MY REVISION NOTES

HODDER EDUCATION

OCR

A Level

PE

2ND EDITION

- Plan and organise your revision
- Reinforce skills and understanding
- Practise exam-style questions

Keri Moorhouse

MY REVISION NOTES
OCR A Level
PE

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My Revision Planner

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Countdown to my exams

6–8 weeks to go

- Start by looking at the specification — make sure you know exactly what material you need to revise and the style of the examination. Use the revision planner on p. 4 to familiarise yourself with the topics.
- Organise your notes, making sure you have covered everything on the specification. The revision planner will help you to group your notes into topics.
- Work out a realistic revision plan that will allow you time for relaxation. Set aside days and times for all the subjects that you need to study, and stick to your timetable.
- Set yourself sensible targets. Break your revision down into focused sessions of around 40 minutes, divided by breaks. These Revision Notes organise the basic facts into short, memorable sections to make revising easier.

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2–6 weeks to go

- Read through the relevant sections of this book and refer to the exam tips, knowledge and skills summaries and key terms. Tick off the topics as you feel confident about them. Highlight those topics you find difficult and look at them again in detail.
- Test your understanding of each topic by working through the 'Now test yourself' questions in the book. Look up the answers at the back of the book.
- Make a note of any problem areas as you revise, and ask your teacher to go over these in class.
- Look at past papers. They are one of the best ways to revise and practise your exam skills. Write or prepare planned answers to the exam practice questions provided in this book. Check your answers on pp. 175–183 and try out the quick quizzes at **www.hoddereducation.co.uk/myrevisionnotesdownloads**
- Use the revision activities to try out different revision methods. For example, you can make notes using mind maps, spider diagrams or flash cards.
- Track your progress using the revision planner and give yourself a reward when you have achieved your target.

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One week to go

- Try to fit in at least one more timed practice of an entire past paper and seek feedback from your teacher, comparing your work closely with the mark scheme.
- Check the revision planner to make sure you haven't missed out any topics. Brush up on any areas of difficulty by talking them over with a friend or getting help from your teacher.
- Attend any revision classes put on by your teacher. Remember, they are an expert at preparing people for examinations.

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The day before the examination

- Flick through these Revision Notes for useful reminders, for example the exam tips, knowledge and skills summaries and key terms.
- Check the time and place of your examination.
- Make sure you have everything you need — extra pens and pencils, tissues, a watch, bottled water, sweets.
- Allow some time to relax and have an early night to ensure you are fresh and alert for the examinations.

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My exams

Paper 1: Component 1 Physiological factors affecting performance (2 hours)

Date: ....

Time: ....

Location: ....

Paper 2: Component 2 Psychological factors affecting performance (1 hour)

Date: ....

Time: ....

Location: ....

Paper 3: Component 3 Socio-cultural issues in physical activity and sport (1 hour)

Date: ....

Time: ....

Location: ....

Introduction

How is A Level PE examined?

This book covers components 1, 2 and 3 (the theory elements of A Level PE). Component 4 is your practical and EAPI (Evaluating and Analysing Performance for Improvement).

Components 1, 2 and 3 are worth 70% of your A Level grade.

As a student of A Level PE it is important that you know these five things about the examination:
- the structure of the exam
- the assessment objectives
- the quantitative skills needed
- practical examples
- the synoptic element within each paper.

The structure of the exam

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Each of the three papers consists of a mixture of objective response, short- and medium-length answers, and extended response items. Each paper may also include multiple choice questions. **You must answer all questions on each paper.**

Paper 1: Component 1: Physiological factors affecting performance

2 hours, 30% of total A Level

This paper will assess:
- 1.1 Applied anatomy and physiology
- 1.2 Exercise physiology
- 1.3 Biomechanics

Total 90 marks

Paper 2: Component 2: Psychological factors affecting performance

1 hour, 20% of total A Level

This paper will assess:
- 2.1 Skill acquisition
- 2.2 Sports psychology

Total 60 marks

Paper 3: Component 3: Socio-cultural issues in physical activity and sport

1 hour, 20% of total A Level

This component will assess:
- 3.1 Sport and society
- 3.2 Contemporary issues in physical activity and sport

Total 60 marks

Assessment objectives

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Your answers will be marked by examiners who will consider how well you have met the three assessment objectives. These are explained in the table below.

Assessment objectives	Requirements	Comments
AO1: Knowledge and understanding	Demonstrate knowledge and understanding of the factors that underpin performance and involvement in physical activity and sport.	Usually 1- or 2-mark questions – recall of information.
AO2: Practical application	Apply knowledge and understanding of the factors that underpin performance and involvement in physical activity and sport.	Questions can range from 1 to 20 marks. Sometimes they assess AO2 alone, but often they combine this with AO1 and AO3.
AO3: Analysis and evaluation	Analyse and evaluate the factors that underpin performance and involvement in physical activity and sport.	Generally, questions range from 4 to 20 marks. Assessment of AO3 is often combined with AO2.
AO4: Practical performance	✚ Demonstrate and apply relevant skills and techniques in physical activity and sport (practical performance). ✚ Analyse and evaluate performance (EAPI).	Not covered in this book.

Quantitative skills

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In the examinations 5% of the overall A Level marks will be from your quantitative skills, including:

- interpretation of data and graphs (exercise physiology, sports psychology, contemporary studies)
- ability to plot, label and interpret graphs and diagrams (biomechanics)
- use of definitions, equations, formulae and units of measurement (biomechanics).

Practical examples

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Throughout all three exam papers you will be asked for practical examples (AO2) from physical activities and sports to show how theory can be applied and to reinforce the understanding you demonstrate. It is important to learn as many practical examples as you can.

Synoptic assessment in each paper

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Synoptic assessment tests your understanding of the connections between different elements of the subject. This involves the explicit drawing together of knowledge, skills and understanding within different parts of the A Level course. Synoptic links will be identified in the 'Making links' features, for example linking classification of skills to the best methods of practice.

Within examined components 1, 2 and 3, each assessment will contain an extended response question (marked with an asterisk, *). Here you must draw together knowledge from more than one topic within the component and demonstrate your understanding of how the topics interrelate. Look out for the 'Making links' feature throughout the book.

1.1a Skeletal and muscular systems

Joints, movements, muscles and the analysis of movement

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Figure 1.1.1 shows the major bones of the skeleton.

