MY REVISION NOTES

HODDER EDUCATION

AQA

A-level

# PE

## SECOND EDITION

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

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MY REVISION NOTES
AQA A-level
PE

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# Get the most from this book

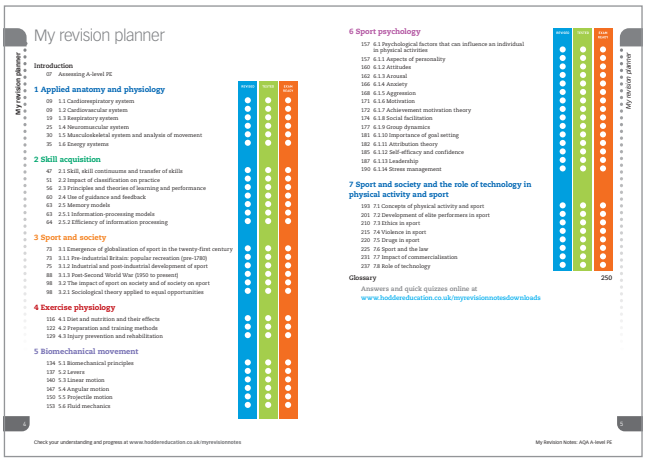
Everyone has to decide their own revision strategy, but it is essential to review your work, learn it and test your understanding. These Revision Notes will help you to do that in a planned way, topic by topic. Use this book as the cornerstone of your revision and don't hesitate to write in it — personalise your notes and check your progress by ticking off each section as you revise.

## Tick to track your progress

Use the revision planner on pages 4 and 5 to plan your revision, topic by topic. Tick each box when you have:

- revised and understood a topic
- tested yourself
- practised the exam questions and gone online to check your answers and complete the quick quizzes

You can also keep track of your revision by ticking off each topic heading in the book. You may find it helpful to add your own notes as you work through each topic.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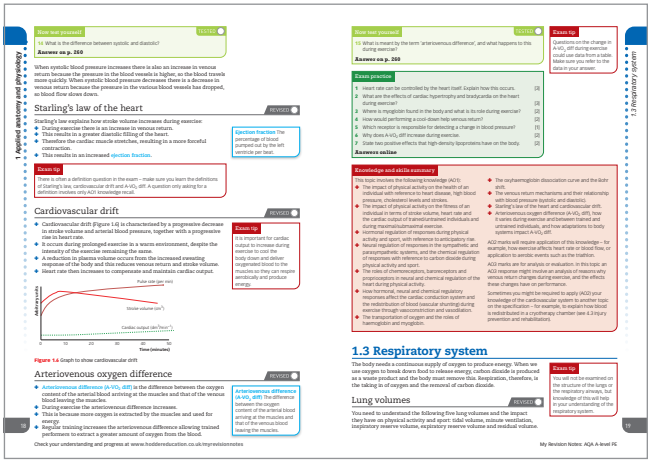
Answers and quick quizzes online at www.hoddereducation.co.uk/myrevisionnotesdownloads


Starling's law of the heart

Cardiovascular drift

Arteriovenous oxygen difference

1.3 Respiratory system

Lung volumes

## Features to help you succeed

### Exam tips

Expert tips are given throughout the book to help you polish your exam technique in order to maximise your chances in the exam.

### Now test yourself

These short, knowledge-based questions provide the first step in testing your learning. Answers are at the back of the book.

### Definitions and key words

Clear, concise definitions of essential key terms are provided.

Key words from the specification are highlighted in bold throughout the book.

### Making links

This feature identifies specific connections between topics and tells you how revising these will aid your exam answers.

### Revision activities

These activities will help you to understand each topic in an interactive way.

### Exam practice

Practice exam questions are provided for each topic. Use them to consolidate your revision and practise your exam skills.

### Knowledge and skills summary

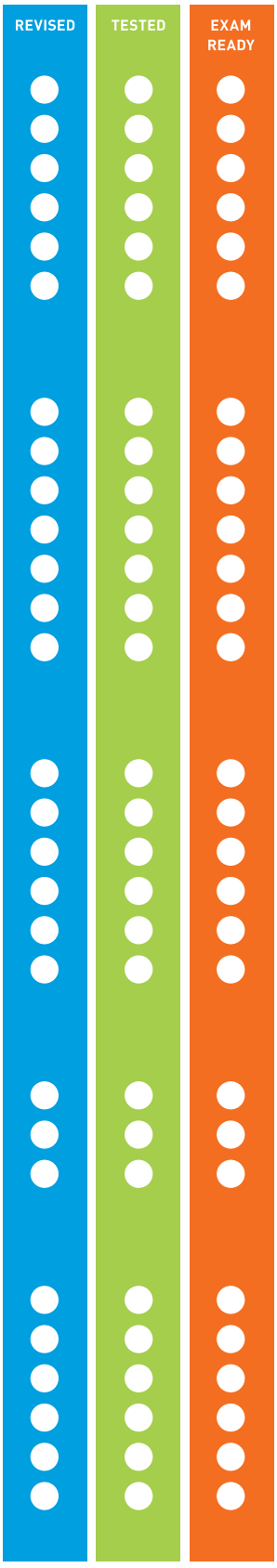
These summaries provide a quick-check bullet list for each topic.

