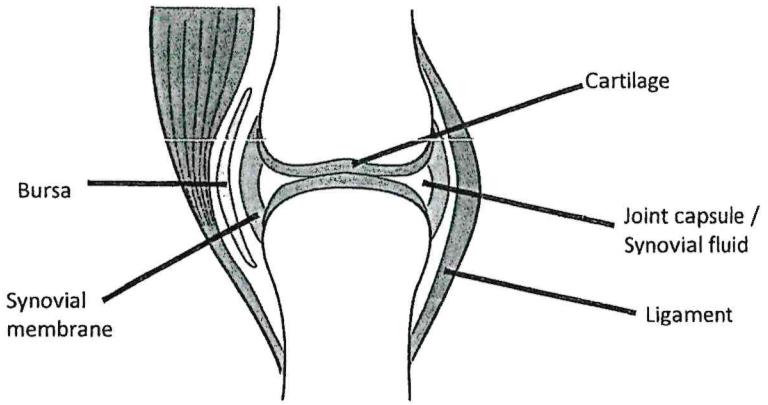
1. Any five from:
   - To provide a site for muscles to attach to bones
   - To provide leverage in order to produce movement
   - To form the supporting framework of the body
   - To provide protection for our vital organs and muscles
   - To produce red blood cells and white blood cells
   - To store minerals

2.

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

3. a) Protection – the cranium will prevent damage to the brain when a player is hit by a large force during a tackle
   b) Support – short bones are short and wide and provide support and stability to the runner. Fine movement, such as adjusting the landing gait, will also be performed by short bones,
   c) Movement, shape and points for attachment – the humerus is a long bone that forms the elbow. In the javelin, the muscles attached to the humerus will contract and relax to pull the javelin behind the athlete's head, and then to release the javelin.

4. See image (right):



5. a) Triceps
   b) Biceps
   c) Tibialis anterior
   d) Deltoid
   e) Gluteus

Chapter 1 – Exam-style Questions

1. C (AO1)

2. A (AO1)

3. Award up to 2/2 for AO1 and up to 2/2 for AO2.
   AO1
   - Abduction
   - Adduction
   - Rotation
   - Circumduction
   - Flexion
   - Extension

   AO2
   Answer must include a relevant sporting example
   - (Abduction) – moving into the 'iron cross' position during the rings in gymnastics
   - (Adduction) – golfer swinging through golf ball following the backswing
   - (Rotation) – bringing arm out of water during a front-crawl swim
   - (Circumduction) – arm motion during butterfly stroke
   - (Flexion) – execution phase of a cricket bowl
   - (Extension) – preparation phase of a cricket bowl

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Chapter 2 – Revision Activities

1. 1. Air is breathed in through the nose and mouth.
   2. Air travels through the trachea.
   3. Air travels into the bronchi, which split into the left and right lungs.
   4. Air moves through the bronchioles.
   5. Air moves into the alveoli, where gaseous exchange takes place.

2. - **Surface area of alveoli** – although alveoli are small, there is a very large number of them in each lung. This increases the total surface area for diffusion to take place.
   - **Thin, moist walls** – the alveoli have moist walls, and the surrounding capillaries are only one cell thick; this aids diffusion.
   - **Diffusion distance** – as well as the thin walls of the capillaries, capillaries and alveoli are very close, which reduces the distance diffusion occurs over.
   - **Amount of capillaries** – surrounding the alveoli are whole networks of capillaries carrying blood. These give oxygen and carbon dioxide as much opportunity as possible to diffuse.

3. Four

4. 1. Aorta
   2. Pulmonary artery
   3. Pulmonary vein
   4. Left atrium
   5. Left ventricle
   6. Right ventricle
   7. Right atrium
   8. Pulmonary vein

5. - During the race, the marathon runner would be breathing forcefully to inhale and exhale as much gas as possible to maintain exercise.
   - (Inspiration) The sternocleidomastoid contracts, causing the thoracic capacity to increase – allowing a greater volume of air to enter the lungs of the runner
   - (Inspiration) The pectorals of the runner contract, causing the thoracic capacity to increase – allowing a greater volume of air to enter the lungs and provide the body with oxygen.
   - (Expiration) The runner's ribcage is pulled downwards quickly and forcefully by the abdominal muscles during expiration, forcing air out of the lungs at a faster rate. This helps to remove as much waste product as possible from the body, allowing the runner to continue without fatigue.