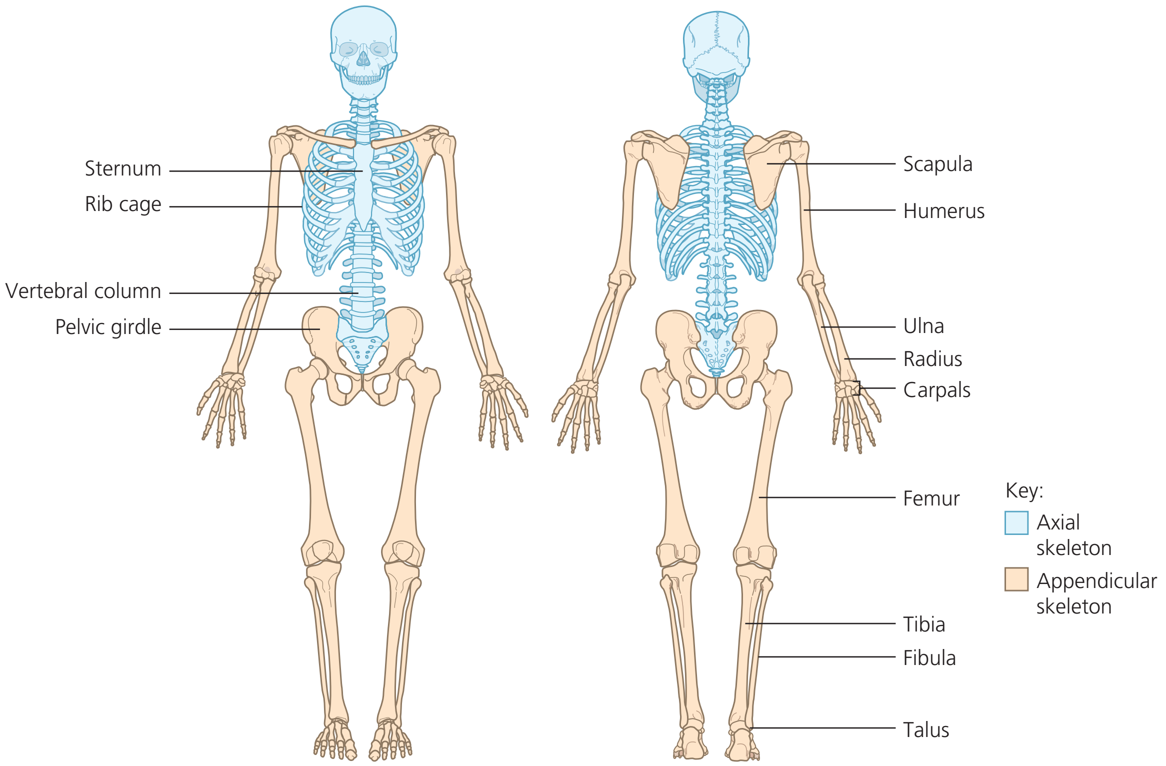


Figure 1.1.1 The bones of the axial and appendicular skeleton

Table 1.1.1 Structure and function of a synovial joint

Common features of a synovial joint	Structure	Function
Ligament	A tough band of slightly elastic connective tissue	Connects bone to bone and stabilises joints during movement
Synovial fluid	Lubricating liquid contained within the joint cavity	Reduces friction and nourishes articular cartilage
Articular cartilage	Smooth tissue that covers the surface of articulating bones	Absorbs shock and allows friction-free movement
Joint capsule	A fibrous sac with an inner synovial membrane	Encloses and strengthens the joint secreting synovial fluid
Bursa	A closed, fluid-filled sac found where tendons rub over bones	Reduces friction between tendons and bones

Joint: an area of the body where two or more bones articulate to create human movement.

Planes of movement

If a person stands in an anatomical position, we describe their movement in three dimensions, based on three planes:

- sagittal plane (vertical – divides body into left/right)
- frontal plane (vertical – divides body into anterior/posterior)
- transverse plane (horizontal – divides body into upper/lower).

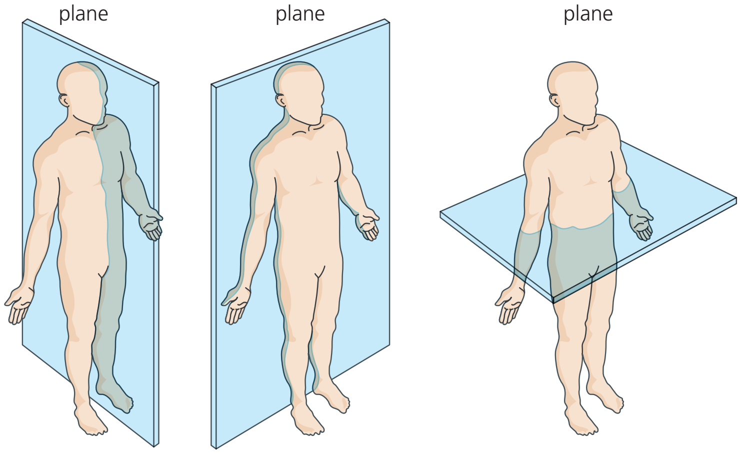


Figure 1.1.2 The three **planes of movement**

Plane of movement: the description of three-dimensional movements at a joint.

Movement patterns

Table 1.1.2 describes the three types of plane and their movements.

Table 1.1.2 Planes and movements

Plane	Movement type	Example
Sagittal plane	Flexion	Bending arm at elbow
	Extension	Straightening arm at elbow
	Dorsi-flexion	Pointing toes up
	Plantar flexion	Pointing toes down
Frontal plane	Abduction	Moving arm at shoulder away from midline
	Adduction	Moving arm at shoulder towards midline
Transverse plane	Horizontal extension	Moving arm at shoulder away from midline parallel to ground
	Horizontal flexion	Moving arm at shoulder towards midline parallel to ground
	Rotation	Movement whereby articulating bones turn about their longitudinal axis in a screwdriver action

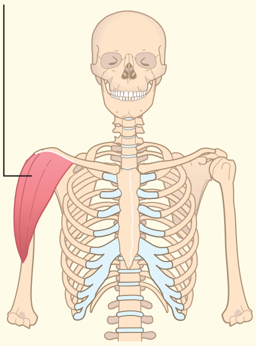
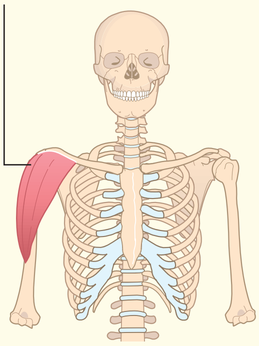
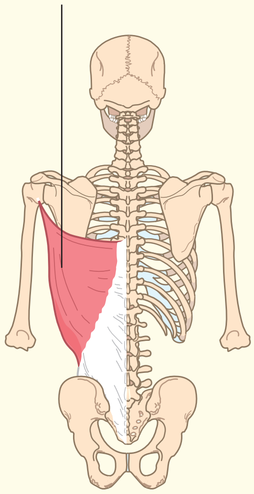
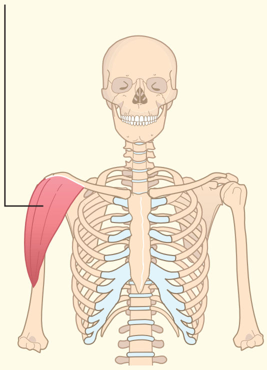
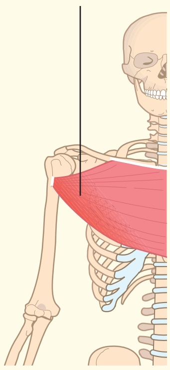
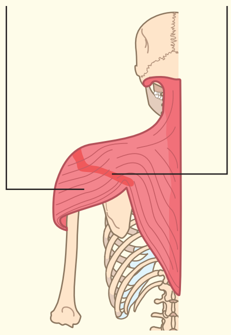
Table 1.1.3 provides an overview of joint types and **movement patterns** possible.