### Online

Go online to check your answers to the exam questions and try out the extra quick quizzes at **www.hoddereducation.co.uk/myrevisionnotesdownloads**

# My revision planner





## 6 Sport psychology



## 7 Sport and society and the role of technology in physical activity and sport



Exam practice answers and quick quizzes online at
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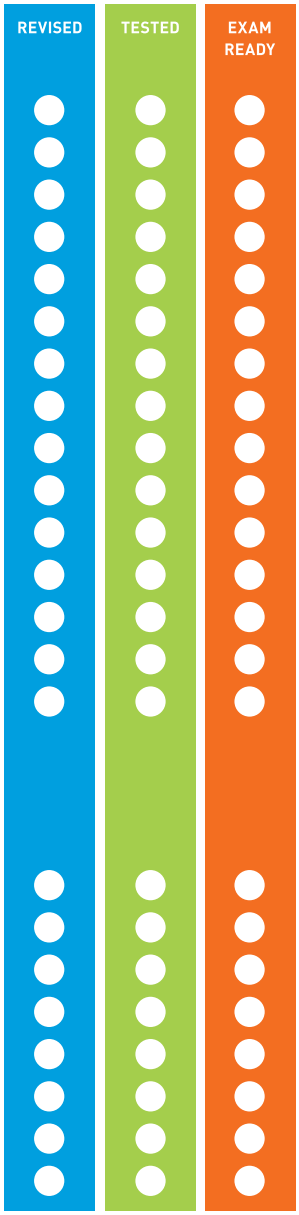

# Countdown to my exams

## 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 pages 4 and 5 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, 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 online and try out the extra 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 experts 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

**A-level PE Paper 1**

Date: .....

Time: .....

Location: .....

**A-level PE Paper 2**

Date: .....

Time: .....

Location: .....

# Exam breakdown

This book covers all the content for Papers 1 and 2 of the AQA A-level PE exam.

## Paper 1: Factors affecting participation in physical activity and sport

- Section A: Applied anatomy and physiology
- Section B: Skill acquisition
- Section C: Sport and society

## Paper 2: Factors affecting optimal performance in physical activity and sport

- Section A: Exercise physiology and biomechanics
- Section B: Sport psychology
- Section C: Sport and society and technology in sport

### Assessment

- Paper 1 and Paper 2 are both 2 hours long.
- Each exam has a total of 105 marks available and they are both worth 35% of your A-level (i.e. 70% in total).
- Each section (i.e. see Sections A–C above) on both papers has questions that total 35 marks.
- The question format is also the same, with each section having two multiple-choice questions (2 marks), a number of short-answer questions (to a total of 10 marks) and two questions requiring extended writing in continuous prose (one worth 8 marks, the other worth 15 marks) – 35 marks in total per section of the exam paper.

## The assessment objectives

Your answers will be marked by examiners who will look to see how well you have met the three assessment objectives set in your papers. These are explained below:

| Assessment objective | Requirements |
|---|---|
| AO1: Knowledge and understanding | Identify/state/provide knowledge of the key term(s) mentioned in the question |
| AO2: Apply knowledge and understanding | Apply your knowledge and understanding to the example in the question (e.g. a particular sport or a sports performer) |
| AO3: Analyse and evaluate this knowledge | Analyse and evaluate your knowledge by:<br>+ giving advantages and disadvantages<br>+ stating the impact on the practical example in the question<br>+ providing reasons for the judgements made<br>+ offering alternative viewpoints |

## Specific question advice

Synoptic assessment will be assessed in each paper and will draw on content from any topic, regardless of which component that topic is predominantly assessed in (e.g. Paper 2 topics such as sports supplements, goal setting or theories of aggression could appear in Paper 1). These questions will always be extended-answer questions worth 8 marks or 15 marks. There is one 8-mark and one 15-mark question in each section so that is three 8-mark and three 15-mark questions in Paper 1 and the same for Paper 2.