Chapter 2 – Exam-style Questions

1. B (AO1)

2. Maximum marks from AO1 = 2, maximum marks from AO2 = 2
   - Pulmonary vein (AO1)
   - Superior or inferior vena cava (AO1)
   - Thin walls – veins have relatively low blood pressure and so the walls of veins need not be as thick (as arteries) (AO2)
   - Large internal diameter – allows as much blood as possible to travel through the vein, back to the heart (AO2)
   - One-way valves – stop backflow of blood (AO2)

3. Maximum marks awarded for AO1 = 2
   - Cardiac output – the volume of blood ejected from the heart in one minute (AO1)
   - Stroke volume – the volume of blood ejected from the heart in each beat (AO1)

4. Maximum marks awarded for AO2 = 2
   - Inspiratory reserve volume decreases (AO2)
   - Expiratory reserve volume increases (AO2)

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Chapter 3 – Revision Activities

1. Example answers given below. Accept other suitable answers.

Anaerobic	Aerobic	Mixture
100m sprinting Weightlifting Javelin Discus Shot-put High jump Long jump Triple jump	Marathon running / long-distance running Long-distance rowing Long-distance cycling Long-distance swimming Walking	Game sports, e.g. rugby, football, hockey Squash Tennis Boxing

2. a) **Aerobic exercise** = glucose + oxygen → energy + **carbon dioxide** + **water**
   b) **Anaerobic exercise** = glucose → energy + **lactic acid**

3. Without using the forbidden words, an example answer is:
   EPOC is the increased inspiration of a person following high-intensity activities. In these high-intensity activities, oxygen is 'borrowed' and owed to the body. Therefore, increased breathing rate occurs, inhaling as much oxygen as possible, to replace the deficit of oxygen in the body.

Chapter 3 – Exam-style Questions

1. Award 1 mark for the correct definition of aerobic exercise (AO1)
   - Aerobic exercise is physical activity that requires the presence of oxygen to provide the muscles with energy (AO1)

2. Maximum marks awarded for AO2 = 2
   - Removal of lactic acid reduces the feeling of fatigue (AO2)
   - Reduced likelihood of DOMS occurring allows the performer to feel less fatigue and return to exercise more quickly (AO2)
   - Allows heart rate and breathing rate to gradually reduce, thereby reducing shock on system (AO2)
   - Redistribution of blood that may have pooled at the body's extremities helps to avoid dizziness or nausea (AO2)

3. Maximum marks awarded for AO1 = 2
   - Athletes need to replace the fluids lost during exercise through sweating (AO1)
   - Fluids should also include any nutrients lost through exercise (e.g. sodium) (AO1)
   - Fluids could contain carbohydrates to replace energy stores used by the body (AO1)

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Chapter 4 – Revision Activities

1. Cardiovascular:
   - Increased heart rate
   - More powerful contractions of the heart
   - Increased stroke volume
   - Increased cardiac output

   Respiratory:
   - Increased breathing depth
   - Increased breathing rate
   - Increased tidal volume
   - Increased efficiency of gaseous exchange

2. Bradycardia

3. Components of fitness:
   - Muscular endurance
   - Strength
   - Flexibility
   - Speed
   - Stamina

4. Any three of the following long-term effects of exercise and application to a swimmer.
   - **Increased strength** – e.g. the swimmer will be able to kick their legs and pull their arms through the water much more powerfully, making them faster
   - **Increased flexibility** – e.g. the swimmer will be more efficient when performing a somersault turn so that they turn quicker
   - **Hypertrophy of the heart / bradycardia** – e.g. the heart will be larger and more powerful, allowing them to push their body harder during a race, as their heart is able to pump sufficient amounts of blood to the working muscle cells
   - **Increased stamina / cardiorespiratory fitness** – e.g. the swimmer will be able to train for longer than before as they will be able to swim for longer distances before fatigue sets in
   - **Increased muscular endurance** – e.g. long-distance swimmers will become better as their legs will be able to kick for the entirety of the race with limited fatigue
   - **Increased speed** – e.g. the swimmer is stronger and more powerful, allowing them to pull themselves through the water at a faster rate
   - **Change in body shape** – e.g. the swimmer will lose excess body fat and gain lean muscle mass. Their new toned shape will make them a more efficient swimmer
   - **Weight loss** – e.g. the swimmer will be carrying less weight through the water and so their stroke efficiency will increase
   - **Hypertrophy of muscles** – e.g. larger muscles will mean the swimmer is more powerful. They will be able to push off from the starting blocks more powerfully than before, giving them a good start to the race.

