GCE AS

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BIOLOGY

ACCREDITED BY OFQUAL

SPECIMEN ASSESSMENT MATERIALS

Teaching from 2015

wjec
cbac

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Contents

Candidate Name	Centre Number					Candidate Number				

AS BIOLOGY

COMPONENT 1

Basic Biochemistry and Cell Organisation

SPECIMEN PAPER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**14**	
3.	**10**	
4.	**18**	
5.	**16**	
6.	**9**	
Total	**75**	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet.

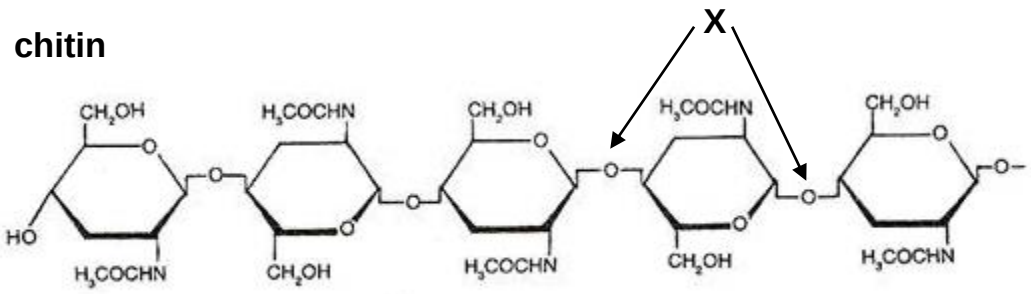
INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in question 6.

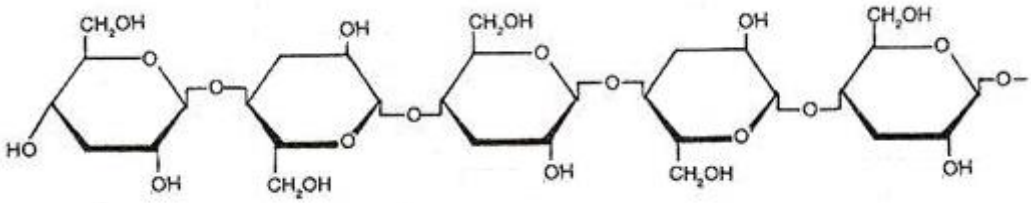
*Answer **all** questions.*

1. Chitin and cellulose are polysaccharides found in the cell walls of some organisms. The structures of these polysaccharides are shown in the diagrams below.

chitin



cellulose



(a) Identify the type of bond labelled **X** on the diagram. [1]

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(b) Describe **one** similarity and **one** difference between the structures of chitin and cellulose. [2]

Similarity: .....

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Difference: .....

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(c) Explain how the structures of these molecules are different to that of starch. [2]

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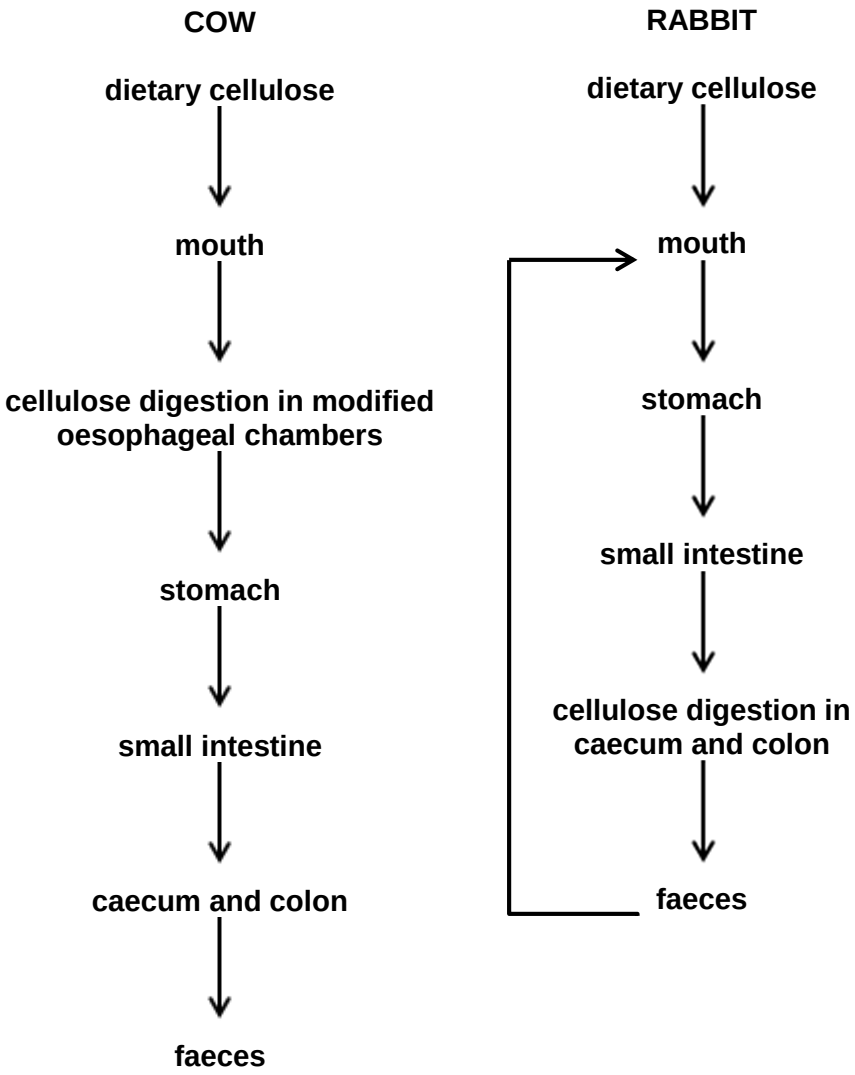
(d) In herbivores, cellulose is digested by cellulase enzymes secreted by bacteria living in the gut. The diagrams below show the site of cellulose digestion in cow and in a rabbit.



Explain why it is necessary for the rabbit to ingest its faeces but not for the cow. [3]

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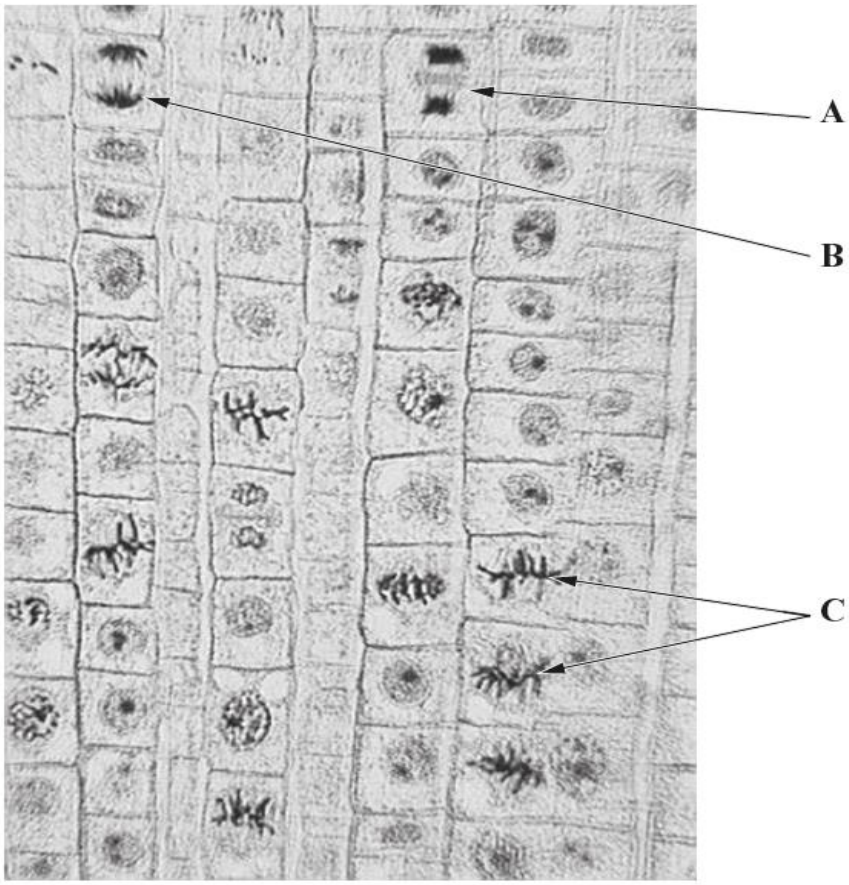
2. Colchicine is an alkaloid compound derived from the corm and other parts of the autumn crocus, *Colchicum autumnale*. Colchicine induces the disassembly of microtubule fibres and thus stops the mitotic process so that chromosome morphology and number can be studied.