'Synoptic' means that the question could ask for:

- Knowledge, application and analysis/evaluation of two topics from the same section, for example:
  - Anatomy – muscles and movement and fibre type
  - Skill – types of practice and operant conditioning
  - Sport and society – sports legislation and strategies to control crowd violence
- Knowledge, application and analysis/evaluation of two topics from different sections, for example:
  - Psychology/Exercise physiology
  - Exercise physiology/Sport and society and the role of technology
  - Sport and society and the role of technology/Psychology
- Knowledge, application and analysis/evaluation of one topic from any section in Paper 1 with another topic from any section in Paper 2.

## Specific exam skills including synoptic skills

- Always look at the command word in the question and make sure you understand what the command word wants you to do. For example, if the command word is 'discuss' make sure you give both strengths and weaknesses or offer alternative views of a debate.
- Synoptic questions are marked using level of response grids, so you are not awarded 1 mark for each correct answer. For example, there are 2 knowledge marks, 3 application marks and 3 analysis or evaluation marks for 8-mark questions and 4 knowledge marks, 5 application marks and 6 analysis/evaluation marks for 15-mark questions. The examiner will look at the depth and quality of your knowledge from the responses given and place you in one of the levels linked to your knowledge, application and analysis/evaluation.

# 1 Applied anatomy and physiology

## 1.1 Cardiorespiratory system

This topic explains the relationship between the cardiovascular system (below) and the respiratory system (pp. 19–25), and describes how these systems change prior to exercise, during exercise of differing intensities and during recovery. Taking part in physical activity can have a positive effect on both these systems. This relationship is therefore covered in the next two sections.

## 1.2 Cardiovascular system

The cardiovascular system is the body's transport system. It includes the heart and the blood vessels. During exercise, an efficient cardiovascular system is extremely important, as the heart works to pump blood through the various blood vessels to deliver oxygen and nutrients to the working muscles and gather waste products such as carbon dioxide.

### Impact of physical activity and sport on health

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#### Heart disease

- Exercise helps prevent coronary heart disease (CHD), which occurs when your coronary arteries, which supply the heart muscle with oxygenated blood, become hardened, blocked or start to narrow through a gradual build-up of fatty deposits. This process is called **atherosclerosis** and the fatty deposits are called atheroma.
- High blood pressure, high levels of cholesterol, lack of exercise and smoking can all cause atherosclerosis, which limits the supply of oxygen to the heart, resulting in a heart attack.

#### High blood pressure

- Blood pressure is the force exerted by the blood against the blood vessel wall. This pressure comes from the heart as it pumps the blood around the body.
- High blood pressure puts extra strain on the arteries and heart, and if left untreated increases the risk of heart attack, heart failure, kidney disease, stroke or dementia.
- Regular **aerobic** exercise can reduce blood pressure. It lowers both systolic and diastolic pressure by up to 5–10 mmHg, which reduces the risk of a heart attack by up to 20 per cent.

#### Effects of cholesterol

There are two types of cholesterol:

- LDLs (low-density lipoproteins) transport cholesterol in the blood to the tissues, and are classed as 'bad' cholesterol since they are linked to an increased risk of heart disease.
- HDLs (high-density lipoproteins) transport excess cholesterol in the blood back to the liver, where it is broken down. They protect the artery walls against LDL cholesterol and have a positive antioxidant effect. HDLs are classed as 'good' cholesterol since they lower the risk of developing heart disease.

**Exam tip**

While structure is not tested in the exam, a good grasp of how the components of the cardiovascular system are arranged and organised will enable you to better understand how the system functions.

**Atherosclerosis** When arteries harden and narrow, and become blocked with fatty deposits.

**Aerobic** A reaction that occurs in the presence of oxygen.

**Exam tip**

Be aware that heart disease can lead to a heart attack. Past questions have asked you to make this link.

Regular physical activity lowers bad LDL cholesterol levels, while significantly increasing good HDL cholesterol levels.

## Stroke

The brain needs a constant supply of oxygenated blood and nutrients to maintain its function. The energy to work all the time is provided by oxygen delivered to the brain in the blood. A **stroke** occurs when the blood supply to part of the brain is cut off, causing damage to brain cells, which then start to die. This can lead to brain injury, disability and sometimes death.

There are two main types of stroke:

- Ischaemic strokes are the most common form and occur when a blood clot stops the blood supply.
- Haemorrhagic strokes occur when a weakened blood vessel supplying the brain bursts.

Research has shown that regular exercise can help to lower your blood pressure and help you maintain a healthy weight, which can reduce your risk of stroke by 27 per cent.

**Now test yourself** TESTED

1 What effect does regular physical activity have on blood pressure and cholesterol?

**Answer on p. 260**

**Revision activity**

Create a table to summarise how physical activity can have an effect on heart disease, high blood pressure, cholesterol levels and strokes.