Chapter 4 – Exam-style Questions

1. D (AO2)

2. Award a maximum of 2 marks for AO1; award a maximum of 2 marks for AO2.
   - **Fatigue or tiredness** (AO1)
   - When muscles have been worked intensely, they swell and become 'heavy' or lethargic (AO2)
   - **DOMS** (AO1)
   - Small tears in muscle fibres which can feel sore after exercise (AO2)
   - **Nausea** (AO1)
   - Caused by a lack of nutrients, lack of fluids, or overexertion (AO2)
   - **Light-headedness** (AO1)
   - Caused by a loss of minerals or fluids, or by blood pooling during exercise (AO2)

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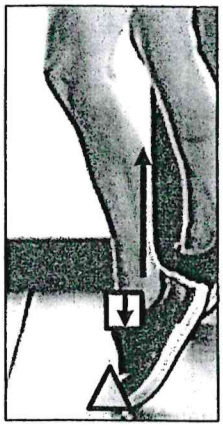
Chapter 5 – Revision Activities

1. a) Third-class lever system
   (i) Resistance/load
   (ii) Effort
   (iii) Fulcrum
   b) First-class lever system
   (i) Resistance/load
   (ii) Fulcrum
   (iii) Effort

2. Students do not need to draw excellent pictures; correct identification of the three components of a lever in a rough sketch is required. For example:



3. Second-class lever systems can move a large load with a small effort.

4. a) Plane of movement = sagittal
   Axis of movement = transverse
   b) Plane of movement = frontal
   Axis of movement = frontal
   c) Plane of movement = transverse
   Axis of movement = longitudinal

Chapter 5 – Exam-style Questions

1. Award a maximum of 2 marks – 1 mark for AO1 and 1 mark for AO2.
   - Identification: second-class lever (AO1)
   - Mechanical advantage: can move a large load with a small effort (AO2)

2. Maximum 1 mark awarded for AO1
   Mechanical advantage = effort arm ÷ resistance arm (AO1)

3. Maximum 2 marks awarded for AO2
   Plane of movement = sagittal (AO2)
   Axis of movement = transverse (AO2)

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Chapter 6 – Revision Activities

1. 1. Mental well-being
   2. Physical well-being
   3. Social well-being

2.
   - Increased risk of cancer
   - Increased blood pressure
   - Increased risk of diabetes
   - Increased risk of injury
   - Depression
   - Lack of confidence
   - Lack of social skills
   - Inability to leave house and socialise
   - Body image consciousness

3. Agility – being able to change direction at speed, maintaining control throughout
   Speed – the rate at which a movement is performed over a specific distance (speed = distance / time)

   Sporting example – e.g. football, rugby, hockey (or any other suitable example)

4.
   - Test = vertical jump test
   - Equipment:
     - Flat wall with distance marked up it
     - Chalk
   - Protocol:
     - The performer starts with their side to the wall
     - With their feet flat on the ground, they reach up and mark the wall – this is their standing reach height
     - The performer completes a maximal vertical jump and marks the wall at the peak height of their jump, with their arm outstretched
     - The distance between the standing reach height and the peak height is the jump height of the performer

Chapter 6 – Exam-style Questions

1. A

2.
   - The fitness test being completed might not be relevant to the sport (e.g. a 100 m sprinter completing the bleep test)
   - Factors may affect whether the fitness test can be carried out successfully (e.g. elderly people may not be physically able to complete some tests)
   - There may not be normative data to compare the participant to
   - There may be more valid and reliable tests that could be used to measure the component of fitness

3. **Marks awarded for this question: AO1 = 2, AO2 = 2, AO3 = 5**
   Example used in this answer is linked to tennis. Accept other suitable sporting examples