The photograph below shows a preparation of garlic (*Allium sativum*) root tip using colchicine to show different stages of the mitotic cell cycle.



(a) (i) Name the stages shown in **A** and **C.** [1]

Stage **A**……

Stage **C**……

(ii) Explain why the disassembly of microtubules would stop mitosis at the different stages that can be observed. [2]

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(iii) Explain the purpose of the process occurring during the stage labelled **B**. [2]

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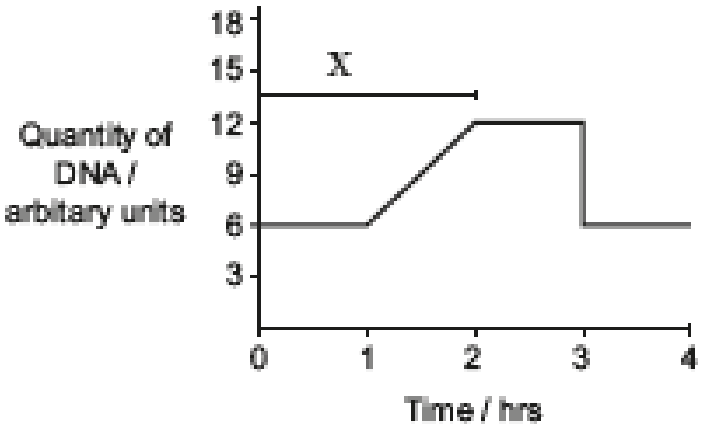
(b) The quantity of DNA in the nucleus of an animal cell was monitored for a period of four hours as shown in the graph below.



(i) Name the stage in the cell cycle which is represented by the time period labelled **X** on the graph above. [1]

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(ii) Using evidence from the graph give a reason for your answer in part (b)(i). [1]

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(iii) What additional evidence would be needed to conclude if the cell is undergoing mitosis or meiosis? Explain your answer. [1]

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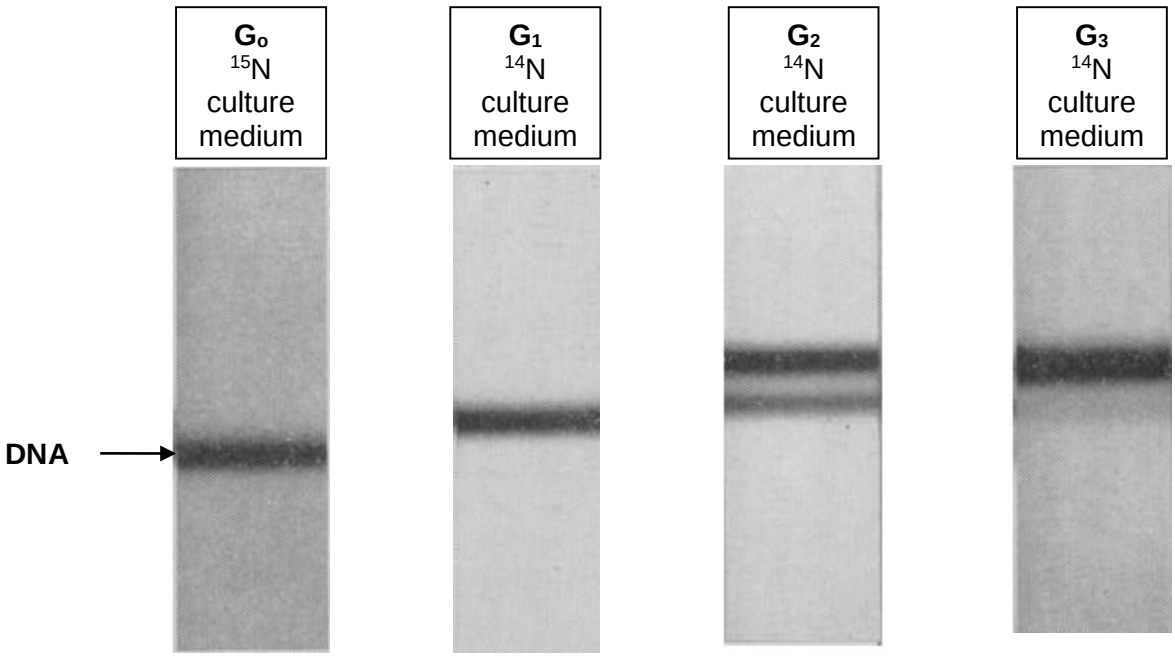
(c) Experiments conducted in the 1950s proved that DNA replication is semi-conservative. The experimental procedure involved growing bacteria with the heavy ^{15}N isotope of nitrogen until the entire DNA contained ^{15}N. The bacteria were then grown for several generations (**G**) in culture medium containing the ^{14}N isotope of nitrogen. At each stage samples of DNA were extracted and separated using ultracentrifugation. The results from one of these experiments are shown in the image below.



(i) Name the part of the DNA molecule which contained the ^{15}N. [1]

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(ii) State what is meant by **semi-conservative** replication and explain how the results shown above support this theory. [5]

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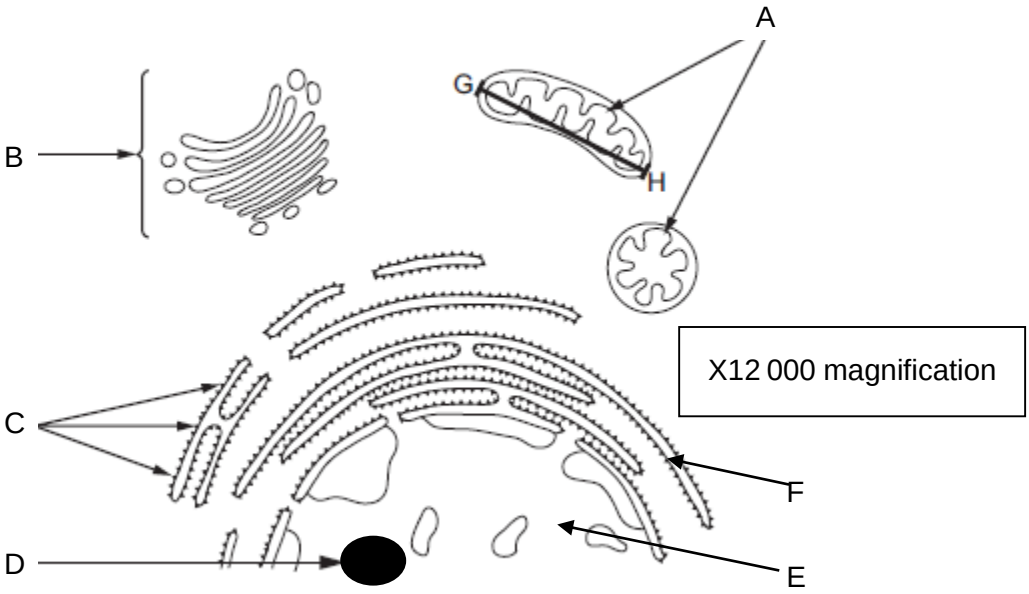
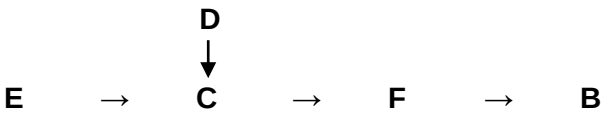
3. The production and secretion of functional proteins from a cell involves a number of cell organelles. The drawing shows part of a generalised animal cell.



(a) Some of these organelles shown above are involved in the production of a functional protein as shown in the flow chart below:



(i) State how organelles **B** to **F** work together in this particular sequence. [5]

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(ii) Suggest the role of organelle A in the production of functional protein. [1]

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(b) (i) Calculate the actual size of organelle **A** between **G** and **H**. [2]
Express your answer using the most appropriate unit.

Answer .....

(ii) Organelle A is similar in size to prokaryotic cells and has structures in common with them. This led the biologist, Lynn Margulis, to conclude that this organelle evolved from ancient prokaryotes. The theory of endosymbiosis proposes that these ancient prokaryotes were engulfed by other bacterial cells and both benefited from the relationship. This association is thought to have led to the evolution of eukaryotic cells.

