Biology A level

Course plan

This plan shows the structure of the course and gives an outline of the contents. Sections 1–4 cover the requirements of the AS and Part 1 of the A level; Sections 5–8 cover Part 2 of the A level. You need to do Sections 1–8 to prepare for the A level.

Getting Started

Introduction

Making the most of the course

A level Biology Course guide

Section 1 Lifestyle, health and risk

Topic 1 What is cardiovascular disease?

Topic 2 Who is at risk of cardiovascular disease?

Topic 3 Risk factors for cardiovascular disease

Topic 4 Biochemistry involved in cardiovascular disease

Core practical 1 Investigate the effect of caffeine on heart rate in *Daphnia*

Core practical 2 Investigate the vitamin C content of food and drink

Topic 5 Reducing the risk of cardiovascular disease

Assignment 1

Section 2 Genes and health

Topic 1 The effects of cystic fibrosis on the lungs

Core practical 3 Investigate membrane structure, including the effect of alcohol concentration or temperature on membrane permeability

Topic 2 Why is CF mucus so sticky?

Core practical 4 Investigate the effect of enzyme and substrate concentrations on the initial rate of reactions

Topic 3 The roles of proteins and enzymes

Topic 4 How is the CFTR protein made?

Topic 5 How is cystic fibrosis inherited?

Topic 6 Testing for CF

Assignment 2

Section 3 Voice of the genome

Topic 1 Cells and their components

Topic 2 In the beginning

Core practical 5 Prepare and stain a root tip squash to observe the stages of mitosis

Topic 3 From one to many: the cell cycle

Topic 4 How development is controlled

Topic 5 Genes and environment

Assignment 3

Section 4 Biodiversity and natural resources

Topic 1 Why are there so many different species?

Topic 2 How did organisms become so well adapted?

Topic 3 Classification and speciation

Core practical 6 Identify sclerenchyma fibres, phloem sieve tubes and xylem vessels and their location within stems through a light microscope

Core practical 7 Investigate plant mineral deficiencies

Topic 4 Plant cells and tissues

Core practical 8 Determine the tensile strength of plant fibres

Core practical 9 Investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria

Topic 5 Making use of biodiversity in plants

Topic 6 On the brink

Assignment 4

Section 5 On the wild side

Core practical 10 Carry out a study on the ecology of a habitat, such as using quadrats and transects to determine distribution and abundance of organisms, and measuring abiotic factors appropriate to the habitat

Topic 1 What is an ecosystem?

Core practical 11 Investigate photosynthesis using isolated chloroplasts (the Hill reaction)

Topic 2 Ecosystems rely on energy transfer

Topic 3 Global climate change

Core practical 12 Investigate the effects of temperature on the initial rate of an enzyme-catalysed reaction, to include Q10

Core practical 13 Investigate the effects of temperature on the development of organisms (such as seedling growth rate, brine shrimp hatch rates)

Topic 4 Predicting and coping with future climate change

Topic 5 Adapt or die

Topic 6 Getting the balance right

Assignment 5

Section 6 Infection, immunity and forensics

Core practical 14 Use gel electrophoresis to separate DNA fragments of different lengths

Topic 1 Forensic biology

Topic 2 Cause of death

Topic 3 The body's response to infection

Topic 4 Could the infections have been prevented?

Core practical 15 Investigate the effect of different antibiotics on bacteria

Topic 5 Are there treatments for AIDS and TB?

Assignment 6

Section 7 Run for your life

Topic 1 Getting moving

Core practical 16 Investigate rate of respiration

Topic 2 Energy for action

Core practical 17 Investigate the effects of exercise on tidal volume, breathing rate, respiratory minute ventilation and oxygen consumption using data from spirometer traces

Topic 3 Peak performance

Topic 4 Breaking out in a sweat

Topic 5 Overdoing it

Topic 6 Improving on nature

Assignment 7

Section 8 Grey matter

Topic 1 The nervous system and nerve impulses

Topic 2 Reception of stimuli

Topic 3 The brain

Topic 4 Visual development and making sense of what we see

Core practical 18 Investigate habituation to a stimulus

Topic 5 Learning and memory

Topic 6 Problems with synapses

Topic 7 Genetic modification: risks and benefits

Assignment 8

Assignment 9

Sample of the A Level Biology Course from Section 1

Topic 1

What is cardiovascular disease?

Introduction

Diseases of the heart and circulatory system are collectively known as cardiovascular disease (CVD). Heart disease and strokes, caused by CVD, are major causes of death and disability in the world today. What causes them and can anything be done to prevent them? This topic looks at the heart and blood system, how they work in a healthy body and what can go wrong to cause cardiovascular diseases.

