



Walthamstow Academy
The best in everyone™
Part of United Learning

Practice Makes Permanent

AS Biology Summer Holiday Pack

Why complete this booklet?

This booklet has been designed to help you consolidate and strengthen your understanding of the key concepts covered in AS-Level Biology.

Regular practice is one of the most effective ways to improve your knowledge, develop confidence, and prepare for future lessons and assessments.

By completing the questions throughout the summer, you will revisit important topics, identify areas that need further review, and ensure that your knowledge remains fresh for the start of the new academic year.

How to use this booklet

This booklet follows the AQA A-Level Biology specification and is organised by topic, allowing you to work through the content in a logical order.

You should complete the activities independently, referring to your class notes or textbook when necessary to support your learning.

Within each topic you will find:

- **Quick Questions** – short questions designed to check your understanding of key ideas.
- **Exam-Style Questions** – questions that reflect the wording, structure and level of challenge found in AQA examinations.
- **Topic Reviews** – longer sets of questions that bring together the knowledge from an entire topic, helping you make links between concepts.

To get the greatest benefit from this booklet:

- Complete the work regularly rather than leaving it until the end of the holidays.
- Attempt every question before checking your notes or textbook.
- Mark your work carefully using the provided answers where available.
- Correct any mistakes and make notes on topics you need to revisit.
- Ask your teacher about anything you are still unsure of when you return to school.

1

Biological molecules

Monomers and polymers

Quick questions

- SB1 p2 3.1.1 1 What is a monomer?
- SB1 p2 3.1.1 2 What type of reaction takes place in order for two biological monomers to join together in a chemical reaction?

Exam-style questions

- SB1 p2 3.1.1 3 Figure 1 shows two monomers. Use an annotated diagram to show how these two monomers could join together by a condensation reaction. [2]

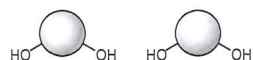


Figure 1

Total: 2

Carbohydrates

Quick questions

- SB1 p2 3.1.2 1 Name the **three** main types of carbohydrates.
- SB1 p2-3 3.1.2 2 Name **three** disaccharides, and for each one list the monosaccharides they contain.
- SB1 p3 3.1.2 3 What type of bond is formed between two monosaccharides?
- SB1 p3 3.1.2 4 What is the difference between an alpha glucose and a beta glucose molecule?
- SB1 p3-4 3.1.2 ATF 5 If you test a solution containing both glucose and sucrose, you cannot show the presence of sucrose by carrying out the non-reducing sugar test. Explain why.

Exam-style questions

- SB1 p2-5 3.1.2 ATF 6-1 Place a tick in the box if the statement applies to the specific carbohydrate. [4]

	Contains galactose	Contains alpha glucose	Contains fructose	Contains a glycosidic bond
Maltose				
Lactose				
Sucrose				
Cellulose				

Carbohydrates

- 6-2 The test for starch using iodine causes a blue/black colour to form. This happens because the iodine forms an ion that sticks inside the amylose (starch) helix as shown in Figure 2. If the starch/iodine complex is boiled, the blue/black colour disappears. Suggest why. [3]

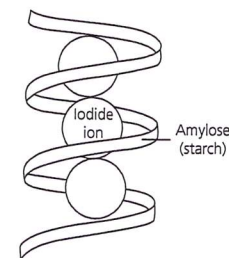


Figure 2

Total: 7

- 7 Mannan is a polysaccharide. It is a polymer of a hexose sugar, mannose. It is insoluble and forms long straight chains of mannose. It is a storage polysaccharide in some plants. It can also form side-chains, and this branched form of mannan can be found in the cell wall of some yeasts.

- 7-1 Define what a polymer is. [2]

Figure 3 shows a molecule of mannose.

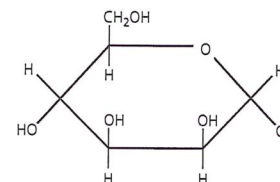


Figure 3

- 7-2 Use a diagram to show how two molecules of mannose join together. [2]
- 7-3 Name the bond formed. [1]
- 7-4 Give **one** way in which the structure of mannan is similar to the structure of cellulose and **one** way in which its structure is different. [2]

Total: 7

- SB1 p3 3.1.2 8 A student investigated the minimum concentration of glucose solution needed to produce a positive Benedict's result. Describe how the student could carry out this test using a 1 mol dm⁻³ solution of glucose. [6]
- SB1 p6-7 3.1.2
- SB1 p15 3.1.2 ATc, f

1 Biological molecules

1

2

Lipids

Quick questions

- SB1 p7 3.1.3 1 Give **two** differences between a triglyceride and a phospholipid.
- SB1 p8 3.1.3 2 A fatty acid can be represented by the formula R-COOH. What does the letter R represent?

Exam-style questions

- 3 Figure 4 shows two different fatty acids.

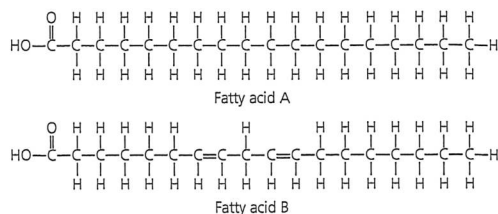


Figure 4

- 3-1 Identify which of these two fatty acids is saturated. Explain your answer. [1]
- 3-2 Olestra is a fat substitute. It is used in foods for people who are trying to lose weight. It is made from a molecule of sucrose with fatty acids attached. Its structure is shown in Figure 5. 'X' represents the positions where fatty acids are attached.

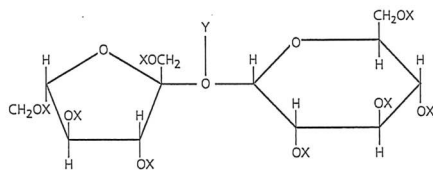


Figure 5

- Name the bond at position Y. [1]
- 3-3 Olestra is not digested in the gut. Explain why. [2]
- 4-1 Describe a test you could carry out to show that biscuits have lipids present. [3]
- 4-2 Draw a phospholipid molecule and label it to explain why it can be called a polar molecule. [3]

Total: 4

Total: 6

Proteins

Quick questions

- 1 Describe the chemical test for the presence of proteins. Describe what a positive result would be.
- 2 What type of bond is formed in the condensation reaction between two amino acids?
- 3 What is meant by the primary structure of a protein?
- 4 What type of bond allows for alpha-helices and beta-pleated sheets to form within the secondary structure of a polypeptide?
- 5 Why is the tertiary structure of a polypeptide so important?
- 6 Which bonds help to contribute to a protein's tertiary structure?
- 7 Some proteins do not have a quaternary structure. Explain why.
- 8 Use a labelled diagram to show the general structure of an amino acid.

3

1 Biological molecules

4

Proteins

Exam-style questions

- 9 Figure 6 shows the effect of substrate concentration on the rate of reaction of a particular enzyme.

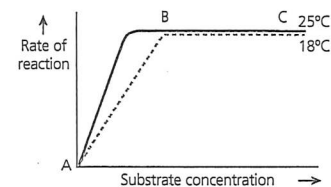


Figure 6

- 9-1 Name two variables that should have been kept constant during this investigation. [1]
- 9-2 The graph obtained at 18°C is different from the graph obtained at 25°C. Explain why the two graphs are different between A and B. [3]
- 9-3 Explain why the two graphs are the same between B and C. [2]
- 9-4 Sketch the result you would expect if the investigation was repeated at 18°C with a non-competitive inhibitor. [2]

Total: 8

- 10 Keratin is a protein that has large amounts of the amino acid cysteine in its structure.

Figure 7 shows the structure of cysteine.

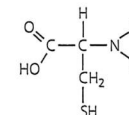


Figure 7

- 10-1 Draw a circle around the R group. [1]
- 10-2 The R group of cysteine is able to form strong bonds with cysteine elsewhere in the molecule. [1]
1. Name these strong bonds. [1]
2. Explain what makes them strong. [1]
- 10-3 Keratin is found in hair, fingernails, hooves and claws. The form of keratin in hair is a slightly more elastic form of keratin than that found in fingernails, hooves and claws. Using your understanding of protein secondary structure, suggest how these forms of keratin may differ in structure. [1]

Total: 4

SB1 p23-7 3.1.4.2 RP1

- 11 A student carried out an experiment with two different samples of amylase, enzyme A and enzyme B. The enzymes were mixed with starch and immediately placed in a water bath at 65°C. The rate of reaction was measured over 30 minutes. Figure 8 shows the results obtained by the student.

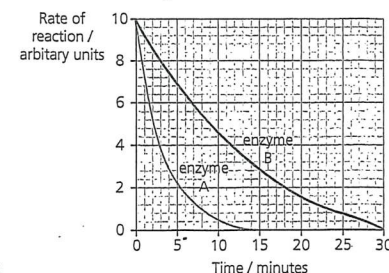


Figure 8

- 11-1 Describe the results for these two enzymes. [3]
 11-2 Use your knowledge of enzyme structure to explain these results. [2]

Total: 5

Proteins

- 12 Figure 9 shows the energy changes during the course of a specific reaction without an enzyme.

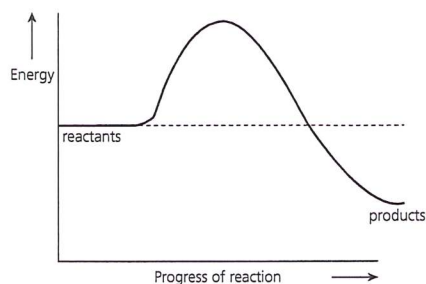


Figure 9

SB1 p20-1 3.1.4.2

- 12-1 Copy the graph and sketch a line to show the result you would expect if an enzyme was present. [2]
 12-2 On your graph, use a labelled arrow to show the activation energy when an enzyme is present. [1]

Total: 3

- 13-1 Describe the induced fit model of enzyme action. [3]

Erectile dysfunction occurs when the blood flow to the penis is insufficient for a man to maintain an erection. Sildenafil is a drug used to treat erectile dysfunction.

Figure 10 shows some of the steps involved in developing an erection.

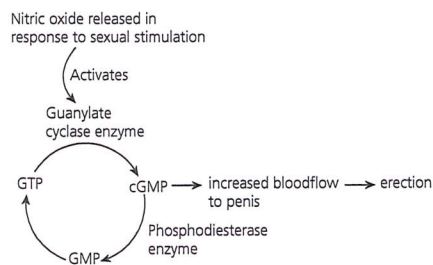


Figure 10

SB1 p27 3.1.4.2

- 13-2 Sildenafil is similar in shape to cGMP. Explain how sildenafil is effective in treating erectile dysfunction. [4]
 13-3 Suggest why sildenafil does not cause erections unless a man is sexually aroused. [1]

Total: 8

1 Biological molecules

5

6

Nucleic acids

Quick questions

- 1 Draw a diagram of a DNA nucleotide.
- 2 Explain why DNA is described as a polymer.
- 3 Which component of a nucleotide contains nitrogen?
- 4 Name the bond formed between two adjacent nucleotides.
- 5 How does a DNA molecule form a double helix?

Exam-style questions

- 6 In the 1950s two scientists carried out an investigation to show that DNA replicates semi-conservatively. They used 'heavy' nitrogen atoms that contain an extra neutron, so the atoms are very slightly heavier than normal nitrogen atoms. However, they behave exactly the same as normal nitrogen atoms.

The scientists grew *E. coli* bacteria in a medium containing heavy nitrogen atoms. This meant that all the DNA in the bacteria contained heavy nitrogen. This was called 'generation 0'.

They transferred the bacteria to a medium containing only normal light nitrogen atoms. This meant that all the new DNA formed would contain normal light nitrogen. The bacteria replicated once in this medium. This was 'generation 1'.

They allowed the bacteria to replicate a second time in this medium. This was called 'generation 2'.

The scientists sampled the DNA from each of these generations of bacteria. The extracted DNA was centrifuged and it formed bands in a test tube according to its density. Denser DNA forms a band lower down in the test tube than less dense DNA.

Figure 11 shows some possible results from this investigation.

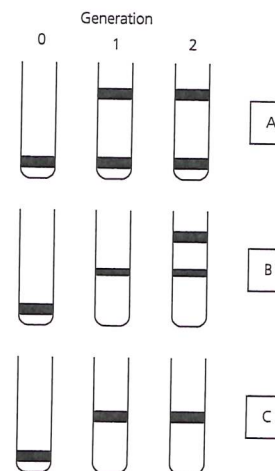


Figure 11

SB1 p77 3.1.5.2

SB1 p57-9 3.1.5.1

- 6-2 Explain which of these results shows that DNA replicates semi-conservatively. [4]
 Identify which component(s) of the DNA contains heavy nitrogen. [1]

Total: 5

- 7-1 DNA is composed of nucleotides. Identify how many nucleotides there are in the diagram of DNA in Figure 12. [1]

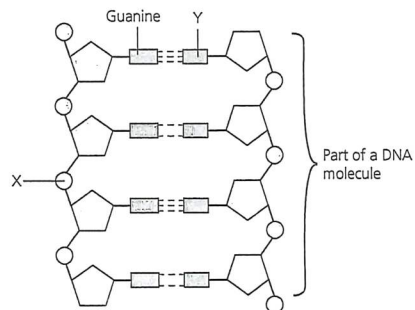


Figure 12

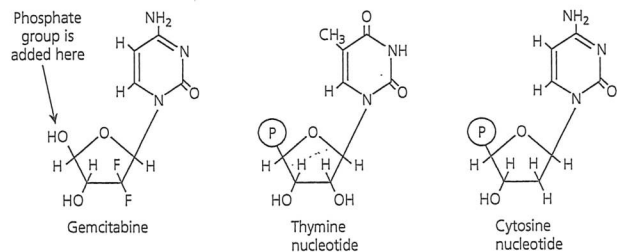
- 7-2 Name components X and Y. [1]

Total: 2

Nucleic acids

- 8 Cancer is a disease that occurs when cells replicate uncontrollably. Gemcitabine is a drug that is used to treat cancer.

Figure 13 shows gemcitabine as well as cytosine and thymine nucleotides. Gemcitabine is injected into the blood. An enzyme adds a phosphate group at the point shown.



Key: (P) = Phosphate group

Figure 13

- 8-1 Gemcitabine stops DNA replication. Explain how. [3]
- 8-2 Women who are taking gemcitabine are warned that they should not become pregnant. Explain why. [2]

Total: 5

7

8

- 9-1 Draw and label a nucleotide of RNA. [2]
- 9-2 Give three structural differences between DNA and RNA. [3]
- 9-3 Name the bond formed when two RNA nucleotides bond together. [1]
- 9-4 Scientists believe that the earliest living things had RNA as their genetic material. However, all living organisms today have DNA as their genetic material. Suggest the advantage of this. [2]

Total: 8

1 Biological molecules

TP

Quick questions

- 1 Draw and label a diagram of a single molecule of ATP.
- 2 What type of reaction resynthesises ATP from ADP and P_i ?

Exam-style questions

- 3 Give one similarity and one difference between ATP and a nucleotide in RNA. [2]
- 4 Give two functions of ATP. [2]
- 5-1 Name the enzyme that produces ATP. [1]
- 5-2 Name the products of ATP hydrolysis. [1]
- 5-3 The cells of a typical human hydrolyse 50–75 kg of ATP every day. The average body mass of a human is also 50–75 kg. At any given time, the mass of ATP in a person's body is considerably less than this. Explain how it is possible for the body to hydrolyse this amount of ATP every day. [2]

Total: 4

Water

Quick questions

- 1 Water has a number of important properties in Biology.
- For each of the following, name the property of water that explains the effect:
- a) When a dog is hot, it pants and sticks its tongue out to cool down.
- b) Some insects are able to move over the surface of the water without being immersed in water.
- c) Blood consists mainly of water. Blood transports nutrients, gases and hormones around the body.
- d) A molecule of water is used when a peptide bond is broken.
- e) The temperature of a pond fluctuated between 18 and 21°C over a period of several hours. However, the air temperature above the pond fluctuated between 15 and 25°C over the same period.
- 2 The elements in a water molecule are held together by
- A: Hydrogen bonds
- B: Covalent bonds
- C: Ionic bonds
- D: Hydrophobic bonds
- 3 Water molecules show cohesion because of which type of bond?
- A: Hydrogen bonds
- B: Covalent bonds
- C: Ionic bonds
- D: Hydrophobic bonds
- 4 Which of the following occurs because of the high surface tension of water?
- A: Water at the bottom of a lake does not freeze, even though it is very cold
- B: Water flows upwards from the roots to the leaves in plants

SB1 p183-4 3.1.6

- C: Evaporation of sweat from the body prevents overheating
D: Some insects, such as pond skaters, can walk across the surface of a pond
- 5 Water has a high specific heat capacity. Explain the main reason for this.

Exam-style questions

SB1 p183-4 3.1.6

- 6 Give **three** properties of water, and for each explain their importance to living organisms.

SB1 p183-4 3.1.6 PS2.4

- 7 **Table 1** shows the rise in temperature when aluminium and water are heated at the same rate.

Heat added/J	Temperature of aluminium/°C	Temperature of water/°C
25	22	10
50	44	17
55	80	21
100	100	26

Table 1

- 7-1 The materials were heated in identical containers. What other variable would need to be controlled in this investigation? Explain why.
- 7-2 Explain the results of this investigation.
- 7-3 Explain why the property of water you identified in Question 4 is so important to animals.

[6]

[2]

[3]

[2]

Total: 7

- 8 A student investigated whether water from a freshwater lake and water from the sea affected the properties of water. They used a large coin on a table and they counted the number of cumulative drops that could be added to the surface of the coin to form one pool without it splitting into smaller pools.

The results of the investigation can be seen in **Figure 14**.

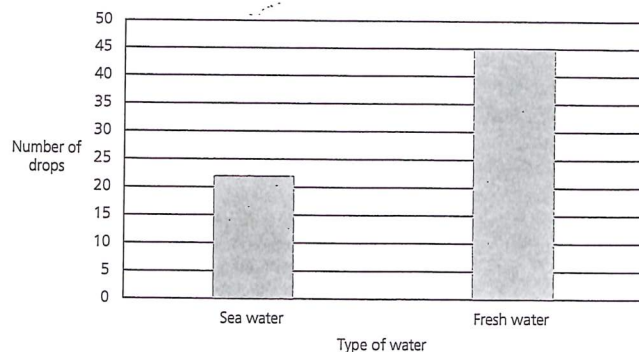


Figure 14

- 8-1 Deduce what property of water the student was investigating.
- 8-2 Describe what the results show.

[1]

[2]

Total: 3

Water

Inorganic ions

Quick questions

3.1.6

- 1 Using your understanding of the formulae $\text{pH} = -\log_{10}[\text{H}^+]$ what is the pH for the following concentrations of H^+ ?
- a) $[\text{H}^+] \text{ mol dm}^{-3} = 1 \times 10^{-4}$
- b) $[\text{H}^+] \text{ mol dm}^{-3} = 1 \times 10^{-7}$
- c) $[\text{H}^+] \text{ mol dm}^{-3} = 1 \times 10^{-2}$
- d) $[\text{H}^+] \text{ mol dm}^{-3} = 1 \times 10^{-10}$

Exam-style questions

3.1.6

- 2 Name each of the ions that has a role in the following:
- 2-1 pH
- 2-2 Haemoglobin
- 2-3 Co-transport
- 2-4 DNA and ATP

[1]

[1]

[1]

[1]

Total: 4

- 3-1 If $[\text{H}^+(\text{aq})]$ is 0.25 mol dm^{-3} , what is the pH?

Give your answer to 2dp.

[1]

- 3-2 In a solution with a pH of 4.25, calculate the concentration of $\text{H}^+(\text{aq})$.

[1]

Total: 2

Topic review: biological molecules

SB1 p14-15 3.1.2 ATc

- 1-1 A student has 1M glucose solution. Describe how she could produce a dilution series of four other concentrations of glucose solution.

[4]

SB1 p14-15 3.1.2 ATc

PS3.2

PS3.1

- 1-2 Describe how the student could then use this dilution series and colorimetric techniques to produce a calibration curve.

[5]

SB1 p14-15 3.1.2 PS3.2

- 1-3 Describe how the student could then use this calibration curve to ascertain the concentration of glucose in an unknown solution.

[2]

Total: 11

- 2 Chromatography is a technique that can be used to separate out components of a mixture. A student set up a paper chromatogram with two standard solutions containing different carbohydrates. She put a spot of each solution on the chromatography paper on the pencil line, left it to dry and suspended it in a solvent. The components of the solutions separated, as shown in **Figure 15**.

Biological molecules

9

10

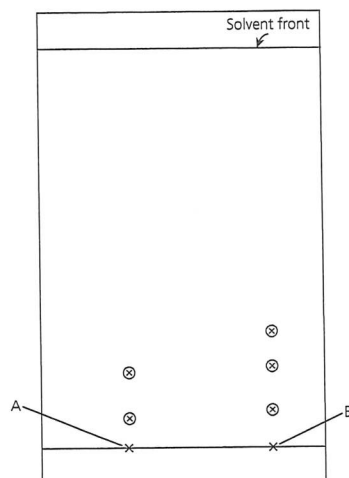


Figure 15

- SB1 p2-4, p149 3.1.2 ATg 2-1 The student drew the lines on the paper in pencil and not ink. Explain why. [1]
- 2-2 A locating agent was needed to be able to see the spots after chromatography. Explain why. [1]
- 2-3 Table 2 shows the R_f value of some sugars.