Using your knowledge of cell structures and processes described, justify this conclusion. [2]

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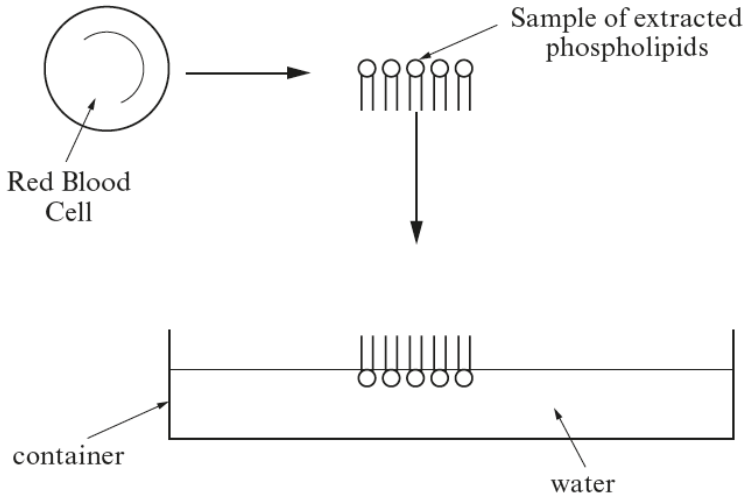
10

4. (a) In 1925, two scientists, Gorter and Grendel investigated the arrangement of phospholipids in the plasma membrane. Their investigation involved the removal of the phospholipids from the surface membrane of red blood cells in 10 cm^3 of blood. The phospholipids were then placed on the surface of water and allowed to spread out to form a single layer called a monofilm.



(i) Explain fully why the phospholipid molecules are arranged as shown in the container in the diagram above. [2]

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(ii) The area covered by all of the phospholipids in the monofilm was found to be 12.2 m^2. It was concluded that the total surface area of the intact red blood cells was 6.1m^2. Justify how Gorter and Grendel reached this conclusion. [2]

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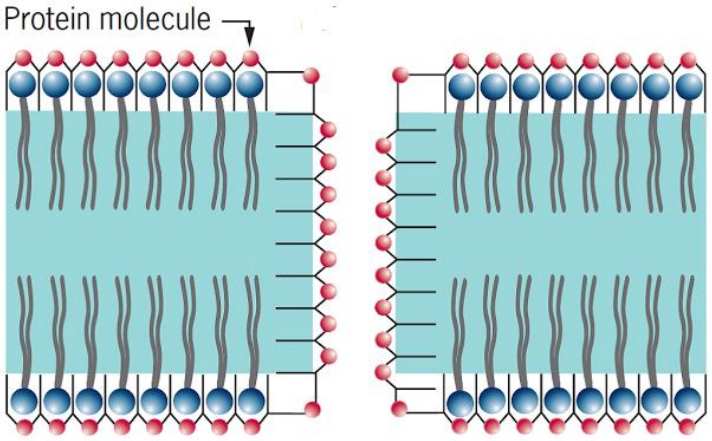
(b) In 1935, Davson and Danielli, proposed a model for the structure of the plasma membrane that built on the findings of Gorter and Grendel together with the discovery that the plasma membrane contained proteins. A diagram to show their proposed structure is shown below.



(i) Describe how this model differs from the currently accepted model of the plasma membrane structure. [3]

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(ii) The currently accepted model is called the fluid-mosaic model. Explain why it has been given this name. [2]

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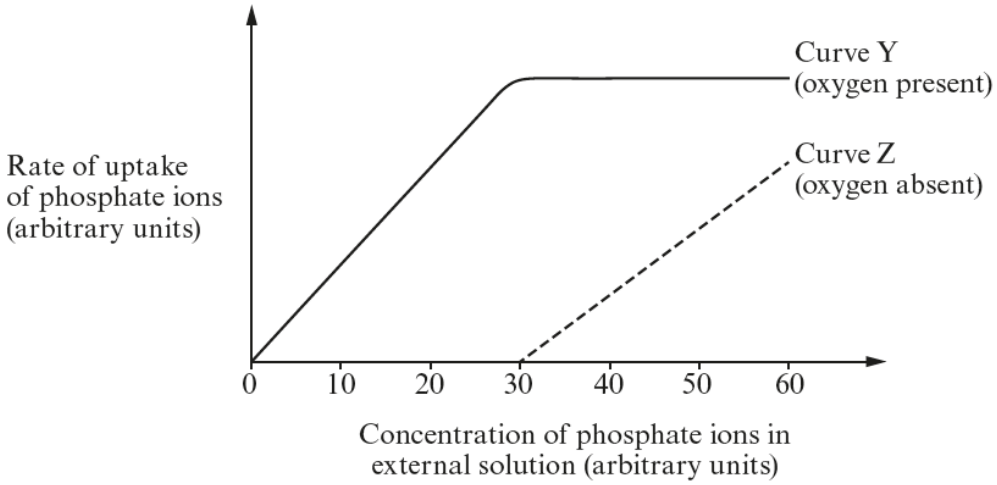
(c) An investigation was carried out on the uptake of phosphate ions in root tissue. The root tissue was cut into discs of uniform size and each disc was added to an equal volume of solution containing phosphate ions of varying concentrations. The experiment was first carried out with oxygen present and then repeated with oxygen absent. The results are shown in the graph below.



(i) Explain why pH and temperature would have to be kept constant in this experiment. [3]

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(ii) Using the results shown on the graph, what conclusions can be drawn about the uptake of phosphate ions by the cells. Justify your conclusions. [6]

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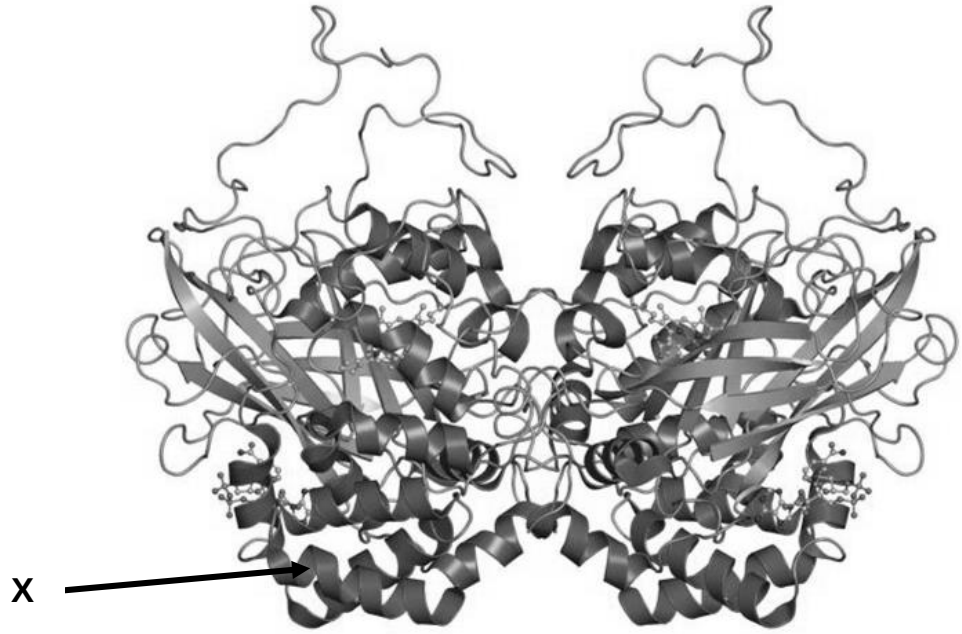
5. Catalase is an enzyme which is found in high concentrations in many tissues including potato tissue. This enzyme catalyses the breakdown of hydrogen peroxide into oxygen and water.

Catalase is composed of a tetramer of four polypeptide chains each bonded to a haem group containing an atom of iron. A diagram of the structure of catalase is shown in the diagram below.



