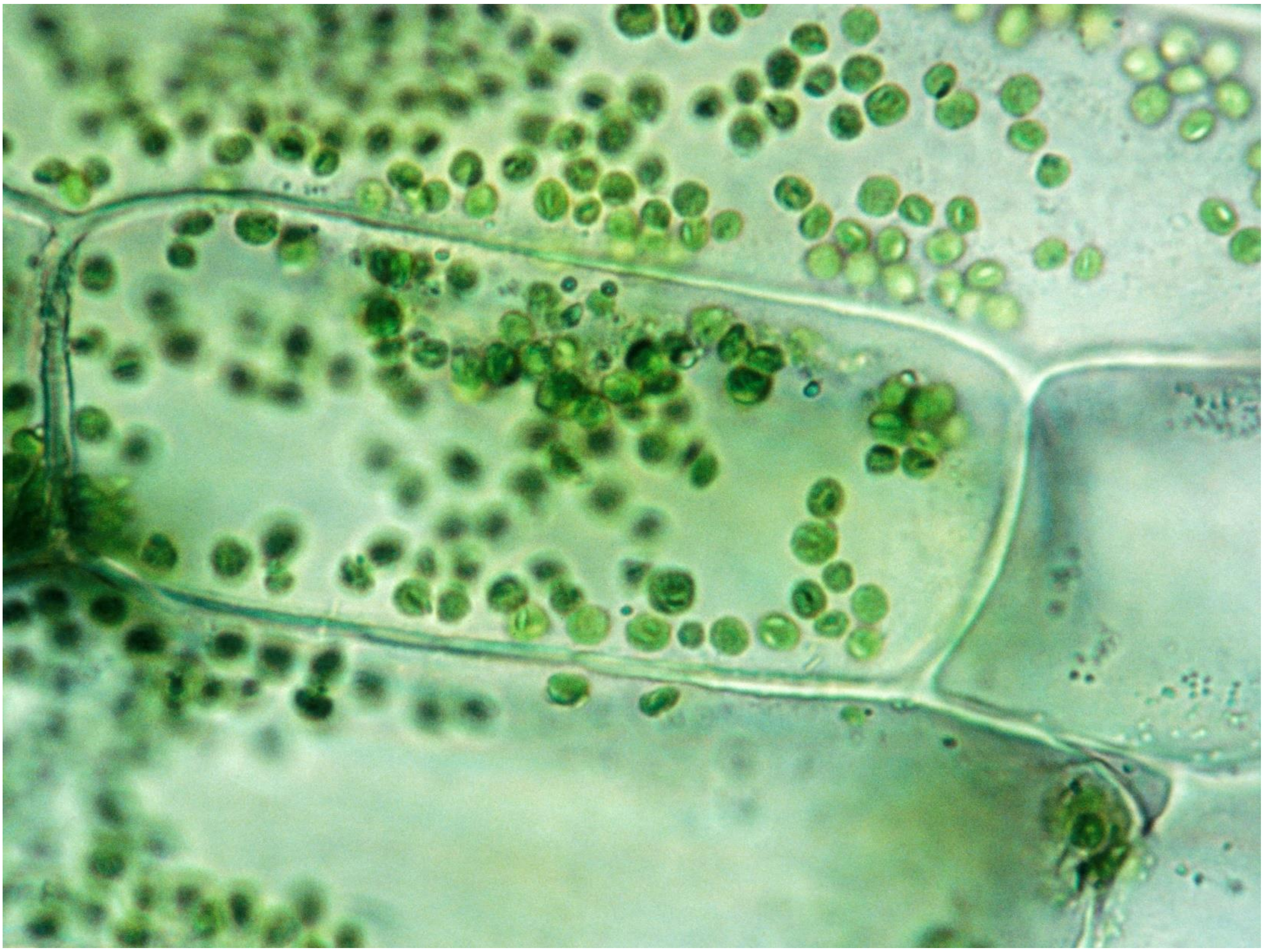
A-level Biology



Bridging Course - Week 3

Entry Requirements for Studying A-level Biology?

- Students who are expected to achieve at least a grade 7 in GCSE Biology Separate Science or a grade 7 in Combined Science.
- Students who have enjoyed their GCSE Biology course, and who enjoy extra reading and research.
- Students should be competent in both Mathematics and Chemistry.

What to expect from A-level Biology.

The study of A Level Biology compliments a large number of university courses such as Medicine, Dentistry, Biomedical Science, Genetic Engineering, Environmental Science along with many others. It can also provide academic credentials for unrelated courses such as Law and Architecture.
The course covers both animal, plant and environmental Biology, which will be taught through a combination of theory and practical work. This is a demanding A level, and students will need to be competent in both Maths and Chemistry.

This bridging course will provide you with a mixture of information about A-level Biology, and what to expect from the course, as well as key work to complete. Students who are expecting to study Biology at A-level, and are likely to meet the entry requirements, must complete the bridging course fully and thoroughly, to the best of their ability. You should complete all work digitally if possible, so it is available to print and place in your file at the start of the course. You will submit it to your teacher in September. All of the work will be reviewed and selected work will be assessed, and you will be given feedback on it. This work will be signalled to you. If you do not have access to the internet, please contact the school and appropriate resources will be sent to you. If you are thinking about studying Biology at A-level you should attempt this work to see whether or not you think studying a subject like this is right for you. If you later decide to study Biology, you must ensure you complete this work in full. This work should be completed after you have read and completed the Study Skills work that all of Year 12 should complete.