You will probably need 4 hours to complete this topic.

Objectives

When you have completed this topic you should be able to:

- explain why many animals have a heart and circulation
- explain the importance of water as a solvent in transport
- describe how the structure of blood vessels relates to their functions
- describe the cardiac cycle and how the structure and operation of the mammalian heart relate to its function

- list the course of events that leads to atherosclerosis
- describe the blood clotting process and its role in cardiovascular disease.

Key terms

Arterioles Small **blood vessels**, with walls containing smooth muscle, formed when **arteries** divide

Artery Large **blood vessel** which carries **blood** away from the **heart** to the body organs

Atherosclerosis A form of **cardiovascular disease** involving deposits of cholesterol and formation of **plaques** in damaged **arteries**

Atheroma Deposited cholesterol in a damaged artery

Atrial systole First phase of the **cardiac** cycle when both atria contract

Atrium (plural **atria**) One of two small chambers of the **heart** into which blood flows from **veins**

Blood Liquid that transports soluble substances and blood cells around the body

Blood vessel Tube in which **blood** is carried around the body

Capillary Tiny **blood vessel**, with wall one cell thick, which passes through the tissues of the body

Cardiac cycle Sequence of events in the **heart** during a single heart beat

Cardiovascular disease (CVD) Disease of the circulatory system (**heart** and **blood vessels**)

Cholesterol A fatty substance present in cell walls and carried in blood

Coronary artery Artery that carries **blood** to the **heart** muscle

Coronary heart disease (CHD) Disease of the arteries supplying the heart

Diastole Phase of the **cardiac cycle** when **heart** muscle relaxes

Dipole Molecule that has a different electric charge at each end, also known as a **polar** molecule

Double circulation **Blood** flows through the **heart** twice for every circuit around the body – once through the **pulmonary** system and once through the **systemic** system

Endothelium A delicate layer of cells which lines the inside of an **artery** or **vein**

Fibrin Insoluble protein, produced from **fibrinogen**, involved in the clotting process

Fibrinogen Soluble protein found in **blood plasma** involved in the clotting process

Heart Organ in the body that pumps blood round the body

Hydrogen bond Weak type of chemical bond due to electrostatic attraction between a positively charged hydrogen atom and a negatively charged oxygen or nitrogen atom in another molecule or part of the same molecule

Hydrophilic Literally 'water-loving' – this term is applied to chemical groups which attract water

Hydrophobic Literally 'water-fearing' – this term is given to chemical groups which repel water

Mass flow Bulk transport of materials from one point to another as a result of a pressure difference between the two points

Metabolism All the chemical reactions that take place in the body

Plaque A deposit of calcium salts and fibrous tissue that forms in a damaged **artery**

Plasma The liquid component of **blood**

Platelets Small cell fragments found in the **blood**, involved with the blood clotting mechanism

Polar See **dipole**

Prothrombin Inactive protein found in **blood plasma** involved in the clotting process

Pulmonary circulation Vessels which carry **blood** between the **heart** and lungs

Systemic circulation **Blood vessels** which carry **blood** around the whole body apart from to and from the lungs

Systole Phase of **cardiac cycle** when **heart** muscle contracts

Thrombin **Plasma** protein involved in the clotting process

Thromboplastin Protein initiating the clotting process

Vein Large **blood vessel** carrying **blood** to the **heart**

Ventricle Large lower chamber of the **heart**

Ventricular systole Second part of **cardiac cycle** when both **ventricles** contract

Venule Small **blood vessel** formed when **capillaries** join to return **blood** to the **heart**

What is cardiovascular disease?

Cardiovascular disease (CVD) is a term used to describe a disease of the circulatory system, which consists of the **heart** and **blood vessels**. **Blood** is a liquid tissue containing blood cells and dissolved substances that is pumped around the body by the heart. Movement of blood is an example of **mass flow**, the bulk transport of materials from a place of higher pressure (provided by the heart) to where pressure is lower.

Before you go on to look at the reasons why CVD develops, you need to learn why humans need a circulatory system and how it works.

In Topic 1 Section 1.1 of the textbook, read from the beginning to the heading *How does the circulation work?* including the *Key biological principle: Why have a heart and circulation?* Then do Activity 1.

Activity 1

(Allow 10 minutes)

1 Write a short summary explaining why many animals have a heart and circulation. Your summary should include an explanation of the concept of mass flow.

2 Suggest why only small animals have an open circulatory system.

3 What are the advantages for larger animals of having a double circulatory system?

1 Your summary should include these points:

- All cells need substances which they get by the process of **diffusion** through their cell membranes.
- Complex, **multicellular organisms** are too large for substances to diffuse through their skin and to reach all their cells quickly enough.