(a) (i) Explain why this protein is said to have a quaternary structure. [1]

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(ii) Identify the name of the type of protein structure labelled **X** on the diagram and explain how this structure is formed. [1]

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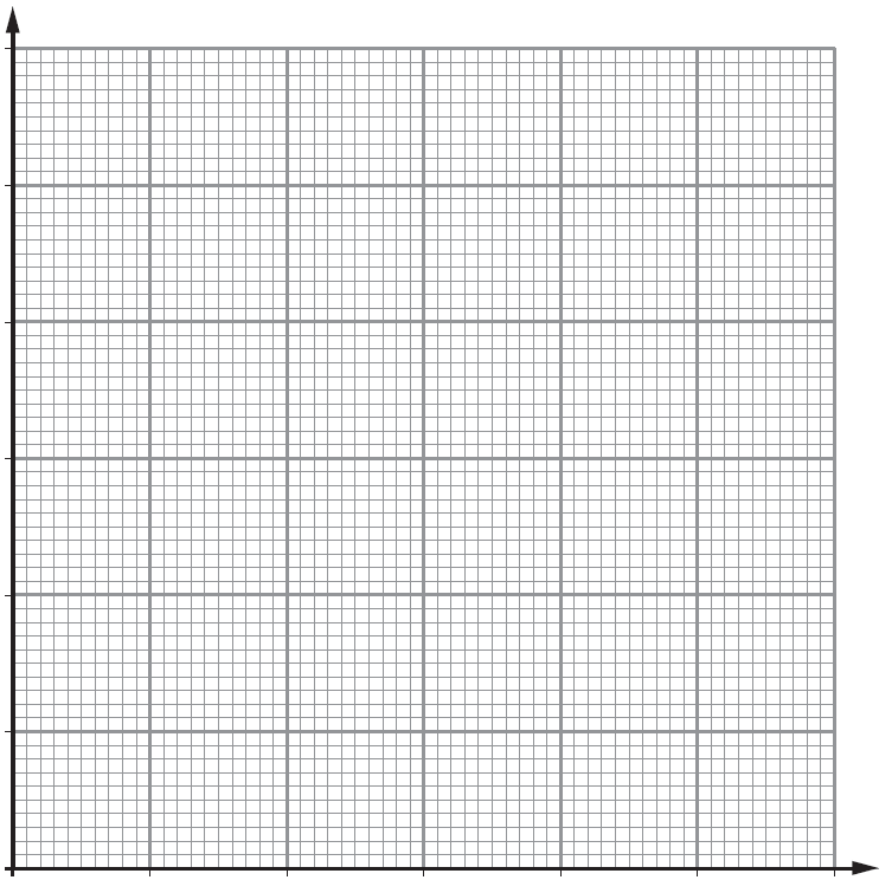
A student investigated the action of the enzyme catalase. The student homogenised 1g of potato tissue in 5cm^3 of water and soaked discs of filter paper of 5mm diameter in the potato extract. The filter paper was then pushed to the bottom of a test tube containing a fixed height of hydrogen peroxide solution and the time taken for the filter paper to reach the surface of the liquid was recorded. Using the same hydrogen peroxide solution, the experiment was repeated twice to obtain three results for a range of hydrogen peroxide concentrations.

The results of the student's investigation are shown below.

Concentration of hydrogen peroxide solution (% of stock solution)	Time taken for filter paper disc to reach the surface (s)				Mean rate of reaction ($s^{-1}10^2$)
	Trial 1	Trial 2	Trial 3	mean	
0.75	20	21	23	21.3	
1.50	19	15	12	15.3	6.5
3.00	13	13	12	12.7	7.9
4.50	11	12	12	11.7	8.5
6.00	12	10	13	11.7	8.5

(b) (i) Calculate the mean rate of reaction for the 0.75% hydrogen peroxide solution and write your answer in the table. [1]

(ii) Plot the data on the graph below. [3]



(iii) Explain the shape of the graph. [6]

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(c) Apart from human error, suggest two sources of error which could have led to inaccuracies occurring within this experiment and two ways in which these could have been minimised. [4]

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16

6. Some scientists have claimed that without liquid water, life could not exist on Earth. With reference to the properties of water, explain why water is claimed to be essential for life on this planet.
(The quality of extended response will be assessed in this question.) [9QER]

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Candidate Name	Centre Number					Candidate Number				

AS BIOLOGY

COMPONENT 2

Biodiversity and Physiology Of Body Systems

SPECIMEN PAPER

1 hour 30 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**8**	
2.	**20**	
3.	**15**	
4.	**12**	
5.	**11**	
6.	**9**	
Total	**75**	

ADDITIONAL MATERIALS

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INSTRUCTIONS TO CANDIDATES

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INFORMATION FOR CANDIDATES

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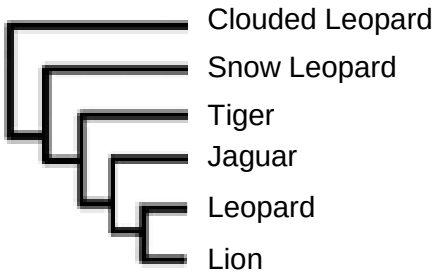
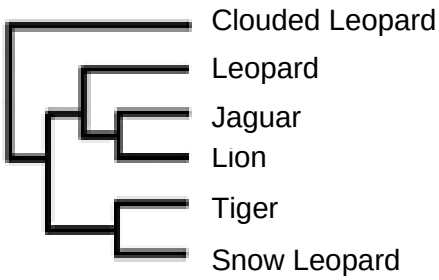
The assessment of the quality of extended response (QER) will take place in question 6.

1. Different scientists interpret available scientific evidence in different ways. The models below show possible evolutionary relationships between different species of 'big cat'. Model A is based solely on morphological evidence and model B is based on biochemical analyses.

A



B



(a) (i) What name is given to this type of diagram? [1]

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(ii) Big cats are classified into the kingdom Animalia. Name the other kingdoms used in the classification of organisms. [2]

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(b) The big cats shown in the diagrams above have been given the following scientific names according to the binomial system:

Clouded Leopard	*Neofelis nebulosa*
Leopard	*Panthera pardus*
Lion	*Panthera leo*
Jaguar	*Panthera onca*
Snow Leopard	*Uncia uncia*
Tiger	*Panthera tigris*

Based on their scientific names which of the big cats are the **least** closely related to the tiger? Give a reason to support your answer. [2]

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(c) Samples of mitochondrial DNA from a lion, a tiger and a snow leopard were analysed. The base sequences for the same section of their mitochondrial DNA are shown below.

	10	20	30	40
Lion	ATACGTGTAT	ACGTGTACGT	GTGTACGTGT	GTACGTGTGT
Tiger	ACGTGTACGT	GTGTATACGT	GTACGTGTGT	ACGTGTGTAT
Snow Leopard	ATACGTGTAC	GTGTATACGT	GTACGTGTGT	ACGTGTGTAC

Species 1	Species 2	Number of bases in common
Lion	Tiger	20
Tiger	Snow Leopard	31
Lion	Snow Leopard	25

Based on this information which of the two proposed models is supported by these results? Explain your answer. [1]

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(d) Human mitochondrial DNA codes for proteins essential for some of the reactions which take place within the mitochondrion. Name **two** forms of RNA which are essential for the synthesis of these proteins within the mitochondrial matrix. [2]

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8

2. Plants need water for transport, support and photosynthesis among other biochemical processes. Water uptake from the soil is largely passive and the flow of water from the roots to the leaves is driven in part by the loss of water through the stomata.

(a) State the name of the process by which plants lose water from their leaves. [1]

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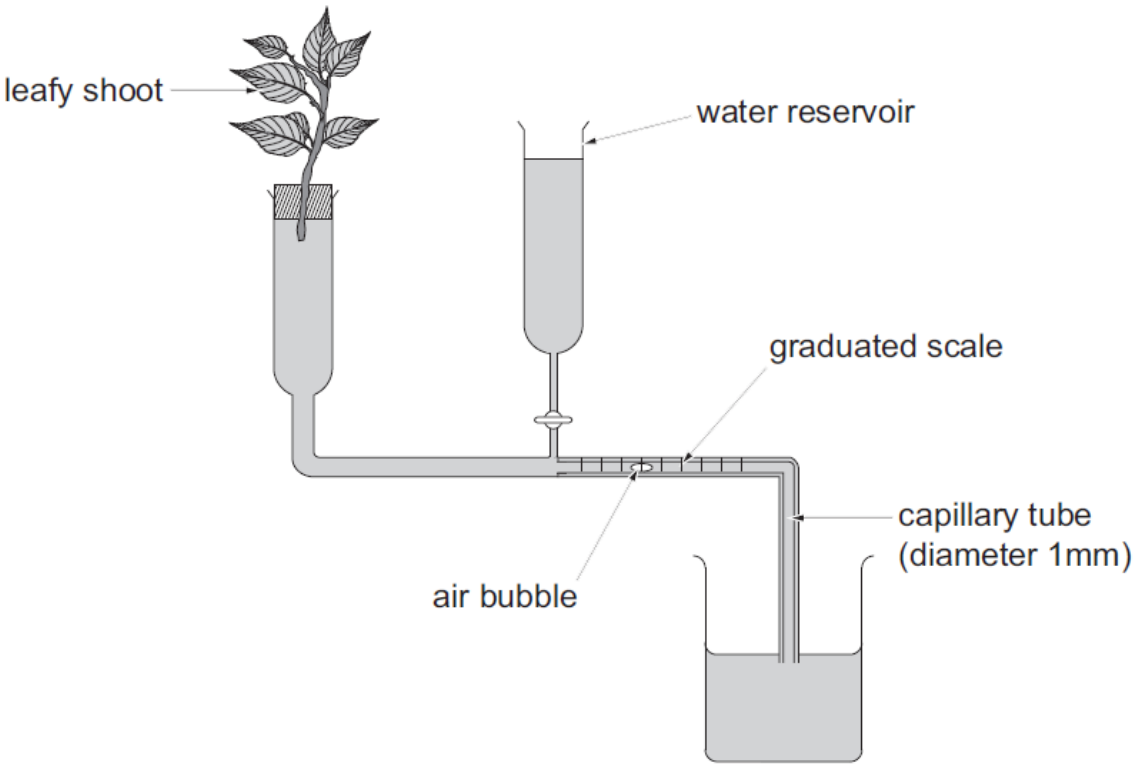
The apparatus shown in the diagram was used to study how wind speed affects the rate at which a leafy shoot takes up water.