Movement pattern: a description of the action taking place at a joint.

Table 1.1.3 Joints and movements

Joint type	Location	Plane of movement	Movement patterns possible
Ball and socket	Shoulder and hip	Sagittal plane	Flexion and extension
		Frontal plane	Abduction and adduction
		Transverse plane	Horizontal flexion, horizontal extension, medial and lateral rotation
Hinge	Elbow, knee and ankle	Sagittal plane	Flexion, extension, dorsi-flexion and plantar flexion
Condyloid	Wrist	Sagittal plane	Flexion and extension
		Frontal plane	Abduction and adduction

Shoulder

Joint type	Ball and socket joint	
Articulating bones	Humerus and scapula	
Movement	Sagittal plane	
	Flexion	Extension
Agonist muscles	Anterior deltoid 	Posterior deltoid 
Movement	Frontal plane	
	Adduction	Abduction
Agonist muscles	Latissimus dorsi 	Middle deltoid 
Movement	Transverse plane	
	Horizontal flexion	Horizontal extension
Agonist muscles	Pectoralis major 	Posterior deltoid and teres minor 

→

Shoulder *continued*

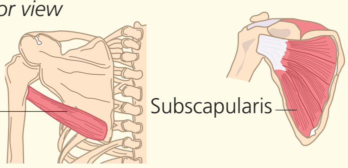
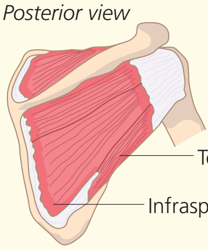
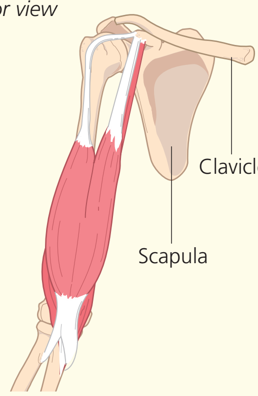
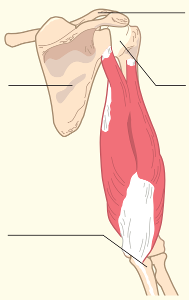
Movement	Transverse plane	
	Medial rotation	Lateral rotation
	Teres major and subscapularis *Anterior view* 	Teres minor and infraspinatous *Posterior view* 
Movement	Circumduction is characterised by shoulder circles and arm swings. It is a combination of flexion, extension, abduction, adduction and rotation.	
Practical application	To mobilise the shoulder joint as part of a warm-up, an individual may use star jumps. In the outward phase of a star jump, the agonist, the middle deltoid, concentrically contracts to abduct the shoulder joint. 	

Figure 1.1.3 The shoulder joint in detail

Elbow

Joint type	Hinge joint	
Articulating bones	Humerus, radius and ulna	
Movement	Sagittal plane	
	Flexion	Extension
Agonist muscles	Biceps brachii *Anterior view* 	Triceps brachii *Posterior view* 

Elbow *continued*

Practical application	The elbow joint is essential for creating power in a netball shot. In the preparation phase, the biceps brachii will concentrically contract to flex the elbow, lowering the ball. In the execution phase, the triceps brachii concentrically contracts to extend the elbow joint through a large range of motion to generate a large force to apply to the ball. 

Figure 1.1.4 The elbow joint in detail

Wrist

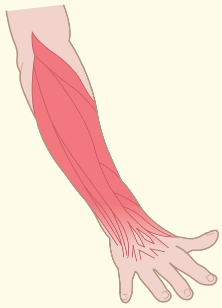
Joint type	Condyloid joint	
Articulating bones	Radius, ulna and carpals	
Movement	Sagittal plane	
	Flexion	Extension
Agonist muscles	Wrist flexors 	Wrist extensors 
Practical application	Basketball players concentrically contract the agonist, the wrist flexors, to flex the wrist as the ball is released in a jump shot. This enables backspin to be put on the ball, causing the ball to 'pop up' from the back board rather than roll off. 	

Figure 1.1.5 The wrist joint in detail

Hip

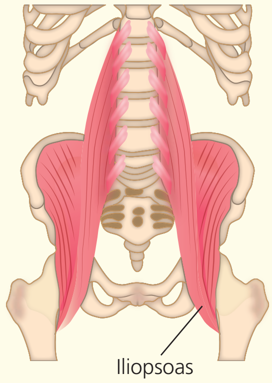
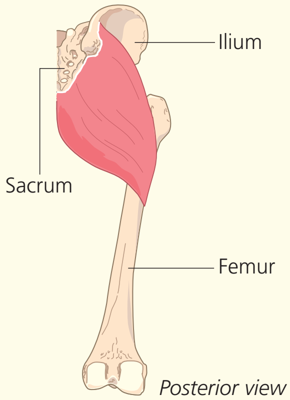
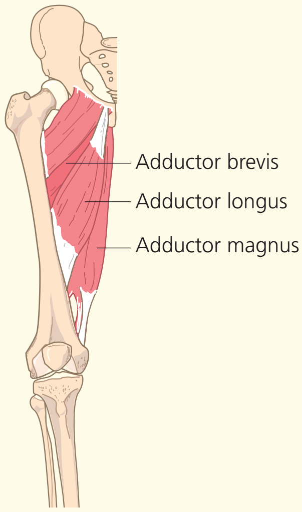
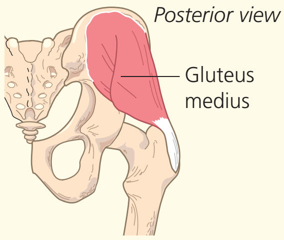
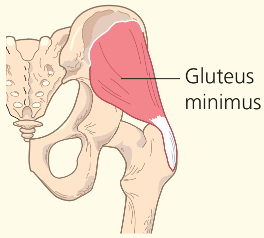
Joint type	Ball and socket joint	
Articulating bones	Pelvic girdle and femur	
Movement	Sagittal plane	
	Flexion	Extension
Agonist muscles	Iliopsoas 	Gluteus maximus 
Movement	Frontal plane	
	Adduction	Abduction
Agonist muscles	Adductor brevis, adductor longus and adductor magnus 	Gluteus medius and gluteus minimus  
Movement	Transverse plane	
	Medial rotation	Lateral rotation
Agonist muscles	Gluteus medius and gluteus minimus (as above)	Gluteus maximus (as above)
Practical application	When weightlifting in the upward phase, the agonist, the gluteus maximus, will concentrically contract to create hip extension while the antagonist, the iliopsoas, co-ordinates the action.	