Carbohydrate	R_f value
Xylose	0.354
Galactose	0.190
Mannose	0.230
Fructose	0.291
Arabinose	0.138
Glucose	0.202
Maltose	0.069
Sucrose	0.093
Lactose	0.150

Table 2

Using Table 2 determine which carbohydrates were present in Sample A and B. [2]

Total: 4

11

1 Biological molecules

12

Figure 16 shows three different rates of reaction of Enzyme X.

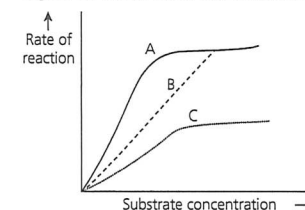


Figure 16

- SB1 p26-7 3.1.4.2 3-1 Identify which of the three lines in Figure 16 represents Enzyme X in the presence of a competitive inhibitor. Explain your answer. [3]
- 3-2 Identify which of the three lines in Figure 16 represents Enzyme X in the presence of a non-competitive inhibitor. Explain your answer. [5]
- SB1 p27-9 3.1.4.2 3-3 Explain why, in all three reactions, the rate of reaction levels off. [2]
- Total: 10
- SB1 p57-61 3.1.5.2 4-1 Describe the process of DNA replication. [7]
- SB1 p57-61 3.1.5.2 4-2 Explain why DNA replication is described as being semi-conservative. [2]
- Total: 9
- SB1 p184-5 3.1.7 5 Pond skaters are a group of insects that are able to walk on the surface of water due to surface tension. Explain what property of water plays a role in surface tension. [2]
- SB1 p56-65 3.1.6, 3.1.5.1 6 Compare and contrast the structure of ATP and a DNA nucleotide. [4]
- 7 Figure 17 shows one glycerol and three fatty acid molecules.

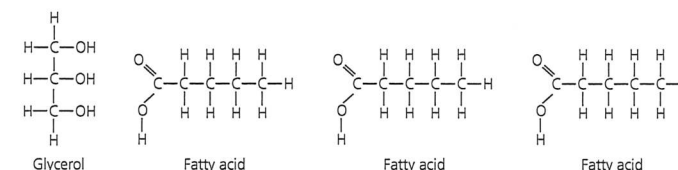


Figure 17

- 7-1 Draw a circle around the atoms that will be removed when the glycerol joins with the three fatty acid molecules. [1]
- 7-2 Name the molecule formed as a result of the joining of these four molecules. [1]
- 7-3 Give the type of reaction this is and what molecules are formed as a result. [2]
- 7-4 Name the bond formed between the glycerol and fatty acid. [1]
- 7-5 Give the type of fatty acid this is and explain how you know. [2]
- Total: 7

- 8 A student investigated the effect of temperature of an enzyme-controlled reaction. The mass of product formed was measured over 15 minutes.

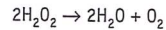
The results are shown in Table 3.

Temperature/°C	Mass of product/mg	Rate of reaction/ _____
10	5	
20	14	
30	27	
40	36	
50	23	
60	0	

Table 3

- SB1 p19-29 3.1.4.2 PS3.2 8-1 Complete the units for the 'rate of reaction' column. [1]
- 8-2 Calculate the rate of reaction and complete the table to suitable significant figures. [2]
- SB1 p19-29 3.1.4.2 PS3.1 8-3 Plot a graph to show the results in Table 3. [3]
- SB1 p19-29 3.1.4.2 8-4 Explain the result at 60°C. [6]
- SB1 p19-29 3.1.4.2 PS2.3 8-5 The student concluded that this enzyme's optimum temperature was 40°C. Evaluate this conclusion. [4]
- Total: 16**

- 9 Catalase is an enzyme found in potato cells. It breaks down hydrogen peroxide to oxygen and water.



A student investigated this reaction. The apparatus she used is shown in Figure 18. She cut three cores of potato tissue, each 4 cm long and 1 cm diameter, and placed them in the conical flask. Then she added 20 cm³ of hydrogen peroxide solution using the syringe.

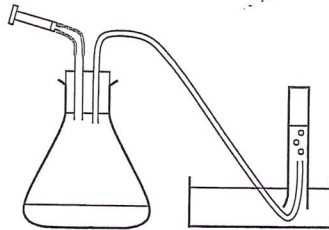


Figure 18

- SB1 p19-29 3.1.4.2 PS3.2 9-1 Describe how the student could find the rate of this reaction. [3]
- SB1 p111 3.1.4.2 PS1.11.2 9-2 The student repeated the experiment using the same volume and concentration of hydrogen peroxide solution, but this time she cut the potato cores in half before putting them into the conical flask. Describe how you would expect the results of this second experiment to be different from the first results, giving reasons for your answer. [2]
- SB1 p19-29 3.1.4.2 PS2.4 9-3 Suggest a suitable control for this investigation, explaining why it is needed. [2]
- Total: 7**

2 Cells

Cell structure

Quick questions

- SB1 p41 3.2.1.1 ATd 1 Identify the parts of the cell labelled in Figure 1.

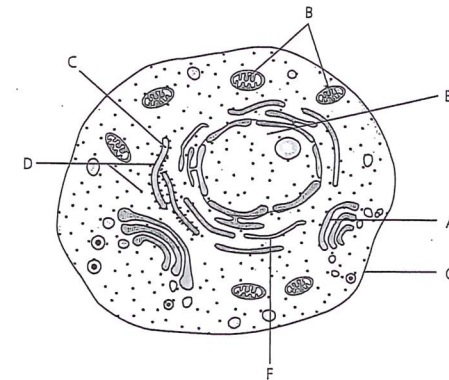


Figure 1

- 2 Copy and complete Table 1.

Structure	Function
	Synthesises proteins
	Contains hydrolytic enzymes to break down worn-out organelles
Golgi apparatus	
Smooth endoplasmic reticulum	
Chloroplast	
	Produces ATP in aerobic respiration
Rough endoplasmic reticulum	
Nucleus	

Table 1

- SB1 p51 3.2.1.2 3 Plant cells are eukaryotic. Both plant cells and prokaryotic cells have cell walls. How does a prokaryotic cell wall structure differ from a plant cell wall?
- SB1 p38 3.2.1.3 4 Electron microscopes and optical microscopes have different resolutions. Explain how their resolutions differ.
- SB1 p40 3.2.1.3 5 Cell fractionation is the process by which different components of a cell are able to be separated due to their differing densities. Name and explain the three conditions necessary for successful cell fractionation.
- SB1 p51 3.2.1.3 6 Both prokaryotes and eukaryotes possess genetic material. Give two ways in which the structure of genetic material in prokaryotes differs from that in eukaryotes.
- SB1 p50-2 3.2.1.2 Give four features that make prokaryotic cells different from eukaryotic cells.

Exam-style questions

8 Electron and optical microscopes are both used to observe cells and tissues.

8-1 Copy and complete Table 2.

Feature	Electron microscope	Optical microscope
Type of radiation		
Resolution		

Table 2

8-2 Give two advantages of using an optical microscope rather than an electron microscope.

Total: 4

9 Eukaryotic cells can become specialised in order to carry out a specific function. Describe and explain two features a specialised eukaryotic cell might have if it is adapted to carry out large amounts of active transport.

10 Table 3 lists different structures and organelles. Copy and complete the table indicating which structures might be found in a phagocyte, HIV and a bacterium.

	Phagocyte	HIV	Bacterium
Plasmid			
Ribosome			
Capsid			
Mitochondria			
RNA			

Table 3

11 Figure 2 shows a eukaryotic cell.

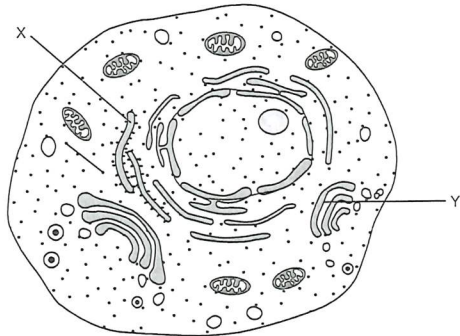


Figure 2

11-1 Identify organelles X and Y.

11-2 This eukaryotic cell is specialised to produce and secrete a large amount of a specific enzyme. Explain why it is an advantage for this cell to have a large quantity of organelles X and Y.

Total: 4

Cell structure

SB1 p51 3.2.1.3

Figures 3 and 4 show two cells. Calculate the ratio of the length of Cell A to Cell B. Note: cells are drawn to different scales.

[3]

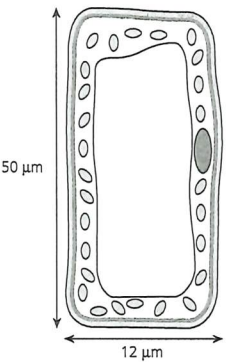


Figure 3

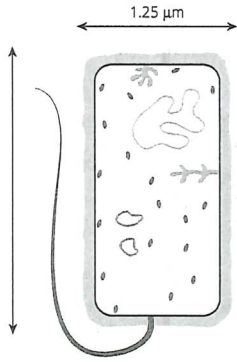


Figure 4

13 Figure 5 shows a diagram of two organelles of the same type from the same eukaryotic cell.

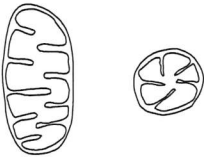


Figure 5

13-1 Identify the organelle.

[1]

13-2 Give the function of this organelle.

[1]

13-3 These organelles are the same size and shape. Explain why they appear different in this diagram.

[2]

Total: 4

14 Figure 6 is an image of red blood cells. Identify the type of microscope that was used to obtain this image. Explain your answer.

[2]

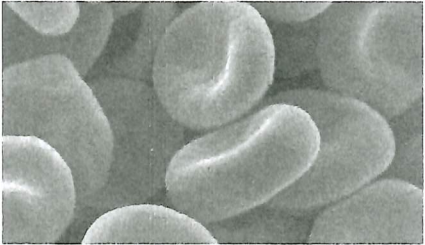


Figure 6

SB1 p41 3.2.1.1

SB1 p39 3.2.1.3

2 Cells

15

16

SB1 p40 3.2.1.3

15 A student wanted to investigate isolated mitochondria. Describe the process by which she could obtain isolated mitochondria starting with fresh liver tissue. [5]

SB1 p51 3.2.1.3 ATd

16 A student was investigating the sizes of cells of an onion using an optical microscope. [2]

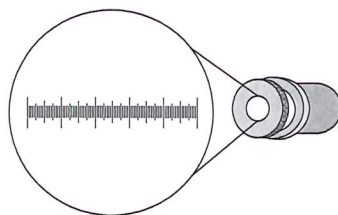


Figure 7

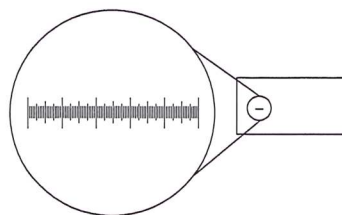


Figure 8

16-2 Describe how the student could calibrate the units on the apparatus of Figure 7. [3]

SB1 p51 3.2.1.3

16-3 The student used the equipment shown in Figures 7 and 8 to find the length of an onion cell. Give one way that the student could ensure that her measurement of cell length was reliable. [1]

Total: 6

17 Figure 9 shows a single-celled protist called *Euglena*. It lives in fresh water.

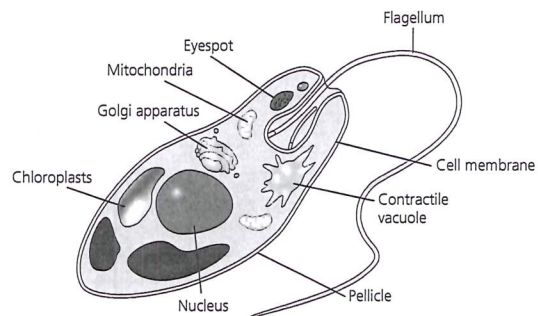


Figure 9

17-1 Give two features, visible in Figure 9, that enable you to identify this as a eukaryotic cell. [1]

SB1 p51 3.2.1.3 MS1.8

17-2 The *Euglena* cell is 40 μm long. Calculate the magnification of this diagram. [2]

SB1 p41 3.2.1.1

17-3 The contractile vacuole collects excess water from inside the cell and releases it outside the cell. Explain why this is necessary. [3]

17-4 The eyespot enables the *Euglena* to swim towards light. [1]

1. Explain the advantage of this to *Euglena*.
2. The flagellum allows the *Euglena* to swim forward, with the cell rotating all the time. Suggest how the position of the eyespot enables the *Euglena* to detect the direction of light as it swims. [2]

Total: 9

Cell structure

2 Cells

17

18

18 Figure 10 shows a goblet cell from the lining of the intestine. This cell secretes mucus. Mucus is a glycoprotein made by adding a carbohydrate chain to a protein.

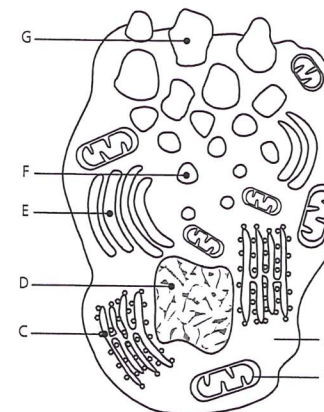


Figure 10

18-1 This cell is 20 μm in length. Calculate its magnification. Show your working. [2]

SB1 p41 3.2.1.1

18-2 Name structures B, D and E. [3]

18-3 The cytoplasm at A contains amino acids. These amino acids are used to make mucus, which is secreted from the cell. Place the appropriate letters in the correct order to show the path taken by an amino acid from the cytoplasm at A until it is secreted from the cell in mucus at G. [2]

Total: 7

19 A technician prepared a suspension of chloroplasts for an investigation. The flow chart in Figure 11 shows the method he used.

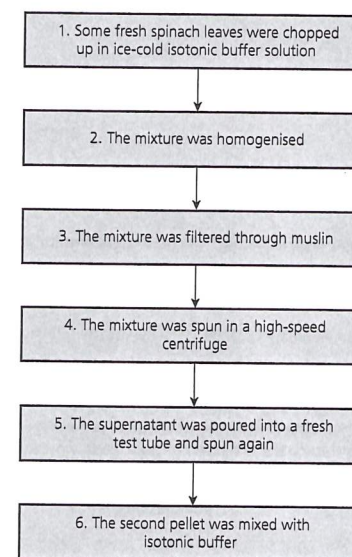


Figure 11

SB1 p40 3.2.1.3

19-1 Explain why the technician used a solution that

1. Was ice cold; [1]
2. Had the same water potential as the cells; [1]
3. Contained a buffer. [1]

19-2 1. The mixture was filtered in Stage 3. Explain why. [1]

2. The mixture was spun in a high speed centrifuge in Stage 4. Explain why. [2]

19-3 An electron microscope is required to see the detailed structure of a chloroplast, rather than an optical microscope. Explain why. [2]

Total: 8

Cell replication

Cell replication

Quick questions

SB1 p79-81 3.2.2

1 DNA replication is a crucial process that occurs in the cell cycle. During what stage of the cell cycle does the DNA replicate?

SB1 p79 3.2.2

2 One part of the cell cycle in eukaryotic cells is mitosis. Within mitosis there are a number of stages. List these stages in order.

SB1 p78-9 3.2.2

3 One of the noticeable changes at the start of mitosis is that the chromosomes become visible. Describe what happens to chromosomes in order for them to become visible.

SB1 p83 3.2.2

4 Mitosis is a carefully controlled process. Why is it so important that mitosis is a controlled process?

SB1 p82 3.2.2

5 One way in which eukaryotic and prokaryotic cells differ is the way in which they divide. How do prokaryotes divide?

Exam-style questions

SB1 p78 3.2.2

6 In Figure 12 there are two chromosomes that appear different. Describe and explain the difference between Chromosome A and B. [2]

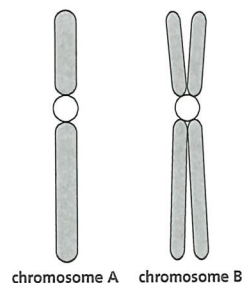


Figure 12

2 Cells

19

20

SB1 p80 3.2.2 RP2 MS0.3

8-1 Use this image to calculate the mitotic index of this tissue. Count how many cells are in mitosis. Use this number to calculate the mitotic index. [1]

8-2 Explain how the student could ensure that their calculation of mitotic index was as reliable as possible. [3]

Total: 4

SB1 p80 3.2.2

9 Lengths of cell cycles differ depending on the type of cell. If the cell cycle takes 20 hours, calculate how long it takes to complete mitosis if the mitotic index is 20%. [1]

SB1 p79 3.2.2

10 Figure 14 shows the mean distances between sister chromatids in mitosis.

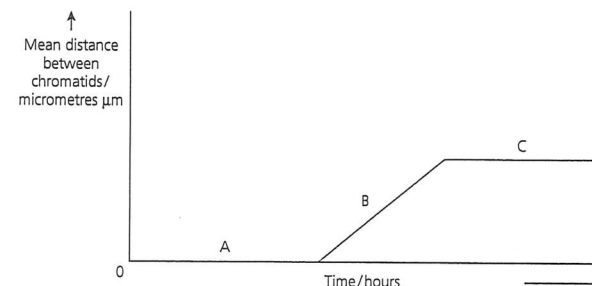


Figure 14

Describe and explain what is happening in the cell during stages A, B and C. [4]

SB1 p78-9 3.2.2

Table 4 shows a table with different stages of the cell cycle. Copy and complete the table according to the specific stage that cell is in. [3]

Stage of cell cycle	Number of chromosomes per nucleus	Mass of DNA per nucleus/au
Early interphase		50
Early prophase	46	
Late telophase		

Table 4

8 A student was examining the tip of a garlic root using an optical microscope. Figure 13 shows a field of view in an optical microscope of cells in different stages of the cell cycle.

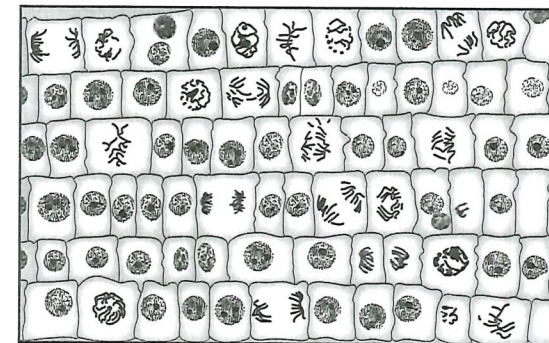


Figure 13

SB1 p81 3.2.2

- 11 Table 5 shows two different cells during their cell cycle. One way that cancerous cells can be identified is by looking at how long they spend in specific parts of cell cycle.

Identify which cells are cancer cells, A or B. Give a reason for your answer.

Stage of cell cycle	Time taken / hours	
	Cell A	Cell B
Interphase	12	8
Prophase	6	5
Metaphase	1	1
Anaphase	2	3
Telophase	1	2

Table 5

[2]

Cell replication

SB1 p79 3.2.2

- 12 Indole sulphonamide is a drug used to treat cancer. It works by stopping spindle fibres forming.

12-1 Suggest what stage in the cell cycle it would affect.

12-2 Explain why this would mean that a cancer cell would be unable to complete the cell cycle.

[1]

[2]

Total: 3

SB1 p79 3.2.2

- 13 Figure 15 shows different stages of mitosis, but in the wrong order.

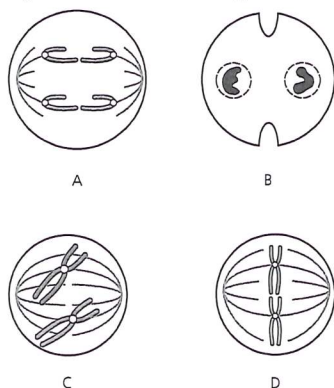


Figure 15

- 13-1 Place the stages of mitosis in the correct order, and name each stage.
13-2 Describe what is occurring in Stage D. Explain the importance of this stage.
13-3 Name the process that occurs after stage B.

[2]

[3]

[1]

Total: 6

21

2 Cells

22

SB1 p79 3.2.2

- 14-1 Name two processes that occur in a cell during interphase.

[1]

14-2 Vinblastine and fludarabine are two drugs that inhibit the cell cycle. Vinblastine inhibits the formation of spindle fibres. Fludarabine is similar in shape to an adenine nucleotide.

1. Use this information to explain how vinblastine inhibits the cell cycle.

[2]

2. Use this information to explain how fludarabine inhibits the cell cycle.

[2]

- 14-3 Figure 16 shows a cell during mitosis.

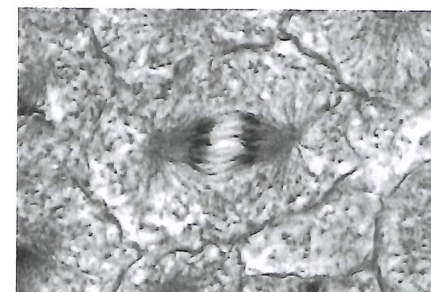


Figure 16

1. This cell is 20 μm long. Calculate the magnification of the micrograph.

[2]

2. Describe what will happen in this cell in the next stage of mitosis.

[2]

Total: 9

- 15 Figure 17 shows the time spent in each phase of the cell cycle in a specific organism.

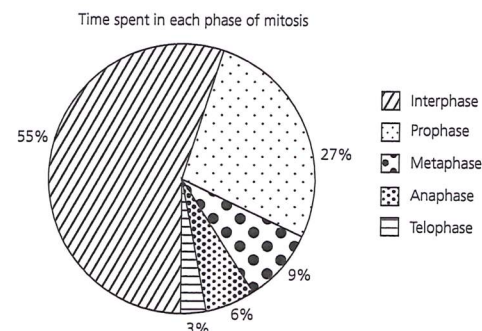


Figure 17

- 15-1 Complete Table 6 to show the stage of the cell cycle in which each event takes place.

