edexcel

AS and A Level Biology

TRANSITION GUIDE

Reinforcing knowledge, skills and literacy in biology

Contents

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Introduction

Reinforcing knowledge, skills and literacy in biology

From our research, we know that it is easy for teachers to fall into the trap of going over work that has already been covered extensively at KS4. This may be because of a feeling that during the summer break students have forgotten what they had been taught or, if they are from different centres, uncertainty about the standard they have reached so far. This is where you can lose valuable teaching time and later find yourself rushed to complete the A-level content.

To help you with planning and teaching your first few A level lessons and to save you time, we have worked with practising teachers and examiners to develop these valuable, focussed transition materials. These will help you reinforce key concepts from KS4 and KS5 and guide your students' progression.

These transition materials include:

- mapping of the 9 to 1 KS4 Edexcel GCSE(s) to the Edexcel A level Biology specifications
- baseline assessment
- summary sheets
- student worksheets
- practice questions.

The mapping of content and skills from KS4 to KS5 should enable you to streamline your teaching and move on to the KS5 content within the first two weeks of term.

This will serve two purposes.

1 Learners will feel they are learning something new and will not get bored with over-repetition – particularly true for your most able learners.

2 Learners will be able to discover very early on in the course whether A level Biology is really a suitable subject choice for them.

You may choose to use this resource in one of several ways.

- After KS4 exams – if your school brings back Year 11 learners after their exams.
- In sixth-form induction weeks.
- As summer homework in preparation for sixth form.
- To establish the level of performance of your students from their range of KS4 qualifications.

Transition guide overview

Topic	Specification links	Resources
Section A Cells	Cell structure: 1.1 – 1.2 Microscopy: 1.3 – 1.4, 1.6 Diffusion, osmosis and active transport: 1.15 – 1.17, 8.4B Mitosis: 2.1 – 2.3	• Students' strengths and misconceptions • Summary sheets • Worksheets 1 & 2: Cell structures • Practice questions
Section B Molecules	Enzymes: 1.7 – 1.12 Protein synthesis: 3.8 – 3.10 Mutations: 3.22 – 3.23	• Students' strengths and misconceptions • Summary sheets • Worksheet 1: Carbohydrates • Worksheet 2: Data analysis • Practice questions

Topic	Specification links	Resources
Section C Human biology	Heart / lungs and circulatory system: 8.3 – 8.4, 8.6 – 8.8, 8.12	• Students' strengths and misconceptions • Summary sheets • Worksheet 1: Prefixes • Worksheet 2: Keywords • Practice questions
Appendix 1	Biology A Specification mapping	
Appendix 2	Biology B Specification mapping	
Appendix 3	Answers to Baseline assessment	
Appendix 4	Exam practice	
Appendix 5	Answers to exam practice	

The table below outlines the types of resources to be found in each section along with a description of its intended uses.

Type of resource	Description
Baseline assessment	This tests fundamental understanding of: • biological molecules • cells and reproduction • biodiversity and natural selection • exchange and transport.
Summary sheets	Review of KS4 concepts. Summary of key points and guide to correct use of key terms. Tips on how to answer exam questions.
Student worksheets and practice questions	Checking understanding of key points from Baseline assessment and Summary sheet. Checking understanding of new KS5 learning.
Examples of students' responses from Results Plus – Examiners' report	How to answer exam-type questions and KS5 level.

Baseline assessment

Name: _____ Form: _____

Biology group: _____

GCSE Biology/Science grade: _____

Date: _____

Targets for improvement

- ☐ DNA structure and genetics
- ☐ Protein synthesis and enzymes
- ☐ Cell structures
- ☐ Biodiversity
- ☐ Heart and bloodflow

Question	Marks
1	/5
2	/6
3	/4
4	/4
5	/4
6	/8
7	/9
8	/9
9	/7
Total	/55
%	
Grade	

Target grade

- ☐ **OT**
- ☐ **BT**
- ☐ **AT**

1 Read through the following passage on the structure of DNA, then fill in the most appropriate word or words to complete the passage.

A DNA molecule consists of two strands of mononucleotides. Each of these strands is twisted around the other, forming a _____.

Each mononucleotide consists of a pentose sugar called deoxyribose, a base and a phosphate. The two strands are held together by complementary base pairing.

Adenine bonds with _____ and cytosine bonds with _____. The name of the bond that forms between these bases is a _____ bond. A DNA molecule that is composed of 34% adenine will be composed of _____ % cytosine.

(6 marks)

2 Cystic fibrosis and albinism are examples of recessive genetic disorders. Krabbe disease is another example of a recessive genetic disorder.
Krabbe disease is caused by mutations in the GALC gene, resulting in a deficiency of an enzyme called galactocerebrosidase.

a Explain the meaning of each of the following terms.

i Mutation

(2 marks)

ii Recessive

(1 mark)

b Explain how a mutation in the GALC gene could result in a change in the enzyme galactocerebrosidase.

(3 marks)

3 Transcription and translation are two main stages in protein synthesis.

a Complete the table below by writing the word **transcription** or **translation** next to the appropriate statement about protein synthesis.

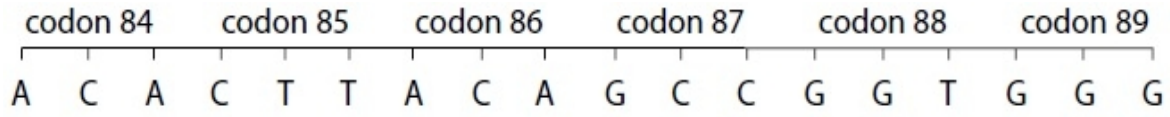
Statement	Stage of protein synthesis
Ribosomes are involved.	
DNA acts a s a template.	
tRNA is involved.	
Peptide bonds are made.	
mRNA is made.	

(5 marks)

b The table below shows some amino acids and their corresponding DNA triplet codons. The DNA triplet codons for a stop signal are also shown.

Amino acid/stop signal	DNA triplet codons
Proline	GGT GGG GGA
Alanine	CGG CGA CGT CGC
Cysteine	ACA ACG
Serine	AGG AGA AGT AGC
Leucine	GAA GAG GAT GAC
Arginine	GCA GCG GCT GCC
Glutamine	CTT CTC
Gkycine	CCT CCG CCA CCC
Threonine	TGC TGA TGT TGG
Stop signal	ATT ATC ACT

The diagram below shows part of a DNA molecule.



i Place a cross (☒) in the box next to the amino acid coded for by codon 85.

A Leucine ☐
B Glutamine ☐
C Glycine ☐
D Serine ☐

(1 mark)

ii Place a cross (☒) in the box next to the sequence of amino acids found in the polypeptide chain that is coded for by this part of the DNA strand.

A cysteine glutamine cysteine arginine proline proline ☐
B threonine leucine threonine alanine glycine glycine ☐
C cysteine glutamine cysteine arginine glycine glycine ☐
D cysteine proline cysteine arginine proline proline ☐

(1 mark)

iii Place a cross (☒) in the box next to the sequence of bases on a molecule of messenger RNA (mRNA) synthesised from this part of the DNA molecule.

A A C A C T T A C A G C C G G T G G G ☒

B T G T G A A T G T C G G C C A C C C ☒

C U G U G A A U G U C G G C C A C C C ☒

D A G A C U U A G A C G G C C U G G G ☒

(1 mark)

4 Animal and plant cells are eukaryotic. Bacterial cells are prokaryotic.

Name **three** structures that are present in prokaryotic cells but absent in animal cells.

1

2

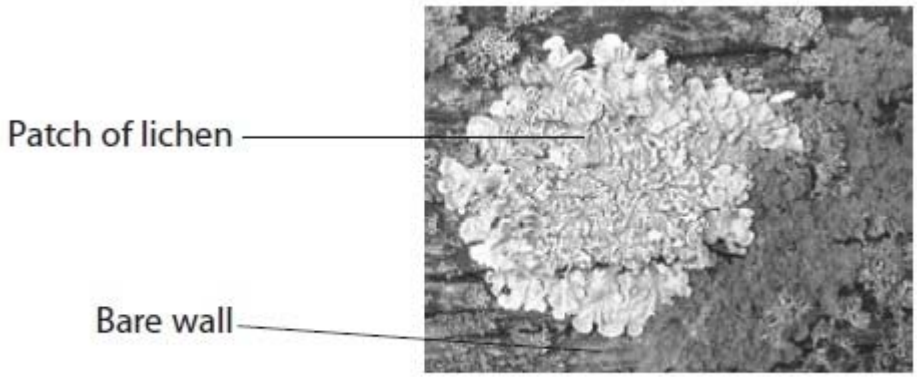
3

(3 marks)

5 Lichen consists of two organisms, an alga and a fungus, growing together.

The alga photosynthesises producing carbohydrate for the two organisms and the fungus absorbs and retains water so that the lichen does not dry out.

The photograph below shows a patch of lichen growing on a wall.



Magnification × 1

Algae and fungi are eukaryotic organisms.

a Place a cross (☒) in the box next to one difference in cell structure between these two eukaryotic organisms.

A algae have chloroplasts, fungi do not ☐

B algae have circular DNA, fungi have linear DNA ☐

C fungi have chloroplasts, algae do not ☐

D fungi have circular DNA, algae have linear DNA ☐

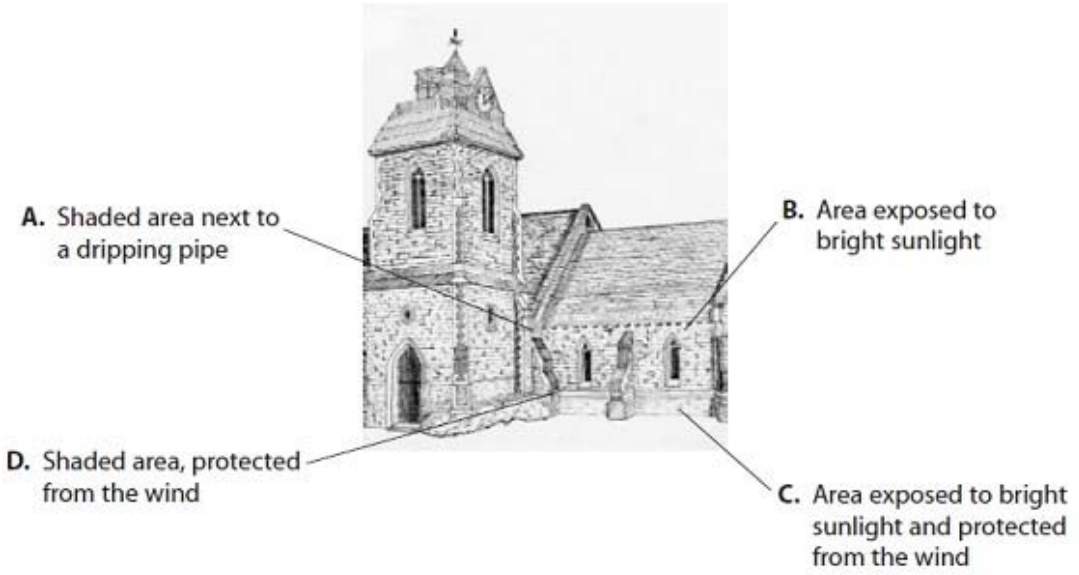
(1 mark)

b Lichens can reproduce sexually and asexually. Sexual reproduction involves meiosis and asexual reproduction involves mitosis.

Describe the advantages to lichens of being able to reproduce both sexually and asexually.

(2 marks)

c The diagram below shows the conditions at four positions, A, B, C and D, on a building.



Place a cross (☒) in the box next to one difference in cell structure between these two eukaryotic organisms.

A ☐

B ☐

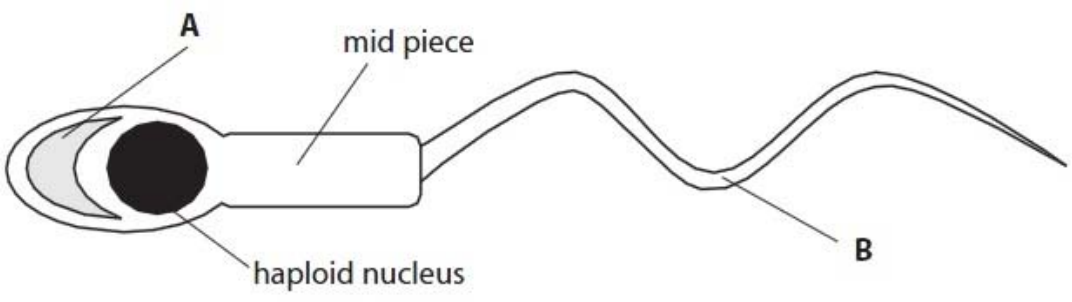
C ☐

D ☐

(1 mark)

6 Fertilisation involves the fusion of haploid nuclei.

a The diagram below shows a human sperm cell.



Name the structures labelled **A** and **B**.

A

B

(2 marks)

b Explain why it is important that the sperm has a nucleus that is haploid.

(2 marks)

7 Rhododendrons are shrubby plants that are widely distributed throughout the northern hemisphere.

The flowering periods and habitats of two species of rhododendron, found on Yakushima Island in Japan, are shown in the table below.

Species	Flowering period	Main flowering period	Habitat
Rhododendron eriocarpum	April to July	May	Rocky areas in lowland regions
Rhododendron indicum	May to July	June	High mountainous regions

Where these populations overlap, hybrid plants are found that have arisen as a result of cross-fertilisation between these two species. These hybrid plants are capable of flowering and producing viable seeds.

a Describe the reasons why some scientists might prefer to classify *Rhododendron eriocarpum* and *Rhododendron indicum* as varieties within the same species rather than as two separate species.

(3 marks)

b Explain why there is likely to be a greater genetic diversity in the hybrid plants than in either of the two separate species.

(2 marks)

c Adaptation can occur within the same species.

Leopards and panthers are members of the same species found in Africa.

Leopards have spotted fur and hunt in open grasslands, whilst panthers have black fur and hunt in forests.

Suggest how natural selection has led to the evolution of these two different forms of the same species.

(4 marks)

8 In an osmosis investigation, a student prepared five pieces of raw potato of equal mass and a range of sucrose solutions of different concentrations.

One piece of potato was placed in each sucrose solution. After two hours, the potato pieces were removed and blotted dry and the change in mass of each potato piece was calculated.

The results are shown in the table below.

Concentration of sucrose solution/mol dm^{-3}	Change in mass of potato piece/g
0.2	+1.34
0.4	+0.82
0.6	+0.31
0.8	–0.11
1.0	–0.65

a Explain the meaning of the term **osmosis**.

(2 marks)

b **i** Explain why the piece of potato placed in 0.2 mol dm^{-3} sucrose solution had the largest change in mass.

(3 marks)

ii The student suggested that there would be no change in the mass of a piece of potato placed in a sucrose solution of 0.75 mol dm^{-3}. Give an explanation for this suggestion.

c The student repeated this investigation using another potato and the results were different.

The student concluded that there was a difference in water content of the two potatoes. Describe **two** reasons for this difference in water content.

1

2

(2 marks)

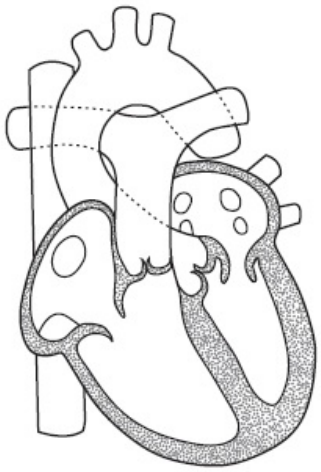
9 **a** Read through the following passage about the heart and its major blood vessels, then fill in the most appropriate word or words to complete the passage.

The mammalian heart consists of four chambers, two upper chambers called _____ and two lower chambers called ventricles.

The _____ carries oxygenated blood away from the _____ ventricle to the cells of the body and the pulmonary _____ carries deoxygenated blood to the lungs. The _____ returns deoxygenated blood back to the heart from the body.

(5 marks)

b The diagram below shows the structure of the heart.



Describe the stage of the cardiac cycle which is shown in the diagram and give a reason for your answer.

(2 marks)

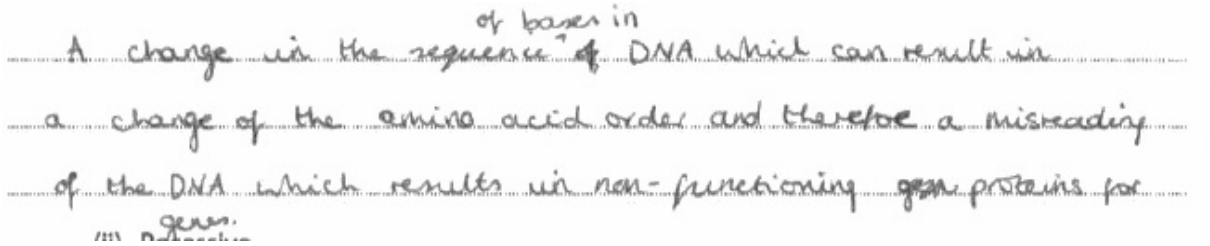
-End of assessment-

Examples of students' responses from Results Plus – Examiners' report

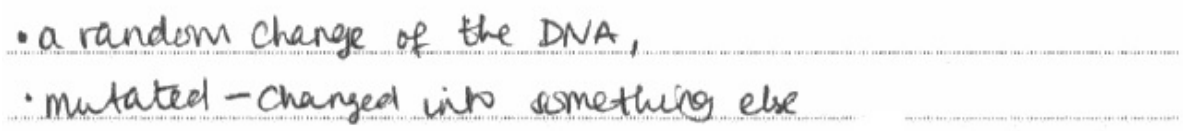
Here are some commentaries on and examples of answers to questions used in the baseline assessment – you may want to print out the answers and ask your students to mark them before sharing the examiners' commentaries.

2 a i

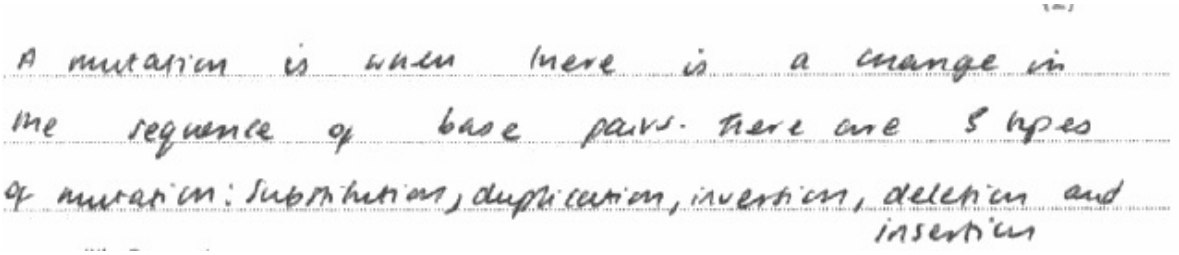
A common error here was not to refer to DNA in the answer related to a specific gene mutation. The better candidates did refer to this and clearly explained the change in base sequence or quantity of DNA. There were a few responses referring to insertion, deletion etc, but a significant number of candidates spoiled answers with references to changes in amino acid sequence in genes/DNA or alteration of cells.



The candidate has described what is changed in the DNA for both marks.



This response gains one of the two marks available. The candidate has recognised what is altered, the DNA, but has not described what the nature of the change is.