The same shoot was exposed to air moving at different speeds. At each speed the distance moved by the air bubble in 5 minutes was recorded. The results were then used to calculate the rate of water uptake by the leafy shoot in $mm^3\ min^{-1}$.



(b) The table below shows the results of the investigation.

Wind speed (m s^{-1})	0	5.0	10.0	15	20	25.0
Distance travelled by air bubble in 5 minutes (mm)	64	98	129	163	175	151
Rate of water uptake (mm^3 min^{-1})	10.0	15.3	20.2	25.5	27.4	.....

(i) Using the formula below, calculate the rate of water uptake by the plant in mm^3 min^{-1} at a wind speed of 25 m s^{-1}. [3]

Volume of water = **distance travelled by bubble** x π x **radius²** (π = 3.14)

Answer = ... mm^3 min^{-1}

(ii) Explain why the rate of water uptake increased as the wind speed increased from 0 to 20 m s^{-1}. [3]

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(c) The results show, that at a wind speed above 20 m s^{-1}, the rate of water uptake by the leafy shoot decreased. One explanation for this decrease could be due to the closure of the stomata by guard cells.

Describe the role of **each** of the following in the operation of guard cells in **opening** stomata.

(i) K^+ (potassium ions). [1]

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(ii) Water potential of the cells. [1]

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(iii) Unevenly thickened cell walls. [1]

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(d) Suggest how you could adapt the experimental technique given to determine the location of the highest density of stomata. Predict the results you would expect. [3]

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(e) Many plants are adapted to living in regions of low water availability.

(i) What term is used to describe this type of plant? [1]

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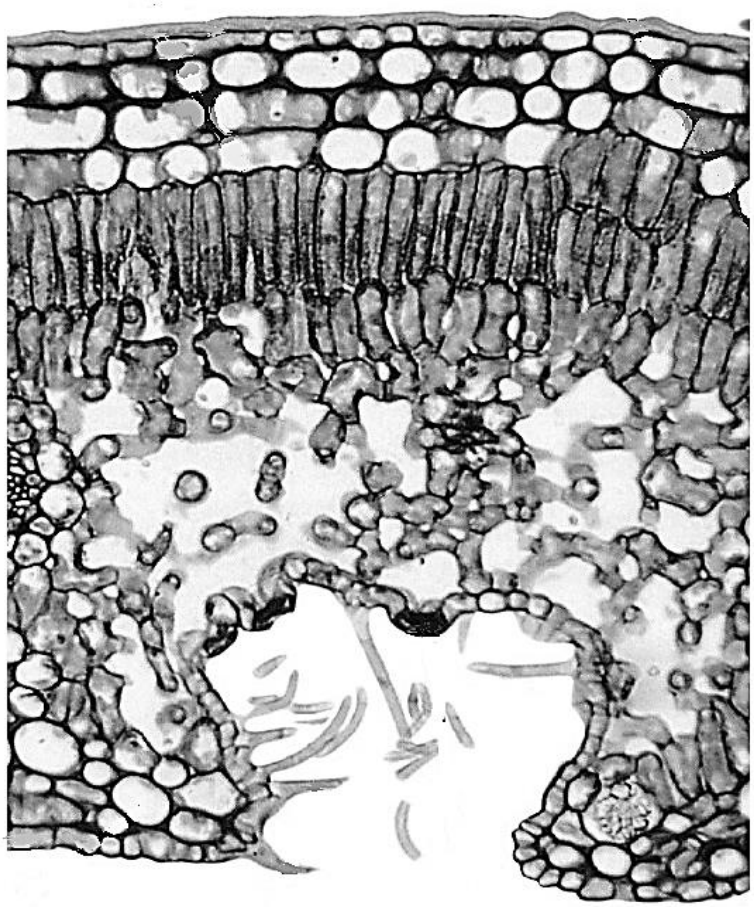
(ii) The photomicrograph below shows a section through a leaf showing a number of adaptations to living in an arid environment.



Identify three features that can be seen in the photomicrograph and explain how each helps the plant to reduce water loss. [6]

Feature 1:

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Feature 2:

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Feature 3:

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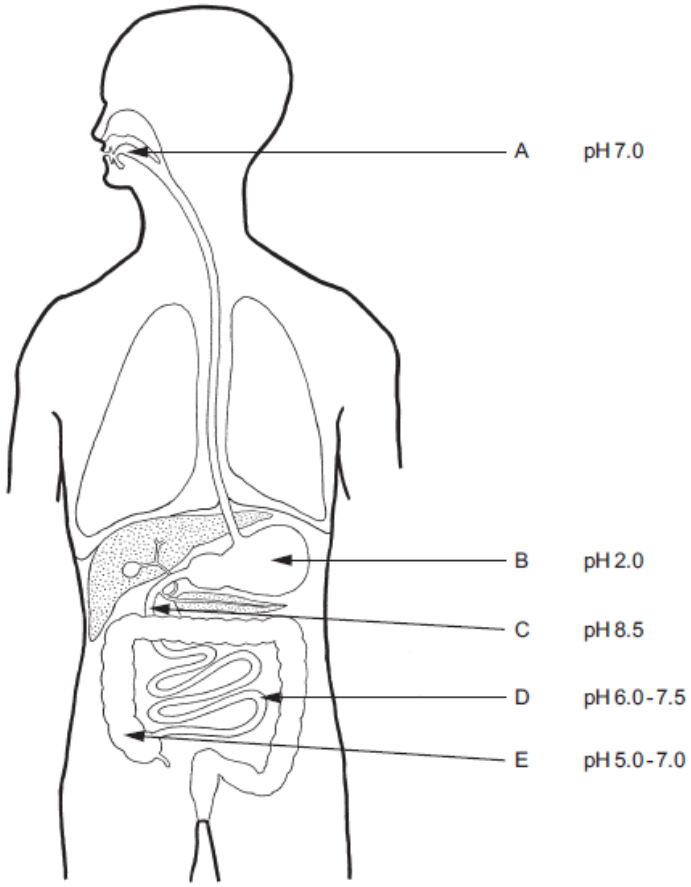
20

3. The mammalian gut is divided into several regions, each adapted to carry out different functions. The conditions in each region are different and parasites that inhabit the gut must be able to adapt to these conditions.

The diagram below shows how the pH of the alimentary canal changes in different regions.



(a) Explain the cause of the following:

(i) the increase in pH in region C; [1]

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(ii) the decrease in pH in region D. [2]

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(b) (i) Using letters from the diagram, identify the regions of the human alimentary canal where you would expect to find the tapeworm *Taenia solium* in an infected person. [1]

……...

(ii) How is the tapeworm adapted to survive in these regions? [2]

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(c) Adult *Taenia solium* usually have about 1 000 proglottids (segments), each of which contains both male and female reproductive systems. A mature proglottid can contain about 50 000 eggs and a mature tapeworm releases an average of six mature proglottids each day. Each tapeworm can survive for about 25 years.

(i) Suggest why *Taenia solium* needs to produce so many eggs. [1]

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(ii) Estimate the number of eggs that could be produced by a single *Taenia solium* during its lifetime. Show your workings and give your answer in standard form to two significant figures. [3]

Answer ..... eggs

(d) Explain why both humans and the tapeworm *Taenia solium* are described as being **heterotrophic** but only the human has **holozoic** nutrition. [3]

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(e) The body of an animal, previously unknown to science, was discovered in Papua New Guinea. The passage below describes some of the initial observations made.

"The animal is a mammal approximately 1.2 m long and 0.6 m high. It has sharp upper and lower incisors with well-developed canines; the first pre-molars are sharp with serrated edges while the rear premolars are similar to the molars and have strong ridges. Total gut length is approximately 15.0m (compared to 30.8 m in a sheep and 5.1 m in a dog of similar size). The ratio of body length to intestine length is 1:13 (compared to 1:25 in a sheep and 1:6 in a dog of similar size)."