- Therefore substances need to be moved by mass flow – the bulk transport of materials from one point to another as a result of a pressure difference between the two points.
- Therefore substances are carried in blood.
- The heart generates the pressure to keep blood moving.

2 Circulation of body fluid in insects and other small animals is mainly in the body cavities surrounding organs. Diffusion of substances into and out of cells in these organs is only efficient over short distances, and would be too slow in larger animals.

3 The advantage of a double circulatory system is that blood can pass slowly through the region where gas exchange takes place, giving time for maximum transfer of oxygen and carbon dioxide, and then be pumped vigorously round the rest of the body, enabling the animal to be active.

Study hint

You may find it helpful to watch some short videos and animations showing open and closed circulatory systems. Here are some examples.

closed circulatory system

https://www.youtube.com/watch?v=KCC_FrbuR3U
(1 minute 38 seconds)

open circulatory system

http://www.cengage.com/biology/discipline_content/animations/blood_circulation.html (interactive animation)

How does the circulation work?

Because human beings are relatively large organisms, they need a complex and efficient system to move substances around their bodies. Next you will learn about the human circulatory system, which is made up of:

- blood – a liquid that contains dissolved substances being transported around the body
- blood vessels – blood travels in these
- heart – a pump that creates the pressure needed to keep the blood moving.

Blood consists of a liquid **plasma**, cells (both red blood cells and white blood cells) and **platelets** (small fragments involved in clotting). The soluble substances being transported around the body are dissolved in the water of the plasma.

Study hint

You can learn more about the composition of blood here:

http://www.myvmc.com/anatomy/blood-function-and-composition/

Activity 2

(Allow 5 minutes)

List as many substances as you can think of that need to be moved around the body.

You could have included:

- nutrients, e.g. glucose and amino acids
- oxygen
- carbon dioxide
- waste substances, e.g. urea
- hormones.

These fit into four main categories:

- respiratory gases (oxygen and carbon dioxide)
- metabolites – substances which take part in metabolic reactions (e.g. glucose, amino acids)
- metabolic waste produced as a result of metabolism, that is, the chemical reactions in the body (e.g. urea)
- hormones (e.g. insulin).

Water as a solvent

Water is a very good solvent, being able to dissolve many different types of substances. This property is due to the structure of the water molecules and how they interact together and with other substances. Each water molecule consists of two hydrogen atoms joined to one oxygen atom. The electrons are not evenly spread over the molecule, with the result that the oxygen atom has a negative charge and the hydrogen atoms a positive charge. Molecules like this are called **dipoles**, or **polar** molecules.

Another useful property of water is that it has a high specific heat capacity, meaning that it is slow to warm up and cool down.

Molecules or parts of molecules that readily mix with water are called **hydrophilic**. These include salts, sugars and many proteins. Those that repel water are known as **hydrophobic**.

Study hint

To learn more about water and why it is so important to life, go to the powerpoint called 'Water and life'. You can find another powerpoint including a multiple choice quiz at:

https://www.boundless.com/biology/textbooks/boundless-biologytextbook/ the-chemical-foundation-of-life-2/water-51/water-51- powerpoint-templates/

In Topic 1 Section 1.1 of the textbook, read the *Key biological principle: Properties of water that make it an ideal transport medium.*

Activity 3

(Allow 10 minutes)

1 What is the name given to a molecule such as water which has a difference in electrostatic charge between one side of the molecule and the other?

2 What is the name given to the weak bonds by which water molecules are attracted to each other?

3 Why is water such a good solvent of ionic compounds such as salt (sodium chloride)?

4 Define the terms hydrophilic and hydrophobic.

5 Suggest an example of a substance whose molecules are hydrophobic.

1 A molecule of water is an example of a dipole or a polar molecule.

2 Hydrogen bonds attract polar molecules such as water to each other.

3 Ionic compounds, e.g. salts, dissolve in water because the small negative charges at the oxygen end of the water molecules are attracted to the positive ions and surround them. These water molecules are, in turn, surrounded by more water molecules

attracted to them and so the ion is dissolved in the water. A negative ion similarly attracts the small negative charge of the hydrogen atoms in the water molecule.

4 Hydrophilic means 'water loving'. (This applies to molecules containing polar groups, e.g. –OH in sugars and –NH2 in amino acids.) Hydrophobic means 'water-hating'.

5 Examples of substances which are hydrophobic, and therefore do not dissolve in water, include fats and oils, which have no or very few polar groups.

You now know that mammals have a double circulatory system. In the next part of this section you will be looking in more detail at the blood vessels that carry the blood to and from the heart.