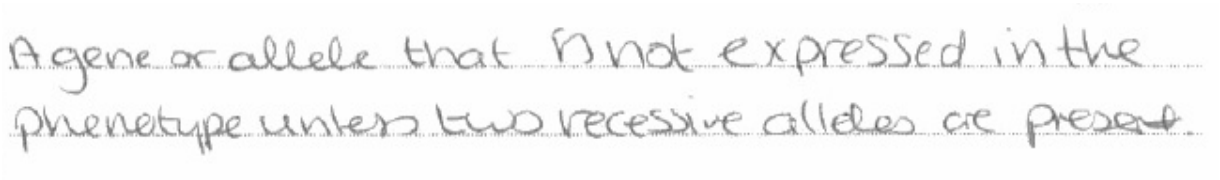
This response gains one of the two marks available. The candidate has explained what the change is, but has not stated which molecule is altered.

Results Plus: Examiner Tip

Remember if a question is worth two marks more detail or two clear statements are often required.

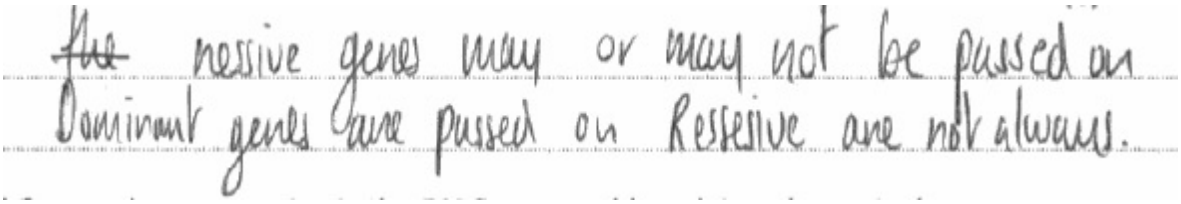
2 a ii

It was pleasing to see the large number of candidates who were able to express themselves very clearly here, demonstrating a good understanding of the term recessive. However, there were a few candidates that simply referred to 'not dominant' or 'never expressed' or 'not expressed' or 'carry disease'. There were also several irrelevant references to inheritance in answers.

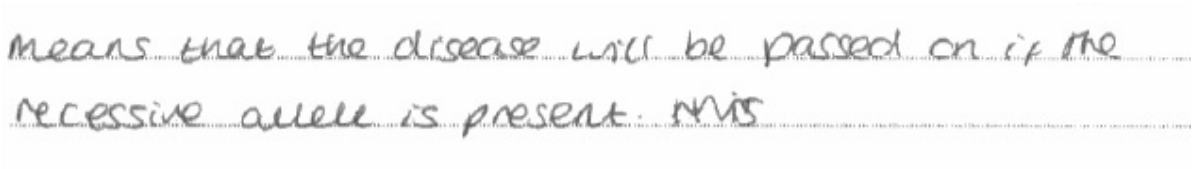


This is an example of the common correct response.

This response illustrates another common way of acceptably expressing what recessive means.



This response scores no marks. Many candidates who failed to score the mark concentrated on inheritance rather than expression of the characteristic.



This response scores no marks. Many candidates mistakenly associate recessive genes only with disease and disorders.

Results Plus: Examiner Tip

A genetic disorder could be caused by a recessive or dominant allele. It is also important to remember that genes are not only associated with diseases and disorders – they do a lot more as well.

2 b

This was generally well answered with many candidates correctly describing the effects of a mutation on primary structure, the shape of protein/enzyme (3D/tertiary structure) and on the active site, thus gaining all 3 marks. There were only a few candidates who identified the potential effect of incorrect stop codons and only a few on no synthesis or incomplete synthesis of the enzyme. A number of candidates vaguely referred to the enzyme not functioning.

A mutation in GALC gene leads to a change in the primary structure of the enzyme. This leads to different amino acids being joined and so are bonded differently. This can change the shape of the enzyme and so the enzyme may no longer be specific to carry out its function. The active site of the enzyme will be different and so will not be able to catalyse any ~~substrate~~ Substrate

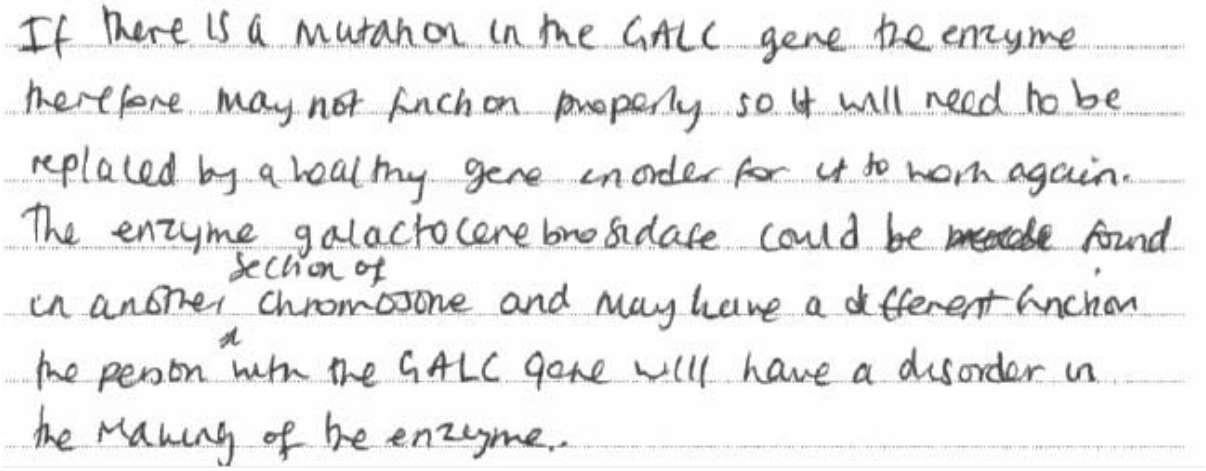
This response scores all three marks available. This candidate has correctly identified that the mutation will affect the primary structure of the protein that will change the 3D shape and therefore the active site of the enzyme will be changed.

The mutation in the gene could lead to an enzyme diffraency if the mutation changes ~~the~~ ~~blocks~~ the active sites of the enzyme. the enzyme would then not be able to bind with a substrate

This response scores one of the three marks available. The candidate has correctly identified what will happen to the enzyme for a mark, but has not answered the question which asks them how the mutation results in the change.

Results Plus: Examiner Tip

Read the question carefully and answer the question asked!



This response scores no marks. This is an example of a candidate who has failed to focus on what has been asked by the question.

3

Candidates generally scored well in this question. A good understanding of the genetic code was demonstrated in **b**. It is acknowledged that for a multiple choice-type question there was a lot of working out needed and that this was time-consuming for the candidates.

4

Generally, this question was well answered. However, when a question asks for **'three'** structures and there are spaces for three responses, clearly numbered 1, 2 and 3, it is advisable to stick to three and not to write several possibilities on each line. When candidates provide more answers than requested, they cannot expect an examiner to pick the three correct ones from a list and just ignore all the incorrect guesses.

The commonest error was providing 'flagellum' as an example, even though candidates should have studied the structure of human gametes for this paper, and should have been aware of the fact that sperms cells are animal cells which possess a flagellum.

Other errors included 'plastid' instead of 'plasmid' and 'capsid' instead of 'capsule'.

5

Students performed well in this question overall, despite the study of lichen being an unfamiliar context for field work.

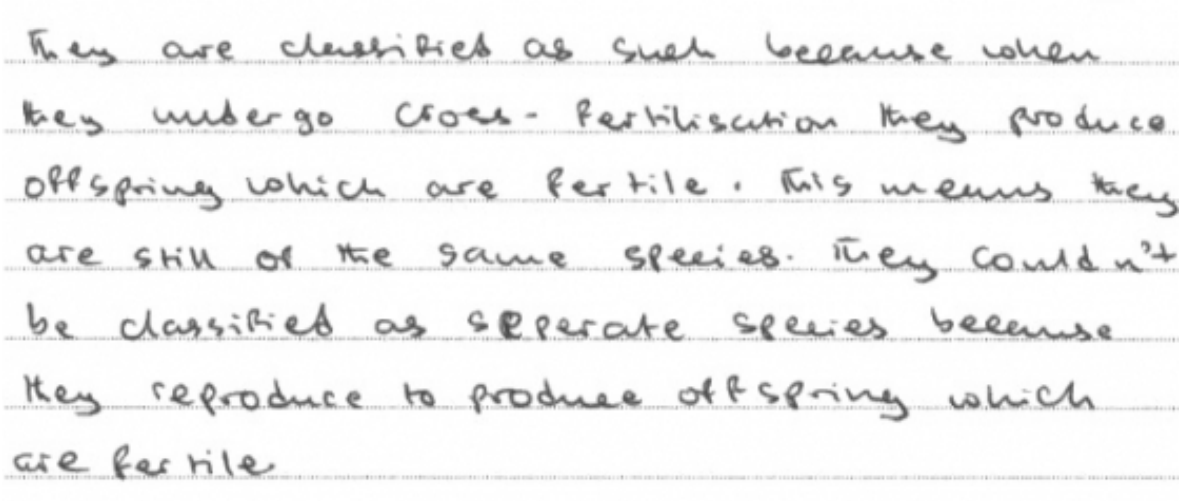
The majority of students scored well in parts **a**, **b** and **c**, indicating that the AS content has been revisited in preparation for the synoptic element of this question.

6

The accurate naming of sperm cell structures is expected. Many responses to **a ii** focused on fertilisation restoring the diploid number, but some explanations needed more clarity. Few candidates made reference to 23 and 46 (23 pairs) of chromosomes, nor did many extend their comments to cover the other major function of allowing genetic variation.

7 a

Many candidates were able to gain some credit by giving a definition of a species. However, relatively few of these then related this to these actual examples being able to produce a hybrid that is able to produce viable seed. Some candidates gave lengthy descriptions about similar features without any reference to the possibility of interbreeding. The terms 'fertile' and 'viable' were used by many candidates to mean the same thing.


They are classified as such because when they undergo cross-fertilisation they produce offspring which are fertile. This means they are still of the same species. They couldn't be classified as seperate species because they reproduce to produce offspring which are fertile

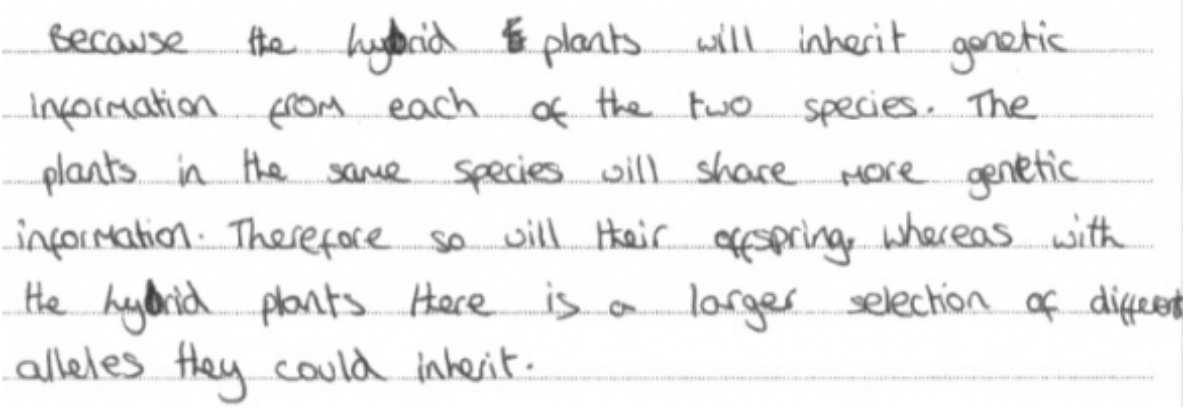
This response has the correct idea of the definition of a species. However, the hybrids being fertile does not mean that the seed they produce would be viable.

Results Plus: Examiner Tip

Pay careful attention to terms such as 'fertile' and 'viable' to make sure you understand exactly what they mean.

7 b

Most candidates realised that the hybrids would inherit from two types of parent but did not use terminology correctly or include sufficient detail. As in the previous question, the terms 'allele' and 'gene' were often confused. Many answers were too vague and did not explain why the two separate gene pools of the parents would have different alleles so that there was a greater variety available to the hybrids.


Because the hybrid plants will inherit genetic information from each of the two species. The plants in the same species will share more genetic information. Therefore so will their offspring whereas with the hybrid plants there is a larger selection of different alleles they could inherit.

The reference to 'genetic information' is not sufficient to give the idea of different alleles from both parents. The last sentence justifies awarding a mark.

Results Plus: Examiner Tip

When referring to genetic information, be specific and use 'allele' and 'gene' appropriately.

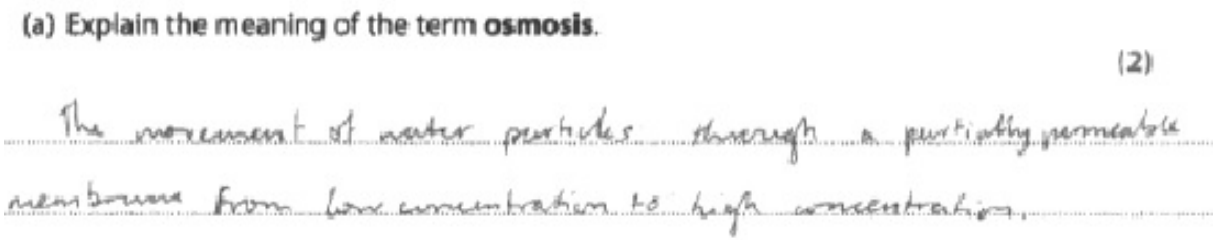
7 c

Part **c** enabled some candidates to demonstrate a very clear understanding of the evolutionary process. The best answers tackled the question in a logical sequence. Most comments that gained few marks either tended to detail just one area, or considered that the question was a genetics one relating to cross breeding.

8

This question caused candidates the most problems, even though it was based on a very basic and traditional biological experiment.

If **a** had been well answered we could have made the comment that candidates knew the meaning of the term, but had no understanding of the process. However, very few candidates could clearly explain the meaning of the term, giving vague statements that did not clearly indicate what concentrations they were referring to. This is illustrated in the response below that could only be awarded mp 1.


(a) Explain the meaning of the term **osmosis**.

(2)

The movement of water particles through a partially permeable membrane from low concentration to high concentration.

The marks for this question were generally scored in **c** and **d**.

9

This question was well answered by candidates who knew the names of the stages of the cardiac cycle and the valves. Candidates are expected to know the names of the stages of the cardiac cycle and the names of the chambers of the heart, the valves and the blood vessels entering and leaving the heart.

Section A: Cells

Table of resources in this section

Topics covered	Type of resource	Resource name	Brief description and notes for resource
• Cells and microscopy • Mitosis • Gram staining • Osmosis	Teacher resource	Suggested activities	Specification references and practical information for the lesson ideas.
• Cell structure • Mitosis • Microscopy • Diffusion, osmosis and active transport	Teacher resource	Summary sheets	Information that can used to support practical activities in the lab or completion of the consolidation activities
• Cell structures	Student worksheet	Worksheet 1: Cell structures 1	Extracting information from text to list the features of animal, plant and bacterial cells.
• Cell structures	Student worksheet	Worksheet 2: Cell structures 2	Extracting information from text and using it to draw and label animal, plant and bacterial cells.
• Bacterial, animal and plant cell features. • Mitosis and magnification calculations. • Diffusion, osmosis and active transport.	Student questions	Practice questions	Exam questions on section covering KS4 to KS5 content. Checking how far students have progressed at the end of the section.
Lesson ideas			
• Microscope work on animal and plant cells. • Identification of cell features from light and electron microscopy images. • Measure cell length and calculate actual cell size. • Root tip squash to show cells undergoing mitosis. • Gram staining of bacteria. • Investigating osmosis in potato chips.			

Teacher resources

Suggested activities

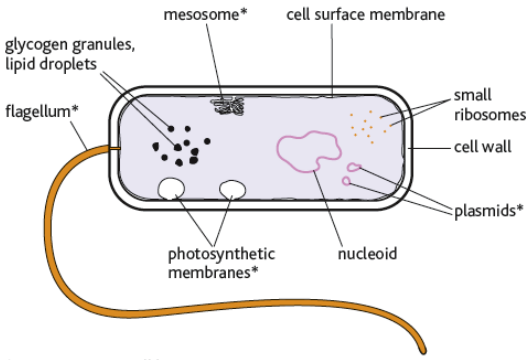
Suggested activity	Knowledge/skill addressed	A Spec reference	B Spec reference
Microscope work on animal and plant cells. Compare light and electron microscope images. Measure cell length and calculate actual cell size.	Practice using microscopes. Magnification calculations.	3.3	2.1
Root tip squash to show cells undergoing mitosis. http://www.nuffieldfoundation.org/practical-biology/investigating-mitosis-allium-root-tip-squash Calculate the actual sizes of observed cells.	Stages of mitosis. Practice using microscopes. Magnification calculations.	Core practical 5	2.3
Gram staining of bacteria and comparison with animal and plant cell size.	Understanding of scale. Cell wall structure.		2.1
Identification of cell features from electron microscopy images.	Cell structures. Magnification calculations.	3.5	2.1
Investigating osmosis in potato chips.	Osmosis. Recording data in tables with SI units and to the correct number of decimal places.	2.3	4.2

Summary sheet 1: Cell structure

Prokaryotes are single celled organisms, including bacteria. They are simpler and smaller than Eukaryotic cells.

Bacterial cells have:

- no nucleus with circular DNA free in the cytoplasm
- cell wall made from peptidoglycan
- no membrane-bound organelles
- small ribosomes.

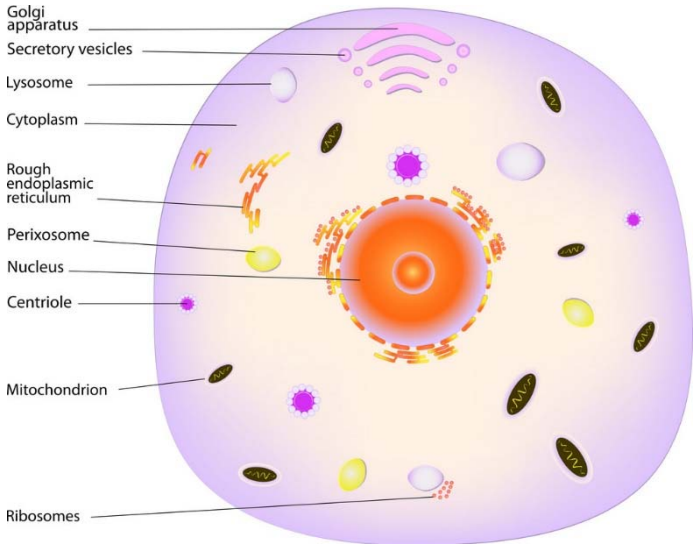


* = not present in all bacteria

Eukaryotic cells include animal and plant cells. They are larger and more complex than prokaryotic cells.

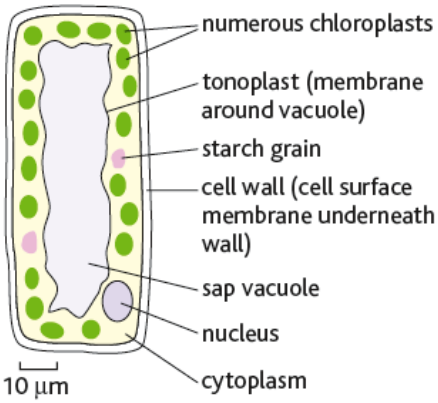
Animal cells have:

- linear DNA contained inside a nucleus
- no cell wall
- larger ribosomes and many membrane-bound organelles including mitochondria where aerobic respiration occurs and endoplasmic reticulum and golgi which are involved in the processing of proteins.