Event	Stage of cell cycle
DNA is replicated	
New organelles are synthesised	
Nuclear membrane breaks down	

Table 6

- 15-2 Describe how a student could recognise that a cell is in metaphase.

[2]

- 15-3 One complete cell cycle lasts 34 hours in this organism. Calculate how long anaphase lasts in minutes.

[2]

Total: 7

SB1 p81 3.2.2 PS3.2

Transport across cell membranes

Quick questions

- SB1 p43-4 3,2,3
- SB1 p43-4 3,2,3
- SB1 p44-50 3,2,3
- SB1 p44-50 3,2,3
- SB1 p45 3,2,3
- SB1 p46 3,2,3
- SB1 p46-7 3,2,3
- The membranes of all organelles, including the cell surface membrane, consist mainly of one type of lipid. Name this lipid.
 - Cell membranes are flexible but need a certain amount of control in shape to retain their structure. Name the molecule present in cell membranes that restricts movement of other molecules making up the membrane.
 - The cell surface membrane is able to control what molecules can pass through it and also by what process they pass through. Name **five** ways that molecules can move across a membrane.
 - Cells are able to control the rate of movement across their cell surface membranes. One of the ways cells are adapted to do this is by increasing the surface area. Name another adaptation that would help to increase the rate of movement of ions and water soluble molecules.
 - The rate of diffusion can be affected by different factors. Give **four** factors that affect the rate of diffusion.
 - Proteins that span the phospholipid bilayer can have various roles. Name the type of transport protein that is involved only in facilitated diffusion and not active transport.
 - The phospholipid bilayer is selectively permeable and will only allow certain molecules to diffuse across it by simple diffusion. What properties would a molecule have that would make it able to cross the phospholipid bilayer by facilitated diffusion?

Exam-style questions

- 8 Figure 18 shows some structures in the phospholipid bilayer.

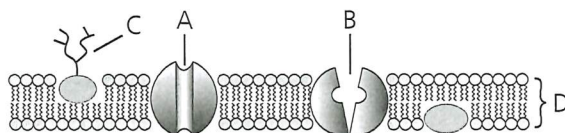


Figure 18

- 8-1 Give the letter(s) of the structure(s) that could be used for facilitated diffusion. [1]
- 8-2 Name the properties that molecules must have to pass through D. [1]

Total: 2

23

Transport across cell membranes

SB1 p45-7 3,2,3

Figure 19 shows the movement of two different molecules, A and B, across the cell surface membrane.

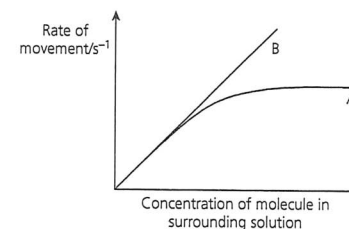


Figure 19

- 9-1 Name the process by which the molecules are moving across the membrane in each line. [1]
1. Line A [1]
2. Line B [2]
- 9-2 Describe and explain the shape of line A. [2]
- 9-3 Describe and explain the shape of line B. [2]
- 9-4 Explain which line would represent the movement of amino acids and ions. [1]
- 9-5 Explain which line would represent the movement of carbon dioxide. [1]

Total: 8

- 10 A student investigated how alcohol affects the permeability of cell membranes using beetroot.
- He used a cork borer to take samples of beetroot. He used the same beetroot for all the samples.
 - He placed different concentrations of alcohol in different test tubes.
 - He placed three equal-sized pieces of beetroot in each test tube for 20 minutes.
 - At regular intervals he stirred the samples.
 - After 20 minutes he removed the beetroot discs.
 - The student was able to see varying shades of red in the alcohol as the pigment had leaked out of the beetroot.

- 10-1 Describe how the student could measure the amount of pigment that had leaked out of the cells into the alcohol. [3]
- 10-2 Describe how the student could use this data to estimate the concentration of an unknown alcohol solution that has been treated with beetroot in the same way as the known concentrations of alcohol. [4]
- 10-3 The student stirred the tubes of alcohol containing beetroot at regular intervals. Explain why. [1]
- 10-4 1. The test tubes of containing alcohol and beetroot were kept at a constant temperature. Explain why. [2]
2. Describe how the student could ensure that the temperature remained constant. [2]

Total: 12

2 Cells

24

SB1 p47 3,2,3 ATb

SB1 p47 3,2,3 ATb
PS3.1

SB1 p47 3,2,3

SB1 p47 3,2,3 PS2.4

SB1 p47 3,2,3

SB1 p45-7 3,2,3

- 11 A student was investigating water potential in a carrot.
- She set up a series of dilutions of sucrose solution.
 - She cut equal-sized pieces of carrot from the same carrot and recorded their mass.
 - She placed each piece in a different concentration of sucrose solution for one day.
 - After one day she removed the pieces of carrot from the solutions and blotted them dry before measuring the mass again.

The results for this experiment can be found in Table 7.

Concentration of sucrose solution/mol dm ⁻³	Initial mass of carrot/g	End mass of carrot/g	Ratio of end mass to initial mass
1.2	3.2	2.8	
1.0	3.1	2.9	
0.8	3.2	3.0	
0.6	3.3	3.2	
0.4	3.3	3.6	
0.2	3.4	3.8	

Table 7

- SB1 p47-9 3.2.3 PS3.2 11-1 Copy and complete Table 8. Data should be to two decimal places. [1]
- SB1 p47-9 3.2.3 PS2.1 2.4 11-2 Explain why it was necessary to ensure that:
1. The pieces were from the same carrot. [2]
 2. The pieces were the same size and dimensions. [2]
 3. The mass of each piece was measured before and after. [2]
 4. The pieces were blotted dry before the end mass was measured. [1]
- SB1 p47-9 3.2.3 11-3 A solution of starch would not be appropriate in this investigation. Explain why. [2]
- SB1 p47-9 3.2.3 PS 3.1 RP3 11-4 Give a way that the student could use the results to find the water potential of the carrot tissue. [1]
- SB1 p47-9 3.2.3 11-5 Describe and explain the results. [6]
- SB1 p47-9 3.2.3 ATc 11-6 Describe how the student would create 100 cm³ of each dilution of sucrose, using 2M sucrose solution. [1]
- SB1 p47-9 3.2.3 PS3.1 11-7 Describe and explain how the student could find the sucrose solution that has the same water potential as the carrot. [2]
- SB1 p43 3.2.3 12 Explain why the cell surface membrane is described as fluid mosaic. [2]
- SB1 p47-9 3.2.3 13 Table 8 shows the concentration of ions in seawater and in the cytoplasm of a single-celled alga that lives in seawater. [2]

Total: 20

Sample analysed	Ion concentration/mg dm ⁻³	
	Sodium	Potassium
Cytoplasm	0.11	0.50
Seawater	0.49	0.01

Table 8

- SB1 p47-9 3.2.3 PS1.2 13-1 1. Explain how potassium ions enter the cells of the alga. [2]
2. Explain how you could test whether your answer to 13-1-1 was correct. [4]
- 3.2.3 13-2 Give one role of sodium ions in living organisms. [1]

Total: 7

Cell recognition and the immune system

Quick questions

- SB1 p89 3.2.4 1 Name the type of white blood cell involved in the non-specific immune response.
- SB1 p90 3.2.4 2 Define an antigen.
- SB1 p91 3.2.4 3 Name the protein produced by B-cells that is able to bind to an antigen.
- SB1 p93 3.2.4 4 Name the cell that is able to stimulate both the humoral and cell-mediated response.
- SB1 p92 3.2.4 5 What are phagocytes able to do once they have engulfed and ingested a pathogen?
- SB1 p99 3.2.4 6 Name structures A, B and C on Figure 20.

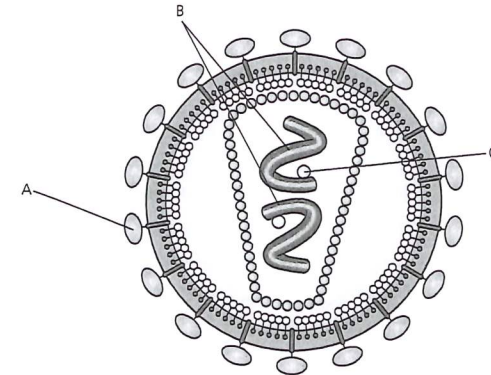


Figure 20

- SB1 p102 3.2.4 7 Name two uses of monoclonal antibodies.
- SB1 p100 3.2.4 8 Explain why HIV only infects helper T cells.

Exam-style questions

- 9 Describe the role of phagocytes in an immune response. [4]
- 10 Describe the role played by helper T cells that leads to agglutination of pathogens. [5]
- 11 People suffer from infections like colds and flu multiple times, but rarely suffer from infections such as chickenpox more than once in their life time. Use your understanding of antibodies and antigens to explain why. [5]
- 12 Figure 21 shows the changes in antibody concentration in the blood between a primary and secondary immune response when a person is exposed to a pathogen for the first and second time.

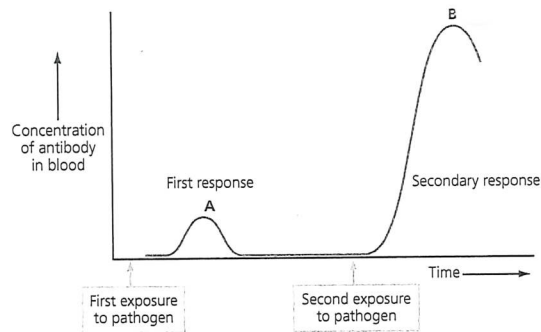


Figure 21

12-1 Describe the pattern shown on the graph. [3]

12-2 Explain the pattern shown on the graph. [2]

Total: 5

13-1 Define 'herd immunity'. [1]

13-2 Explain why herd immunity gives some protection to people who have not been vaccinated. [2]

Total: 3

14 HIV only infects helper T cells. Use your understanding of proteins and the structure of cell surface membranes to explain why. [2]

15 Figure 22 shows one method used to treat cancer. It involves the use of monoclonal antibodies in a technique called ADEPT (antibody-directed enzyme prodrug therapy).

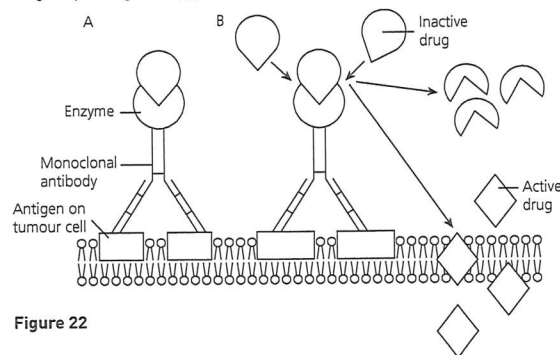


Figure 22

The monoclonal antibody has an enzyme attached. The antibody binds to antigens on the cancer cell. This is shown as stage A.

In stage B, an inactive prodrug is given to the patient. The enzyme converts the prodrug to an active cytotoxic drug that enters the cancer cell.

- 15-1
1. The monoclonal antibody binds only to cancer cells. Explain how. [2]
 2. Explain the advantage of using monoclonal antibodies to treat cancer. [2]
 3. There is a time delay between stage A and B to allow any antibodies that have not bound to cancer cells to be broken down so that they are no longer present in the blood. Explain why. [2]

16-2 The monoclonal antibody used in this process is produced using mouse cells. Suggest a possible disadvantage of this for the cancer patient. [3]

Total: 9

16 Figure 23 shows the Human Immunodeficiency Virus (HIV).

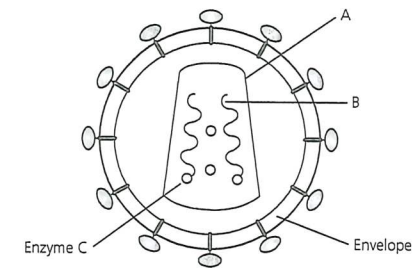


Figure 23

16-1 1. Name structures A and B. [2]

2. Describe the importance of enzyme C. [2]

Antibodies can be used to test whether a person is infected with HIV. People who are infected with HIV have antibodies against the virus in their blood. Figure 24 shows how one kind of test works.

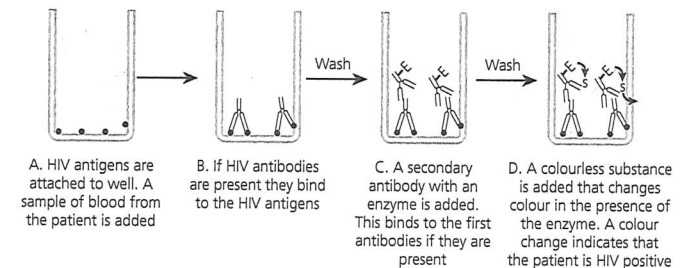


Figure 24

- 16-2
1. It is important that the well is washed between stages B and C and between stages C and D. Explain why. [3]
 2. Explain why it is necessary to use a secondary antibody with an enzyme and a substrate that changes colour in the presence of the enzyme. [2]
- 16-3 There will be no colour change if a patient does not have HIV antibodies in their blood. Explain why. [2]

Total: 11

Topic review: cells

- 1 Beetroot contains a coloured pigment that is stored inside the cells within a membrane. Scientists investigated the effects of two different alcohols on the permeability of beetroot membrane.

The scientists cut cylinders of beetroot with a cork borer and sliced them into 3 mm discs. They washed the discs thoroughly with tap water then placed them in Petri dishes each containing 10 cm³ of medium with ten discs. They used three different media:

- 10% methanol
- 10% butanol
- Control

The scientists sampled the media in the dishes using a colorimeter at various intervals. **Figure 25** shows the results.

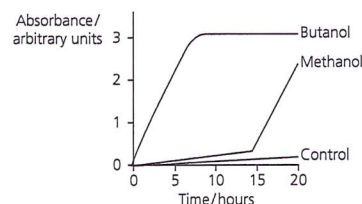


Figure 25

- SB1 p47 3.2.3 PS2.1 PS2.4 RP4
- 1-1 Explain why the discs were washed thoroughly with tap water before use. [1]
- 1-2 Explain why it was important that the beetroot discs were identical in size and shape. [2]
- 1-3 The dishes were kept at a constant temperature during the investigation. Explain why. [1]
- 1-4 It was important that each Petri dish contained the same volume of medium. Explain why. [1]
- 1-5 Suggest what the control medium should be. [1]
- 1-6 Explain why the control investigation was necessary. [2]
- SB1 p47 3.2.3 ATc
- 1-7 Describe how the colorimeter should be used to obtain the absorbance readings shown. [3]
- SB1 p47 3.2.3
- 1-8 Describe the results shown in **Figure 25**. [3]
- 1-9 Suggest an explanation for the effects of alcohol on the permeability of beetroot membrane. [2]
- 1-10 The scientists decided to conduct a statistical test to determine whether the difference in permeability of beetroot membrane when treated with butanol and methanol is significant. Give an appropriate hypothesis. [1]
- SB1 p78 3.2.2
- 2-1 A scientist investigated mitosis in onion root tips. She found that some cells contained 8.2 units of DNA, and others contained only 4.1 units of DNA. Explain why. [4]

Total: 17

Topic review: cells

2 Cells

29

30

Figure 26 shows some information about the chromatids in a cell that was dividing by mitosis.

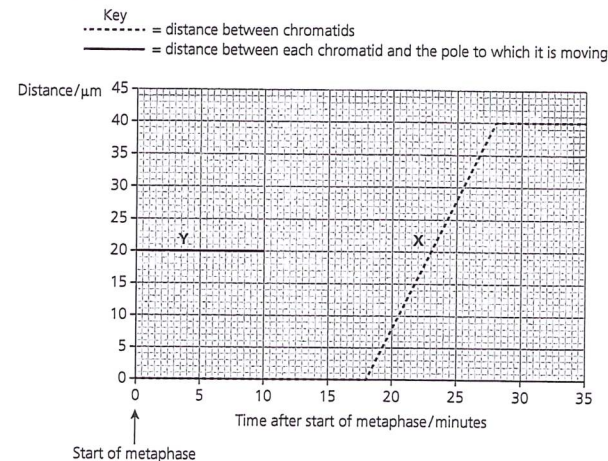


Figure 26

- 2-2 How long did metaphase last in this cell? [1]
- 2-3 Describe what happened in this cell between 18 and 28 minutes. [2]
- 2-4 Complete line Y. [2]

Total: 9

- 3 Penicillin is an antibiotic that kills bacteria. It can be used to treat bacterial infections in humans. Some bacteria are able to produce the enzyme penicillinase. This hydrolyses penicillin so that it is no longer effective.

- 3-1 Define hydrolysis. [1]

Figure 27 shows the structure of penicillin and another substance called clavulanic acid.

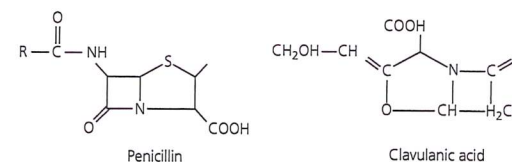


Figure 27

- 3-2 If clavulanic acid is given to a patient with penicillin, the penicillin is effective at killing bacteria that produce penicillinase. Use the diagram to explain why. [4]
- Penicillin prevents the cross-linking of small peptide chains in peptidoglycan, the polymer that is needed to make new cell walls in bacteria.
- 3-3 Penicillin stops new cell walls forming but does not affect old cell walls. Explain why. [1]
- 3-4 Penicillin does not damage human cells. Explain why. [1]
- 5 Explain how penicillin kills bacteria. [3]

Total: 10

- 4 The Papuan Taipan is a snake that produces very poisonous venom. It can kill a person within 30 minutes of biting them.

It is possible to make antivenom containing antibodies specific to Papuan Taipan venom. If this antivenom is injected into the person very quickly after the snake bite, they can make a full recovery.

SB1 p90-103 3.2.4

- 4-1 The antivenom is specific to the Papuan Taipan venom and not any other snake venom. Explain why. [2]

The antivenom is made by extracting venom from the snake then diluting it. A very small amount of the diluted venom is injected into an animal, such as a horse. A few weeks later, a little more venom is injected. This is repeated several times. The antivenom is made by taking blood from the horse and extracting the antibodies.

- 4-2 The venom is injected several times, rather than just once. Explain why. [2]

SB1 p94 3.2.4

- 4-3 If a person is treated with this antivenom it will not protect them against a future bite by the same snake. Explain why. [2]

- 4-4 The antivenom cannot be used on the same person a different time. Explain why. [3]

Total: 9

- 5 In the 1960s, Dr Lynn Margulis proposed the endosymbiotic theory to explain the origin of some organelles in eukaryotic cells.

She proposed that a primitive cell engulfed an aerobic bacterium by phagocytosis about 2.5 billion years ago. Over millions of years this engulfed aerobic bacterium became a mitochondrion.

SB1 p41 3.2.1.2

- 5-1 A mitochondrion has a double membrane around it. Explain how this information supports Dr Margulis's theory. [2]

SB1 p37-41 3.2.1.2

- 5-2 Mitochondria have their own DNA and ribosomes. The structure of these also supports Dr Margulis' theory. Explain how their structure supports Dr Margulis' theory using your knowledge of prokaryotic and eukaryotic cells. [3]

SB1 p41 3.2.1.2

- 5-3 Name **one** feature that all prokaryotes have that is not found in a mitochondrion. [1]

- 5-4 Mitochondria divide by binary fission in the same way as bacteria. Describe this process. [2]

Total: 8

- 6 Figure 28 shows a yeast cell. Yeast is a fungus.

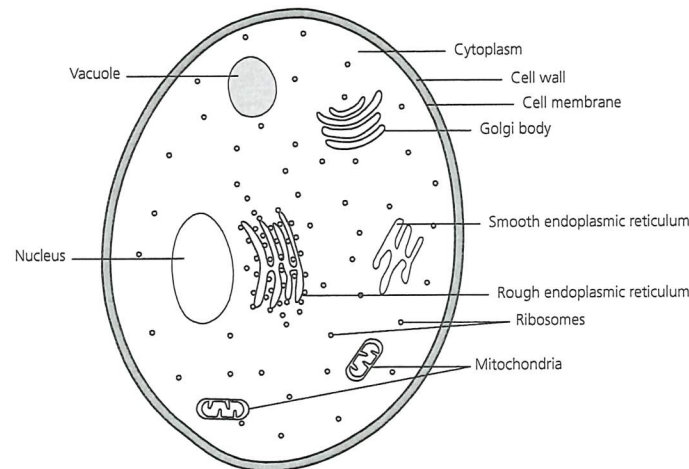


Figure 28

SB1 p41 3.2.1.2 ATb

- 6-1 Give **two** features that enable you to identify this as a eukaryotic cell. [1]

2 Cells

31

32

One way to estimate the number of cells in a liquid culture is to use a special slide called a haemocytometer. This has a grid etched on it. The depth of the grid, when the cover slip is placed on the slide, is exactly 0.1 mm. A student placed a sample of a yeast cell suspension on a haemocytometer and viewed it under the microscope. Figure 29 shows a typical square on the grid.

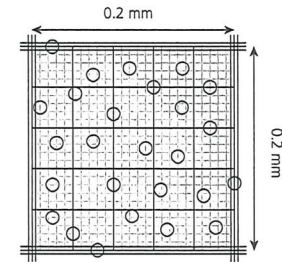


Figure 29

The cells in a typical square can be counted. If a cell is touching the middle line of the three lines on the north and west sides of the square, it is counted. If it is overlying the middle line on the east and south of the square, it is not counted.