Figure 1.1.6 The hip joint in detail

Knee

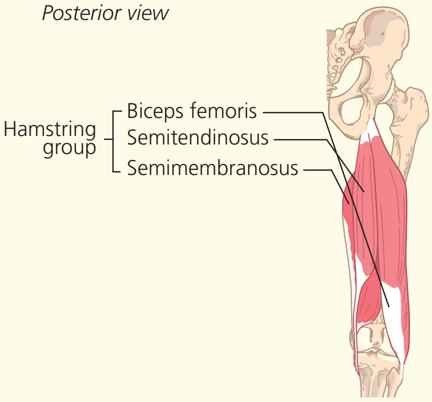
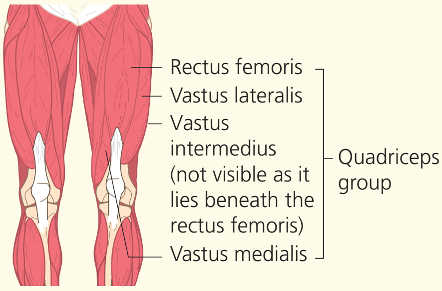
<table>
<tr><td>Joint type</td><td colspan="2">Hinge joint</td></tr>
<tr><td>Articulating bones</td><td colspan="2">Femur and tibia</td></tr>
<tr><td rowspan="2">Movement</td><td colspan="2">Sagittal plane</td></tr>
<tr><td>Flexion</td><td>Extension</td></tr>
<tr><td>Agonist muscles</td><td>Biceps femoris, semitendinosus and semimembranosus (hamstring group)

</td><td>Rectus femoris, vastus lateralis, vastus intermedius and vastus medialis (quadriceps group)

</td></tr>
<tr><td>Practical application</td><td colspan="2">The knee joint is essential for creating power in a penalty shot in football. Concentrically contracting the biceps femoris flexes the knee joint in the preparation phase. Concentrically contracting the rectus femoris extends the knee joint in the execution phase through a large range of motion to generate a large force to apply to the football.
</td></tr>
</table>

Figure 1.1.7 The knee joint in detail

Ankle

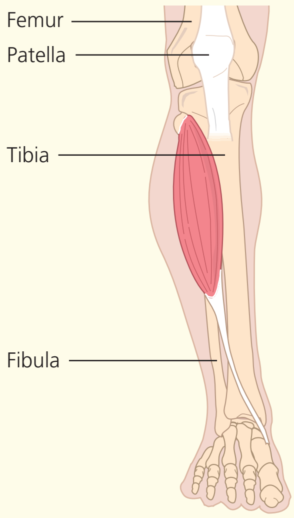
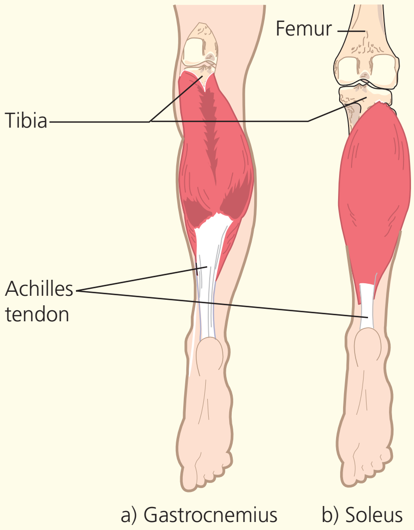
<table>
<tr><td>Joint type</td><td colspan="2">Hinge joint</td></tr>
<tr><td>Articulating bones</td><td colspan="2">Tibia, fibula and talus</td></tr>
<tr><td rowspan="2">Movement</td><td colspan="2">Sagittal plane</td></tr>
<tr><td>Dorsi-flexion</td><td>Plantar flexion</td></tr>
<tr><td>Agonist muscles</td><td>Tibialis anterior

</td><td>Gastrocnemius and soleus

</td></tr>
<tr><td>Practical application</td><td colspan="2">Contemporary dancers use their feet for shaping body movements. Concentrically contracting the gastrocnemius and soleus to plantar flex the ankle joint creates a fully extended finish to the leg in a split leap or when rising to the toes to go en pointe.
</td></tr>
</table>

Figure 1.1.8 The ankle joint in detail

Functional roles of muscles and types of contraction

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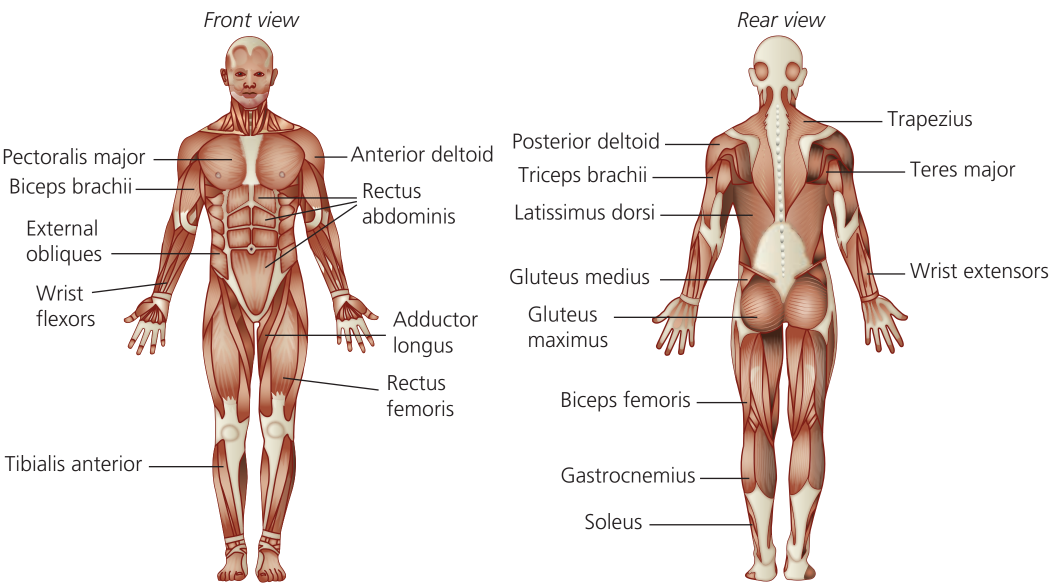

Figure 1.1.9 Major skeletal muscles

- Muscles are made of up fibres that contain filaments.
- Thick filaments are made of the protein myosin and thin filaments are made of the protein actin.
- **Myosin and actin filaments** are arranged to form an overlapping pattern, which gives muscle tissue its striated appearance.
- During contraction, the myosin thick filaments grab on to the actin thin filaments by forming cross bridges.
- An increased number of cross bridges will increase the overall force of contraction.

Myosin and actin filaments: proteins that form the contractile units of skeletal muscles.

Agonist: a muscle responsible for creating movement at a joint. Also known as the prime mover.

Antagonist: a muscle that opposes the agonist, providing a resistance for co-ordinated movement.

Fixator: a muscle that stabilises one part of a body while another part moves.

Antagonistic muscle action

Muscles never work alone. They work in pairs or groups to produce co-ordinated movement. As the **agonist** shortens to create movement, the **antagonist** lengthens to co-ordinate the action. The **fixator** muscle stabilises one part of a body while another part moves.

It is important to understand the common muscle pairings for flexion at various joints, as shown in Table 1.1.4.

Table 1.1.4 The common antagonistic muscle pairings for flexion

Joint	Agonist	Antagonist
Wrist	Wrist flexors	Wrist extensors
Elbow	Biceps brachii	Triceps brachii
Shoulder	Anterior deltoid	Posterior deltoid
Hip	Iliopsoas	Gluteus maximus
Knee	Biceps femoris (hamstring group)	Rectus femoris (quadriceps group)
Ankle (dorsi-flexion)	Tibialis anterior	Gastrocnemius and soleus

Muscle contraction

A muscle uses energy to create force. Muscles create force by contracting. They can contract in the different ways shown in Table 1.1.5.