# Impact of physical activity and sport on fitness

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## Stroke volume

Stroke volume is the volume of blood pumped out by the heart ventricles in each contraction. On average, the resting stroke volume is approximately 70ml.

Stroke volume will increase due to the following:

- Venous return – when this increases then stroke volume will also increase.
- The elasticity of cardiac fibres – this is concerned with the degree of stretch of cardiac tissue during the diastole phase (when the heart is relaxed) of the cardiac cycle. The more the cardiac fibres can stretch the greater the force of contraction will be.
- The contractility of cardiac tissue (myocardium) – the greater the contractility of cardiac tissue, the greater the force of contraction.

### Stroke volume in response to exercise

Stroke volume increases as exercise intensity increases. However, this is only the case up to 40–60 per cent of maximum effort. Once a performer reaches this point then stroke volume plateaus (evens out) because the ventricles simply do not have as much time to fill up with blood, and so cannot pump as much out.

## Heart rate

Heart rate refers to the number of times the heart beats per minute. On average, the resting heart rate is approximately 72 beats per minute.

### Heart rate range in response to exercise

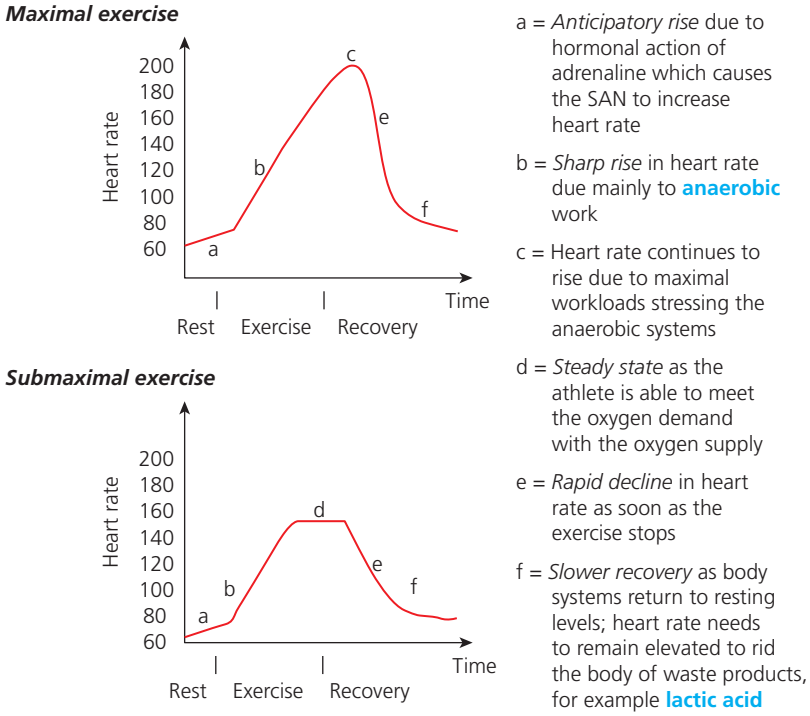
Heart rate increases with exercise, but how much it increases depends on the intensity of the exercise. Heart rate will increase in direct proportion to exercise intensity. The higher the intensity, the higher the heart rate. Heart rate does eventually reach a maximum. Maximum heart rate can be

calculated by subtracting your age from 220. An 18-year-old will therefore have a maximum heart rate of 202 beats per minute:

$$220 - 18 = 202$$

A trained performer has a greater heart rate range because their resting heart rate is lower than average, and their maximum heart rate is higher.

The graphs in Figure 1.1 illustrate what happens to heart rate during maximal exercise, such as sprinting, and submaximal exercise, such as jogging.




a = *Anticipatory rise* due to hormonal action of adrenaline which causes the SAN to increase heart rate

b = *Sharp rise* in heart rate due mainly to **anaerobic** work

c = Heart rate continues to rise due to maximal workloads stressing the anaerobic systems

d = *Steady state* as the athlete is able to meet the oxygen demand with the oxygen supply

e = *Rapid decline* in heart rate as soon as the exercise stops

f = *Slower recovery* as body systems return to resting levels; heart rate needs to remain elevated to rid the body of waste products, for example **lactic acid**

**Figure 1.1** Heart rate responses to maximal and submaximal exercise

- Regular aerobic training will result in more cardiac muscle. When the cardiac muscle becomes bigger and stronger this is known as **cardiac hypertrophy**.
- Consequently, a bigger, stronger heart will enable more blood to be pumped out per beat (i.e. stroke volume). This is known as **bradycardia**, which means there is a decrease in resting heart rate to below 60 beats per minute. When this occurs oxygen delivery to the muscles improves because there is less oxygen needed for each contraction of the heart, as it beats less frequently.