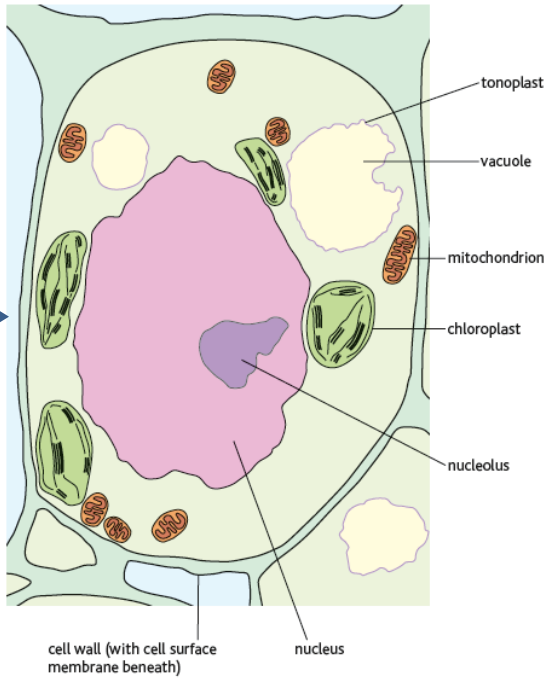


Plant cells have the same organelles as animal
cells but they also have:

- a cell wall
- a large vacuole containing cell sap
- chloroplasts for photosynthesis.



greater detail

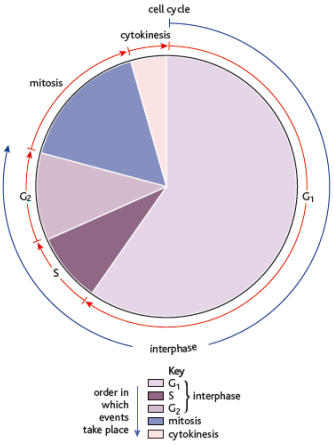


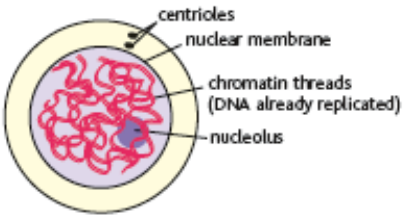
Summary sheet 2: Mitosis

Mitosis results in the production of two genetically identical diploid body cells. It occurs during growth, repair and asexual reproduction.

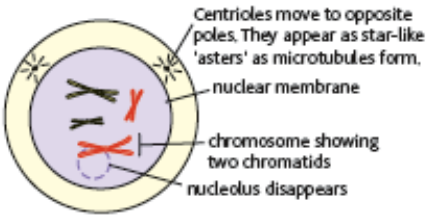
Mitosis occurs during the cell cycle. The cell cycle consists of a period of cell growth and DNA replication known as interphase and then a period of cell division called mitosis followed by cytokinesis where the cytoplasm divides and the cell membrane constricts to form the two daughter cells.

Mitosis is broken down into stages – prophase, metaphase, anaphase and telophase, followed by cytokinesis.

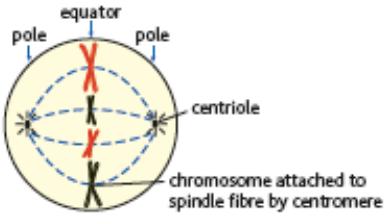




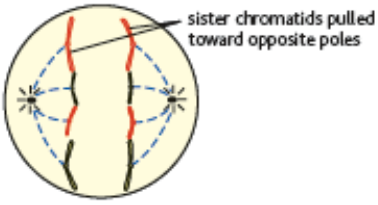
A Interphase: before mitosis the tangled, uncoiled mass of chromosomes fills the nucleus. DNA is replicated during this stage.



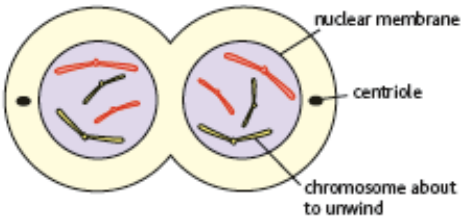
B Prophase: the chromosomes coil and condense, each one appearing as two chromatids. The nucleolus breaks down and the centrioles begin to separate and start to form the spindle.



C Metaphase: the nuclear membrane breaks down. Spindles made of microtubules have been formed by the centrioles. The chromatids line up on the equator.



D Anaphase: the centromeres separate and each chromatid is pulled along a along a spindle tubule towards one of the poles centromere first.



E Early telophase: the chromatids reach the poles of the cell where they are now known as chromosomes. The membrane begins to reform and the cytoplasm to divide.

F Late telophase: the chromosomes begin to 'decondense'. The nuclear membranes and nucleoli are fully reformed and centrioles are present again. The division of the cytoplasm continues until two new identical cells are formed which once more enter interphase.

Summary sheet 3: Microscopy

Magnification is how much bigger the image is than the specimen on the microscope slide.

The size of the specimen can be calculated using the formula:

$$\textbf{length of the specimen} = \frac{\textbf{length of the image}}{\textbf{magnification}}$$

With a light microscope the magnification is the combination of the magnification of the objective lens and the eye piece lens.

For example a 40× objective lens and a 10× eye piece lens produce a total magnification of 400×.

When you are doing magnification calculations you must have all the lengths in the same units.

1 cm	10 mm
1 mm	1000 µm
1 µm	1000 nm

Calculation

Calculate the actual size of a cell with a diameter of 8 mm using 100× magnification.

$$\text{Actual size} = \frac{8}{100} = 0.08 \text{ mm}$$

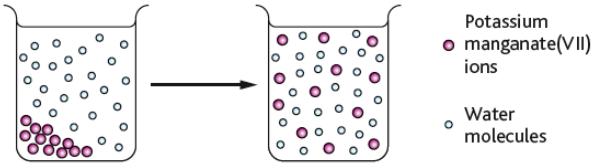
$$= 80 \text{ µm}$$

Resolution is a measure of how easy it is to distinguish between two points that are close together i.e. how much detail can be distinguished. Electron microscopes have a better resolution than light microscopes so they can see more detail.

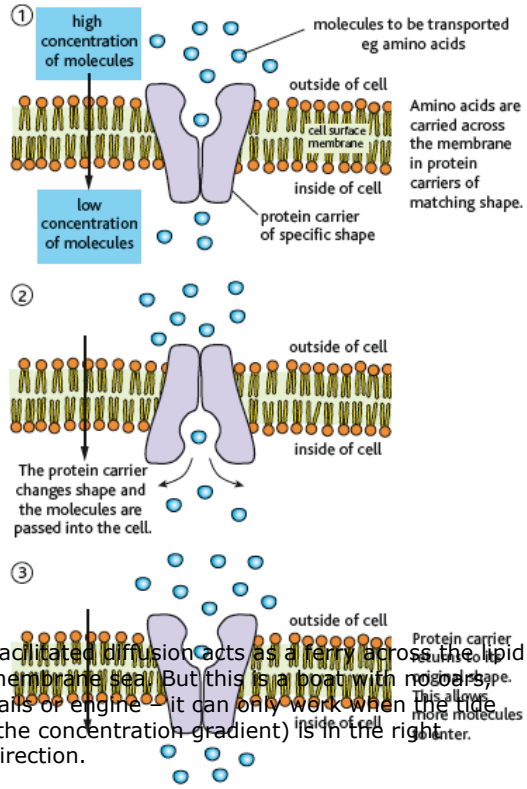
Summary sheet 4: Diffusion, osmosis and active transport

Diffusion

Liquid and gas particles are constantly moving which causes particles to move from an area of high concentration to an area of low concentration.



Observing the process of diffusion. If the beaker is left to stand the random motion of both the water and the purple manganate(VII) ions will ensure they are eventually evenly mixed.

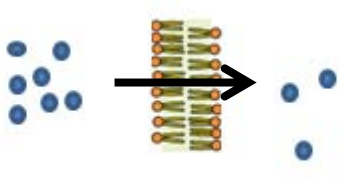


Facilitated diffusion acts as a ferry across the lipid membrane seal. But this is a boat with no oars, sails or engine – it can only work when the tide (the concentration gradient) is in the right direction.

Small particles can diffuse across cell membranes and no energy is required. Some molecules, such as glucose, are too large to diffuse across the cell membrane so they must be helped by carrier proteins. Each molecule has its own carrier protein that allows the molecule through the cell membrane without the need for energy. This is known as facilitated diffusion.

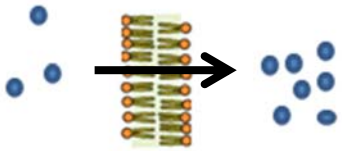
Osmosis

Osmosis is the diffusion of water molecules from an area of higher concentration of water molecules to an area of lower concentration of water molecules across a partially permeable membrane.



Active transport

Active transport uses energy to transport substances across membranes from an area of lower concentration to an area of higher concentration



Worksheet 1: Cell structures 1

Extracting key information from text is an important study skill for A-level candidates.

Read through the passage below about animal, plant and bacterial cells. Use the information and your own knowledge to complete the table to list some of the structural features of animal, plant and bacterial cells.

The plant cell and the animal cell possess a nucleus containing chromosomes and a nucleolus. In a bacterial cell the DNA is located in the cytoplasm. Only the bacterial cell and the plant cell have a cell wall but all three cells have a cell membrane. The plant cell wall is made of cellulose and the bacterial cell wall is made of peptidoglycan.

Centrioles are present only in the animal cell and chloroplasts are found only in the plant cell. Mitochondria and rough endoplasmic reticulum are not present in the bacterial cell. All three cells contain structures called ribosomes which are involved in the synthesis of protein. Bacterial cells can have pili or a capsule.

Features present in animal cells	Features present in plant cells	Features present in bacterial cells

Extension activity – research a function for each feature listed.

Worksheet 2: Cell structures 2

Extracting key information from text is an important study skill for A-level candidates.

Read through the passage below about animal, plant and bacterial cells. Use the information and your own knowledge to draw and label an animal, plant and bacterial cell. You should include the features listed if appropriate.

The plant cell and the animal cell possess a nucleus containing chromosomes and a nucleolus. In a bacterial cell the DNA is located in the cytoplasm. Only the bacterial cell and the plant cell have a cell wall but all three cells have a cell membrane. The plant cell wall is made of cellulose and the bacterial cell wall is made of peptidoglycan.

Centrioles are present only in the animal cell and chloroplasts are found only in the plant cell. Mitochondria and rough endoplasmic reticulum are not present in the bacterial cell. All three cells contain structures called ribosomes which are involved in the synthesis of protein. Bacterial cells can have pili or a capsule.

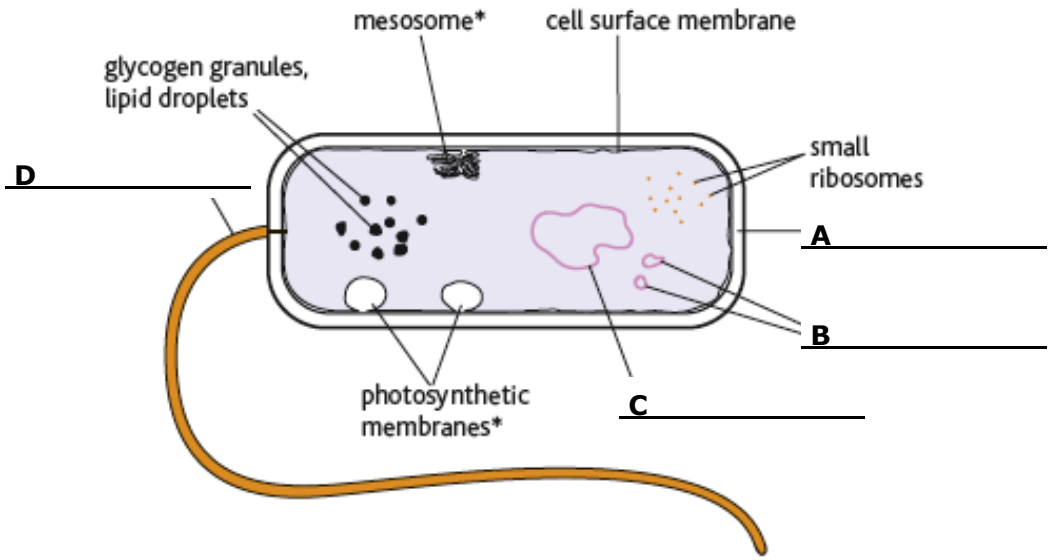
cell wall	nucleus	cell membrane	ribosome	capsule
mitochondria	cytoplasm	chloroplast	plasmid	chromosome

Animal cell	**Plant cell**
Bacterial cell	

Extension activity – research any unfamiliar features and add them to your cell diagrams.

Practice questions

1 The diagram shows a bacterial cell with some of the key features labelled.



a Label cell features A, B, C and D.

b Complete the table to identify three features present in animal cells and describe their function.

Animal cell feature	Function

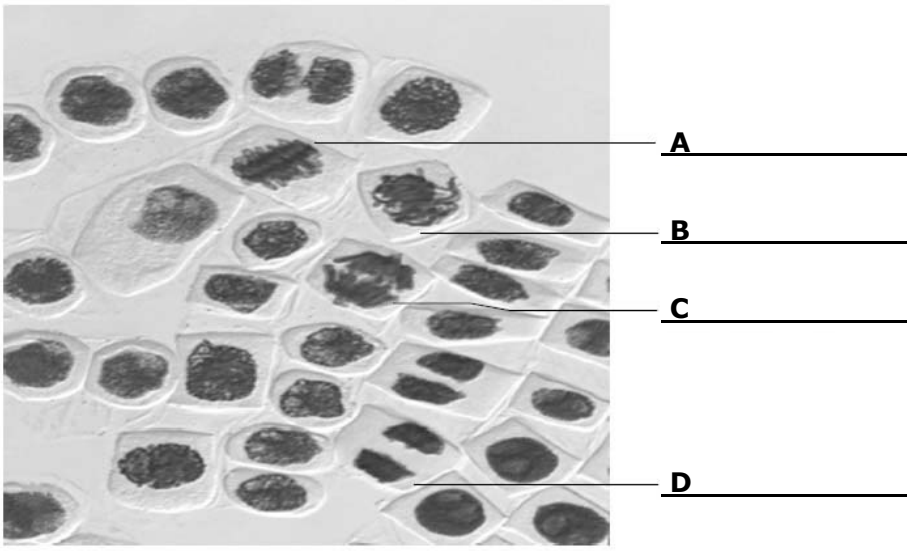
c Some antibiotics prevent protein synthesis by targeting the ribosome.

Ribosomes in eukaryotes have a different structure to prokaryotes.

In no more than 50 words, explain why these types of antibiotics can be used to treat bacterial infections without effecting human cells.

Concise writing which refers to key scientific ideas is effective.

2 The image shows root tip cells at different stages of the cell cycle.

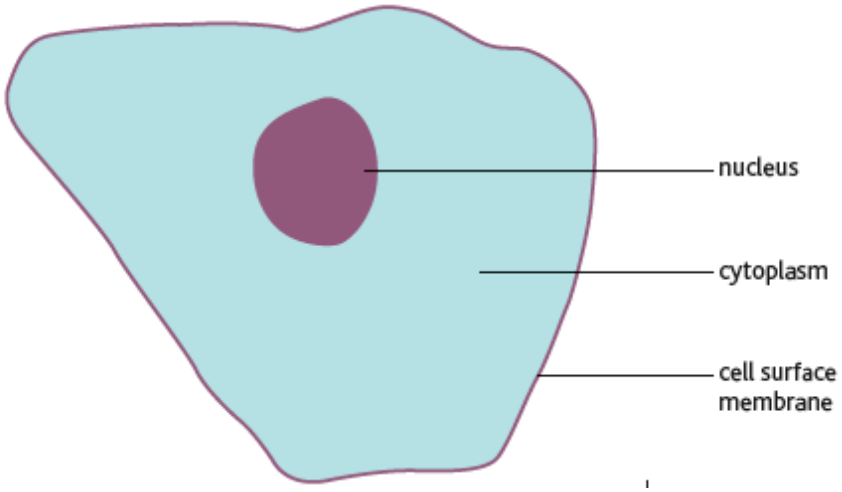


a Identify the stages of mitosis for cells A, B, C and D.

b The microscope used to view the cells had a 10× eye piece lens. Which objective lens was needed to view the cells at this magnification level?

c Calculate the length of cell A.

3 The diagram shows an animal cell with three key features labelled.



a Identify three additional features which are found in animal cells and describe their functions.

1

2

3

b An image of an animal cell nucleus with a diameter of 6 μm was obtained using a 10× eye piece lens and 20× objective lens. Calculate the diameter of the nucleus on the image.

Substances can be transported into cells through diffusion, osmosis and active transport.

4 Write a definition for diffusion, osmosis and active transport.

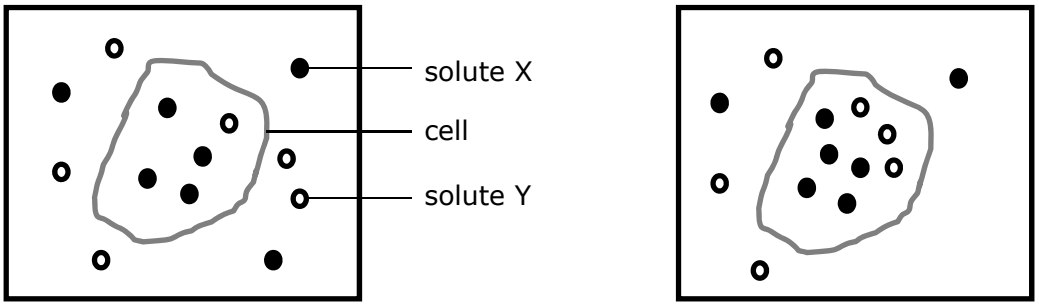
Diffusion:

Osmosis:

Active transport:

5 Cells were placed in a solution containing solute X and solute Y.

The diagram below represents the concentration of the two solutes inside and outside one of the cells, when this cell was placed in the solution and then after 30 minutes.



Explain the movement of solute X and solute Y into the cell.

6 A red blood cell was placed in a solution of distilled water.

Explain the effect on the red blood cell of being placed in a solution of distilled water.

7 Explain the key word 'isotonic'.

8 A student took 15 identical sized potato chips. The mass of each chip was recorded and the chips were placed in 4 salt solutions (0.1M, 0.2M, 0.3M and 0.4M) and pure water for 30 minutes. The chips were dried and the mass recorded. The mass change and % change in mass was calculated.

Design a table to record the students raw and processed data.

When recording data in tables units must be included in headers of the tables. All units should be SI.

Section B: Molecules

Table of resources in this section

Topics covered	Type of resource	Resource name	Brief description and notes for resource
• Enzyme activity and action • Translation	Teacher resource	Suggested activities	Specification references and practical information for the lesson ideas.
• Protein synthesis • Enzyme activity	Teacher resource	Summary sheets	Information that can used to support practical activities in the lab or completion of the consolidation activities
• Carbohydrates	Student worksheet	Worksheet 1: Carbohydrates	Distinguishing between monosaccharides, disaccharides and polysaccharides.
• Data analysis	Student worksheet	Worksheet 2: Data analysis	Task to show the effect of recording and processing data to the correct number of decimal places.
• Rates of reaction for enzymes. • Effect of temperature on the rate of enzyme activity. • Transcription and translation and the effect of mutations on DNA sequences.	Student questions	Practice questions	Exam questions on section covering KS4 to KS5 content. Checking how far students have progressed at the end of the section.
Lesson ideas			
• Practical on the action of amylase on starch. • Practical on factors effecting enzyme action. • Modelling of lock and key hypothesis of enzyme action.			