   Indicative content:
   AO1 – knowledge of fitness components and named tests
   - **Muscular endurance** – the ability of muscles to perform continuous contractions without fatigue
   - (Sit-up bleep test) The performer must run the 20 m distance in the set time given by the 'bleeps' of the CD instructions / the time between the bleeps gets shorter so the performer will have to get faster to cover the distance in time / the performer continues until they cannot keep up with the pace of the bleeps
   - **Coordination** – the ability to use more than one body part at the same time efficiently
   - (Wall toss test) The performer throws the ball against the wall using one hand / the ball is caught with the opposite hand / this is repeated for 30 seconds / the number of times the ball is thrown and caught is counted

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AO2 – application to named sporting example

- Tennis requires muscles to be able to contract for long periods of time due to the length of time tennis matches can take
- Tennis players need good coordination to control their movement and move around the court efficiently, moving their legs while moving their arms, ready to hit the ball

AO3 – justifying tests used for each fitness component with links to sporting example

- (Wall toss test) – test does use equipment that is relevant in tennis (e.g. a tennis ball) and mimics hand-eye coordination that would be used in tennis matches
- (Wall toss test and sit-up bleep test) – tests do not replicate the conditions faced when in a competitive situation, e.g. the tests are carried out in non-competitive, friendly environments
- (Wall toss test and sit-up bleep test) – can be used to identify weakness in performance, e.g. coordination in returning a serve / not being able to maintain performance without fatigue for the length of the match
- (Wall toss test and sit-up bleep test) – can be used to assess the impact of a specific training programme, e.g. has the training programme improved/reduced the tennis player's coordination / muscular endurance
- (Wall toss test and sit-up bleep test) – tests can be used to establish starting levels of fitness components, e.g. wall toss test shows poor coordination at start of a training programme, suggesting coordination needs to be improved. Sit-up bleep test shows relatively good muscular endurance, but still room for improvement.
- (Wall toss test and sit-up bleep test) – establish end level of fitness (following a training programme) e.g. following a training programme coordination and muscular endurance can be compared to see if they have improved
- (Wall toss test and sit-up bleep test) – to compare fitness levels to national averages, e.g. whether the tennis player has the ability to be an elite player based on the data from fitness tests
- (Wall toss test and sit-up bleep test) – to aid goal-setting, e.g. the tennis player identifies muscular endurance is a weakness and so sets a six-month goal of being able to play tennis for a full three hours without fatigue
- Many tests are not sport-specific and so do not represent the actual skills being performed in the sport, e.g. sit-up bleep test does not represent the actions that will be performed during a tennis match
- (Wall toss test) – validity and reliability of test may not be good enough, as the test is an indirect measurement of coordination
- Give recognition for identifying wall toss test as a suitable measure for identifying hand-eye coordination, how other fitness tests for measuring coordination may be more suitable and specific.
- Give recognition for identifying sit-up bleep test as not the most suitable test for measuring muscular endurance, as it does not replicate main muscles used in tennis match. Other tests, such as Cooper 12-minute run, may be more suitable for measuring muscular endurance of the legs.

Level	Marks	Description
3	7–9	Student shows precise and detailed knowledge of fitness components given and fitness tests used to measure each fitness component. They accurately link to a named sporting example. Student provides comprehensive justification for the usefulness, or not, of these fitness tests for given sporting example and draws well-reasoned conclusion. Correct terminology is used throughout.
2	4–6	Student shows some detailed knowledge of fitness components given and fitness tests used to measure each fitness component, but for one more than the other. They link to a named sporting example, but this is not always clear. Student provides clear justification for the usefulness, or not, of one fitness test more than the other, and draws some well-reasoned conclusions. Correct terminology is used intermittently.
1	1–3	Students' knowledge of fitness components given and fitness tests used to measure each fitness component is restricted. They provide limited application to named sporting example or don't provide one at all. Justification lacks focus, and conclusions aren't clear or aren't provided. Terminology is not used accurately.
0	0	No related answers given.

