Unit 3

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 ✓

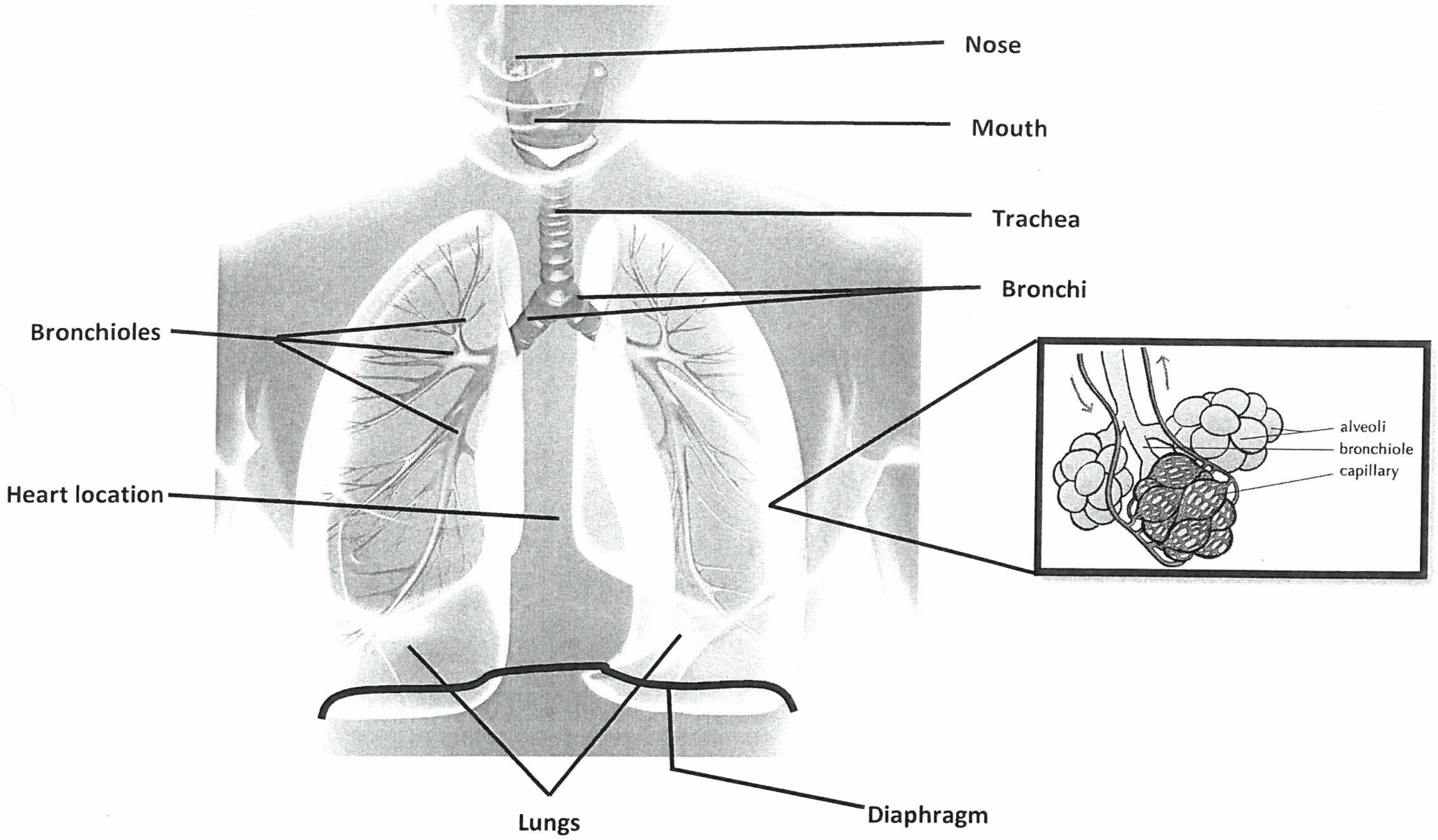
	Revised	Understood	What you need to do
Be able to describe the pathways of air from the atmosphere to the red blood cells			
Explain the process of gaseous exchange and the factors that aid gaseous exchange			
Describe the functions and structural characteristics of blood vessels			
Be able to label 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

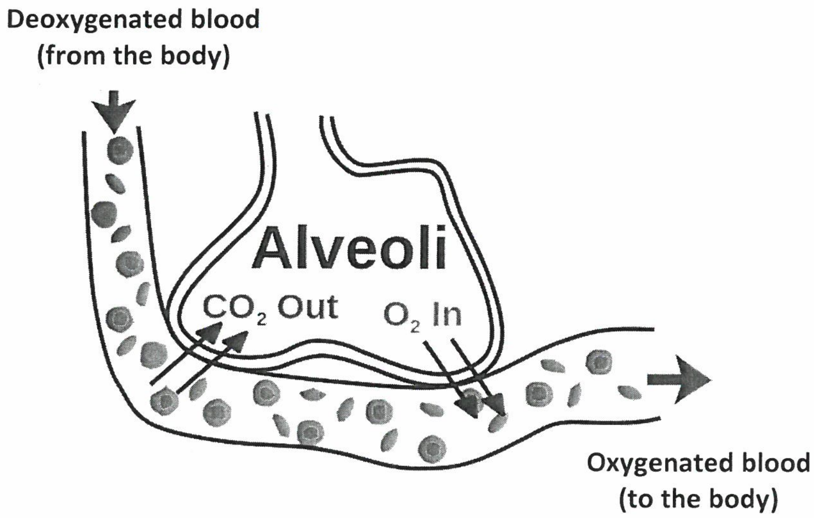
1. **Alveoli** – sacs in the lungs that are the site of gaseous exchange
2. **Artery** – large blood vessel that transports oxygenated blood from the heart to the body
3. **Capillary** – small blood vessel that surrounds body tissues and is the site of gaseous exchange
4. **Gaseous exchange** – the process 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