## Cardiac output

Cardiac output is the volume of blood pumped out by the heart ventricles per minute. It can be calculated using the following equation:

$$\text{cardiac output } (Q) = \text{stroke volume (SV)} \times \text{heart rate (HR)}$$

$$Q = 70\,\text{ml} \times 72 \text{ beats per minute}$$

$$Q = 5040\,\text{ml (5.04 litres)}$$

It can be seen from this calculation that if heart rate or stroke volume increases, then cardiac output will also increase.

### Cardiac output in response to exercise

During exercise there is a large increase in cardiac output due to an increase in heart rate and an increase in stroke volume. Cardiac output will increase as the intensity of exercise increases until maximum intensity is reached. Then it plateaus.

**Exam tip**

Maximum heart rate is calculated as 220 minus age.

**Anaerobic** A reaction that occurs without the presence of oxygen.

**Lactic acid** A by-product of anaerobic respiration. As it accumulates, it causes fatigue.

**Cardiac hypertrophy** When the heart becomes bigger and stronger due to a thickening of the muscular wall.

**Bradycardia** When there is a decrease in resting heart rate to below 60 beats per minute.

Table 1.1 shows the differences in cardiac output between a trained and untrained individual, both at rest and during exercise. The individual in this example is aged 18, so their maximum heart rate will be 202 beats per minute.

**Table 1.1** Cardiac output during exercise and at rest

| | stroke volume × heart rate = cardiac output (SV × HR = *Q*) | |
|---|---|---|
| | **Exercise** | **At rest** |
| Untrained | 120 ml × 202 = 24.24 litres | 70 ml × 72 = 5.04 litres |
| Trained | 170 ml × 202 = 34.34 litres | 84 ml × 60 = 5.04 litres |

Impact of an increase in cardiac output on performance:

- Able to transport more blood to the working muscles and therefore more oxygen.
- Easier to continue working at a higher intensity for longer.

**Exam tip**

Do not be caught out by an exam question asking for the effects of a period of training on resting cardiac output. Resting cardiac output remains unchanged – it is *maximum* cardiac output that changes.

It is important to understand the impact of a bigger cardiac output on a performer for AO2.

**Now test yourself** TESTED

2 Define cardiac output and stroke volume, and explain the relationship between them.

3 Explain how and why the components of cardiac output would differ for an elite football player at rest.

4 How would maximal cardiac output differ between a trained performer and an untrained performer?

**Answers on p. 260**

# Regulation of responses during physical activity and sport

REVISED

Heart rate increases with exercise, but how much it increases depends on the intensity of the exercise. The higher the intensity, the higher the heart rate.

## Cardiac conduction system

When the heart beats, the blood needs to flow through it in a controlled manner – in through the atria and out through the ventricles. Heart muscle is described as being **myogenic** because the beat is generated in the heart muscle itself with an electrical signal in the **SAN** (Figure 1.2). This electrical signal then spreads through the heart in what is often described as a wave of excitation (similar to a Mexican wave), in the following order:

- The sinoatrial node (SAN) sends an impulse through the walls of the atria.
- This spreads as a wave of excitation.
- This causes atrial systole/the atria to contract.
- The impulse then passes to the atrioventricular node (AVN), which delays the impulse for around 0.1 seconds, enabling the atria to empty fully.
- The impulse passes down the bundle of His (in the septum of the heart) to the Purkinje fibres in the (walls of) the ventricles.
- Ventricular systole then occurs/the ventricles contract.

**SAN** A small mass of cardiac muscle (sinoatrial node or SAN) found in the wall of the right atrium that generates the heartbeat. It is more commonly called the pacemaker.

**Now test yourself** TESTED

5 Identify the correct order of events in a cardiac impulse.

**Answer on p. 260**

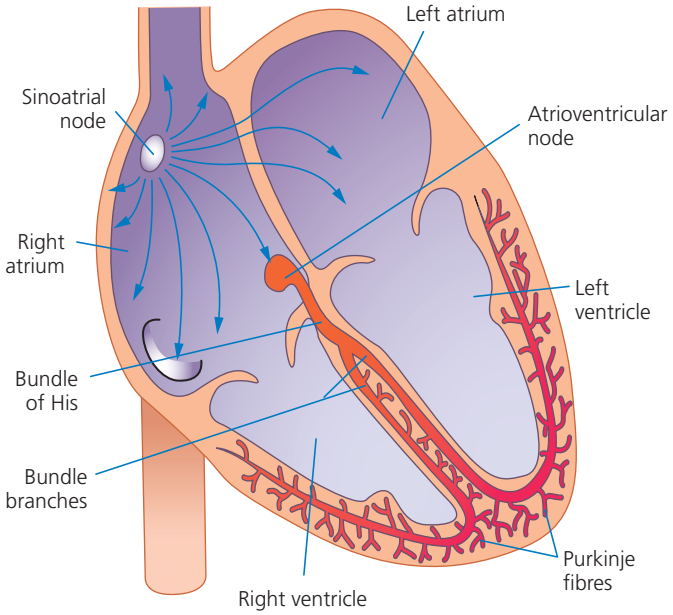



**Figure 1.2** The cardiac conduction system

The conduction system ensures that heart rate increases during exercise to allow the working muscles to receive more oxygen. The rate at which the heart generates its own impulses from the SAN involves hormonal, neural and chemical regulation.