Table 1.1.5 Muscle contraction

Isotonic (changes length)	Concentric	Muscle shortens to produce tension, e.g. during the upward phase of a biceps curl, the biceps brachii concentrically contracts to lift weight
	Eccentric	Muscle lengthens to produce tension, e.g. during the downward phase of a biceps curl, the biceps brachii eccentrically contracts to lower weight
Isometric (does not change length)		Muscle contracts but does not change length and no movement is created, e.g. holding the press-up position still with arms and elbows extended

Exam tip

You need to be able to use all the information given so far to analyse different movements from sport. Always identify the joint type, articulating bones, movement pattern, agonist muscle, antagonist muscle and contraction type.

Always refer to a joint when identifying a movement pattern, for example 'flexion at the shoulder'. 'Arm flexion' is too vague.

Revision activity

Choose a picture of an athlete playing football, hockey, netball or rugby. Complete a movement analysis of the knee, shoulder, hip, ankle, wrist and elbow. Refer to all the key points: joint type, articulating bones, movement pattern, agonist muscle, antagonist muscle and contraction type.

Skeletal muscle contraction

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Skeletal muscle can only contract when stimulated by an electrical impulse sent from the central nervous system.

- Motor neurons are specialised cells that transmit nerve impulses rapidly to a group of muscle fibres. They have a cell body in the brain or spinal cord with an extending axon that branches to connect motor end plates to a group of muscle fibres.
- The motor neuron and its muscle fibres are termed the 'motor unit'.
- Sending the nerve impulse to the muscle fibres is an electrochemical process that relies on a nerve **action potential** to conduct the nerve impulse as a wave of electrical charge down the axon to the end plates.
- The point where the axon's motor end plates meet the muscle fibre is called the neuromuscular junction.
- There is a small gap between the motor end plates and muscle fibre called the synaptic cleft. An action potential cannot cross a synaptic cleft without the neurotransmitter acetylcholine (ACh).
- The neurotransmitter is secreted into the synaptic cleft to help the nerve impulse cross the gap.
- If enough of the neurotransmitter is secreted and the electrical charge is above the threshold, a muscle action potential is created. This creates a wave of contraction down the muscle fibres.
- If the stimulus is above the threshold, all the muscle fibres will give a complete contraction, but if the stimulus is below the threshold, none of the muscle fibres will contract at all. This is known as the **all-or-none law**.

Action potential: positive electrical charge inside the nerve and muscle cells that conducts the nerve impulse down the neuron and into the muscle fibre.

All-or-none law: depending on whether the stimulus is above the threshold, all the muscle fibres will give a complete contraction or no contraction at all.

1 Nerve impulse initiated in the motor neuron cell body

↓

2 Nerve impulse conducted down the axon of the motor neuron by a nerve action potential to the synaptic cleft

↓

3 Neurotransmitter called acetylcholine is secreted into the synaptic cleft to conduct the nerve impulse across the gap

↓

4 If the electrical charge is above threshold, the muscle fibre will contract

↓

5 This happens in an 'all-or-none law' fashion (depending on whether the stimulus is above threshold, all muscle fibres will give either a complete contraction or no contraction at all)

Figure 1.1.10 Flow diagram summarising the role of a motor unit

Muscle fibre type and exercise intensity

The strength of muscular contraction is dependent on the number of units recruited by the brain. The greater the number of motor units, the greater the force. As shown in Table 1.1.6, any one muscle contains three fibre types; the percentage of each fibre is dependent on genetics.

Table 1.1.6 The structural and functional characteristics of the three muscle fibre types

Fibre type	Slow oxidative	Fast oxidative glycolitic	Fast glycolitic
Structural characteristics			
Neuron size	Small	Large	Large
Fibres per neuron	Few	Many	Many
Capillary density	High	High	Low
Mitochondria density	High	Moderate	Low
Myoglobin density	High	Moderate	Low
Phosphocreatine store	Low	High	High
Functional characteristics			
Speed of contraction	Slow	Fast	Fast
Force of contraction	Low	High	High
Fatigue resistance	High	Moderate	Low
Aerobic capacity	High	Moderate	Low
Anaerobic capacity	Low	Moderate	High
Sporting application			
Highest percentage of fibres	Endurance athletes: + marathon + triathlon + cross-country skiing	High-intensity athletes: + 800–1500 m + 200 m freestyle	Explosive athletes: + 60–100 m sprinting + javelin + long jump

Combining motor units and muscle fibre type indicates how the nervous system can produce movement for different activity requirements.

- Small motor neurons stimulate relatively few muscle fibres. This is important for activities that require sustained muscle contraction, such as posture.
- Large motor neurons stimulate many large muscle fibres. This is important for brief exertions of large force, such as jumping and throwing.

Revision activity

Using Table 1.1.6, copy out the information and colour code/add diagrams to help you learn it.

Muscle fibre type and recovery rates

Slow oxidative (SO) fibres

- These are recruited and provide energy for sub-maximal aerobic work.
- They contract intermittently to give overall low force of contraction.
- Individual fibres will recover very quickly.

Application for training and recovery

- 1:1 or 1:0.5 work:relief ratio, for example 3 minutes moderate-intensity running with relief of 90 seconds.
- Training can be performed on a daily basis, as fibre damage is not associated with low-intensity training.
- Low-intensity use of SO fibres is advised between heavy weight training sessions to increase blood flow and enhance the healing process.

Fast oxidative glycolytic (FOG) fibres

- These are designed to produce a large amount of force quickly.
- They have capacity to resist fatigue.

Application for training and recovery

- They are more likely to be used in high-intensity activities lasting a few minutes, for example the 800 m.

Fast glycolytic (FG) fibres

- These are recruited in the last 2–10 seconds of contraction when maximal efforts are needed quickly.
- This will be accompanied by eccentric muscle fibre damage, which causes delayed onset muscle soreness (DOMS). This can be felt 24–48 hours after exercise and may worsen up to 72 hours after.

Delayed onset muscle soreness (DOMS): pain and stiffness felt in the muscles, which peaks 24–72 hours after exercise, associated with eccentric muscle contraction.

Application for training and recovery

- If fast glycolytic fibres have been used to exhaustion, they take 4–10 days to recover.
- Maximal weight training sessions should leave 48 hours between using the same muscle group again.

Making links

- Consider the link between our muscle fibre types and the energy systems that are predominantly used (Chapter 1.1c, Energy for exercise).
- Consider the recovery process and its impact on different muscle types (Chapter 1.1c, Energy for exercise).
- These types of links are likely to feature in the 20-mark question at the end of Paper 1.

Now test yourself TESTED

1 Identify the agonist and antagonistic pairings for flexion in the:
  a) wrist
  b) elbow
  c) shoulder
  d) hip
  e) knee
  f) ankle (dorsi-flexion)
2 What are the three planes of movement and how do they divide the body?
3 What are the roles of the agonist, antagonist and fixator muscles?
4 What is the difference between concentric and eccentric muscle contraction?
5 What makes a motor unit?
6 Name the three types of muscle fibre.
7 State three structural characteristics of each muscle fibre type.
8 State three functional characteristics of each muscle fibre type.