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

Factors That Aid Gaseous Exchange

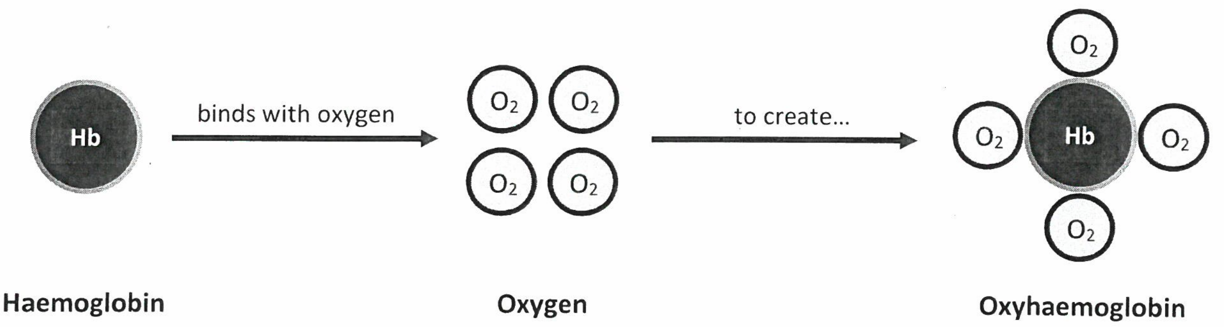
Large surface area of alveoli – although alveoli are small, there is a very large number of them in each lung. This increases the total surface area for diffusion to take place.

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.

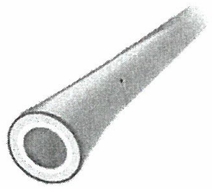
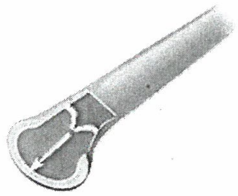
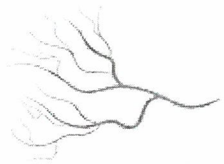
Vast amount of capillaries – surrounding the alveoli are whole networks of capillaries carrying blood. These give oxygen and carbon dioxide as much opportunity as possible to diffuse.

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



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

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.

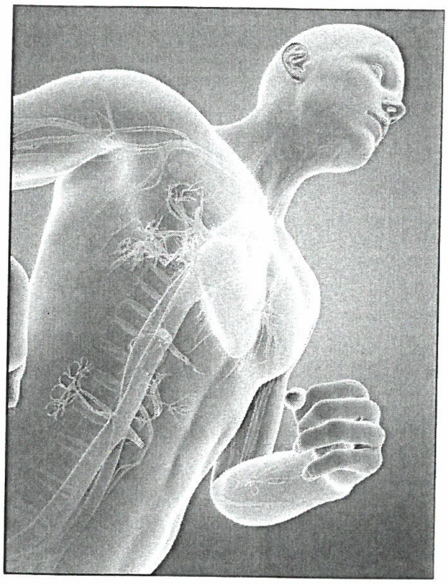
	Artery	Vein	Capillary
			
Structural characteristics	• Largest diameter of the blood vessels • Thick outer walls • Elastic walls • Muscles to vasoconstrict and vasodilate (changing diameter)	• Thin walls • Large internal diameter	• High number of capillaries in body • Very small in diameter • Thin walls
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

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.