Blood vessels

In order to understand how the heart works we first need to know how blood vessels work. Figures 1.10A and 1.10B in the textbook are diagrams showing the outside and inside of the heart respectively, with the blood vessels – the arteries and veins. We will be returning to these figures a little later.

First, you need to understand the differences between arteries, veins and capillaries.

Blood vessels are:

- **arteries** – carry blood from the heart
- **veins** – carry blood to the heart
- **capillaries** – very narrow vessels with thin walls, carrying blood to body tissues; they branch off from arteries and join to form veins.

Arterioles are small arteries formed after a larger artery divides, and **venules** are small veins that join to form a larger vein.

Each type of blood vessel has a different structure related to its function. The structures of the three main types of blood vessel are shown in Figure 1.11A in the textbook. Figure 1.11B is a photomicrograph showing a cross-section of a vein and an artery close together; the differences between the two blood vessels are clear.

Study hint

This short lecture makes use of a three-dimensional model of an artery and veins, clearly showing the differences in their structures: https://www.youtube.com/watch?v=170ty_bkasU

(2 minutes 26 seconds)

In Topic 1 Section 1.1 of the textbook, read the section headed *The structure of blood vessels*, then do Activity 4.

Activity 4

(Allow 10 minutes)

Print or copy the table below.

1 How does the structure of an artery enable the artery to withstand high pressure and then recoil to maintain a steady flow of blood?

2 Complete the table comparing the three main types of blood vessel. We have completed some of the boxes to get you started.

Vessel	Artery	Vein	Capillary
Direction of blood flow (from–to)			From arteries to veins, through tissues
Function			Allows exchange of materials between blood and tissues
Structure of wall			
Presence of valves (Y/N)			

1 An artery has a thick layer of elastic fibres to allow expansion and recoil of the artery. This is surrounded by a thick layer of collagen fibres, which are tough and durable to withstand high pressure.

2 You will find the answer to Question 2 at the end of this topic.

Exam hint

In the exam, you will need to be able to recognise an artery and a vein from photomicrographs and drawings.

Check that you have understood the function and structure of the different blood vessels in Self check 1.

Self check 1

(Allow 10 minutes)

1 In which type of vessel is blood velocity the lowest and how does this help with the exchange of substances between the blood and tissue?

2 Which vessels have the thickest walls and why is this?

3 How does the structure of the capillaries relate to their role?

4 What is the function of the smooth muscle in the walls of arteries and some arterioles?

You will find feedback to self checks at the end of the section.

The heart is divided into two sides, left and right, and four chambers:

- **two atria**, one on the left and one on the right, which receive blood (from the lungs to the left atrium and from the systemic system to the right atrium)
- **two ventricles**, one on the left and one on the right, which pump blood out to the tissues.

Study hint

You may find it helpful to visualise blood flow through the heart by watching an animation. Here's an example.

https://www.youtube.com/watch?v=l7ejcLxKW8c
(2 minutes 26 seconds)

The left and right sides of the heart are completely separate.

The benefit of this arrangement is that it:

- keeps oxygenated and oxygenated blood separate

- gives blood returning to the heart from the lungs an extra boost, which reduces the time it takes to circulate round the body.

The walls of the ventricles are composed of thick cardiac muscle which contracts to generate the pressures needed to move blood out of the heart. Between the atria and ventricles on both sides of the heart are valves held by tendons which prevent blood flowing back into the atria when the ventricles contract.

Look at Figure 1.10 again in the textbook and learn the labels.

Revision advice

When you are learning names of structures such as components of the heart, a good way to revise is to print an unlabelled diagram and see how many components you can label correctly. If you print several copies of unlabelled diagrams you can keep checking your answers and repeating as many times as you need to until you get them all right. To find an unlabelled diagram of the heart do a search online.

Activity 5

(Allow 10 minutes)

Go to http://www.tutorvista.com/content/biology/biologyii/transportation/hearts-parts.php

Select Identify parts of the heart and see what you score.

Learning the details of the heart's structure can be easier if you can see it. There are some good videos of heart dissection online. Try doing this in Activity 6. You might be able to have a go at dissecting an animal heart yourself.

Activity 6

(Allow 10 minutes)

(If you wish to carry out the dissection of an animal heart allow extra time)

Watch this video of a heart dissection:

https://www.youtube.com/watch?v=yE3Y-XR8Ax4
(4 minutes 10 seconds). This is from the At-Bristol Science Centre.

If you wish, you can have a go at dissecting an animal heart yourself. Hearts are available at butcher's shops and some supermarkets.

Safety

Take care when you are handling raw meat and sharp knives. Cover any cuts or grazes on your hands. Clean cutting boards and knives with hot water and disinfectant.