**Exam tip**

When explaining the cardiac conduction system, make sure you can give the correct order of events involved in a cardiac impulse.

## Sympathetic and parasympathetic control

The sympathetic and parasympathetic systems are part of the peripheral nervous system. Their role is to transmit information from the brain to the parts of the body that need to adjust what they are doing to prepare for exercise:

- The sympathetic nervous system prepares the body for exercise, and is often referred to as the 'fight or flight response'.
- The parasympathetic nervous system has the opposite effect and relaxes the body and slows down many high-energy functions. It is often described by the phrase 'rest and relax'.

**Exam tip**

Make sure you do not confuse the sympathetic and parasympathetic systems. The sympathetic system is fight or flight – it fires up the body for exercise. The parasympathetic system is 'rest and relax' – it slows everything down.

**Making links**

Knowledge of the sympathetic and parasympathetic systems is needed in several topics: heart, blood flow, respiratory system and neuromuscular system.

## Hormonal regulation

The hormone adrenaline is secreted by the adrenal gland and makes the heart beat faster and stronger.

**Adrenaline** A stress hormone released by the nervous system to increase heart rate.

### Anticipatory rise

An anticipatory rise is when heart rate increases prior to exercise. It occurs when the hormonal adrenaline is released by the nervous system in anticipation of exercise. This stimulates the heart to increase both the speed and force of contraction, therefore increasing cardiac output. This results in more blood being pumped to the working muscles so they can receive more oxygen for the energy they need.

### Neural and chemical regulation

Neural regulation involves the sympathetic and parasympathetic nervous systems. Chemical regulation involves the levels of oxygen and carbon dioxide in the blood and the pH of the blood. The sympathetic and parasympathetic systems are coordinated by the cardiac control centre located in the medulla oblongata of the brain.

**Medulla oblongata** The most important part of the brain, because it regulates the processes that keep us alive.

The cardiac control centre is stimulated by chemoreceptors, baroreceptors and proprioceptors. It will then send an impulse through either the sympathetic system to the SAN to increase heart rate or the parasympathetic system to the SAN to decrease heart rate.

# Receptors involved in regulation of responses during physical activity

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- Chemoreceptors are tiny structures in the carotid and aortic arch that detect changes in blood acidity caused by an increase or decrease in the concentration of carbon dioxide.
- Proprioceptors are sensory nerve endings in the muscles, tendons and joints that detect changes in muscle movement.
- Baroreceptors are special sensors in the aortic arch, carotid sinus, heart and pulmonary vessels that respond to changes in blood pressure to either increase or decrease heart rate.

## How neural and chemical regulation works

- chemoreceptors → increase in blood carbon dioxide → cardiac control centre → sympathetic system → SAN increases heart rate
- baroreceptors → increase in blood pressure → cardiac control centre → parasympathetic system → SAN decreases heart rate
- proprioceptors → increase in muscle movement → cardiac control centre → sympathetic system → SAN increases heart rate

**Making links**

Knowledge of the receptors is the same for the control of heart rate, blood flow and breathing.

**Now test yourself** TESTED

6 Identify and explain the roles of chemoreceptors and proprioceptors in increasing heart rate.

**Answer on p. 260**

**Exam tip**

Do not be vague – tell the examiner what the receptors detect. For example, chemoreceptors detect an increase in carbon dioxide during exercise – do not just say chemical changes.

## Redistribution of blood during exercise (vascular shunting)

The distribution of blood flow is different at rest compared with during exercise. During exercise the skeletal muscles require more oxygen, so more blood needs to be redirected to them to meet this increase in oxygen demand. The redirecting of blood flow to the areas where it is most needed is known as vascular shunting.

**Vascular shunting** The redistribution of cardiac output to where oxygen is needed most.

- More blood goes to the heart because the heart muscle needs more oxygen to beat faster and with more force.
- More blood goes to the muscles because they need more oxygen for energy.
- More blood goes to the skin because more energy is needed to cool the body down.
- Blood flow to the brain remains constant because it needs oxygen for energy to maintain function.
- A full stomach would result in more blood being directed to the gut instead of the working muscles, and this would have a detrimental effect on performance because less oxygen is being made available.