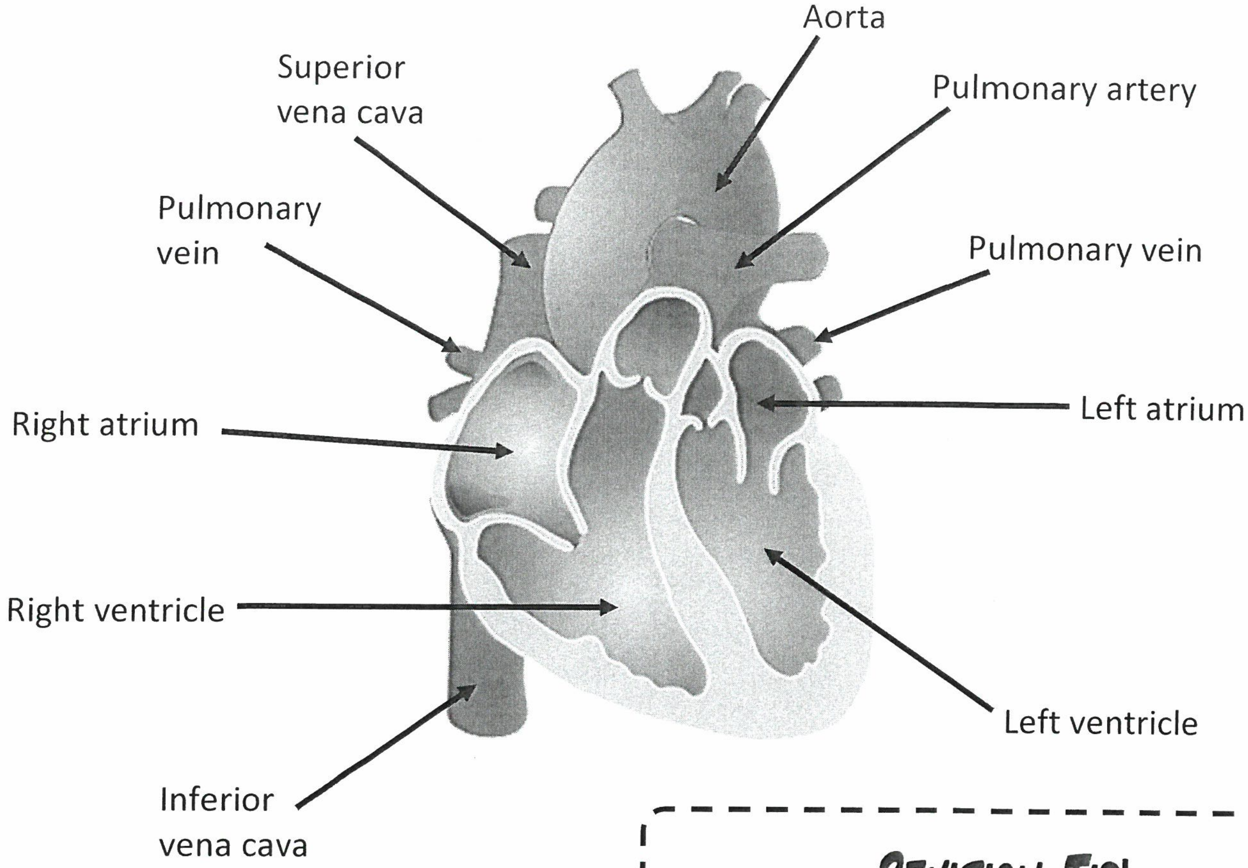
A batter warms up to prepare to go out batting. He does some short sprints (ready to run between the bases) and swings his bat a few times to warm up his arms.

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.

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!

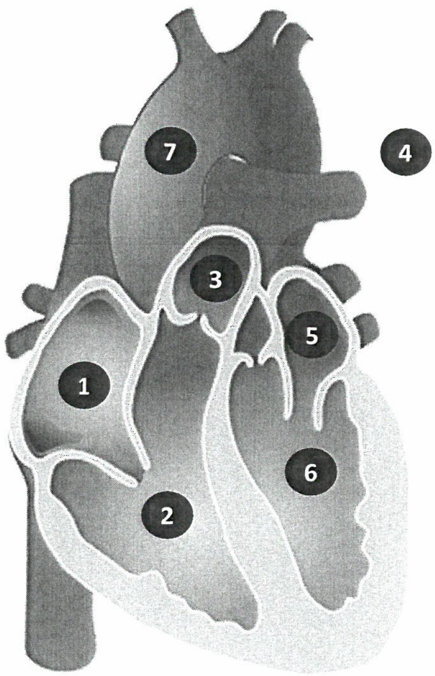
When you look at a diagram of the heart, the right-hand side appears on the left of the diagram, and the left-hand side appears on the right.