Teacher resources

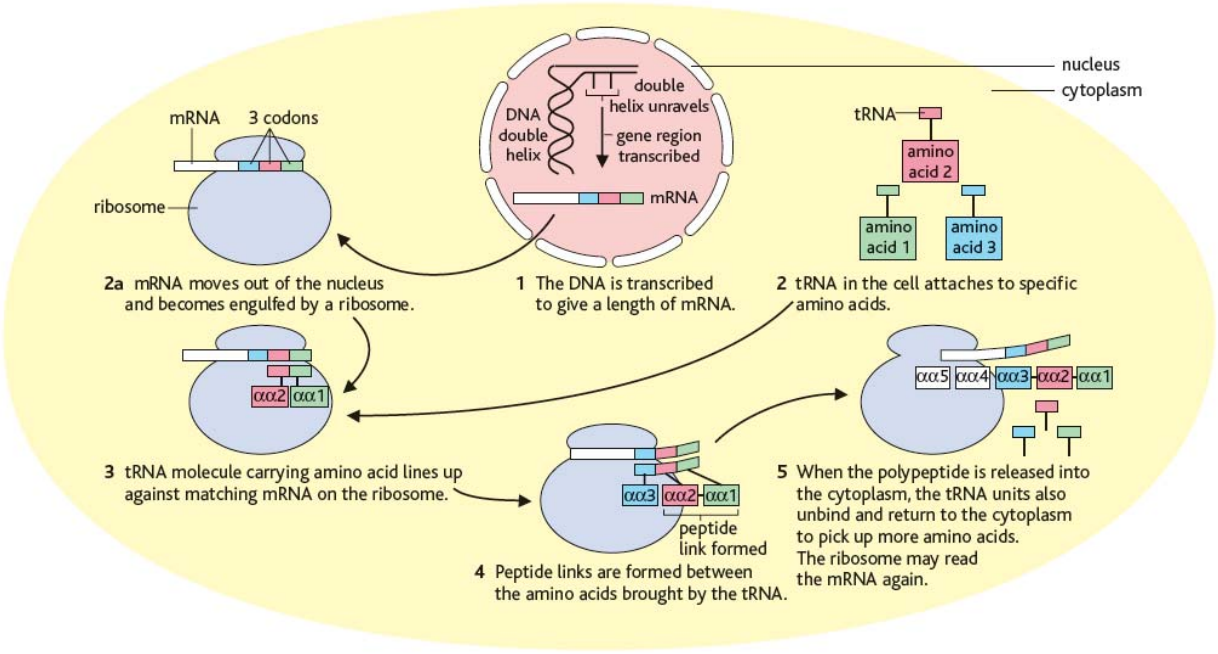
Suggested activities

Suggested activity	Knowledge/skill addressed	A Spec reference	B Spec reference
Practical investigating action of amylase on starch	Role of amylase Enzyme specificity and action Practical skills	1.12	1.1 & 1.5
Practical investigating factors effecting enzyme action http://www.nuffieldfoundation.org/practical-biology/investigating-effect-temperature-activity-lipase	Factors affecting enzyme action Practical skills	2.10 and practical	1.5
Modelling of lock and key hypothesis of enzyme action	Enzyme specificity	2.10	1.5
Translation of given DNA sequences	Transcription and translation	2.6 & 2.7	1.4

Summary sheet 1: Protein synthesis

A gene is a sequence of DNA which codes for a protein. Proteins are synthesised in a two-step process – transcription and translation.

Transcription takes place in the nucleus and translation takes place at the ribosome. A complementary mRNA strand is made using the DNA as a template. The mRNA leaves the nucleus and attaches to the ribosome in the cytoplasm. A triplet of bases on the mRNA (a codon) code for specific amino acids. The amino acids are delivered to the ribosome by tRNA. Peptide bonds are formed between the amino acids to make the polypeptide.



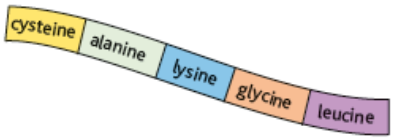
The DNA gene sequence is ACA CGG AAA CCT GAC.

The mRNA sequence is UGU GCC UUU GGA CUG.

This codes for the amino acid sequence is:

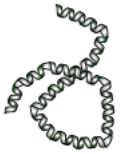
Cys-Ala-Lys-Gly-Leu

The protein folds into a specific structure.
For enzymes this means that the active site forms a specific shape that binds specific substrates.

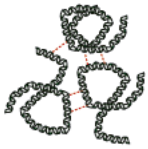


Primary structure – the linear sequence of amino acids in a peptide.

Secondary structure – the repeating pattern in the structure of the peptide chains, such as an α-helix or pleated sheets.



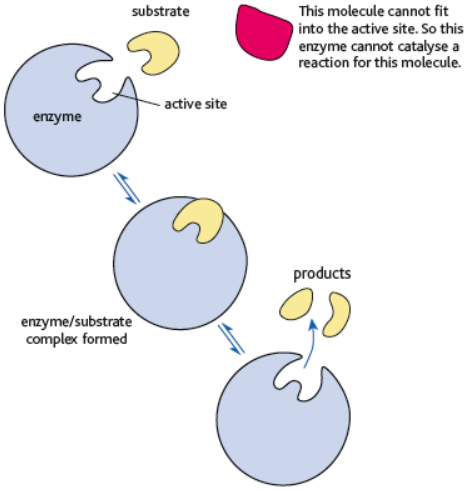
Tertiary structure – the three-dimensional folding of the secondary structure.



Quaternary structure – the three-dimensional arrangement of more than one tertiary polypeptide.

Summary sheet 2: Enzymes activity

Enzymes are biological catalysts that speed up chemical reactions. Enzymes work by reducing the amount of activation energy needed for the reaction to occur.

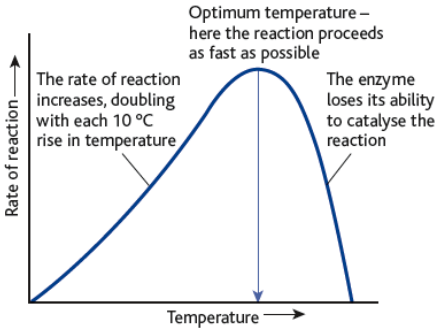


The active site of the enzyme is where the substrate binds. It has a specific shape which means enzymes can only bind to a specific substrate.

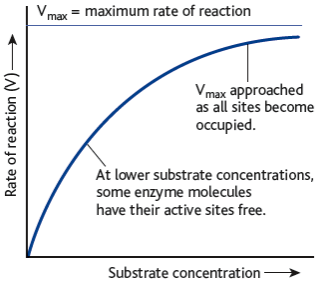
The substrate binds to the active site forming an enzyme-substrate complex. The reaction is catalysed and the products released.

Different factors can affect how quickly the enzymes work. These include temperature, pH, enzyme concentration and substrate concentration.

As temperature increases there is more chance of a collision between the enzyme and substrates, as they have more kinetic energy. This continues until the optimum temperature where the rate of reaction is highest. As the temperature continues to rise the enzyme denatures, as the active site changes shape, when bonds holding the protein together break.



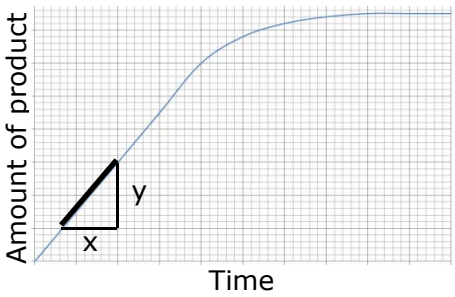
Enzymes also have an optimum pH, above and below the optimum pH the enzyme denatures.



As the substrate concentration increases there is more chance of a collision between the substrate and the enzyme. The rate of reaction increases until all the actives sites are occupied.

The rate of reaction increases as enzyme concentration increases until all the substrate is bound to an enzyme.

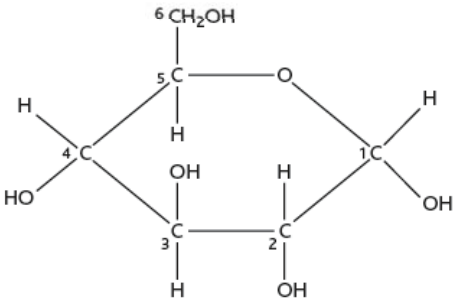
In practical situations you can sometimes measure the amount of product formed over time. The initial rate of the reaction for an enzyme can be calculated by measuring the gradient of the graph. If the line is curved a tangent to the curve can be used : gradient = y ÷ x.



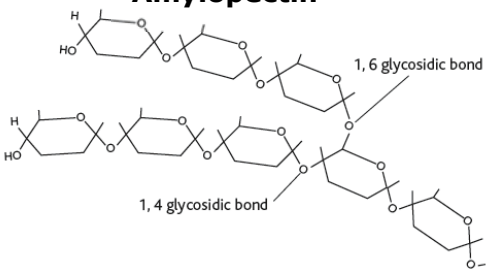
Worksheet 1: Carbohydrates

The diagram shows the chemical structures of some monosaccharides, disaccharides and polysaccharides. Giving a reason, separate the molecules into these three groups.

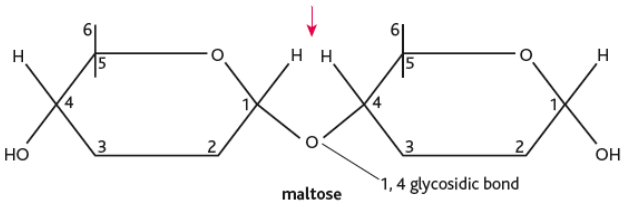
Glucose



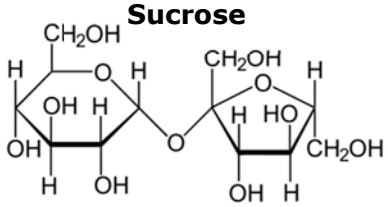
Amylopectin



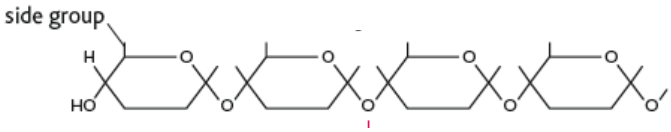
Maltose



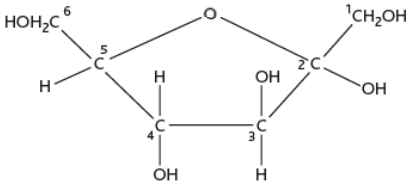
Sucrose



Amylose



Fructose



Monosaccharides	Disaccharides	Polysaccharides

Worksheet 2: Data analysis

Processed data should be recorded to the same number of decimal places as the primary data

This table shows the same data recorded to different numbers of decimal places.

Data set 1	Data set 2
2.4	2.37
3.6	3.55
4.1	4.05
2.8	2.76
3.5	3.51

1 Compare the mean values for data set 1 and data set 2.

2 Express data set 2 to 1 decimal place. What do you notice?

3 Explain why it is incorrect to record 3.28 as the mean for data set 1.

Being able to convert data, using standard form and different units, is an important skill

4 Convert the data in the table below.

Data		Value
45 100 g	into standard form	
45 100 g	into kilograms	
34 ms	into seconds	
780 μm	into millimetres	
0.25×10^{-9} s	into nanoseconds	

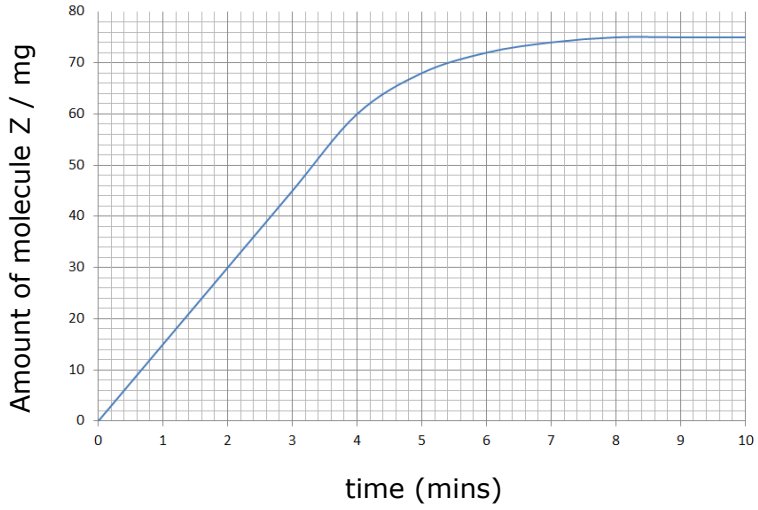
Practice questions

1 Enzyme A catalyses the breakdown of molecule X into Y and Z.

$$X \xrightarrow{\text{Enzyme A}} Y + Z$$

Molecule X and enzyme A were mixed together at 30°C at pH 6.8.

This graph shows the mass of molecule Z formed over a 10 minute time period.



a Calculate the initial rate of reaction of enzyme A.

b What is the rate of reaction of enzyme A after 8 minutes?

c Suggest a reason for the rate of reaction calculated in **b**.

2 Enzyme B catalyses the breakdown of molecule X into Y and Z.

$$X \xrightarrow{\text{Enzyme B}} Y + Z$$

Molecule X and enzyme B were mixed together at different temperatures.

This table shows the initial rate of reaction of enzyme B at 15°C, 25°C, 30°C, 35°C, 40°C and 50°C.

Temperature	Initial rate of reaction of enzyme B ($mmol.min^{-1}$)
15	8
25	14
30	18
35	20
40	18
50	12

a The table has some missing information. Add the missing information to the table.

b Plot the data from the table on graph to show the initial rate of reaction of enzyme B at different temperatures.

You should consider:

- the variable which should be on the x-axis
- the labels for the axis
- the title of the graph.

c Compare different rates of reaction of enzyme B at 20°C, 37°C and 45°C.

For questions which involve the use of data from a graph you must use scientific knowledge to explain the data you have extract from the graph.

3 Mutations in DNA can impact on the activity of enzymes.

This DNA sequence is from the region of the gene which codes for the active site of an enzyme.

GAA GAG AGT GGA CTC ACA GCT CGG

The table shows the amino acid coded for by some codons.

Amino acid/stop signal	**DNA triplet codons**
Proline	GGT GGG GGA
Alanine	CGG CGA CGT CGC
Cysteine	ACA ACG
Serine	AGG AGA AGT AGC
Leucine	GAA GAG GAT GAC
Arginine	GCA GCG GCT GCC
Glutamine	CTT CTC
Gkycine	CCT CCG CCA CCC
Threonine	TGC TGA TGT TGG
Stop signal	ATT ATC ACT

a State the amino acid sequence coded for by the sequence above.

b Using the information above explain the effect on the protein produced for the following mutations.

GAA GA**T** AGT GGA CTC ACA GCT CGG

GAA GAG AGT GGA CTC **C**CA GCT CGG

GAA GAG AGT GGA CTC ACA **A**CT CGG

Section C: Human biology

Table of resources in this section

Topics covered	Type of resource	Resource name	Brief description and notes for resource
• Practical activities on the heart, lungs, blood vessels and diffusion	Teacher resource	Suggested activities	Specification references and practical information for the lesson ideas.
• Heart and lungs • Circulatory system	Teacher resource	Summary sheets	Information that can used to support practical activities in the lab or completion of the consolidation activities
• Prefixes to scientific terms	Student worksheet	Worksheet 1: Prefixes	Defining the meaning of common prefixes used in scientific terms.
• Use of keywords	Student worksheet	Worksheet 2: Keywords	Increasing the level of detail in exam question answers.
• Heart structure and the use of keywords in answers. • The circulatory system. • Diffusion and active transport.	Student questions	Practice questions	Exam questions on section covering KS4 to KS5 content. Checking how far students have progressed at the end of the section.
Lesson ideas			
• Heart dissection • Lung dissection • Comparing the elasticity of arteries and veins. • Diffusion in agar cubes. • Calculation of surface area: volume ratios.			

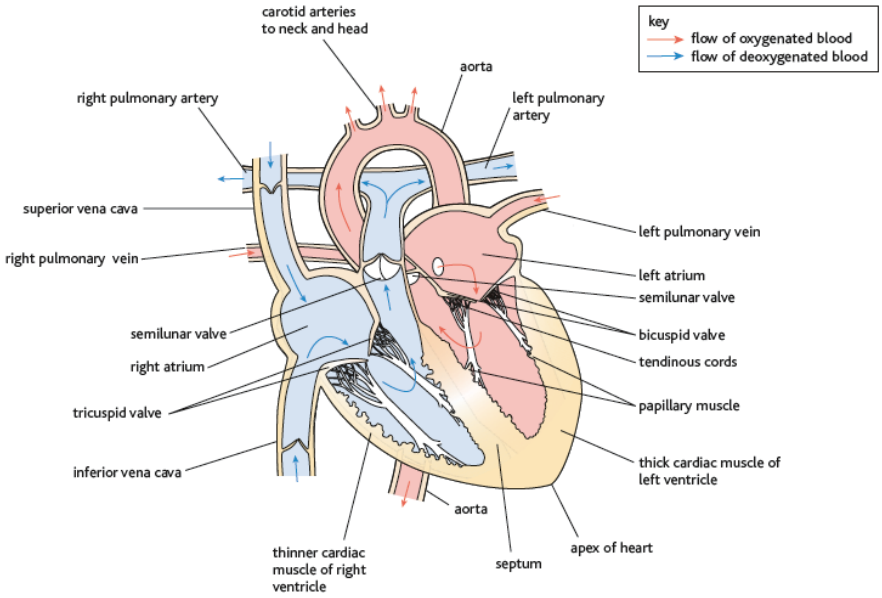
Teacher resources

Suggested activities

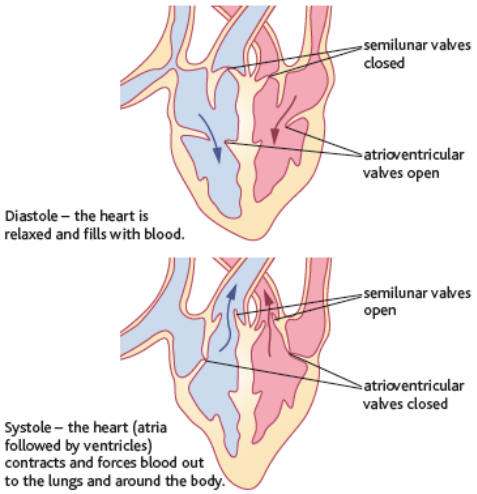
Suggested activity	Knowledge/skill addressed	A Spec reference	B Spec reference
Heart dissection Lung dissection	Heart structure Comparison of the thickness of chamber walls and blood vessels Lung structure	1.4	4.3 & 4.4
Comparing the elasticity of arteries and veins	Structure of arteries and veins Practical skills	1.3 & 2.1	4.4
Diffusion in agar cubes	Diffusion Surface area: volume ratio calculations Practical skills	2.1	4.1

Summary sheet 1: Heart and lungs

The left side of the heart pumps oxygenated blood from the lungs around the body. The blood enters the left atrium from the pulmonary vein. It flows through the atrioventicular or bicuspid valve to the left ventricle. The blood is then pumped into the aorta, through a semi-lunar valve, and around the body.