Assume that this square is typical of all the squares on the grid. Use this to calculate the number of yeast cells in 1 mm³ of the suspension. Show your working. [2]

- 6-3 The yeast suspension the student placed on the slide was a 10⁻³ dilution of the original culture. Determine how many yeast cells were in 1 mm³ of the original culture. [1]

- 6-4 The cells touching the north and west sides are counted, but not those cells touching the east and south sides. Suggest why. [1]

Total: 5

- 7 Figure 30 shows a bacterial cell.

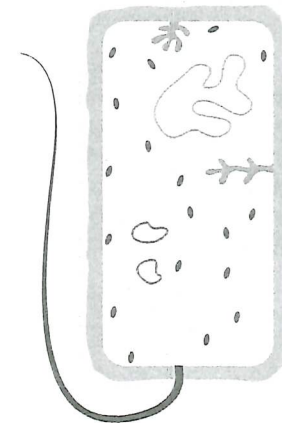


Figure 30

- 7-1 Name **two** features shown in this diagram that would not be found in every prokaryotic cell. [1]

- 7-2 Name **two** features shown in this diagram that would also be present in a eukaryotic cell. [1]

SB1 p41 3.2.1.2

- 7-3 The bacterial cell wall is made of murein. The structure of murein is shown in Figure 31.

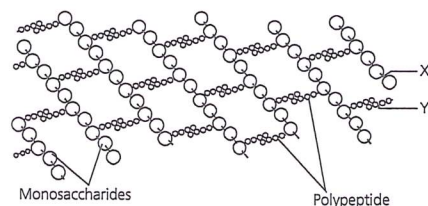


Figure 31

Name the bonds represented by X and Y.

[1]

- 7-4 Name the reaction that forms bond Y.

[1]

In some older textbooks, diagrams of bacterial cells show an infolding of the cell surface membrane labelled a mesosome. This was thought to have a function in bacterial respiration. However, when a different technique was used to prepare specimens for electron microscopy, mesosomes were not seen.

- 7-5 Mesosomes are now described as artefacts in bacterial cells. Explain what this means.

[2]

Total: 6

- 8 Table 9 gives some descriptions of organelles in an animal cell.

Structure	Description
A	A series of membranes with spaces between them and ribosomes present on the outside
B	A double-membraned structure. The outer membrane is smooth and the inner membrane highly folded.
C	A membrane-bound structure that is roughly spherical. It contains hydrolytic enzymes.

Table 9

- 8-1 Name structures A, B and C.

[3]

- 8-2 Give two advantages of using an optical microscope to study cells, rather than an electron microscope.

[2]

A student used an eyepiece graticule to measure a cell. It was 6 eyepiece units long. Then she used a stage micrometer to calibrate the eyepiece graticule. Figure 32 shows the eyepiece graticule and the stage micrometer.

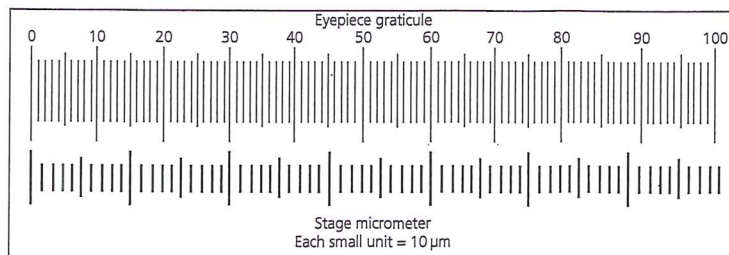


Figure 32

- 8-3 Use Figure 32 to calculate the length of the cell in millimetres. Show your working.

[3]

Total: 8

- 9 Sometimes a patient's blood is tested to see if they have enough red and white blood cells. Until fairly recently, this was done using a blood pipette.

Figure 33 shows a red blood cell pipette.

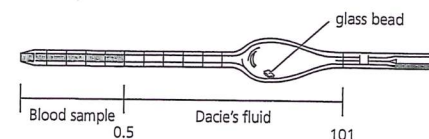


Figure 33

A scientist used this pipette to dilute a blood sample so that the number of red blood cells in a sample could be counted.

- The scientist filled the pipette with blood up to the 0.5 mark.
- Then he filled the pipette with a fluid called Dacie's fluid up to the 101 mark. This meant the blood was diluted 200 times.
- The scientist then allowed the first few drops of the mixture to run into a beaker to be discarded.
- He then used the diluted sample to find the concentration of red blood cells in the sample.

- 9-1 Dacie's fluid has the same water potential as blood plasma. Explain why this is important.

[1]

- 9-2 Suggest the function of the glass bead in the pipette.

[1]

- 9-3 The scientist discarded the first few drops of the mixture. Explain why.

[1]

- 9-4 The scientist found that the mean number of cells in 0.004 mm^3 of the mixture was 10. Calculate the number of red blood cells in 1 mm^3 of the original blood sample. Show your working.

[3]

Figure 34 shows a white blood cell pipette.

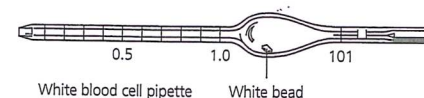


Figure 34

- The scientist filled the pipette with blood to the 0.5 mark.
- He added diluting fluid to the 1.0 mark. This diluting fluid causes red blood cells to burst, but white blood cells remain intact.
- He mixed the blood sample and the diluting fluid together. This gave a dilution of 20 times.
- He let a third of the mixture in the pipette run into a beaker to be discarded, then he counted the number of white blood cells. There were three cells in 0.1 mm^3 of the mixture.

- 9-5 Calculate the number of white blood cells in 1 mm^3 of the original blood sample. Show your working.

[2]

- 9-6 It was important that the diluting fluid caused the red blood cells to burst. Explain why.

[2]

Total: 10

3

Exchange of substances

Surface area to volume ratio

Quick questions

- SB1 p109 3.3.1
- SB1 p110-11 3.3.1
- SB1 p110 3.3.1
- 1 What is the primary function of gas exchange in animals?
 - 2 What is the relationship between the size of an organism and its surface area to volume ratio?
 - 3 Larger organisms need specialised gas exchange organs, but single-celled organisms like *Chlamydomonas* do not. Explain why.

Exam-style questions

- 4 A student investigated how surface area to volume ratio affected the rate of diffusion using agar blocks containing indicator. The agar blocks were cut into cubes of varying sizes and were then placed in acid. The time taken for the entire block to change colour was recorded. The student repeated the investigation three times for each block.

Their results are shown in Table 1.

Length of side of cube/cm	Volume of agar block/cm ³	Surface area of agar block/cm ²	Surface area to volume ratio	Mean time taken for diffusion/s
1				80
2				150
3				230
4				450
5				710

Table 1

- SB1 p111 3.3.1
- SB1 p111 3.3.1
- 4-1 Copy and complete Table 1 to show the volume, surface area and surface area to volume ratio for the agar blocks. [3]
 - 4-2 Describe the relationship between size of the cube and its surface area to volume ratio. Use values to support your answer. [2]
 - 4-3 This investigation helps to show why single-celled organisms can rely on simple diffusion across their surface membrane for gas exchange, but larger organisms cannot. Explain how. [3]

Total: 8

35

Surface area to volume ratio

Gas exchange

Quick questions

- SB1 p115 3.3.2
- 1 Figure 1 shows the human gas exchange system. Identify the labelled structures A-F.

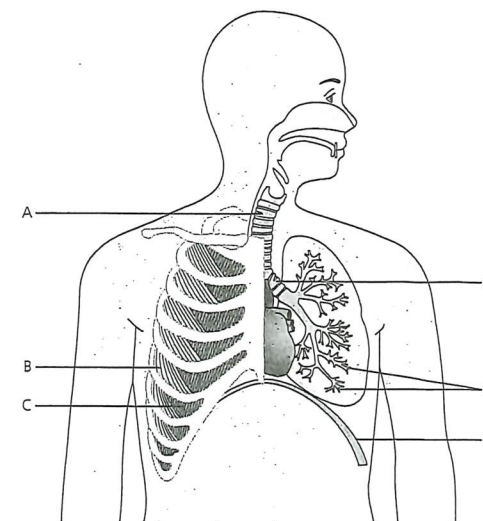


Figure 1

- SB1 p113 3.3.2
- SB1 p114 3.3.2
- SB1 p116-17 3.3.2
- SB1 133 3.3.2
- 2 Terrestrial insects have an exoskeleton that is fairly rigid and coated with a waxy substance. This makes their surface waterproof, which is important to ensure they do not dry out. However, this means that gas exchange through simple diffusion through the body surface, such as with single-celled organisms, is not possible. Describe how insects have evolved to overcome this.
 - 3 The blood system in the lamellae of fish gills is arranged to allow water to flow in the opposite direction to the blood flow. Name this process and explain why it is an advantage to the fish.
 - 4 In the lungs of humans, each bronchiole ends in a cluster of alveoli. The alveoli are surrounded by a network of capillaries. Explain how a good blood supply ensures that gas exchange in the lungs is efficient.
 - 5 Xerophytes are plants that live in conditions where there is very little fresh water. They have evolved adaptations to deal with this lack of water. Give five ways in which xerophytes can be adapted.

Exam-style questions

- SB1 p111-13 3.3.2
- 6 Insects have evolved to have a series of openings leading to a network of tubes that are able to transport oxygen to their tissues and organs around their body.
 - 6-1 Describe the pathway of oxygen from the surrounding air to the cells, naming the structures that are involved. [3]

Exchange of substances

3

36

- 6-2 During times of vigorous movement, such as flying, changes occur at the ends of the tracheoles. **Figure 2** shows these changes. Describe and explain these changes, and explain why it is advantageous for this to happen during flight. [3]

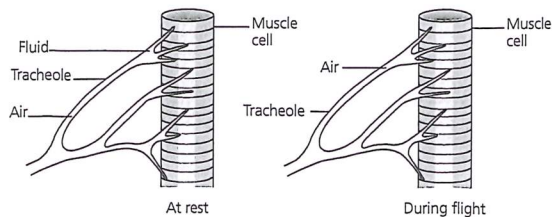


Figure 2

- 6-3 Explain how these changes occur. [2]
6-4 Explain the advantage of these changes when an insect is very active. [2]

Total: 10

- 7 **Figure 3** shows the structure of a single gill.

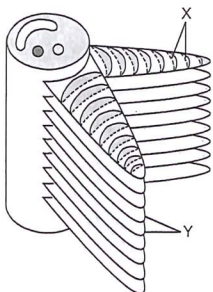


Figure 3

- 7-1 Identify X and Y. [2]
7-2 Explain how this arrangement of the gills is an adaptation for efficient gas exchange. [2]
7-3 **Figure 4** shows the flow of water and blood in a gill filament. The numbers indicate the relative concentration of oxygen in the water and in the blood. Explain how this ensures efficient gas exchange between the blood and the water. [4]

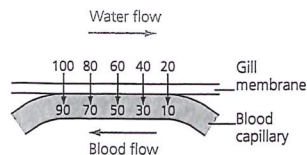


Figure 4

Total: 8

- 6-2 During times of vigorous movement, such as flying, changes occur at the ends of the tracheoles. **Figure 2** shows these changes. Describe and explain these changes, and explain why it is advantageous for this to happen during flight. [3]

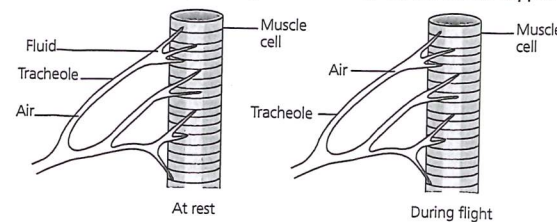


Figure 2

- 6-3 Explain how these changes occur. [2]
6-4 Explain the advantage of these changes when an insect is very active. [2]

Total: 10

- 7 **Figure 3** shows the structure of a single gill.

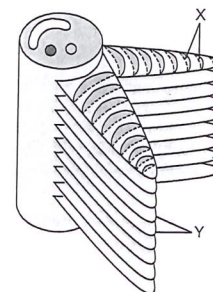


Figure 3

- 7-1 Identify X and Y. [2]
7-2 Explain how this arrangement of the gills is an adaptation for efficient gas exchange. [2]
7-3 **Figure 4** shows the flow of water and blood in a gill filament. The numbers indicate the relative concentration of oxygen in the water and in the blood. Explain how this ensures efficient gas exchange between the blood and the water. [4]

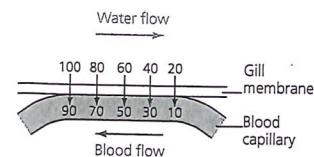


Figure 4

Total: 8

Figure 8 shows the rate at which air is expelled from the lungs in a healthy person and a person with emphysema.

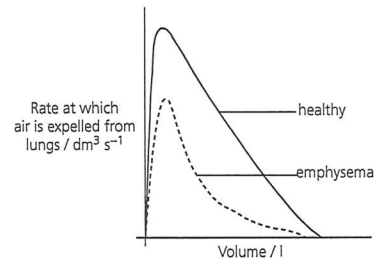


Figure 8

- SB1 p116 3.3.2 9-2 There are differences in the way air is expelled from healthy lungs and from lungs with emphysema. Use Figure 8 to identify two of these differences. [2]
- SB1 p116 3.3.2 PS 3.1 9-3 Use Figure 8 to explain the difference in the rate at which air is breathed out between the healthy person and the person with emphysema. [4]
- Total: 7

10 Figure 9 shows the changes in breathing rate and depth of breathing of a person as they change the activity that they are doing.

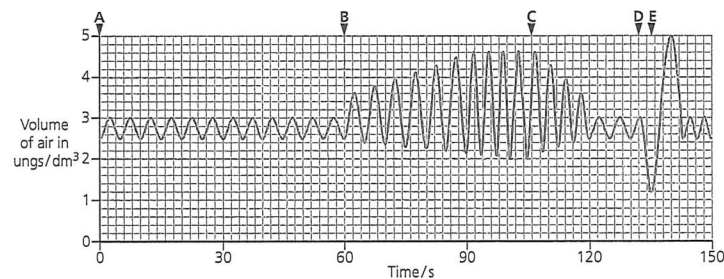


Figure 9

- SB1 p122 3.3.2 PS3.2 10-1 Calculate the pulmonary ventilation rate (PVR) of this person when they are at rest. [2]
- SB1 p122 3.3.2 10-2 Between B and C the person is exercising. Explain the changes that occur in their breathing. [3]
- Total: 5
- SB1 p122 3.3.2 PS3.1 11 Figure 10 shows the relative pressure changes in the alveoli during inspiration and expiration. Figure 11 shows the volume of air in the lungs.

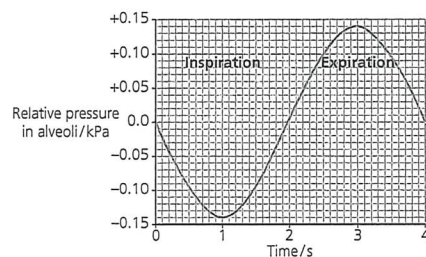


Figure 10

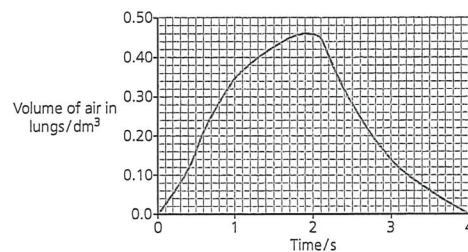


Figure 11

Describe and explain the relationship between the two graphs. [4]

Gas exchange

3 Exchange of substances

39

40

Figure 12 shows the main components of the circulatory system of a frog. A frog has two gas exchange surfaces: its skin and its lungs.

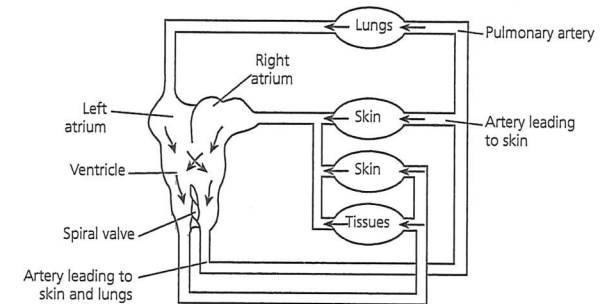


Figure 12

Scientists carried out an investigation to find out how much gas exchange occurs through the skin and the lungs in a frog during a dive. Their results are shown in Figure 13.

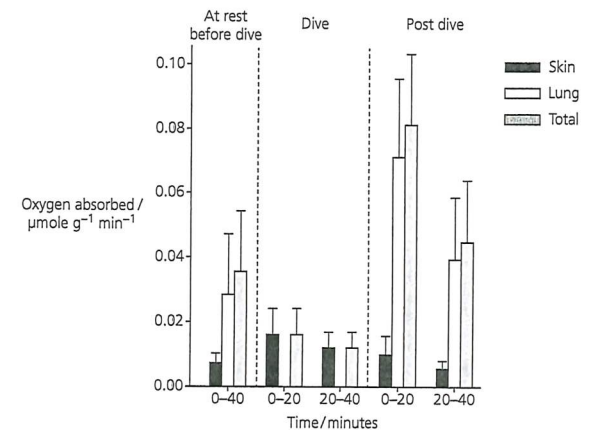


Figure 13

- SB1 p115 3.3.2 12-1 Gas exchange was measured per gram of body mass. Explain why. [2]
- SB1 p109 3.3.2 12-2 1. Describe the relative importance of the lungs and skin in gas exchange when a frog is at rest. [2]
2. Gas exchange through the skin increases during a dive. Use Figure 12 and your own knowledge of circulatory systems to suggest how this occurs. [3]
- SB1 p109 3.3.2 PS3.2 3.3 12-3 1. Total gas exchange falls during the dive and increases considerably after the dive. Explain why. [3]
2. The scientists calculated the standard deviation of their measurements. Explain why. [2]
- SB1 p166 3.3.2 12-4 A mammalian heart is more efficient than that of an amphibian. Explain why. [2]
- SB1 p166 3.3.2 PS3.2 12-5 A scientist measured the gas exchange in a resting frog. Table 2 shows the results.

Gas exchange surface	Gas exchange $\mu\text{mol g}^{-1} \text{h}^{-1}$
Skin	0.34
Lungs	1.80

Table 2

Calculate the percentage of gas exchange that is occurring through the skin. Show your working.

[2]

Total: 16

SB1 p114 3.3.2

- 13-1 There is a counter-current flow system in the gills of a fish. This achieves efficient gas exchange. Explain how.

[2]

- 13-2 Table 3 shows data for different kinds of marine fish.

Fish	Activity level	Mass/g	Number of filaments	Total filament length/mm	Secondary lamellae per mm	Gill area/mm ² g ⁻¹
Toadfish	Slow	305	656	4 752	11.0	151
Tautog	Intermediate	466	1 580	12 537	19.0	450
Mackerel	Active	226	2 814	19 271	29.4	1 040

Table 3

The gill area is measured in mm² per gram of fish. Explain why mm² per gram is used.

[2]

SB1 p114 3.3.2

- 13-3 Describe and explain the relationship between the activity level of the fish and the data for the filaments and lamellae.

[3]

SB1 p114 3.3.2 PS3.2

- 13-4 A fish has a mass of 260 g. It needs 4580 mg of oxygen per kg of body mass per day. The water contains 8.93 mg of oxygen per dm³. Assume that the fish gills absorb 70% of the dissolved oxygen from the water. Calculate the volume of water in dm³ that passes through the fish gills in one hour to supply the fish with the oxygen it needs. Show your working.

[3]

SB1 p114 3.3.2

- 13-5 The value you calculated in 13-4 would be higher if the temperature was increased by 3°C. Give two reasons why.

[2]

Total: 12

SB1 p113 3.3.2

- 14 Fireflies are insects that are active at night. They are able to produce light signals using ATP. This is called bioluminescence. They use this in their courtship behaviour.

Fireflies have light organs that are surrounded by tracheoles. Organs inside the tracheoles contain chemicals that will produce bioluminescence but only in the presence of oxygen. Figure 14 shows the light-producing organs and the tracheoles when a firefly is not producing light, and the same structures when light is being produced.

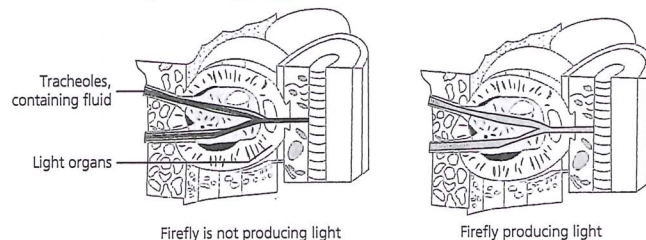


Figure 14

- 14-1 Describe the changes that occur in the tracheoles when the firefly is producing light.

[1]

- 14-2 Explain how these changes help the firefly to produce light.

[3]

Total: 4

- 15 Birds that live in cold environments, such as certain species of duck, may spend a long time standing on ice. This means they can lose a great deal of body heat through their feet. It is important that blood flow is maintained to the cells in their feet or the cells will die.

41

3 Exchange of substances

42

Gas exchange

Figure 15 shows the position of the artery and vein in a duck's foot. The artery and vein run very close to each other. There are sphincter (ring) muscles that control blood flow.

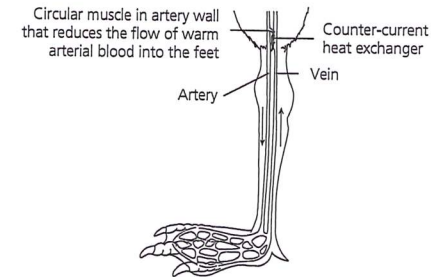


Figure 15

SB1 p114 3.3.2

- 15-1 Explain how the circular muscle in the artery enables the duck to lose as little body heat as possible when standing on ice.

[2]

Table 4 shows the changes in temperature in both blood vessels of a duck.