Course outline

Paper 1	Paper 2	Paper 3
What's assessed	**What's assessed**	**What's assessed**
• Any content from topics 1– 4, including relevant practical skills	• Any content from topics 5–8, including relevant practical skills	• Any content from topics 1–8, including relevant practical skills
Assessed	**Assessed**	**Assessed**
• written exam: 2 hours • 91 marks • 35% of A-level	• written exam: 2 hours • 91 marks • 35% of A-level	• written exam: 2 hours • 78 marks • 30% of A-level
Questions	**Questions**	**Questions**
• 76 marks: a mixture of short and long answer questions • 15 marks: extended response questions	• 76 marks: a mixture of short and long answer questions • 15 marks: comprehension question	• 38 marks: structured questions, including practical techniques • 15 marks: critical analysis of given experimental data • 25 marks: one essay from a choice of two titles

The topics that you will study over the two years are as follows;

Year 12
Topic 1 - Biological molecules
Topic 2 – Cells
Topic 3 – Organisms exchange substances with their environment
Topic 4 – Genetic information, variation and relationships between organisms
Topic 5 – Energy transfers between organisms - Respiration and photosynthesis

Year 13
Topic 5 - Energy transfers between organisms – Energy and ecosystems
Topic 6 - Organisms respond to changes in their environment
Topic 7 - Genetics, populations, evolution and ecosystems
Topic 8 - The control of gene expression

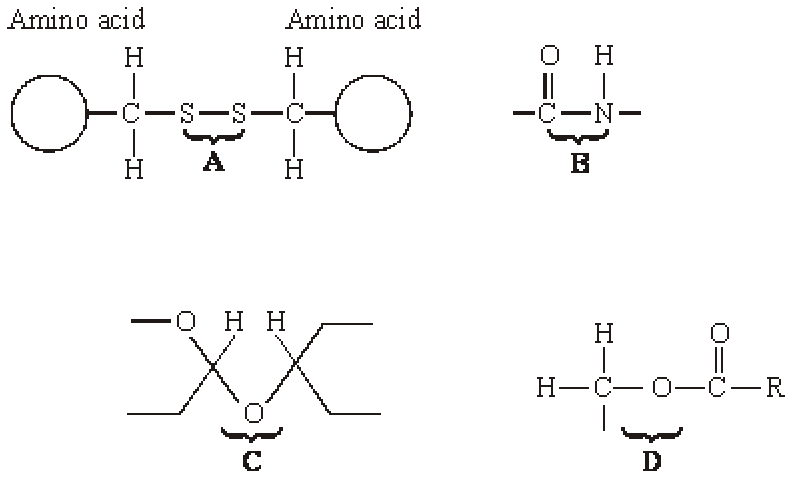
The following work will introduce key aspects of the Year 12 content along with some of the skills required during the A-level Biology course. This week we will be looking at the circulatory system.

Recap Task

So far, we have looked at cell structure and the structure of some of the biological molecules that make up cells. All cells need a supply of oxygen and nutrients to survive, and this week we will look at how these are provided.

To recap and assess your knowledge answer the following questions.

Q1. The diagrams show four types of linkage, **A** to **D**, which occur in biological molecules.



(a) Name the chemical process involved in the formation of linkage **B**.

____

(1)

(b) Give the letter of the linkage which

(i) occurs in a triglyceride molecule;

____

(1)

(ii) might be broken down by the enzyme amylase;

____

(1)

(iii) may occur in the tertiary, but not the primary structure of protein.

____

(1)

(c) Describe how a saturated fatty acid differs in molecular structure from an unsaturated fatty acid.

____

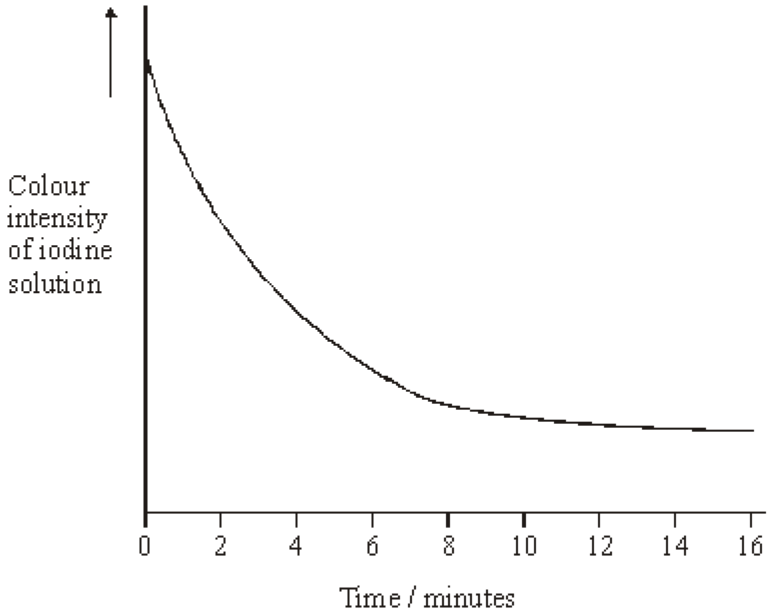
____

____

____

(2)

In an investigation into carbohydrase activity, the contents from part of the gut of a small animal were collected. The contents were added to starch solution at pH 7 and kept in a water bath at 25°C. At one-minute intervals, samples were removed and added to different test tubes containing dilute iodine solution. The colour intensity of each sample was determined. The graph shows the results.



(d) Explain the change in colour intensity.

____

____

____

____

(2)

(e) Draw clearly labelled curves on the graph to show the expected result if the experiment was repeated

(i) at 35 °C;

(ii) at pH 2.

(2)

(f) Explain how

(i) raising the temperature to 35 °C affects carbohydrase activity;

(ii) decreasing the pH affects carbohydrase activity.

(7)
(Total 17 marks)

Mark schemes

Q1.

(a) (i) condensation;

1

(b) (i) **D**;

1

(ii) **C**;

1

(iii) **A**;

1

(c) absence of a double bond;
in the (hydrocarbon) chain;
unable to accept more <u>hydrogen</u> / saturated with hydrogen;

2 max

[6]

(d) colour results from starch-iodine reaction;
decrease due to breakdown of starch by carbohydrase / enzyme;

2

(e) (i) curve drawn below curve on graph and starting at same point;

1

(ii) curve drawn above curve on graph and starting at same point but finishing above;

(allow curve or horizontal line)

(allow alternative curve for pH if explanation in (ii) is consistent)

1

(f) (i) 1. increase in temperature increases kinetic energy;
2. increases collisions (between enzyme / active site and substrate) / increases formation of enzyme / substrate complexes;
3. increases rate of breakdown of starch / rate of reaction / carbohydrase activity;

(ii) 4. (decrease in pH) increases H^+ ions / protons which attach / attracted to amino acids;
5. hydrogen / ionic bonds disrupted / broken which denatures enzyme / changes tertiary structure;
6. changes <u>shape / charge</u> of active site so active site / enzyme unable to combine / fit with starch / enzyme-substrate complex no longer able to form;
7. decreases rate of breakdown of starch / rate of reaction / carbohydrase activity;

(allow alternative explanation for pH if consistent with line drawn in (ii))