The cardiac cycle

The heart has a regular beat. Each beat consists of the heart muscle contracting and relaxing in an organised way. In fact it is a double beat. Each double beat is called a **cardiac cycle**.

Read the outline of the cardiac cycle in Topic 1 Section 1.1 of the textbook, from the heading *How the heart works* to the heading *What is atherosclerosis?*

One complete cardiac cycle takes about 0.8 seconds. The thickness of the muscle walls of the chambers of the heart determines the pressure that can be generated. For example, the walls of the left ventricle are the thickest and so generate the greatest pressure. This ensures that blood leaving the left ventricle can be pushed around the entire **systemic circulation**.

Activity 7

(Allow 5 minutes)

1 When the heart is in diastole (relaxed) how is blood prevented from flowing back into ventricles due to the elastic recoil of the arteries, especially if you are standing or sitting upright?

2 The average time taken for a cardiac cycle is 0.8 seconds. Calculate the heart rate in beats per minute.

1 The blood pressure in the ventricles falls below that in the arteries, leading to closure of the semilunar valves between each artery and ventricle. This prevents backflow of blood from the arteries into the ventricles.

2 To work out heart rate divide 60 by the time taken in seconds for each cardiac cycle (0.8), which gives 75 beats per minute.

The cardiac cycle consists of:

- electrical activity
- muscle contractions
- pressure changes
- movements of valves.

Figure 1.1 links the cardiac cycle to valve movements which prevent backflow of blood during the cardiac cycle. Remember, valves open or close due to differences in pressure on each side of them. When they close the sound may be heard – during the cardiac cycle it is a double beat known as 'lub dub'.

Figure 1.1 Valve movement in the cardiac cycle

	PHASE		
STRUCTURE	Atrial systole	Ventricular systole	Diastole
Atria	Contract	Relax	Relax
Ventricles	Relax	Contract	Relax
AV valves	← Open →	← Closed →	← Open →
Semilunar valves	← Closed →	← Open →	← Closed →

There are some helpful animations online showing the cardiac cycle. Here's an example.

https://www.youtube.com/watch?v=jLTdgrhpDCg
(1 minute 20 seconds)

Activity 8

(Allow 10 minutes)

Study the graph in Figure 1.14 in the textbook, then answer Q1.7 in the textbook.

You will find the answer at the end of the textbook. You have earned about the phases of the cardiac cycle and the electrical activity from the information on ECGs. You now need to integrate this information into a complete picture of the cardiac cycle.

Activity 9

(Allow 15 minutes)

Print or copy the passage below. Fill in the gaps in the passage below to obtain a complete account of the cardiac cycle. (You will not get any exam questions in this form but it is useful for revision of topics.)

During ..... the atria and ventricles are relaxed. Blood enters the left atrium from the ..... and the right atrium from the .....

During ..... both atria contract. This increases the pressure in the atria until it is ..... than the pressure in the ventricles. This causes the ..... to open. Blood flows into the ventricles. Both ventricles contract increasing the pressure inside them. When the pressure in the ventricles is greater than the pressure in the atria, the ..... shut.

The pressure in the ventricles continues to rise until it is ..... than that in the arteries. Then the ..... open. Blood flows into the arteries.

From the ..... ventricle blood flows into the aorta and from the ..... ventricle blood flows into the pulmonary arteries.

All four chambers of the heart relax and the heart enters ..... once more. As the ventricles relax the pressure in them falls. When it is lower than the pressure in the ....., the semilunar valves shut.

You will find the answer to this activity at the end of the topic.

Exam hint

You need to be able to identify the stage of the cardiac cycle by the positions of the valves in a diagram.

Now check that you have understood the cardiac cycle in Self check 2.

Self check 2

(Allow 10 minutes)

1 About how long does one cardiac cycle take in a person at rest?

2 In which chamber of the heart does the pressure reach its highest level?

3 At what part of the cycle is the pressure at its highest?

4 What is the name given to the period when the atria fill with blood?

5 What happens during atrial systole? Which valves are open at this time?

6 Which area of the heart initiates the heartbeat?

You will find feedback to self checks at the end of the section.

What is atherosclerosis?

Now that you have learned how the heart works and the roles the blood vessels play, you can move on to what can go wrong with this system and how this can lead to cardiovascular disease.

In Topic 1 Section 1.1 of the textbook, read the section headed What is atherosclerosis? to the heading Why does the blood clot in arteries?

Atherosclerosis is a narrowing of an artery due to deposits of cholesterol and formation of **plaques**. The process can be summarised as follows:

- the **endothelium** which lines the artery becomes damaged
- white blood cells move into the damaged artery wall and cause **cholesterol** to be deposited in the artery wall to form an **atheroma**
- a plaque then forms from deposited calcium salt and fibrous tissue
- atheromas and plaques partially block arteries, increasing blood pressure and leading to risks of heart disease and strokes. The increasing blood pressure may cause further damage to arteries, a process known as positive feedback.