Distance down leg/cm	Temperature of blood in artery/°C	Temperature of blood in vein/°C
0	37	36
4	29	28
6	22	21
8	15	15

Table 4

- 15-2 Use your understanding of the counter-current system and the information given in Figure 15 and Table 4 to explain how birds are able to use this mechanism to be able to survive in such cold climates.

[4]

Birds, such as ducks, need a high rate of respiration to stay warm. This means they need to take in plenty of oxygen. Figure 16 shows the gas exchange system of a bird. The arrows show the flow of air through the respiratory system.

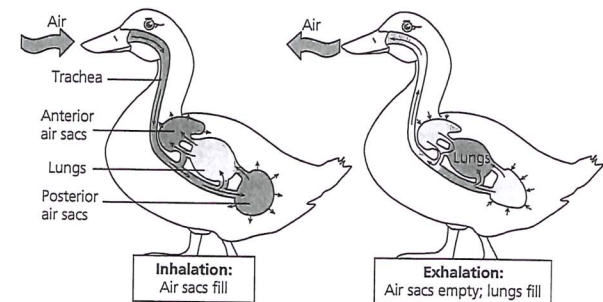


Figure 16

- 15-3 The gas exchange system of a bird is more efficient at extracting oxygen from inhaled air than the human gas exchange system. Explain how.

[2]

- 15-4 The lungs of a bird are filled with tiny tubes called parabronchi through which air flows. The parabronchi have many capillaries in their lining. Explain how the presence of parabronchi improves the efficiency of gas exchange.

[1]

Total: 9

SB1 p116 3.3.2

Digestion and absorption

Quick questions

- SB1 p141 3.3.4
- 1 Explain why it is necessary for food to be digested in order to be absorbed into our body.
- SB1 p142 3.3.4
- 2 Digestion of carbohydrates occurs in two parts of the digestive system. Describe the role of enzymes in digesting starch into glucose.
- SB1 p147 3.3.4
- 3 Describe the role played by endopeptidases, exopeptidases and dipeptidases in the digestion of proteins.

Exam-style questions

- SB1 p148 3.3.4
- 4-1 Explain the role played by sodium ions in the movement of amino acids from the gut lumen into the blood capillaries. [4]
- 4-2 Explain the effect a respiratory inhibitor would have on amino acid absorption. [2]
- Total: 6
- SB1 p147 3.3.4
- 5 Snakes can kill prey by producing venom. Snake venom consists of proteins that act as toxins and enzymes. Snake venom kills prey when it is inserted directly into the bloodstream or tissues. Ingesting or swallowing snake venom is not harmful. Suggest why. [3]
- 6 Figure 17 shows the human digestive system.

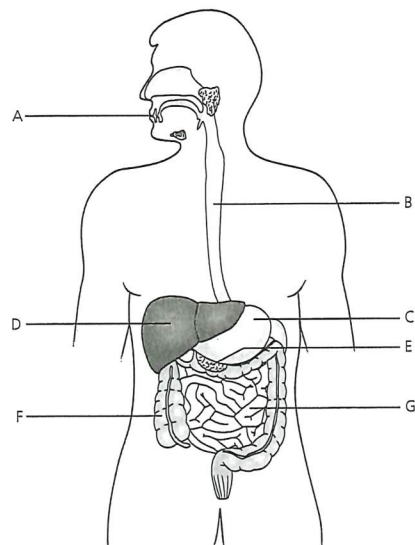


Figure 17

- SB1 p141 3.3.4
- 6-1 Copy and complete Table 5 with the relevant letter(s). The first one is done for you. [4]

Description	Part(s) of digestive system
Food is chewed into smaller pieces and swallowed here	A
Produces amylase	
Most digested food molecules are absorbed here	
Produces bile	
Produces lipase	

Table 5

43

3 Exchange of substances

44

SB1 p150 3.3.4

- 6-2 Some people have their gall bladder removed because of medical problems. After surgery they may be advised to avoid very high fat foods. Suggest why. [3]
- 6-3 Coeliac disease is a condition that causes damage to the villi. The villi are significantly reduced in size and some may disappear completely. People who develop coeliac disease may experience fatigue and unexpected weight loss. Explain why. [4]

Total: 11

Mass transport

Quick questions

- SB1 p161 3.3.4.1
- 1 Explain why haemoglobin is said to have a 'quaternary structure'.
- SB1 p161 3.3.4.1
- 2 Figure 18 shows the oxygen dissociation of three different animals. Explain why it is necessary for different animals to have haemoglobin that has different affinities for oxygen.

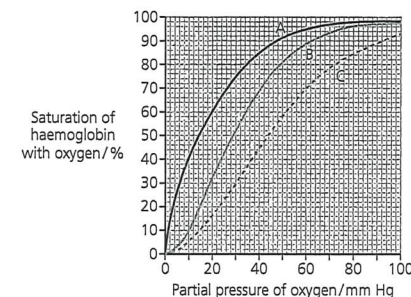


Figure 18

SB1 p166 3.3.4.1

- 3 A diagram of the human heart is shown in Figure 19. Identify the structures labelled A-H.

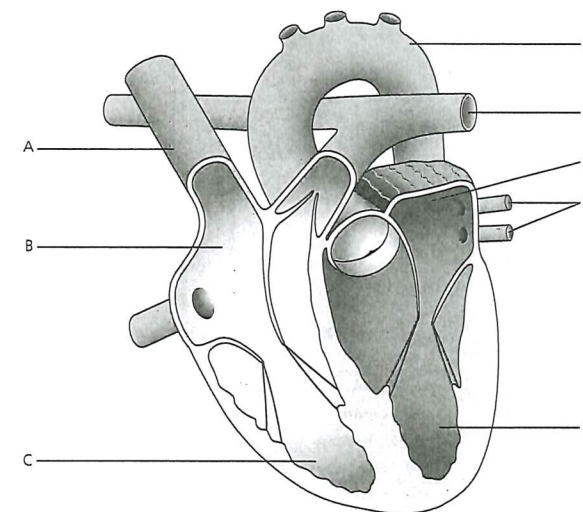


Figure 19

SB1 p170 3.3.4.1

- 4 Table 6 shows the different stages in a cardiac cycle. Name each stage, and copy and complete the table.

	Stage A	Stage B	Stage C
Atria			Relaxed
Ventricles	Relaxed		
Semi-lunar valves		Open	
Atrio-ventricular valves	Open		

Table 6

SB1 p162 3.3.4.1

- 5 Figure 20 shows the dissociation curve for human haemoglobin.

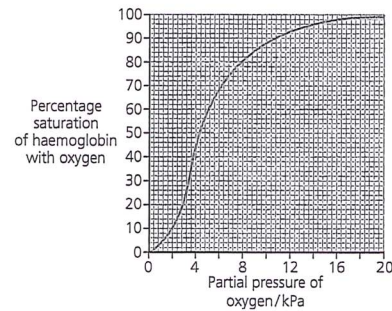


Figure 20

- a) Describe how the dissociation curve would change when a greater concentration of carbon dioxide is present and what this effect is called.
 b) The partial pressure of oxygen in the liver is 4 kPa. What percentage of oxygen is released by the haemoglobin at the liver?

SB1 p182 3.3.4.2

- 6 Describe the movement of water through a plant.

- 7 Transpiration is a passive process.

- a) What does the term passive mean?

SB1 p182 3.3.4.2

- b) Describe the properties of water that enable transpiration to occur.

SB1 p185 3.3.4.2

- 8 Figure 21 shows a section of phloem tissue. Identify the structures labelled A–C.

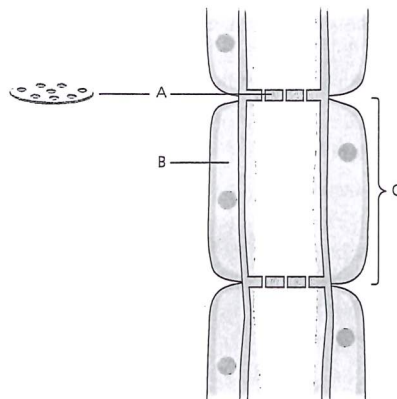


Figure 21

Mass transport

SB1 p186–7 3.3.4.2

- 9 The part of a plant that is considered to be a source or sink can change depending on the season. In the growing season (generally spring and summer), sinks are the actively growing parts of the plant such as new leaves. Sinks are the sugar storage locations, such as roots, tubers and bulbs. If the plant loses its leaves at the end of the growing season, these roots, tubers or bulbs are considered sources at the start of the next growing season. Explain why.

Exam-style questions

SB1 p155 3.3.4.1

- 10 Figure 22 shows a basic plan of the circulatory system of a mammal. Identify the blood vessels A, B, C, D, E, F.

[3]

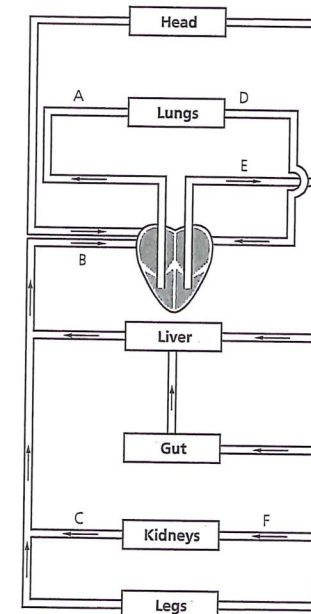


Figure 22

3 Exchange of substances

SB1 p155–7 3.3.4.1

- 11 Arteries and veins carry out different roles within our bodies. Describe and explain how their structures relate to their function.

[5]

SB1 p157 3.3.4.1

- 12 A capillary lumen is estimated to be around 8 μm . A red blood cell's diameter is approximately 6.2–8.2 μm . Figure 23 shows the cross-section of a capillary. Use the information provided and the diagram to describe two features that adapt the capillary for rapid and efficient diffusion.

[4]

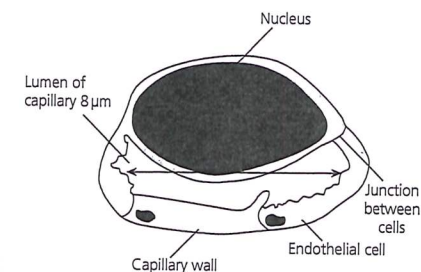


Figure 23

45

46

- 13 The structure of capillaries is extremely important in allowing them to be an exchange surface throughout an organism. It is because of their structure that tissue fluid is able to be formed. The lymphatic system also plays an important role in returning substances from tissue fluid to the circulatory system.

Figure 24 shows the relationship between the mass of molecules and the permeability of the capillaries and lymph vessels.

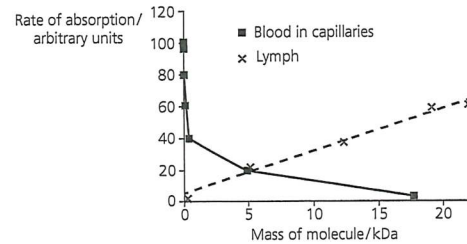


Figure 24

SB1 p158 3.3.4.1

- 13-1 Describe the relationship shown in Figure 24. [3]
- 13-2 1. There are valves in the lymph vessel. Suggest why these are important. [1]
2. Lymph vessels in legs are between muscles. People who walk more have faster flow of lymph in their legs. Explain why. [2]
- 14 A fetus obtains its supply of oxygen from its mother, via the placenta. Fetal haemoglobin is different from adult haemoglobin. Figure 25 shows the oxygen dissociation curves of adult and fetal haemoglobin.

Total: 6

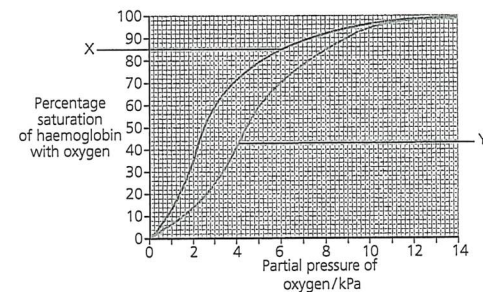


Figure 25

SB1 p164 3.3.4.1

- 14-1 Identify which line represents fetal haemoglobin. Give a reason for your answer. [1]
- 14-2 Explain the advantage of fetal haemoglobin having a different dissociation curve from maternal haemoglobin. [3]
- 14-3 At birth, the amount of fetal haemoglobin present in a baby's blood falls quite rapidly, and is replaced with adult haemoglobin. Suggest the advantage of this. [2]

Total: 6

47

48

- 15 Figure 26 shows the changes in pressure in the left side of the heart, in the atrium, ventricle and aorta.

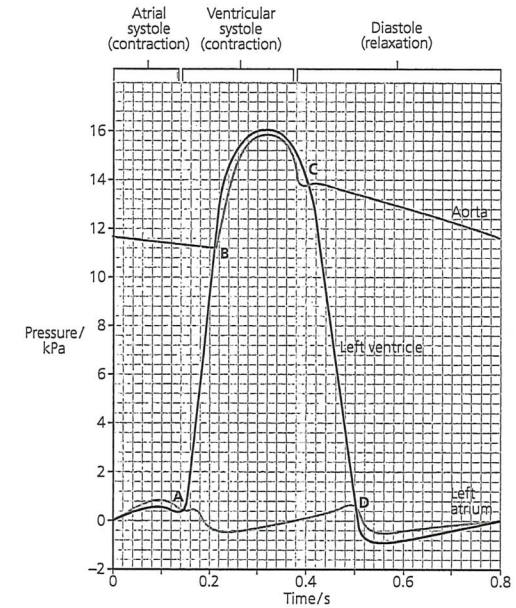


Figure 26

SB1 p171 3.3.4.1

- 15-1 For each of the points, A, B, C and D, identify which valves are open and which are closed. Give a reason for each of your answers. [5]
- 15-2 Copy and complete Figure 26, sketching a line to represent the pressure changes in the right ventricle. [2]
- 16 Figure 27 shows the relationship between transpiration and water uptake for one plant over a day.

Total: 7

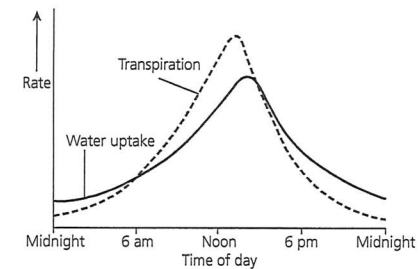


Figure 27

SB1 p182 3.3.4.1

SB1 p182 3.3.4.1

- 16-1 Describe the relationship between water uptake and transpiration. [2]
- 16-2 Explain the relationship between water uptake and transpiration. [6]

Total: 8

- 17-1 Describe the role of hydrogen ions in the process of translocation. [4]
- 17-2 Explain how sucrose is transported from the sieve tubes at the source to the sink. [3]
- 17-3 Figure 28 shows an investigation into the process of translocation. The investigators used a technique called ringing. This is when the outer tissues of the stem are removed including the phloem leaving only the xylem intact. The ring was removed below the lowest leaf on the plant. The second drawing shows the results after one day.

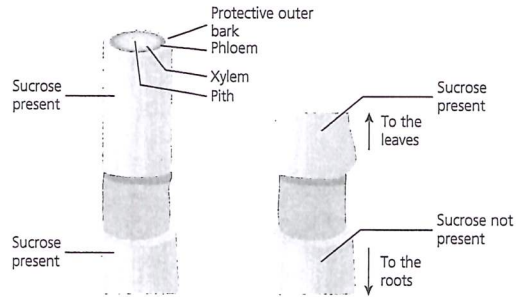


Figure 28

Explain how this investigation gives evidence that sucrose is transported in the phloem.

[3]

Total: 10

- 18 Figure 29 shows the gills of a lugworm. Lugworms live in burrows on sandy beaches. They obtain oxygen from seawater when the sand is covered by the tide. The burrow has two openings. Seawater enters by one opening and leaves by the other, circulated by movements of the lugworm's body.

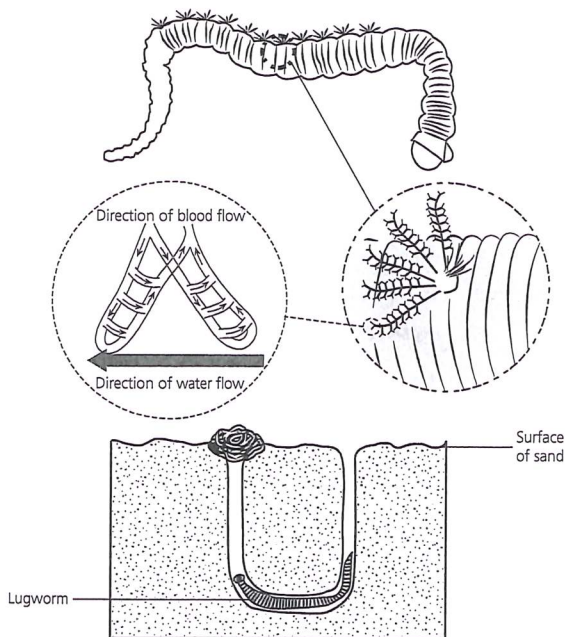


Figure 29

49

3 Exchange of substances

50

- 18-1 The blood in the lugworm's gills and the seawater flow in different directions. Explain the advantage of this to the lugworm. [3]
- 18-2 When the tide goes out, the lugworm's burrow is filled with air rather than seawater. Air contains a much higher concentration of oxygen than seawater. However, the lugworm is unable to absorb significant amounts of oxygen from air. Use information in Figure 29 to explain why. [3]
- 18-3 Figure 30 shows the oxyhaemoglobin dissociation curve for a lugworm and a human.

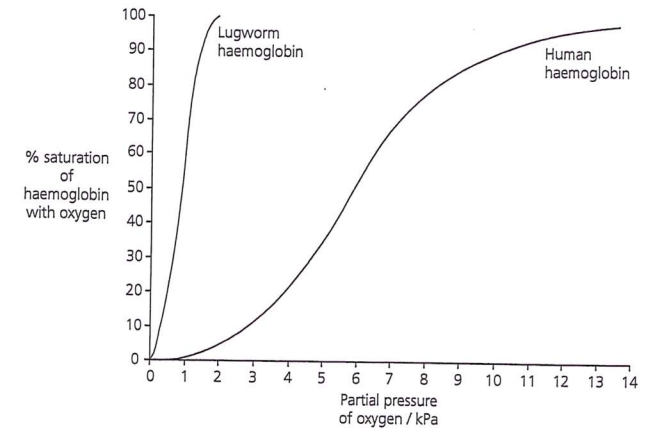


Figure 30

1. Describe how lugworm haemoglobin is different from human haemoglobin. [2]
2. Explain the advantage to the lugworm of having this kind of haemoglobin. [4]

Total: 12

- 19 Figure 31 shows the volume changes in the left ventricle of the heart during two cardiac cycles.

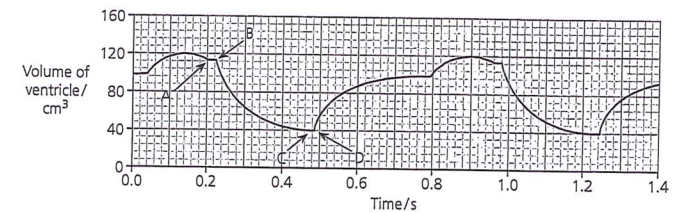


Figure 31

- 19-1 Between which times is the ventricle contracting? Give the evidence from the graph to support your answer. [2]
- 19-2 Use Figure 31 to calculate the volume of blood pumped per minute by the left ventricle. Show your working. [2]
- 19-3 From Figure 31, state which of the times, A, B, C or D, is when
- the semi-lunar valve opens. [1]
 - the atrio-ventricular valve closes. [1]

Total: 6

20 Figure 32 shows how tissue fluid is formed and returned to the blood system.

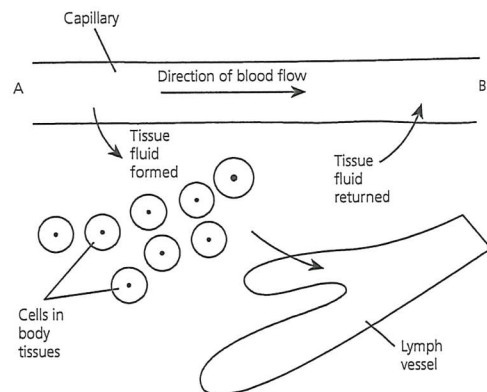


Figure 32

SB1 p158 3.3.4.1

- 20–1 Tissue fluid is forced out of the capillary at A. Explain how. [2]
- 20–2 1. The water potential of the blood at B is lower than the water potential of the body tissues. Explain why. [2]
2. Describe how tissue fluid is reabsorbed at B. [2]
- 20–3 1. A diet that is very low in protein can result in kwashiorkor. Children with this condition have enlarged abdomens caused by accumulation of tissue fluid. Explain how. [3]
2. Filariasis occurs when a parasitic worm blocks the lymph vessels in the leg. This causes accumulation of tissue fluid in the leg. Explain how. [1]

Total: 10

Topic review: exchange of substances

- 1 Figure 33 shows the results from an experiment where a plant was ringed. This is when the outer tissues of the stem are removed including the phloem, leaving only the xylem intact. Radioactive carbon dioxide was used.