7

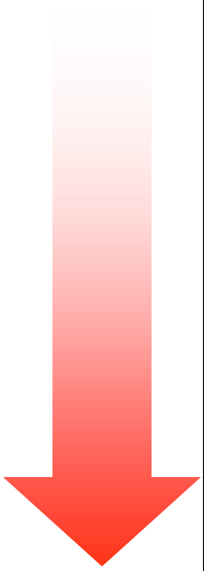
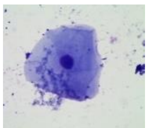
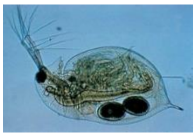
[17]

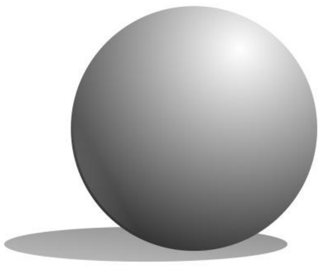
The Circulatory System

Students will investigate the relationship between SA:Vol and the need for a transport system.
Students will build on their knowledge of the human circulatory system.
Students will learn how oxygen is transported by the blood.
Students will plan an investigation into factors affecting heart rate.

1.Surface Area: Volume and the need for a transport system

Chemicals move in and out of cells by diffusion. The rate at which this happens will be affected by:
Distance the chemicals need to diffuse.
Surface Area:Volume.
Temperature.
Concentration gradient.

Organism	**Diameter**	**Level of activity**	**Transport system**
E. coli 	2µm		No
Animal cell 	30 µm		No
Small amoeba 	90 µm		No
Large amoeba 	800 µm		No
Water flea 	2mm		Yes
Frog 	50mm		Yes



The whole volume of the organism needs a supply of chemicals and must have waste products removed.

This can only happen at the surface of the organism.
The organism's ability to do this will depend on how much surface area there is compared to the volume.
This is known as the surface area : volume.

Q1. We can approximate the shape of most animals to a sphere. Assuming these organisms are approximately spherical calculate the surface area to volume ratio (SA:Vol) of the organisms in the table.

Volume of a sphere = $\frac{4\pi r^3}{3}$

Surface area of a sphere = $4\pi r^2$

Organism	**Radius (**mm)	**Surface Area (**mm^2)	**Volume (**mm^3)	**SA:Vol**
E. Coli				
Animal cell				
Small amoeba				
Large amoeba				
Water flea				
Frog				

Q2. What is the relationship between SA:Vol and the size of the organism?
Q3. Why does the frog need a transport system when the E. coli and the amoeba does not?

The human circulatory system

Watch the following video https://www.youtube.com/watch?v=NJzJKvkWWDc and read the following text;

7.3 Circulatory system of a mammal

Learning objectives

- → Explain why large organisms move substances around their bodies.
- → Describe the features of the transport systems of large organisms.
- → Describe the circulatory system of mammals.

Specification reference: 3.3.4.1

Diffusion is fast enough for transport over short distances (see Topic 4.2). The efficient supply of materials over larger distances requires a mass transport system.

Why large organisms have a transport system

All organisms exchange materials between themselves and their environment. We have seen that in small organisms this exchange takes place over the surface of the body (see Topic 6.2). However, with increasing size, the surface area to volume ratio decreases to a point where the needs of the organism cannot be met by the body surface alone (see Topic 6.1). Specialist exchange surfaces are therefore required to absorb nutrients and respiratory gases, and remove excretory products. These exchange surfaces are located in specific regions of the organism. A transport system is required to take materials from cells to exchange surfaces and from exchange surfaces to cells. Materials have to be transported between exchange surfaces and the environment. They also need to be transported between different parts of the organism. As organisms have evolved into larger and more complex structures, the tissues and organs of which they are made have become more specialised and dependent upon one another. This makes a transport system all the more essential.

▲ **Figure 1** *Large organisms require a transport system to take materials from exchange surfaces to the cells that need them*

Features of transport systems

Any large organism encounters the same problems in transporting materials within itself. Not surprisingly, the transport systems of many organisms have many common features:

- A suitable medium in which to carry materials, for example blood. This is normally a liquid based on water because water readily dissolves substances and can be moved around easily, but can be a gas such as air breathed in and out of the lungs.
- A form of mass transport in which the transport medium is moved around in bulk over large distances – more rapid than diffusion.
- A closed system of tubular vessels that contains the transport medium and forms a branching network to distribute it to all parts of the organism.
- A mechanism for moving the transport medium within vessels. This requires a pressure difference between one part of the system and another.

It is achieved in two main ways:

a Animals use muscular contraction either of the body muscles or of a specialised pumping organ, such as the heart (see Topic 7.4).

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b Plants rely on natural, passive processes such as the evaporation of water (see Topic 7.8).

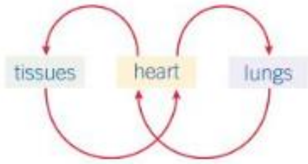
- A mechanism to maintain the mass flow movement in one direction, for example, valves.
- A means of controlling the flow of the transport medium to suit the changing needs of different parts of the organism.
- A mechanism for the mass flow of water or gases, for example, intercostal muscles and diaphragm during breathing in mammals.

Circulatory systems in mammals

Mammals have **a closed, double circulatory system** in which blood is confined to vessels and passes twice through the heart for each complete circuit of the body (Figure 2). This is because, when blood is passed through the lungs, its pressure is reduced. If it were to pass immediately to the rest of the body its low pressure would make circulation very slow. Blood is therefore returned to the heart to boost its pressure before being circulated to the rest of the tissues. As a result, substances are delivered to the rest of the body quickly, which is necessary as mammals have a high body temperature and hence a high rate of **metabolism**. The vessels that make up the circulatory system of a mammal are divided into three types: arteries, veins and capillaries. We will look in more detail at these in Topic 7.6.

The arrangement of the main arteries and veins that make up the circulatory system of a mammal is shown in Figure 3.

Although a transport system is used to move substances longer distances, the final part of the journey to cells is by diffusion. The final exchange from blood vessels into cells is rapid because it takes place over a large surface area, across short distances and there is a steep diffusion gradient.