Activity 10

(Allow 10 minutes)

Look at the photomicrographs of cross-sections of arteries in Figures 1.15A and 1.15B of the textbook.

1 What are the key differences between the two arteries?

2 Can you explain the changes in the artery in Figure 1.15B?

3 What is the role of positive feedback in development of atherosclerosis?

1 The artery in Figure 1.15B is almost blocked from deposits in its wall, leaving a very narrow lumen for blood to flow through.

2 The deposits are an atheroma caused by deposited cholesterol in the artery wall, and plaques made of calcium salts and fibrous tissue. These resulted from damage to the endothelium lining the artery.

3 High blood pressure is one cause of damage to the endothelium, leading to atherosclerosis. Partially blocked arteries themselves cause a rise in blood pressure, making it more likely that more atheromas and plaques will form. This is an example of positive feedback.

You have learned that atherosclerosis narrows arteries and makes them less elastic. If the narrow lumen becomes blocked by a blood clot, then no blood can reach the tissues supplied by that artery. If it is an artery that supplies the heart muscle, called a **coronary artery**, it may lead to a heart attack. If the artery is supplying the brain with blood, a stroke occurs. Mark's and Peter's stories in the textbook (Topic 1 *Introduction*) describe the effects of a heart attack and stroke respectively.

Why does blood clot in the arteries?

Blood clotting is an important process. If we cut ourselves we need blood to clot to prevent further blood loss and to form a barrier against infections. But if a clot forms in an intact artery it can cause problems.

In Topic 1 Section 1.1 of the textbook, read the section *Why does the blood clot in arteries?* to the heading *The consequences of atherosclerosis.*

Blood clotting is a complex process involving several factors including plasma proteins, calcium ions, vitamin K and platelets. Figure 1.17 in the textbook and the sub-section headed The clotting cascade describe the role of these various components in the process of blood clotting, which can be initiated in an intact artery when the endothelium becomes damaged. Table 1.1 gives a summary of the main factors involved in blood clotting, with a brief description of their function.

Table 1.1 Functions of the main factors involved in blood clotting

Factor	Its function
Platelets	Are activated to stick to damaged blood vessel walls and each other, forming a temporary plug.
Thromboplastin	Soluble protein is released from platelets and damaged tissue. It catalyses the conversion of prothrombin to thrombin.
Prothrombin	Soluble protein that is activated by thromboplastin to form the thrombin
Calcium ions	Necessary for thrombin production.
Vitamin K	Necessary for thrombin production
Thrombin	Enzyme that catalyses conversion of fibrinogen to fibrin.
Fibrinogen	Soluble protein converted to fibrin by the action of thrombin
Fibrin	Insoluble protein that forms a mesh over the damaged tissue.

Activity 11

(Allow 10 minutes)

Study Figure 1.17 in the textbook and the numbered list below it describing the sequence of events leading to a blood clot.

Now draw a flowchart on a piece of paper to summarise how blood clots form including the following words:

platelet plug collagen thromboplastin

thrombin	prothrombin	fibrinogen
calcium ions	vitamin K	fibrin
activated platelets	clot	

You will find answers to this activity at the end of the topic.

Read the section in the textbook headed *The consequences of atherosclerosis*. This describes how blocked arteries to the heart and brain can respectively cause a heart attack or a stroke.

Activity 12

(Allow 10 minutes)

Go back to Peter's story in the Introduction to Topic 1 in the textbook and list the risk factors that could have contributed to his heart attack.

You could have included high blood pressure and hereditary factors as well as drinking too much alcohol. The hereditary factors were made worse for Peter's father because he was overweight, ate a lot of fatty food and smoked heavily.

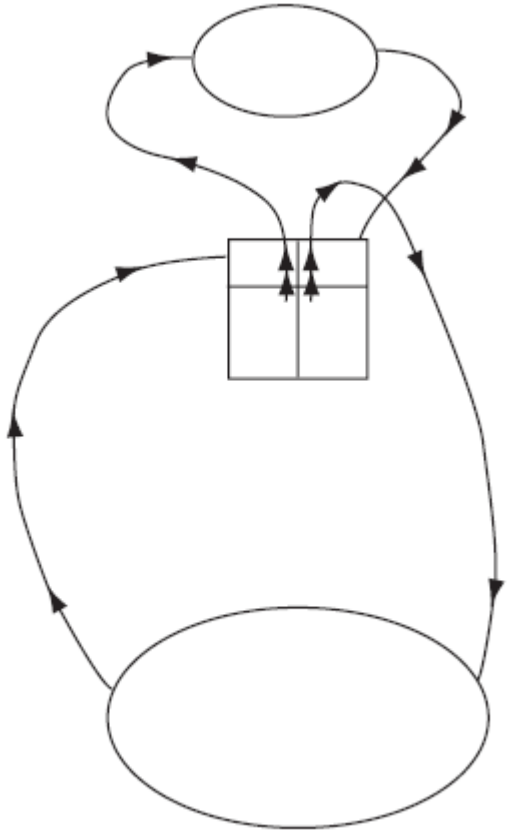
Finish this topic by completing Self check 3.