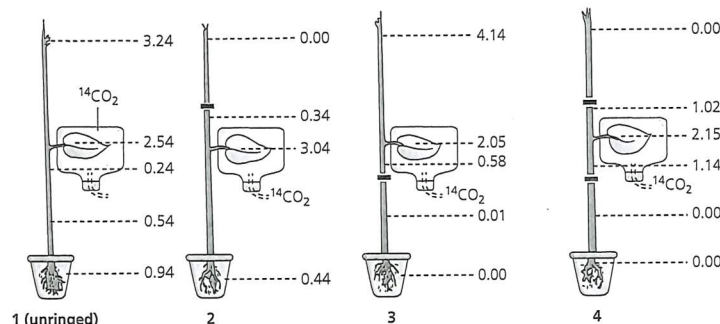


Figure 33

SB1 p185 3.3.4.1

- 1–1 Explain the importance of investigation 1. [2]
- 1–2 Explain why it was important that the carbon dioxide contained radioactive carbon atoms. [2]

51

3 Exchange of substances

SB1 p188 3.3.4.1

- 1–3 The scientists were very careful not to damage the xylem tissue when carrying out the investigation. Explain why. [2]
- 1–4 Explain what investigations 2, 3 and 4 show about the process of translocation. [2]

Total: 8

- 2 Figure 34 shows a human heart.

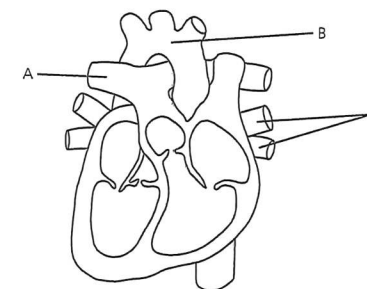


Figure 34

Name structures A, B and C. [3]

- 3 The circulation of a fetus is different from the circulation of the baby after it is born. Some of the differences are:
- the ductus arteriosus connects the aorta with the pulmonary artery
 - the foramen ovale is a hole between the right and left atria

- 3–1 Explain the advantage to the fetus of:

1. The ductus arteriosus [3]
2. The foramen ovale. [1]

A human fetus also has a different kind of haemoglobin. Figure 35 shows the oxygen dissociation curve of fetal haemoglobin and adult (mother's) haemoglobin.

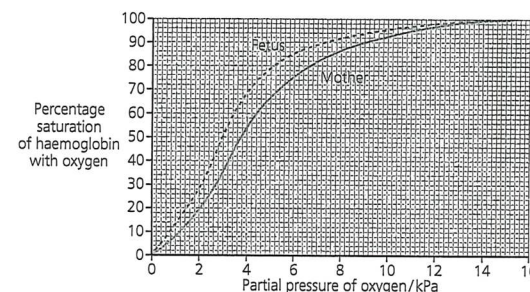


Figure 35

SB1 p162 3.3.4.1 PS3.1

- 3–2 1. Calculate the difference between the percentage saturation of fetal haemoglobin and the mother's haemoglobin when the partial pressure of oxygen is 4 kPa. [1]

SB1 p162 3.3.4.1

2. Explain the advantage to the fetus of having this type of haemoglobin. [3]

Total: 8

52

4 Figure 36 shows the pressure changes during one cardiac cycle.

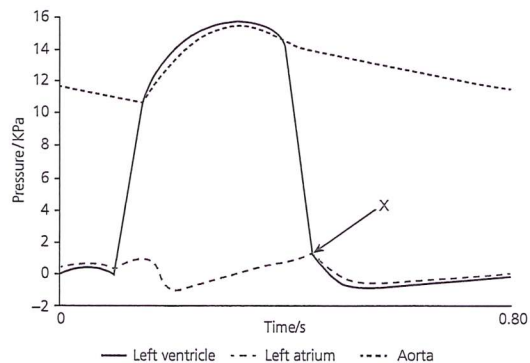


Figure 36

SB1 p171 3.3.4.1

4-1 Copy and complete the diagram, using an arrow and the letter Y to label the time when the semi-lunar valves open.

[1]

4-2 Use an arrow and the letter Z to label the time when the atrioventricular valves close.

[1]

4-3 Describe and explain what happens at point X in the diagram.

[3]

SB1 p173 3.3.4.1 PS3.2

4-4 1. Sketch a line to show the pressure in the right ventricle during this cardiac cycle.

[2]

2. Calculate the heart rate of this person. Show your working.

[1]

Total: 8

5 Phloem tissue transports organic molecules between sources and sinks.

5-1 Explain what is meant by a source.

[1]

5-2 Explain what is meant by a sink.

[1]

5-3 Explain how the following features adapt the cells to their function.

1. Companion cells have a large number of mitochondria in their cytoplasm.

[2]

2. Sieve tubes have very few cell contents.

[2]

Total: 6

6 Figure 37 shows some features of different kinds of blood vessel.

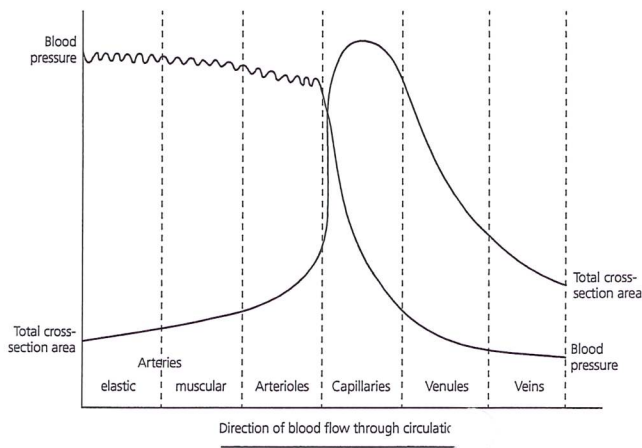


Figure 37

53

3 Exchange of substances

54

SB1 p155 3.3.4.1

6-1 Use Figure 37 to explain why:

1. the blood pressure in the arteries fluctuates slightly [2]

2. the total cross-sectional area of the veins is higher than that of the arteries [2]

3. the blood pressure in the capillaries falls rapidly. [2]

6-2 Table 7 gives the roles of blood vessels. Copy and complete the table with the names of the blood vessels. [4]

Role	Name of blood vessel
Carries oxygenated blood from the lungs to the heart	
Carries oxygenated blood away from the heart	
Carries deoxygenated blood away from the kidneys	
Carries oxygenated blood to the heart muscle	

Table 7

7 Scientists wanted to study the causes of coronary heart disease (CHD). They studied the death rate from CHD in men aged 55–64 years in 40 different countries. They also measured the mean intake of cholesterol and saturated fat in the diets of men in each country. This was calculated as a cholesterol saturated fat index (CSI) per 1000 kcal of food intake. A kcal is a unit of energy in food.

Total: 10

The results are shown in Figure 38.

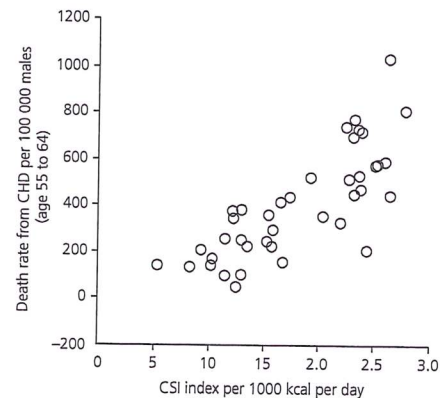


Figure 38

SB1 p175 3.3.4.1 PS1.2

7-1 The scientists calculated the cholesterol and saturated fat consumed per 1000 kcal of food intake. Suggest why. [2]

SB1 p175 3.3.4.1 PS2.3, 2.1

7-2 A journalist saw these results and wrote an article entitled 'High cholesterol in your diet causes coronary heart disease'. Evaluate this conclusion. [6]

Total: 8

4

Genetics, variation and diversity

DNA, genes and chromosomes

Quick questions

- SB1 p62 3.4.1
- SB1 p62 3.4.1
- SB1 p62 3.4.1
- SB1 p62 3.4.1
- SB1 p62 3.4.1
- One way in which eukaryotic DNA differs from prokaryotic DNA is that it is associated with proteins. Explain what this means.
 - List the **two** functions of a gene.
 - The genetic code is described as being universal, non-overlapping and degenerate. Explain what these **three** terms mean.
 - Much of the DNA in a eukaryote is non-coding. Some of this DNA is in the form of introns. What is an intron?
 - What name is given to the position of a particular gene on a chromosome?

Exam-style questions

- SB1 p62 3.4.1
- 6-1 Table 1 shows different properties that DNA might possess. Copy and complete the table. [3]

Type of DNA	Circular	Linear	Associated with proteins	Possesses introns
Eukaryotic DNA				
Prokaryotic DNA				
Mitochondrial DNA				

Table 1

- 6-2 Name **one** other organelle that has its own DNA. [1]
- 6-3 In eukaryotic cells DNA is described as being associated with proteins. Explain what this means. [1]
- 6-4 Describe **two** ways in which an ATP molecule differs from a nucleotide in a DNA molecule. [2]
- Total: 7**
- 7 Scientists were investigating a gene that consisted of 3.9×10^5 base pairs.
- 7-1 Calculate the maximum number of amino acids that this gene codes for. Give your answer in standard form. [2]
- 7-2 The actual number of amino acids is much lower than the value calculated in question 7-1. Give **two** possible reasons why. [2]
- 7-3 The number of amino acids that make up the polypeptide chain that this gene codes for can never be more than the number calculated in 7-1. Explain why. [2]

Total: 6

DNA, genes and chromosomes

4 Genetics, variation and diversity

55

56

DNA and protein synthesis

Quick questions

- SB1 p63 3.4.2
- SB1 p65 3.4.2
- SB1 p67 3.4.2
- SB1 p66 3.4.2
- SB1 p68 3.4.2
- Explain the difference between a genome and a proteome.
 - DNA and RNA are both polynucleotide molecules. Give **three** ways in which DNA and RNA differ from each other.
 - RNA polymerase is an enzyme that is involved in the process of transcription. Describe the role RNA polymerase plays in this process.
 - Describe what must happen after transcription before the mRNA is able to code for proteins at the ribosome.
 - Translation is the process by which a polypeptide chain is synthesised. Describe the role played by tRNA in this process.

Exam-style questions

- 6 Table 2 shows some properties that DNA, tRNA and mRNA may possess. Copy and complete the table to indicate which properties the molecules have. [4]

Molecule	Contains hydrogen bonds	Double stranded	Variable in length	Associated with an amino acid
DNA				
tRNA				
mRNA				

Table 2

- 7 Rifamycin is an antibiotic that is used to treat bacterial infections. It is a non-competitive inhibitor of the enzyme that forms mRNA in bacteria.
- 7-1 Use your knowledge of transcription to suggest how this drug works to kill bacteria. [3]
- 7-2 Rifamycin moves freely across all cell membranes within the body. Use your understanding of enzyme structure to suggest why this drug does not affect transcription within cells of the human patient. [3]
- 7-3 One challenge faced by scientists is that strains of bacteria resistant to Rifamycin can develop. Explain how. [3]
- 7-4 Resistant bacteria are still able to carry out transcription. Suggest how a mutation in these bacteria would make bacteria resistant to this drug. Explain your answer. [3]
- Total: 12**
- 8 Scientists have found that the same gene can produce more than one protein. They think this happens because of 'alternative splicing'. This is shown in Figure 1.

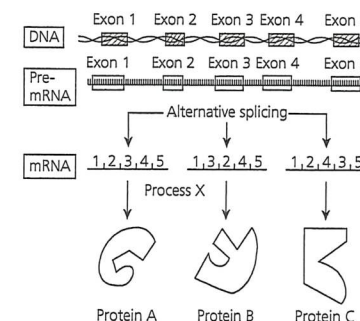


Figure 1

SB1 p62 3.4.1

SB1 p67 3.4.2

8-1 Define what an exon is. [1]

8-2 The sections between the exons are all removed from pre-mRNA. Name these sections. [1]

8-3 Name process X. [1]

SB1 p68 3.4.2

8-4 Use Figure 1 to explain how this gene is able to produce **three** different proteins, A, B and C. [2]

8-5 Proteins A, B and C have different tertiary structures. Explain why. [2]

SB1 p69 3.4.2

8-6 When scientists first decoded the human genome, they estimated that humans had between 20 000–25 000 genes. The number of proteins a human is able to make is far greater than this number. Explain how alternative splicing causes this to happen. [1]

Total: 8

9 Figure 2 shows an image of a tRNA molecule that is involved in protein synthesis.

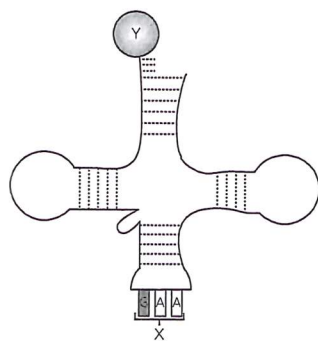


Figure 2

SB1 p69 3.4.2

9-1 Name the sections X and Y in Figure 2. [1]

9-2 Describe the role of X and Y in translation. [3]

9-3 Name the **three** bases that this tRNA would bind to on the mRNA. [1]

Total: 5

10 Aminoacyl-tRNA synthetase (aaRS) is an enzyme involved in the attachment of the correct amino acid to its corresponding tRNA. This process is referred to as 'loading' the tRNA. Once it is loaded, the tRNA molecule can be involved in the process of translation by delivering the amino acid to the growing polypeptide chain. The antibiotic mupirocin works by inhibiting aaRS in bacteria.

SB1 p69 3.4.2

10-1 Explain how mupirocin kills bacteria. [3]

10-2 There are growing concerns for bacteria developing resistance to the antibiotic, and so scientists are trying to develop new drugs that act in the same way as mupirocin. One challenge they have faced in early testing is that the synthetic versions of this antibiotic also inhibit human aaRS. Suggest why this might occur. [1]

Total: 4

DNA and protein synthesis

SB1 p197 3.4.3

SB1 p193 3.4.3

SB1 p196 3.4.3

SB1 p193-5 3.4.3

SB1 p193 3.4.3

Gene mutations and meiosis

Quick questions

- Gene mutations occur when the base sequence in a gene changes during DNA replication. Some mutations have no impact on the polypeptide that they code for. Suggest **two** possible explanations for this.
- In the process of meiosis, four haploid cells are formed. Explain what is meant by **haploid**.
- Sometimes chromatids fail to separate properly during meiosis. What term is used to describe this? What is the effect of this on the gametes made?
- Meiosis generates a large amount of variation within gametes. Name the **two** processes that occur in meiosis that cause this variation.
- Explain what is meant by the term **homologous chromosome**.

Exam-style questions

6 Table 3 shows the mRNA codons and the corresponding amino acid that they code for.

		Second position									
		U		C		A		G			
		code	amino acid	code	amino acid	code	amino acid	code	amino acid		
First position	U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U	Third position
		UUC		UCC		UAC		UGC		C	
		UUA	Leu	UCA		UAA	STOP	UGA	STOP	A	
		UUG		UCG		UAG	STOP	UGG	Trp	G	
	C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U	
		CUC		CCC		CAC		CGC		C	
		CUA		CCA		CAA	Gln	CGA		A	
		CUG		CCG		CAG	CGG	G			
	A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U	
		AUC		ACC		AAC		AGC		C	
		AUA		ACA		AAA	Lys	AGA	A		
		AUG		ACG		AAG	AGG	Arg	G		
	G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U	
		GUC		GCC		GAC		GGC		C	
		GUA		GCA		GAA	Glu	GGA		A	
		GUG		GCG		GAG	GGG	G			

Table 3

6-1 Using Table 3 determine the amino acid sequence for the following DNA strand.

TAC, GTA, GTA, TCA, CCT, CAT, CGC, ATT

[1]

6-2 Table 4 shows two mutations of the original sequence.

Mutation 1	Mutation 2
TAC, GTG, GTA, TCA, CCT, CAT, CGC, ATT	TAC, GTA, GTA, TCA, ACT, CAT, CGC, ATT

Table 4

- Name the type of mutation shown. [1]
- Describe and explain the consequences of these two mutations. [4]

Total: 6

4 Genetics, variation and diversity

57

58

7 **Figure 3** shows a process that occurs in meiosis.

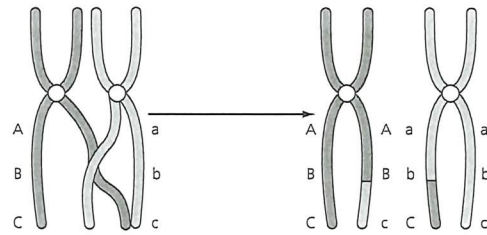


Figure 3

SB1 p196 3.4.3

- 7-1 Name the process shown in **Figure 3**. [1]
- 7-2 Describe and explain how this process increases variation. Use information from the diagram in your explanation. [3]
- Total: 4**
- 8 **Figure 4** shows the process of meiosis in an organism with a diploid number of four.

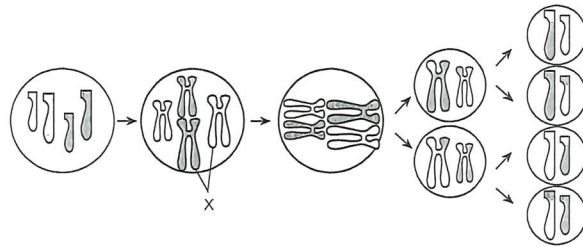


Figure 4

Figure 5 also shows the process of meiosis in the same organism, on a different occasion.

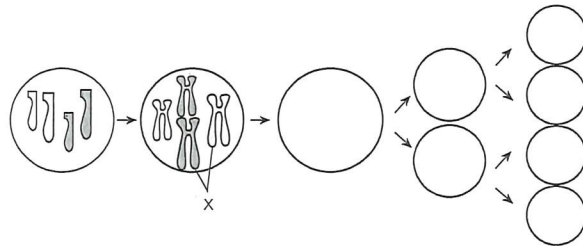


Figure 5

SB1 p196 3.4.3

- 8-1 Describe and explain the relationship between the chromosomes labelled X. [2]
- 8-2 Copy and complete **Figure 5** to show **four** gametes that could be produced at the end of meiosis but are different from the gametes in **Figure 4**. [3]
- 8-3 1. Give the number of different gametes that can be produced in this organism through independent assortment alone. [1]
2. Explain why the actual number of genetically different gametes is much greater than this. [1]
- 8-4 Name another source of genetic variation in organisms that does not occur during the cell cycle. [1]
- Total: 5**

SB1 p196 3.4.3 PS3.2

SB1 p196 3.4.3

SB1 p192 3.4.3

gene mutations and meiosis

4 Genetics, variation and diversity

59

60

SB1 p195 3.4.3

9 **Figure 6** shows the life cycle of one kind of fungus.

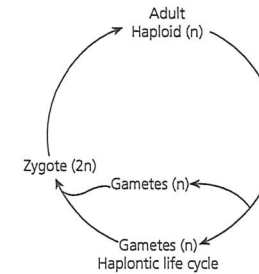


Figure 6 Gamete production

- 9-1 1. Copy **Figure 6** and place an X to indicate where meiosis is taking place. [1]
2. Explain your answer. [1]
- 9-2 Using **Figure 6** explain why this lifecycle provides very little variation between parent cell and gametes. [2]
- Total: 4**

10 **Figure 7** shows the karyotype of a person born with Edwards Syndrome.

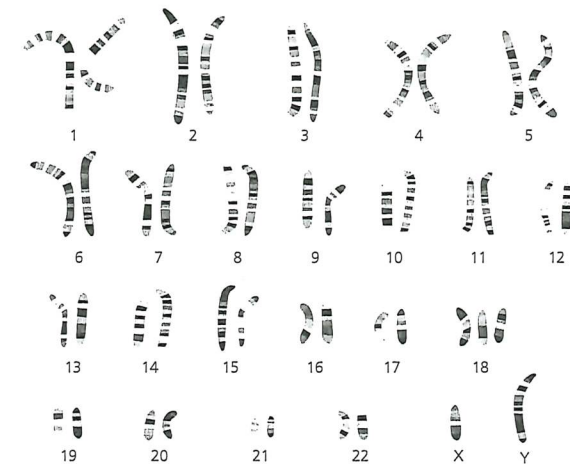


Figure 7

- 10-1 Give the cause of Edwards syndrome. [1]
- 10-2 Give the cause of this mutation. [1]
- 10-3 Describe how events in meiosis can lead to Edwards syndrome. [4]
- Total: 6**

- 11 Figure 8 shows a cell at the start of meiosis.



Figure 8

SB1 p193 3.4.3

- 11-1 Sketch the appearance of **one** possible daughter cell at the end of the first division of meiosis.

[2]

- 11-2 Give **two** ways in which meiosis contributes to variation.

[2]

SB1 p194 3.4.3

- 11-3 Figure 9 shows the life cycle of bracken fern.

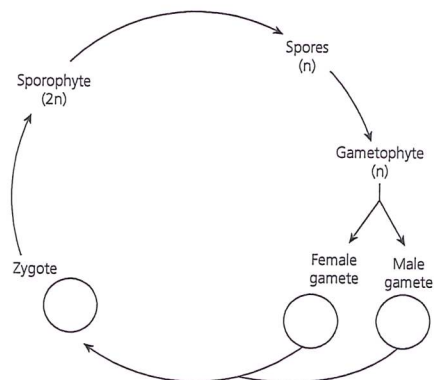


Figure 9

- Copy the diagram and complete the empty circles to show which stages are haploid (n) or diploid ($2n$).
- Mark a letter X on the diagram to show a stage when meiosis takes place.

[1]

[1]

Total: 6

61

Gene mutations and meiosis

SB1 p198 3.4.4

SB1 p199 3.4.4

SB1 p198 3.4.4

SB1 p199 3.4.4

SB1 p199 3.4.4

SB1 p200 3.4.4

4 Genetics, variation and diversity

62

SB1 p198 3.4.4

SB1 p200 3.4.4

SB1 p204 3.4.4

Genetic diversity and adaptation

Quick questions

- Define the term 'allele'.
- When discussing natural selection, the term 'increased reproductive success' is used. Explain what this means.
- What changes in allele frequency would be expected over a long period of time when natural selection is acting on a population?
- Define the terms 'species' and 'population'.
- What is meant by these three types of adaptation?
 - Anatomical
 - Physiological
 - Behavioural
- Figure 10 shows the effect of natural selection on human birth weight. What type of selection is shown here? Explain your answer.