The right side of the heart pumps deoxygenated blood from the body back to the lungs. The blood returns from the body to the right atrium via the vena cava. It flows through the atrioventicular or tricuspid valve to the right ventricle. The blood is then pumped into the pulmonary artery, through a semi-lunar valve, and to the lungs.

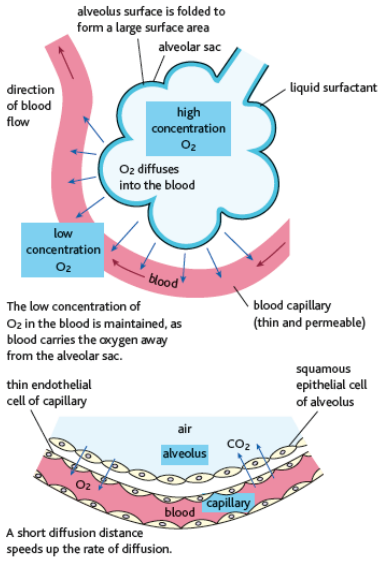


The atrioventricular valves between the atrium and ventricles open to allow blood to flow from the atrium into the ventricles and close when the pressure in the ventricles rises to prevent back flow.

The semi-lunar valves in the aorta and pulmonary artery open to allow blood from the ventricles to flow into the arteries. They close to prevent backflow into the ventricles as the heart relaxes.

Oxygen enters the blood in the alveoli of the lungs. Oxygen in the alveolus is at a high concentration and it diffuses down the concentration gradient into the blood which has a low concentration of oxygen. This low concentration is maintained because the blood is moving and carries the oxygen away.

The walls of the alveolus and capillaries are only one cell thick. This creates a short diffusion distance between the alveolus and the blood allowing a high rate of diffusion.

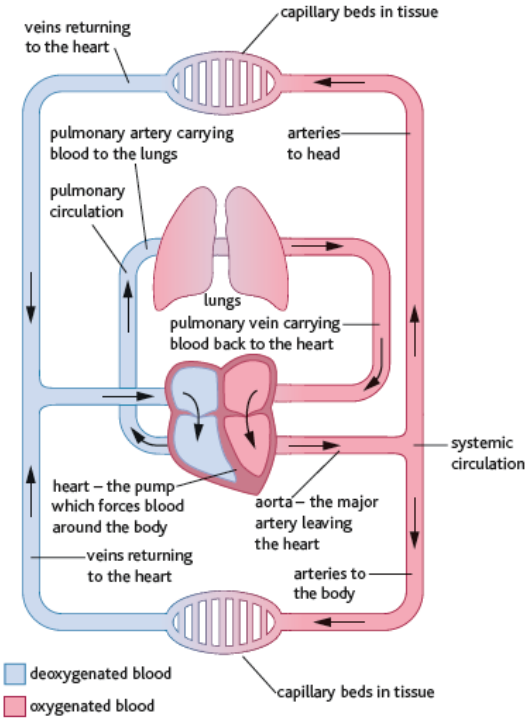


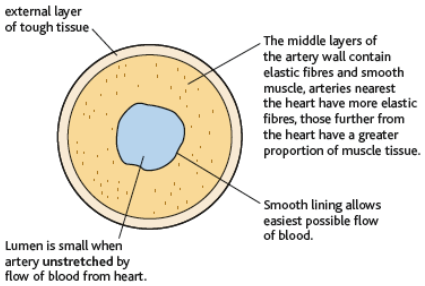
Summary sheet 2: Circulatory system

Blood flows around the body via a network of arteries, veins and capillaries.

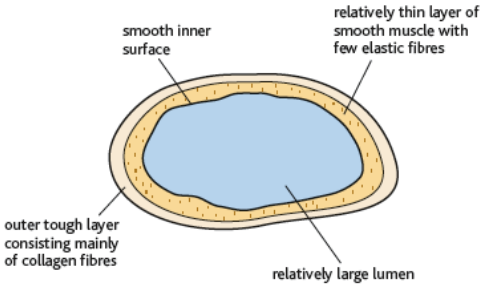
The double circulation system of mammals means that blood flows through the heart twice in one complete cycle of the body.

The pulmonary system pumps blood around the lungs and the systemic system pumps blood around the rest of the body.

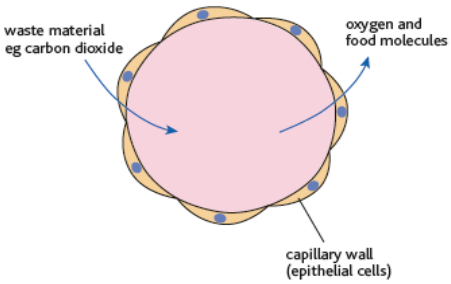




Arteries carry blood away from the heart. The vessel walls are thick and muscular with elastic fibres to withstand the high pressure generated by the heart.



Veins carry blood from capillary beds back to the heart. The blood is at low pressure and the walls of the vessels are relatively thin with less elastic fibre. The contraction of muscles help push the blood though veins and the vessels have valves to prevent backflow.



Capillaries are thin vessels that form capillary networks around tissues. They allow the exchange of substances such as oxygen, glucose and waste materials between cells and the blood.

Worksheet 1: Prefixes

Scientific terms use common prefixes. Find out the definition/meaning of the prefixes shown in the table.

Word/prefix	Definition/meaning
endo	
exo	
pulmonary	
cardiac	
hepatic	
mono	
di	
photo	
haem	
bio	
chemo	

Worksheet 2: Keywords

Candidates frequently lose marks in examinations because they do not use sufficient key words in detailed responses.

Read the responses to the questions below. Using the keywords from the box write improved answers to the questions.

concentration		capillaries		vein			
	diffusion		thin		semi-lunar		
right		pulmonary		valve			
	gradient		atrioventricular		left		
aorta		vena cava		artery			
	thick		osmosis				

1 Explain how oxygen enters the blood at the alveoli.

In the alveolus oxygen from the air moves into the blood vessels through the walls of the alveolus. The blood is moving so there is always a low concentration in the blood.

2 Describe the route blood takes from the lungs to the body.

Blood from the lungs blood travels through a vein to the atrium. The blood is pumped from the atrium into the ventricle and then into the aorta.

Practice questions

1 **a** Write a definition for each key word in the box. If possible give a structural feature for each key word.

atria	ventricles	aorta	vena cava	pulmonary artery
pulmonary vein	atrioventricular valves	septum		
semi-lunar valves	diastole	systole		

atria:

ventricles:

aorta:

vena cava:

pulmonary artery:

pulmonary vein:

atrioventricular valves:

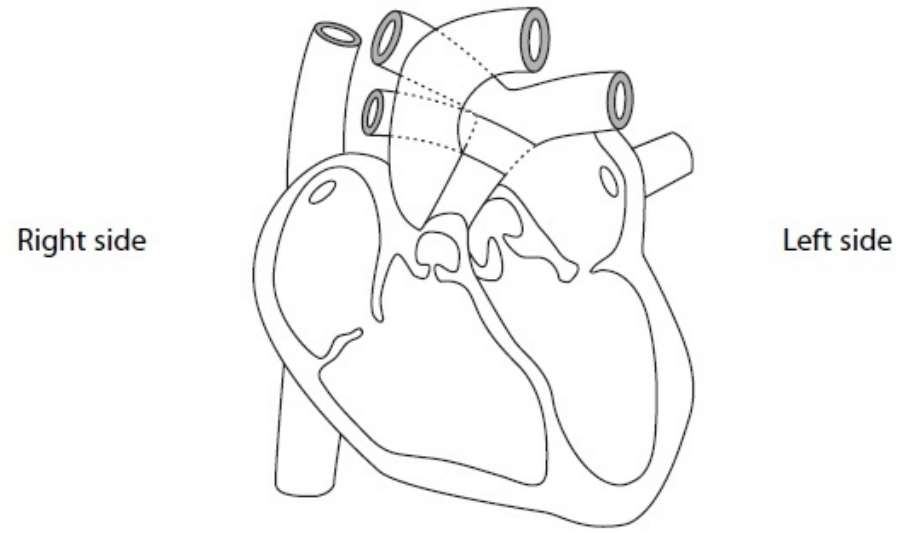
septum:

semi-lunar valves:

diastole:

systole:

b Label this diagram of the heart using as many of the key words from **1 a** as possible.

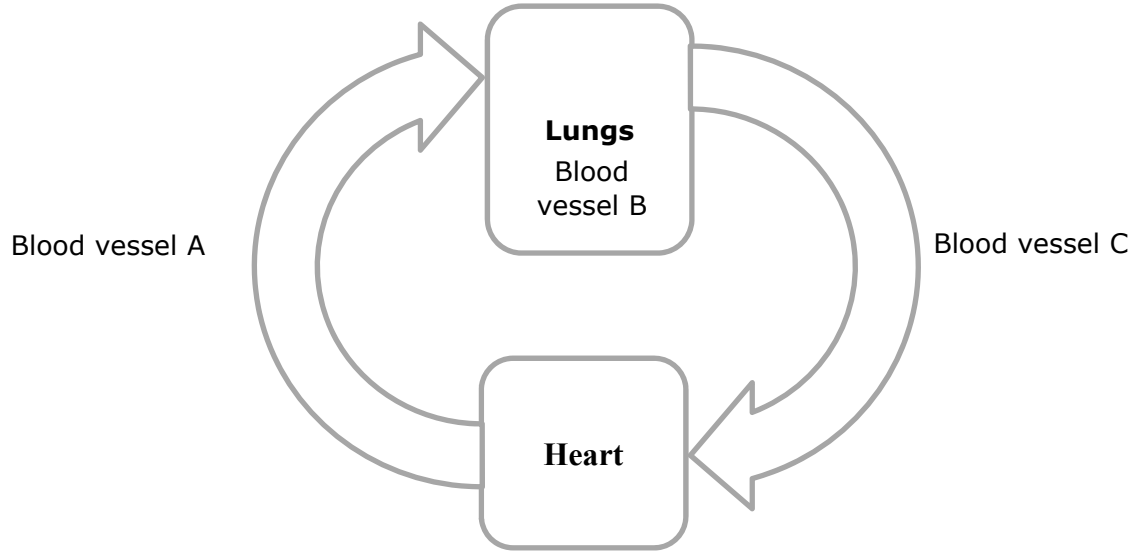


c Use the keywords from **1 a** in your answers to the following questions.

i Explain why the left ventricles has thicker chamber walls than the right ventricle and the atriums.

ii Describe the role of the atrioventricular valves.

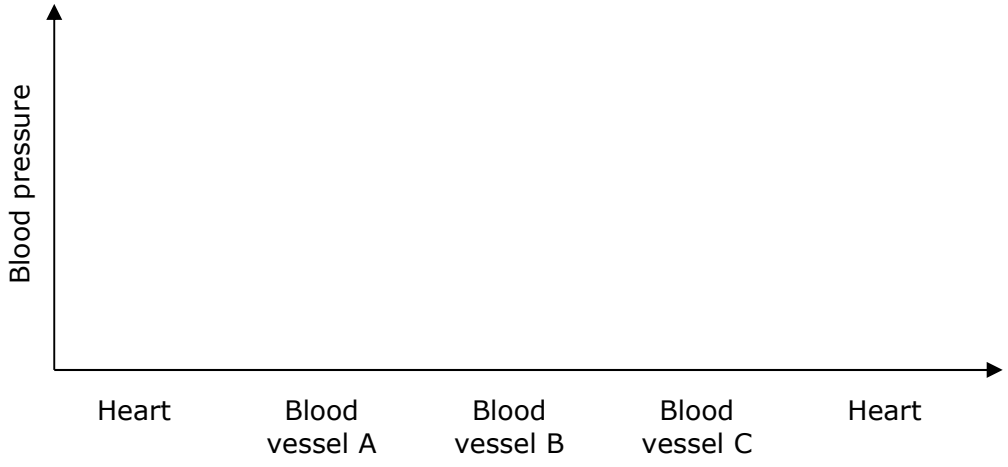
2 This flow diagram shows the part of the circulation system in a mammal.



a Complete a table to show conditions of blood vessel A, B and C.

Blood vessel	Type of vessel	Level of oxygen saturation	Relative pressure of the blood	Valves present in the vessel	Thickness of blood vessel walls
A					
B					
C					

b Draw a line on the axis to show the blood pressure changes in the blood as it flows from the heart to the lungs before returning to the heart.



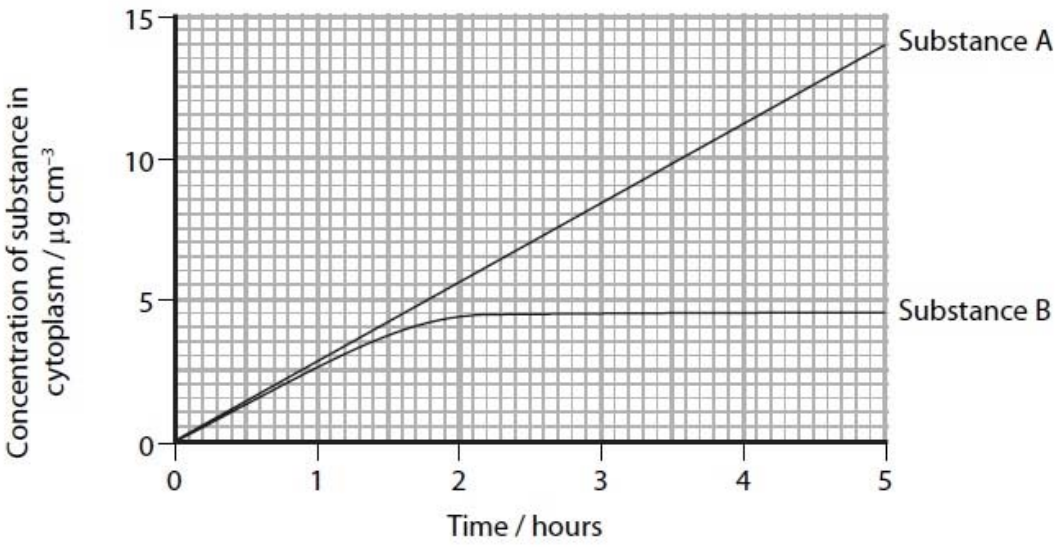
3 *Amoeba* is a single-celled aquatic organism. Substances in the water can enter the cell by a variety of mechanisms.

An experiment was carried out to compare the uptake into *Amoeba* of substance A and substance B.

Some of these organisms were placed in a solution containing equal concentrations of both substances and kept at 25ºC.

The concentration of substances A and B, in the cytoplasm of these organisms, was measured every 30 minutes over a period of 5 hours.

The results of this experiment are shown in the graph below.



a Using the information in the graph, compare the uptake of substance A with the uptake of substance B during this period of 5 hours.

b Substance B enters the cells by diffusion. Describe and explain how the results of this experiment support this statement.

c Substance A enters the cells by active transport. Give **two** differences between active transport and diffusion.

1

2

Appendices

Appendix 1: Biology A Specification mapping

GCSE to AS Biology A - Reinforcing knowledge, skills and literacy in Biology

The purpose of this document is to demonstrate the overlap between GCSE and GCE. For an effective progression through to KS5, it will be useful if centres establish a baseline point from which to build on. As teachers we sometimes fall in the trap of going over the work that has already been covered extensively at KS4; either because we feel that during the summer break students might have forgotten what they have been taught, or, if they are from different centres, they have not been taught to a good standard. This is where we lose valuable teaching time and end up rushing through the actual KS5 content. The mapping document should enable teachers to streamline the teaching and get to the KS5 content within the first two weeks of term. This will serve two purposes:

a) learners will actually feel they are learning something new and not get bored with over repetition (particularly the most able learners)

b) learners will be able to discover very early on in the course whether Biology A-Level is really a suitable subject choice for them.

The following are some suggestions for how to use this resource:

1) post KS4 exams – if your school brings back the Yr11s after their exams

2) induction weeks at the start of 6th Form

3) setting summer homework in preparation for 6th Form

4) levelling the baseline of all students from their range of KS4 qualifications.

GCSE to AS Biology A – Reinforcing knowledge, skills and literacy in Biology

GCSE statements marked with a B are additional content for single science biology only. All other statements are covered in combined science as well as biology.

GCSE statements in **bold** are higher content only

Topic 1- Lifestyle, Health and Risk	**9 - 1 GCSE**
1.1 Understand why many animals have a heart and circulation (mass transport to overcome limitations of diffusion in meeting the requirements of organisms).	8.1 Describe the need to transport substances into and out of a range of organisms, including oxygen, carbon dioxide, water, dissolved food molecules, mineral ions and urea 8.2 Explain the need for exchange surfaces and a transport system in multicellular organisms including the calculation of surface area : volume ratio
1.3 Understand how the structures of blood vessels (capillaries, arteries and veins) relate to their functions.	8.7 Explain how the structure of the blood vessels is related to their function
1.4 i) Know the cardiac cycle (atrial systole, ventricular systole and cardiac diastole) and relate the structure and operation of the mammalian heart, including the major blood vessels, to its function. ii) Know how the relationship between heart structure and function can be investigated practically.	8.8 Explain how the structure of the heart and circulatory system is related to its function, including the role of the major blood vessels, the valves and the relative thickness of chamber walls
1.6 Understand the blood-clotting process (thromboplastin release, conversion of prothrombin to thrombin and fibrinogen to fibrin) and its role in cardiovascular disease (CVD).	8.6 Explain how the structure of the blood is related to its function: a) red blood cells (erythrocytes) b) white blood cells (phagocytes and lymphocytes) c) plasma d) platelets

	5.25 Evaluate some different treatments for cardiovascular disease, including: a) life-long medication b) surgical procedures c) lifestyle changes
1.8 Be able to analyse and interpret quantitative data on illness and mortality rates to determine health risks, including distinguishing between correlation and causation and recognising conflicting evidence.	
1.13 Know how monosaccharides join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (glycogen and amylose) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.	1.12 Explain the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol
1.14 i) Know how a triglyceride is synthesised by the formation of ester bonds during condensation reactions between glycerol and three fatty acids. ii) Know the differences between saturated and unsaturated lipids.	1.12 Explain the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol
1.16 Understand how people use scientific knowledge about the effects of diet, including obesity indicators, body mass index and waist-to-hip ratio, exercise and smoking to reduce their risk of coronary heart disease.	5.24 Explain the effect of lifestyle factors on non-communicable diseases at local, national and global levels, including: a) exercise and diet on obesity and malnutrition, including: BMI and waist : hip calculations, using the BMI equation: $BMI = mass\ (kg) / (height\ (m))^2$ b) alcohol on liver diseases c) smoking on cardiovascular diseases
CORE PRACTICAL 1: Investigate the effect of caffeine on heart rate in daphnia.	