### Vasodilation and vasoconstriction

- During exercise chemoreceptors detect an increase in carbon dioxide. Baroreceptors detect an increase in blood pressure. Proprioceptors detect an increase in muscle movement.

- These receptors send impulses to the vasomotor centre located in the medulla oblongata.
- The medulla oblongata controls blood flow by sending out increased sympathetic nervous impulses to cause both **vasoconstriction** to the blood vessels and the closing of the pre-capillary sphincters surrounding the non-essential organs.
- The medulla oblongata decreases sympathetic nervous impulses to cause both **vasodilation** to the blood vessels and the opening of the pre-capillary sphincters surrounding the working muscles.

**Vasoconstriction** The narrowing of the blood vessels to reduce blood flow into the capillaries.

**Vasodilation** The widening of the blood vessels to increase the flow of blood into the capillaries.

**Now test yourself** TESTED

7 Why does blood flow to the skin and heart increase during exercise?

8 Explain why there is a need for an increase in blood flow to the skeletal muscles during exercise and how this is achieved.

**Answers on p. 260**

# Transportation of oxygen

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Arteries, arterioles, veins, venules and capillaries transport blood from the heart, distribute it around the body and then return it back to the heart (systemic circulation). They also transport deoxygenated blood from the heart to the lungs and oxygenated blood back to the heart (pulmonary circulation).

- Veins transport deoxygenated blood back to the heart (with the exception of the pulmonary vein), have thinner muscle/elastic tissue layers, contain blood at low pressure, and have valves and a wider lumen.
- Arteries transport oxygenated blood around the body (with the exception of the pulmonary artery), have the highest pressure, thick and elastic outer walls, and have thick layers of muscle, a smaller lumen and a smooth inner layer.
- Capillaries have a tiny lumen and are only wide enough to allow one red blood cell to pass through at a given time. This slows down blood flow and allows the exchange of nutrients with the tissues to take place by diffusion. They are also one cell thick, which allows for a short diffusion pathway.

**Now test yourself** TESTED

9 Explain why arteries have the highest pressure.

10 How does the structure of capillaries help diffusion?

**Answers on p. 260**

**Revision activity**

Create a spider diagram to highlight the key structures of arteries, veins and capillaries.

## Haemoglobin

Oxygen can be transported as follows:

- 3 per cent dissolves into plasma.
- 97 per cent combines with haemoglobin to form oxyhaemoglobin.

At the tissues oxygen is released from oxyhaemoglobin due to the lower pressure of oxygen that exists there. The release of oxygen from oxyhaemoglobin to the tissues is referred to as oxyhaemoglobin dissociation.

## Myoglobin

In the muscles, oxygen is stored by **myoglobin**, which is often called 'muscle haemoglobin'. It is an iron-containing muscle pigment in slow-twitch muscle fibres that has a higher affinity for oxygen than haemoglobin. It stores the oxygen until it is used by the **mitochondria** in muscle cells.

**Myoglobin** A protein found in muscle cells which stores and provides oxygen.

**Mitochondria** Components of cells that are often referred to as the 'powerhouses' of the cells because respiration and energy production occur there.

**Now test yourself** TESTED

**11** What is the difference between haemoglobin and myoglobin?

**Answer on p. 260**

## Oxyhaemoglobin dissociation curve

The oxyhaemoglobin dissociation curve (Figure 1.3) helps us to understand how haemoglobin in our blood carries and releases oxygen. The curve represents the relationship between oxygen and haemoglobin.

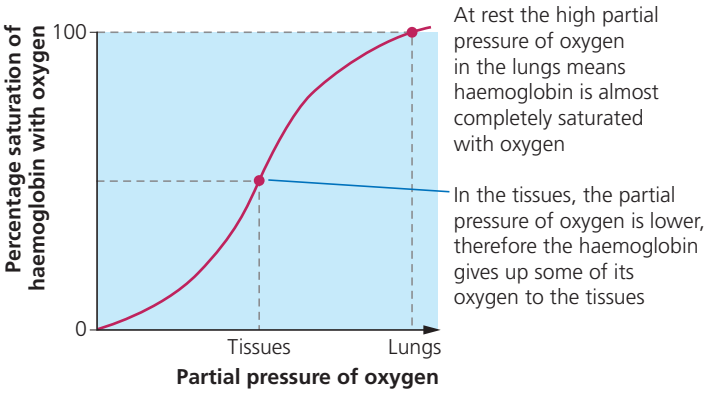


**Figure 1.3** The oxyhaemoglobin dissociation curve

From this curve you can see that in the lungs there is almost full saturation (concentration) of haemoglobin but at the tissues the partial pressure of oxygen is lower.