Self check 3

(Allow 10 minutes)

1 Use the following words to label the diagram below:

lungs pulmonary artery right side of heart venae cavae pulmonary circulation body tissues pulmonary veins left side of heart aorta systemic circulation



2 Describe how the build-up of plaque in the arteries contributes to an increase in blood pressure.

3 Give one reason why high blood pressure increases the risk of cardiovascular disease.

4 Why do arteries need a large amount of elastic tissue in their walls? What effect does atherosclerosis have on this property?

You will find feedback to self checks at the end of the section.

Summary

- Animals have a heart and circulation which use mass flow to overcome the limitations of diffusion in meeting the requirements of the organism.
- Water is important as a solvent in transport because of its dipole nature.
- The structures of blood vessels are related to their functions.

- The cardiac cycle consists of diastole, atrial systole and ventricular systole.
- The structure and operation of the heart relate to its function.
- The events that lead to atherosclerosis include endothelial damage, the inflammatory response, plaque formation and raised blood pressure.
- Blood clotting is a cascade of events triggered by the release of thromboplastin, which converts prothrombin to thrombin and in turn this converts soluble fibrinogen to insoluble fibrin.

References

Boundless, water powerpoint, accessed 24 June 2015,

https://www.boundless.com/biology/textbooks/boundless-biologytextbook/ the-chemical-foundation-of-life-2/water-51/water-51- powerpoint-templates/

Cengage Learning, circulatory system animation, accessed 6 May 2015,
http://www.cengage.com/biology/discipline_content/animations/blood_circulation.html

Exton, R, At-Bristol Science, dissection of heart demonstration video, 5 November 2013, accessed 18 January 2015,
http://www.youtube.com/watch?v=yE3Y-XR8Ax4
(4 minutes 10 seconds)

Interactive heart to label, accessed 28 January 2015,

http://www.tutorvista.com/content/biology/biologyii/transportation/hearts-parts.php

Keeley, L, *Insect circulatory system*, 4 September 2011, accessed 6 May 2015, https://www.youtube.com/watch?v=KCC_FrbuR3U
(1minute 38 seconds)

McGraw Hill, animation of cardiac cycle video, 5 May 2009, accessed 28 January 2015, http://www.youtube.com/watch?v=jLTdgrhpDCg
(1 minute 20 seconds)

Medical Institution, *Blood flow through heart animation*, 10 January 2014, accessed 6 May 2015,
https://www.youtube.com/watch?v=l7ejcLxKW8c
(2 minutes 26 seconds)

UCDenver Anatomy Lab, *Artery and vein layering model*, 3 November 2013, accessed 6 May 2015,
https://www.youtube.com/watch?v=170ty_bkasU
(2 minutes 26 seconds)

Virtual Medical Centre, *Blood function and composition*, 2015, accessed 6 May 2015, http://www.myvmc.com/anatomy/bloodfunction-and-composition/

Feedback to activities

Activity 4

1 Your table should look like this

Vessel	Artery	Vein	Capillary
Direction of blood flow (from–to)	**From heart to capillaries in tissues**	**From capillaries in tissues to heart**	From arteries to veins, through tissues
Function	**Carries blood at high pressure all round body (lower pressure in lungs)**	**Carries blood at low pressure to heart to be pumped round body again**	Allows exchange of materials between blood and tissues
Structure of wall	**Thick to withstand pressure; elastic fibres for recoil and to cope with pressure changes**	**Thinner walls, less elastic**	**Single layer of cells**
Presence of valves (Y/N)	**N**	**Y**	**N**

Activity 9

During diastole the atria and ventricles are relaxed. Blood enters the left atrium from the lungs / pulmonary veins and the right atrium from the systemic system / vena cava.

During atrial systole both atria contract. This increases the pressure in the atria until it is greater than the pressure in the ventricles. This causes the atrio-ventricular valves to open. Blood flows into the ventricles.

Both ventricles contract increasing the pressure inside them. When the pressure in the ventricles is greater than the pressure in the atria, the atrio-ventricular valves shut.