▲ **Figure 2** *Double circulation of a mammal*

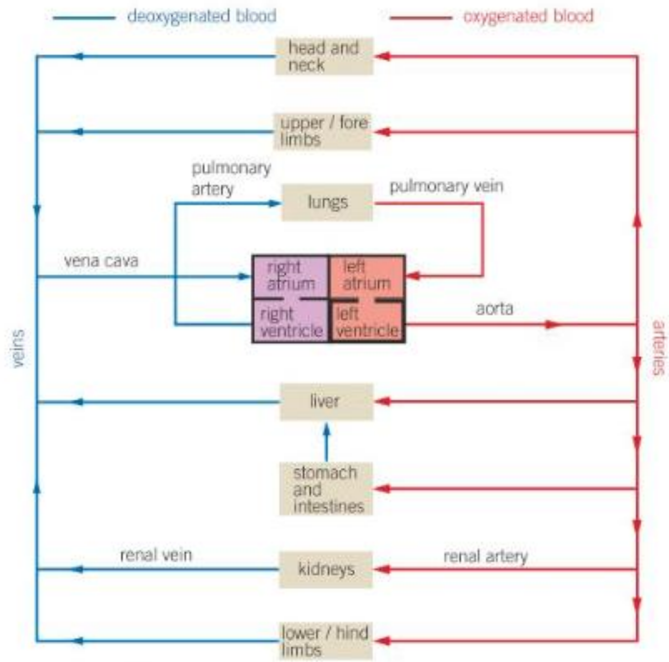
Study tip

Almost all cells in the body are within 1 mm of a capillary – a short diffusion path.

Summary questions

1 Name the blood vessel in each of the following descriptions:

  a joins the right ventricle of the heart to the capillaries



▲ **Figure 3** *Plan of the mammalian circulatory system*

of the lungs

b carries oxygenated blood away from the heart

c carries deoxygenated blood away from the kidney

d the first main blood vessel that an oxygen molecule reaches after being absorbed from an alveolus

e has the highest blood pressure.

2 State **two** factors that make it more likely that an organism will have a circulatory pump such as the heart.

3 State the main advantage of the double circulation found in mammals.

7.4 The structure of the heart

Learning objectives

- → Describe the appearance of the heart and its associated blood vessels.
- → Explain why the heart is made up of two adjacent pumps.
- → Explain how the structure of the heart is related to its functions.

Specification reference: 3.3.4.1

The heart is a muscular organ that lies in the thoracic cavity behind the sternum (breastbone). It operates continuously and tirelessly throughout the life of an organism.

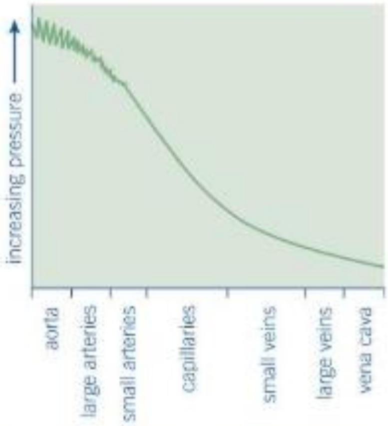
Structure of the human heart

The human heart is really two separate pumps lying side by side. The pump on the left deals with oxygenated blood from the lungs, while the one on the right deals with deoxygenated blood from the body. Each pump has two chambers:

- The **atrium** is thin-walled and elastic and stretches as it collects blood.

Study tip

Although the left ventricle has a thicker wall than the right ventricle, their internal volumes are the same. They have to be, otherwise more blood would be pumped out of one side of the heart than the other.



▲ **Figure 1** *Pressure changes in blood vessels*

Study tip

The left and right sides of the heart both contract together.

- The **ventricle** has a much thicker muscular wall as it has to contract strongly to pump blood some distance, either to the lungs or to the rest of the body.

Why have two separate pumps? Why not just pump the blood through the lungs to collect oxygen and then straight to the rest of the body before returning it to the heart? The problem with such a system is that the blood has to pass through tiny capillaries in the lungs in order to present a large surface area for the exchange of gases (see Topic 6.8). In doing so, there is a very large drop in pressure and so the blood flow to the rest of the body would be very slow. This drop in pressure is illustrated in Figure 1. Mammals therefore have a system in which the blood is returned to the heart to increase its pressure before it is distributed to the rest of the body. It is essential to keep the oxygenated blood in the pump on the left side separate from the deoxygenated blood in the pump on the right.

The right ventricle pumps blood only to the lungs, and it has a thinner muscular wall than the left ventricle. The left ventricle, in contrast, has a thick muscular wall, enabling it to contract to create enough pressure to pump blood to the rest of the body. Although the two sides of the heart are separate pumps and, after birth, there is no mixing of the blood in each of them, they nevertheless pump in time with each other. Both atria contract together and then both ventricles contract together, pumping the same volume of blood.

Between each atrium and ventricle are valves that prevent the backflow of blood into the atria when the ventricles contract. There are two valves:

- the **left atrioventricular (bicuspid) valve**
- the **right atrioventricular (tricuspid) valve**

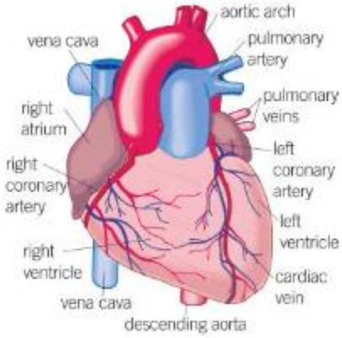
Each of the four chambers of the heart is connected to large blood vessels that carry blood towards or away from the heart. The ventricles pump blood away from the heart and into the arteries. The atria receive blood from the veins.

Vessels connecting the heart to the lungs are called **pulmonary** vessels. The vessels connected to the four chambers are therefore as follows:

- The **aorta** is connected to the left ventricle and carries oxygenated blood to all parts of the body except the lungs.
- The **vena cava** is connected to the right atrium and brings deoxygenated blood back from the tissues of the body (except the lungs).
- The **pulmonary artery** is connected to the right ventricle and carries deoxygenated blood to the lungs, where its oxygen is replenished and its carbon dioxide is removed. Unusually for an artery, it carries deoxygenated blood.
- The **pulmonary vein** is connected to the left atrium and brings oxygenated blood back from the lungs. Unusually for a vein, it carries oxygenated blood.