What conclusion could be reached about the animal's mode of nutrition? Give reasons for your answer. [2]

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4. Insects and mammals have both evolved to live in terrestrial environments. One of the main problems they have had to overcome is the absorption of oxygen from the air. To do this both types of organism have evolved internal gas exchange systems.

(a) (i) Name the sites of gas exchange in insects and mammals. [1]

Insects .....

Mammals .....

(ii) Explain why insects and mammals have internal gas exchange systems. [2]

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The table below compares some facts about gas exchange and oxygen transport in insects and mammals.

		Insects	Mammals
% oxygen in air	before gas exchange	21%	21%
	after gas exchange	17 – 18%	13.5 - 16%
Surface Area of gas exchange surface : Volume of body tissue		Very high	High
Association with transport system		None	Close
Haemoglobin required		No	Yes
Maximum thickness of body tissue (approximate value)		20 mm	no limit

(b) Use the information above to evaluate the following statement:
'*The size and shape of insects is limited but that of mammals is not.'* [4]

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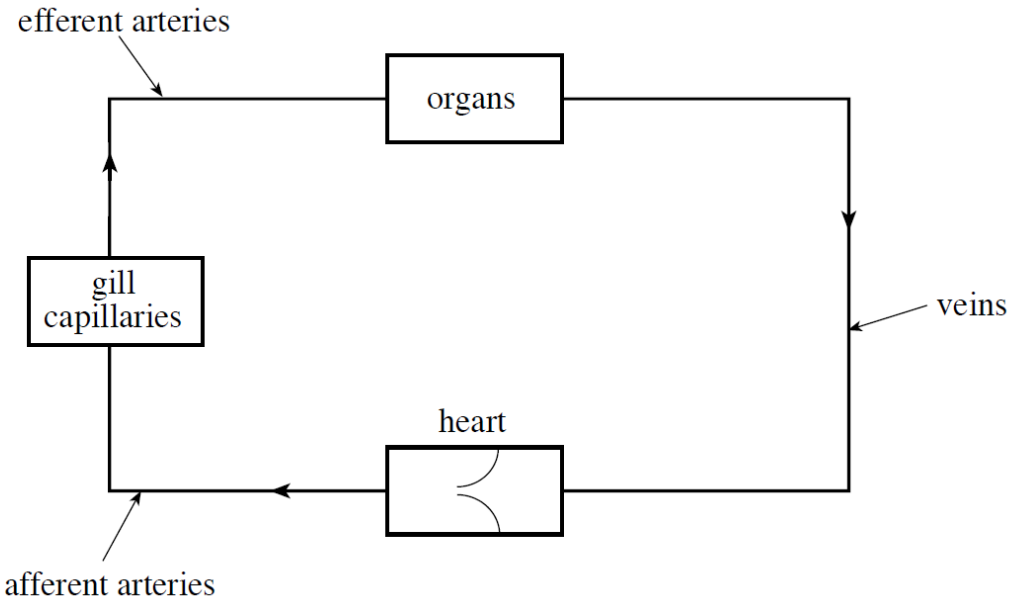
The diagram below represents the circulatory system of a fish.



(c) Name the type of circulatory system. [1]

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(d) Fish have evolved gills that allow gas exchange. Water contains approximately 1% dissolved oxygen but fish are able to absorb about 80% of the available oxygen and remain highly active.

Describe how the structure of their gills enables bony fish to be so efficient at gas exchange. [4]

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12

5. In recent years scientists have become increasingly concerned about the global decrease in **biodiversity**. A higher than normal rate of **extinction** caused by humans has been proposed as the main reason for this decrease. In the UK, hedges have been identified as being habitats that have a high biodiversity.

(a) State what is meant by the terms: [2]

biodiversity

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extinction

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(b) To assess the change in biodiversity the presence of some types of plant growing in a 100 m length of hedge was surveyed in 2000 and again in 2010. Each of these species provide a source of food for a wide variety of animals.

A diversity index was calculated based on the results. These are shown in the table below.

Species (description)	**Number of plants present per species**	
	2000	**2010**
Hawthorn dense structure; fairly slow growing; grows to 5 – 14m tall	**37**	**8**
Hazel open structure; grows to 4 – 8 m tall; grows many shoots directly from the roots	**21**	**10**
Ivy a climbing plant that covers the ground and grows up other plants to get light	**36**	**41**
Elder fast growing shrub usually between 3 and 8 m tall	**12**	**50**
Bramble produces long stems but usually does not exceed 2 m in height	**61**	**12**
DIVERSITY INDEX		**0.60**

(i) Using the formula and the table given below, calculate the Diversity Index for the year 2000 data. [3]

$$\textbf{Diversity Index} = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

Where: N = total number of individual plants
n = number of individuals per species
Σ = sum of

Species	*n*	*(n-1)*	*n(n-1)*
Hawthorn	37		
Hazel	21		
Ivy	36		
Elder	12		
Bramble	61		
	N =		$\sum n(n-1)$ =
	N-1 =		

$N\ (N-1)$ = _____

Diversity Index = _____

(ii) Many hedges are being removed each year and many are not being maintained as hedges, but are turning into lines of trees with a corresponding change in the biodiversity of the habitat.
Using the information given and the values for the Diversity Index, what conclusions can be made about the change in biodiversity in this hedge? Suggest an explanation for this change. [3]

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(c) Describe how a sweep net could be used to estimate the Diversity index of insects at the base of a hedge. [3]

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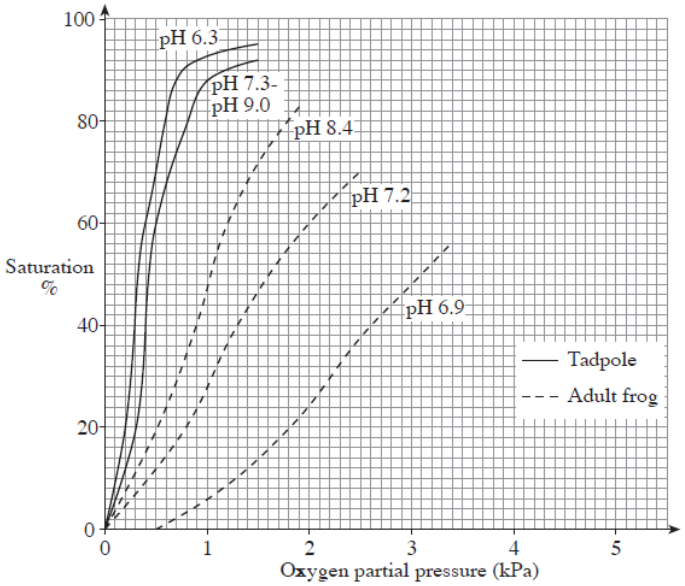
6. Frogs have a larval form called tadpoles. As tadpoles, they obtain oxygen from water which has a relatively low oxygen content, but as adults, oxygen is absorbed from the air in simple lungs. This change is accompanied by changes in the properties of the haemoglobin of the larval and adult frogs, which are similar to that observed in foetal and adult humans. Both larval and adult frog haemoglobin can adjust to changing oxygen demands and availability. The graph below shows the effect of pH on haemoglobin from tadpole and adult frogs.



With reference to the information provided, explain how the properties of haemoglobin enable tadpoles and frogs to gain the oxygen required for survival. (The quality of extended response will be assessed in this question.)

[9QER]

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COMPONENT 1 – Basic Biochemistry and Cell Organisation

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

Examiners must mark in red ink.