Answers on p. 166

Exam practice

1 Ali kicks a football with her left foot. State the movement, at the ankle joint, of the striking foot at the point of contact and name the agonist muscle responsible for creating the movement. [2]
2 An athlete performs an upright row. Complete the table (A, B, C, D) for the athlete's shoulder joint while the bar is being raised. [4]

Joint	Joint type	Movement	Agonist	Antagonist	Type of muscular contraction
Shoulder	A	Abduction	B	C	D

3 Explain the role of the triceps brachii in both the upward and downward phases of a press-up. [4]
4 Explain how a performer's mix of muscle fibre types might influence their reasons for choosing to take part in particular types of physical activity. [4]
5 Explain why a marathon runner predominantly uses slow oxidative muscle fibres. [4]

Answers on p. 175

Knowledge and skills summary

By the end of this chapter, you should have the following knowledge (AO1):

- Joints, movements and muscles – including analysis of movement with reference to: joint type, movement produced, agonist and antagonist muscles involved, and type of muscle contraction taking place, at the:
  - shoulder
  - elbow
  - wrist
  - hip
  - knee
  - ankle.
- Planes of movement: frontal, transverse, sagittal.
- Roles of muscles: agonist, antagonist, fixator.
- Types of contraction: isotonic, concentric, eccentric, isometric.
- Structure and role of motor units in skeletal muscle contraction.
- Nervous stimulation of the motor unit: motor neuron, action potential, neurotransmitter, 'all-or-none' law.
- Muscle fibre types: slow oxidative, fast oxidative glycolytic, fast glycolytic.
- Recruitment of different fibre types during exercise of differing intensities and during recovery.

AO2 and AO3

- For application of knowledge (AO2), you may be asked to refer to muscle action or types of muscle fibre in specific practical examples.
- Sometimes you may be required to apply (AO2) your knowledge of the muscular system to another topic on the specification, for example explaining how the muscular system adapts after training.
- AO3 marks are for analysis or evaluation. In this topic an AO3 response may involve an analysis of reasons why different types of muscle fibre are used for different exercise intensities.

1.1b Cardiovascular and respiratory systems

The cardiovascular system at rest

REVISED

The cardiovascular system refers to the heart, blood and blood vessels.

At the core is the heart, a dual pump moving blood through two separate circuits:

- the pulmonary circuit
- the systemic circuit.

Pulmonary circuit: circulation of blood through the pulmonary artery to the lungs and pulmonary vein back to the heart.

Systemic circuit: circulation of blood through the aorta to the body and vena cava back to the heart.