## The Bohr shift

During exercise this S-shaped curve shifts to the right. This is because when muscles require more oxygen the dissociation of oxygen from haemoglobin in the blood capillaries to the muscle tissue occurs more readily. This shift to the right is known as the **Bohr shift** (Figure 1.4).

**Bohr shift** When an increase in blood carbon dioxide and a decrease in pH results in a reduction of the affinity of haemoglobin for oxygen.

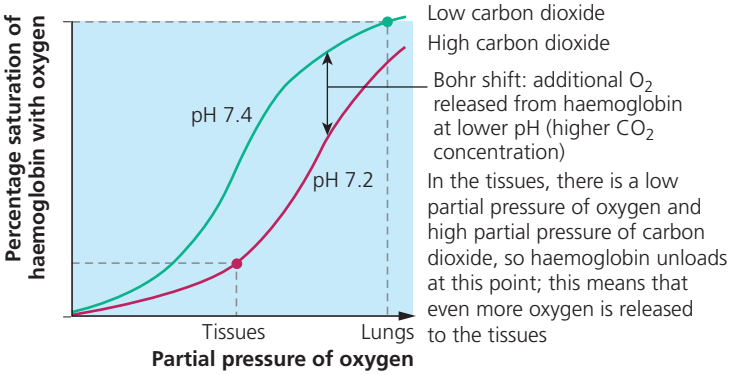


**Figure 1.4** The effect of changing acidity on the oxyhaemoglobin dissociation curve

Three factors are responsible for this increase in the dissociation of oxygen from haemoglobin, which results in more oxygen being available for use by the working muscles:

- Increase in blood temperature – when the blood and muscle temperature increases during exercise oxygen will dissociate from haemoglobin more readily.
- Increases in partial pressure of carbon dioxide – as the level of blood carbon dioxide rises during exercise oxygen will dissociate more quickly from haemoglobin.
- A drop in pH – more carbon dioxide will lower the pH in the body; this causes oxygen to dissociate from haemoglobin more quickly (the Bohr shift — Figure 1.4).

**Exam tip**

When giving the causes of the Bohr shift, do not forget the word 'blood' – *blood* pH, *blood* carbon dioxide levels, *blood* temperature.

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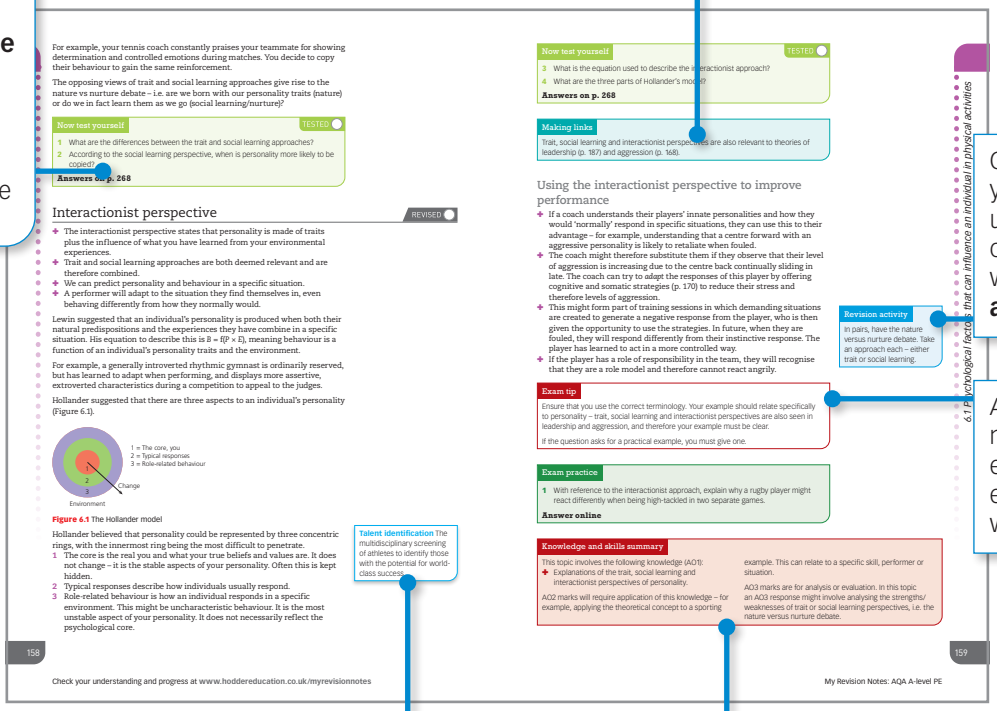

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