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Marking rules

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Extended response question

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Marking abbreviations

The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
ecf = error carried forward
bod = benefit of doubt

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	(a)			beta glycosidic bond (1)	1			1		0
	(b)			**similarity** alternative monosaccharides / sugars rotated by 180^{o} (1) **difference** -OH on C_2 of cellulose replaced by $-NHCOCH_2$ in chitin (1)	2			2		
	(c)			(in **cellulose** and **chitin)** hydrogen bonds form to cross-link adjacent polysaccharide chains (1) (in **starch)** hydrogen bonds will coil the polysaccharide to form an alpha helix. (1)	2			2		
	(d)			Main area of digestion and absorption is stomach and small intestine (1) In the cow cellulose digestion by bacteria takes place before stomach and small intestine so digested food can be absorbed. (1) In the rabbit cellulose digestion takes place after the stomach and small intestine so the rabbit has to eat the faeces so that digestion of materials can be completed and nutrients absorbed. (1)		3		3		
				Question 1 total	**5**	**3**	**0**	**8**	**0**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)		Stage A – telophase and Stage C – metaphase (1)	1			1		1
		(ii)		microtubules used to form the spindle apparatus (1) so spindle cannot form / separate / move chromatids (1)		2		2		
		(iii)		To separate each pair of chromatids/ to pull a copy of each chromosome to opposite poles(1) so that each resulting nucleus will be genetically identical(1)	2			2		
	(b)	(i)		Interphase (1)	1			1		
		(ii)		The quantity of DNA has <u>doubled/</u> returns to its initial value / (quantity of) DNA changes from 6 to 12 (1) NOT: increase		1		1		
		(iii)		Observe the cell for a longer period of time and if the DNA quantity doubles cell division is mitosis and if it halves it is meiosis(1)			1	1		1
	(c)	(i)		nitrogenous / organic bases (1)	1			1		
		(ii)		each strand of DNA used as a template to make a new DNA strand/ New DNA molecules are made of an old/ original strand and a new strand (1) G_0 – all DNA heavy due to ^{15}N (1) G_1 – all DNA is intermediate / lighter because each ^{15}N strand has acted as a template for the synthesis of a ^{14}N strand (1) G_2 – half DNA is light / lighter again due to ^{14}N strands acting as template but half is intermediate due to presence of original ^{15}N strands (1) G_3 – increasing amount of ^{14}N DNA as more ^{14}N strands acting as templates (1)	1	4		5		4
				Question 2 total	**6**	**7**	**1**	**14**	**0**	**6**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		E = (DNA) carries genetic code and is transcribed into mRNA (1) C=(ribosomes) translate mRNA to form polypeptide chain (1) D=(nucleolus) involved in production of ribosomes /rRNA (1) F=(RER) transports polypeptides to Golgi body (1) B= (Golgi body) processes/ modifies and packages protein (1)	5			5		
		(ii)		production / synthesis of ATP to provide the energy for eg peptide bond formation/ amino acid activation (1)		1		1		
	(b)	(i)		24 × 1 000 ÷ 12 000 (1) 2 µm (1)		2		2	2	2
		(ii)		Organelle A = mitochondrion +Two structural similarities for 1 mark from: a loop/ circle of DNA,70S ribosome, infolding of membranes, stalked particles (1) Mitochondria has two membranes, same as is if a bacterium had been {enclosed in a phagocytic vesicle/ engulfed by another cell}(1)			2	2		
				Question 3 total	**5**	**3**	**2**	**10**	**2**	**2**

Question				Marking details	Marks available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
4	(a)	(i)		{Heads/ phosphates} are {hydrophilic/ polar} and are attracted to the water (1) {Tails/ fatty acids} are {hydrophobic/ non polar} and are {repelled by/ above/ avoid} water (1) NOT react/ dissolve with water		2		2		
		(ii)		The total surface area of red blood cell is half the area of the monofilm as phospholipids arrange themselves as a bilayer (1) With hydrophilic heads facing the polar/ ionic molecules on both sides of the membrane(1)			2	2		
	(b)	(i)		proteins are embedded in the phospholipid bilayer as well as being located outside phosphate head / there are extrinsic and intrinsic proteins not just extrinsic (1) many proteins present in the membrane but not linked together as in the diagram (1) channel / pore is formed from a single protein not lined with protein (1)		3		3		
		(ii)		Mosaic = protein molecules embedded in the membrane (1) Fluid = protein and phospholipid molecules free to move (1)	2			2		
	(c)	(i)		Change in temperature would change the kinetic energy of the molecules and therefore the rate(1) High temperature could denature proteins in the membrane(1) Change in pH could change the tertiary structure of the protein membranes(1)	3			3		3

		(ii)		Concentration of phosphate ions inside cell must be 30a.u.(1) Because in the absence of oxygen and in concentrations less than 30a.u. there is no uptake of phosphate(1) Absence of oxygen uptake must be by facilitated diffusion/ diffusion(1) In the presence of oxygen and in concentrations less than 30a.u. must be active transport as phosphate uptake is against concentration gradient and ATP is present(1) At concentrations greater than 30 a.u. and oxygen present uptake is by both active transport and facilitated diffusion/ diffusion (1) At high concentration of phosphate all carrier proteins are in use and become a limiting factor(1)		2	4	6		
				Question 4 total	**5**	**7**	**6**	**18**	**0**	**3**

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)		four polypeptide chains bonded together to produce functional protein (1)	1			1		
		(ii)		alpha helix and hydrogen bonds formed between polar H and O atoms / amino and hydroxyl groups (1)	1			1		
	(b)	(i)		4.7 (1)		1		1	1	
		(ii)		Axes correctly assigned with correct labels (1) Appropriate linear scales plus units (1) All points correctly plotted and joined with a curve or ruled straight lines (tolerance ½ small square) (1)		3		3	3	
		(iii)		Between 0.75% and 4.50% hydrogen peroxide concentration: As the concentration of hydrogen peroxide increases the rate of reaction increases (1) As the hydrogen peroxide concentration increases there are more enzyme-substrate complexes formed (per unit time) (1) The concentration of hydrogen peroxide is limiting the rate / hydrogen peroxide concentration is the limiting factor (1) Above 4.50% As the concentration increases the rate of reaction remains constant(1) all of the active sites (of catalase) are occupied/ catalase is saturated (1) The concentration of catalase is now limiting the rate / catalase concentration is a limiting factor (1)		4	2	6		

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(c)			Any two inaccuracies + two linked improvements The reaction is exothermic and this would affect the rate of reaction (1) Use of a water bath to control temperature (1) The concentration of catalase in the potato extract could vary (1) Use of catalase solution (1) pH could vary (1) Use a buffer (1) Time of disc in enzyme could vary (1) Leave disc in enzyme solution for a set time (1) By using same hydrogen peroxide solution each time, concentration would decrease(1) Use fresh solution each time (1)			4	4		4
				Question 5 total	**2**	**8**	**6**	**16**	**4**	**4**

Question	Marking details	Marks available					
		AO1	AO2	AO3	Total	Maths	Prac
6	Indicative content Water is a polar molecule: ● it forms hydrogen bonds with other water molecules so it is liquid in the usual range of temperatures found on Earth ● it can also form H bonds with other ionic and polar molecules and so is able to dissolve and transport these molecules ● due to H bonds water molecules can move up through xylem vessels through a combination of cohesive and adhesive forces ● liquid water also has a high surface tension that provides a habitat for some organisms Water has a high specific heat capacity: ● as it requires a large amount of energy to raise its temperature. This helps to maintain body temperatures at a fairly constant temperature ● aquatic habitats also have a fairly stable temperature Water has a high latent heat of evaporation: ● as it requires a large amount of energy to evaporate it it can be used to cool bodies e.g. evaporation of sweat ● aquatic habitats do not disappear easily through evaporation Additional Points: ● as water is transparent light can pass through it and aquatic plants can photosynthesise ● ice is less dense than water so insulates the water beneath it as it forms thus stopping it from freezing ● due to its polar nature it is a reactant in many biochemical reactions e.g. hydrolysis /photosynthesis	4	5		9		

				7-9 marks The importance of water as a polar molecule is explained in detail in terms of the interactions of water molecules with each other and with other molecules and structures. In addition, there is a clear understanding of how the thermal properties of water affect temperature control of habitats and organisms. Explanations of how other properties of water are important to life are also given. *The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.* **4-6 marks** The polar nature of water is described and is linked to how this property makes it important to life on earth. The thermal properties of water are explained in terms of how they affect temperature control of habitats and / or organisms and some explanations of how other properties of water are important to life are also given. *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.*						

				1-3 marks A number of properties of water are described together with an attempt at explaining how these properties are important to life on earth. Reference to the polar nature of water molecules or the thermal properties of water are limited or incorrect. *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
				Question 6 total	**4**	**5**	**0**	**9**	**0**	**0**

COMPONENT 1: BASIC BIOCHEMISTRY AND CELL ORGANISATION

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	3	0	8	0	0
2	6	7	1	14	0	6
3	5	3	2	10	2	2
4	5	7	6	18	0	3
5	2	8	6	16	4	4
6	4	5	0	9	0	0
TOTAL	**27**	**33**	**15**	**75**	**6**	**15**

COMPONENT 2 - Biodiversity and Physiology of Body Systems

MARK SCHEME

GENERAL INSTRUCTIONS

Recording of marks

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ecf = error carried forward
bod = benefit of doubt