The pressure in the ventricles continues to rise until it is greater than that in the arteries. Then the semilunar valves open. Blood flows into the arteries.

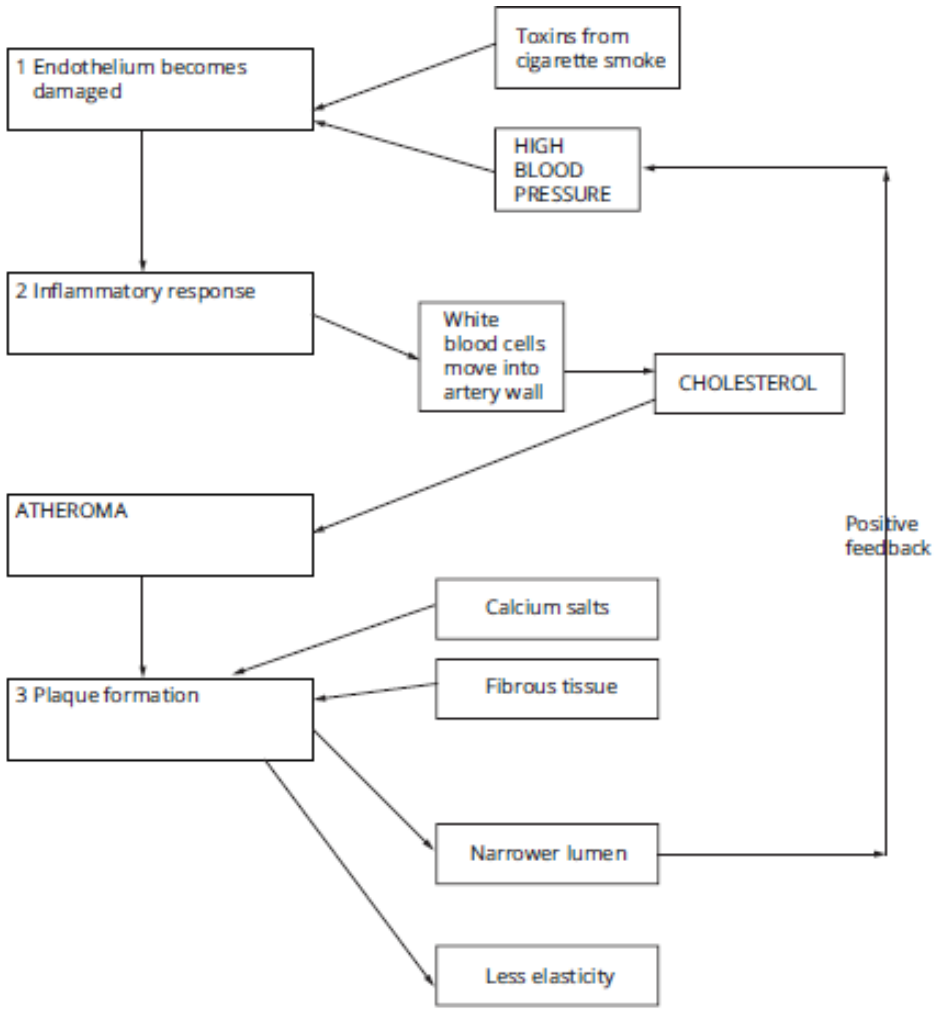
From the left ventricle blood flows into the aorta and from the right ventricle blood flows into the pulmonary arteries.

All four chambers of the heart relax and the heart enters diastole once more. As the ventricles relax the pressure in them falls. When it is lower than the pressure in the arteries the semilunar valves shut.

Activity 11

Your flowchart should look like this. Thromboplastin is released from damaged tissue and from platelets.

Events leading to atherosclerosis



The important point to note is the cascade of events triggered by the release of thromboplastin. Proteins already present in plasma

(prothrombin and fibrinogen) are converted quickly to give rise to fibrin which forms the basis of the clot.

What next?

We hope this sample has helped you to decide whether this course is right for you.

If you have any further questions, please do not hesitate to contact us using the details below.

If you are ready to enrol, you have different options:

- **enrol online** – for many courses you can enrol online through our website. Just choose your course, click 'enrol now' and then checkout
- **enrol by telephone** – just call our course advice team free on 0800 389 2839 and we can take your details over the telephone
- **pay in full** – you can pay in full with a credit or debit card
- **pay in instalments** – if spreading the cost would be useful, we can arrange that for you. Just call our course advice team to organise this.

Contact us

There are many ways to get in touch if you have any more questions.

Freephone: 0800 389 2839

Email us: info@nec.ac.uk

Website: www.nec.ac.uk

You can also find us Facebook, Twitter and LinkedIn