Topic 2 – Genes and health	**9 - 1 GCSE**
2.1 i) Know the properties of gas exchange surfaces in living organisms (large surface area to volume ratio, thickness of surface, difference in concentration). ii) Understand how the rate of diffusion is dependent on these properties and can be calculated using Fick's Law of Diffusion. iii) Understand how the structure of the mammalian lung is adapted for rapid gaseous exchange.	8.2 Explain the need for exchange surfaces and a transport system in multicellular organisms including the calculation of surface area : volume ratio 8.3 Explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries 8.4B Describe the factors affecting the rate of diffusion, including surface area, concentration gradient and diffusion distance 8.5B Calculate the rate of diffusion using Fick's law: rate of diffusion $\propto$ $\frac{\text{surface area x concentration difference}}{\text{thickness of membrane}}$
2.2 i) Know the structure and properties of cell membranes. ii) Understand how models such as the fluid mosaic model of cell membranes are interpretations of data used to develop scientific explanations of the structure and properties of cell membranes.	1.1 Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including: a) animal cells – nucleus, cell membrane, mitochondria and ribosomes b) plant cells – nucleus, cell membrane, cell wall, chloroplasts, mitochondria, vacuole and ribosomes c) bacteria – chromosomal DNA, plasmid DNA, cell membrane, ribosomes and flagella
2.3 Understand what is meant by osmosis in terms of the movement of free water molecules through a partially permeable membrane (consideration of water potential is not required).	1.15 Explain how substances are transported into and out of cells, including by diffusion, osmosis and active transport *1.16 Core practical: Investigate osmosis in potatoes* 1.17 Calculate percentage gain and loss of mass in osmosis
2.4 i) Understand what is meant by passive transport (diffusion, facilitated diffusion), active transport (including the role of ATP as an immediate source of energy), endocytosis and exocytosis. ii) Understand the involvement of carrier and channel proteins in membrane transport.	1.15 Explain how substances are transported into and out of cells, including by diffusion, osmosis and active transport

2.5	i) Know the basic structure of mononucleotides (deoxyribose or ribose linked to a phosphate and a base, including thymine, uracil, cytosine, adenine or guanine) and the structures of DNA and RNA (polynucleotides composed of mononucleotides linked through condensation reactions). ii) Know how complementary base pairing and the hydrogen bonding between two complementary strands are involved in the formation of the DNA double helix.	3.4 Describe DNA as a polymer made up of: a) two strands coiled to form a double helix b) strands linked by a series of complementary base pairs joined together by weak hydrogen bonds c) nucleotides that consist of a sugar and phosphate group with one of the four different bases attached to the sugar
2.6	i) Understand the process of protein synthesis (transcription) including the role of RNA polymerase, translation, messenger RNA, transfer RNA, ribosomes and the role of start and stop codons. ii) Understand the roles of the DNA template (antisense) strand in transcription, codons on messenger RNA and anticodons on transfer RNA.	3.7B **Explain how the order of bases in a section of DNA decides the order of amino acids in the protein and that these fold to produce specifically shaped proteins such as enzymes** 3.8B **Describe the stages of protein synthesis, including transcription and translation:** **a) RNA polymerase binds to non-coding DNA located in front of a gene** **b) RNA polymerase produces a complementary mRNA strand from the coding DNA of the gene** **c) the attachment of the mRNA to the ribosome** **d) the coding by triplets of bases (codons) in the mRNA for specific amino acids** **e) the transfer of amino acids to the ribosome by tRNA** **f) the linking of amino acids to form polypeptides**
2.7	Understand the nature of the genetic code (triplet code, non-overlapping and degenerate).	3.8B **Describe the stages of protein synthesis, including transcription and translation:** **a) RNA polymerase binds to non-coding DNA located in front of a gene** **b) RNA polymerase produces a complementary mRNA strand from the coding DNA of the gene** **c) the attachment of the mRNA to the ribosome**

	d) the coding by triplets of bases (codons) in the mRNA for specific amino acids **e) the transfer of amino acids to the ribosome by tRNA** **f) the linking of amino acids to form polypeptides**
2.8 Know that a gene is a sequence of bases on a DNA molecule that codes for a sequence of amino acids in a polypeptide chain.	3.7B **Explain how the order of bases in a section of DNA decides the order of amino acids in the protein and that these fold to produce specifically shaped proteins such as enzymes** 3.13 Explain the terms: chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype, gamete and zygote
2.10 i) Understand the mechanism of action and the specificity of enzymes in terms of their three-dimensional structure. ii) Understand that enzymes are biological catalysts that reduce activation energy. iii) Know that there are intracellular enzymes catalysing reactions inside cells and extracellular enzymes produced by cells catalysing reactions outside of cells.	1.7 Explain the mechanism of enzyme action including the active site and enzyme specificity 1.8 Explain how enzymes can be denatured due to changes in the shape of the active site 1.9 Explain the effects of temperature, substrate concentration and pH on enzyme activity 1.11 Demonstrate an understanding of rate calculations for enzyme activity
CORE PRACTICAL 4: Investigate the effect of enzyme and substrate concentrations on the initial rates of reactions.	1.10 *Core practical: Investigate the effect of pH on enzyme activity*
2.12 i) Understand how errors in DNA replication can give rise to mutations. ii) Understand how cystic fibrosis results from one of a number of possible gene mutations.	3.22 State that there is usually extensive genetic variation within a population of a species and that these arise through mutations 3.23 State that most genetic mutations have no effect on the phenotype, some mutations have a small effect on the phenotype and, rarely, a single mutation will significantly affect the phenotype

2.13 i) Know the meaning of the terms: gene, allele, genotype, phenotype, recessive, dominant, incomplete dominance, homozygote and heterozygote. ii) Understand patterns of inheritance, including the interpretation of genetic pedigree diagrams, in the context of monohybrid inheritance.	3.12 Explain why there are differences in the inherited characteristics as a result of alleles 3.13 Explain the terms: chromosome, gene, allele, dominant, recessive, homozygous, heterozygous, genotype, phenotype, gamete and zygote 3.14 Explain monohybrid inheritance using genetic diagrams, Punnett squares and family pedigrees 3.16 Calculate and analyse outcomes (using probabilities, ratios and percentages) from monohybrid crosses and pedigree analysis for dominant and recessive traits
2.14 Understand how the expression of a gene mutation in people with cystic fibrosis impairs the functioning of the gaseous exchange, digestive and reproductive systems.	
2.15 i) Understand the uses of genetic screening, including the identification of carriers, pre-implantation genetic diagnosis (PGD) and prenatal testing, including amniocentesis and chorionic villus sampling. ii) Understand the implications of prenatal genetic screening.	
Topic 3 – Voice of the genome	**9 - 1 GCSE**
3.2 Know the ultrastructure of eukaryotic cells, including nucleus, nucleolus, ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, and Golgi apparatus.	1.1 Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including: a) animal cells – nucleus, cell membrane, mitochondria and ribosomes b) plant cells – nucleus, cell membrane, cell wall, chloroplasts, mitochondria, vacuole and ribosomes
3.4 Know the ultrastructure of prokaryotic cells, including cell wall, capsule, plasmid, flagellum, pili, ribosomes, mesosomes and circular DNA.	1.1 Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including:

			c) bacteria – chromosomal DNA, plasmid DNA, cell membrane, ribosomes and flagella
3.5	Be able to recognise the organelles in 3.2 from electron microscope (EM) images.	1.6	*Core practical: Investigate biological specimens using microscopes, including magnification calculations and labelled scientific drawings from observations*
3.6	Understand how mammalian gametes are specialised for their functions (including the acrosome in sperm and the zona pellucida in the egg).	1.2	Describe how specialised cells are adapted to their function, including: a) sperm cells – acrosome, haploid nucleus, mitochondria and tail b) egg cells – nutrients in the cytoplasm, haploid nucleus and changes in the cell membrane after fertilisation
3.7	Know the process of fertilisation in mammals, including the acrosome reaction, the cortical reaction and the fusion of nuclei.	1.2	Describe how specialised cells are adapted to their function, including: a) sperm cells – acrosome, haploid nucleus, mitochondria and tail b) egg cells – nutrients in the cytoplasm, haploid nucleus and changes in the cell membrane after fertilisation
3.8	i) Know that a locus (loci) is the location of genes on a chromosome. ii) Understand the linkage of genes on a chromosome and sex linkage.	3.18B	**Explain how sex-linked genetic disorders are inherited**
3.9	Understand the role of meiosis in ensuring genetic variation through the production of non-identical gametes as a consequence of independent assortment of chromosomes and crossing over of alleles between chromatids (details of the stages of meiosis are not required).	3.3 3.20	Explain the role of meiotic cell division, including the production of four daughter cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes The stages of meiosis are not required Describe the causes of variation that influence phenotype, including: a) genetic variation – different characteristics as a result of mutation and sexual reproduction

3.10 Understand the role of mitosis and the cell cycle in producing identical daughter cells for growth and asexual reproduction.	2.1 Describe mitosis as part of the cell cycle, including the stages interphase, prophase, metaphase, anaphase and telophase and cytokinesis 2.2 Describe the importance of mitosis in growth, repair and asexual reproduction 2.3 Describe the division of a cell by mitosis as the production of two daughter cells, each with identical sets of chromosomes in the nucleus to the parent cell, and that this results in the formation of two genetically identical diploid body cells
CORE PRACTICAL 5: Prepare and stain a root tip squash to observe the stages of mitosis.	2.1 Describe mitosis as part of the cell cycle, including the stages interphase, prophase, metaphase, anaphase and telophase and cytokinesis
3.11 i) Understand what is meant by the terms 'stem cell, pluripotency and totipotency'. ii) Be able to discuss the way society uses scientific knowledge to make decisions about the use of stem cells in medical therapies.	2.6 Explain the importance of cell differentiation in the development of specialised cells 2.8 Describe the function of embryonic stem cells, stem cells in animals and meristems in plants 2.9 Discuss the potential benefits and risks associated with the use of stem cells in medicine
3.12 Understand how cells become specialised through differential gene expression, producing active mRNA leading to synthesis of proteins, which in turn control cell processes or determine cell structure in animals and plants, including lac operon.	3.9B **Describe how genetic variants in the non-coding DNA of a gene can affect phenotype by influencing the binding of RNA polymerase and altering the quantity of protein produced**
3.13 Understand how the cells of multicellular organisms are organised into tissues, tissues into organs and organs into systems.	
3.14 i) Understand how phenotype is the result of an interaction between genotype and the environment.	3.20 Describe the causes of variation that influence phenotype, including: a) genetic variation – different characteristics as a result of mutation and sexual reproduction

ii) Know how epigenetic changes, including DNA methylation and histone modification, can modify the activation of certain genes. iii) Understand how epigenetic changes can be passed on following cell division.	b) environmental variation – different characteristics caused by an organism's environment (acquired characteristics)
3.15 Understand how some phenotypes are affected by multiple alleles for the same gene at many loci (polygenic inheritance) as well as the environment and how this can give rise to phenotypes that show continuous variation.	3.19 State that most phenotypic features are the result of multiple genes rather than single gene inheritance
Topic 4 – Exchange and transport	**9 - 1 GCSE**
4.1 Know that over time the variety of life has become extensive but is now being threatened by human activity	9.9 Explain the positive and negative human interactions within ecosystems and their impacts on biodiversity, including: a) fish farming b) introduction of non-indigenous species c) eutrophication
4.3 Understand the concept of niche and be able to discuss examples of adaptation of organisms to their environment (behavioural, physiological and anatomical).	6.14B Explain how plants are adapted to survive in extreme environments including the effect of leaf size and shape, the cuticle and stomata
4.4 Understand how natural selection can lead to adaptation and evolution.	4.1B Describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology 4.2 Explain Darwin's theory of evolution by natural selection 4.3 Explain how the emergence of resistant organisms supports Darwin's theory of evolution including antibiotic resistance in bacteria

4.5	i) Understand how the Hardy-Weinberg equation can be used to see whether a change in allele frequency is occurring in a population over time. ii) Understand that reproductive isolation can lead to accumulation of different genetic information in populations potentially leading to the formation of new species.		
4.6	i) Understand that classification is a means of organising the variety of life based on relationships between organisms using differences and similarities in phenotypes and in genotypes, and is built around the species concept. ii) Understand the process and importance of critical evaluation of new data by the scientific community, which leads to new taxonomic groupings, including the three domains of life based on molecular phylogeny, which are Bacteria, Archaea, Eukaryota	4.7	Describe how genetic analysis has led to the suggestion of the three domains rather than the five kingdoms classification method
4.7	Know the ultrastructure of plant cells (cell walls, chloroplasts, amyloplasts, vacuole, tonoplast, plasmodesmata, pits and middle lamella) and be able to compare it with animal cells.	1.1	Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including: b) plant cells – nucleus, cell membrane, cell wall, chloroplasts, mitochondria, vacuole and ribosomes
4.8	Be able to recognise the organelles in 4.7 from electron microscope (EM) images.	1.6	*Core practical: Investigate biological specimens using microscopes, including magnification calculations and labelled scientific drawings from observations*
4.10	Understand how the arrangement of cellulose microfibrils and secondary thickening in plant cell walls contributes to the physical properties of xylem vessels and sclerenchyma fibres in plant fibres that can be exploited by humans.	6.8	Explain how the structures of the xylem and phloem are adapted to their function in the plant, including: a) lignified dead cells in xylem transporting water and minerals through the plant b) living cells in phloem using energy to transport sucrose around the plant

CORE PRACTICAL 6: Identify sclerenchyma fibres, phloem sieve tubes and xylem vessels and their location within stems through a light microscope.	
4.11 Know the similarities and differences between the structures, position in the stem and function of sclerenchyma fibres (support), xylem vessels (support and transport of water and mineral ions) and phloem (translocation of organic solutes).	6.8 Explain how the structures of the xylem and phloem are adapted to their function in the plant, including: a) lignified dead cells in xylem transporting water and minerals through the plant b) living cells in phloem using energy to transport sucrose around the plant
4.14 Understand the conditions required for bacterial growth.	5.18B *Core practical: Investigate the effects of antiseptics, antibiotics or plant extracts on microbial cultures*
CORE PRACTICAL 9: Investigate the antimicrobial properties of plants, including aseptic techniques for the safe handling of bacteria	5.17B Explain the aseptic techniques used in culturing microorganisms in the laboratory, including the use of an autoclave to prepare sterile growth medium and petri dishes, the use of sterile inoculating loops to transfer microorganisms and the need to keep petri dishes and culture vials covered 5.18B *Core practical: Investigate the effects of antiseptics, antibiotics or plant extracts on microbial cultures*

Appendix 2: Biology B Specification mapping

GCSE to AS Biology B – Reinforcing knowledge, skills and literacy in Biology

The purpose of this document is to demonstrate the overlap between GCSE and GCE. For an effective progression through to KS5, it will be useful if centres establish a baseline point from which to build on. As teachers we sometimes fall in the trap of going over the work that has already been covered extensively at KS4 either because we feel that during the summer break students might have forgotten what they had been taught, or, if they are from different centres, they have not been taught to a good standard. This is where we lose valuable teaching time and end up rushing through the actual KS5 content. The mapping document should enable teachers to streamline the teaching and get on to the KS5 content within the first two weeks of term. This will serve two purposes:

a) learners will actually feel they are learning something new and not get bored with over repetition (particularly the most able learners)

b) learners will be able to discover very early on in the course whether Biology A-Level is really a suitable subject choice for them.

The following are some suggestions for how to use this resource:

1) post KS4 exams, if your school brings back the Yr11s after their exams

2) induction weeks at the start of 6th Form

3) setting summer homework in preparation for 6th Form

4) levelling the baseline of all students from their range of KS4 qualifications.

GCSE to AS Biology B – Reinforcing knowledge, skills and literacy in Biology

GCSE statements marked with a B are additional content for single science biology only. All other statements are covered in combined science as well as biology.

GCSE statements in **bold** are higher content only

Topic 1- Biological molecules		**9 - 1 GCSE**
1.1	**Carbohydrates**	1.12 Explain the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol
i	Know the difference between monosaccharides, disaccharides and polysaccharides.	
ii	Know the structure of the hexose glucose (alpha and beta) and the pentose ribose.	
iii	Understand how monosaccharides (glucose, fructose, galactose) join to form disaccharides (sucrose, lactose and maltose) and polysaccharides (starch formed from amylose and amylopectin; glycogen) through condensation reactions forming glycosidic bonds, and how these can be split through hydrolysis reactions.	
iv	Understand how the structure of glucose, starch, glycogen and cellulose relates to their function.	
1.2	**Lipids**	1.12 Explain the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol
i	Understand how a triglyceride is synthesised including the formation of ester bonds during condensation reactions between glycerol and three fatty acids.	
ii	Know the differences between saturated and unsaturated lipids.	
iii	Understand how the structure of lipids relates to their role in energy storage, waterproofing and insulation.	

iv Understand how the structure and properties of phospholipids relate to their function in cell membranes.	
1.3 Proteins i Know the structure of an amino acid (structures of specific amino acids are not required). ii Understand the formation of polypeptides and proteins (as amino acid monomers linked by peptide bonds in condensation reactions). iii Understand the role of ionic, hydrogen and disulphide bonding in the structure of proteins. iv Understand the significance of the primary, secondary, tertiary and quaternary structure of a protein in determining the properties of fibrous and globular proteins, including collagen and haemoglobin. v Understand how the structure of collagen and haemoglobin are related to their function.	1.12 Explain the importance of enzymes as biological catalysts in the synthesis of carbohydrates, proteins and lipids and their breakdown into sugars, amino acids and fatty acids and glycerol
1.4 DNA and protein synthesis i Know the structure of DNA, including the structure of the nucleotides (purines and pyrimidines), base pairing, the two sugar-phosphate backbones, phosphodiester bonds and hydrogen bonds. ii Understand how DNA is replicated semi-conservatively, including the role of DNA helicase, polymerase and ligase. iii Know that a gene is a sequence of bases on a DNA molecule coding for a sequence of amino acids in a polypeptide chain. iv Know the structure of mRNA including nucleotides, the sugar phosphate backbone and the role of hydrogen bonds. v Know the structure of tRNA, including nucleotides, the role of hydrogen bonds and the anticodon.	3.4 Describe DNA as a polymer made up of: a two strands coiled to form a double helix b strands linked by a series of complementary base pairs joined together by weak hydrogen bonds c nucleotides that consist of a sugar and phosphate group with one of the four different bases attached to the sugar **3.7B Explain how the order of bases in a section of DNA decides the order of amino acids in the protein and that these fold to produce specifically shaped proteins such as enzymes** **3.8B Describe the stages of protein synthesis, including transcription and translation:** **a RNA polymerase binds to non-coding DNA located in front of a gene**

vi Understand the processes of transcription in the nucleus and translation at the ribosome, including the role of sense and anti-sense DNA, mRNA, tRNA and the ribosomes. vii Understand the nature of the genetic code, including triplets coding for amino acids, start and stop codons, degenerate and non-overlapping nature, and that not all the genome codes for proteins. viii Understand the term gene mutation as illustrated by base deletions, insertions and substitutions. ix Understand the effect of point mutations on amino acid sequences, as illustrated by sickle cell anaemia in humans.	**b RNA polymerase produces a complementary mRNA strand from the coding DNA of the gene** **c the attachment of the mRNA to the ribosome** **d the coding by triplets of bases (codons) in the mRNA for specific amino acids** **e the transfer of amino acids to the ribosome by tRNA** **f the linking of amino acids to form polypeptides** **3.10B Describe how genetic variants in the coding DNA of a gene can affect phenotype by altering the sequence of amino acids and therefore the activity of the protein produced** 3.23 State that most genetic mutations have no effect on the phenotype, some mutations have a small effect on the phenotype and, rarely, a single mutation will significantly affect the phenotype
1.5 Enzymes i Know the structure of enzymes as globular proteins. ii Understand the concepts of specificity and the induced fit hypothesis. iii Understand that enzymes are catalysts that reduce activation energy. iv Understand how temperature, pH, substrate and enzyme concentration affect the rate of enzyme activity. CORE PRACTICAL 1: Investigate a factor affecting the initial rate of an enzyme– controlled reaction. v Understand how the initial rate of enzyme activity can be measured and why this is important. vi Understand how enzymes can be affected by competitive, non-competitive and end-product inhibition. vii Know that enzymes catalyse a wide range of intracellular reactions as well as extracellular ones.	1.7 Explain the mechanism of enzyme action including the active site and enzyme specificity 1.8 Explain how enzymes can be denatured due to changes in the shape of the active site 1.9 Explain the effects of temperature, substrate concentration and pH on enzyme activity 1.10 *Core Practical: Investigate the effect of pH on enzyme activity* 1.11 Demonstrate an understanding of rate calculations for enzyme activity