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
1	*(a)*	(i)		Phylogenic/ phylogenetic tree (1)	1			1		
		(ii)		Protoctista, Plantae, Prokaryotae, Fungi All correct 2 marks 2/3 correct 1 mark	2			2		
	(b)			{*Neofelis nebulosa* / Clouded Leopard} and {*Uncia uncia* / Snow Leopard}(1) different genus names to the tiger (1)		2		2		
	(c)			Model B **+** Tiger and snow leopard have the most bases in common (1)			1	1		
	(d)			ribosomal RNA (1) transfer RNA (1)	2			2		
				Question 1 total	**5**	**2**	**1**	**8**	**0**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
2	(a)			Transpiration (1)	1			1		
	(b)	(i)		Volume of water = ($151 \times 3.14 \times 0.5^2$) (1) divided by 5 (1) = 23.7 (1)		3		3	3	3
		(ii)		Wind removed water vapour from leaf surface / removes diffusion shells /removes water molecules from the leaves microclimate (1) Increased {diffusion gradient/ water potential} between inside and outside of leaf (not: blows water away) (1) Therefore more water lost and more water taken up to replace it(1)		3		3		
	(c)	(i)		[K+] (actively) pumped into cells {which lowers the cell water potential /draw water in by osmosis} (not: move in/diffuse) (1)	1			1		
		(ii)		[water potential] decreased to draw water in (from adjacent cells) (1)	1			1		
		(iii)		[uneven thickness] inner wall is thicker causing cells to {bend/curve} (not: open) (1)	1			1		

Question				Marking details	Marks available					
					AO1	**AO2**	**AO3**	**Total**	**Maths**	**Prac**
	(d)			Cover top surface of leaf with Vaseline / grease on one plant and bottom surface of leaf on another (1) Calculate the rate of water uptake for both (1) Rate of water uptake would be lower when lower surface is covered as this is where most stomata are (1)			3	3		3
	(e)	(i)		Xerophytes (1)	1			1		
		(ii)		Thick (waxy) cuticle (1) **Reduce** evaporation (1) NOT stop Sunken stomata(1) Increase humidity outside stomata / reduce {diffusion gradient/ water potential gradient} (1) Hairs surrounding stomata / on lower leaf surface (1) Trap moisture / increase humidity in stomatal pit/ reduces water potential gradient (1)		6		6		
				Question 2 total	**5**	**12**	**3**	**20**	**3**	**6**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)		Alkaline {mucus / secretions}/ bile from gall bladder/ Brunners Gland (1)	1			1		
		(ii)		Nutrients digested (1) Into amino acids /fatty acids/ acid products (1)		2		2		
	(b)	(i)		C and D (1)	1			1		
		(ii)		Thick cuticle / secretes mucus to withstand acid / alkaline pH/ host immune system (1) Scolex / hooks and suckers to attach to gut wall / prevent being removed by peristalsis (1)	2			2		
	(c)	(i)		Increase the chance of infecting a secondary host/ many will die (1)	1			1		
		(ii)		50 000 x 6 x 365 x 25 (1) = 2 737 500 000 (1) = 2.7×10^9 (1) Max 2 if answer not given in standard form Max 2 if answer not rounded to 2 sig figures eg 2.737×10^9		3		3	3	
	(d)			(Heterotrophic) both obtain their energy and raw materials from other organisms (1) Holozoic nutrition involves ingesting and then digesting food internally (1) *Taenia* only absorbs pre-digested nutrients (1)		3		3		

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
	(e)			more likely omnivore because it has incisors and sharp pre-molars for biting and cutting food indicates animal material in diet and grinding surfaces of rear premolars and molars indicate plant material in diet (1) {gut length / ratio of body length : gut length} intermediate between omnivore and carnivore (but closer to that of a carnivore (1)			2	2		
				Question 3 total	**5**	**8**	**2**	**15**	**3**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)		Insects – (ends of)tracheoles and Mammals – alveoli (1)	1			1		
		(ii)		Protection of gas exchange surface (1) Reduce heat / water loss (1)	2			2		
	(b)			Mammals can absorb more O_2 from air than insects (1) Mammals need a smaller surface area:volume ratio to absorb sufficient oxygen(1) Circulatory system can transport oxygen to all tissues but in insects relies on diffusion alone (1) The haemoglobin in mammals increases volume of O_2 that can be absorbed / transported (1)		1	3	4		
	(c)			Single (1)	1			1		
	(d)			Large surface area provided by gill filaments and lamellae (1) Extensive network of blood capillaries (1) Maintain (oxygen/concentration) gradient along whole length of capillaries/filament (1) blood flow in opposite direction to water/ description of countercurrent(1)	4			4		
				Question 4 total	**8**	**1**	**3**	**12**	**0**	**0**

Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
5	(a)			**Biodiversity:** The number of species and number of organisms within each species found within a specified geographic region (1) **Extinction:** All individuals of a species are dead / species which has no living members (1)	2			2		
	(b)	(i)		**Calculation of N(N-1)** = 167 x 166 = 27722 (1) **Calculation of Σn(n-1)** = 1332 + 420 + 1260 + 132 + 3660 = 6804 (1) **Calculation of Diversity Index** 1 – (6804/27722) = 0.75 (1) Max 2 for correct process but incorrect answer		3		3	3	3
		(ii)		Biodiversity has decreased (1) Elder has increased in number/ ivy covers more plants/ less hazel – open structure/ more hawthorn – dense structure (1) Caused increased shade so other plants can't get enough light (1)		2	1	3		
	(c)			Take random distances along hedge (1) Use same technique with net at each position (1) Classify and count organisms found (1)			3	3		
				Question 5 total	**2**	**5**	**4**	**11**	**3**	**3**

Question	Marking details	Marks Available					
		AO1	AO2	AO3	Total	Maths	Prac
6	Indicative content • Tadpole haemoglobin has a higher oxygen affinity than adult frog haemoglobin at a given partial pressure of oxygen which enables it reach a higher % saturation with oxygen than the adult frog • This can be seen from the graph at any pH, as the dissociation curve for tadpole haemoglobin lies to the left of that for adult frog haemoglobin and reaches a higher % saturation • Tadpoles live in water with a low pO_2 and this enables the tadpole to absorb oxygen more efficiently than adult frogs • Adult frogs that are able to breathe air with a higher pO_2 do not need as high an O_2 affinity because of the higher O_2 content of air • Due to its higher O_2 affinity, tadpole haemoglobin does not dissociate and release O_2 as easily as adult frog haemoglobin • This can be seen from the graph as % saturation does not fall, showing dissociation, until pO_2 is very low while the % saturation of adult frog haemoglobin decreases at higher pO_2 showing that it dissociates more easily than tadpole haemoglobin –this is due to its lower O_2 affinity • To meet changing oxygen needs, adult frog haemoglobin dissociates more easily as pH decreases – this fall in pH would be caused by an increase in pCO_2 release during respiration.	2	5	2	9		

				• This is called the Bohr Shift / Effect and enables the adult frog to increase O_2 availability to muscles and tissues if the O_2 demand increases • Tadpole haemoglobin shows the opposite effect – as pH decreases O_2 affinity increases; • This enables the tadpole to absorb more O_2 if pO_2 falls, i.e. the water where it lives becomes more anaerobic. As a result, if O_2 levels become lower the tadpole is still able to absorb enough O_2 for respiration.						
				7-9 marks Clear and detailed explanations are given of why tadpoles need haemoglobin with a high O_2 affinity while adult frog haemoglobin does not need to be as high. The effect of pH on oxygen affinity and the dissociation of oxyhaemoglobin are also explained in detail. Explanations must include clear references to the information provided and the advantages that these adaptations give to the larval and adult frogs. *The candidate constructs an articulate, integrated account, correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.*						

				4-6 marks A partial explanation of the links between low O_2 content of water and high O_2 content of air and the oxygen affinity of tadpole and frog haemoglobin. Some explanation of the effect of pH on oxygen affinity and dissociation of haemoglobin is made together and an understanding of the advantage to the larval and adult frog is communicated. References to the information provided are made to support explanations given. *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.* **1-3 marks** A limited understanding of the need for different oxygen affinities and dissociation of haemoglobin in larval and adult frogs is communicated. Some reference is made to the information provided but the understanding of the effect of pH is limited or incorrect. An attempt is made to link between the changes described and the advantages to the tadpole and adult frog. *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.* **0 marks** *The candidate does not make any attempt or give a relevant answer worthy of credit.*						
				Question 6 total	**2**	**5**	**2**	**9**	**0**	**0**

COMPONENT 2: BIODIVERSITY AND PHYSIOLOGY OF BODY SYSTEMS

SUMMARY OF MARKS ALLOCATED TO ASSESSMENT OBJECTIVES

Question	AO1	AO2	AO3	TOTAL MARK	MATHS	PRAC
1	5	2	1	8	0	0
2	5	12	3	20	3	6
3	5	8	2	15	3	0
4	8	1	3	12	0	0
5	2	5	4	11	3	3
6	2	5	2	9	0	0
TOTAL	**27**	**33**	**15**	**75**	**9**	**9**