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Chapter 7 – Revision Activities

1.
   - **Specificity**
     - *'I am a 200 m sprinter for my local athletics club. My coach has changed by training plan because before I included long jogs and agility training as part of my routine.'*
   - **Progressive overload**
     - *'I was recently picked to join the British squash team. My coach is making training sessions harder every week so I am at the right fitness levels to compete at the highest levels.'*
   - **Reversibility**
     - *'I recently broke my leg in a rugby match so I cannot train or compete until it has healed.'*
   - **Tedium**
     - *'Sometimes I complete circuit training because it gives me a variety of activities to complete such as press-ups, skipping and lunges.'*
     - *'I often vary my training routine by using different training methods, so that I don't get bored. This helps maintain my motivation levels.'*
     - *'Sometimes I complete circuit training because it gives me a variety of activities to complete such as press-ups, skipping and lunges.'*

2.
   - **Frequency** – the number of times an individual participates in training – the footballer should participate in training approximately three to four times a week to maximise the advantages of training
   - **Intensity** – how hard the performer is working during the training regime – the footballer should be pushed harder each training session to continuously improve their fitness/performance
   - **Time** – the duration of the training session – the training session should be long enough for training adaptions to occur
   - **Type** – activities should be specific to the sport the performer participates in – the footballer should complete specific football skills and complete training that is relevant (e.g. fartlek training) as footballers are required to stop and start throughout the game

3.
   - **Fartlek Training**
     - **Sports:** (games sports) football, rugby, hockey, basketball
     - **Justification:** fartlek training changes the intensity and duration that athletes work for. This is representative of team sports because they may have to go from walking to running to jogging constantly throughout a match
   - **Weight Training**
     - **Sports:** any athlete / sports – weight training can target different components of fitness (e.g. muscular endurance / maximum strength)
     - **Justification:** weight training can be altered to match the strength requirement desired (e.g. endurance or maximal). All sports require some element of strength
   - **Continuous Training**
     - **Sports:** long-distance swimming, marathons, long-distance cycling
     - **Justification:** continuous training improves aerobic endurance which is a requirement of these sports. It also requires little to no extra equipment and so can be completed easily by the athletes.
   - **Static Stretching**
     - **Sports:** any athlete / sport to reduce injury. Specific sport = gymnastics.
     - **Justification:** before participating in any sport stretching should take place to increase the range of motion about a joint. This helps to prevent injuries caused by overstretching muscles.

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1. Maximum 3 marks for AO3. Sub-max 2 marks from either suitable or non-suitable.

   Suitable
   - Improves cardiovascular fitness which is a key requirement in football (AO3)
   - Footballers are required to exercise for a long period of time in a match (AO3)
   - Forces body to work anaerobically – footballers compete for 90 minutes (AO3)

   Non-suitable
   - Footballers do not train at continuous intensities (steady state) throughout the match (AO3)
   - Footballers do not always work aerobically in a match so continuous training does not work their anaerobic system (AO3)
   - Cannot be tailored to include skills and more football-based situations (sport specific)

2. Maximum 2 marks awarded for AO1.
   - **Specificity** – training should be specific to the sporting event that is being trained for (AO1)
   - **Progressive overload** – training should progress in either difficulty or intensity. This helps to prevent the performer plateauing in their progress. (AO1)
   - **Reversibility** – regular training ensures positive adaptions due to training won't be lost (AO1)
   - **Tedium** – training should be varied with different activities to prevent boredom (AO1)

Do not accept answers that refer to the principles of overload (FITT).

3. Maximum marks awarded for AO1 = 1, AO2 = 2 and AO3 = 3.

   AO1 – knowledge of the principles of overload
   - Frequency – the number of times an individual participates in training
   - Intensity – how hard the performer is working during the training regime
   - Time – the duration of the training session
   - Type – activities should be specific to the sport the performer participates in

   AO2 – applying FITT to hockey player
   - Frequency – the hockey player should train as much as possible (without overtraining) to maximise possible benefits from training
   - Intensity – hockey player should work as hard as possible to push themselves during each training session
   - Time – training session shouldn't be too long or too short. It could be the length of an actual hockey match, for example.
   - Type – activities / training type should be relevant to a hockey player, e.g. interval/fartlek training