1.6 Inorganic ions i Understand the role in plants of: • nitrate ions – to make DNA and amino acids • calcium ions – to form calcium pectate for the middle lamellae • magnesium ions – to produce chlorophyll • phosphate ions – to make ADP and ATP.	
Topic 2 - Cells, Viruses and Reproduction of Living Things	**9 - 1 GCSE**
2.1 Eukaryotic and prokaryotic cell structure and function i Understand that cell theory is a unifying concept that states that cells are a fundamental unit of structure, function and organisation in all living organisms. ii Understand that in complex organisms, cells are organised into tissues, organs, and organ systems. iii Know the ultrastructure of prokaryotic cells and the structure of organelles, including: nucleoid, plasmids, 70S ribosomes and cell wall. iv Be able to distinguish between Gram positive and Gram negative bacterial cell walls and understand why each type reacts differently to some antibiotics. v Know the ultrastructure of eukaryotic cells and the functions of organelles, including: nucleus, nucleolus, 80S ribosomes, rough and smooth endoplasmic reticulum, mitochondria, centrioles, lysosomes, Golgi apparatus, cell wall, chloroplasts, vacuole and tonoplast. vi Know how magnification and resolution can be achieved using light and electron microscopy.	1.1 Explain how the sub-cellular structures of eukaryotic and prokaryotic cells are related to their functions, including: a animal cells – nucleus, cell membrane, mitochondria and ribosomes b plant cells – nucleus, cell membrane, cell wall, chloroplasts, mitochondria, vacuole and ribosomes c bacteria – chromosomal DNA, plasmid DNA, cell membrane, ribosomes and flagella 1.3 Explain how changes in microscope technology, including electron microscopy, have enabled us to see cell structures and organelles with more clarity and detail than in the past and increased our understanding of the role of sub-cellular structures 1.6 *Core Practical: Investigate biological specimens using microscopes, including magnification calculations and labelled scientific drawings from observations*

vii Understand the importance of staining specimens in microscopy. CORE PRACTICAL 2: Use of the light microscope, including simple stage and eyepiece micrometers and drawing small numbers of cells from a specialised tissue.	
2.3 Eukaryotic cell cycle and division i Know that the cell cycle is a regulated process in which cells divide into two identical daughter cells, and that this process consists of three main stages: interphase, mitosis and cytokinesis. ii Understand what happens to genetic material during the cell cycle, including the stages of mitosis. iii Understand how mitosis contributes to growth, repair and asexual reproduction. CORE PRACTICAL 3: Make a temporary squash preparation of a root tip to show stages of mitosis in the meristem under the light microscope. iv Understand how meiosis results in haploid gametes, including the stages of meiosis. v Understand that meiosis results in genetic variation through recombination of alleles, including independent assortment and crossing over. vi Understand what chromosome mutations are, as illustrated by translocations. vii Understand how non-disjunction can lead to polysomy, including Down's syndrome, and monosomy, including Turner's syndrome.	2.1 Describe mitosis as part of the cell cycle, including the stages interphase, prophase, metaphase, anaphase and telophase and cytokinesis 2.2 Describe the importance of mitosis in growth, repair and asexual reproduction 2.3 Describe the division of a cell by mitosis as the production of two daughter cells, each with identical sets of chromosomes in the nucleus to the parent cell, and that this results in the formation of two genetically identical diploid body cells 2.5 Describe growth in organisms, including: a cell division and differentiation in animals b cell division, elongation and differentiation in plants 3.3 Explain the role of meiotic cell division, including the production of four daughter cells, each with half the number of chromosomes, and that this results in the formation of genetically different haploid gametes The stages of meiosis are not required
2.4 Sexual reproduction in mammals i Understand the process of oogenesis and spermatogenesis.	

ii Understand the events of fertilisation from the first contact between the gametes to the fusion of nuclei. iii Understand the early development of the embryo to blastocyst stage.	
Topic 3 - Classification and Biodiversity	**9 - 1 GCSE**
3.1 Classification i Know that the classification system consists of a hierarchy of domain, kingdom, phylum, class, order, family, genus and species. ii Understand the limitations of the definition of a species as a group of organisms with similar characteristics that interbreed to produce fertile offspring. iii Understand why it is often difficult to assign organisms to any one species or to identify new species. iv Understand how gel electrophoresis can be used to distinguish between species and determine evolutionary relationships. v Know that DNA sequencing and bioinformatics can be used to distinguish between species and determine evolutionary relationships. vi Understand the role of scientific journals, the peer review process and scientific conferences in validating new evidence supporting the accepted scientific theory of evolution. vii Understand the evidence for the three-domain model of classification as an alternative to the five-kingdom model and the role of the scientific community in validating this evidence.	4.7 Describe how genetic analysis has led to the suggestion of the three domains rather than the five kingdoms classification method
3.2 Natural selection	**4.1B Describe the work of Darwin and Wallace in the development of the theory of evolution by natural selection and explain the impact of these ideas on modern biology**

i Understand how evolution can come about through natural selection acting on variation bringing about adaptations. ii Understand how organisms occupy niches according to physiological, behavioural and anatomical adaptations. iii Understand how reproductive isolation can lead to allopatric and sympatric speciation. iv Understand that there is an evolutionary race between pathogens and the development of medicines to treat the diseases they cause.	4.2 Explain Darwin's theory of evolution by natural selection 4.3 Explain how the emergence of resistant organisms supports Darwin's theory of evolution including antibiotic resistance in Bacteria 4.4 Describe the evidence for human evolution, based on fossils, including: a Ardi from 4.4 million years ago b Lucy from 3.2 million years ago c Leakey's discovery of fossils from 1.6 million years ago 4.5 Describe the evidence for human evolution based on stone tools, including: a the development of stone tools over time b how these can be dated from their environment **4.6B Describe how the anatomy of the pentadactyl limb provides scientists with evidence for evolution**
Topic 4 – Exchange and transport	**9 - 1 GCSE**
4.2 Cell transport mechanisms i Know the structure of the cell surface membrane with reference to the fluid mosaic model. ii Understand how passive transport is brought about by: • diffusion • facilitated diffusion (through carrier proteins and protein channels) • osmosis. iii Understand how the properties of molecules affects how they are transported, including solubility, size and charge. iv Know that large molecules can be transported into and out of cells through the formation of vesicles, in the processes of endocytosis and exocytosis.	1.15 Explain how substances are transported into and out of cells, including by diffusion, osmosis and active transport 1.16 *Core Practical: Investigate osmosis in potatoes* 1.17 Calculate percentage gain and loss of mass in osmosis

CORE PRACTICAL 5: Investigate the effect of temperature on beetroot membrane permeability. CORE PRACTICAL 6: Determine the water potential of a plant tissue. Water potential = turgor pressure + osmotic potential $\psi = P + \pi$ v Understand the process of active transport, including the role of ATP. vi Know that phosphorylation of ADP requires energy and that hydrolysis of ATP provides an accessible supply of energy for biological processes.	
4.3 Gas exchange i Understand how insects, fish and mammals are adapted for gas exchange. CORE PRACTICAL 7: Dissect an insect to show the structure of the gas exchange system taking into account the safe and ethical use of organisms. ii Understand gas exchange in flowering plants, including the role of stomata, gas exchange surfaces in the leaf and lenticels.	8.3 Explain how alveoli are adapted for gas exchange by diffusion between air in the lungs and blood in capillaries 8.11 *Core Practical: Investigate the rate of respiration in living organisms* **6.11B Explain how the structure of a leaf is adapted for photosynthesis and gas exchange**
4.4 Circulation i Know the structure of the heart, arteries, veins and capillaries. ii Understand the advantages of a double circulatory system in mammals over the single circulatory systems in bony fish, including the facility for blood to be pumped to the body at higher pressure and the splitting of oxygenated and deoxygenated blood. iii Know the sequence of events of the cardiac cycle.	8.7 Explain how the structure of the blood vessels is related to their function 8.8 Explain how the structure of the heart and circulatory system is related to its function, including the role of the major blood vessels, the valves and the relative thickness of chamber walls 8.6 Explain how the structure of the blood is related to its function: a red blood cells (erythrocytes) b white blood cells (phagocytes and lymphocytes) c plasma

iv Understand myogenic stimulation of the heart, including the roles of the sinoatrial node (SAN), atrioventricular node (AVN) and bundle of His. v Be able to interpret data showing ECG traces and pressure changes during the cardiac cycle. vi Know the structure of blood as plasma and blood cells, to include erythrocytes and leucocytes (neutrophils, eosinophils, monocytes and lymphocytes). vii Know the function of blood as transport, defence, and formation of lymph and tissue fluid. viii Understand the role of platelets and plasma proteins in the sequence of events leading to blood clotting, including: • platelets form a plug and release clotting factors, including thromboplastin • prothrombin changes to its active form, thrombin • soluble fibrinogen forms insoluble fibrin to cover the wound. ix Understand the stages that lead to atherosclerosis, its effect on health and the factors that increase the risk of its development.	d platelets 5.24 Explain the effect of lifestyle factors on non-communicable diseases at local, national and global levels, including: c smoking on cardiovascular diseases
4.7 Transport in plants i Understand the structure of xylem and phloem tissues in relation to their role in transport. ii Understand how water can be moved through plant cells by the apoplastic and symplastic pathways. iii Understand how the cohesion-tension model explains the transport of water from plant roots to shoots. iv Understand how temperature, light, humidity and movement of air affect the rate of transpiration.	6.8 Explain how the structures of the xylem and phloem are adapted to their function in the plant, including: a lignified dead cells in xylem transporting water and minerals through the plant b living cells in phloem using energy to transport sucrose around the plant 6.9 Explain how water and mineral ions are transported through the plant by transpiration, including the structure and function of the stomata 6.10 Describe how sucrose is transported around the plant by translocation

v Understand the strengths and weaknesses of the mass-flow hypothesis in explaining the movement of sugars through phloem tissue. CORE PRACTICAL 8: Investigate factors affecting water uptake by plant shoots using a potometer.	6.12 Explain the effect of environmental factors on the rate of water uptake by a plant, to include light intensity, air movement and temperature 6.13 Demonstrate an understanding of rate calculations for transpiration

Appendix 3: Exam practice

These are higher exam questions from previous Biology GCSE examinations.

They relate to the topics covered in AS Biology and can be used to refresh the knowledge from KS4.

1 Mutations can occur in genes.

Mutations can cause genetic disorders in humans.

Phenylketonuria (PKU) is a genetic disorder caused by a gene mutation.

People with PKU produce an inactive enzyme.

The normal base sequence and the mutated base sequence which can cause PKU are shown below.

normal base sequence ..... C T C G G C C C T

mutated base sequence .....C T T G G C C C T

a Describe how the changes that have occurred in the mutated base sequence produce an inactive enzyme.

(2 marks)

b Explain how the mutated base sequence will result in an inactive enzyme being produced during protein synthesis.

(6 marks)

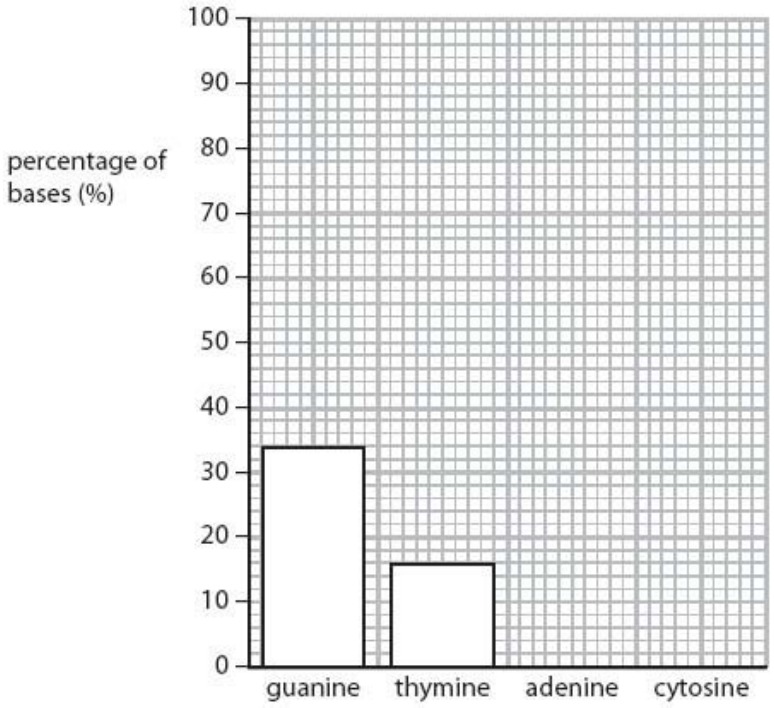
2 A DNA molecule consists of two strands coiled to form a double helix.

a Describe how the two strands of a DNA molecule are linked together.

(2 marks)

b The bar chart shows the percentage of guanine and thymine in a sample of DNA.

Complete the bar chart to show the percentage of adenine and cytosine in the sample.



(2 marks)

c The diagram shows part of one DNA strand.

i Complete the empty boxes to show the mRNA strand coded for by this DNA strand.

DNA strand	G	G	C	T	A	G	T	T	G
mRNA strand									

(2 marks)

ii State the maximum number of amino acids that are coded for by this DNA strand.

(1 mark)

d Name the structure where translation occurs.

(1 mark)

3 Proteins are made up of amino acids.

a The table shows the DNA bases that code for some of the amino acids found in proteins.

DNA bases	AAA	AAC	CAA	TAC	TTC
Amino acid	Phe	leu	val	met	lys

Part of the DNA coding for a protein is:

T A C C A A T T C

i State the order of amino acids coded for by this sequence of DNA.

(1 mark)

ii These amino acids will be joined together during protein synthesis.
During which stage of protein synthesis will this take place?

(1 mark)

iii Complete the sentence by putting a cross (☒) in the box next to your answer.
Amino acids are joined together…

A at the membrane ☐

B in the mitochondria ☐

C in the nucleus ☐

D at the ribosome ☐

(1 mark)

b DNA can code for the amino acids in the active site of an enzyme.
Explain the role of the active site of an enzyme.

(2 marks)

c Mutations can occur in DNA.
Describe what effect a mutation could have on the action of an enzyme.

(3 marks)

4 There are many different types of cell in the human body.

a Complete the sentence by putting a cross (☒) in the box next to your answer.

An embryonic stem cell can…

A differentiate into any type of cell ☒

B differentiate into only one type of cell ☒

C only be obtained from embryos ☒

D only produce haploid cells ☒

(1 mark)

b Describe how the structure of a red blood cell is related to its function.

(3 marks)

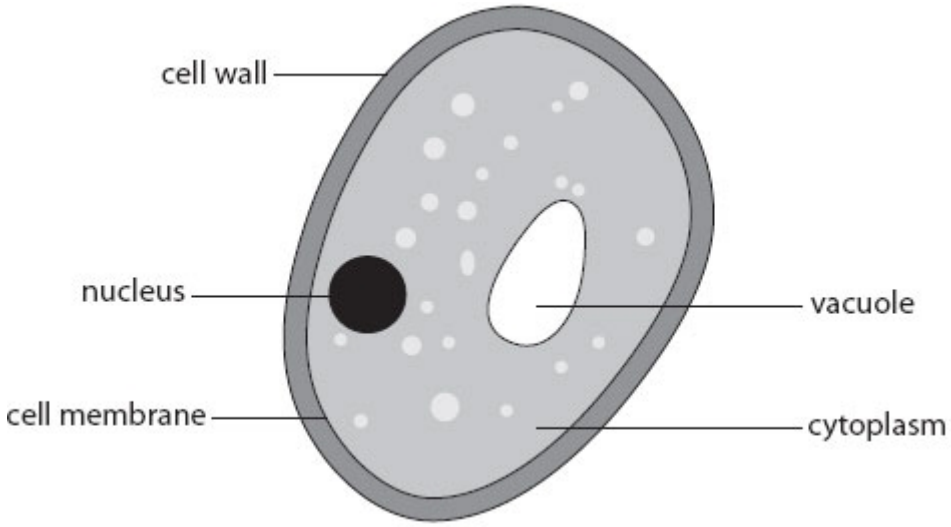
c Describe the function of platelets.

(2 marks)

d Mitosis and meiosis are types of cell division.
Compare these two types of cell division.

(6 marks)

5 Yeasts are microorganisms that are used in the brewing and baking industries.
The diagram shows a yeast cell.



a **i** State **two** ways in which the structure of this yeast cell differs from the structure of a bacterial cell.

(2 marks)

ii Plant cells can produce glucose.
Suggest why yeast cells cannot produce glucose.

(1 mark)

b The table shows the number of different components found in the blood of a healthy person and the blood of two other people.

	number of components per dm^3 of blood		
component of blood	**healthy person**	**person A**	**person B**
red blood cells	5×10^{12}	6×10^{12}	3×10^{12}
white blood cells	7×10^{9}	5×10^{10}	8×10^{10}
platelets	3×10^{11}	3×10^{11}	3×10^{11}

i Calculate the difference in the number of white blood cells per dm^3 of blood between the healthy person and person A.

(2 marks)

ii Describe the functions of white blood cells.

(2 marks)

iii Person B has a low number of red blood cells compared to the healthy person.

Suggest an effect this may have on person B.

(1 mark)

6 Corals are animals that live on the sea bed.
The photograph shows some species of coral.

After fertilisation, mitosis takes place to form an embryo.
The embryo develops into new coral.

a Describe mitosis.

(3 marks)

b Describe how the embryo develops into new coral.

(3 marks)

7 Cells in a human body can be haploid or diploid.

When an egg cell combines with a sperm cell a fertilised egg, known as a zygote, is formed.

a Which row of the table gives correct information about the egg cell, the sperm cell and the zygote?

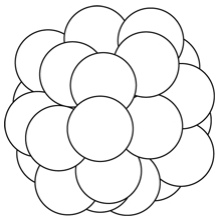
Put a cross (☒) in the box next to your answer.

	egg cell	sperm cell	zygote
☒ **A**	**diploid**	**diploid**	**haploid**
☒ **B**	**diploid**	**haploid**	**diploid**
☒ **C**	**haploid**	**diploid**	**haploid**
☒ **D**	**haploid**	**haploid**	**diploid**

(1 mark)

b The single cell of the zygote divides into two cells in 15 hours. These cells continue to divide in this way to form an embryo.

This diagram shows an embryo with 32 cells.



Calculate the length of time it takes the single cell of the zygote to form an embryo with 32 cells.

(2 marks)

c The cells of this embryo are genetically identical.

Explain how these genetically identical cells are produced.

(3 marks)

8 **a** Tigers are classified as vertebrates.
The binomial name for the tiger is *Panthera tigris.*

i Complete the sentence by putting a cross (☒) in the box next to your answer.

The word *Panthera* in the tiger's binomial name refers to its…

A class ☐
B genus ☐
C order ☐
D species ☐

(1 mark)

ii State the phylum that includes mammals such as tigers.