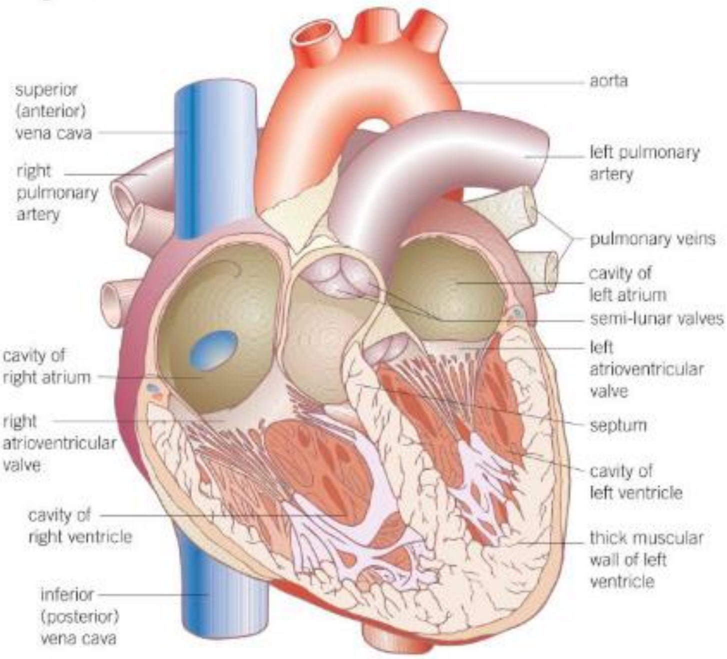
Hint

An easy way to recall which heart chambers are attached to which type of blood vessel is to remember that A and V always go together. Hence: Atria link to Veins and Arteries link to Ventricles.



▲ **Figure 3** *External appearance of the human heart showing the blood supply to the heart muscle*

The structure of the heart and its associated blood vessels is shown in Figure 2.



▲ **Figure 2** *Section through the human heart*

Supplying the heart muscle with oxygen

Although oxygenated blood passes through the left side of the heart, the heart does not use this oxygen to meet its own great respiratory needs. Instead, the heart muscle is supplied by its own blood vessels, called the **coronary arteries**, which branch off the aorta shortly after it leaves the heart. Blockage of these arteries, for example by a blood clot, leads to **myocardial infarction**, or heart attack, because an area of the heart muscle is deprived of blood and therefore oxygen also. The muscle cells in this region are unable to respire (aerobically) and so die.

7.6 Blood vessels and their functions

Learning objectives

- → Describe the structures of arteries, arterioles and veins.
- → Explain how the structure of each of the above vessels is related to its function.
- → Explain the structure of capillaries and how it is related to their function.

Specification reference: 3.3.4.1

In Topic 7.3 we saw that, in larger organisms, materials are transported around the body by the blood that is confined to blood vessels. This topic looks in more detail at these vessels.

Structure of blood vessels

There are different types of blood vessels:

- **Arteries** carry blood away from the heart and into arterioles.
- **Arterioles** are smaller arteries that control blood flow from arteries to capillaries.
- **Capillaries** are tiny vessels that link arterioles to veins.
- **Veins** carry blood from capillaries back to the heart.

Arteries, arterioles and veins all have the same basic layered structure. From the outside inwards, these layers are:

- **tough fibrous outer layer** that resists pressure changes from both within and outside
- **muscle layer** that can contract and so control the flow of blood
- **elastic layer** that helps to maintain blood pressure by stretching and springing back (recoiling)
- **thin inner lining (endothelium)** that is smooth to reduce friction and thin to allow diffusion
- **lumen** that is not actually a layer but the central cavity of the blood vessel through which the blood flows.

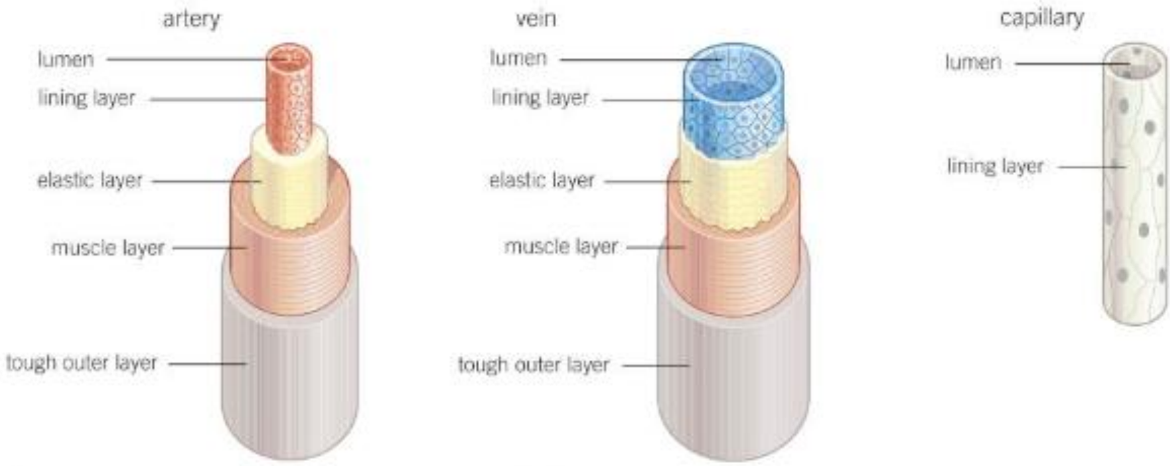
What differs between each type of blood vessel is the relative proportions of each layer. These differences are shown in Figure 1. Arterioles are not included because they are similar to arteries. They differ from arteries in being smaller in diameter and having a relatively larger muscle layer and lumen. The differences in structure are related to the differences in the function that each type of vessel performs.

Study tip

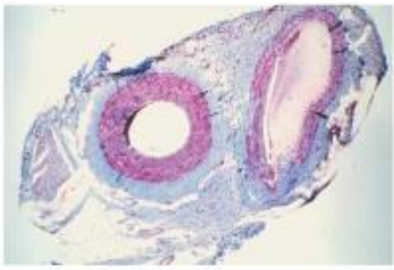
Arteries, arterioles and veins carry out transport not exchange; only capillaries carry out exchange.

Study tip

The elastic tissue of arteries will stretch and recoil. It is not muscle and will not contract and relax.



▲ **Figure 1** *Comparison of arteries, veins and capillaries*


▲ **Figure 2** *Artery (left) and vein (right)*

Artery structure related to function

The function of arteries is to transport blood rapidly under high pressure from the heart to the tissues. Their structure is adapted to this function as follows:

- **The muscle layer is thick compared to veins.** This means smaller arteries can be constricted and dilated in order to control the volume of blood passing through them.
- **The elastic layer is relatively thick compared to veins** because it is important that blood pressure in arteries is kept high if blood is to reach the extremities of the body. The elastic wall is stretched at each beat of the heart (systole). It then springs back when the heart relaxes (diastole) in the same way as a stretched elastic band. This stretching and recoil action helps to maintain high pressure and smooth pressure surges created by the beating of the heart.
- **The overall thickness of the wall is great.** This also resists the vessel bursting under pressure.
- **There are no valves** (except in the arteries leaving the heart) because blood is under constant high pressure due to the heart pumping blood into the arteries. It therefore tends not to flow backwards.