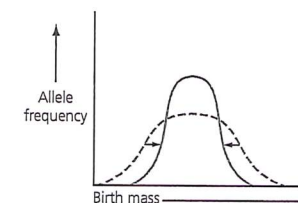


Figure 10

Exam-style questions

- 7 *Bufo marinus* (Cane toad) is a poisonous toad that was introduced to Australia in the 1930s. The cane toad was introduced to help control crop pests. Their introduction resulted in the rapid reduction in populations of many predators such as snakes and lizards. However, two species of snakes, the red-bellied black snake and the green tree snake, which were extremely susceptible to the toad's poison, have now evolved so that they are able to survive even though they are still susceptible to the poison. Snakes eat their prey whole, so the size of their jaw determines what they eat. Scientists have seen a change in jaw size in these two species of snakes over the past 80 years.

- 7-1 Explain how natural selection could have led to snakes developing the ability to survive in areas where the cane toad lives.

[6]

- 7-2 Name the type of selection this is. Explain your answer.

[2]

Total: 8

- 8 Cheetahs are big wild cats found in Africa. Scientists have found low genetic diversity in cheetah populations, so they think there was a big fall in population in the past.

- 8-1 Define genetic diversity.

[1]

- 8-2 Explain why the lack of genetic diversity in cheetah populations is such a concern. Use your understanding of natural selection when answering this question.

[2]

- 8-3 Suggest how a fall in population could lead to low genetic diversity.

[1]

- 8-4 Wild cheetahs form small isolated populations across east and south Africa. This can contribute to low genetic diversity. Explain how.

[2]

A group of scientists compared the genetic diversity of cheetahs in the east and south African cheetah with the genetic diversity of other big cats present in Africa. **Figure 11** shows their findings. The numbers in brackets represent the number of gene loci investigated.

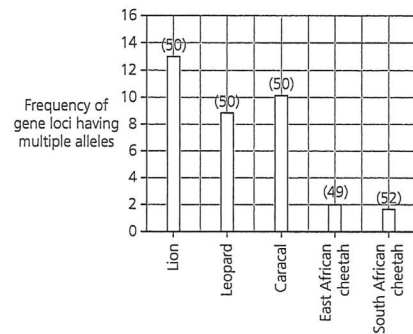


Figure 11

- 8–5 Calculate the percentage of the gene loci investigated that showed multiple alleles for:
1. East African cheetah [2]
 2. Lion [2]

Total: 12

- 8–6 One researcher commented that other cat species might be better able to adapt to environmental change in Africa than cheetahs. Use **Figure 11** to explain which of the cats might be best adapted to environmental change. [2]

- 9 A student wanted to find out which brand of bathroom cleaning spray was best at killing bacteria. She used aseptic technique to spread *E.coli* bacteria over the surface of agar jelly in a Petri dish.

The student dipped a filter paper disc into one of the bathroom sprays and placed it on the agar. She repeated this with two other brands of bathroom spray.

The student also dipped one filter paper disc in sterile distilled water and placed this on the agar. She incubated the dish for 24 hours at 30°C.

Figure 12 shows the appearance of the dish after incubation.

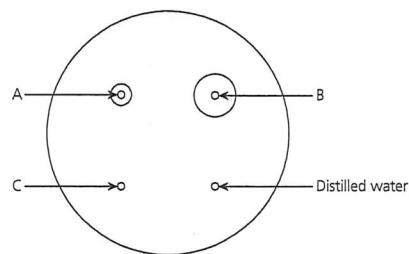


Figure 12

- 9–1 Give **two** examples of aseptic technique that the student should have used. [2]
- 9–2 The student soaked one filter paper disc in distilled water. Explain why. [2]
- 9–3 The student concluded that brand B is the best bathroom spray for killing bacteria. Evaluate this conclusion. [5]

Total: 9

Genetic diversity and adaptation

SB1 p199 3.4.4

- 10 Aye-ayes are primates that are found only on the island of Madagascar. They are dark brown/black and have a bushy tail that is larger than their body. They have big eyes that enable them to detect colour even when there is very little light, and large ears that are extremely sensitive. On each hand, they have long, thin fingers, with one especially long and mobile finger. They tap branches with their fingers to detect hollows in the branches where insect grubs might be found. They bite into the wood with their sharp teeth, and scoop out the grubs with their very long finger to eat them. Aye-ayes are nocturnal and spend their days sleeping in nests made within the tree branches.

Using the information above, identify **two** anatomical and **two** behavioural adaptations. For each one suggest how each adaptation helps aye-ayes to survive. [4]

Species and taxonomy

Quick questions

- SB1 p212 3.4.5
- SB1 p215 3.4.5
- SB1 p216 3.4.5
- 1 Many animals display courtship behaviour as a necessary process before mating can commence. Explain the advantage to these animals of displaying courtship behaviour.
 - 2 What is meant by a phylogenetic hierarchy?
 - 3 One hierarchy classifies the Eurasian wolf, *Canis lupus*, as shown in **Table 5**.

Kingdom	
	Chordata
	Mammalia
	Carnivora
	Canidae
Genus	
Species	

Table 5

Copy and complete **Table 5**.

Exam-style questions

- 4 Biological classification classifies organisms into a phylogenetic hierarchy. [1]
- 4–1 Define 'phylogenetic'. [1]
- 4–2 **Figure 13** shows the relationship between six different members of the taxonomic order Primates.

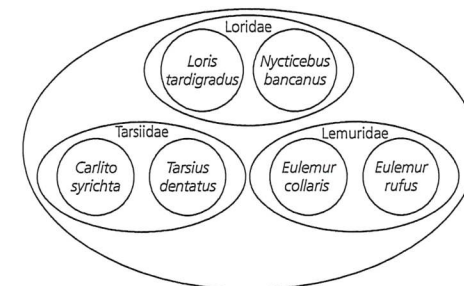


Figure 13

1. Lemuridae, Loridae and Tarsiidae are all examples of the same taxon. Name this taxon. [1]
2. Name **two** other taxa that *Nycticebus bancanus* and *Tarsius dentatus* have in common. [1]

4 Genetics, variation and diversity

63

64

SB1 p204 3.4.4 PS2.3

SB1 p204 3.4.4 AT1 RP6

SB1 p202 3.4.4

- 4–3 *Eulemur collaris*, *Eulemur rufus* and *Lemur catta* are all lemurs. What do their binomial names tell you about their evolutionary relationships to each other? Explain your answer. [3]
- 4–4 Scientists believe that the Loridae and Lemuridae are more closely related to each other than either group is to the Tarsiidae. Suggest and explain two pieces of evidence that could be used to investigate this statement. [4]
- 5 Male freshwater turtles can display a series of different courtship behaviours that are visual, auditory and chemical in order to succeed in mating. Table 6 shows information about the different types of innate behaviour shown by each species of turtle. Total: 10

SB1 p211 3.4.5

Species	Foreclaw display	Head movement	Nudge	Gulp
<i>Chelodina expansa</i>		X		
<i>Chelodina longicollis</i>		X	X	
<i>Elseya latisternum</i>	X	X	X	X
<i>Emydura macquarii</i>	X	X	X	X
<i>Emydura subglobosa</i>	X	X	X	X

Table 6

Innate behaviour is determined by alleles. Use the information in Table 6 to suggest the evolutionary relationship between these species. [4]

Total: 14

Biodiversity within a community

Quick questions

- 1 Explain the difference between 'species richness' and 'species index diversity'.
- 2 Modern farming techniques have been blamed for the reduction of rural biodiversity. Explain how farming has caused a reduction in biodiversity.

SB1 p227 3.4.6

SB1 p230 3.4.6

Exam-style questions

- 3 Over the past 100 years, artificial fertilisers used by farmers have leached into waterways such as lakes and rivers. This has led to eutrophication and decreased species diversity.
- 3–1 Explain how leaching of fertilisers into waterways can lead to decreased species diversity. [5]
- Thousands of years ago, lakes in northern Europe were populated by whitefish. This population separated into groups with different appearance and behaviour. One population reproduced at the bottom of lakes, while the others lived and reproduced closer to the surface. Scientists have found that pollution in lakes is causing the whitefish populations to merge. They are interbreeding and hybridising.
- 3–2 Were the whitefish populations separate species? Explain your answer. [2]
- 4 Scientists carried out a study to compare the effect of two farming methods on biodiversity. They compared conventional farming, where pesticides and artificial fertilisers were used, with organic farming that does not use pesticides and only uses natural fertilisers. The data collected from these fields was collated and can be seen in Table 7. SE represents the standard error, which measures the statistical accuracy of an estimate, equal to the standard deviation of the theoretical distribution of a large population of such estimates. Total: 7

SB1 p230 3.4.6

Biodiversity within a community

4 Genetics, variation and diversity

65

66

Plant/Animal being observed	Conventional farming ($\pm$ SE)	Organic farming ($\pm$ SE)
Crop yield	9.3 $\pm$ 0.25	4.3 $\pm$ 0.24
Plants (cover)	1.5 $\pm$ 0.10	12.9 $\pm$ 0.75
Plants (species)	2.5 $\pm$ 0.12	9.9 $\pm$ 0.34
Earthworms (individuals)	2.1 $\pm$ 0.28	3.2 $\pm$ 0.45
Earthworms (species)	1.1 $\pm$ 0.11	1.6 $\pm$ 0.15
Bumblebees (individuals)	0.7 $\pm$ 0.03	0.9 $\pm$ 0.04
Bumblebees (species)	1.50 $\pm$ 0.08	1.9 $\pm$ 0.09
Solitary bees (individuals)	0.8 $\pm$ 0.04	0.8 $\pm$ 0.04
Solitary bees (species)	1.2 $\pm$ 0.08	1.4 $\pm$ 0.10
Butterflies (individuals)	1.9 $\pm$ 0.20	2.7 $\pm$ 0.31
Butterflies (species)	1.1 $\pm$ 0.09	1.4 $\pm$ 0.12
Hoverflies (individuals)	1.6 $\pm$ 0.07	1.2 $\pm$ 0.06
Hoverflies (species)	2.0 $\pm$ 0.11	1.9 $\pm$ 0.11
Farmland birds (individuals)	84.0 $\pm$ 5.06	91.4 $\pm$ 9.48
Farmland birds (species)	8.5 $\pm$ 0.22	7.8 $\pm$ 0.27

Table 7

- SB1 p230 3.4.6 PS 2.3, 3.3 4–1 Compare the crop yields in the two types of farming. [2]
- SB1 p230 3.4.6 4–2 Suggest how the scientists could measure crop yields. Include suitable units in your answer. [2]
- SB1 p230 3.4.6 ATK 4–3 Explain what is meant by 'natural fertilisers' in organic farming. [1]
- SB1 p230 3.4.6 4–4 Explain why farmers use fertilisers. [1]
- SB1 p230 3.4.6 PS2.1 4–5 A journalist used these data to claim that organic farming is better than conventional. Evaluate this statement. [3]
- 5 Students investigated the frequency of different invertebrates in three different locations. The data that they collected can be seen in Figure 14. Total: 9

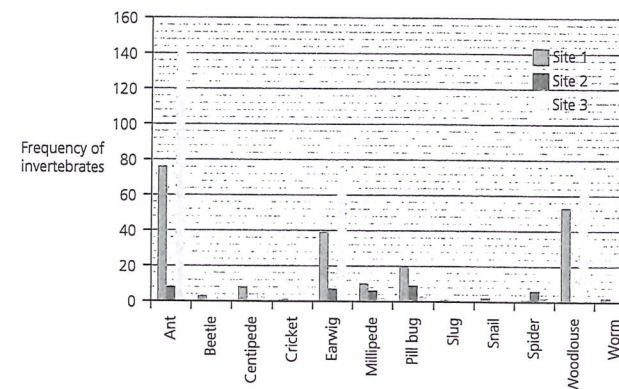


Figure 14

- SB1 p230 3.4.6 MS2.3 5–1 Calculate the index of diversity of each site and explain which site has the greatest biodiversity. [3]
- 5–2 Explain how the use of land as farmland can affect diversity. [2]

Total: 5

Investigating diversity

Quick questions

- 1 Our understanding of biological molecules and their structure has enabled scientists to gain a deeper understanding of the evolutionary links between species. What biological molecule is most useful to investigate genetic diversity between species?
- 2 Name the process that leads to changes in the base sequence of a gene that could lead to increased genetic diversity within a species.
- 3 Explain why it is practically easier for scientists to isolate mRNA for a given gene from a cell than from DNA.
- 4 Scientists select areas at random to sample organisms when carrying out a diversity investigation.
 - a) Suggest a method they could use to select areas at random.
 - b) Why is it important to select areas to sample at random?

Exam-style questions

- 5 Cytochrome C is a protein present in all eukaryotes and is involved in aerobic respiration. Table 8 shows the amino acids in one section of cytochrome C in several animals.

Animal	Amino acid sequences in cytochrome-c																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Human	Gln	Pro	Tyr	Ser	Thr	Ala	Lys	Asn	Lys	Ile	Gly	Glu	Asp	Thr	Leu	Met	Glu	Lys	Ala	Thr	Asn	Glu
Horse	Gln	Pro	Phe	Thr	Thr	Ala	Lys	Asn	Lys	Thr	Lys	Glu	Glu	Thr	Leu	Met	Glu	Lys	Ala	Thr	Asn	Glu
Chicken	Gln	Glu	Phe	Ser	Thr	Asp	Lys	Asn	Lys	Thr	Gly	Glu	Asp	Thr	Leu	Met	Glu	Lys	Ala	Thr	Ser	Lys
Frog	Gln	Glu	Phe	Ser	Thr	Asp	Lys	Asn	Lys	Thr	Gly	Glu	Asp	Thr	Leu	Met	Glu	Ser	Ala	Cys	Ser	Lys
Shark	Gln	Gln	Phe	Ser	Thr	Asp	Lys	Asn	Lys	Thr	Gln	Gln	Glu	Thr	Leu	Arg	Ile	Lys	Thr	Ala	Ala	Ser
Rabbit	Gln	Val	Phe	Ser	Thr	Asp	Lys	Asn	Lys	Thr	Gly	Glu	Asp	Thr	Leu	Met	Glu	Lys	Ala	Thr	Asn	Glu

Table 8

- 5-1 Using Table 8, give the animal to which humans are most closely related. Explain your answer.
- 5-2 Using the information in Table 8 give the evolutionary relationship between the horse, chicken and shark. Explain your answer.
- 5-3 Name two other biological molecules that could be used to compare evolutionary relationships between organisms.
- 5-4 A scientist compared DNA and mRNA base sequences between organisms from different species. The scientist found that the mRNA sequence for a particular gene was the same, but that the DNA for this same gene differed between the two species. Explain why.

Total: 11

- Table 9 shows the comparison of base sequence of a section of mitochondrial DNA in five different species.

Species	Base sequence
Human	GTAATATAGTTTAAACAAAACATCAGATTGTGAATCTGACAACAGAGGCTACGACCCCTCC
Orangutan	GTAATATAGTTTAAACAAAACATTAGATTGTGAATCTAATAATAGGGCCCCAACCCTCC
Gibbon	GTAACATAGTTTAAATCAAAACATTAGATTGTGAATCTAACAATAGAGGCTCGAACCTCTACC
Chimpanzee	GTAATATAGTTTAAACAAAACATCAGATTGTGAATCTGACAACAGAGGCTACGACCCCTACC
Gorilla	GTAATATAGTTTAAACAAAACATCAGATTGTGAATCTGATAACAGAGGCTCAACCCCTACC

Table 9

- 6-1 Draw a phylogenetic tree based on the information in Table 9.
- 6-2 It is more useful to use genes related to respiration when studying evolutionary relationships, rather than genes that code for physical characteristics such as hair colour or skull type. Suggest why.
- 6-3 Our understanding of biological molecules and their structure has enabled scientists to gain a deeper understanding of the evolutionary links between species. Explain why biological molecules are useful in investigating genetic diversity.
- 7 Anole lizards live in the Caribbean Islands. They can be grouped according to their physical characteristics as well as their ecological niche. Table 10 shows some features of Anole lizards.

Total: 8

Habitat	Body length/mm	Leg length	Toe length	Tail length	Colour
Bush and blades of grass	33-51	Long	Intermediate	Very Long	Brown
Trunks	40-58	Intermediate	Intermediate	Short	Grey
Lower trunk and ground	55-79	Long	Intermediate	Long	Brown

Table 10

- 7-1 Suggest how the features of Anole lizards living in the bush and on blades of grass are adapted to their habitat.
- 7-2 Give two ways in which lizards that live on trunks and those that live on the lower trunk and ground are adapted to their habitat.
- 7-3 The Anole lizards that live on trunks and on the lower trunk and ground are believed to have evolved from a common ancestor. Describe how this might have occurred.
- 7-4 All species of anole lizards that inhabit these three habitats are found on all the islands of the Caribbean, including Cuba, Jamaica, Hispaniola and Puerto Rico. At one time the islands were interlinked by land. Scientists have offered two different explanations about how these species have evolved:

Explanation 1: Each group of Anoles evolved before the separation of the islands took place. After this evolution took place, they migrated to different islands and then the islands separated.

Explanation 2: The islands separated before any evolution of the lizards took place. The lizards then evolved independently on each island to inhabit the different niches.

In order to investigate which of these hypotheses was correct, scientists compared the DNA sequences from a large number of species of anoles from the different Caribbean anoles. From this, they drew a phylogenetic tree. This can be seen in **Figure 15**.

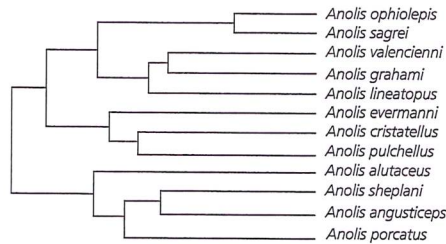


Figure 15

Table 11 shows which island each species inhabits.

Species	Island
<i>Anolis alutaceus</i>	Cuba
<i>Anolis angusticeps</i>	Cuba
<i>Anolis cristatellus</i>	Puerto Rico
<i>Anolis evermanni</i>	Puerto Rico
<i>Anolis graham</i>	Jamaica
<i>Anolis lineatopus</i>	Jamaica
<i>Anolis ophiolepis</i>	Cuba
<i>Anolis porcatus</i>	Cuba
<i>Anolis pulchellus</i>	Puerto Rico
<i>Anolis sagrei</i>	Cuba
<i>Anolis sheplani</i>	Hispaniola
<i>Anolis valencienni</i>	Jamaica

Table 11

Using the information in **Figure 15** and **Table 11** explain which of the two hypotheses is most likely to be correct. Give reasons and use information in the figures in your explanation.

[4]

SB1 p204 3.4.7 PS 3.3

- 7–5 When scientists collect quantitative data in diversity investigations, they calculate means and standard deviations. Standard deviation provides a more reliable way of comparing variation in populations than range. Explain why.

[3]

Total: 16

Topic review: genetics, variation and diversity

- 1 Grey tree frogs (*Hyla versicolor*) and Green tree frogs (*Hyla cinerea*) are two species of tree frogs that live in the southern United States. Both species have very similar niches: eating insects, laying their eggs in pools and living off the ground on plants and vegetation. Grey tree frogs live farther north in wooded areas and Green tree frogs live in more open wetland areas. Tree frogs' main predators are snakes and birds.

SB1 p216 3.4.5

- 1–1 How does the Latin name of these frogs tell you that they are closely related to each other?
- 1–2 Describe how scientists could test whether these two types of frogs are definitely separate species.

[1]

[2]

69

70

SB1 p198–9 3.4.4

- 1–3 The scientists think that these two kinds of tree frogs evolved from the same common ancestor. Use your knowledge of natural selection to describe how this might have happened.

[6]

Total: 9

- 2 *Orcinus orca* is the binomial name for the killer whale. **Table 12** shows the classification of this species.

Kingdom	Animalia
	Chordata
	Mammalia
	Cetartiodactyla
	Delphinidae
Genus	
Species	

Table 12

- 2–1 Copy and complete **Table 12**.

[2]

- 2–2 Killer whales are mammals. Like other mammals, they need the amino acid methionine in their diet. They obtain this from eating protein. Some killer whales eat fish, while others eat small mammals such as seals and dolphins. Some of the methionine they eat is needed to make other amino acids such as cysteine. Whales feeding on small mammals do not always find prey on a regular basis, and they have a gene that allows them to store surplus cysteine from their meals.

Suggest why those killer whales eating one mammal a day would benefit from this evolutionary adaptation in comparison to those that have a more regular diet of fish.

[4]

- 2–3 Cysteine and methionine are both amino acids. Explain how cysteine is different from methionine.

[1]

Total: 7

- 3 When scientists first started to work out the genetic code, they made artificial RNA with a known base sequence. They already knew that three bases coded for one amino acid. The mRNA they made was put into a cell-free mixture and polypeptides were produced.

Table 13 shows some of the mRNA sequences they tested and the sequences of the polypeptides that were produced.

mRNA base sequence	Polypeptide produced
UUU UUU UUU UUU UUU UUU	PhePhePhe PhePhePhe
AAA AAA AAA AAA AAA AAA	LysLysLys LysLysLys
CCC CCC CCC CCC CCC CCC	ProProPro ProProPro
GGG GGG GGG GGG GGG GGG	GlyGlyGly GlyGlyGly
ACA CAC ACA CAC ACA CAC	ThrHisThr HisThrHis
UUC UUC UUC UUC UUC UUC	PhePhePhe PhePhePhe

Table 13

- 3–1 Use **Table 13** to explain how DNA is a 'degenerate' code.