(1 mark)

b Bacteria are classified as prokaryotes.
State **two** characteristics of prokaryotes.

1

2

(2 marks)

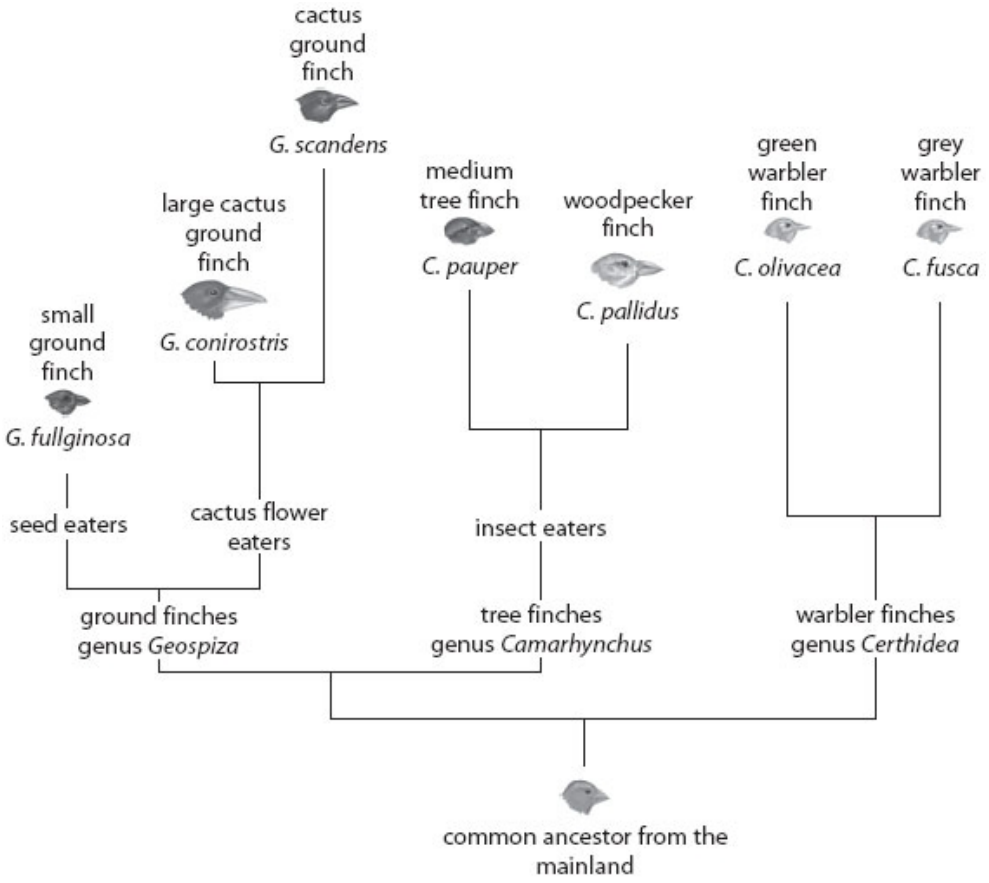
c Explain why it is difficult to classify some living organisms.

(2 marks)

d Describe how scientists classify vertebrates into different groups.

(6 marks)

9 Charles Darwin studied the variety of finches on the Galapagos Islands.
He used this information to develop his theory of evolution.
Some of the finches are shown in the diagram.



a **i** State the genus and the species of the large cactus ground finch.

(2 marks)

ii Suggest how the size and shape of their beaks enabled all of these types of finches to survive.

(2 marks)

iii Complete the sentence by putting a cross (☒) in the box next to your answer.

Darwin's finches are an example of speciation due to…

A selective breeding ☐

B geographic isolation ☐

C hybridisation ☐

D the development of ring species ☐

(1 mark)

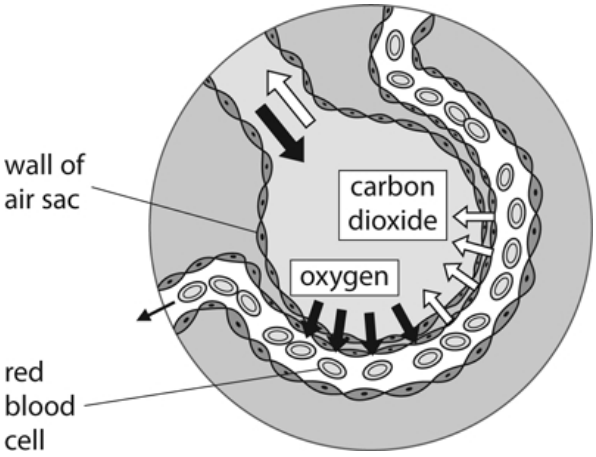
b Suggest how these species of finches could have evolved.

(3 marks)

10 a Gas exchange in the air sacs of the lungs takes place in a similar way to gas exchange between body cells and capillaries.

Each of these air sacs are surrounded by blood capillaries.

The diagram shows one air sac.



i Describe how oxygen is transported from the air sac into the surrounding blood capillary.

(2 marks)

ii Complete the sentence by putting a cross (☒) in the box next to your answer.

The blood transports oxygen to body cells.

Oxygen is used by body cells when…

A energy is released during respiration ☐

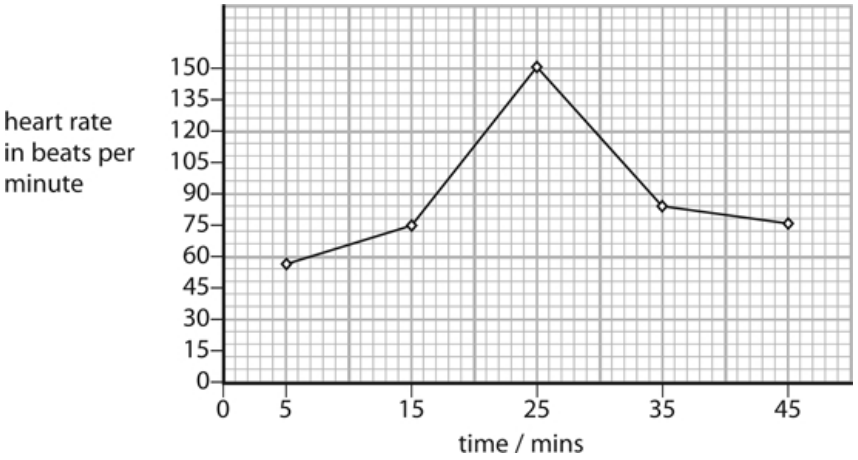
B energy is released from carbon dioxide ☐

C glucose is produced during respiration ☐

D energy is taken in during respiration ☐

(1 mark)

b The graph shows how the heart rate of a person changes during and after aerobic exercise.



i The volume of blood leaving the heart during one heart beat at 25 minutes is 0.07 dm^3.

The person's cardiac output can be calculated using the equation:

cardiac output = stroke volume × heart rate

Calculate the cardiac output of this person at 25 minutes.

(3 marks)

ii Explain the trend shown by the graph between 5 and 25 minutes.

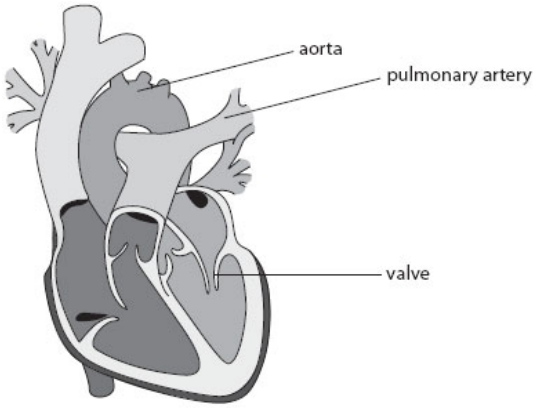
(3 marks)

c Anaerobic respiration takes place when the muscle cells are not supplied with enough oxygen.

Give the word equation for anaerobic respiration.

(1 mark)

11 This diagram shows a human heart.



a **i** Draw an arrow onto the diagram to show where oxygenated blood enters the heart.

(1 mark)

ii Suggest how the blood flowing through the pulmonary artery would be different from the blood flowing through the aorta.

(2 marks)

iii Describe the role of the valve labelled on the diagram.

(2 marks)

b Heart disease can significantly reduce cardiac output.

i Complete the sentence by putting a cross (☒) in the box next to your answer.

Cardiac output is the volume of blood leaving the…

A atrium every heart beat ☐

B atrium every minute ☐

C ventricle every heart beat ☐

D ventricle every minute ☐

(1 mark)

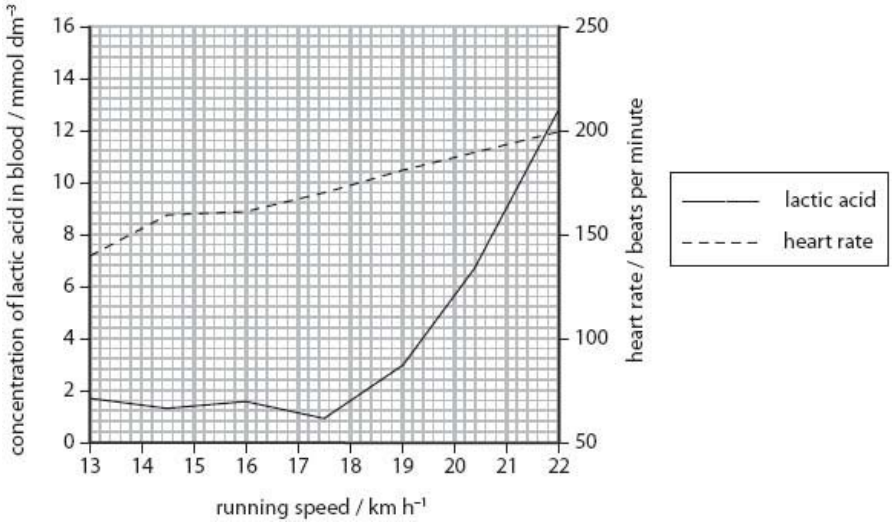
ii A reduced cardiac output would affect the performance of an athlete.

Explain the effects that a reduced cardiac output would have on the muscle cells of an athlete.

(6 marks)

12 In an investigation, a person ran at different speeds.

The graph shows the concentration of lactic acid in the blood and the heart rate of this person while running.



a When the running speed is 22 km h^{-1}, the stroke volume of the runner is 0.18 dm^3.

Calculate the cardiac output in dm^3 per minute of the runner using the equation.

cardiac output = stroke volume × heart rate

(2 marks)

b Complete the sentence by putting a cross (☒) in the box next to your answer.

When the heart rate is at its maximum the concentration of lactic acid in the blood is…

A 11.2 mmol dm^{-3} ☒

B 12.8 mmol dm^{-3} ☒

C 200.0 mmol dm^{-3} ☒

D 210.0 mmol dm^{-3} ☒

(1 mark)

c Complete the sentence by putting a cross (☒) in the box next to your answer.

The graph shows that…

A as the heart rate increases the concentration of lactic acid increases ☒

B as the concentration of lactic acid increases the heart rate decreases ☒

C the concentration of lactic acid increases as running speed increases ☒

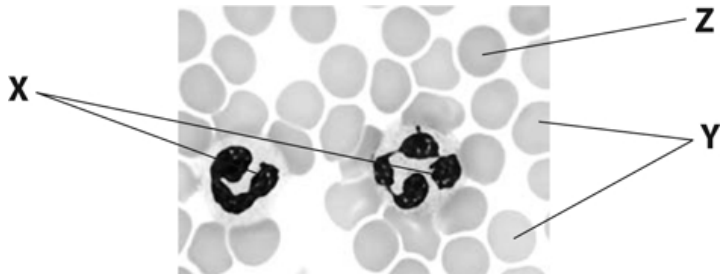
D the concentration of lactic acid is not dependent on heart rate ☒

(1 mark)

d Explain why the concentration of lactic acid changes at running speeds greater than 18 km h^{-1}.

(3 marks)

13 The photograph shows a blood smear from a healthy person.



a Name the **two** types of blood cells, X and Y, shown in the photograph.

(2 marks)

b Complete the sentence by putting a cross (☒) in the box next to your answer.

The function of the cells labelled X is to…

A engulf bacteria ☐

B produce antigens ☐

C transport carbon dioxide ☐

D transport oxygen ☐

(1 mark)

c Measure the diameter of the cell labelled Z to the nearest mm.

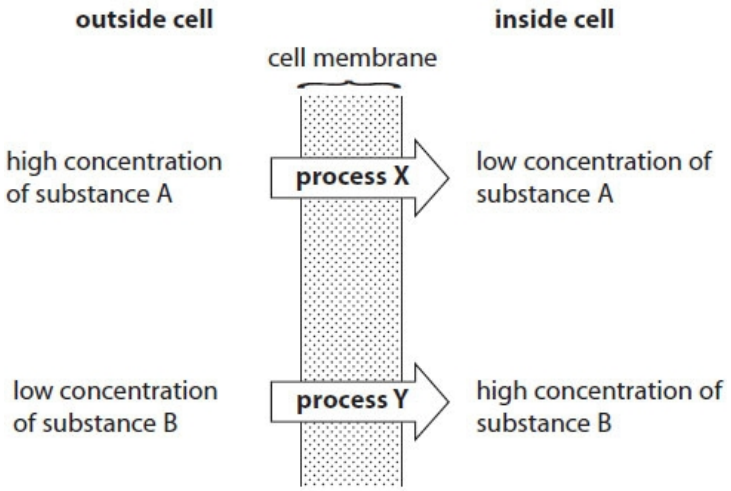
(1 mark)

d The cell labelled Z is magnified ×900.
Calculate the actual diameter of the cell labelled Z in μm.

(2 marks)

14 a Substances in the soil are taken up by plant root hair cells.

The diagram shows the direction of movement of two substances A and B across the cell membrane of a root hair cell.



i Name process X.

(1 mark)

ii Name process Y.

(1 mark)

iii Mineral ions are taken up by the root hair cells of plants.

Name the type of vessel that transports these mineral ions through the plant.

(1 mark)

b A student investigated osmosis in a courgette.

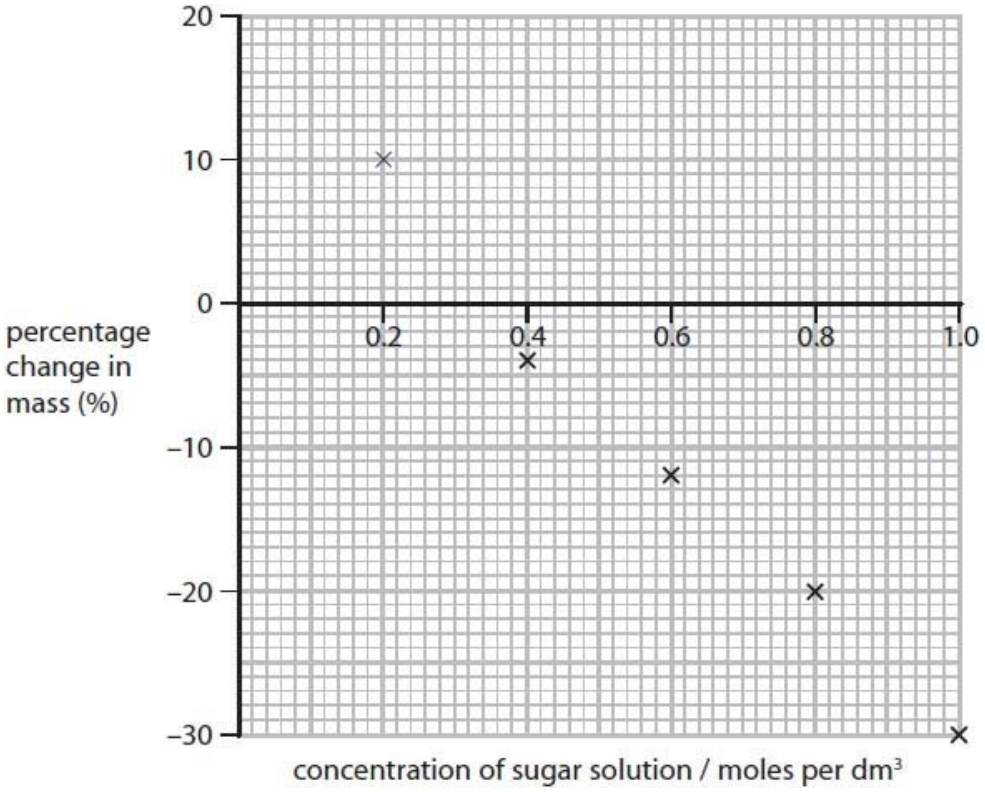
The photograph shows a courgette.

The student weighed pieces of courgette and placed them in five different concentrations of sugar solution.

After one hour she dried and reweighed the pieces of courgette.

She calculated the percentage change in mass.

The graph shows the results of this investigation.



i Draw a line of best fit on the graph. (1 mark)

ii Use your line of best fit to estimate the concentration of sugar solution in moles per dm^3 that would result in no change in mass.

(1 mark)

iii Explain why there was an increase in the mass of the courgette in the sugar solution at 0.2 moles per dm^3.

(3 marks)

15 Photograph A shows a *Coleus* plant that has wilted due to lack of water. If this plant is given some water it will recover and stand upright again. Photograph B shows the plant after it has been watered.

photograph A

photograph B

a Describe how a plant takes in water from the soil.

(2 marks)

b The soil surrounding the roots of the *Coleus* plant contains water with a higher concentration of dissolved mineral ions than the plant cell vacuole.

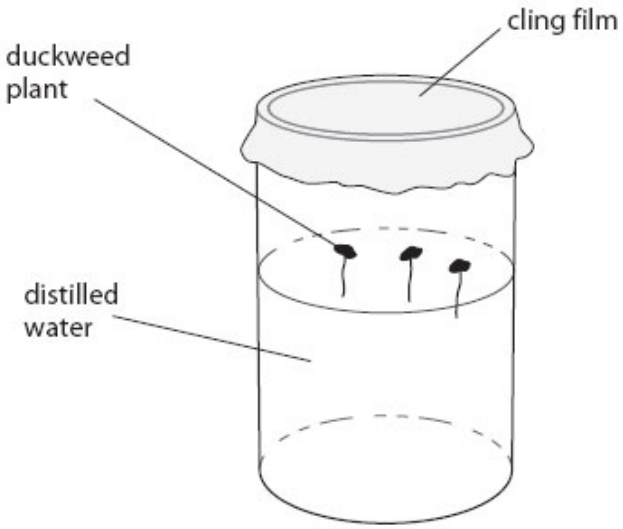
Which row of the table gives the method of transport of mineral ions into the plant cell of this *Coleus* and the type of vessel which transports mineral ions to its leaves?

Put a cross (☒) in the box next to your answer.

	Method of transport into the plant cell	Type of vessel which transports mineral ions
A ☒	Active transport	Phloem
B ☒	Active transport	Xylem
C ☒	Diffusion	Phloem
D ☒	Diffusion	Xylem

(1 mark)

16 This diagram shows three duckweed plants in a beaker of distilled water.



a Explain how the water moves into these plants.

(3 marks)

b Salt was added to the water in the beaker to form a salt solution.

Explain how the salt solution would affect the movement of water into and out of the plant.

(2 marks)

c Complete the sentence by putting a cross (☒) in the box next to your answer.

When the concentration of mineral ions in the soil is greater than in the root hair cell, mineral ions are transported into the root hair cells by…

A diffusion ☐

B osmosis ☐

C respiration ☐

D transpiration ☐

(1 mark)

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