Arteriole structure related to function

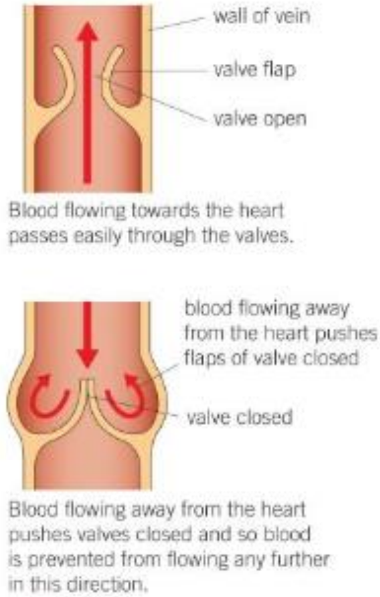
Arterioles carry blood, under lower pressure than arteries, from arteries to capillaries. They also control the flow of blood between the two. Their structure is related to these functions as follows:

- **The muscle layer is relatively thicker than in arteries.** The contraction of this muscle layer allows constriction of the lumen of the arteriole. This restricts the flow of blood and so controls its movement into the capillaries that supply the tissues with blood.
- **The elastic layer is relatively thinner than in arteries** because blood pressure is lower.

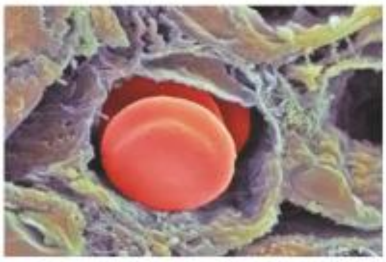
Vein structure related to function

Veins transport blood slowly, under low pressure, from the capillaries in tissues to the heart. Their structure is related to this function as follows:

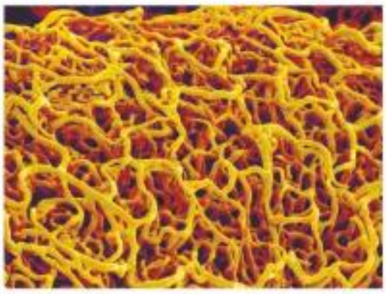
- **The muscle layer is relatively thin** compared to arteries because veins carry blood away from tissues and therefore their constriction and dilation cannot control the flow of blood to the tissues.
- **The elastic layer is relatively thin** compared to arteries because the low pressure of blood within the veins will not cause them to burst and pressure is too low to create a recoil action.
- **The overall thickness of the wall is small** because there is no need for a thick wall as the pressure within the veins is too low to create any risk of bursting. It also allows them to be flattened easily, aiding the flow of blood within them (see below).
- **There are valves at intervals throughout** to ensure that blood does not flow backwards, which it might otherwise do because the pressure is so low. When body muscles contract, veins are compressed, pressurising the blood within them. The valves ensure that this pressure directs the blood in one direction only: towards the heart (Figure 3).



▲ **Figure 3** *Action of valves in veins in ensuring one-way flow of blood*



▲ **Figure 4** *False-colour SEM of a section through a capillary with red blood cells passing through it*



▲ **Figure 5** *Resin cast of a capillary network from the large intestine*

Capillary structure related to function

The function of capillaries (Figures 4 and 5) is to exchange metabolic materials such as oxygen, carbon dioxide and glucose between the blood and the cells of the body. The flow of blood in capillaries is much slower. This allows more time for the exchange of materials.

The structure of capillaries is related to their function as follows:

- **Their walls consist mostly of the lining layer**, making them extremely thin, so the distance over which diffusion takes place is short. This allows for rapid diffusion of materials between the blood and the cells.
- **They are numerous and highly branched**, thus providing a large surface area for exchange.
- **They have a narrow diameter** and so permeate tissues, which means that no cell is far from a capillary and there is a short diffusion pathway.
- **Their lumen is so narrow** that red blood cells are squeezed flat against the side of a capillary. This brings them even closer to the cells to which they supply oxygen. This again reduces the diffusion distance.
- **There are spaces between the lining (endothelial) cells** that allow white blood cells to escape in order to deal with infections within tissues.

Although capillaries are small, they cannot serve every single cell directly. Therefore the final journey of metabolic materials is made in a liquid solution that bathes the tissues. This liquid is called **tissue fluid**.

Q4. Complete the summary table showing the structure and functions of the different types of blood vessels.

Blood vessel	**Structure**	**Function**
Arteries		
Arterioles		
Capillaries		
Venules		
Veins		

Q5. Complete a flow diagram showing the passage of blood through the heart and the kidney starting at the vena cava. Include all blood vessels, chambers and valves in the heart.

Vena cave ➔ ………

Transport of Oxygen

Read the following text;

7 Mass transport
7.1 Haemoglobin

In the last chapter we looked at how substances are exchanged between the internal and external environments. This chapter looks at how these substances are distributed throughout an organism. Before considering mass transport systems, it begins by looking at an important group of molecules that are highly adapted for transporting oxygen – the haemoglobins.

Haemoglobin molecules

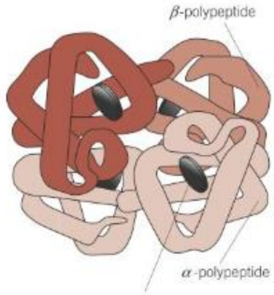
The haemoglobins are a group of chemically similar molecules found in a wide variety of organisms. In Topic 1.6 we investigated the structure of proteins and how their shape is important to their functions. Haemoglobins are protein molecules with a quaternary structure that has evolved to make it efficient at loading oxygen under one set of conditions but unloading it under a different set of conditions. The structure of a haemoglobin molecule is shown in Figure 1. It is made up as follows:

- **primary structure**, sequence of amino acids in the four polypeptide chains
- **secondary structure**, in which each of these polypeptide chains is coiled into a helix
- **tertiary structure**, in which each polypeptide chain is folded into a precise shape – an important factor in its ability to carry oxygen
- **quaternary structure**, in which all four polypeptides are linked together to form an almost spherical molecule. Each polypeptide is associated with a haem group – which contains a ferrous (Fe^{2+}) ion. Each Fe^{2+} ion can combine with a single oxygen molecule (O_2), making a total of four O_2 molecules that can be carried by a single haemoglobin molecule in humans.