[2]

- 3–2 The cell-free mixture was produced by breaking open *E. coli* bacteria to release the cytoplasm and its contents. Name **four** components present in the cell-free mixture that enabled polypeptides to be made.

[2]

- 3–3 1. A protein consists of 220 amino acids. What is the minimum number of mRNA nucleotides needed to code for this protein?
2. The number of nucleotides in the gene that codes for this protein is actually much higher than this. Explain why.

[1]

Total: 6

SB1 p211 3.4.5

SB p198 3.4.5

SB1 p11 3.1.4.1

SB1 p70 3.4.1

SB1 p37–43 3.2.1

SB1 p65 3.4.1

- 4 Figure 16 shows the structure of a DNA nucleotide.

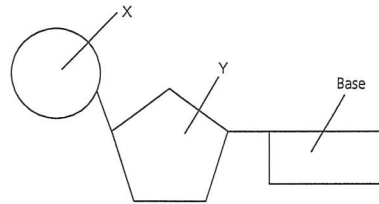


Figure 16

SB1 p56-9 3.4.1

- 4-1 1. Name parts X and Y. [1]
2. Name the reaction in which nucleotides join together to form a polynucleotide. [1]
3. Name the bond formed when nucleotides join together to form a polynucleotide. [1]

SB1 p65 3.4.1

- 4-2 Table 14 shows the percentage composition of bases in the DNA of two different organisms.

Organism	Adenine	Cytosine	Guanine	Thymine
Yeast	31.3	17.1		
Sea urchin	32.8		17.7	

Table 14

1. Copy Table 14. Calculate the missing values and use them to complete the table. [1]
2. Explain your answer. [1]
4-3 The cells in the lungs and the skin of a person contain the same DNA base sequence but the cells are very different in appearance. Use your knowledge of genes to explain why these cells are different in appearance. [2]

Total: 7

- 5 Scientists researched a gene that was 2×10^4 base pairs long. The mRNA that was transcribed from this gene was 2×10^3 nucleotides long.
5-1 Explain the reason for this difference in length. [1]
5-2 Explain why a gene is described in terms of base pairs, but an mRNA strand in terms of nucleotides. [1]
5-3 Calculate the length of the mRNA as a percentage of the length of the original gene. [2]

Total: 4

- 6 Seahorses reproduce sexually. After a pair bond is formed, they perform ritual dances with their partner every morning. Seahorses are unusual in that it is the male who protects and carries the fertilised eggs within his brood pouch until they are developed and are ready to be released, roughly 21 days after fertilisation.

SB1 p215 3.4.5

- 6-1 Suggest the reason for repeated courtship dances every day. [1]
6-2 When two seahorses are ready to mate, they become pale in colour. Suggest an advantage of this. [1]
6-3 Female seahorses release up to 650 eggs into the brood pouch of the male. Each egg has a diameter of roughly 1.5 mm and is spherical. Assuming that all the eggs are then fertilised, what is the total volume of all the eggs in the pouch? [3]

Topic review

SB1 193-6 3.4.3

SB1 p195 3.4.3

SB1 p225-9 3.4.8 MS2.3 7

- 4-4 The diploid number of chromosomes in seahorses is 48.

1. How many genetically different gametes could one seahorse produce from independent assortment only? [1]
2. How many genetically different offspring would one pair of seahorses be able to produce, assuming that the only source of variation in the gametes is from independent assortment? [1]

Total: 7

A group of students carried out an investigation to find the biodiversity of wildflowers in three different habitats, A, B and C. Table 15 shows their results.

Species	Number of individuals of each species in each habitat		
	A	B	C
A	0	0	3
B	32	25	9
C	0	0	7
D	86	126	1
E	78	0	8
F	0	56	5
G	0	0	2
H	0	10	0
I	0	0	3
J	0	0	2
K	0	0	12
L	0	4	0
Species richness		5	10
Total number of wildflowers (N)	196	221	52
Index of diversity		2.49	7.85

Table 15

- 7-1 1. Define 'biodiversity'. [2]
2. Describe a method the students might have used to collect reliable data. [4]
The diversity index (d) can be calculated using the formula in Figure 17.

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

Where N = total number of organisms of all species
and n = total number of organisms of each species

Figure 17

- 7-2 Calculate the following for site A. (This is the information that is missing from Table 15).
1. Species richness. [1]
2. Index of diversity. [2]
7-3 Use this data to evaluate the use of species richness and index of diversity to compare biodiversity between these three habitats. [4]

Total: 13

4 Genetics, variation and diversity

71

72

5

Energy transfers

Photosynthesis

Quick questions

SB2 p3 3.5.1

SB2 p3 3.5.1

SB2 p8 3.5.1

SB2 p3 3.5.1

SB2 p3 3.5.1

SB2 p8 3.5.1

SB2 p8 3.5.1

SB2 p9 3.5.1

SB2 p10 3.5.1

- 1 Name the two products and one waste product of the light-dependent reaction.
- 2 For a plant to be able to photosynthesise, it first needs to absorb light. Name the photosynthetic pigment that absorbs light.
- 3 ATP synthesised in the light-dependent stage is used in the light-independent stage, when glycerate-3-phosphate (GP) is reduced to triose phosphate. When GP is reduced to triose phosphate, energy from ATP is used. Name the type of reaction when ATP is converted to ADP.
- 4 Photosynthesis is split into two separate stages, the light dependent and the light independent. Name the part of the chloroplast where each of these stages take place.
- 5 What is the term given to the maintenance of a proton gradient across the thylakoid membrane and the subsequent movement of those protons back across the membrane down their concentration gradient?
- 6 Name the enzyme that catalyses the carboxylation of ribulose biphosphate in the light-independent stage of photosynthesis.
- 7 Triose phosphate can be used in two ways during the light-independent stage of photosynthesis. Name the **two** ways in which it can be used.
- 8 Name three environmental factors that can affect the rate of photosynthesis.
- 9 How can farmers use their understanding of limiting factors to increase yield?

Exam-style questions

- 10 Scientists wanted to investigate the effect that changes to environmental conditions had on the rate of photosynthesis.

They provided a plant with radioactive carbon in the form of carbon dioxide, as shown in Figure 1.

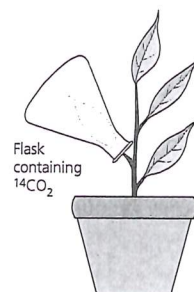


Figure 1

The scientists were able to record the concentrations of RuBP and GP produced over time. After 3 minutes the scientists changed one environmental factor in order to study the effect this had on the production of specific substances. All other conditions were kept the same.

Photosynthesis

SB2 p4 3.5.1

SB2 p8 3.5.1

SB2 p7 3.5.1

5 Energy transfers

73

74

SB1 p40 3.1.2.3

Details of the experiments and the results are shown in Table 1.

Experiment 1: Light, dark after 3 minutes

Experiment 2: CO₂ removed after 3 minutes

Time/minutes	Relative RuBP concentration/au		Relative GP concentration/au	
	Experiment 1	Experiment 2	Experiment 1	Experiment 2
1	4	4	8	8
2	4	4	8	8
3	4	4	8	8
4	2	8	12	4
5	2	9	13	3
6	2	9	13	2

Table 1

- 10-1 Radioactive carbon dioxide was used in this investigation. Explain why. [2]
 - 10-2 1. Describe the results of **Experiment 1**. [3]
2. Explain the results of **Experiment 1**. [4]
 - 10-3 1. Describe the results of **Experiment 2**. [3]
2. Explain the results of **Experiment 2**. [3]
- Total: 15**

- 11 Figure 2 shows some of the structures within the thylakoid membrane.

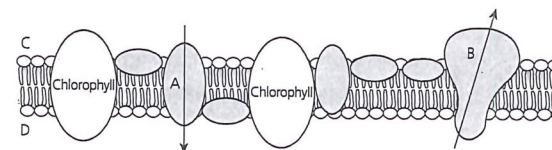


Figure 2

- 11-1 The arrows indicate the movement of a particular ion. Name this ion. [1]
- 11-2 Give the letter in Figure 2 that represents the stroma. Explain your answer. [3]
- 11-3 Explain the role of structure B. [4]

Total: 8

- 12 A student investigated the effect of light intensity on the rate of photosynthesis. In order to measure the rate he used dichlorophenolindophenol (DCPIP). DCPIP is dark blue when oxidised, but when reduced it is colourless.
- 12-1 The student obtained a suspension of chloroplasts from fresh spinach leaves using cell fractionation. Describe how. [4]

This homogenate was then used to set up six tubes. Table 2 lists the contents of each tube.

Tube number	0.5 cm ³ chloroplast suspension	3 cm ³ cold buffer solution	1.5 cm ³ cold distilled water	1.0 cm ³ DCPIP
1	X	X	X	
2		X	X	X
3	X	X	X	X
4	X	X	X	X
5	X	X	X	X
6	X	X	X	X

Table 2

Table 3 shows the conditions for each tube.

Tube number	Distance From light/mm	Covered in foil?
1	11.5	No
2	11.5	No
3	11.5	Yes
4	37.0	No
5	27.0	No
6	5.0	No

Table 3

All tubes were placed in their positions for 6 minutes. The student used a colorimeter to measure the absorbance of light through each mixture as an indicator of the rate of photosynthesis. This was measured at the start and then after 6 minutes.

Table 4 show the results.

Tube number	Absorbance at 0 minutes	Absorbance at 6 minutes
1	0.160	0.160
2	0.510	0.510
3	0.480	0.480
4	0.470	0.300
5	0.480	0.210
6	0.460	0.160

Table 4

SB2 p8 3.5.1 PS 1.2, 2.1

12-2 Explain the purpose of test tubes 1, 2 and 3.

[4]

SB2 p9 3.5.1 PS 3.2

12-3 The student processed the data so that he could compare rates of photosynthesis.

1. Explain what it means to 'process data'.

[1]

2. Copy and complete Table 5.

[2]

Tube number	Rate of photosynthesis/ _____
4	
5	
6	

Table 5

SB2 p9 3.5.1

12-4 Describe and explain the results.

[4]

SB1 p255 3.4.6.2 ATb

12-5 Describe the steps the student should have taken before he used the colorimeter.

[3]

SB1 p10-13 3.1.4.4

12-6 1. Explain why the student placed the chloroplasts into a solution containing a buffer.

[1]

2. Explain why the buffer solution used was ice cold.

[1]

SB1 p10-13 3.1.4.1 PS1.2

12-7 The midrib of the leaf was removed from the leaf before blending. Suggest why.

[1]

Total: 21

Photosynthesis

13 A student carried out an experiment to investigate the pigments present in spinach leaves. She used paper chromatography to separate the pigments. When she set up the chromatogram, she used a pencil to draw the origin line.

Figure 3 shows the results.

Table 6 shows the R_f values for four different pigments.

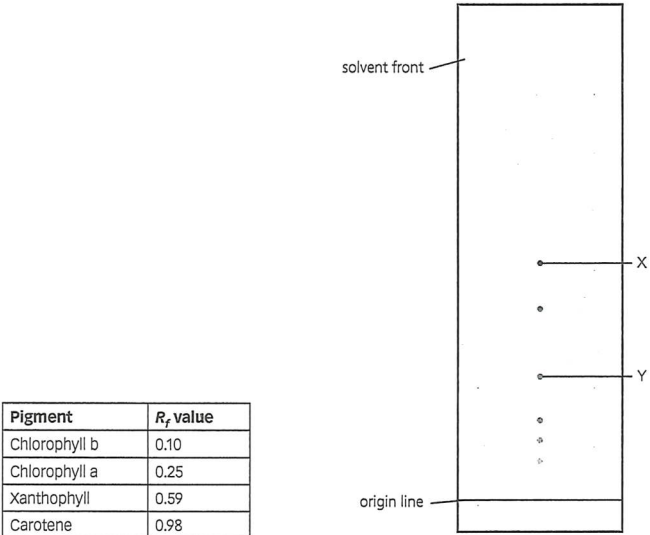


Figure 3

Table 6

SB1 p149 p264-5 3.5.1 ATg PS2.1 RP7

13-1 In setting up the chromatogram, explain why the student:

1. marked the origin on the paper using pencil

[1]

2. placed a concentrated spot of pigment on the origin line

[1]

3. ensured the level of the solvent was below the origin line.

[1]

13-2 Using the information supplied, identify the pigments at positions X and Y.

[4]

Total: 7

5 Energy transfers

SB2 p264-5 3.5.1

Respiration

Quick questions

- What is the only stage of respiration that takes place in both aerobic and anaerobic respiration, and where does it take place?
- In anaerobic respiration, what is the advantage of animal cells converting pyruvate into lactic acid, and plant and fungi cells converting pyruvate into ethanol and carbon dioxide?
- How is pyruvate transported into the mitochondria?
- Coenzyme A is involved in the link reaction in aerobic respiration. What is coenzyme A's specific role in aerobic respiration?

SB2 p15 3.5.2

SB2 p15 3.5.2

SB2 p16 3.5.2

SB2 p16 3.5.2

75

76

Exam-style questions

- 5 A student set up the respirometer shown in Figure 4 to investigate respiration in living seeds.

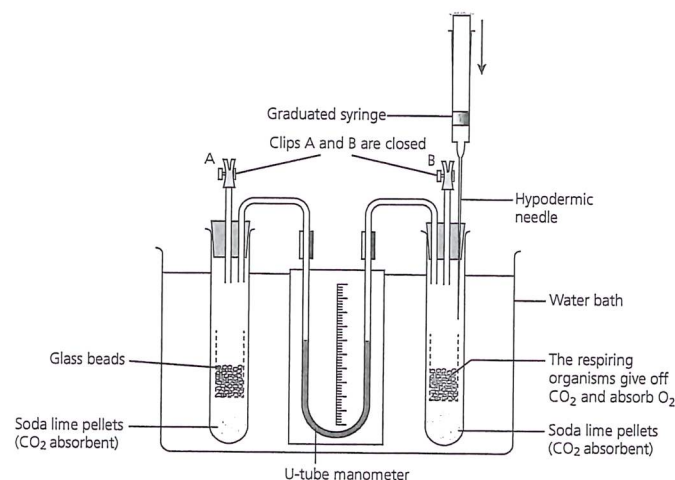


Figure 4

- SB2 p16 3.5.2 PS2.1 5-1 Explain the purpose of tube A. [1]
- SB2 p17 3.5.2 5-2 The student allowed the seeds to respire for several hours. After this time he was able to see a movement in the fluid in the U-tube manometer. Describe and explain how the fluid moved. [4]
- SB2 p17 3.5.2 PS2.4 5-3 Explain the reason for carrying out this investigation in a water bath. [2]

Total: 7

- 6 A student investigated the respiration of yeast as shown in Figure 5.

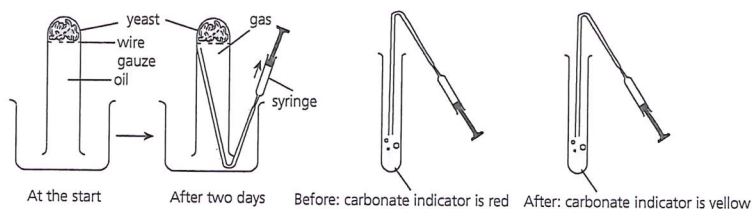


Figure 5

Table 7 shows the colour of the carbonate indicator at different pHs.

Colour of Indicator	pH
Yellow	7.6
Orange	8.0
Red	8.4
Magenta	8.8
Purple	9.2

Table 7

Respiration

SB2 p17 3.5.2 PS2.1

SB2 p17 8.5.2

- 6-1 Suggest why oil was used in this investigation. [2]
- 6-2 Explain the change in the colour of the carbonate indicator when gas removed by the syringe is passed through it. [2]
- 6-3 This investigation would not produce the same result if the yeast was replaced with animal cell/tissue. Explain why. [1]
- 7 A student was investigating respiration in germinating seeds. She divided germinating seeds evenly into two groups. She boiled one of the two groups and then sterilised both groups by washing them in disinfectant. She set up the equipment as shown in Figure 6. Cotton wool plugs were used to keep the thermometer in place and ensure that the flasks were not sealed.

Total: 5

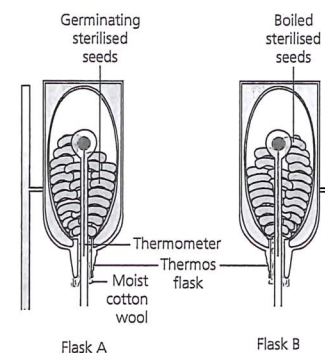


Figure 6

- 7-1 Explain the reason for the student carrying out the following steps. [2]
- Boiling the seeds for flask B. [2]
 - Sterilising the seeds in both flasks.
- 7-2 The student recorded the temperature every day for 6 days. The results can be found in Table 8.

Day	Time from start of investigation / hours	Temperature / °C	
		Vacuum flask with germinating seeds	Vacuum flask with boiled seeds
0	0	15	15
1	24	17	16
2	48	19	16
3	72	23	16
4	96	25	16
5	120	27	18
6	144	29	17

Table 8

- Describe and explain the results. [3]
- Explain why it was important to use cotton wool to keep the thermometer in place. [2]

Total: 9

5 Energy transfers

3.5.2

3.5.2 PS2.1 2.4

SB2 p16 3.5.2

77

78

- 8 Students investigated respiration in woodlice. The flasks contained the following:
- W – Potassium hydroxide, which absorbs carbon dioxide
 - X – Limewater
 - Y – Woodlice
 - Z – Limewater
- They set up the equipment as seen in **Figure 7**.

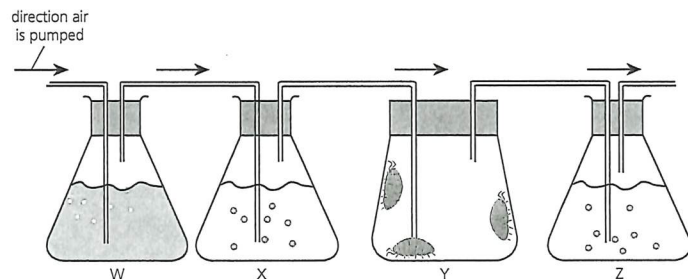


Figure 7

- SB2 p16 3.5.2 PS2.1 8–1 Explain why it was necessary to have potassium hydroxide in Flask W. [2]
- 8–2 Explain why the student included Flask X. [2]
- SB2 p16 3.5.2 8–3 Suggest what you would expect the appearance of the limewater in Flasks X and Z to be after 30 minutes. Explain your answer. [2]

Total: 6

- SB2 p16 3.5.2 ATa, b, h 9 A scientist was investigating the effect of different environmental conditions on the photosynthesis and respiration of oak leaves. She set up the investigation as shown in **Figure 8**. The solution at the bottom of each test tube was carbonate indicator solution. Each test tube was equidistant from a light source.

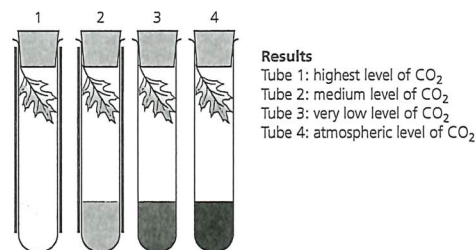


Figure 8

- Tube 1: living leaf + black paper surrounding the test tube
- Tube 2: living leaf + tissue paper surrounding the test tube
- Tube 3: living leaf + no paper
- Tube 4: boiled leaf + no paper

Respiration

SB2 p16 3.5.2

- 1 Explain the reason for setting up tube 4. [2]
- 9–2 Explain the results in
1. tube 1 [2]
 2. tube 2 [2]
 3. tube 3. [2]
- SB2 p16 3.5.2 PS2.4 9–3 Name **two** conditions that the scientist should ensure were kept constant. [2]

Total: 10

Energy and ecosystems

Quick questions

SB2 p19 3.5.3 ATk

- 1 Name the **two** ways biomass can be measured.

- 2 What is gross primary production (GPP)?

SB2 p24 3.5.3

- 3 How does net primary production differ from GPP?

SB2 p24 3.5.3

- 4 The net production of consumers can be calculated with the following equation; $N = I - (F + R)$. What do each of these letters represent?

SB2 p25 3.5.3

- 5 Describe how primary and secondary productivity are measured.

Exam-style questions

SB2 p24 3.5.3

- 5 **Figure 9** shows the net primary productivity in a lake ecosystem in May.

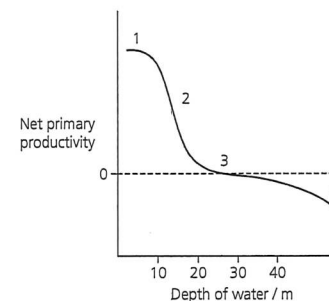


Figure 9

- 5–1 Explain the shape of the line at each of the points numbered. [4]
- 5–2 The same measurements were collected in October. Explain how you would expect the net primary productivity at different depths of water to be different. [3]

Total: 7

- 6 A scientist measured the rate at which oxygen is being produced by photosynthetic organisms. Water samples from a pond were taken containing only photosynthetic organisms. One bottle was exposed to light and the other was left in darkness. The concentration of dissolved oxygen was measured at both the start and then after 24 hours.

Table 9 shows the scientists' results.

Bottle conditions	Initial mass of dissolved oxygen / mg dm ⁻³	Mass of dissolved oxygen after 24 hours / mg dm ⁻³
Light	6.43	6.58
Dark	6.43	5.63

Table 9

5 Energy transfers

79

80