   AO3 – analysis of importance of FITT to a hockey player
   - Frequency – to become a high-level hockey player, they must commit to training as often as possible to improve performance, meaning the difference between being successful and unsuccessful
   - Intensity – to improve performance, the hockey player must push themselves harder each session to continuously improve their performance. Training should also replicate the intensity of performance required during a match, to prepare the athlete for the conditions in a match.
   - Time – getting the hockey player used to training for long periods of time will prepare then physically and mentally for competition – being able to compete successfully throughout a whole match.
   - Type – (link to training types) e.g. interval training is suitable for a hockey player as it replicates what they will do in a match – shorts burst of high-intensity exercise followed by periods of rest (e.g. running to make a tackle and then clearing the ball away)

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Chapter 8 – Revision Activities

1. a) 220 – 33 = 187 bpm
   b) Aerobic training zone = 60–80% of maximal heart rate
   c) 80% of maximal heart rate = 187 × 0.8 = 150 bpm

2. 70% of 1RM = 168 × 0.7 = 118 kg

3. - Examples should include endurance athletes who compete aerobically. For example: marathon/long-distance runners, road cyclists / long-distance cyclists, long-distance swimmers, endurance events (e.g. iron man, triathlon)
   - All the athletes who are likely to train at altitude are aerobic athletes

4. With reference to a sport of your choice throughout:
   - Pre-season (preparation)
     - Athletes will be at base levels of fitness
     - Primary aim will be to improve general fitness levels
     - By the end of pre-season, athletes should be at a competitive level of performance
     - Individual skills can also be worked on in pre-season
   - Competition (peak/playing) season
     - Fitness levels (carried over from pre-season) need to be maintained throughout the competition season to compete at the highest levels
     - Skill sets will be continually trained
   - Post-season (transition)
     - Athletes are allowed to rest and recover following the competitive season. Some exercise should still be undertaken to retain some fitness levels, in preparation for pre-season.

Chapter 8 – Exam-style Questions

1. Maximum 2 marks awarded for AO1
   - Aerobic training zone – training zone that has an athlete working between 60% and 80% of their maximal heart rate (AO1)
   - Anaerobic training zone – training zone that has an athlete working between 80% and 90% of their maximal heart rate (AO1)

2. Maximum 2 marks awarded for AO1
   - Correct technique should be used (AO1)
   - Warm-up and cool-down should be completed (AO1)
   - Taping and bracing should be used for safety (AO1)
   - Appropriate rest breaks between sets should be used (AO1)
   - Avoid overtraining (weight too great) (AO1)

3. Maximum 2 marks awarded for AO2
   - Increased efficiency of gaseous exchange at the alveoli (AO2)
   - Increased production of red blood cells (AO2)
   - Effects of altitude training are maintained for a short period when you return to sea level (timing for competitions) (AO2)

4. Maximum 2 marks awarded for AO1
   - Athlete will be at a base level of fitness (AO1)
   - Primary aim of pre-season is to improve aerobic fitness (AO1)
   - Athlete gradually increases their fitness levels to competitive levels (AO1)
   - Individual skills can also be improved to a competitive level (AO1)

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Chapter 9 – Revision Activities

1.
- The runner had not completed a suitable cool-down that *gradually* reduces exercise intensity
- Gradually reducing exercise intensity:
  - reduces shock placed on body
  - removal of waste products (lactic acid, carbon dioxide)
  - reduced likelihood of injury/fatigue through DOMS

2.
- Body temperature is gradually increased, preparing the body for exercise
- Increased amount of oxygen to the working muscles
- Gradual preparation of the body for exercise reduces the shock that exercise will have on the body
- Stretching increases the range of movement about a joint
- Reduced likelihood of injury
- Athlete is able to practise sport-specific skills in preparation for exercise
- The athlete will be physiologically and psychologically prepared

3.
- Athlete is able to practise sport-specific skills in preparation for exercise
- The athlete will be physiologically and psychologically prepared

Chapter 9 – Exam-style Questions

1. C

2. Maximum 2 marks awarded for AO1
   - Reduced shock of stopping exercise on the body
   - Allows the body to recover
   - Removal of lactic acid, carbon dioxide and other waste products from the body
   - Reduced likelihood of injury/fatigue
   - Helps to prevent delayed onset muscle soreness (DOMS)

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