Learning objectives

- → Describe the structure and function of haemoglobins.
- → Explain the differences between haemoglobins in different organisms and the reasons for these differences.
- → Explain what is meant by loading and unloading of oxygen.

Specification reference: 3.3.4.1



▲ **Figure 1** *Quaternary structure of a haemoglobin molecule*

Loading and unloading oxygen

The process by which haemoglobin binds with oxygen is called **loading**, or **associating**. In humans this takes place in the lungs.

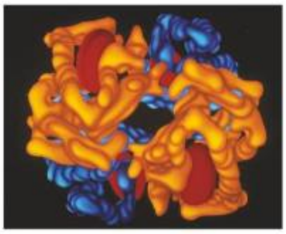
The process by which haemoglobin releases its oxygen is called **unloading**, or **dissociating**. In humans this takes place in the tissues.

Haemoglobins with a high affinity for oxygen take up oxygen more easily, but release it less easily. Haemoglobins with a low affinity for oxygen take up oxygen less easily, but release it more easily.

The role of haemoglobin

The role of haemoglobin is to transport oxygen. To be efficient at transporting oxygen, haemoglobin must:

- readily associate with oxygen at the surface where gas exchange takes place
- readily dissociate from oxygen at those tissues requiring it.



▲ **Figure 2** *Computer graphic representation of a haemoglobin molecule showing two pairs of polypeptide chains (orange and blue) associated with a haem group (red)*

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Investigating the effect of exercise on heart rate.

During exercise heart rate will increase. This is because respiration rate increases and so cells require an increased supply of oxygen and glucose. They also need to remove more carbon dioxide. You are going to plan an investigation the effect of exercise on heart rate. You may need to carry some research to complete this task.

Complete all your answers in the table below;

Explain precisely how you will measure your subject's heart rate.	
What type of exercise will you use?	
How will you determine the level/intensity of the exercise?	
Describe how your subjects will carry out the exercise.	
Explain how you will choose your subjects. Include number of subjects and any factors you will control to ensure that the results you gain are reliable.	
Explain how you will present your results. You could use a sample table and/or a sketch graph.	

Exam Questions

The answers for Q1, Q4, Q5, Q6 and Q7 are at the end of this document.

Q2 and Q3 will be marked by your teacher and feedback given.

Q1.

In a healthy person, blood moves in one direction as it passes through the heart. Give **two** ways in which this is achieved.

1. ____

____

____

2. ____

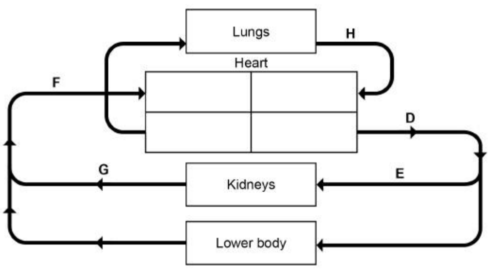
____

(Total 2 marks)

Q2.

(a) **Figure 1** shows part of the blood circulation in a mammal.

Figure 1



Use **Figure 1** to give the letter that represents each of these blood vessels.

Aorta	
Renal vein	
Vena cava	

(3)

(b) Name the blood vessels that carry blood to the heart **muscle**.

____

(1)

(Total 4 marks)

Q3.

(a) Describe the relationship between size and surface area to volume ratio of organisms.

____

____

____

____

____

(1)

(b) A scientist calculated the surface area of a large number of frog eggs. He found that the mean surface area was 9.73 mm^2. Frog eggs are spherical.

The surface area of a sphere is calculated using this equation

$$\text{Surface area} = 4\pi r^2$$

where r is the radius of a sphere

$$\pi = 3.14$$

Use this equation to calculate the mean diameter of a frog egg.

Show your working.

Diameter = ______________________ mm

(2)

The scientist calculated the ratio of surface area to mass for eggs, tadpoles and frogs. He also determined the mean rate of oxygen uptake by tadpoles and frogs.

His results are shown in the table.

Stage of frog development	**Ratio of surface area to mass**	**Mean rate of oxygen uptake / μmol g^{-1} h^{-1}**
Egg	2904 : 1	no information
Tadpole	336 : 1	5.7
Adult	166 : 1	1.3

(c) The scientist used units of μmol g^{-1} h^{-1} for the rate of oxygen uptake.

Suggest why he used μmol in these units.

____

____

____

____

____

(1)

(d) The scientist decided to use the ratio of surface area to mass, rather than the ratio of surface area to volume. He made this decision for practical reasons.

Suggest **one** practical advantage of measuring the masses of frog eggs, tadpoles and adults, compared with measuring their volumes.

____

____

____

____

____

____

(1)

(e) Explain why oxygen uptake is a measure of metabolic rate in organisms.

(1)

(f) A student who looked at these results said that they could not make a conclusion about the relationship between stage of development and metabolic rate.

Use information in the table to explain reasons why they were unable to make a conclusion.

(3)
(Total 9 marks)

Q4.

Haemoglobin transports oxygen around the body of many animals.

(a) Haemoglobin is a protein with a quaternary structure.

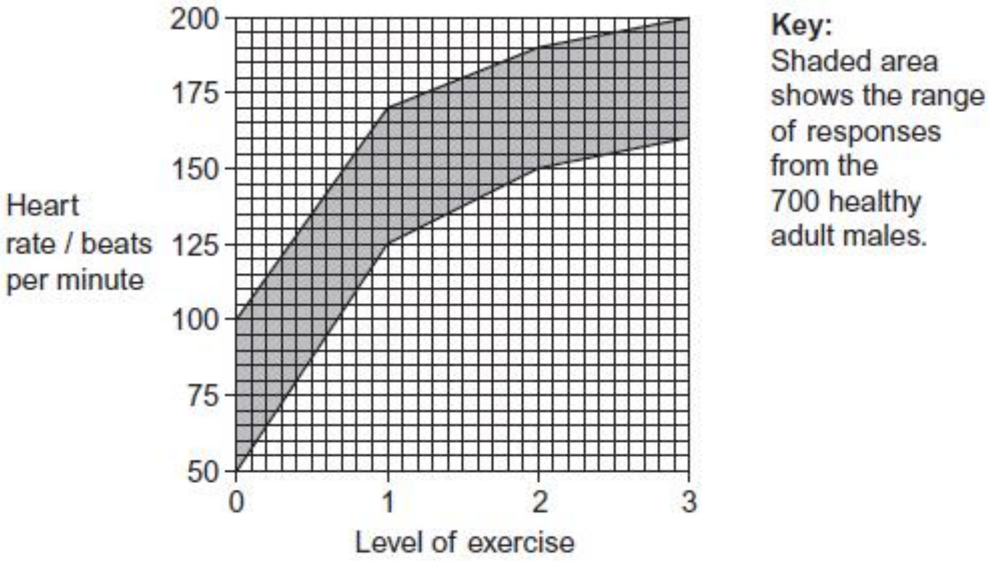
Explain the meaning of **quaternary structure**.

