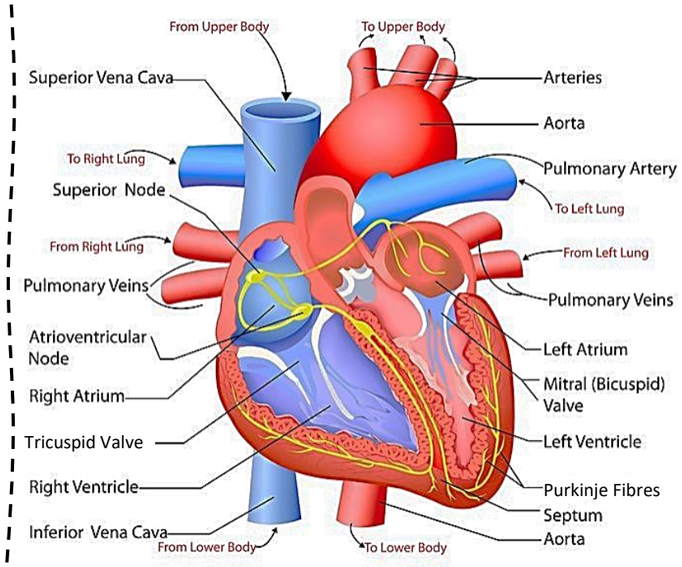
THE CARDIOVASCULAR SYSTEM...

Impact on Health and Fitness

A

Fill in the table with as many effects of physical activity on health and fitness as you can think of.

Health	Fitness



Cardiac Conduction System

C

The conduction system involves the electrical impulses that cause the cardiac cycle of the heart. **The cardiac muscle is myogenic**, meaning it generates its own impulses. **Outline the order of the cardiac conduction system on the diagram below.**

1.
2.
3.
4.

Atrial depolarisation:
Stimulus from the SA node travels across the atria, causing atrial contraction.

Ventricular depolarisation:
The effect that the AV node has on the ventricles by causing them to contract by providing an electrical stimulus.

Atrial and ventricular repolarisation:
Occurs during a brief time period following depolarisation and describes the electrical impulse returning to a baseline value.

The Relationship between Heart Values...

B

Complete the equation for cardiac output and explain how training status and exercise intensity can affect each heart value.

Cardiovascular Drift and A-VO_2 Difference

- **Cardiovascular drift** – the increase in heart rate which occurs despite no change in the intensity of exercise.
- **Arteriovenous oxygen difference (A-VO_2 diff)** – the difference in oxygen concentration between the arteries and veins.
- High-intensity exercise will result in a greater A-VO_2 diff as more oxygen is taken out of the arteries to fuel muscular contractions. However, a plateau will be reached when more oxygen cannot be removed from the arteries.
- Trained athletes will have higher starting A-VO_2 diffs and will experience a bigger change during exercise.
- Regular training can increase the A-VO_2 diff due to: *greater capillary density, greater alveoli density* and *greater myoglobin in the muscles.*

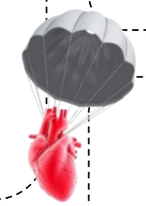
Factors Regulating Heart Rate

D

How do these three factors regulate heart rate?

1. Neural

2. Hormonal



3. Intrinsic

Transportation of Oxygen

Oxygen is transported within the body in association with:

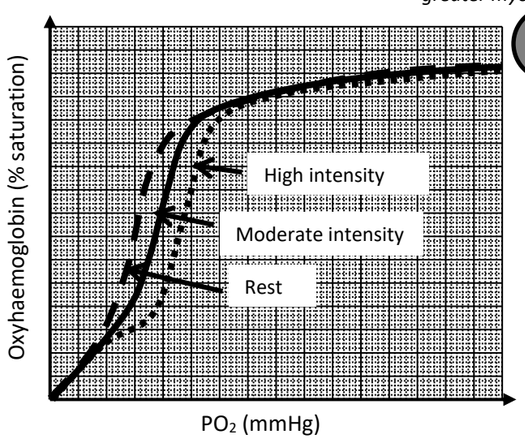
- **Haemoglobin** – the oxygen-carrying component of red blood cells
- **Myoglobin** – the oxygen-carrying component of the muscle tissue

The graph shows an oxyhaemoglobin dissociation curve which displays the **Bohr shift** during exercise of different intensities.

The Bohr shift is demonstrated by the line shifting to the right as the conditions within the blood become more acidic (reduced pH due to increased levels of CO_2) during higher-intensity exercise.