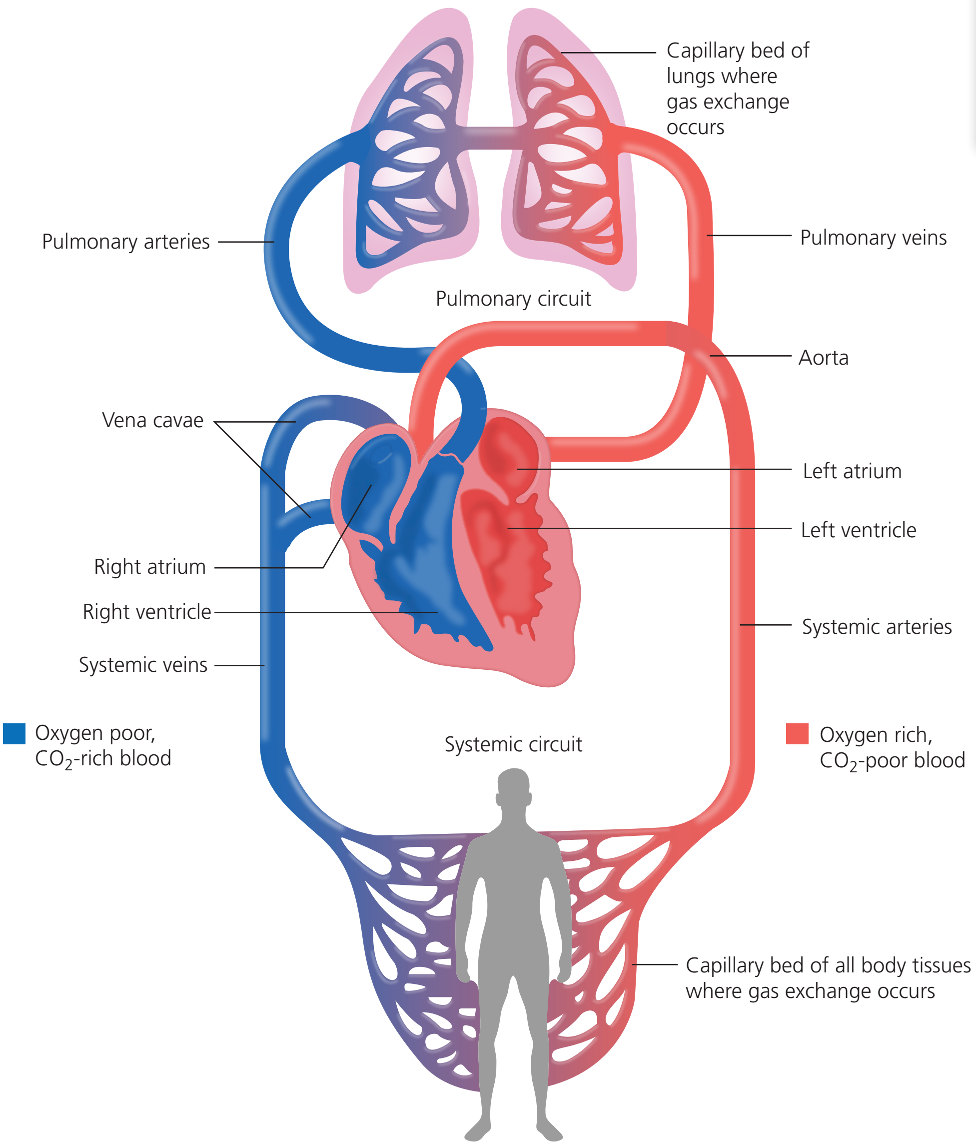


Figure 1.1.11 The heart: pulmonary and systemic circuits

The structure of the heart

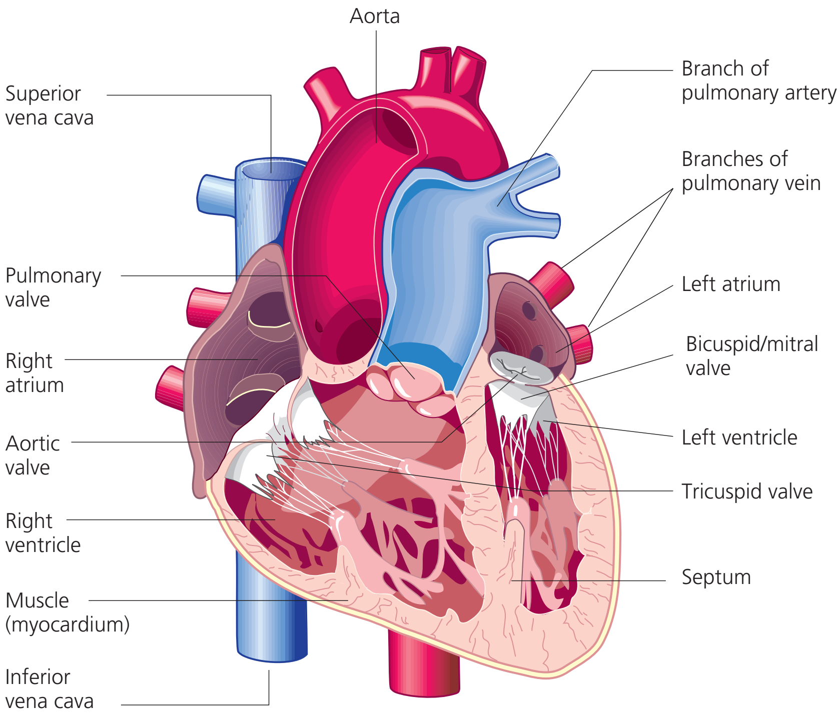


Figure 1.1.12 The structure of the heart

The left side of the cardiac muscle has a thicker wall than the right side, allowing it to forcefully contract to circulate **oxygenated blood** through the systemic system to the muscles and organs. The atrioventricular (bicuspid and tricuspid) valves and semilunar (aortic and pulmonary) valves prevent the backflow of blood. The right side of the heart circulates **deoxygenated blood** which enters the heart through the vena cava.

Oxygenated blood: blood saturated with oxygen and nutrients, such as glucose.

Deoxygenated blood: blood depleted of oxygen, saturated with carbon dioxide and waste products.

The path of blood through the heart

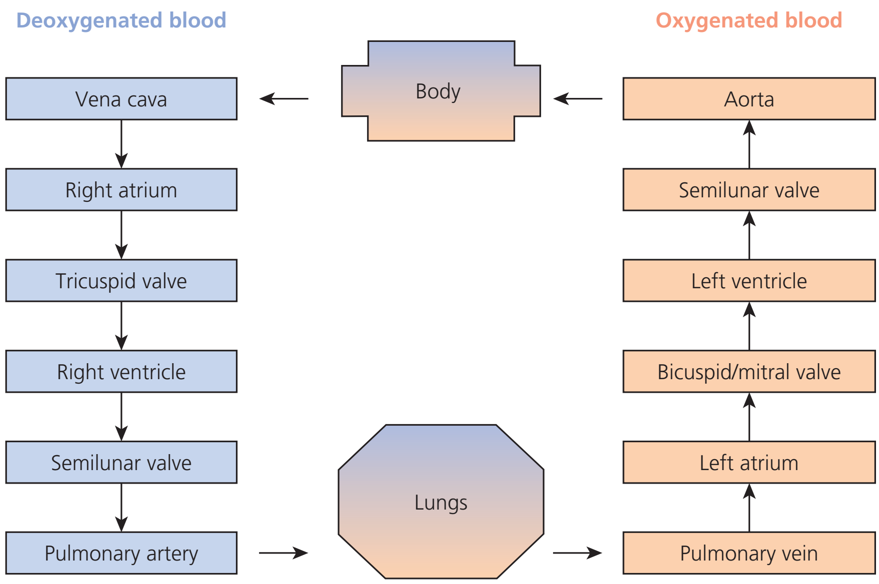


Figure 1.1.13 The pathway of blood

The conduction system

The cardiac muscle is **myogenic**. The **conduction system** is a set of five structures that pass the electrical impulse through the cardiac muscle:

1. SA node – this generates electrical impulses, causing the atria walls to contract. It is known as the 'pacemaker' and determines heart rate.
2. AV node – this collects the impulse and delays it by 0.1 seconds to allow the atria to finish contracting.
3. Bundle of His – located in the septum, this splits the impulse in two, ready to be distributed to the ventricles.
4. Bundle branches – these carry the impulses to the base of each ventricle.
5. Purkinje fibres – these distribute the impulse through the ventricle walls, causing them to contract.

Revision activity

Draw a flow diagram to help you learn the conduction system. Add small illustrations to each structure to create a visual learning medium or create a mnemonic to help you remember the order – SABBP.

Myogenic: the capacity of the heart to generate its own electrical impulse, which causes the cardiac muscle to contract.

Conduction system: a set of structures in the cardiac muscle that create and transmit an electrical impulse, forcing the atria and ventricles to contract.

Diastole: the relaxation phase of cardiac muscle where chambers fill with blood.

Systole: the contraction phase of cardiac muscle where blood is forcibly ejected into the aorta and pulmonary artery.

The cardiac cycle

The cardiac cycle refers to cardiac muscle contraction and the movement of blood through its chambers. One complete cardiac cycle is a single heartbeat. At rest, a complete cycle takes approximately 0.8 seconds. It has two phases, **diastole** and **systole**, as described in Table 1.1.7.

Table 1.1.7 Diastole and systole phases

Diastole (relaxation)	+ Relaxation of the atria and ventricles means lower pressure within the heart. + Blood then passively flows through the atria and into the ventricles. + AV valves are open, allowing blood to move freely from the atria to the ventricles. + Semilunar valves are closed at this time.
Systole (contraction)	**Atrial systole** + Atria contract, forcing blood into the ventricles. **Ventricular systole** + Ventricles contract. + AV valves close. + Semilunar valves open. + Blood is pushed out of the ventricles and into the large arteries leaving the heart.

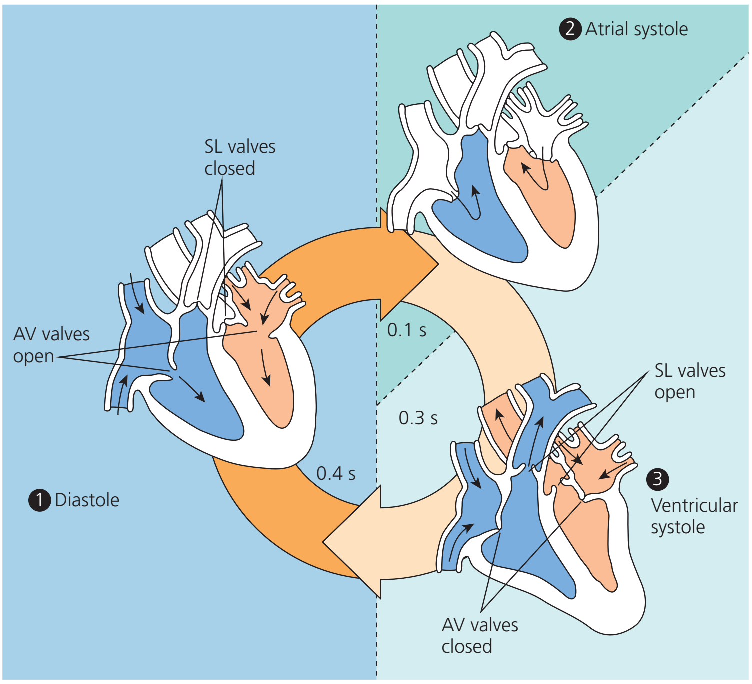


Figure 1.1.14 The stages of the cardiac cycle

Heart rate, stroke volume and cardiac output

Table 1.1.8 Definitions of HR, SV, CO, bradycardia and maximum heart rate

Key term	Definition	Typical resting value
Heart rate (HR)	The number of times the heart beats per minute	72 bpm
Stroke volume (SV)	The amount of blood ejected from the left ventricle per beat	70 ml
Cardiac output (CO)	The amount of blood ejected from the left ventricle per minute: HR × SV = CO	5l/min
Bradycardia	A resting heart rate below 60 bpm	< 60 bpm
Maximum heart rate	Calculated by subtracting your age from 220	220 – age = HRmax (bpm)

Table 1.1.9 Comparison of HR, SV and CO of an untrained and trained individual at rest

	HR	SV	CO
Untrained	70–72 bpm	70 ml	5l/min
Trained	50 bpm	100 ml	5l/min

The cardiovascular system during exercise and recovery

REVISED

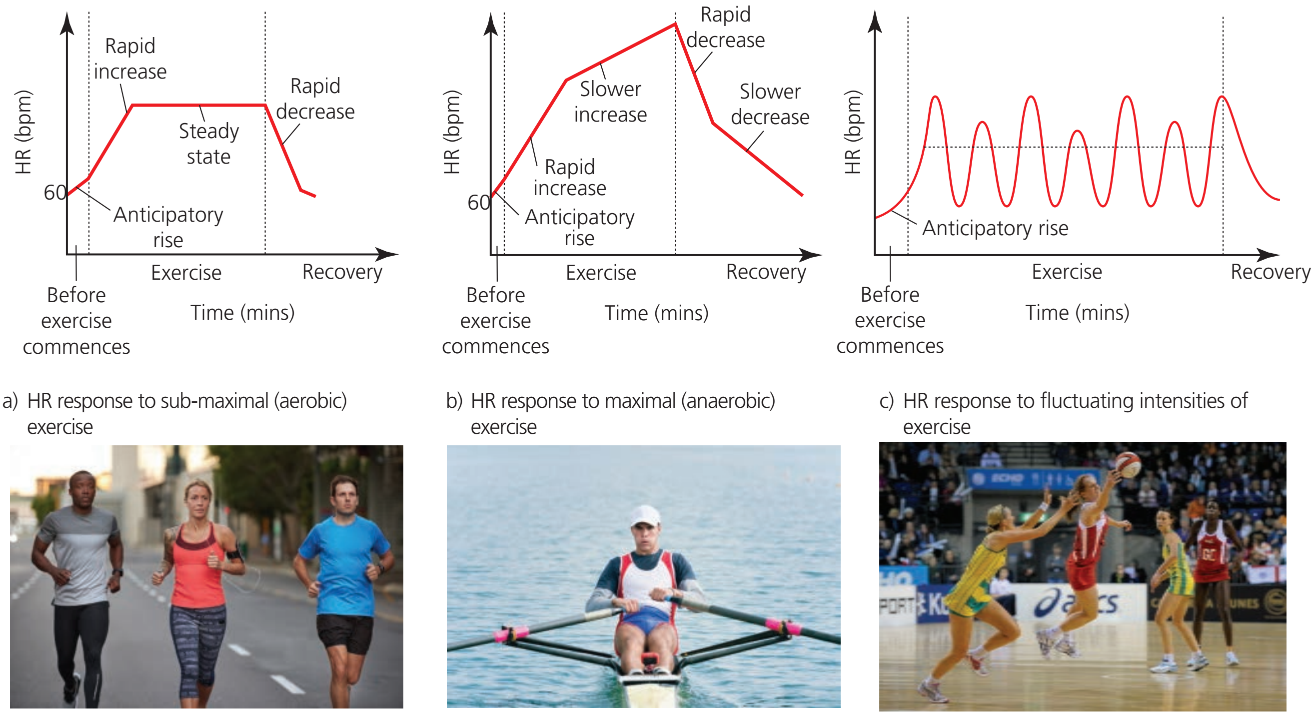
As we start to exercise, the demand for oxygen of the muscles increases rapidly. It is the role of the cardiovascular system to increase oxygenated blood flow to the muscles.

Exam tip

It can be helpful to include a sketch of a graph in an answer. Always label axes and take care to plot the resting value (not at zero).

Heart rate response to exercise

HR increases in proportion to the intensity of exercise until we reach HRmax, as shown in Figure 1.1.15.



a) HR response to sub-maximal (aerobic) exercise

b) HR response to maximal (anaerobic) exercise

c) HR response to fluctuating intensities of exercise

Figure 1.1.15 HR response to exercise of different intensities

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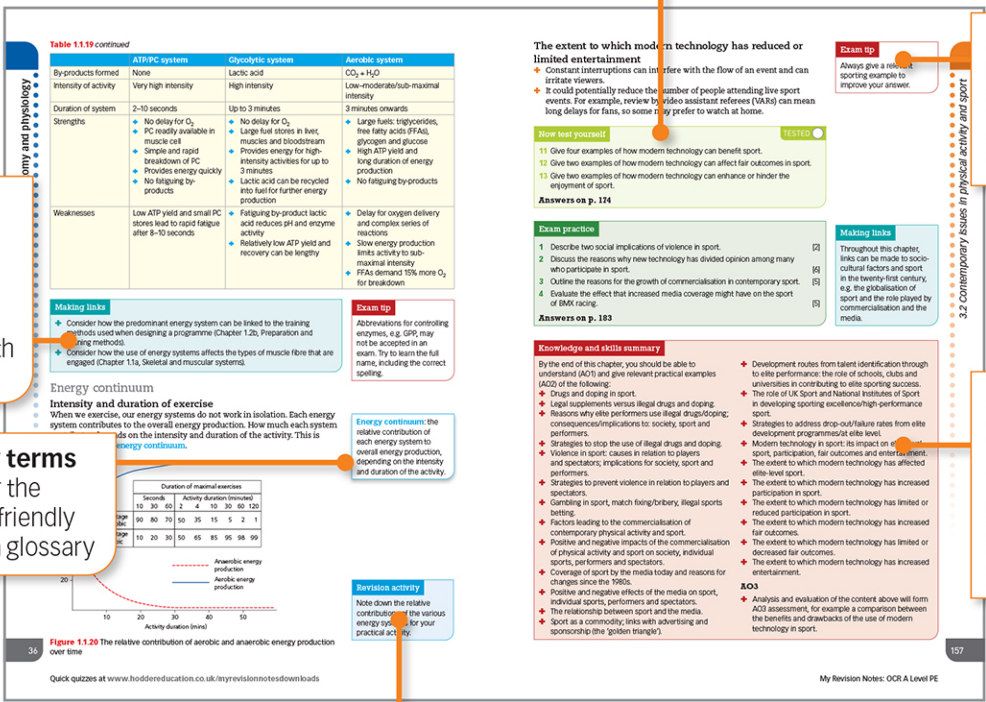

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