Pathway of Blood

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

2. Blood travels from the right atrium into the right ventricle

3. Pulmonary artery transports blood to the lungs



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

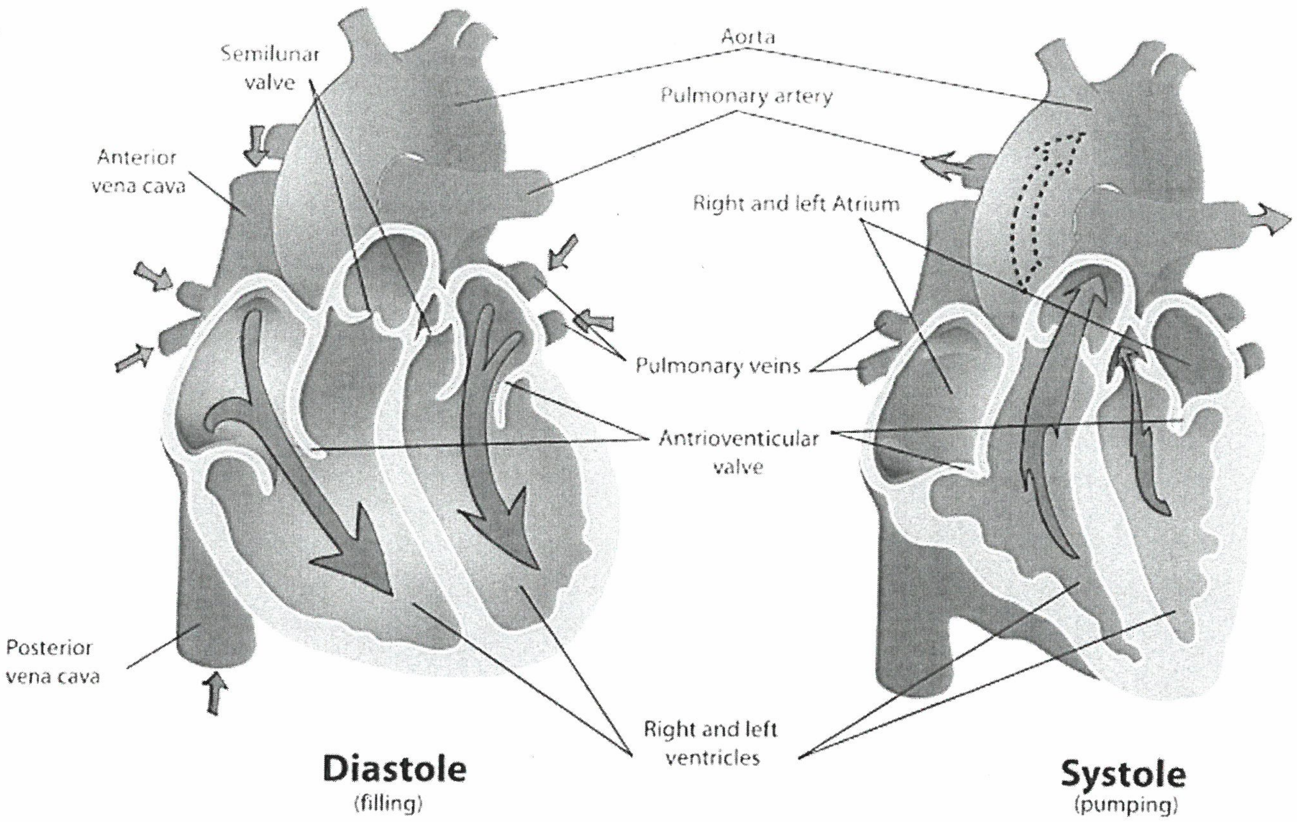
5. Blood travels through the pulmonary vein into the left atrium

6. Blood travels from the left atrium into the left ventricle

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

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.

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.

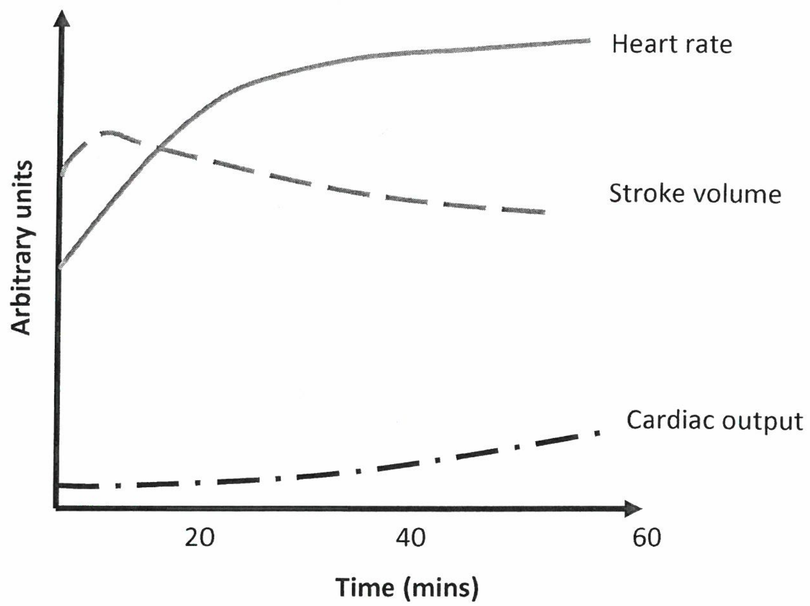
Rugby players may experience an anticipatory rise as they line up before a match begins; for example, when facing the haka.

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)

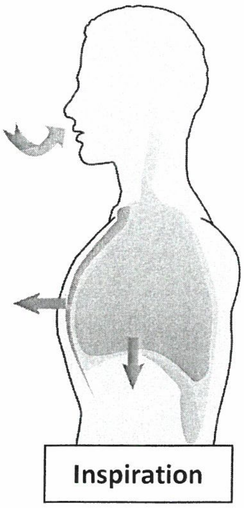
Therefore, to increase cardiac output, the body must instead increase heart rate. Although less blood will be pumped out of the heart per beat (i.e. stroke volume), a significant increase in heart rate will make up for this and lead to an increase in cardiac output, providing the body with the blood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



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.

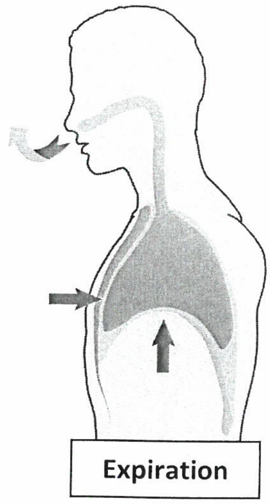
Diaphragm – the diaphragm contracts, causing it to flatten. Flattening the diaphragm increases the thoracic capacity.

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.

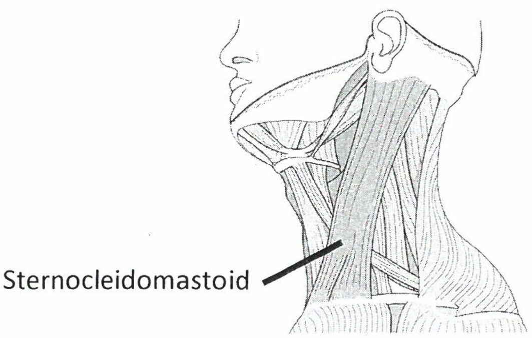


Inhaling and Exhaling during Exercise

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.

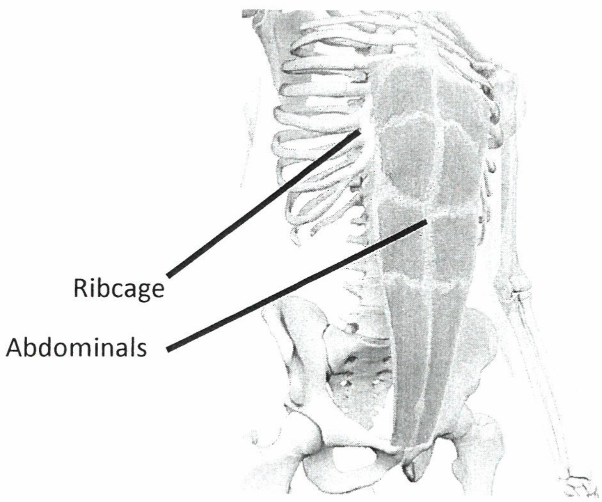
Inspiration

- **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

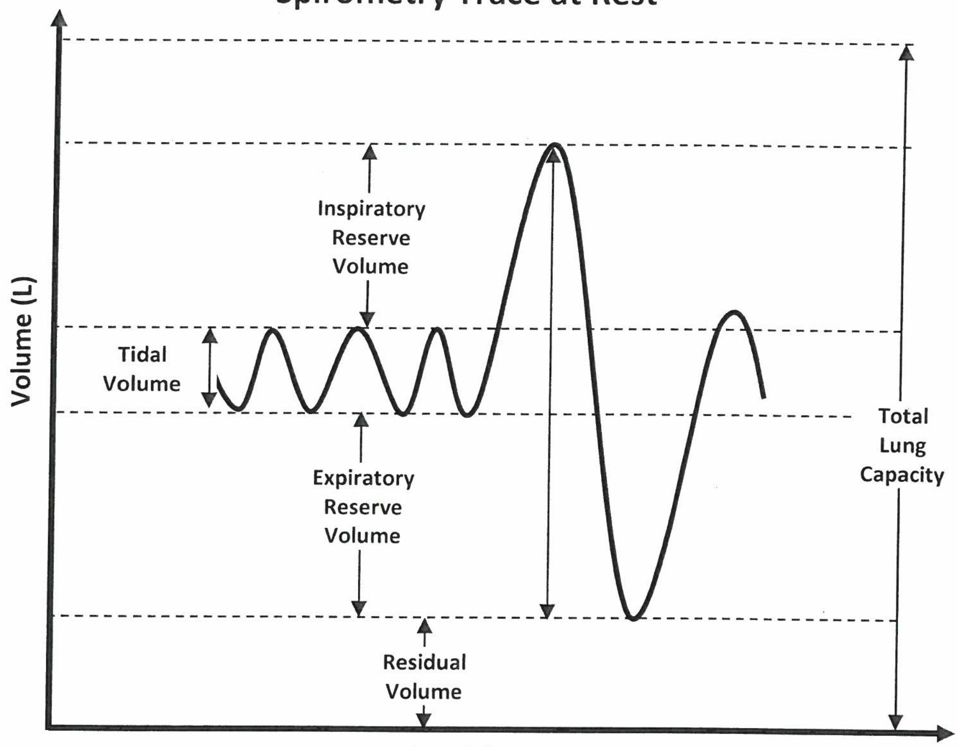


Interpreting Spirometry Traces

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

Spirometry Trace at Rest



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.

Revision Activities Unit 3 a

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?

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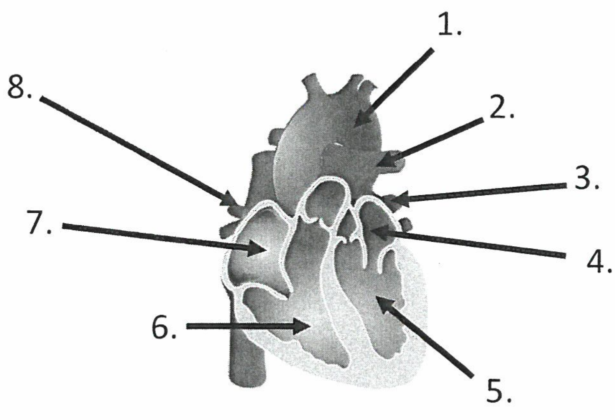
4. Label the diagram of the heart.



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. ....

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(4 marks)

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

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

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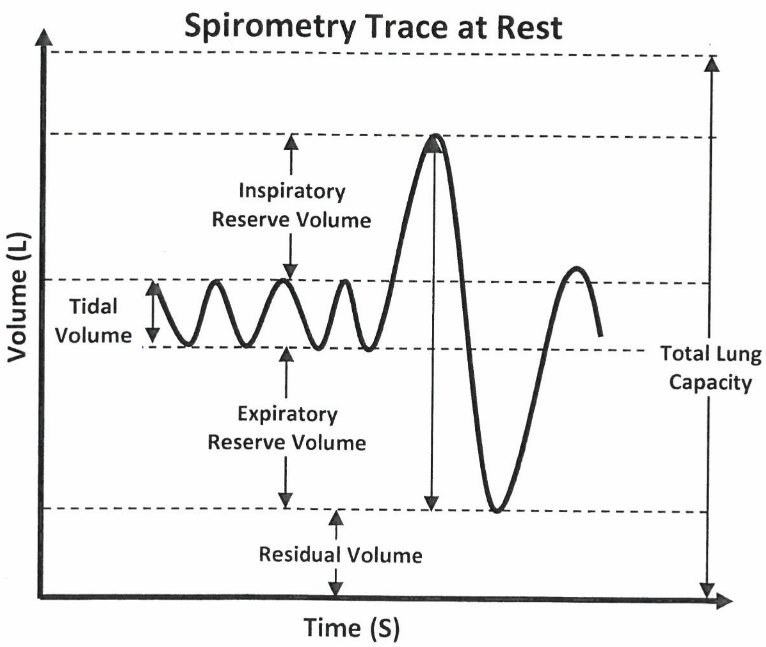
(2 marks)

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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(2 marks)

Unit 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

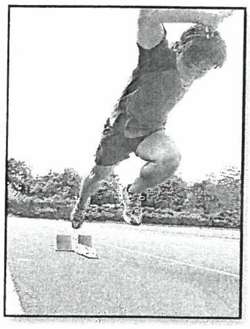
Anaerobic Exercise and Aerobic Exercise

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!

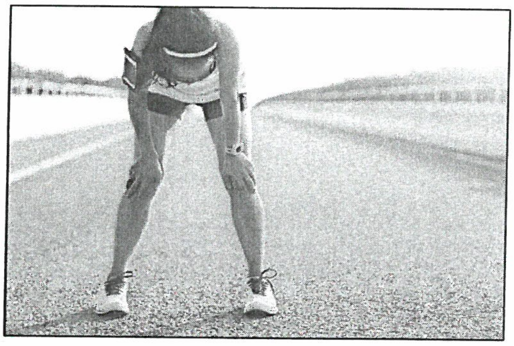
In the exam, if you are asked to justify whether an activity is aerobic or anaerobic, remember to justify with regard to the activity's **intensity** and **duration**.

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

The Recovery Process

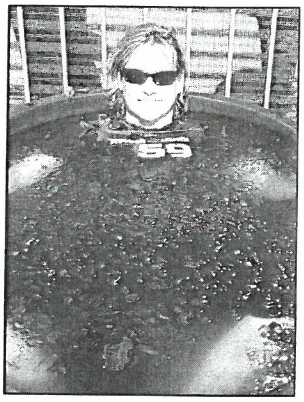
Following vigorous exercise, athletes want to reduce the effects of exercise on their body, such as nausea, light-headiness and sore muscles – the delayed onset of muscle soreness (DOMS). There are numerous strategies that performers use to reduce the effects of exercise to recover as quickly as possible.

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

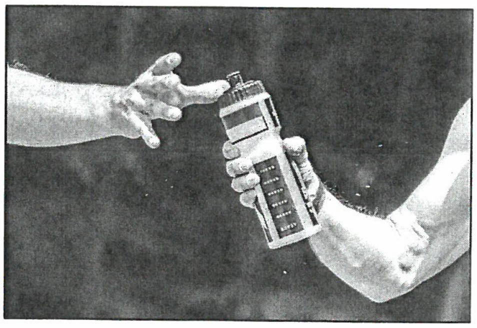


Ice baths aim to reduce swelling of muscles following exercise. Intense exercise can cause microtears in muscles, contributing towards DOMS. The cold temperature of ice baths causes blood vessels to vasoconstrict, reducing the flow of blood to the damaged muscle, thereby reducing swelling.

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

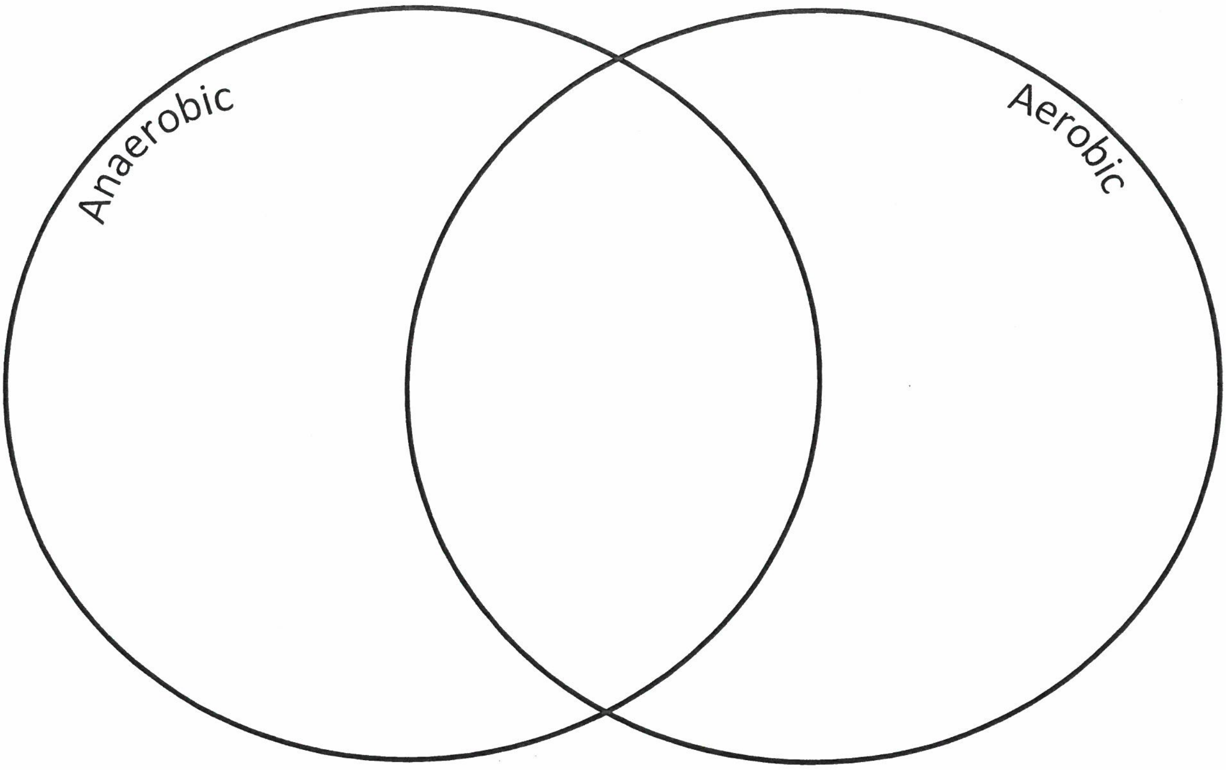
- Rehydration – athletes need to replace the fluids lost during exercise through sweating. Fluids should include any nutrients lost through exercise too (e.g. sodium). Fluids could contain carbohydrates to replace energy stores used by the body.
- Carbohydrates – any energy stores used by the body during 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.

Revision Activities Unit 3

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

   ....

   ....

   ....

   ....

1. Define 'aerobic exercise'.

....

....

(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)

Unit 3 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 ✓

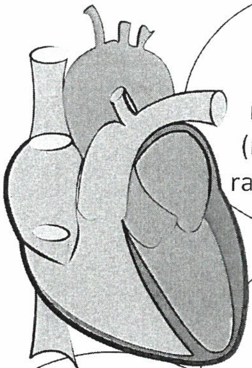
	Revised	Understood	What you need to do
Explain the changes in the cardiorespiratory system during exercise			
Be able to describe the short-term effects of exercise on the body			
Be able to describe the long-term effects of exercise on the body			

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

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.

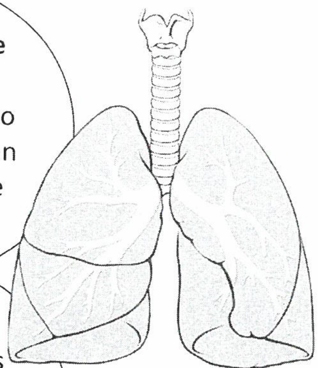


Heart rate increases to required level (maximal heart rate = 220 – age)

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**

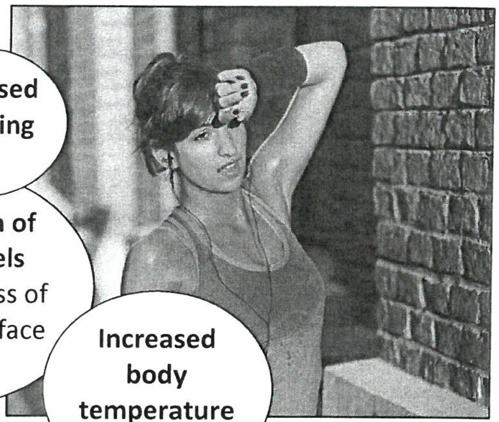
A greater cardiac output means that more oxygenated blood can reach the muscles



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.