(1)
(Total 1 marks)

Q5.

It is possible to test for signs of heart disease using an exercise test. This involves the patient doing a controlled period of exercise whilst their heart rate is monitored.

Scientists measured the heart rates of 700 healthy adult males aged between 25 and 54 before, during and after an exercise test. The test involved running on a treadmill at different speeds. Their results are shown in the graph below in the form in which they were presented.



(a) Suggest **two** variables the scientists would have controlled during the exercise test.

1 ____

2. ____

(2)

(b) Calculate the ratio of the range of heart rates at exercise level 3 and exercise level 1.

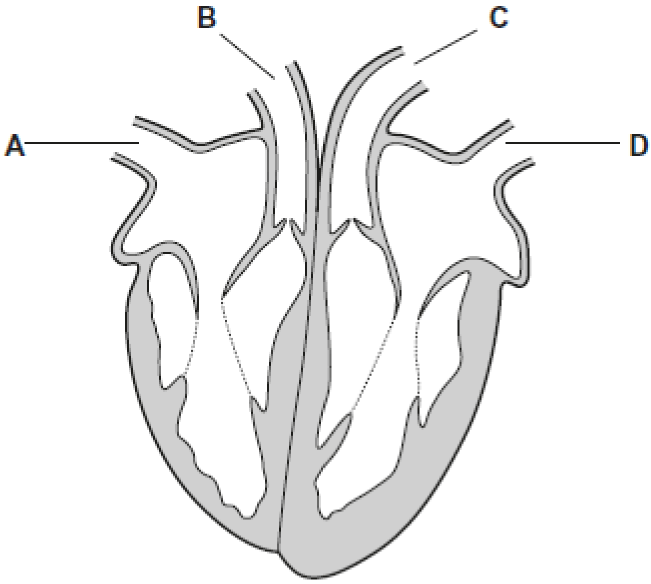
Answer = __________________________________ : 1

(2)

(Total 4 marks)

Q6.

The diagram shows a section through the heart. The main blood vessels are labelled **A**, **B**, **C** and **D**.



(a) Write a letter, **A**, **B**, **C** or **D**, in the box to represent the correct blood vessel.

(i) Which blood vessel carries oxygenated blood away from the heart?

☐

(1)

(ii) Which blood vessel carries deoxygenated blood to the heart?

☐

(1)

(b) Explain how the highest blood pressure is produced in the left ventricle.

____

____

____

(1)

(c) Some babies are born with a hole between the right and the left ventricles.

These babies are unable to get enough oxygen to their tissues.
Suggest why.

(2)
(Total 5 marks)

Q7. A student determined their pulse rate when sitting down. Describe how they could have investigated whether their results were typical of all students of their age.

(Total 3 ma

Help and mark scheme

You should be able to find the answers to part 1 and 2 quite easily in the text.

Surface area:Volume

1.

Organism	Radius (mm)	Surface Area (mm^2)	Volume (mm^3)	SA:Vol
E. Coli	0.001	0.00001256	0.0000000004	3000.0
Animal cell	0.015	0.002826	0.00001413	200.0
Small amoeba	0.045	0.025434	0.00038151	67.0
Large amoeba	0.400	2.0096	0.26794667	7.5
Water flea	1.000	12.56	4.18666667	3.0
Frog	25.000	7850	65416.6667	0.1

2. The larger the organism the smaller the SA:Vol.
3. The frog has a greater level of activity so requires more oxygen per unit area, and has a lower SA:Vol than the E. coli.

Mark schemes

Q1.

1. Pressure gradient / moves from high to low pressure;

2. Valves stop backflow;

Accept 'valves close when pressure gradient is 'the wrong way' for 2 marks

2. Accept 'one way valves'

2. 'Valves' on its own is insufficient

[2]

Q4.

(a) (Molecule contains) more than one polypeptide (chain).

Accept: has four polypeptides

1

[1]

Q5.

(a) 1. Length of time of exercise;

2.Difficulty of exercise;

3. An environmental factor;
Answers about variables relating to the subjects themselves are not valid.
2. E.g. speed of treadmill / running, incline on treadmill.
3. E.g. temperature / humidity / clothing worn.

2 max

(b) 0.89;

Ranges correct – level 3 range of 40 and level 1 range of 45 = 1 mark;
If value of 1.125 (level 1: level 3) is calculated award 1 mark
Accept any number significant figures as long as rounding is correct

2
[4]

Q6.

(a) (i) C;
Ignore name of vessel

1

(ii) A;
Ignore name of vessel

1

(b) Strongest/stronger contractions;
Accept most muscle in wall / thickest/thicker muscular wall
A comparative statement is needed
Answer must be in context of producing force and not resisting it

1

(c)

1. Blood flows from left ventricle to right ventricle/ mixing of oxygenated and deoxygenated blood;
2. Lower volume of (oxygenated) blood leaves left ventricle/flows into aorta/C
OR
Lower pressure in blood leaving left ventricle/flowing into aorta/C
OR
Less oxygen in blood leaving left ventricle/aorta/C;

2
[5]

Q7.

1. Obtain pulse rates for a large number of students;

Accept this idea for carrying out the investigation or for collecting data from other scientists work / published data

2. (belonging to) a range of different sexes / ethnic groups/from different parts of the country / employment groups;

Accept suitable alternative variables but the idea of a range must be included

Reject generic references to controlling these variables

3. Calculate mean and standard deviation (of students their age);

Allow 'calculate standard error / 95% confidence limits / t test / statistical test'

4. See if their mean lies within the standard deviation;

Accept 'see if my mean lies within the 95% confidence limits'

If statistical test used, accept 'see if there is a significant difference between means'