Factors influencing Bohr shift include:

1. Increase in CO_2
2. Decrease in pH – due to increase in CO_2
3. Increase in temperature



Redistribution of Cardiac Output

E

During exercise our blood needs to redistribute to working muscles. Describe the methods given below:

Vascular shunt

Arterioles

Pre-capillary sphincters

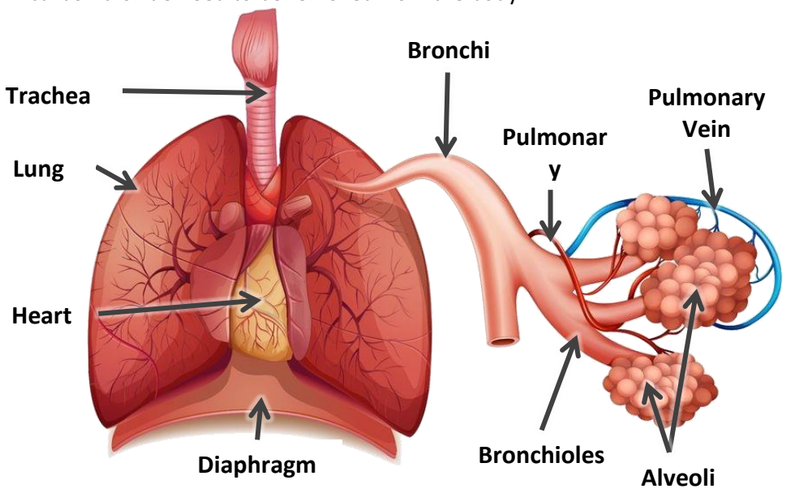
Venous return:
The rate at which blood returns to the heart.

As intensity increases:
Blood redistribution needs to be quicker otherwise cardiac output decreases. Exercise increases it through the **muscle pump** and **respiratory pump** which force blood back to the heart. This process is also aided by **pocket valves** in the veins, **smooth muscle** in the walls of the blood vessels and **gravity**. Venous return is quickest in the arteries and during **systole** as systolic blood pressure is larger than diastolic.

During recovery the lower venous return results in a lower stroke volume. This is due to reduced stretching of the ventricles with a low venous return (**Frank-Starling law**).

THE RESPIRATORY SYSTEM...

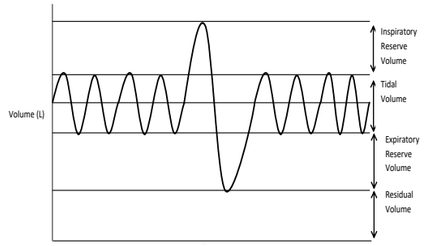
The respiratory system consists of a number of structures (outlined in the diagram below) which allow gasses to be transferred between the body and the external environment. This is an important process during exercise when large volumes of oxygen are required by the muscles and large volumes of carbon dioxide need to be removed from the body.



Lung Volumes

There are a number of different lung volumes which can be measured in order to determine how a person's respiratory system is functioning. These volumes will change depending on the level of physical activity, the training status and the health of the person.

Complete the table below by defining each of the lung volumes, identifying a typical resting value and indicating how this volume would change during exercise. **A**

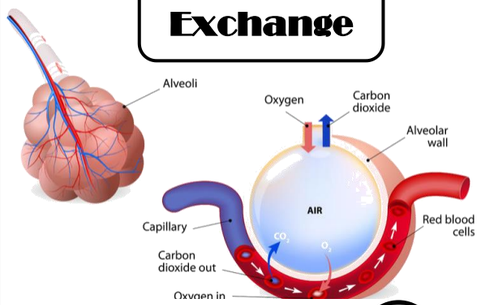


	Tidal volume	Minute ventilation	Residual volume	Expiratory reserve volume	Inspiratory reserve volume
Definition					
Typical resting value					
Change during exercise					

Minute ventilation = Breathing frequency × Tidal volume

At the alveoli:

Gas Exchange



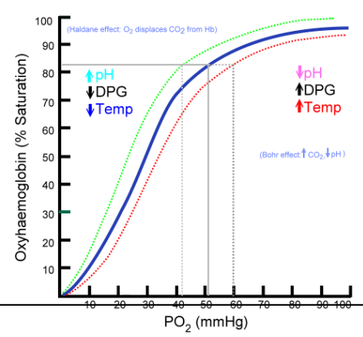
Explain how gas exchange occurs at the alveoli and the muscles. **B**

At the muscles:

Gas Exchange during Exercise

Dissociation of oxyhaemoglobin

In a high partial pressure of oxygen (e.g. at the lungs), oxygen binds more readily to haemoglobin. As this partial pressure decreases (e.g. at the exercising muscles) oxygen is more readily released. As exercise intensity increases, the partial pressure of oxygen decreases and so oxygen is easily released from haemoglobin.