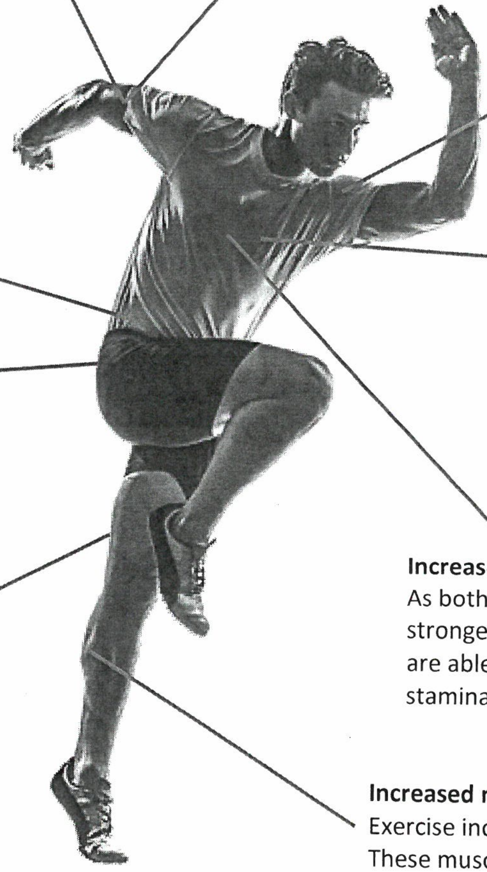
Long-term Effects of Exercise

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.

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

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.

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.



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

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.

Revision Activities Unit 3

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?

   ....

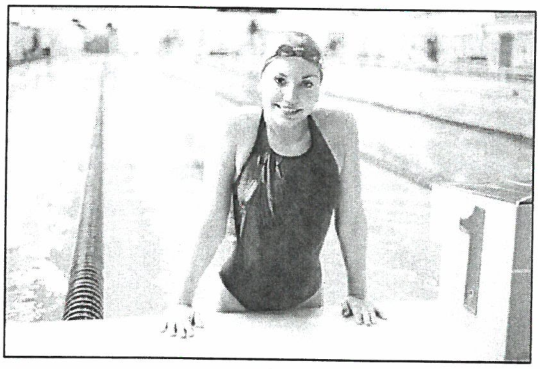
3. Name three components of fitness that can improve as a result of long-term exercise.

   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)

Unit 3

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.

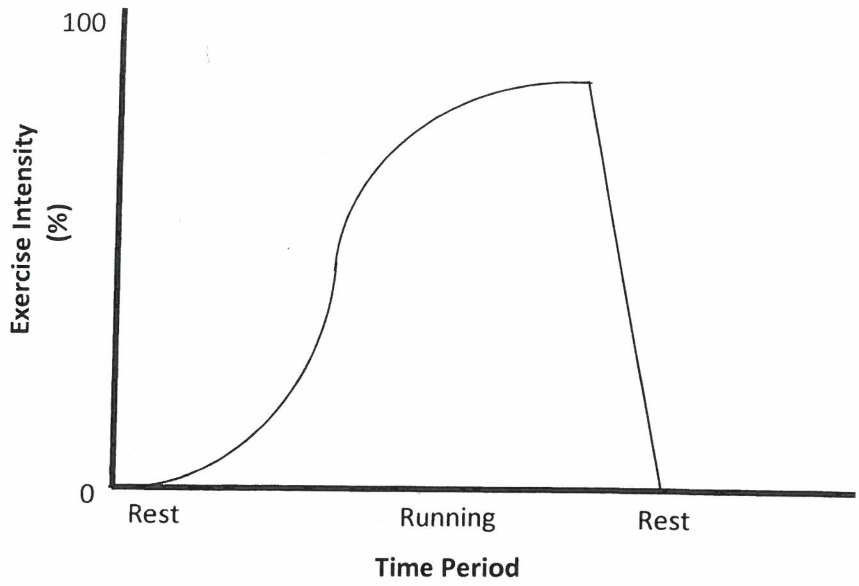
Components of an effective warm-up	Benefits of an effective warm-up
Pulse should be raised gradually	• Body temperature is gradually increased, preparing the body for exercise • Increased amount of oxygen to the working muscles • Gradual preparation of the body for exercise reduces the shock exercise 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

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)

1. Below is a graph mapping the intensity of exercise undertaken by a recreational runner during training.



Identify a feature of this exercise regime that is missing, and outline the benefits of this feature to the athlete.

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2. Describe the benefits that an effective warm-up has on an athlete.

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3. How would mental preparation and sport-specific drills help a professional football player in preparation for a match?

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1. Which of the following is a benefit of an effective warm-up?
   - A Allows the body to recover from exercise ☐
   - B Removal of lactic acid and waste products ☐
   - C Athlete is able to practise sport-specific skills in preparation for exercise ☐
   - D Prevents DOMS ☐

(1 mark)

2. A cool-down is often used by athletes following performance or exercise.

   State **two** reasons why athletes use cool-downs.

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(2 marks)