As exercise intensity increases, there is a larger **pressure gradient** between CO_2 and O_2 levels at the sites of gas exchange.

Regulation of Breathing Rate

The respiratory control centre of the brain is made up of the **inspiratory control centre** and the **expiratory control centre**. These two centres work together to regulate breathing at rest and during exercise without conscious thought and, therefore, require different receptors to send them information in order to control breathing rate.

Explain how neural, chemical and hormonal factors control breathing rate.

1. **Neural**
2. **Chemical**
3. **Hormonal**

The Neuromuscular System

Muscle Contraction during Exercise and Recovery

There are two different types of muscle fibres – slow twitch and fast twitch. There are two types of fast-twitch fibres – fast oxidative glycolytic (type IIa) and fast glycolytic (type IIb).

Identify the characteristics of each muscle fibre type in the table below and give one sport each fibre type would be beneficial in.

Slow oxidative (1)	Fast oxidative (11a)	Fast glycolytic (11b)
Sport:	**Sport:**	**Sport:**

Muscle fibre recruitment
Muscle fibre recruitment is dependent on the intensity of the exercise; higher-intensity exercise requires more force, with lower-intensity exercise requiring less force.

The Size Principle (Henneman et al. 1974)
Smaller motor units are recruited first as they have a smaller firing threshold than larger motor units.

The Recruitment of Muscle Fibres

'All or none' law

- Each muscle fibre controlled by a motor unit is either fully contracted or not contracted at all.
- They can contract in different ways depending on how they are innervated.
- Therefore, a muscle fibre cannot partially contract.

The Nervous Systems

The autonomic nervous system is responsible for subconsciously controlling muscular contractions.

There are two systems which make up the autonomic nervous system:

- The **parasympathetic** nervous system is responsible for actions that occur when resting.
- The **sympathetic** nervous system is responsible for actions when active.

Both nervous systems innervate the muscle tissues by sending a nervous impulse to them.

Proprioceptive

Describe what proprioceptive neuromuscular facilitation is and the role that muscle spindles and the Golgi tendon organ play.

Types of Contraction

Muscles have many different roles within the body, namely **movement**, **heat production**, **digestion** and **maintaining posture**. The capability of the muscles to undergo contraction and relaxation is the key enabler of movement. Muscles can contract in different ways depending on what action they are trying to perform.

Provide a definition for the following types of contraction.

Muscle contractions aren't all the same. Sometimes muscles contract and lengthen, sometimes they contract and shorten and sometimes they contract and don't change length at all.

Isotonic:

Isometric:

Concentric:

Eccentric:

The Musculoskeletal System and Movement Analysis

Identify the agonist and antagonist muscles used in each of the following movements.

Joint	Type	Articulating Bones	Joint Action	Agonist	Antagonist
Shoulder	Ball and Socket	Scapula and humerus	Flexion		
			Extension		
			Adduction		
			Abduction		
			Horizontal abduction		
			Horizontal adduction		
Elbow	Hinge	Humerus, radius and ulna	Flexion		
			Extension		
Hip	Ball and Socket	Femur and pelvis	Flexion		
			Extension		
			Adduction		
			Abduction		
			Horizontal abduction		
			Horizontal adduction		
Knee	Hinge	Femur and tibia	Flexion		
			Extension		
Ankle	Hinge	Talus, tibia and fibula	Plantar flexion		
			Dorsiflexion		

Analysis of Movement

Analysing movement is a key concept of biomechanics, and is completed to help improve sport performance by improving the efficiency of sporting movements, and identifying how technique could be improved.

When analysing movement you should refer to:

- the movement produced
- the plane of movement
- the axis of movement
- the type of muscle contraction taking place

Analyse the movements in the images below:

Elbow and shoulder

Javelin withdrawal phase

Knee and ankle

Kicking backswing

Hip

Holding the leg outstretched

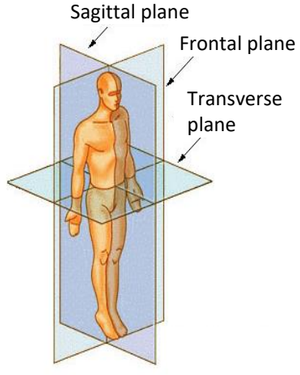
Planes of Movement

There are three planes of movement, each with an associated dimension for your body to move in. **Give as many sporting movements which occur in each plane as you can think of.**

Frontal:

Transverse:

Sagittal:



Axes of Rotation

There are three axes of rotation, each with an associated direction for your body to rotate. **Give as many sporting movements which occur around each axis.**

Transverse:

Frontal:

Longitudinal: