AQA A-LEVEL BIOLOGY

BIOLOGY



EXAM QUESTION PACK

UNIT 2 OLD SPECIFICATION PAPERS

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AQA

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Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

AS BIOLOGY

Unit 2 The variety of living organisms

Tuesday 7 June 2016 Afternoon Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Answer **all** questions in the spaces provided.

1 Explain what is meant by a

1 (a) (i) phylogenetic group

[1 mark]

1 (a) (ii) species.

[2 marks]

The classification of tigers and clouded leopards is shown in **Table 1**.

Table 1

Taxonomic group	Tiger	Clouded Leopard
Kingdom	Animalia	Animalia
	Chordata	Chordata
	Mammalia	Mammalia
Order	Carnivora	Carnivora
	Felidae	Felidae
	Panthera	Neofelis
Species	tigris	nebulosa

1 (b) Complete **Table 1** by adding the **four** other taxonomic groups to which the tiger and clouded leopard belong.

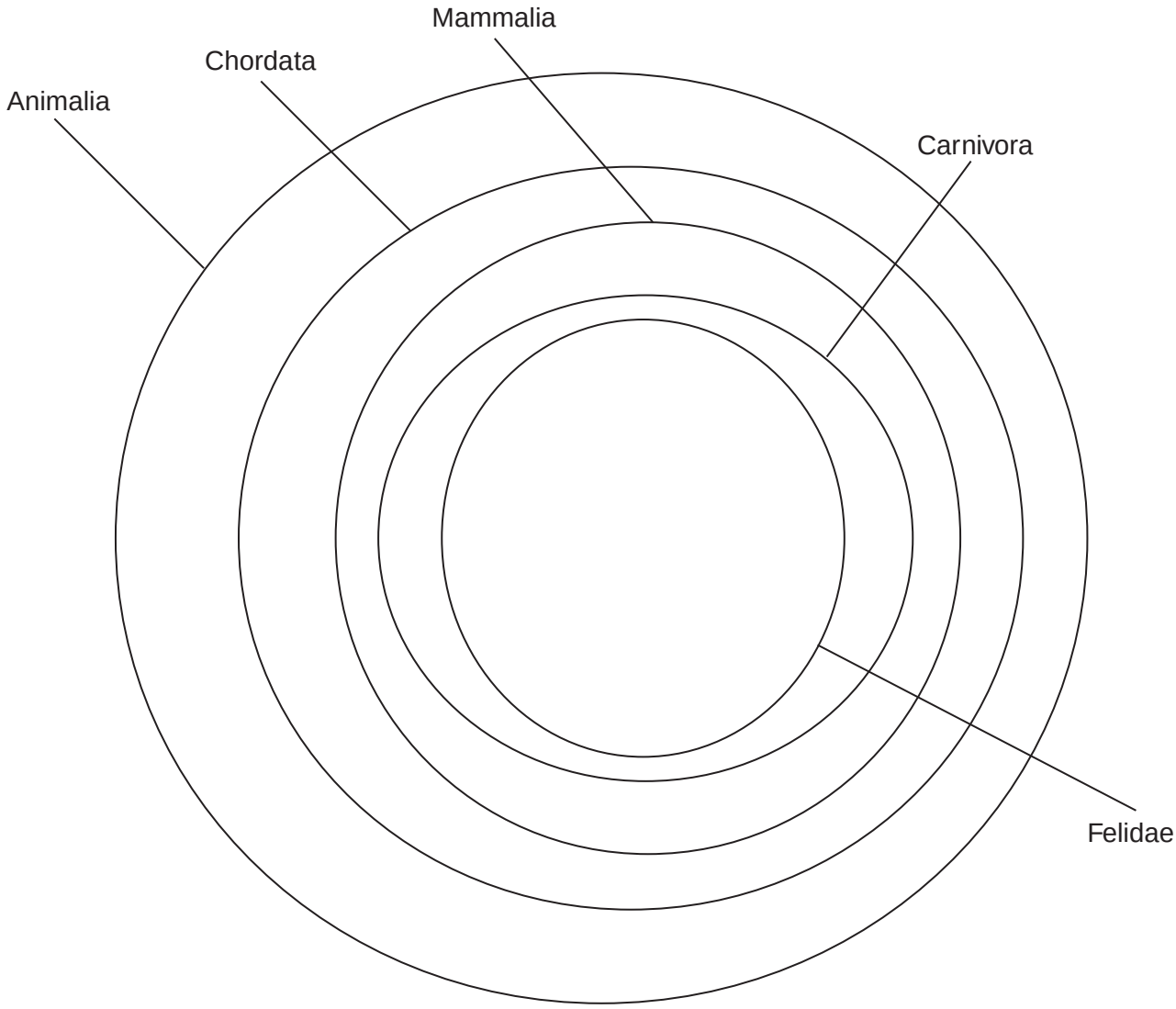
[1 mark]

Turn over ▶

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The circles in **Figure 1** represent the hierarchy of taxonomic groups for the classification shown in **Table 1**.

Figure 1



1 (c) Draw additional circles on **Figure 1** and label them to include all the information about the tiger and clouded leopard shown in **Table 1**.

[2 marks]

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Table 2 shows part of the nucleotide sequence in a gene in populations of tigers living in different parts of the world.

Table 2

Siberian tiger	G C A C C G T
South China tiger	A C G C C G C
Sumatran tiger	A C G C C G C

1 (d) Explain what the information in **Table 2** suggests about the phylogenetic relationships between these tigers.

[2 marks]

_____

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8

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ANSWER IN THE SPACES PROVIDED

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2 Haemoglobin is a protein. It is made of two alpha polypeptides and two beta polypeptides. Each alpha polypeptide has 141 amino acids and each beta polypeptide has 146 amino acids.

2 (a) What term is used to describe the structure of a protein made of two or more polypeptides?

[1 mark]

_____

2 (b) Calculate the minimum number of DNA bases needed to code for the number of amino acids in one alpha polypeptide.

[1 mark]

Answer = _____

2 (c) Describe the role of haemoglobin in supplying oxygen to the tissues of the body.

[2 marks]

_____

_____

_____

_____

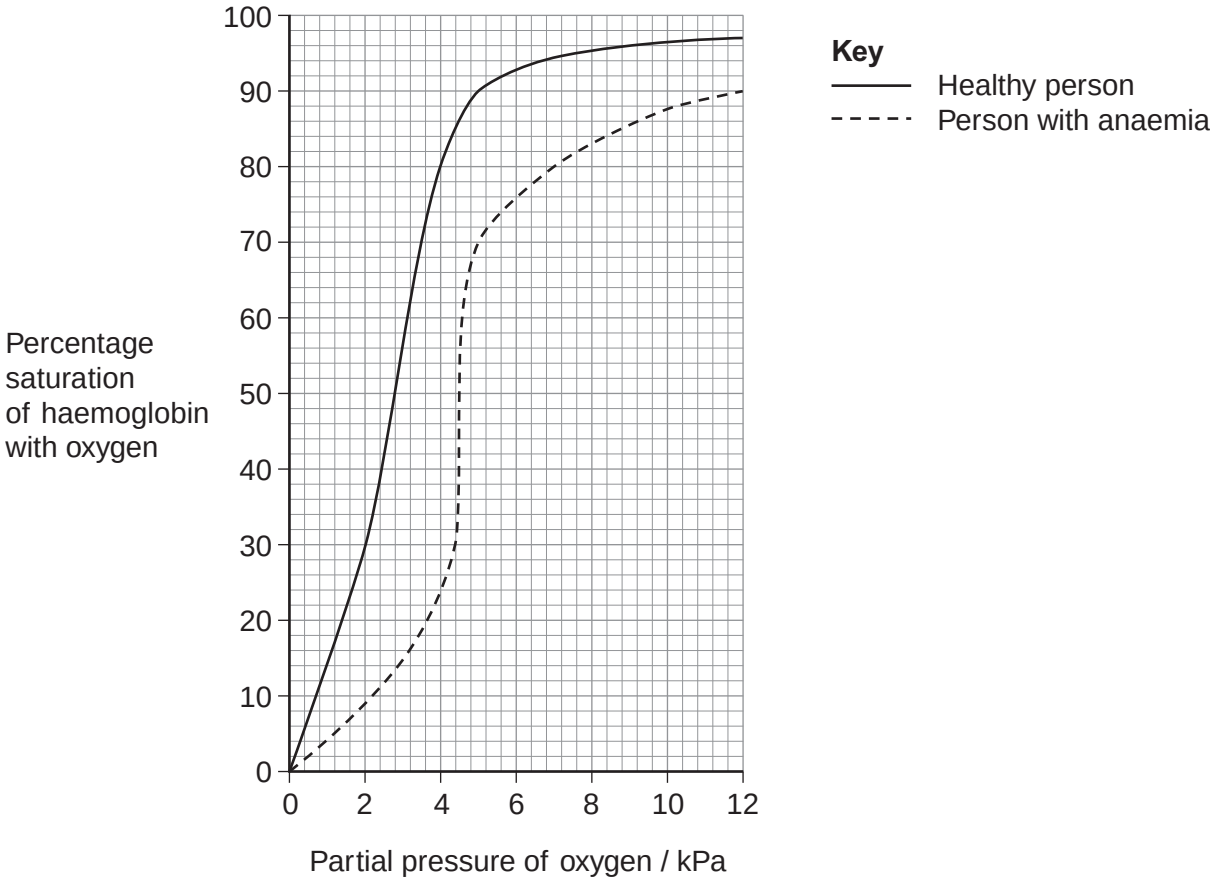
Question 2 continues on the next page

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Anaemia is a condition in which there is a decrease in the concentration of haemoglobin in blood. In some people with anaemia, substances are produced which change the oxygen dissociation curve of haemoglobin.

Figure 2 shows the effect of these substances on the oxygen dissociation curve of haemoglobin.

Figure 2



2 (d) (i) Use information in **Figure 2** to find the difference in the percentage saturation of haemoglobin with oxygen between a healthy person and a person with anaemia at a partial pressure of oxygen of 4 kPa.

[1 mark]

Answer = _____

Do not write outside the box

2 (d) (ii) Explain the advantage to a person with anaemia of the change shown in the oxygen dissociation curve.

[3 marks]

_____

_____

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8

Turn over for the next question

Do not write outside the box

3 (a) What is meant by species diversity?

[1 mark]

3 (b) Give **two** pieces of information needed to calculate an index of diversity for a community.

[2 marks]

1 _____

2 _____

3 (c) A scientist investigated the effect sewage entering a river had on the distribution of organisms living in the river. Where sewage entered the river, he found a high density of organisms but a low index of diversity.

Suggest how sewage entering the river could explain the scientist's findings.

[2 marks]

Do not write outside the box

3 (d) A second scientist repeated the investigation of the first scientist at the same place. The second scientist obtained a high index of diversity.

3 (d) (i) Explain how the second set of results affects the ability of the scientists to make any conclusions about the effect of sewage on the index of diversity.

[2 marks]

3 (d) (ii) Suggest the additional steps that should be taken by the scientists before they are able to make any conclusions about the effect of sewage entering this river.

[1 mark]

8

Turn over for the next question

Do not write outside the box

4 (a) (i) Name the structure through which gases enter and leave the body of an insect.

[1 mark]

_____

4 (a) (ii) Name the small tubes that carry gases directly to and from the cells of an insect.

[1 mark]

_____

4 (b) Explain the movement of oxygen into the gas exchange system of an insect when it is at rest.

[3 marks]

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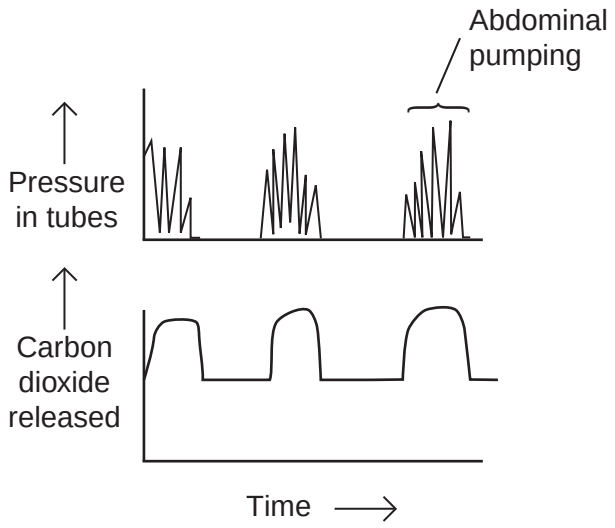
Do not write outside the box

4 (c) Abdominal pumping takes place during vigorous activity in insects. This causes regular squeezing of the tubes of the gas exchange system.

A scientist investigated the effect of abdominal pumping on the pressure in the tubes and the volume of carbon dioxide released by the insect.

Figure 3 shows his results.

Figure 3



Describe and explain these results.

[3 marks]

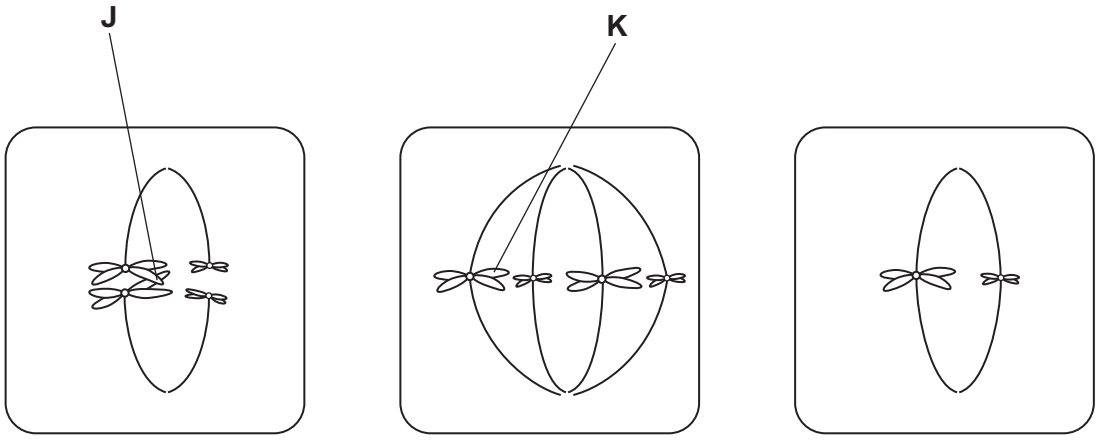
8

Turn over for the next question

Do not write outside the box

5 **Figure 4** shows three cells, **B**, **C** and **D**, from tissues in the same organism. Each cell is in a stage of either mitosis or meiosis.

Figure 4



Cell **B** Cell **C** Cell **D**

5 (a) Complete **Table 3** with a tick if the cell shows the feature.

[2 marks]

Table 3

	Cell B	Cell C	Cell D
homologous chromosomes are present			
a stage of mitosis			

5 (b) Describe and explain the appearance of chromosome **K** in cell **C**.

[2 marks]

Do not write outside the box

5 (c) Explain what is happening at point **J** in cell **B**.

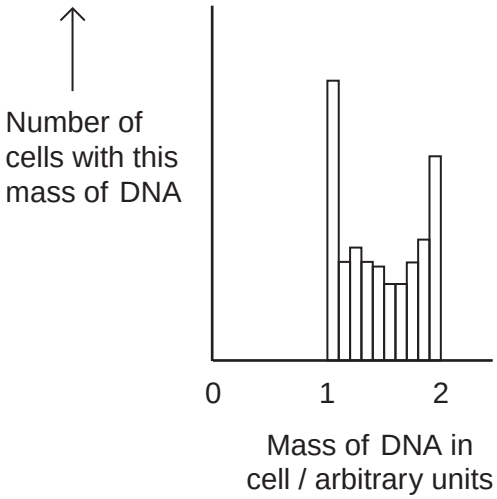
[2 marks]

5 (d) Use information from all three cells in **Figure 4** to explain how the number of chromosomes in cell **D** was produced.

[1 mark]

5 (e) **Figure 5** shows the mass of DNA present in cells of a population of healthy cells where mitosis is occurring.

Figure 5



Explain why some cells contain a mass of DNA between 1 and 2 arbitrary units.

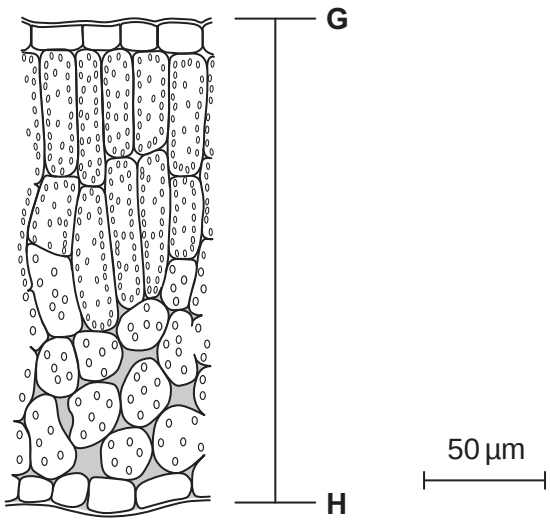
[1 mark]

8

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6 A scientist examined the structure of mustard plant leaves. He viewed temporary mounts of leaf tissues with an optical microscope. **Figure 6** shows a drawing of typical results.

Figure 6



6 (a) Describe how temporary mounts are made.

[2 marks]

_____

_____

_____

_____

_____

Do not write outside the box

6 (b) Calculate the distance in micrometres between **G** and **H** on the leaf.

[2 marks]

Answer = _____ µm

6 (c) Describe how the scientist could have used the temporary mounts of leaves to determine the mean number of chloroplasts in mesophyll cells of a leaf.

[3 marks]

_____

_____

_____

_____

_____

_____

_____

6 (d) There are many different types of cell in a leaf, each with its own function. What term is used to describe a structure such as a leaf?

[1 mark]

_____

8

Turn over for the next question

Do not write outside the box

7 (a) What is the name of a position of a gene on a chromosome?

[1 mark]

_____

7 (b) What is meant by genetic diversity?

[1 mark]

_____

_____

A geneticist investigated genetic diversity in four different breeds of dog. She compared DNA base sequences of the same genes from a large number of dogs from each breed.

The geneticist calculated the mean genetic diversity for each breed of dog. The value of this mean was between 0 and 1.

- A mean value of 1 shows maximum genetic diversity.
- A mean value of 0 shows no genetic diversity.

Her results are shown in **Table 4**.

Table 4

Breed of dog	Mean genetic diversity	Standard deviation
Airedale terrier	0.51	± 0.03
Bull terrier	0.38	± 0.02
Jack Russell terrier	0.76	± 0.01
Miniature terrier	0.47	± 0.02

Do not write outside the box

7 (c) What do these data show about the differences in genetic diversity between these breeds of dog?

[3 marks]

7 (d) Miniature terriers were first bred from bull terriers in the 19th century.

Suggest **one** explanation for the observed difference in genetic diversity between miniature terriers and bull terriers.

[2 marks]

7

Turn over for the next question

Do not write outside the box

8 In mammals, the mesenteric artery connects the aorta to blood vessels of the small intestine.

Sport scientists recorded increases in blood flow in the mesenteric artery after different types of meal. The types of meal were:

- carbohydrate only
- fat only
- protein only.

Typical results are shown in **Table 5**.

Table 5

Type of meal	Maximum percentage increase in blood flow in mesenteric artery	Time taken to reach maximum increase in blood flow in mesenteric artery / minutes
Carbohydrate only	64	15
Fat only	60	30
Protein only	57	45

8 (a) The sport scientists concluded that the three types of meal had no major effect on maximum percentage increase in blood flow in the mesenteric artery.

What else can be concluded from their results?

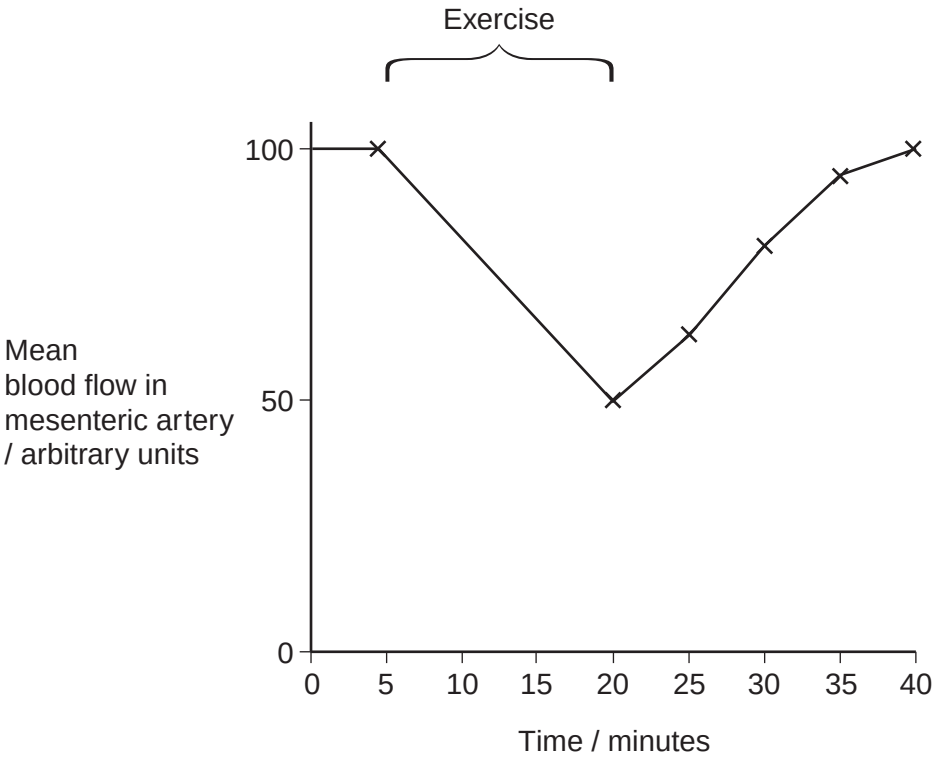
[2 marks]

Do not write outside the box

In another investigation, the sport scientists recorded blood flow in the mesenteric artery before and after vigorous exercise.

Figure 7 shows their results for a large group of volunteers.

Figure 7



8 (b) Suggest the advantage of the change in blood flow in the mesenteric artery during exercise.

[3 marks]

Question 8 continues on the next page

Do not write outside the box

8 (c) The sport scientists concluded people should **not** do vigorous exercise after a meal. Does the information from **Table 5** and **Figure 7** support this conclusion?

[4 marks]

8 (d) Blood leaving the kidney eventually returns to the kidney.
Describe the pattern of blood circulation in a mammal that causes blood to return to the kidney.

[6 marks]

15

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9 Scientists investigated the presence of bacteria resistant to the antibiotic neomycin in turkeys, chickens and the farmers who kept the turkeys and chickens. They looked for *Escherichia coli* (*E. coli*) resistant to neomycin. At 46 farms, the scientists obtained samples of bacteria from faeces of turkeys, turkey farmers, chickens and chicken farmers. The turkey farmers very often used turkey food containing neomycin. The chicken farmers did not use chicken food containing neomycin very often.

The bacteria were grown on nutrient agar in cultures. The nutrient agar contained neomycin. Any resistant bacteria grew and divided to form visible colonies.

The results are shown in **Table 6**.

Table 6

Samples taken from	**Percentage of samples of faeces containing *E. coli* resistant to neomycin**
Turkeys	81
Turkey farmers	57
Chickens	24
Chicken farmers	8

9 (a) Suggest **two** hypotheses the scientists were testing in this investigation.

[2 marks]

Hypothesis 1 _____

_____

_____

Hypothesis 2 _____

_____

_____

Do not write outside the box

9 (b) (i) Describe what the results in **Table 6** show.

[2 marks]

9 (b) (ii) Suggest and explain **one** reason for the observed differences in percentage of neomycin-resistant *E. coli* in turkeys and chickens.

[2 marks]

9 (c) The scientists followed strict safety guidelines when collecting samples of faeces. Apart from the risk of contamination from *E. coli* this was especially important when collecting samples from humans.

Explain why.

[1 mark]

Question 9 continues on the next page

Do not write outside the box

9 (d) Use the information provided to identify and explain **one** way in which the scientists increased the reliability of their method.

[2 marks]

9 (e) Suggest how the scientists could use DNA to investigate whether the neomycin-resistant bacteria in farmers were identical to the strain of bacteria in the birds they kept.

[2 marks]

9 (f) At one time, most animal feeds contained antibiotics that increased the rate of animal growth. In the UK, fewer animal feeds now contain antibiotics.

Suggest reasons why.

[4 marks]

END OF QUESTIONS

15

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AQA

A-LEVEL
BIOLOGY

BIOL2 – The variety of living organisms

Mark scheme
June 2016

Version: 1.0 Final

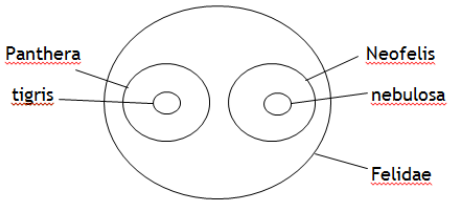
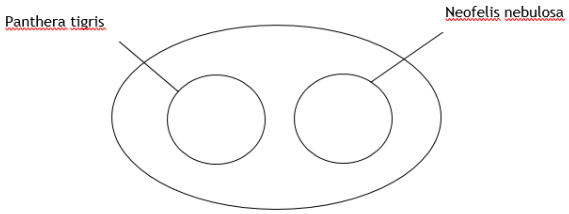
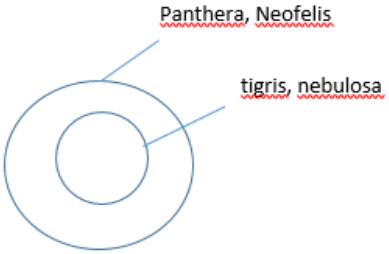
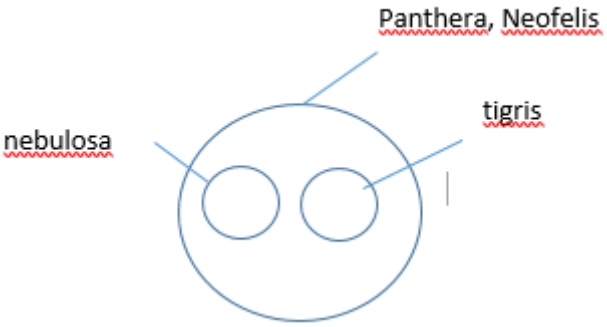
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Question	Marking Guidance	Mark	Comments
1(a)(i)	(Grouped according to) evolutionary links/history/relationships / common ancestry;	1	Ignore: closely related, factors, characteristics Ignore: genetically similar
1(a)(ii)	1. Able to reproduce; 2. To produce fertile offspring;	2	1. Accept: smallest taxonomic group/groups of organisms with same genes/ chromosomes/same number of chromosomes 1. Accept: Breed for 'reproduce' 1. Ignore: Mate 1. Reject: genetically identical. 1. Ignore: similar genes/chromosomes 2. Ignore: that are 'viable'
1(b)	Phylum Class Family Genus;	1	Accept: pleural answers phyla / genera / families Accept phonetic answers phyllem/phylem/fylum/fyla/phylae/phyli/jenus/ jenera/familys All 4 in correct order for 1 mark

1(c)	1. Two circles/with two inner circles with no overlap; 2. Labels correct;	2	 = 2marks Or  = 2 marks OR  = 1 mark OR  = 1 mark 2. Ignore underlining / capitals 2. Accept: P tigris/ N nebulosa 2. Accept: phonetic spelling

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1(d)	1. South China and Sumatran tigers share a more recent common ancestor; 2. (because) identical/same/matching (nucleotide) sequences;	2	1. Accept: more closely related (statement must be comparative) 1. Accept: a labelled hierarchy. Accept converse for Siberian tiger eg Siberian is less closely related to South China AND Sumatran tigers 

Question	Marking Guidance	Mark	Comments
2(a)	Quaternary (structure);	1	Accept: phonetic spelling eg quarternary/quarternery /4° Award no mark for quaternary as part of a list.
2(b)	423;	1	
2(c)	1. Oxyhaemoglobin formed/ haemoglobin is loaded/ uptakes/associates/binds with oxygen in area of higher ppO_2 / in gas exchange surface/lungs/gills; 2. (oxygen) unloaded/dissociates from/released (in area of lower ppO_2 / in capillaries/to cells/tissues);	2	Reference to "react with" = max 1 1. Accept: reversible interaction with oxygen Ignore: Haemoglobin is carried / contained in red blood cells
2(d)(i)	56(%);	1	Accept responses in the range 54-58(%)
2(d)(ii)	1. (Anaemia curve shifted to right) haemoglobin has lower affinity for oxygen / binds less tightly; 2. releases more oxygen / oxygen is released quicker / oxygen dissociates/ unloads more readily to muscles/tissues/cells; 3. (For) respiration;	3	Assume reference is to haemoglobin of anaemia unless stated 3. Accept: even with a lower haemoglobin concentration / meet demand for ATP/energy;

Question	Marking Guidance	Mark	Comments
3(a)	Number of species in a community;	1	Accept: Number of species in a habitat/area/ ecosystem Accept: Species richness Accept: All the species for number of species Ignore: Variation/diversity Reject: in a population
3(b)	1. Number of (organisms of) each species; 2. Total number of organisms (of all species) / Total number of species;	2	Accept 'population' for number and accept individual for organism. 1. Accept 'species richness' 2. Idea of grand total of all organisms, not just number of different species
3(c)	1. Described effect of sewage (eg oxygen depletion/is toxic/kills); 2. Prevents some/many species colonising/ reproducing/remaining; 3. Sewage is food source for (individuals of) some/a few/species; 4. (So) increase only in their numbers;	Max 2	1. Accept: increase in BOD 1. Accept: eutrophication/description of eutrophication 2. Accept: only a few species survive
3(d)(i)	1. Results are not repeatable / are not representative / unreliable / conflict / contradict; 2. Can't make any conclusions;	2	1. Accept: different / don't agree 1. Ignore: not valid/not reproducible/inaccurate
3(d)(ii)	Do repeats to find a pattern/distribution/mean (of index of diversity);	1	Accept: use a different technique to obtain more reliable evidence; Need idea of more than one repeat Accept: calculate an average Accept: at different times Accept: Statistical test to see if results differ significantly

Question	Marking Guidance	Mark	Comments
4(a)(i)	Spiracle;	1	Accept: Spiracles
4(a)(ii)	Tracheole/trachea;	1	Accept: Tracheoles/tracheae Ignore: System
4(b)	1. Oxygen used in (aerobic) respiration; 2. (so) oxygen (concentration) gradient (established); 3. (so) oxygen <u>diffuses</u> in;	3	2. Accept description of gradient 2 and 3. Accept: Oxygen moves down a <u>diffusion</u> gradient for 2 marks Ignore: 'along gradient idea' unless direction is made clear 2. Reject: Gradient in wrong direction Ignore: movement through gas/water
4(c)	1. Abdominal pumping/pressure in tubes linked to carbon dioxide release; 2. (Abdominal) pumping raises pressure in body; 3. Air/carbon dioxide pushed out of body /air/carbon dioxide moves down pressure gradient (to atmosphere);	3	MP1 relates to description of link shown in graphs 2. Needs idea of causation, not just description of correlation 3. Reject: ref to concentration gradients/diffusion

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>5(a)</td><td><table><tr><th></th><th>Cell B</th><th>Cell C</th><th>Cell D</th></tr><tr><td>homologous chromosomes are present</td><td>✓</td><td>✓</td><td></td></tr><tr><td>a stage of mitosis</td><td></td><td>✓</td><td></td></tr></table>;;</td><td>2</td><td>Mark horizontally
1 mark for each correct row</td></tr>
<tr><td>5(b)</td><td>1. (Chromosomes consist of) two chromatids connected at centromere;
2. (Because) DNA has replicated;
OR
3. K is on equator of spindle;
4. (because) attached at centromere;</td><td>2</td><td>Mark as pairs, do not mix and match
1. Accept sister chromatids for two chromatids
3. Ignore ‘middle’
Ignore - reference to meiosis / bivalents / homologous pairs</td></tr>
<tr><td>5(c)</td><td>1. Crossing over / exchange of alleles /lengths of DNA / recombination;
2. Between (chromatids of) homologous chromosomes;</td><td>2</td><td>1. Accept: description of crossing over eg sections of chromatids break and re-join
1. Accept: reference to chiasma/ chiasmata
2. Accept: ‘between non-sister chromatids’
2. Accept: ‘bivalent’ for homologous
Ignore: genes exchanged</td></tr>
<tr><td>5(d)</td><td>1. Separation/segregation of pairs/homologous chromosomes;</td><td>1</td><td>Accept: result of meiosis I / result of division of cell B
Accept: pulled to opposite poles for ‘separation’
Ignore ref to chromatids</td></tr>
<tr><td>5(e)</td><td>(DNA) replication taking place/not finished;</td><td>1</td><td>Accept: They are cells in S phase</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
6(a)	1. Thin slice/section; 2. Put on slide in water / solution / stain; 3. Add cover slip;	Max 2	3. Accept: 'between two slides'
6(b)	200 (µm);; OR 1. Divide image length by key length eg 64/16=4; 2. Multiply by 50 eg 4x50;	2	Accept for 2 marks answers in the range of 185-217 (µm) Max 1 mark for responses not within the range. 1. Accept measurements in the ranges 63-65mm and 15-17mm
6(c)	1. Select large number of cells / select cells at random; 2. Count number of chloroplasts; 3. Divide number of chloroplasts by number of cells;	3	1. Accept: > 3 for "large number" 1. Accept: many fields of view for 'large number of cells' 1. Accept: all cells in field of view 3. Ignore: 'calculate the mean'
6(d)	Organ;	1	Reject organ system

Question	Marking Guidance	Mark	Comments
7(a)	Locus;	1	Accept: Loci
7(b)	Differences in DNA / differences in base sequence of DNA;	1	Accept: Number of different alleles / size/variation in gene pool Reject: genes
7(c)	1. Jack Russell (genetic) diversity is (significantly) greatest; 2. Bull terrier (genetic) diversity is (significantly) smallest / is most inbred; 3. Miniature terrier and Airedale terriers are similar; 4. Standard deviations do not overlap / do overlap with correct ref to significance;	Max 3	1-3 Do not credit just a list of values 4. Reference to significance must be relevant to examples given
7(d)	1. (Bull terrier) breeding has included a genetic bottleneck/ small population/more inbreeding/ greater selection (pressure); 2. Reduced number of different alleles/size of gene pool; Or 3. Miniature (terrier) breeding has included more outbreeding/less selection (pressure); 4. Increased number of different alleles/larger gene pool/more variety of alleles;	2	1. Accept: Founder effect 2. Reject: decrease in number of genes 2. Ignore ref to mutations 4. Reject: If genes used instead of alleles 4. Reject: lower frequency of alleles 4. Ignore ref to mutations

Question	Marking Guidance	Mark	Comments
8(a)	1. Time taken to reach maximum blood flow varied widely/significantly; 2. Quickest after a carbohydrate-only meal; Or Slowest after a protein-only meal;	2	1. Must be emphasis on idea of 'widely'. Mention only of 'vary' is insufficient. Ignore use of numbers unless a comparison is given. Ignore: any mention of a correlation between maximum percentage increase in blood low and time taken to reach maximum increase in blood flow.
8(b)	1. More blood flows to (skeletal) muscles (during exercise); 2. (supplying) more oxygen / glucose / removing more carbon dioxide/ lactic acid/ heat; 3. For high (rate of) respiration / to meet increased demand for energy/ATP; OR Prevents anaerobic respiration/lactic acid build up;	3	1 and 2. Idea of 'more' is needed. More blood to muscles delivering oxygen = 2 marks 3. Accept reduces/delays for prevent

8(c)	**Immediate effect of exercise after meal** 1. Meal increases blood flow in (mesenteric) artery AND exercise decreases blood flow in (mesenteric) artery; **Overall effect on blood circulation** 2. Insufficient blood (flow to small intestines / muscles); **Effect on blood flow of type of meal** 3. Carbohydrate meal quick(er) / during exercise; OR Protein/fat meal slow(er) / after exercise; **Effect of reduced blood flow on cells** 4. (More) anaerobic (respiration) / lactic acid produced; OR less aerobic respiration; **Consequence for person of changed blood flow** 5. Less absorption (of digested food) / faeces contains digested food; 6. Cramp / indigestion / discomfort / fatigue;	Max 4	Look for **ideas** in each of 5 areas MP1 might be spread throughout the answer 1. Will relate to information given in the tables 2. Accept: Blood diverted away/shunted Ignore: references to 'strain on heart', 'heart disease', 'cardiovascular diseases' Ignore: references to controlling variables and reliability 6. Ignore: references to digestion

8(d)	1. (blood flows from kidney along) renal vein to vena cava; 2. (along) vena cava to right atrium/side of heart; 3. (along) pulmonary artery to lungs; 4. (along) capillaries to pulmonary vein; 5. (along) pulmonary vein to left atrium/side of heart; 6. (along) aorta to renal artery (to kidney); 7. Blood may pass through several complete circuits before returning to kidney;	6 max	Reject: 'blood vessel pumps' only once. Ignore: references to valves Ignore: references to heart action/cardiac cycle Accept: labelled diagram must include directional arrows

Question	Marking Guidance	Mark	Comments
9(a)	1. Type of feed affects (antibiotic) resistant bacteria (in animals); 2. (Antibiotic) resistant bacteria infect /are passed on to animals/farmer / resistant bacteria are passed between animals; 3. Incidence of (antibiotic) resistant bacteria differs in chickens and turkeys; 4. Incidence of (antibiotic) resistant bacteria differs in chicken farmers and turkey farmers;	Max 2	Accept: null hypotheses Accept predictions, for example 1. More antibiotic resistant bacteria form in animals fed with antibiotics in their food 2. Accept: bird to bird/bird to human/human to human 2. Accept: A link (exists) between (antibiotic) resistance in animals and their keepers/farmers – as lowest level QWC 3 & 4 Accept: a comparison, eg 'more resistant bacteria in chickens than turkeys'
9(b)(i)	1. Large(r) percentage of resistant bacteria in turkeys/low(er) percentage of resistant bacteria in chickens; 2. Large(r) percentage of resistant bacteria in turkey farmers/low(er) percentage of resistant bacteria in chicken farmers;	2	Accept: E coli for bacteria Ignore: number, eg. ignore 'more'/'fewer' turkeys/chickens
9(b)(ii)	1. (More) antibiotic in turkey feed kills (more) non-resistant bacteria / resistant bacteria survive; 2. (Resistant bacteria) reproduce / pass on gene for resistance;	2	1. Accept: Antibiotic creates selection pressure 1. survive must be explicit, not implied by 'reproduce'
9(c)	(Human) faeces contain pathogens;	1	Accept harmful organisms
9(d)	1. Large number of farms / farmers (surveyed) / 46; 2. so results are (likely to be) representative / can identify anomalous results;	2	'Reliable' is used in the question stem 2. Ignore: reproducible / accurate / valid / reliable 2. Accept: valid explanation of replicates minimising effects of chance
9(e)	1. (DNA) hybridisation (of gene for resistance in bacteria taken from bird and farmer); 2. (Identical) strands separate at	2	Mark in pairs, do not mix and match.

	high(est) temperature; OR 3. Compare base/nucleotide sequence (of gene for resistance in bacteria taken from bird and farmer); 4. (Identical strains) have identical/same base sequences		Accept: bacteria in bird and farmer/both types of bacteria have identical base sequences = 2 marks

Question	Marking Guidance	Mark	Comments
9(f)	1. (Antibiotic use has) increased cases of bacterial resistance; 2. Transfer/horizontal transmission of (resistance) gene to pathogens/harmful bacteria; 3. (Antibiotic) resistant bacteria cause harm / medical treatments less effective; 4. Avoids side effects on animals; 5. Increased demand for organic food; 6. Antibiotic/resistant bacteria could be present in human food; 7. High cost of antibiotics; 8. Legislation has controlled antibiotic use;	4 Max	1. Accept: number 2. Accept: conjugation 3: Accept: superbug 8. Accept: EU/government guidelines

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Biology BIOL2

Unit 2 The variety of living organisms

Monday 1 June 2015 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) What is the function of the coronary arteries?

[2 marks]

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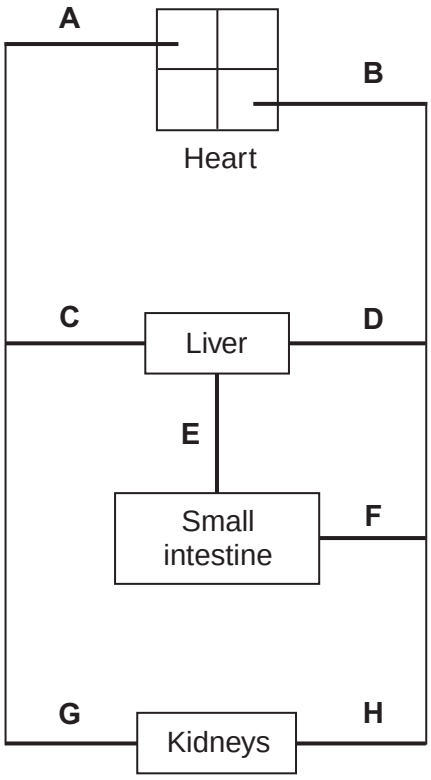
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1 (b) **Figure 1** shows some of the large blood vessels in a mammal.

Figure 1



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1 (b) (i) Which of the blood vessels **A** to **H** is the vena cava?

[1 mark]

1 (b) (ii) Which of the blood vessels **A** to **H** is the renal artery?

[1 mark]

1 (b) (iii) Which of the blood vessels **A** to **H** is the hepatic portal vein?

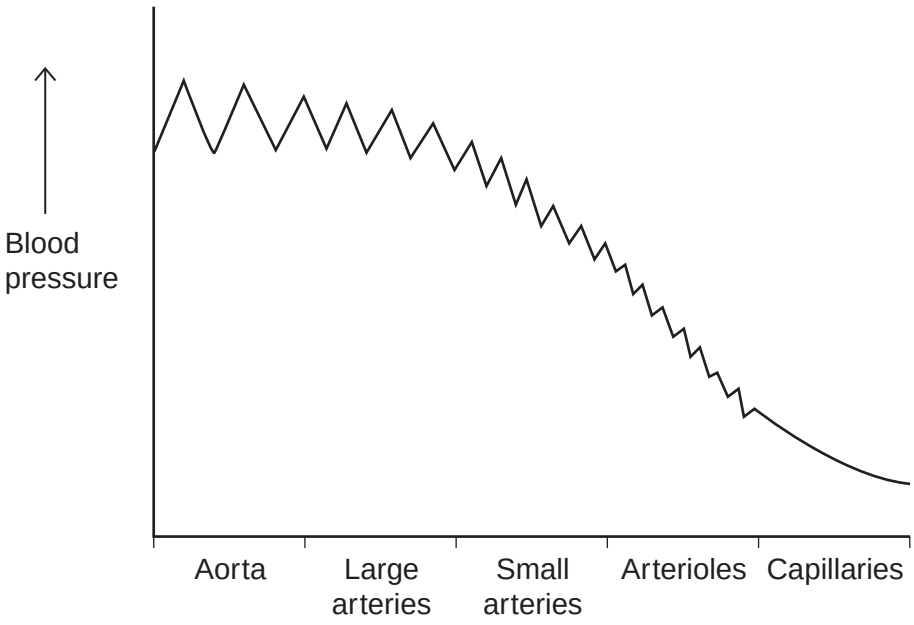
[1 mark]

Question 1 continues on the next page

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1 (c) **Figure 2** shows how the blood pressure changes as blood travels from the aorta to the capillaries.

Figure 2



The rise and fall in blood pressure in the aorta is greater than in the small arteries. Suggest why.

[3 marks]

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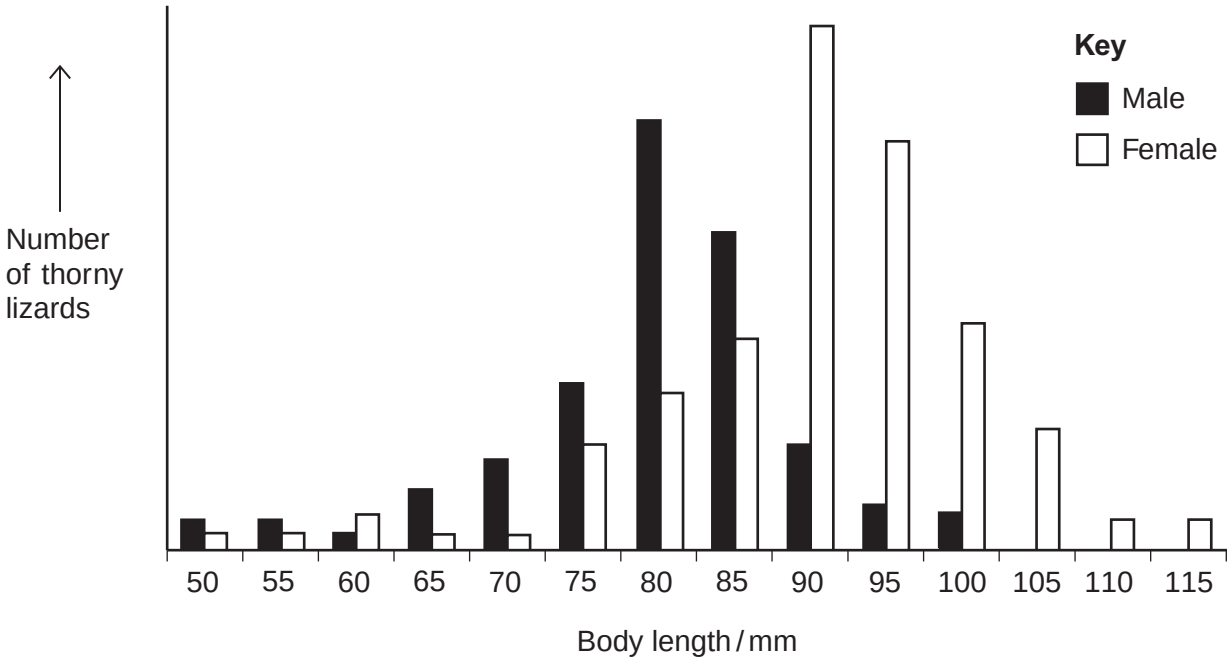
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2 (a) Ecologists measured the body lengths of male and female thorny lizards living in the same habitat. The ecologists measured the body lengths to the nearest 5 mm. **Figure 3** shows how they presented their results.

Figure 3



Give **two** differences in the variation in body length of male and female thorny lizards.

[2 marks]

1 .....

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2 .....

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Question 2 continues on the next page

Do not write outside the box

2 (b) Another group of ecologists investigated biodiversity of lizards in a woodland area.

Table 1 shows their results.

Table 1

Lizard species	Number of individuals
Dominican giant anole	5
Hispaniolan green anole	11
Hispaniolan stout anole	22
Bark anole	91
Hispaniolan grass anole	13
Cope's galliwasp	5
Cochran's least gecko	8
Peninsula least gecko	1

The index of diversity can be calculated using the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

2 (b) (i) Use the formula to calculate the index of diversity of lizards in the woodland area.
Show your working.

[2 marks]

Answer = ...

Do not write outside the box

2 (b) (ii) The ecologists also determined the index of diversity of lizards in an oil palm plantation next to the woodland area. They found fewer species of plant in the oil palm plantation. Lizards feed on plants and insects.

Explain why fewer species of plant would lead to fewer species of lizard in the oil palm plantation.

[3 marks]

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[Extra space] .....

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7

Turn over for the next question

Do not write outside the box

3 (a) (i) Give **two** ways in which the structure of starch is **similar** to cellulose.

[2 marks]

1 .....

2 .....

3 (a) (ii) Give **two** ways in which the structure of starch is **different** from cellulose.

[2 marks]

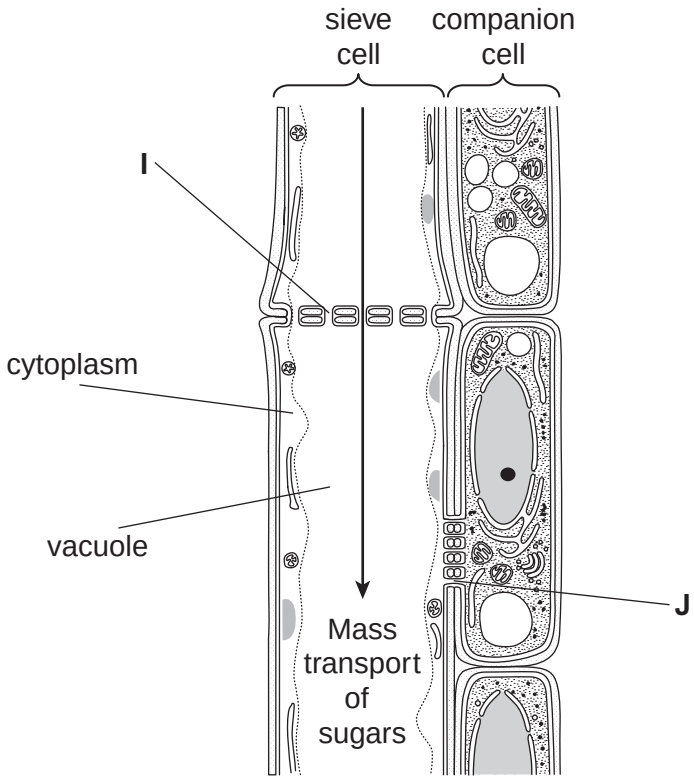
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3 (b) In plants, mass transport of sugars takes place through columns of sieve cells in the phloem. Other cells, called companion cells, transport sugars into, and out of, the sieve cells.

Figure 4 shows the structure of phloem.

Figure 4



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Structures **I** and **J** allow the transport of sugars between cells.

3 (b) (i) Using **Figure 4**, suggest and explain **one** other way in which sieve cells are adapted for mass transport.

[2 marks]

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3 (b) (ii) Using **Figure 4**, suggest and explain **one** other way in which companion cells are adapted for the transport of sugars between cells.

[2 marks]

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Turn over for the next question

Do not write outside the box

4 (a) (i) Describe the role of DNA polymerase in DNA replication.

[1 mark]

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4 (a) (ii) Other than being smaller, give **two** ways in which prokaryotic DNA is different from eukaryotic DNA.

[2 marks]

1 .....

2 .....

4 (b) **Table 2** shows the percentage of each base in the DNA from three different organisms.

Table 2

Organism	Percentage of each base in DNA			
	Adenine	Guanine	Thymine	Cytosine
Human	30.9	19.9	29.4	19.8
Grasshopper	29.4	20.5	29.4	20.7
Virus	24.0	23.3	21.5	31.2

4 (b) (i) Humans and grasshoppers have very similar percentages of each base in their DNA but they are very different organisms.

Use your knowledge of DNA structure and function to explain how this is possible.

[2 marks]

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4 (b) (ii) The DNA of the virus is different from that of other organisms.

Use **Table 2** and your knowledge of DNA to suggest what this difference is.
Explain your answer.

[2 marks]

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7

Turn over for the next question

Do not write outside the box

5 (a) Give **three** ways in which courtship behaviour increases the probability of successful mating.

[3 marks]

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3 .....

Male field crickets produce a courtship song by vibrating their wings. The natural song contains seven low-pitched 'chirps' followed by two high-pitched 'ticks'.

Scientists recorded this song and used a computer program to change the number of chirps and ticks. Different versions of the song were then played back continuously to females in the presence of a male. This male had previously had one wing removed so he could not produce a courtship song. The scientists determined the percentage of females that showed courtship behaviour within 5 minutes of hearing each recorded song.

Table 3 shows the results of the scientists' playback experiments.

Table 3

Version of recorded song played	Number of chirps	Number of ticks	Percentage of females that showed courtship behaviour within 5 minutes
K	No song played		30
L (natural)	7	2	83
M	7	0	70
N	0	2	65
O	7	1	83
P	7	4	82

Do not write outside the box

5 (b) The scientists wanted to know if the recorded natural song was less effective than the natural song in stimulating courtship behaviour.

Suggest how the scientists could determine if the recorded natural song (**L**) was less effective than the natural song.

[2 marks]

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5 (c) A student concluded from **Table 3** that the number of chirps and ticks is essential for successfully stimulating courtship behaviour.

Do these data support this conclusion? Explain your answer.

[4 marks]

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6 (a) The events that take place during interphase and mitosis lead to the production of two genetically identical cells. Explain how.

[4 marks]

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6 (b) A student cut thin sections of tissue at different distances from the tip of a root. She stained the sections and viewed them with an optical microscope.

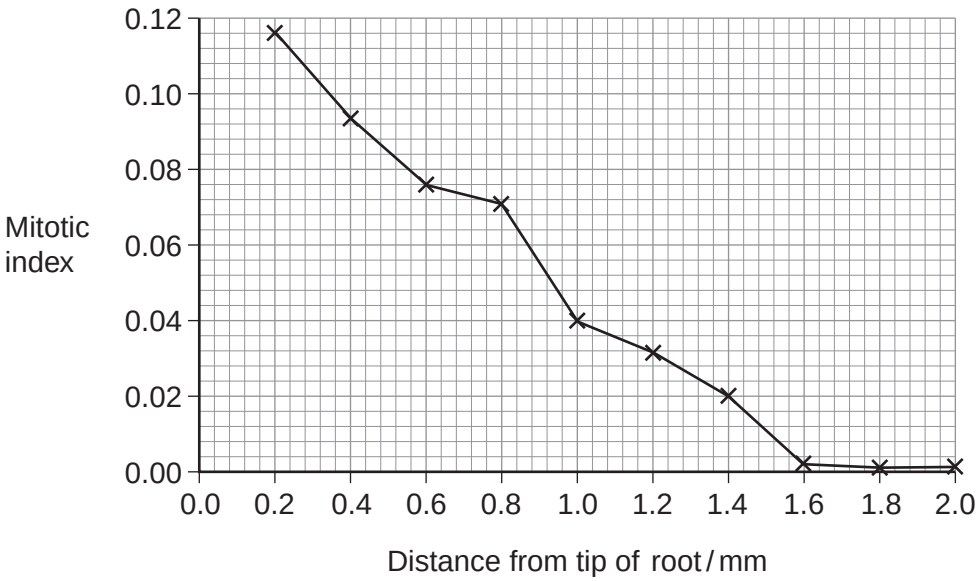
For each section, the student counted the number of cells in mitosis and the total number of cells in each field of view. She then calculated a **mitotic index** for each section using the equation:

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}}$$

Do not write outside the box

Figure 5 shows the student's results.

Figure 5



6 (b) (i) The student cut thin sections of tissue to view with an optical microscope.
Explain why it was important that the sections were thin.

[2 marks]

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6 (b) (ii) What does **Figure 5** show about the growth of roots?
Use the data to explain your answer.

[2 marks]

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Turn over ▶

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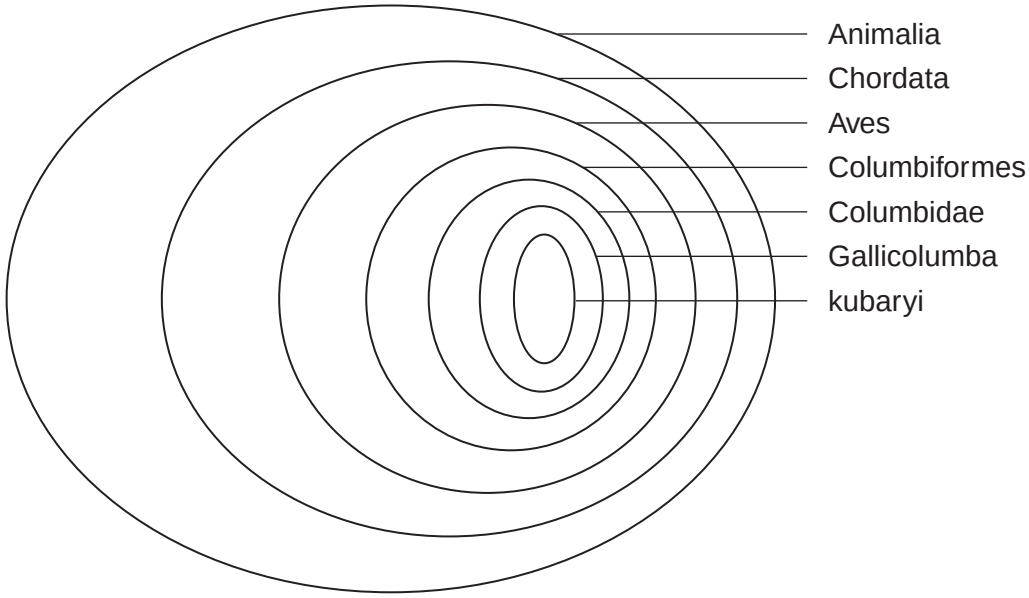
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ANSWER IN THE SPACES PROVIDED

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7 (a) Micronesia is a group of islands in the Pacific Ocean. The white-fronted ground dove is a bird found on these islands.

Figure 6 shows how the white-fronted ground dove is classified.

Figure 6



7 (a) (i) To which class does the white-fronted ground dove belong?

[1 mark]

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7 (a) (ii) Give the scientific name for the white-fronted ground dove.

[1 mark]

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7 (a) (iii) This classification system consists of a hierarchy as there are small groups within larger groups.

Give **one** other feature of a hierarchy that is shown in **Figure 6**.

[1 mark]

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Question 7 continues on the next page

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7 (b) Pingelap is a small island in Micronesia. About 200 years ago, a large storm killed most of the population, leaving only 20 people alive on the island. One of these survivors carried a faulty allele for a genetic disease that causes complete colour blindness. There are approximately 3000 people living on Pingelap today and nearly all of them are descended from the 20 survivors.

Table 4 shows the frequencies of complete colour blindness and the approximate populations of Pingelap and the USA.

Table 4

Region	Frequency of complete colour blindness	Approximate population
Pingelap	1 in 10	3000
USA	1 in 33 000	318 000 000

7 (b) (i) Complete colour blindness occurs at a higher frequency on Pingelap than in the USA.

Use the information provided to explain why.

[3 marks]

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7 (b) (ii) Use **Table 4** to calculate the ratio of the number of people who have complete colour blindness in the USA to the number of people who have complete colour blindness on Pingelap.

Show your working.

[2 marks]

Answer = ... : 1

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Turn over for the next question

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8 (a) A mutation can lead to the production of a non-functional enzyme. Explain how.

[6 marks]

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Question 8 continues on the next page

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Scientists investigated the effect of a specific antibiotic on two strains of the same species of bacterium.

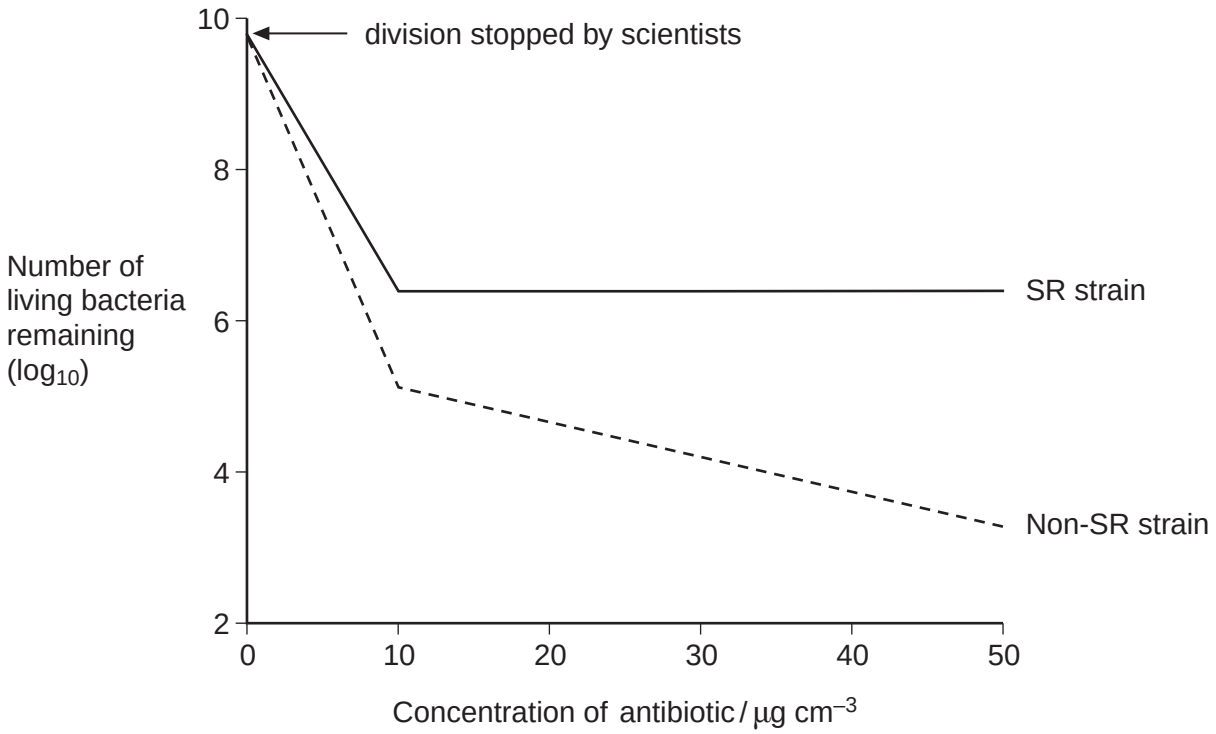
- One strain, SR, shows a **stringent response** in the presence of this antibiotic. Part of this response involves stopping cell division. This gives this strain a greater resistance to the effects of this antibiotic.

- The other strain, non-SR, cannot carry out a stringent response.

The scientists grew cultures of the SR strain and the non-SR strain containing the same number of bacterial cells. They then stopped each strain from dividing and exposed them to different concentrations of the antibiotic. After a fixed time, the scientists estimated the number of living bacteria remaining in the cultures.

Figure 7 shows their results.

Figure 7



Do not write outside the box

8 (b) Describe differences in the effect of increasing the concentration of antibiotic on the SR strain and the non-SR strain.

[2 marks]

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8 (c) One way in which the stringent response gives resistance to this antibiotic is by stopping cell division.

The scientists concluded that stopping cell division is not the **only** way in which the stringent response gives resistance to this antibiotic.

Explain how **Figure 7** supports this conclusion.

[2 marks]

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Question 8 continues on the next page

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8 (d) The stringent response involves a number of enzyme-catalysed reactions.

Explain how scientists could use this knowledge to design drugs that make the treatment of infections caused by the SR strain more successful.

[2 marks]

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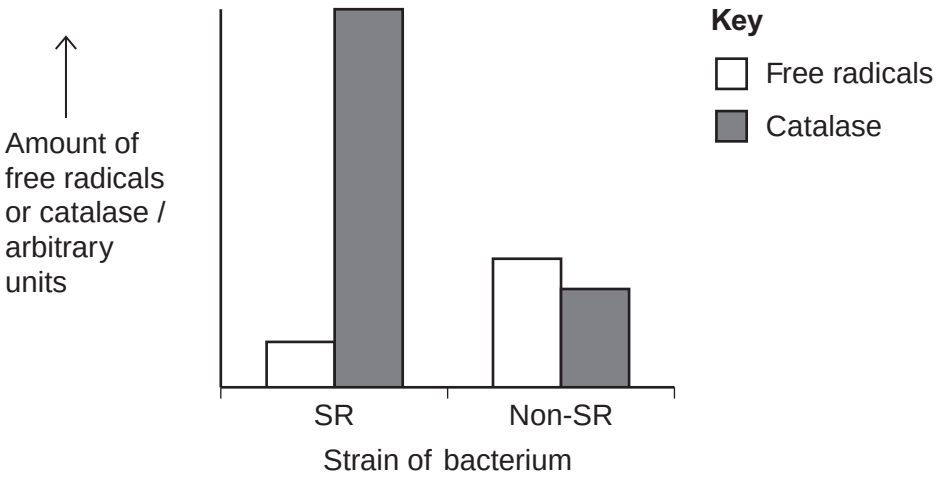
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The antibiotic damages the bacterium by causing the production of substances called free radicals.

The scientists exposed the SR strain and the non-SR strain to the antibiotic. They then measured the amounts of free radicals and an enzyme called catalase in both strains.

Figure 8 shows their results.

Figure 8



Do not write outside the box

8 (e) Use the information provided and **Figure 8** to suggest an explanation for the greater resistance of the SR strain to this antibiotic.

[3 marks]

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Turn over for the next question

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9 Oestrogen is a substance produced by the enzyme aromatase. In females, the main source of oestrogen is the ovaries but aromatase is produced by many other organs in the body, including the lungs. Oestrogen can stimulate the development of some lung tumours. In these tumours, binding of oestrogen to cell-surface receptors stimulates cell division.

Scientists investigated whether two drugs could prevent lung tumours in female mice. First, they removed the ovaries from these mice. They then injected the mice with a tumour-causing chemical found in tobacco twice a day for 4 weeks. The mice were then randomly allocated to one of four groups. Each group contained 10 mice.

- Group **Q** was given a placebo. This placebo did not contain either drug.
- Group **R** was given the drug anastrozole. This inhibits the enzyme aromatase.
- Group **S** was given the drug fulvestrant. This binds to oestrogen receptors.
- Group **T** was given both anastrozole and fulvestrant.

The mice were given these drugs each week during weeks 5–15 of the investigation.

9 (a) The scientists removed the ovaries from the mice for the investigation. They also gave the mice injections of the substrate of aromatase each day.

Explain why these steps were necessary.

[2 marks]

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9 (b) The scientists predicted that fulvestrant would be more effective when given with anastrozole than when given alone.

Use the information provided to suggest why they predicted this.

[2 marks]

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Question 9 continues on the next page

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At week 15, the lungs of the mice were removed and examined. The scientists then determined the number of tumours present and the mean tumour area for each group.

Figure 9 and **Figure 10** show the scientists' results.

Figure 9

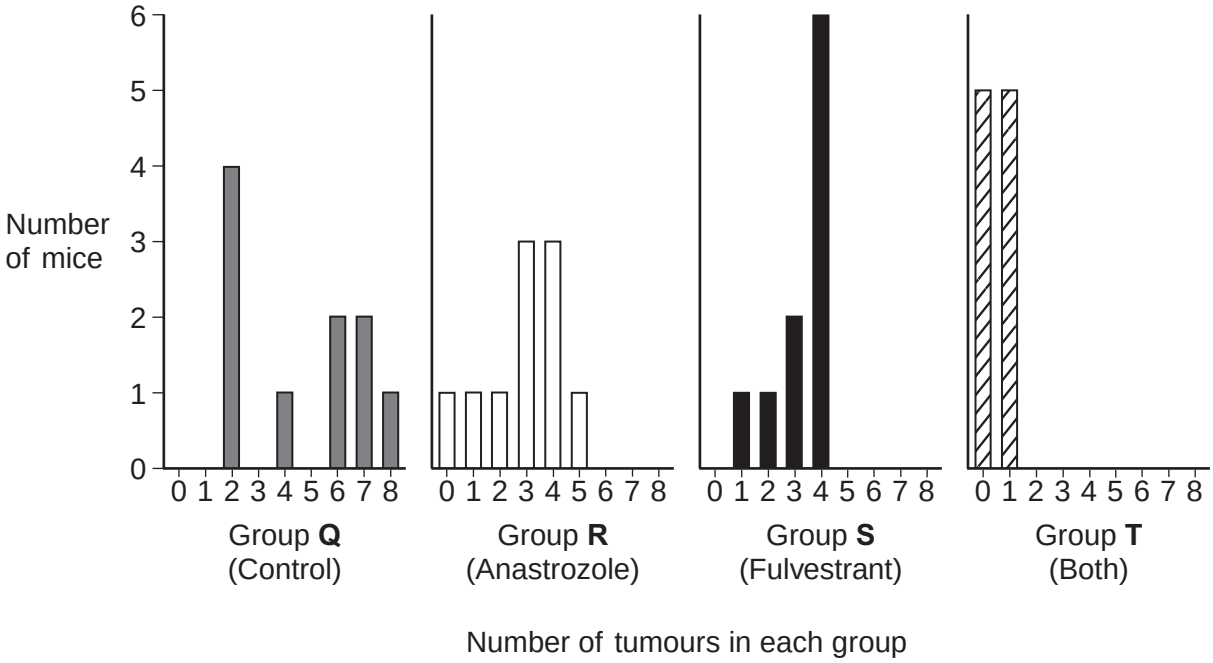
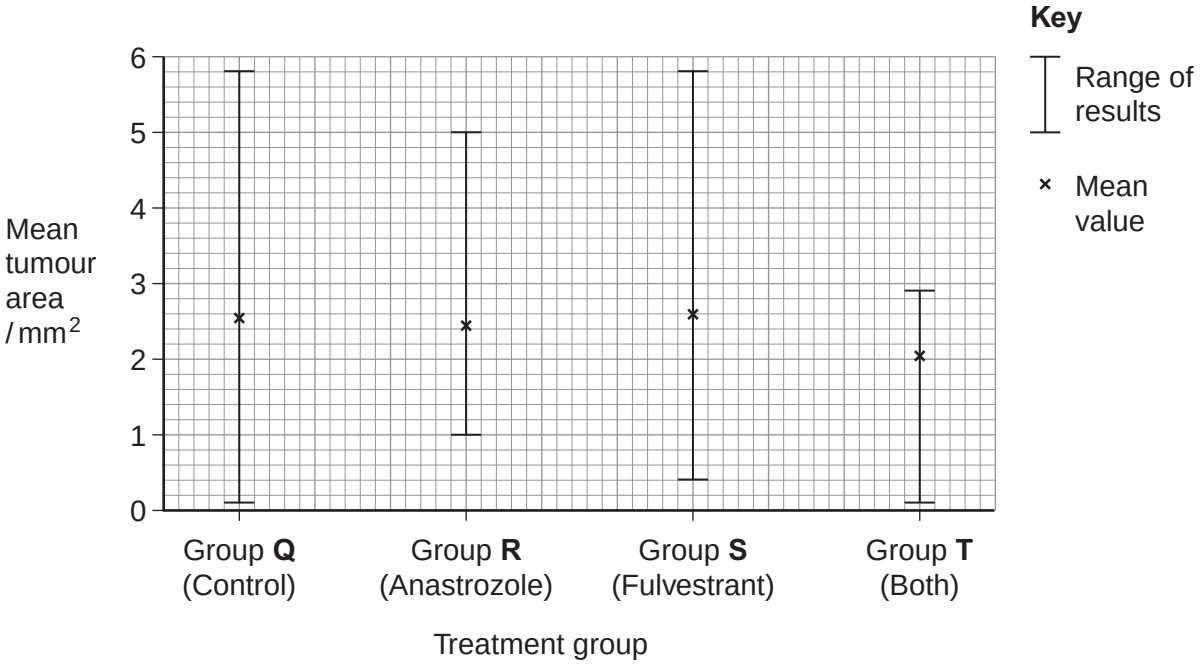


Figure 10



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9 (c) The scientists concluded that both drugs should be used together to reduce the risk of lung cancer in women exposed to tobacco products.

Do you agree? Explain your answer.

[5 marks]

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9 (d) The scientists used tumour area as an indicator of tumour size.

Explain why tumour area may **not** be the best indicator of tumour size and suggest a more reliable measurement.

[2 marks]

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9 (e) The scientists repeated the investigation but this time they did not give the drugs until week 9.

Suggest why they gave the drugs at week 9, rather than at week 5.

[2 marks]

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9 (f) Another group of scientists is currently using these drugs in human trials. However, the control group is **not** being given a placebo.

Suggest why a placebo is **not** being given and what is being given to this group instead.

[2 marks]

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END OF QUESTIONS

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A-LEVEL

Biology

BIOL2 – The variety of living organisms
Mark scheme

2410
June 2015

Version: 1 Final Mark Scheme

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidance	Mark	Comments
1(a)	1. (Carry) oxygen/glucose; 2. (To) heart muscle/tissue/cells/myocytes;	2	1. Accept: oxygenated blood 1. Ignore references to removing waste products 1. Ignore references to arteries 'pumping' blood 2. Must be supply to heart or cardiac
1(b)(i)	**A**;	1	Accept: A on its own even if outside box Reject if two (or more) letters given
1(b)(ii)	**H**;	1	Accept: H on its own even if outside box Reject if two (or more) letters given
1(b)(iii)	**E**;	1	Accept E on its own even if outside box Reject if two (or more) letters given
1(c)	(Aorta) 1. (is) close/directly linked to to the heart/ventricle / pressure is higher/is very high; 2. (Aorta has) elastic tissue; 3. (Aorta has) stretch/recoil;	3	2. Accept elasticity 2. Ignore reference to muscle 3. **Q** Reject: contracts/relaxes/pumps Accept: for mp 2 and mp 3, converse for small arteries if qualified by little/less

Question	Marking Guidance	Mark	Comments
2(a)	1. Females are (generally) longer/larger/bigger/up to 115(mm) / males are (generally) shorter/smaller/up to 100(mm); 2. Females show a greater range/variation / males show a narrower range/variation;	2	1. Ignore: tall 1. Accept: females have a larger/90 modal/peak/most common value and males have a smaller/80 modal/peak/most common value 1. Accept mean length of females greater/mean length of males shorter 1. Reject: use of mean in relation to 80mm or 90mm 1. Reject: Most of the females are 90 mm long/most of the males are 80 mm long 2. Accept: correct use of figures from the graph: the range of males is 50 to 100 and of females is 50 to 115 / the spread is 50 for males and 65 for females
2(b)(i)	**2.6** to **2.7** = 2 marks;; Incorrect answer but evidence of a numerator of **24180 OR 156 x 155**or denominator of **9014** = 1 mark;	2	
2(b)(ii)	(Fewer plant species) – no mark 1. (So) few(er) habitats/niches; 2. (So) lower diversity of insects / fewer insect species/fewer insect types; 3. (So) fewer food sources / less variety of food;	3	1. Ignore habitat size **1**. **Q** Neutral: fewer homes 2. **Q** Neutral: fewer insects 2. Accept less variety of insects 3. **Q** Neutral: less food Ignore references to pesticides, farmers' actions, competition between lizards and evolution

Question	Marking Guidance	Mark	Comments
3(a)(i)	***(Both)*** 1. Are polymers/polysaccharides/ are made of monomers/of monosaccharides; 2. Contain glucose/carbon, hydrogen and oxygen 3. Contain glycosidic bonds; 4. Have 1–4 links; 5. Hydrogen bonding (within structure);	2 max	Neutral: references to 'unbranched', insoluble, formed by condensation, flexible and rigid Are made of the monomer glucose = MP 1 and 2 = 2 marks 5. Ignore reference to H bonds between cellulose molecules
3(a)(ii)	(Starch) 1. Contains α/alpha glucose; 2. Helical/coiled/compact/branched/not straight; 3. 1,6 bonds/ 1,6 branching; 4. Glucoses/monomers same way up; 5. No H-bonds between molecules; 6. No (micro/macro) fibres/fibrils;	2 max	Assume 'it' refers to starch Accept: converse arguments only if linked directly to cellulose 1. Accept: forms α glycosidic bonds
3(b)(i)	1. No/few organelles / very little cytoplasm / cytoplasm at edge / more room/hollow/large vacuole/large space/thick walls; 2. (So) easier/more flow/ (thick/strong walls) resist pressure;	2	1. Accept strong walls for thick walls 2. Easier flow may be expressed in other ways e.g. lower resistance to flow
3(b)(ii)	1. Mitochondria release energy/ ATP/ site of respiration; 2. For active transport/uptake against concentration gradient; ***OR***: 3. Ribosomes/roughendoplasmic reticulum produce(s) proteins; 4. (Proteins) linked to transport eg carrier proteins/enzymes;	2	1. **Q** Reject: 'produce energy' but accept produce energy in form of ATP Note: no mark is awarded for simply naming an organelle 3. Concept of making proteins needed

4(a)(i)	Joins nucleotides (to form new strand);	1	Accept: joins sugar and phosphate/forms sugar-phosphate backbone Reject: (DNA polymerase) forms base pairs/hydrogen bonds
4(a)(ii)	(Prokaryotic DNA) 1. Circular/non-linear (DNA); 2. Not (associated) with proteins/ histones; 3. No introns / no non-coding DNA;	2 max	Accept converse for eukaryotic DNA Ignore: references to nucleus, binary fission, strands and plasmids 2. Accept does not form chromosomes/chromatin 3. Accept only exons 3. **Q** Neutral: no 'junk' DNA
4(b)(i)	1. Have different genes; 2. (Sobases/triplets) are in a different sequence/order; 3. (So) different amino acid(sequence/coded for) / different protein/different polypeptide/different enzyme;	2 max	1. Reject: different alleles 2. Accept: base sequence that matters, not percentage 3. Unqualified 'different amino acids' does not gain a mark 3. Reject: references to different amino acids formed Ignore: references to mutations/exons/non-coding/introns
4(b)(ii)	(Virus DNA) 1. A does not equal T / G does not equal C; 2. (So) no base pairing; 3. (So) DNA is not double stranded/is single stranded;	2 max	1. Accept: similar for equal 1. Accept: virus has more C than G/has more A than T

Question	Marking Guidance	Mark	Comments
5(a)	1. Recognise/identify/attract same species; 2. Stimulates/synchronises mating/production/release of gametes; 3. Recognition/attraction of mate/opposite sex; 4. Indication of (sexual) maturity/fertility/receptivity/readiness to mate; 5. Formation of a pair bond/bond between two organisms (to have/raise young);	3 max	1. Ignore: references to letting them produce fertile offspring 3. Accept finding a mate 3. Accept: gender
5(b)	1. Use a (real) male (with intact wings/no wing removed); 2. Determine (percentage) response (of females compared with**L)**;	2	Mark ignoring reference to birds/ or other types of animals 1. Accept: use a real cricket, since only males sing 2. Accept: compare results with**L**
5(c)	1. Lowest/only 30% courtship with no song/K/ (or) courtship still occurred when no song played/**K**; 2. Reducedcourtship when no ticks/M / there is some courtship when no ticks/M; 3. Reduced courtship when no chirps/N / there is some courtship when no chirps/N; 4. (So) courtship must involve a visual stimulus/other factor involved; 5. Chirps more important as lowest courtship when none/N / ticks less important as similar courtship when changed/M; 6. Data only show presence and absence of chirps/0 and 7 chirps;	4 max	Note: throughout, for courtship accept response/stimulation/reaction Neutral: references to methodology 1. Answer must make clear there is no song/version K Accept: use of figures from the table <u>in an explanation</u> 5. Must make comparison to gain mark Note: 'courtship still occurred when no sound played so a visual stimulus/other factor/something else (e.g. pheromone?) must be involved' = 2 marks

Question	Marking Guidance	Mark	Comments
6(a)	1. DNA replicated; 2. (Involving) specific/accurate/complementary base-pairing; 3. (Ref to) two identical/sister chromatids; 4. Each chromatid/ moves/is separated to(opposite) poles/ends of cell;	4	1. Reject: DNA replication in the wrong stage 2. Accept:semi conservative replication 4.Reject: meiosis/ homologous chromosomes/crossing over Note: sister chromatids move to opposite poles/ends = 2 marks for mp 3 and mp 4 Reject: events in wrong phase/stage
6(b)(i)	1. To allow (more) light through; 2. A single/few layer(s) of cells to be viewed;	2	1. Accept: transparent 2. Accept: (thin) for better/easier stain penetration
6(b)(ii)	1. More/faster mitosis/division near tip/at 0.2 mm; 2. (Almost) no mitosis/division at/ after 1.6 mm from tip; 3. (So) roots grow by mitosis/adding new cells to the tip;	2 max	Neutral: references to largest mitotic index Accept: cell division for mitosis Penalise once for references to meiosis 3. Accept: growth occurs at/near/just behind the tip (of the root) Accept: converse arguments

Question	Marking Guidance	Mark	Comments
7(a)(i)	Aves;	1	
7(a)(ii)	Gallicolumba kubaryi;	1	Must have both words and in this order Must be capital G If starts with k, award mark as impossible to recognise difference Ignore: underlining Accept: phonetic spelling Accept: G kubaryi (must be a capital/upper case G)
7(a)(iii)	No overlap;	1	
7(b)(i)	1. Genetic bottleneck; 2. Less genetic diversity / small(er) gene pool / less variety of alleles; 3. Individuals breed within group / do not breed with outsiders; 4. High(er) chance of inheriting allele/high(er) frequency of allele in offspring;	3 max	**Q**. Accept: converse arguments for the USA 1. Ignore: founder effect 2. Neutral: fewer alleles 2. Accept: fewer different alleles 3. Accept: inbreeding for 'individuals breed within group' 3. Accept: marry/mate within group 3. Accept: do not interbreed/no gene flow 4. Do not award for 'allele passed on' only, must be idea of more/greater/higher chance
7(b)(ii)	Answer of **32** (:1) = 2 marks;; Incorrect answer but populations calculated as **300** and **9636** = 1 mark;	2	Accept: **32.1** and **32.12** for 2 marks Accept: decimal places after 9636

Question	Marking Guidance	Mark	Comments
8(a)	1. Change/mutation in base/nucleotide sequence (of DNA/gene); 2. Change in amino acid sequence/primary structure (of enzyme); 3. Change in hydrogen/ionic/disulfide bonds; 4. Change in the tertiary structure/shape; 5. Change in active site; 6. Substrate not complementary/cannot bind (to enzyme/active site) / no enzyme-substrate complexes form;	6	Q. Ignore: references to changing base-pairing Accept: affect for change, if in correct context 1. Accept: changes triplets/codons 2. Accept: different amino acid(s) coded for 2. **Q** Reject: different amino acids produced/formed/made 3. Accept: references to sulfur bonds 4. Neutral: alters 3D structure/3D shape 6.Accept: no E S complexes form
8(b)	1. Non-SR strain falls more/SR strain falls less/up to 10(µg/cm–3); 2. Above 10(µg/cm^{-3}), SR strain levels out/offand non-SR strain continues to decrease; 3. Greater difference between strains with increasing concentration of antibiotic;	2 max	Must include 10 but only required once in either MP1 or MP2 Ignore: units or absence of 1. This must be a comparative statement 3. This must be a comparative statement
8(c)	1. Division stopped (of both strains by scientist); 2. SR strain still more resistant/fewer die/none die (at higher concentrations of antibiotic);	2	1. Reject:references to mitosis stopping 2. Accept: SR strain and non-SR strain would be similar if resistance is due to only stopping division 2. Need some comparison with non-SR

8(d)	1. Make a competitive/non-competitive inhibitor; 2. Competitive competes with/blocks active site/non-competitive inhibitor affects/changes <u>active site</u>; OR 3. (Make a drug) that inhibits/denatures/destroys enzyme/stringent response; 4. Give at the same time as/before an antibiotic;	2max	Mark in pairs either MP1 <u>and</u> MP2 OR MP3 <u>and</u> MP4 Do not mix and match 3. Accept: drug that 'knocks out'/destroys enzyme

8(e)	(SR strain) 1. Fewer free radicals (than non-SR); 2. Produces more catalase (than non-SR); 3. Catalase (might be) linked to production of fewer free radicals / breaking down/removing free radicals;	3	1. Note: has to be comparative statement Accept converse statements for non-SR. 3. Accept: hydrolysis of radicals by catalase.

Question	Marking Guidance	Mark	Comments
9(a)	1. Removes (main/largest) source of oestrogen / (different) mice produce different amounts of oestrogen; 2. (Allows) oestrogen to be controlled/oestrogen to be made by aromatase only / only oestrogen made in lungs to be involved;	2	1. Accept: so oestrogen from ovaries not a confounding variable – idea of. Reject: references to injection of aromatase.
9(b)	1. (Anastrozole) prevents/reduces oestrogen production; 2. (Fulvestrant) stops remaining oestrogen binding /less oestrogen binds to receptors;	2	Note: brackets around drug names.

9(c)	(Yes for Group T) 1. Least tumours per animal (from fig. 9) 2. Lowest (mean) tumour area/size (from fig. 10); 3. Lowest top of range; (But) 4. Means (tumour area) are similar; 5. Ranges overlap/share values so differences may not be real/treatments may be just effective in reducing tumour; 6. Range affected by outliers/ SD's would be better; 7. Done on mice / not done on women/humans; 8. Only 10 mice used per group/small sample size so may not be representative/reliable; 9. Might be side effects ; 10. Only did for 15 weeks somaximum effect of drugs may not have been seen;	5 max	Accept: 'mean values' for tumour area. Where candidates confuse range and standard deviation, do not give credit. 5.Ignore significance
9(d)	1. Tumours may be different depths / area does not take depth into account / tumours are 3-D/are not 2-D; 2. (Measure) tumour volume/mass/ weight;	2	1. Neutral: different sizes 1. Accept: height/thickness for depth
9(e)	1. Allows tumours to grow/develop/form; 2. (So) can investigate treatment rather than prevention (of tumours)/ when tumour/cancer is more advanced;	2	1. Neutral: gives drug more time to work. 2. Accept: to see whether it can destroy/treat/stop growth of a tumour (that already exists)/ to allow/assess treatment of a tumour

9(f)	1. Unethical (not to treat patients) / may increase probability of patients dying/getting more ill; 2. Use normal cancer drugs/treatment;	2	1. Reject: references to giving people tumours 2. Accept: named type of cancer treatment, e.. chemotherapy

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
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AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Biology BIOL2

Unit 2 The variety of living organisms

Monday 2 June 2014 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

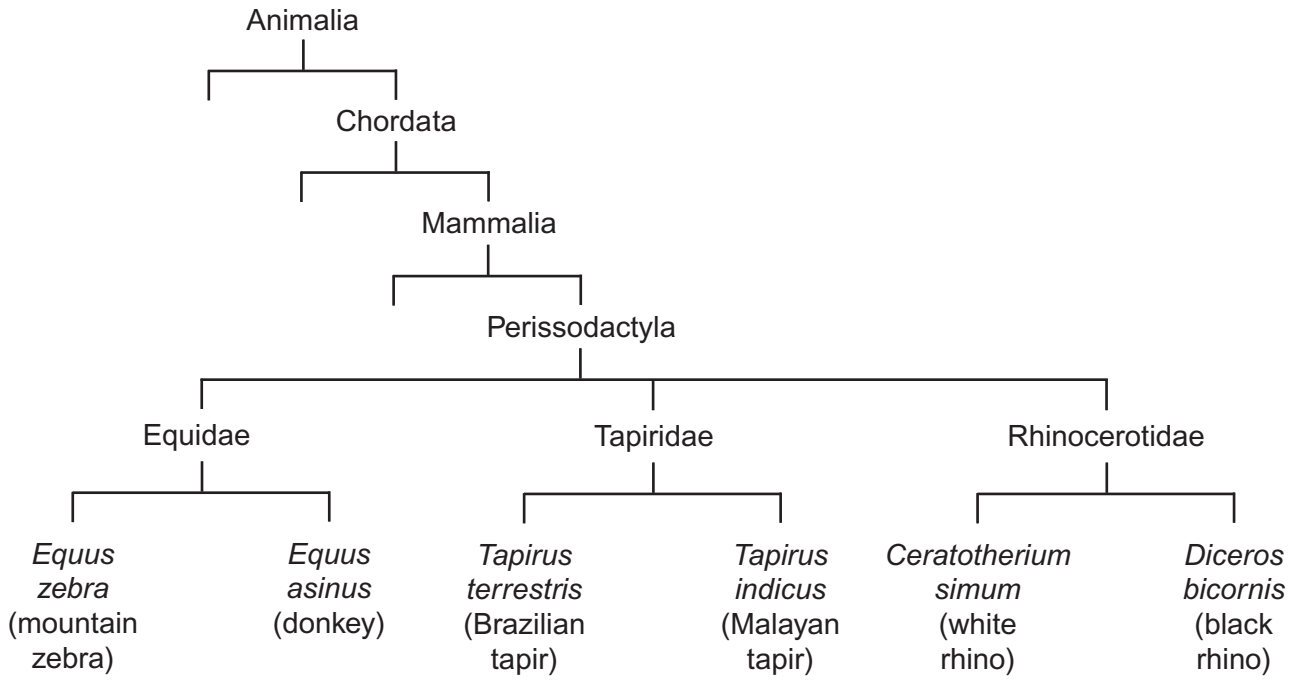
Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- You are expected to use a calculator, where appropriate.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 **Figure 1** shows how some animals with hooves are classified.

Figure 1



1 (a) This type of classification can be described as a phylogenetic hierarchy.

1 (a) (i) What is meant by a **hierarchy**?

[2 marks]

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1 (a) (ii) How many different families are shown in **Figure 1**?

[1 mark]

1 (a) (iii) To which phylum does the white rhino belong?

[1 mark]

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1 (b) (i) Explain the role of independent segregation in meiosis.

[2 marks]

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1 (b) (ii) A zeedonk is the offspring produced from breeding a mountain zebra with a donkey.

- The body cells of a mountain zebra contain 32 chromosomes.
- The body cells of a donkey contain 62 chromosomes.

Use this information to suggest why zeedonks are usually infertile.

[2 marks]

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2 (a) (i) What is **selective breeding**?

[1 mark]

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2 (a) (ii) Explain **one** potential problem that can be caused by selective breeding.

[2 marks]

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2 (b) Heritability is a measure of how much of the variation in a population is due to genetic factors. Values for the heritability of a feature range from 0 to 1. A value of 0 means that there is no influence of genetic factors. A value of 1 means that the feature is completely due to genetic factors.

The Large Munsterlander and Pudelpointer are two breeds of hunting dog. **Table 1** shows the mean heritability values and standard deviations for two features of these two breeds of hunting dog.

Table 1

Feature	**Mean heritability value (± standard deviation)**	
	Large Munsterlander	**Pudelpointer**
Tracking	0.80 ± 0.10	0.17 ± 0.06
Searching	0.19 ± 0.11	0.12 ± 0.08

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2 (b) (i) If a dog breeder wishes to use selective breeding for one of these features, which **one** should he choose? Use information in **Table 1** to explain your answer.

[2 marks]

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2 (b) (ii) What do the standard deviations suggest about the differences in heritability values for searching between the two breeds of hunting dog?

[2 marks]

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7

Turn over for the next question

Do not write outside the box

3 (a) The oxygen dissociation curve for haemoglobin shifts to the right during vigorous exercise. Explain the advantage of this shift.

[3 marks]

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3 (b) Weddell seals are diving mammals that live in cold environments. A Weddell seal is shown in **Figure 2**.

Figure 2



3 (b) (i) Explain how the body shape of a Weddell seal is an adaptation to living in a cold environment.

[2 marks]

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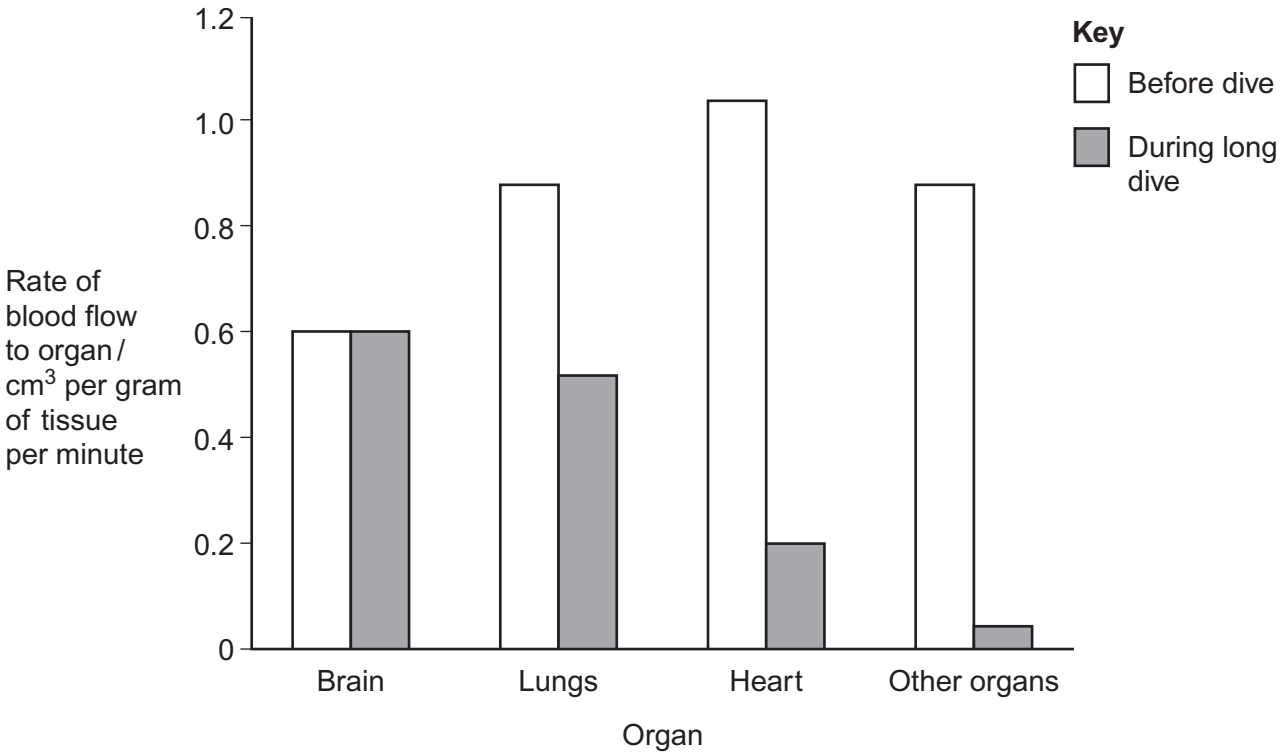
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3 (b) (ii) Weddell seals can remain underwater for long periods of time. **Figure 3** shows the rate of blood flow to different organs of a Weddell seal before a dive and during a long dive.

Figure 3



Describe and explain the changes in the rate of blood flow to the different organs during a long dive.

[3 marks]

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Turn over ▶

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4 (a) Describe and explain how the countercurrent system leads to efficient gas exchange across the gills of a fish.

[3 marks]

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4 (b) Amoebic gill disease (AGD) is caused by a parasite that lives on the gills of some species of fish. The disease causes the lamellae to become thicker and to fuse together.

AGD reduces the efficiency of gas exchange in fish. Give **two** reasons why.

[2 marks]

1 .....

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Do not write outside the box

4 (c) **Table 2** shows some features of gas exchange of a fish at rest.

Table 2

Volume of oxygen absorbed by the gills from each dm^3 of water / cm^3	7
Mass of fish / kg	0.4
Oxygen required by fish / $cm^3\ kg^{-1}\ hour^{-1}$	90

4 (c) (i) Calculate the volume of water that would have to pass over the gills each hour to supply the oxygen required by the fish. Show your working.

[2 marks]

..... dm^3

4 (c) (ii) The volume of water passing over the gills increases if the temperature of the water increases. Suggest why.

[1 mark]

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8

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ANSWER IN THE SPACES PROVIDED

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5 (a) Genes for antibiotic resistance can be transmitted between bacteria. **Table 3** shows features of gene transmission.

Complete **Table 3** by putting a tick in the box if the statement is correct for vertical or horizontal gene transmission.

[2 marks]

Table 3

Statement	**Vertical gene transmission**	**Horizontal gene transmission**
Gene is replicated		
Gene can be passed to other species of bacteria		
Involves conjugation		

5 (b) (i) The antibiotic tetracycline binds to ribosomes in bacterial cells.

Explain how this causes the death of bacterial cells.

[2 marks]

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Question 5 continues on the next page

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Scientists determined the amino acid sequences of two forms of a protein, **A** and **B**, found in two types of the same species of bacterium. They used these amino acid sequences to find the DNA base sequences that code for these proteins.

Table 4 shows their results for the same region of proteins **A** and **B**.

Table 5 shows DNA triplets that code for different amino acids.

Table 4

Protein A							
Amino acid sequence	Lys	Ser	Pro	Cys	Leu	Gly	Ala
DNA base sequence	TTT	TCA	GGT	ACG	GAA	CCA	CGA

Protein B							
Amino acid sequence	Lys	Ser	Pro	Trp	Pro	Trp	Cys
DNA base sequence	TTT	TCA	GGT				

Table 5

Amino acid	**DNA bases that code for this amino acid**
Trp	ACC
Pro	GGT or GGA
Cys	ACA or ACG

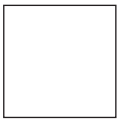
The amino acid sequence of protein **B** was the result of a mutation. A single base was added within the DNA sequence coding for protein **A**.

5 (b) (ii) Use the information provided to complete the DNA base sequence that codes for protein **B**.

[1 mark]

5 (b) (iii) Complete the box to show which DNA base was added.

[1 mark]



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5 (b) (iv) Tetracycline can enter a bacterium through protein **A**. This protein is found in the plasma membrane.

Suggest how a change in the amino acid sequence of this protein could make a bacterium resistant to tetracycline.

[2 marks]

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Turn over for the next question

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6 Evolutionary relationships between different primates can be found by comparing their proteins and DNA.

6 (a) All primates produce a species-specific type of haemoglobin. An antibody against human haemoglobin could be used to compare the evolutionary relationships between different primates. Describe and explain how.

[3 marks]

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6 (b) Scientists used DNA hybridisation to determine the evolutionary relationships between five species of primate.

The temperature at which a molecule of double-stranded DNA separates into two single strands is the separation temperature.

The scientists recorded the mean separation temperature of DNA in which both strands were from the same species.

The scientists then recorded the mean decrease in separation temperature of DNA in which one of the strands was from another species.

Their results are shown in **Table 6**.

Table 6

Primate	**Mean decrease in separation temperature / ºC**				
	Human	Chimpanzee	Gorilla	Orang-utan	Gibbon
Human					
Chimpanzee	1.7				
Gorilla	2.3	2.3			
Orang-utan	3.6	3.6	3.5		
Gibbon	4.8	4.8	4.7	4.9	

Do not write outside the box

6 (b) (i) These data suggest that gibbons are the most distantly related to humans. Explain how.

[2 marks]

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6 (b) (ii) There were differences in separation temperature of DNA formed from single-stranded DNA of the **same** species of primate. Suggest why.

[1 mark]

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6 (b) (iii) The scientists assumed that the decreases in separation temperatures are directly proportional to the time since the evolutionary lines of these primates separated. Gorillas are thought to have separated from orang-utans 20 million years ago.

Use this information to calculate how long ago the evolutionary lines of humans and chimpanzees separated. Show your working.

[2 marks]

..... million years

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7 (a) What **two** measurements are needed to calculate an index of diversity?

[2 marks]

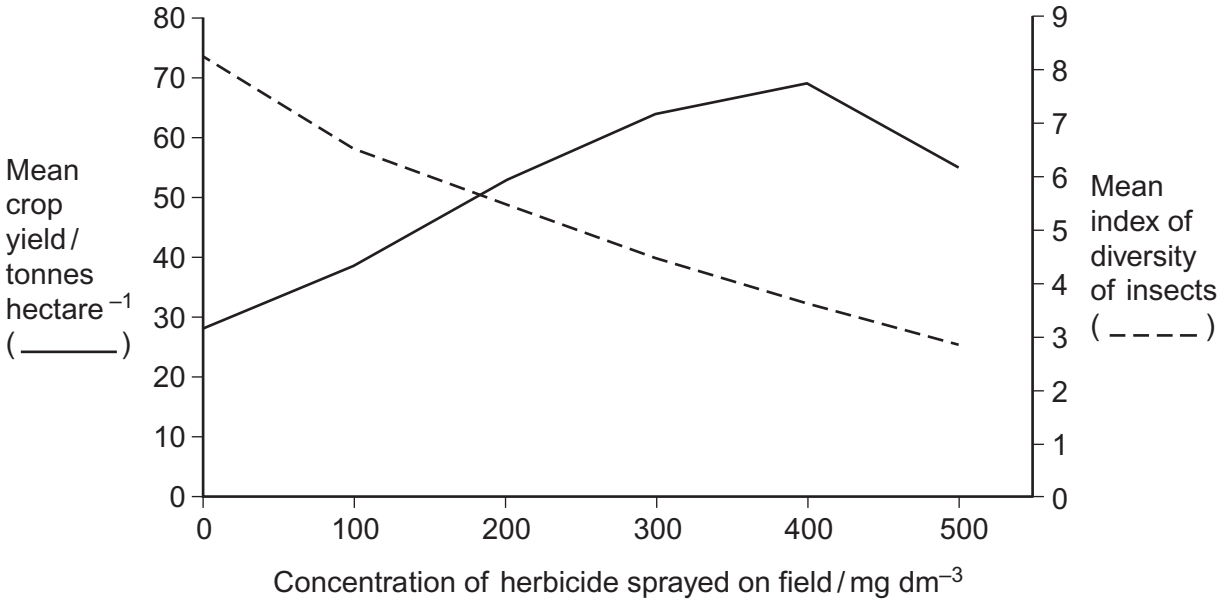
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7 (b) A herbicide is a chemical used to kill weeds. Ecologists investigated the effect of a herbicide on crop yield and the diversity of insects. They sprayed different fields with the same volume of different concentrations of the herbicide. At harvest, the ecologists determined the mean crop yield and the mean index of diversity of insects for fields that had received the same concentration of the herbicide.

Figure 4 shows their results.

Figure 4



7 (b) (i) Some fields acted as controls. They were sprayed with a solution that did not contain the herbicide. Explain the purpose of these control fields.

[1 mark]

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Do not write outside the box

7 (b) (ii) Suggest an explanation for the relationship between the concentration of herbicide and the mean crop yield.

[2 marks]

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7 (b) (iii) Explain the relationship between the concentration of herbicide and the mean index of diversity of insects.

[3 marks]

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Turn over for the next question

Do not write outside the box

8 (a) Explain how the structure of DNA is related to its functions.

[6 marks]

[Extra space]

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Scientists investigated three genes, **C**, **D** and **E**, involved in controlling cell division. They studied the effect of mutations in these genes on the risk of developing lung cancer.

The scientists analysed genes **C**, **D** and **E** from healthy people and people with lung cancer.

- If a person had a normal allele for a gene, they used the symbol N.
- If a person had two mutant alleles for a gene, they used the symbol M.

They used their data to calculate the risk of developing lung cancer for people with different combinations of N and M alleles of the genes. A risk value of 1.00 indicates no increased risk. **Table 7** shows the scientists' results.

Table 7

Gene C	Gene D	Gene E	Risk of developing lung cancer
N	N	N	1.00
M	N	N	1.30
N	N	M	1.78
N	M	N	1.45

N = at least one copy of the normal allele is present
M = two copies of the mutant allele are present

8 (b) What do these data suggest about the relative importance of the mutant alleles of genes **C**, **D** and **E** on **increasing** the risk of developing lung cancer? Explain your answer.

[3 marks]

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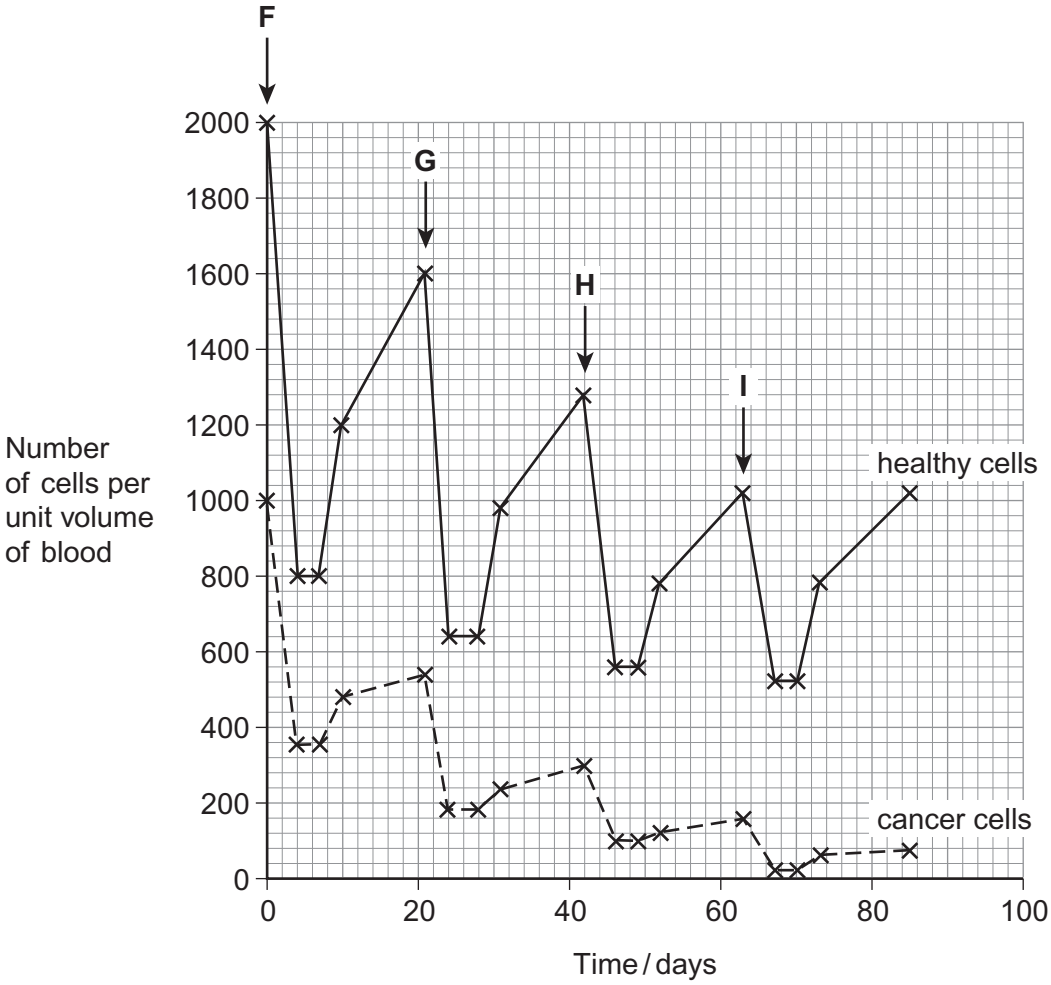
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Question 8 continues on the next page

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Chemotherapy is the use of a drug to treat cancer. The drug kills dividing cells. **Figure 5** shows the number of healthy cells and cancer cells in the blood of a patient receiving chemotherapy. The arrows labelled **F** to **I** show when the drug was given to the patient.

Figure 5



8 (c) Calculate the rate at which healthy cells were killed between days 42 and 46.

[1 mark]

..... cells killed per unit volume of blood per day

Do not write outside the box

8 (d) Describe similarities and differences in the response of healthy cells and cancer cells to the drug between times **F** and **G**.

[3 marks]

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8 (e) More cancer cells could be destroyed if the drug was given more frequently.

Suggest why the drug was **not** given more frequently.

[2 marks]

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15

Turn over for the next question

Do not write outside the box

9 Nicotine is the addictive substance in tobacco. When nicotine reaches the brain, it binds to a specific protein. This causes the release of chemicals that give a feeling of reward to the smoker. This reward is part of the reason why people find it difficult to stop smoking.

Scientists have developed a vaccine against nicotine to help people stop smoking. They set up an investigation, which involved a large number of volunteers. Once a month for 5 months, one group of volunteers was given the vaccine and the other group was given a placebo.

At regular intervals, the scientists measured the concentration of antibodies to nicotine in the blood of each group of volunteers. They also calculated the percentage of volunteers who had stopped smoking from months 2 to 6 of the investigation.

9 (a) (i) In this investigation, neither the volunteers nor the scientists knew if a particular volunteer was receiving the vaccine or a placebo.

Suggest **two** reasons why this made the scientists' results more reliable.

[2 marks]

1 .....

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2 .....

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9 (a) (ii) The scientists measured the concentration of nicotine in the blood of two volunteers who smoked the same number of cigarettes per day.

Suggest **two** reasons why the concentration of nicotine in the blood of these smokers might be different.

[2 marks]

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Do not write outside the box

9 (b) (i) Suggest how this vaccine could help people to stop smoking.

[3 marks]

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9 (b) (ii) Some people have suggested that this vaccine should **not** be given free to smokers on the National Health Service (NHS). Evaluate this suggestion.

[3 marks]

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Question 9 continues on the next page

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The scientists measured the concentration of antibodies to nicotine in the blood of the volunteers for 12 months after the first vaccination. As a result of these measurements, they divided the volunteers who received the nicotine vaccine into three groups:

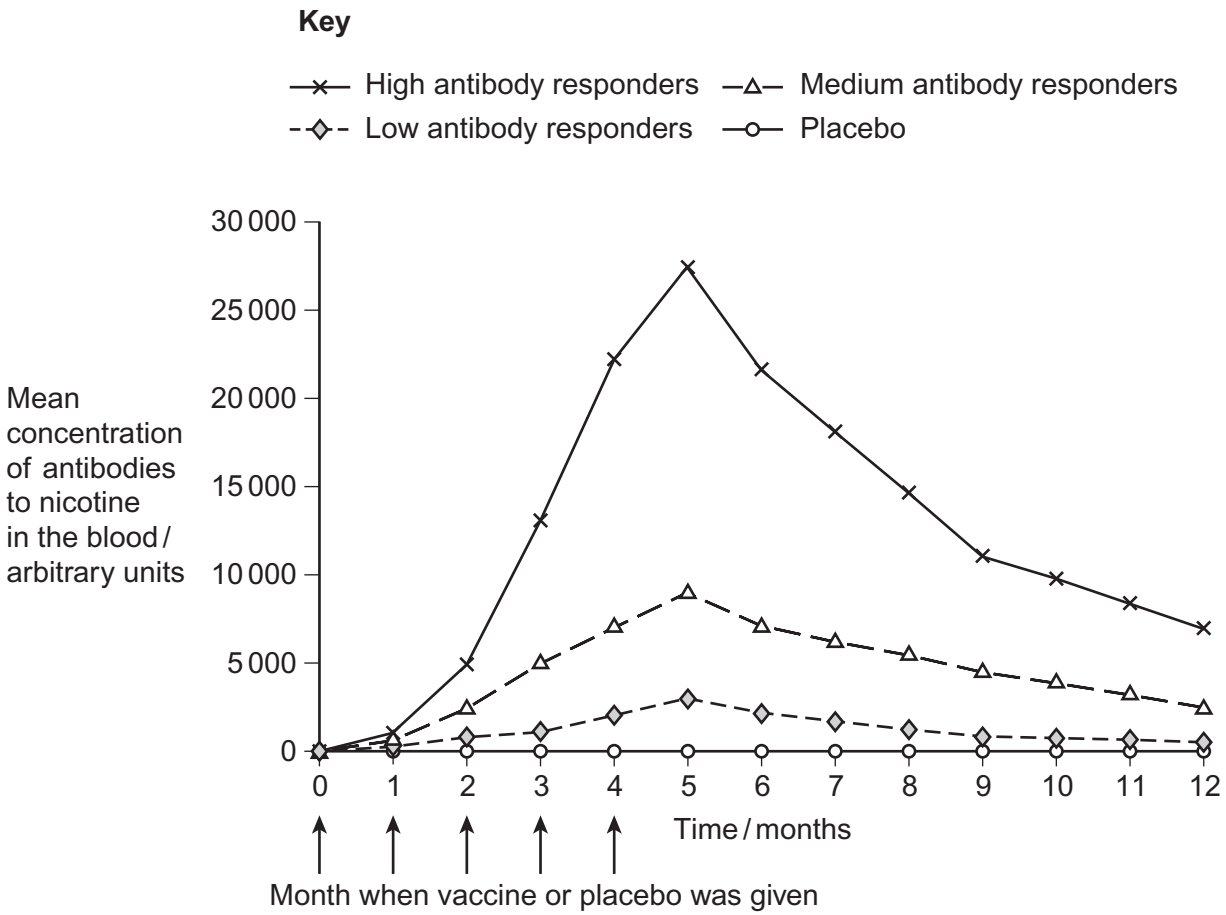
- high antibody responders
- medium antibody responders
- low antibody responders.

Figure 6 shows their results.

The scientists also recorded the number of volunteers who had stopped smoking from months 2 to 6 of the investigation.

Table 8 shows these results.

Figure 6



Do not write outside the box

Table 8

Group	Percentage of volunteers who had stopped smoking from months 2 to 6 of the investigation
High antibody responders	56.6
Medium antibody responders	38.1
Low antibody responders	32.1
Placebo	31.3

9 (c) A journalist reported that this vaccine is a major breakthrough in helping people to stop smoking. Do these data support this statement? Explain your answer.

[5 marks]

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END OF QUESTIONS

15

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Figure 2 Daisy Gilardini/Photodisc/Getty Images

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A-LEVEL
BIOLOGY

BIOL2 – The variety of living organisms
Mark scheme

2410
June 2014

Version 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this Mark Scheme are available from aqa.org.uk

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Although specific marks are not awarded in questions 1-7, marks will take into account the quality of written communication. Credit will only be awarded where candidates have presented information clearly and coherently and have used the specialist vocabulary indicated in the mark scheme for this unit. Specific references to the quality of written communications are marked **Q** in this mark scheme.

Question	Marking Guidance	Mark	Comments
1(a)(i)	1. Groups within groups; 2. No overlap (between groups);	2	1. Accept: idea of larger groups at the top **or** smaller groups at the bottom
1(a)(ii)	**3**;	1	
1(a)(iii)	Chordata;	1	Accept: if phonetically correct eg 'Cordata'
1(b)(i)	1. (To provide) genetic variation; 2. (Allows) different combinations of maternal and paternal chromosomes/ alleles; 3. (To produce) haploid cells/half the chromosome number; 4. (Allows) homologous chromosomes/ homologous pairs to arrange randomly (at equator/middle of cell)/separate;	2 max	1. Genetic variation must be directly stated and not implied 2. Accept: any allele of one gene can combine with any allele of another gene Reference to 'crossing over' negates the first marking point awarded
1(b)(ii)	1. (Zeedonk has) 47/odd/uneven number of chromosomes; 2. Chromosomes cannot pair/are not homologous/ chromosome number cannot be halved / meiosis cannot occur / sex cells/haploid cells are not produced;	2	1. Accept: diploid number would be odd 1. Reject: if wrong number of chromosomes is given 2. Accept: cannot have half a chromosome 2. **Q** Reject: meiosis cannot occur **in** sex cells

Question	Marking Guidance	Mark	Comments
2(a)(i)	(Humans breed) organisms with certain/chosen characteristics/alleles;	1	Accept: suitable examples of organisms possessing certain/chosen characteristics/alleles.
2(a)(ii)	1. Inbreeding / breed closely related organisms; 2. (So higher probability of) mutations being passed on / recessive alleles being expressed / health problems/example given / increase in genetic disease; 3. Reduced genetic variation/diversity / smaller gene pool / less variety of alleles; 4. (So) can be killed by/susceptible to the same/a disease / reduces ability to adapt/survive (future) environmental changes / may not be beneficial to future breeding programmes;	2 max	1. **Q** Reject: interbreeding 2. Neutral: 'inbreeding causes mutations' 3. **Q** Neutral: fewer alleles 4. Neutral: can be killed by diseases
2(b)(i)	1. Select tracking/(Large) Munsterlander; 2. (As) high (heritability) value/0.8/ closer to 1/ mainly due to genetic factors;	2	
2(b)(ii)	1. (SDs) overlap / values shared; 2. (So difference between means) is **not** significant/is due to chance;	2	2. Accept: (difference between means) is **not** real/**not** reliable 2. Award 1 mark max if candidate states that SDs do **not** overlap so (difference) **is** significant/is **not** due to chance 2. Do not award if linked to a large standard deviation only 2. Neutral: spread is not reliable

Question	Marking Guidance	Mark	Comments
3(a)	1. Lower affinity for oxygen / releases more oxygen / oxygen is released quicker / oxygen dissociates/unloads more readily; 2. (To) muscles/tissues/cells; 3. (For) high/rapid respiration;	3	1. **Q** Neutral: the organism/body has a lower affinity for oxygen/releases more oxygen 3. **Q** Reject: '**produces** more energy' on its own Neutral: reference to partial pressure 3. Accept: (for) respiration to produce more energy in the form of ATP/ release more energy
3(b)(i)	1. Small SA:VOL; 2. (So) reduces heat loss / (more) heat retained;	2	1. Neutral: small limbs/small ears/extremities 1. Neutral: small SA 1. Accept: large VOL:SA 1. Neutral: reference to fat/blubber/insulation Note: MP2 is independent of MP1
3(b)(ii)	1. Brain is the same, others fall; 2. Brain controls other organs/remains active/ needs constant supply of oxygen; 3. Lungs not used/are used less / seal is not breathing; 4. Heart rate decreases / heart pumps less; 5. Blood diverted to muscles; 6. Oxygen (in blood) will last longer / less oxygen used / oxygen is conserved;	3 max	Note: 1. might not be given in the same sentence Assume that 'other organs fall' = all three organ categories fall 1. Accept: 'blood flow is reduced to all organs except for the brain' 2. Accept: 'seal would die' = brain remains active 3. Reject: seal is not respiring

Question	Marking Guidance	Mark	Comments
4(a)	1. Water and blood flow in opposite directions; 2. Maintains concentration/diffusion gradient / equilibrium not reached / water always next to blood with a lower concentration of oxygen; 3. Along whole/length of gill/lamellae;	3	Accept: diagram if clearly annotated 2. Must have the idea of 'maintaining' or 'always' in reference to concentration/diffusion gradient 2. Accept: constant concentration/ diffusion gradient 3. Accept: gill plate/gill filament
4(b)	1. (Thicker lamellae so) greater/longer <u>diffusion</u> distance/pathway; 2. (Lamellae fuse so) reduced surface area;	2	1. **Q** Neutral: 'thicker' diffusion pathway 2. Accept: reduced SA:VOL
4(c)(i)	Correct answer of **5.1** or **5.14(2857)** (dm^3) = 2 marks;; One mark for incorrect answers that show **36** or **0.4 x 90** or **90 ÷ 7**;	2	Allow 1 mark max for an answer of **5** if the correct answer of **5.1** or **5.14(2857)** is **not** shown
4(c)(ii)	1. Increased metabolism/respiration/enzyme activity; 2. Less oxygen (dissolved in water);	1 max	1. Accept: enzymes work more efficiently Neutral: references to increased kinetic energy (of water molecules)

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>5(a)</td><td>
<table>
<tr><th>Statement</th><th>Vertical</th><th>Horizontal</th></tr>
<tr><td>Gene is replicated</td><td>✓</td><td>✓</td></tr>
<tr><td>Gene can be passed to other species of bacteria</td><td></td><td>✓</td></tr>
<tr><td>Involves conjugation</td><td></td><td>✓</td></tr>
</table>
</td><td>2</td><td>One mark for each correct column</td></tr>
<tr><td>5(b)(i)</td><td>1. Prevents protein synthesis;

2. (So) enzymes not produced / any named process involving proteins/enzymes is inhibited;</td><td>2</td><td>1. Accept: ribosomes produce proteins/ chains of amino acids/polypeptides

1. Reject: ribosomes produce amino acids

2. Accept: no (DNA) replication

2. Accept: cannot form a cell wall

2. Reject: no mitosis

2. Neutral: no growth/ repair</td></tr>
<tr><td>5(b)(ii)</td><td>ACC GGA ACC ACG;</td><td>1</td><td></td></tr>
<tr><td>5(b)(iii)</td><td>C;</td><td>1</td><td>Accept: ‘cytosine’</td></tr>
<tr><td>5(b)(iv)</td><td>1. Different tertiary structure/tertiary shape;

2. (So tetracycline) does not fit/bind/ is not complementary / does not enter/pass through (protein/into cell);</td><td>2</td><td>Neutral: 3D structure.

2. Q Reject: any reference to ‘active site’, ‘enzyme-substrate complex’ or (tetracycline) not fitting/binding to an enzyme

2. Accept: (so) more tetracycline pumped out of cell</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
6(a)	1. Antibody and haemoglobin/blood (of different primates) mixed/added/bind; 2. Precipitate/complex/band formed; 3. Amount of precipitate/complex/ thickness of band shows relationship/similarity (in protein/DNA);;	3	**Note**: MP3 is worth **2 marks outright** on its own as it subsumes MP2. If MP3 is awarded, do **not** also award MP2 for a total of 3 marks. 1. Neutral: methodology of how the human antibody would be obtained 1. Neutral: mix antibody and plasma/serum 1. Neutral: reference to mixing antibody with **human** haemoglobin /blood 1. Reject: idea of injecting (human) antibody into primates 3. Reject: incorrect relationship eg more precipitate = less closely related
6(b)(i)	(Largest decrease in separation temperature) – no mark 1. (So) few(er) <u>hydrogen/H</u> bonds; 2. (So) few(er) complementary bases/ few(er) base pairs;	2	Accept: 'not many' for 'few' Note: 'fewer hydrogen bonds between complementary bases/base pairs' = 2 marks 2. Neutral: fewer bases 2. Neutral: fewer similar base sequences
6(b)(ii)	(Same species) have different alleles/different base sequences/ (different) mutations/introns/ non-coding DNA/multiple repeats;	1	**Q** Reject: different genes Neutral: different bases Neutral: base sequences

			are not complementary **Q** Neutral: 'junk DNA' Neutral: intraspecific variation/genetic differences Reject: interspecific variation
6(b)(iii)	Correct answer in range of **9.69** to **9.71(4286)** = 2 marks;; One mark for incorrect answers that show any of the following: (1°C =) **5.7(14286)** (million years) OR: **20 000 000 ÷ 3.5** OR: **20 ÷ 3.5**	2	Accept: **9 690 000** to **9 714 286** for 2 marks If **10** is shown **and** an answer in the range of **9.69** to **9.71(4286)**, award **2 marks** If **10** is shown and an answer in the range of **9.69** to **9.71(4286)** is **not shown**, award **1 mark**
7(a)	1. Number of (individuals of) each species; 2. Total number of individuals / number of species;	2	1. Accept: 'population' for 'number' 2. Accept: 'species richness' MP2 allows for other types of diversity index
7(b)(i)	1. (Shows) results are due to the herbicide/ are not due to another factor; 2. (To) compare the effect of using and not using the herbicide / shows the effect of adding the herbicide;	1 max	Neutral: allows a comparison Neutral: ensures results are due to the independent variable Reject: 'insecticide' Accept: 'pesticide'
7(b)(ii)	1. (More) weeds killed **so** more crops/plants survive/higher yield/less competition; 2. High concentrations (of herbicide)	2	2. Accept: 'pesticide' 2. Neutral: 'insecticide'

	harm/damage/kill/are toxic to crops/plants;		2. Accept: use of figures (eg 400+)
7(b)(iii)	1. Reduced plant diversity / fewer plant species / fewer varieties of plant; 2. Fewer habitats/niches; 3. Fewer food sources/varieties of food;	3	Accept: 'weed' for 'plant' 1. Neutral: fewer plants 1. Accept: only one crop species remains 2. **Q** Neutral: fewer homes/shelters 3. Neutral: less food

Question	Marking Guidance	Mark	Comments
8(a)	1. Sugar-phosphate (backbone)/double stranded/helix **so** provides strength/stability /protects bases/protects hydrogen bonds; 2. Long/large molecule **so** can store lots of information; 3. Helix/coiled **so** compact; 4. Base sequence allows information to be stored/ base sequence codes for amino acids/protein; 5. Double stranded **so** replication can occur semi-conservatively/ strands can act as templates; 6. Complementary base pairing / A-T <u>and</u> G-C **so** accurate replication/identical copies can be made; 7. (Weak) hydrogen bonds **for** replication/ unzipping/strand separation; 8. Many hydrogen bonds **so** stable/strong;	6 max	Must be a direct link/obvious to get the mark Neutral: reference to histones 3. Accept: can store in a small amount of space for 'compact' 4. Accept: base sequence allows transcription Accept: 'H-bonds' for 'hydrogen bonds' 8. Must convey the idea of 'many'
8(b)	1. (Mutation) in **E** produces highest risk/1.78; 2. (Mutation) in **D** produces next highest risk/1.45; 3. (Mutation) in **C** produces least risk/1.30;	3	Must be stated directly and not implied **E**>**D**>**C** = 3 marks Accept: values of 0.78, 0.45 and 0.30 for MP1, MP2 and MP3 respectively If no mark is awarded, a principle mark can be given for the idea that all mutant alleles increase the risk

8(c)	**180**;	1	
8(d)	**(Similarities)**: 1. Same/similar pattern / both decrease, stay the same then increase; 2. Number of cells stays the same for same length of time; **(Differences)**: (Per unit volume of blood) 3. Greater/faster decrease in number of healthy cells / more healthy cells killed / healthy cells killed faster; 4. Greater/faster increase in number of healthy cells / more healthy cells replaced/divide / healthy cells replaced/divide faster;	3 max	2. Ignore: wrong days stated 3. & 4. Accept: converse for cancer cells 3. Accept: greater <u>percentage</u> decrease in number of cancer cells / greater <u>proportion</u> of cancer cells killed For **differences**, statements made must be comparative
8(e)	1. More/too many healthy cells killed; 2. (So) will take time to replace/increase in number; 3. Person may die/have side effects;	2 max	2. Neutral: will take time to 'repair'

Question	Marking Guidance	Mark	Comments
9(a)(i)	1. (Scientists) can't show bias/influence/ may have a vested interest/work for the company developing the vaccine; 2. (Volunteers) can't show psychological/mental effects/ 'placebo effect'/expectations;	2	1. Relates to the scientists 2. Relates to the volunteers 2. Accept: reduces the 'Hawthorne effect'/demand characteristics 2. Neutral: so they have no idea what they are taking
9(a)(ii)	Any **two** suitable suggestions, eg 1. Amount of nicotine in cigarettes; 2. Amount inhaled/absorbed / time since last cigarette; 3. (Different) amounts excreted/ metabolism/rate of binding (of nicotine) to protein; 4. (Different) blood volumes; 5. Nicotine from passive smoking/other smokers/other sources; 6. Some volunteers received the vaccine/placebo;	2 max	Neutral: refs.to age and health 1. Neutral: different types of cigarette/ different ways/ frequency of smoking 2. Neutral: absorption by gut/ digestion 2. Accept: absorption by mouth 3. Accept: broken down (differently) 4. Neutral: different body masses 6. Accept: some volunteers would have/would not have the antibodies
9(b)(i)	1. Antibodies to nicotine produced / antibodies bind to nicotine; 2. (So) nicotine does not bind to protein/does not reach the brain; 3. (So) cigarettes/smoking does not satisfy addiction/reward smokers/ release (reward) chemicals;	3	1. **Q** Reject: vaccine contains/ produces antibodies 1. **Q** Neutral: antibodies digest/ kill/fight nicotine 2. **Q** Reject: any reference to 'active site' 2. Neutral: idea that the antibodies bind to the protein
9(b)(ii)	**(Agree):** 1. People choose to smoke/know the risks;	3 max	

	2. Should spend this money on education/preventing people from starting to smoke/treating other health problems/ vaccines are expensive; **(Disagree):** 3. Unethical not to treat; 4. Less money needed to treat the effects of smoking/cancer / smokers pay taxes so are entitled to treatment;		

9(c)	1. High antibody responders have a high % to stop smoking/are more likely to stop smoking; 2. Only a few may be high antibody responders/ no numbers on how many are high/medium/low antibody responders; 3. Percentage who stopped smoking is similar for placebo group and low/medium responders / some/% of placebo group (still) stopped smoking / placebo has the lowest value/% to stop smoking; 4. Large sample size/double blind **so** reliable/representative; 5. Antibody levels peak at/drop after <u>5 months</u> / boosters may be needed at/after 5 months; 6. May start smoking again after 5/6 months / do not know the percentage who stopped smoking after 5/6 months; 7. <u>Nicotine</u> is not the only factor responsible for making people smoke;	5 max	1. 'People producing a high concentration of antibodies' is equivalent to 'high antibody responders' 2. Neutral: not all people are high antibody responders Accept: reference to values from the table for 1. & 3. 7. Must mention nicotine 7. Do not accept: correlation does not mean causation / could be due to other factors

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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6	
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8	
9	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2013

Biology BIOL2

Unit 2 The variety of living organisms

Tuesday 15 January 2013 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- You are expected to use a calculator, where appropriate.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) The table shows some statements about three carbohydrates. Complete the table with a tick in each box if the statement is true.

Statement	Starch	Cellulose	Glycogen
Found in plant cells			
Contains glycosidic bonds			
Contains β-glucose			

(3 marks)

1 (b) Name the type of reaction that would break down these carbohydrates into their monomers.

.....

(1 mark)

1 (c) Give **one** feature of starch and explain how this feature enables it to act as a storage substance.

Feature .....

Explanation .....

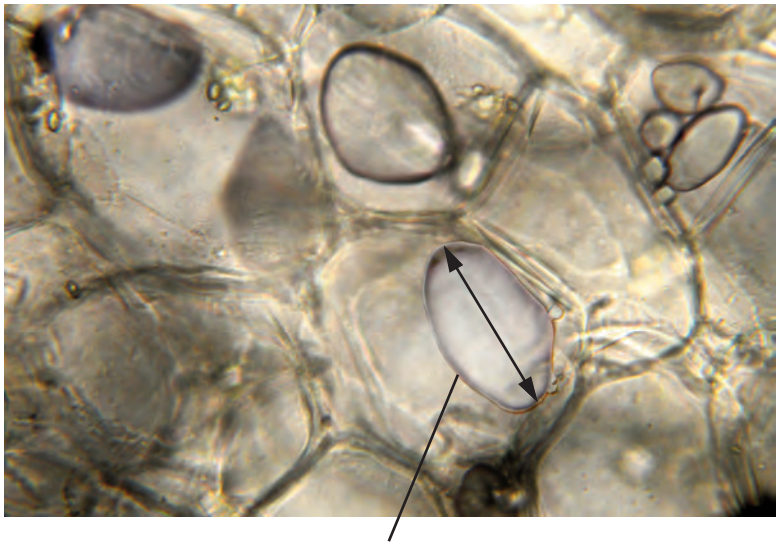
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(2 marks)

Do not write outside the box

1 (d) The picture shows starch grains as seen with an optical microscope. The actual length of starch grain **A** is 48 µm. Use this information and the arrow line to calculate the magnification of the picture. Show your working.



Starch grain **A**

Magnification ..... times
(2 marks)

8

Turn over for the next question

Do not write outside the box

2 (a) (i) An arteriole is described as an organ. Explain why.

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(1 mark)

2 (a) (ii) An arteriole contains muscle fibres. Explain how these muscle fibres reduce blood flow to capillaries.

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(2 marks)

2 (b) (i) A capillary has a thin wall. This leads to rapid exchange of substances between the blood and tissue fluid. Explain why.

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(1 mark)

2 (b) (ii) Blood flow in capillaries is slow. Give the advantage of this.

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(1 mark)

Do not write outside the box

2 (c) Kwashiorkor is a disease caused by a lack of protein in the blood. This leads to a swollen abdomen due to a build up of tissue fluid.

Explain why a lack of protein in the blood causes a build up of tissue fluid.

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(3 marks)

(Extra space) .....

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8

Turn over for the next question

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3 (a) The scientific name of the leopard is *Panthera pardus*. Complete the table to show the classification of the leopard.

Kingdom	**Animalia**
Phylum	Chordata
	Mammalia
	Carnivora
Family	Felidae
Genus	
Species	

(2 marks)

3 (b) Leopards, cheetahs and pumas are all members of the family Felidae.

Biologists used DNA hybridisation to investigate the evolutionary relationships between leopards, cheetahs and pumas. They found that hybrid DNA from a leopard and a cheetah separated into single strands at a higher temperature than hybrid DNA from a leopard and a puma.

These results suggest that leopards are more closely related to cheetahs than to pumas. Explain why.

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(2 marks)

Do not write outside the box

3 (c) All modern cheetahs are thought to have descended from a single female. This female was part of a small population that survived an ice age a long time ago that killed almost all cheetahs. After the ice age, the number of cheetahs increased.

3 (c) (i) Use this information to explain what is meant by a genetic bottleneck.

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(2 marks)

3 (c) (ii) The fertility of cheetahs is low. The proportion of abnormal sperm cells produced is higher in cheetahs than in other members of the family Felidae. Suggest an explanation for this.

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(2 marks)

8

Turn over for the next question

Do not write outside the box

4 (a) What is *intraspecific* variation?

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(1 mark)

4 (b) Schizophrenia is a mental illness. Doctors investigated the relative effects of genetic and environmental factors on the development of schizophrenia. They used sets of identical twins and non-identical twins in their investigation. At least one twin in each set had developed schizophrenia.

- Identical twins are genetically identical.
- Non-identical twins are not genetically identical.
- The members of each twin pair were raised together.

The table shows the percentage of cases where both twins had developed schizophrenia.

Type of twin	Percentage of cases where both twins had developed schizophrenia
Identical	50
Non-identical	15

4 (b) (i) Explain why both types of twin were used in this investigation.

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(2 marks)

4 (b) (ii) What do these data suggest about the relative effects of genetic and environmental factors on the development of schizophrenia?

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(1 mark)

Do not write outside the box

4 (b) (iii) Suggest **two** factors that the scientists should have taken into account when selecting the twins to be used in this study.

1 .....

2 .....

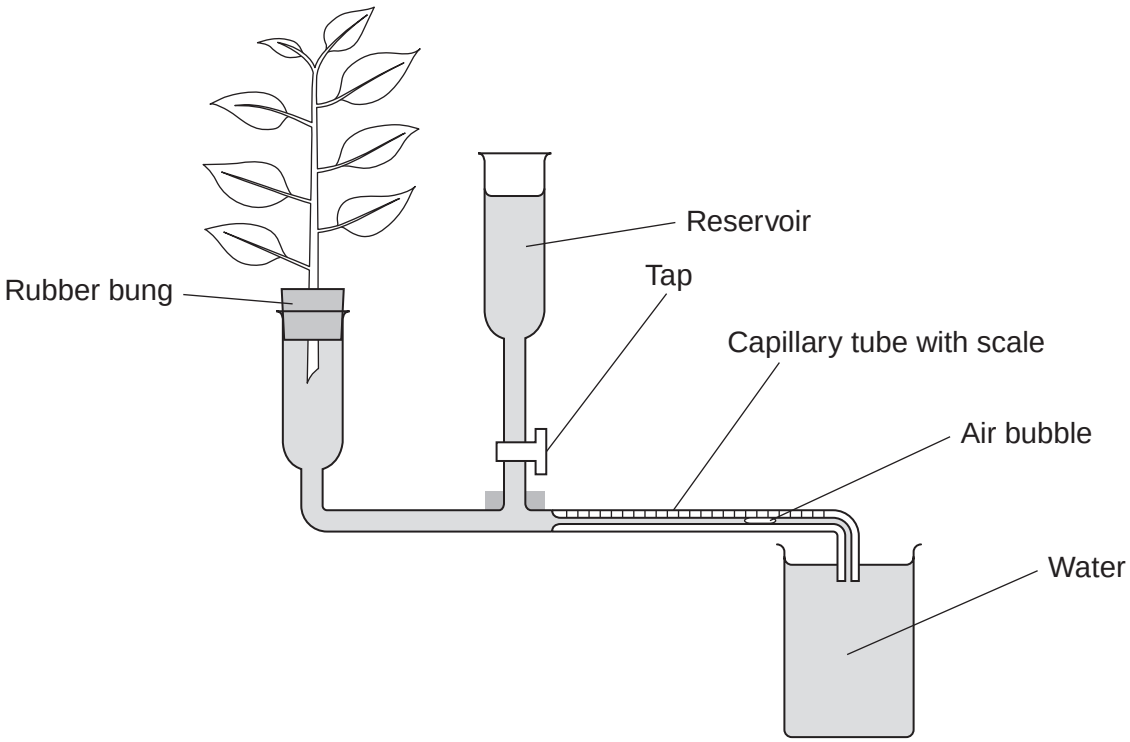
(2 marks)

6

Turn over for the next question

Do not write outside the box

5 Students investigated the effect of removing leaves from a plant shoot on the rate of water uptake. Each student set up a potometer with a shoot that had eight leaves. All the shoots came from the same plant. The potometer they used is shown in the diagram.



5 (a) Describe how the students would have returned the air bubble to the start of the capillary tube in this investigation.

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(1 mark)

5 (b) Give **two** precautions the students should have taken when setting up the potometer to obtain reliable measurements of water uptake by the plant shoot.

1 .....

2 .....

(2 marks)

Do not write outside the box

5 (c) A potometer measures the rate of water uptake rather than the rate of transpiration. Give **two** reasons why the potometer does **not** truly measure the rate of transpiration.

1 .....

2 .....

(2 marks)

5 (d) The students' results are shown in the table.

Number of leaves removed from the plant shoot	Mean rate of water uptake / cm^3 per minute
0	0.10
2	0.08
4	0.04
6	0.02
8	0.01

Explain the relationship between the number of leaves removed from the plant shoot and the mean rate of water uptake.

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(3 marks)

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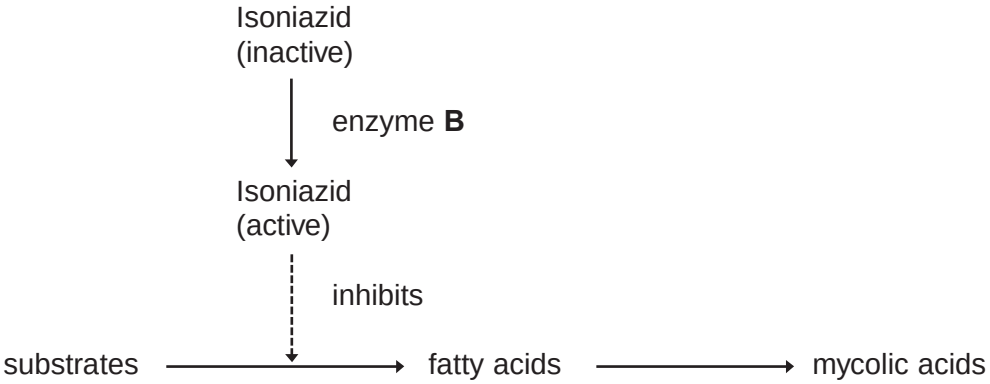
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8

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6 Mycolic acids are substances that form part of the cell wall of the bacterium that causes tuberculosis. Mycolic acids are made from fatty acids. Isoniazid is an antibiotic that is used to treat tuberculosis. The diagram shows how this antibiotic inhibits the production of mycolic acids in this bacterium.



6 (a) Treatment with isoniazid leads to the osmotic lysis of this bacterium. Use information in the diagram to suggest how.

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(2 marks)

6 (b) Human cells also produce fatty acids. Isoniazid does not affect the production of these fatty acids.

Use information in the diagram to suggest **one** reason why isoniazid does **not** affect the production of fatty acids in human cells.

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(1 mark)

Do not write outside the box

6 (c) A mutation in the gene coding for enzyme **B** could lead to the production of a non-functional enzyme. Explain how.

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(3 marks)

(Extra space) .....

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6 (d) Using isoniazid to treat diseases caused by other species of bacteria could increase the chance of the bacterium that causes tuberculosis becoming resistant to isoniazid.

Use your knowledge of gene transmission to explain how.

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(3 marks)

(Extra space) .....

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9

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7 (a) There are ethical and economic arguments for maintaining biodiversity.

7 (a) (i) Suggest **one** ethical argument for maintaining biodiversity.

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(1 mark)

7 (a) (ii) Suggest **one** economic argument for maintaining biodiversity.

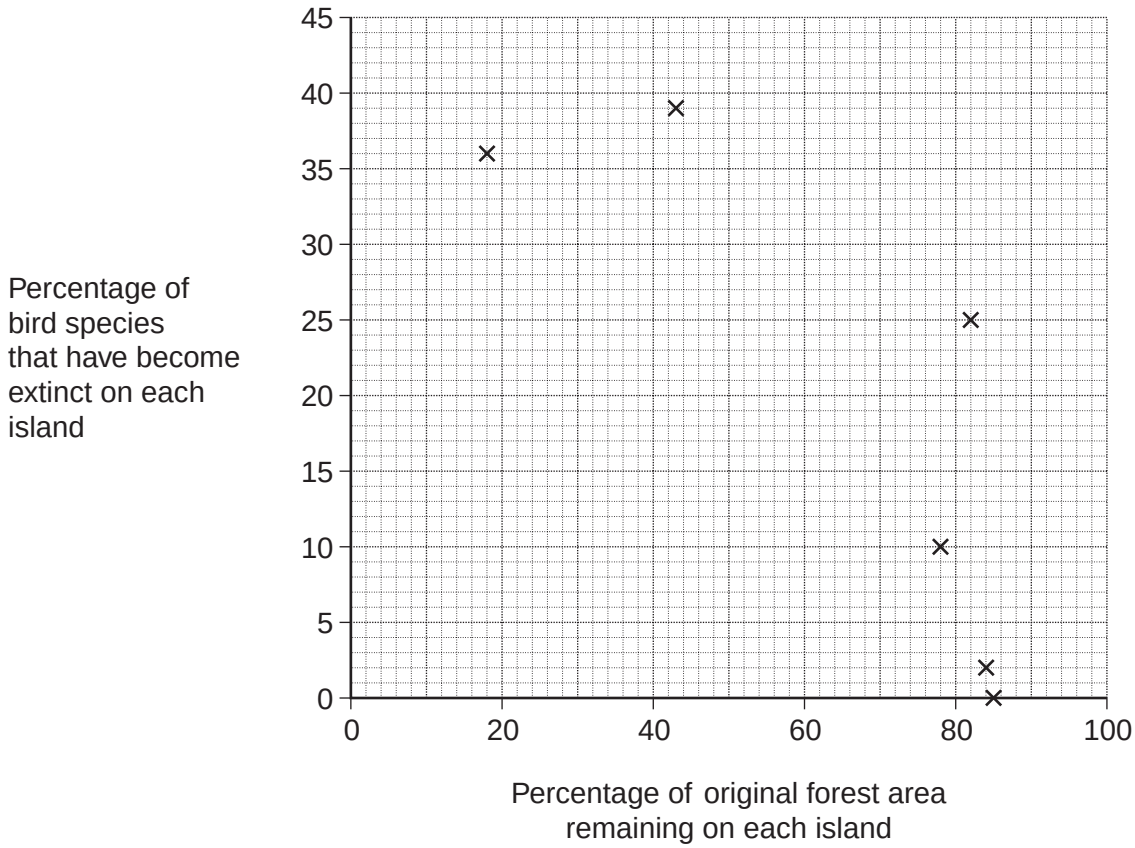
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(1 mark)

Ecologists calculated the percentage of bird species that have become extinct on six islands in the last one hundred years. They also calculated the percentage of original forest area remaining on each island after the same time period. The graph shows their results.



Do not write outside the box

7 (b) Explain the relationship between the percentage of original forest area remaining and the percentage of bird species that have become extinct.

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(2 marks)

7 (c) What **two** measurements would the ecologists have needed to obtain to calculate the index of diversity of birds on each island?

1 .....

2 .....

(2 marks)

7 (d) The ecologists noted that the species of birds surviving on the coldest islands had a larger body size than those surviving on warmer islands.

Explain how a larger body size is an adaptation to a colder climate.

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(2 marks)

8

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Do not write outside the box

8 (a) Describe how DNA is replicated.

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(6 marks)

(Extra space) .....

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Question 8 continues on the next page

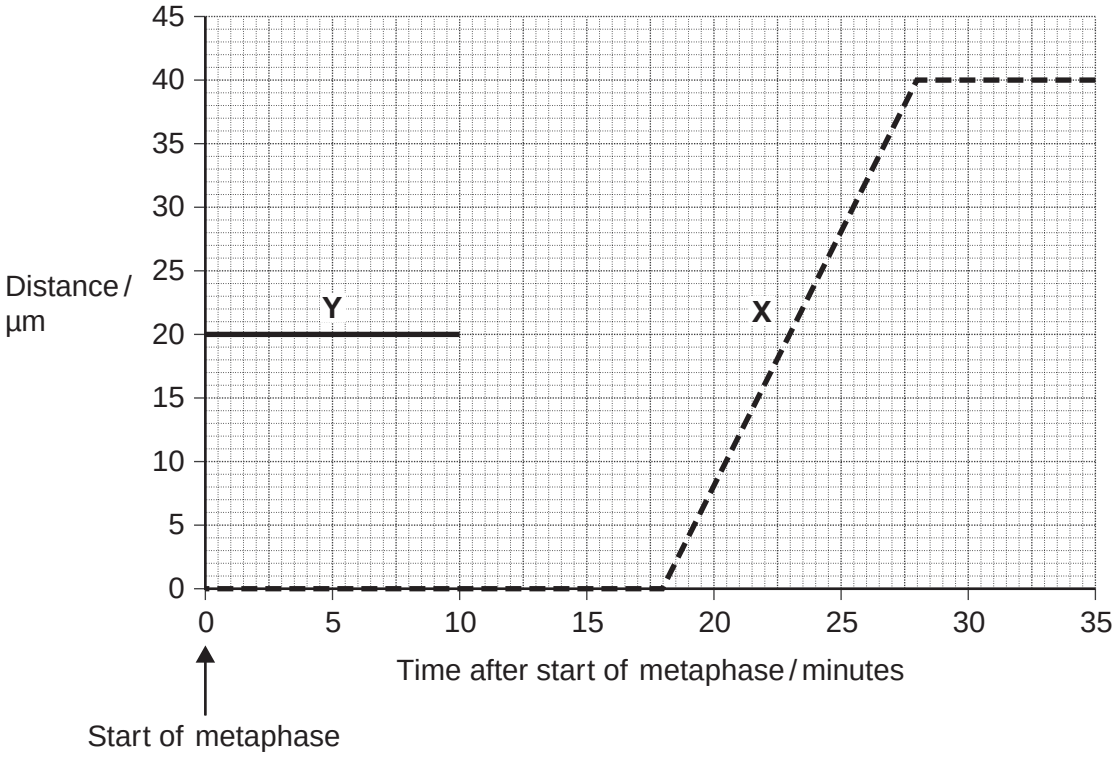
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8 (b) The graph shows information about the movement of chromatids in a cell that has just started metaphase of mitosis.

Key

= distance between chromatids

= distance between each chromatid and the pole to which it is moving



8 (b) (i) What was the duration of metaphase in this cell?

minutes

(1 mark)

8 (b) (ii) Use line **X** to calculate the duration of anaphase in this cell.

minutes

(1 mark)

8 (b) (iii) Complete line **Y** on the graph.

(2 marks)

Do not write outside the box

8 (c) A doctor investigated the number of cells in different stages of the cell cycle in two tissue samples, **C** and **D**. One tissue sample was taken from a cancerous tumour. The other was taken from non-cancerous tissue. The table shows his results.

	Percentage of cells in each stage of the cell cycle	
Stage of the cell cycle	Tissue sample **C**	Tissue sample **D**
Interphase	82	45
Prophase	4	16
Metaphase	5	18
Anaphase	5	12
Telophase	4	9

8 (c) (i) In tissue sample **C**, one cell cycle took 24 hours. Use the data in the table to calculate the time in which these cells were in interphase during one cell cycle. Show your working.

Time cells in interphase ..... hours
(2 marks)

8 (c) (ii) Explain how the doctor could have recognised which cells were in interphase when looking at the tissue samples.

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(1 mark)

8 (c) (iii) Which tissue sample, **C** or **D**, was taken from a cancerous tumour?
Use information in the table to explain your answer.

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(2 marks)

15

Do not write outside the box

9 The 'placebo effect' describes the improvement in patients' symptoms due to psychological effects. Scientists investigated the placebo effect in patients with asthma. They divided a large number of asthma patients into three groups, **1**, **2** and **3**.

- Group **1** inhaled a spray containing albuterol every day. Albuterol is a drug used to treat asthma.
- Group **2** inhaled a placebo spray every day. This was identical to the spray given to group **1** but it did not contain albuterol.
- Group **3** did not receive any spray treatment.

9 (a) Describe **one** way the scientists could have allocated the patients to each group.

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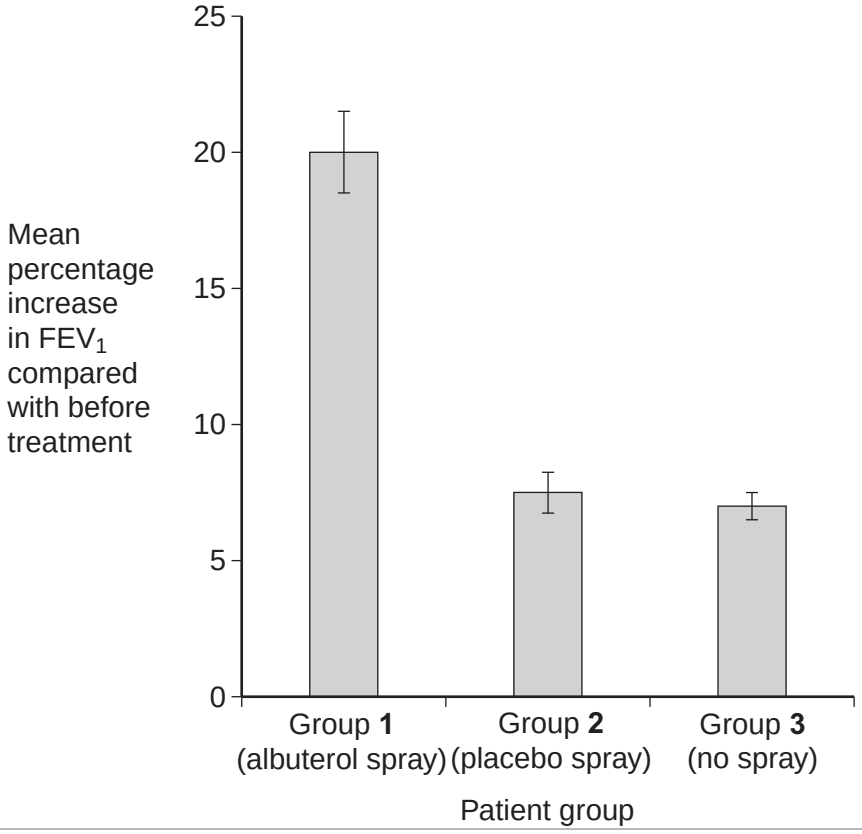
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(2 marks)

The scientists measured the forced expiratory volume (FEV_1) of each patient at regular intervals. The forced expiratory volume (FEV_1) is the volume of air forced out of the lungs in the first second when breathing out. The scientists recorded each patient's FEV_1 before treatment started and after 60 days of treatment. They then calculated the mean increase in FEV_1 for each group. Their results are shown in the graph. The bars show the standard deviation.



Do not write outside the box

9 (b) What do the standard deviation bars suggest about the difference in the mean increase in FEV_1 between Group **1** and the other groups? Explain your answer.

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(2 marks)

9 (c) What do the data suggest about the 'placebo effect' in this investigation? Explain your answer.

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(2 marks)

9 (d) On each occasion that a patient's FEV_1 was measured, a doctor repeated the measurement several times. Explain why.

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(2 marks)

Question 9 continues on the next page

Do not write outside the box

9 (e) All the patients continued with their normal treatment for asthma. The normal treatment was the same for all patients and its effects were short-lived. The patients were told to stop this treatment 24 hours before FEV_1 measurements were taken.

9 (e) (i) Suggest why all the patients were allowed to continue with their normal asthma treatment in this investigation.

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(1 mark)

9 (e) (ii) Suggest why the patients were told to stop their normal asthma treatment 24 hours before their FEV_1 measurements were taken.

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(2 marks)

Do not write outside the box

9 (f) After 60 days, the patients in each group were asked to give themselves an *Improvement Score* from 0 – 10 to show how much they felt their symptoms had improved. This was done before their FEV_1 was measured. The scientists calculated the mean *Improvement Score* for each group.

9 (f) (i) The scientists concluded that the data obtained for the *Improvement Scores* were less reliable than the data obtained measuring FEV_1. Suggest why they concluded this.

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(2 marks)

9 (f) (ii) Group **3** reported the lowest mean *Improvement Score*. Suggest **one** explanation for this.

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(2 marks)

15

END OF QUESTIONS

There are no questions printed on this page

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General Certificate of Education (A-level)
January 2013

Biology BIOL2

(Specification 2410)

Unit 2: The Variety of Living Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>1(a)</td><td>
<table>
<tr><td>Statement</td><td>Starch</td><td>Cellulose</td><td>Glycogen</td></tr>
<tr><td>Found in plant cells</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Contains glycosidic bonds</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Contains β-glucose</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>3</td><td>One mark for each correct row</td></tr>
<tr><td>1(b)</td><td>Hydrolysis;</td><td>1</td><td>Accept: if phonetically correct

Do not accept: ‘hydration’</td></tr>
<tr><td>1(c)</td><td>1. Coiled / helical / spiral;
2. (So) compact / tightly packed / can fit (lots) into a small space;
3. Insoluble;
4. (So) no osmotic effect / does not leave cell / does not affect <u>water potential</u>;
5. Large molecule / long chain;
6. (So) does not leave cell / contains large number of glucose units;
7. Branched chains;
8. (So) easy to remove glucose;</td><td>2 max</td><td>Feature = one mark
Explanation = one mark

Note: these are independent marking points

These must be related for <u>both</u> marks but can be in reverse order

4. Accept: prevents osmosis

4. and 6. Accept: can’t cross membranes</td></tr>
<tr><td>1(d)</td><td>Two marks for correct answer of 479-521;;

One mark for incorrect answers in which candidate clearly divides measured length by actual length;</td><td>2</td><td>Accept: measured and actual lengths in different but correct units for 1 mark

The actual range is 23-25 mm, If they just divide this by 48 they gain 1 mark

Just writing the formula is insufficient, numbers must be used</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
2(a)(i)	Made of (different) tissues / more than one tissue;	1	
2(a)(ii)	1. (Muscle) contracts; 2. (Arteriole) narrows/constricts/reduces size of lumen/vessel / vasoconstriction;	2	Assume that 'they' or 'it' = muscle Ignore: references to pressure **Q** Correct context for muscle contracts, vessel constricts
2(b)(i)	Short diffusion distance/pathway;	1	Accept: thin diffusion pathway
2(b)(ii)	(More) time for exchange/diffusion (of substances);	1	Accept: example of more time for specific substance to be exchanged
2(c)	1. Water potential (in capillary) not as low/is higher/less negative / water potential gradient is reduced; 2. Less/no water removed (into capillary); 3. By osmosis (into capillary);	3	Accept: 'blood or plasma' instead of 'capillary' 2. Accept converse: water remains in the tissue 2. **Q** Marking points 2. and 3. must be in the context of movement into the capillary Neutral: reference to more tissue fluid being formed as in the question stem Neutral: reference to lymphatic drainage

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>3(a)</td><td><table>
<tr><td>Kingdom</td><td>Animalia</td></tr>
<tr><td>Phylum</td><td>Chordata</td></tr>
<tr><td>Class</td><td>Mammalia</td></tr>
<tr><td>Order</td><td>Carnivora</td></tr>
<tr><td>Family</td><td>Felidae</td></tr>
<tr><td>Genus</td><td>Panthera</td></tr>
<tr><td>Species</td><td>pardus</td></tr>
</table></td><td>2</td><td>One mark for each correct column
Do not award mark for last column if ‘<u>P</u>ardus’ is <u>clearly</u> stated
Accept: Panthera pardus in final box</td></tr>
<tr><td>3(b)</td><td>(For the leopard and cheetah)
1. More <u>hydrogen</u> bonds (form);
2. Similar DNA sequence(s) / similar base sequence(s) / more complementary bases / more base pairs;</td><td>2</td><td>Accept converse argument for leopard and puma
Neutral: similar DNA
2. Idea of ‘more’ must be clear</td></tr>
<tr><td>3(c)(i)</td><td>1. Drop in population / many killed / only single female left;
2. Idea of reduced/low genetic variation/diversity / reduction in (variety of) alleles / smaller gene pool;</td><td>2</td><td></td></tr>
<tr><td>3(c)(ii)</td><td>1. Mutation affecting sperm cell or production (in small population);
2. Errors during <u>meiosis;</u>
3. Inbreeding / closely related cheetahs breed;
4. High chance of inheriting allele / high frequency of allele (in the population);</td><td>2 max</td><td>4. Accept: high frequency of homozygous/two recessive alleles</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
4(a)	Variation / differences within the same/a species;	1	
4(b)(i)	1. Identical twins show genetic influence / differences between them show environmental influence; 2. Non-identical twins (also) show an environmental/non-genetic influence;	2	Neutral: allows a comparison It must be clear which set of twins is being referred to Do not credit repetition of bullet points in stem
4(b)(ii)	Genes play a greater role / environment plays a lesser role;	1	Must be comparative Neutral: genes are involved Neutral: involves genes and the environment
4(b)(iii)	Any suitable suggestion for a maximum of two marks e.g.: 1. Age; 2. Sex (non-identical twins); 3. Family/medical history (of mental illness); 4. No use of recreational drugs; 5. Ethnic origins;	2 max	Neutral: 'environment' as in question stem Neutral: unqualified ideas such as health / lifestyle

Question	Marking Guidance	Mark	Comments
5(a)	Open/use tap / add water from reservoir;	1	
5(b)	1. Seal joints / ensure airtight / ensure watertight; 2. Cut shoot under water; 3. Cut shoot at a slant; 4. Dry off leaves; 5. Insert into apparatus under water; 6. Ensure no air bubbles are present; 7. Shut tap; 8. Note where bubble is at start / move bubble to the start position;	2 max	Answer must refer to precautions when setting up the apparatus Ignore: references to keeping other factors constant
5(c)	1. Water used for support/turgidity; 2. Water used in photosynthesis; 3. Water produced in respiration; 4. Apparatus not sealed/'leaks';	2 max	Accept: water used in (the cell's) hydrolysis or condensation (reactions) for one mark. Allow a named example of these reactions
5(d)	As number of leaves are reduced (no mark), 1. Less surface area; 2. Fewer stomata; 3. Less evaporation/transpiration; 4. Less cohesion/tension/pulling (force);	3 max	Accept: converse arguments

Question	Marking Guidance	Mark	Comments
6(a)	1. Cell wall not formed / production inhibited; 2. Lower <u>water potential</u> in bacterium; 3. <u>Water enters</u> and causes lysis/expansion/pressure;	2 max	1. **Q** Accept: weakened cell wall, but do not accept 'cell wall is broken down' 2. Accept: converse 2. Must be clear that the lower water potential is in the bacterium
6(b)	Human cells lack enzyme (**B**)/have a different enzyme/produce different fatty acids/use different substrates;	1	Neutral: 'human cells do not have cell walls' as out of context
6(c)	1. Change in base sequence (of DNA/gene); 2. Change in amino acid sequence / primary structure (of enzyme); 3. Change in hydrogen/ionic/ disulphide bonds; 4. Change in the tertiary structure/active site (of enzyme); 5. Substrate not complementary/cannot bind (to enzyme / active site) / no enzyme-substrate complexes form;	3 max	2. Accept: different amino acids coded for 2. Reject: different amino acids produced 4. Neutral: alters 3D structure /3D shape
6(d)	1. Resistance gene/allele; 2. On plasmid; 3. (Spread by) horizontal transmission; 4. (Involves) conjugation/pilus;	3 max	1. **Q** Reject: if in the context of immunity Neutral: vertical transmission 3. Reject: if any reference to bacteria dividing by mitosis 4. **Q** Ignore: conjunction

Question	Marking Guidance	Mark	Comments
7(a)(i)	(We should maintain biodiversity to) Prevent extinction /loss of populations/ reduction in populations /loss of habitats / save organisms for future generations (idea of);	1	Neutral: references to 'playing God' / animal rights
7(a)(ii)	A suitable example of how some species may be important financially e.g. 1. medical / pharmaceutical uses; 2. commercial products / example given; 3. tourism; 4. agriculture; 5. saving local forest communities;	1 max	
7(b)	1. Fewer plant species / decrease in plant diversity; 2. Fewer habitats/nesting sites; 3. Fewer niches; 4. Fewer food sources/varieties; 5. Less protection from predators/ hunters/environment;	2 max	Accept: converse arguments for islands with a high percentage of forest remaining 1. Neutral: fewer plants 2. Neutral: fewer homes 4. Neutral: less food
7(c)	1. Number of (individuals/birds of) each species; 2. Total number of individuals/birds of all species;	2	1. Neutral: number of species 2. Accept: 'total number of birds' as given context for 'all species' in the investigation
7(d)	1. (Larger birds have) a low(er) SA:VOL; 2. (So) less heat loss / more heat retained;	2	Neutral: reference to fat / feathers MP2 is independent of MP1

Question	Marking Guidance	Mark	Comments
8(a)	1. Strands separate / H-bonds break; 2. DNA helicase (involved); 3. Both strands/each strand act(s) as (a) template(s); 4. (Free) nucleotides attach; 5. Complementary/specific base pairing / AT and GC; 6. DNA polymerase joins nucleotides (on new strand); 7. H-bonds reform; 8. Semi-conservative replication / new DNA molecules contain one old strand and one new strand;	6 max	1. **Q** Neutral: strands split 1. Accept: strands unzip 4. Neutral: bases attach 4. Accept: nucleotides attracted 6. Reject: if wrong function of DNA polymerase 8. Reject: if wrong context e.g. new DNA molecules contain half of each original strand
8(b)(i)	18;	1	Do not accept 17.5
8(b)(ii)	10;	1	
8(b)(iii)	1. Horizontal until 18 minutes; 2. (Then) decreases as straight line to 0 μm at 28 minutes;	2	Allow +/- one small box 2. Allow lines that start from the wrong place, ending at 0 at 28 minutes
8(c)(i)	Two marks for correct answer of 19.68 or 19.7;; One mark for incorrect answers in which candidate clearly multiplies by 0.82;	2	Accept 19hrs 41mins Allow one mark for incorrect answers that clearly show 82% of 24 (hours)
8(c)(ii)	1. No visible chromosomes/chromatids; 2. Visible nucleus;	1 max	
8(c)(iii)	**D** (no mark) 1. Lower % (of cells) in interphase / higher % (of cells) in mitosis/named stage of mitosis; 2. (So) more cells dividing / cells are dividing quicker;	2	1. Accept: 'less' or 'more' instead of '%' 1. Do not accept: higher % (of cells) in each/all stage(s) 2. Accept: uncontrolled cell division 2. Do not award if Tissue **C** is chosen

Question	Marking Guidance	Mark	Comments
9(a)	1. Random; 2. Method e.g. number generator / number out of a hat; ***OR*** 3. Matched / all the same; 4. For e.g. age / sex;	2 max	Random number generator = 2 marks Same age = 2 marks
9(b)	1. (Differences) are real/significant/not due to chance; 2. (As) bars/SDs do not overlap;	2	It = the difference 2. Accept: 'standard errors do not overlap' as told 'standard deviation' in the question stem
9(c)	1. No/slight (placebo) effect; 2. Group **2** and **3** results are similar/the same/ SDs/bars overlap;	2	2. Accept: other descriptions of Groups **2** and **3** 2. Accept: that Groups **2** and **3** are not significantly different
9(d)	1. (Allows) anomalies to be identified/ ignored/ effect of anomalies to be reduced / effect of variation in data to be minimised / concordant results; 2. (Makes) average/mean (more) reliable;	2	Accept: 'outliers' instead of anomalies 1. Reject: idea of not recording anomalies / preventing anomalies from occurring 1. Accept: 'cancels out anomalies' as bottom line response 2. **Q** Neutral: makes the average/mean more accurate 2. Ignore: 'more reliable' alone
9(e)(i)	1. Unethical/unfair not to treat patients; 2. Dangerous / could cause an asthma attack;	1 max	

9(e)(ii)	1. Ensures normal treatment does not affect results / improvements are only due to the spray; 2. (As) normal treatment is short-lived/ effective for less than 24 hours/ (24h) is long enough for normal treatment to wear off;	2	
9(f)(i)	1. (Improvement scores) are qualitative / subjective/rely on own judgement/ different patients may assess symptoms differently; 2. Some patients may lie/exaggerate/want to please doctors;	2	Accept: converse arguments for measuring FEV_1 e.g. quantitative/objective patients cannot lie 1. Neutral: empirical evidence
9(f)(ii)	1. Not blind / patients knew they were not receiving treatment/ patients did not receive treatment; 2. (So) more likely to underestimate/give lower scores / did not expect to improve / less improvement;	2	

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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7	
8	
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TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Biology BIOL2

Unit 2 The variety of living organisms

Monday 3 June 2013 9.00 am to 10.45 am

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

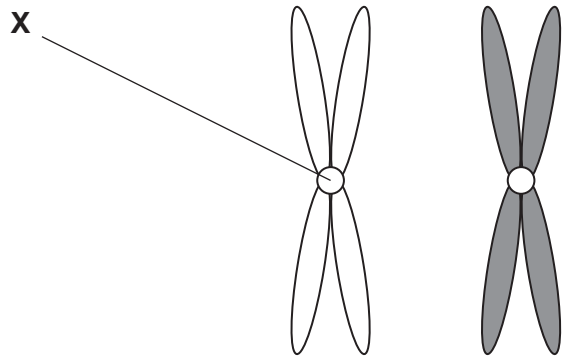
Information
- The maximum mark for this paper is 85.
- You are expected to use a calculator, where appropriate.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) **Figure 1** shows one pair of homologous chromosomes.

Figure 1



1 (a) (i) Name **X**.

.....

(1 mark)

1 (a) (ii) Describe the role of **X** in mitosis.

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(2 marks)

1 (a) (iii) Homologous chromosomes carry the same genes but they are **not** genetically identical. Explain why.

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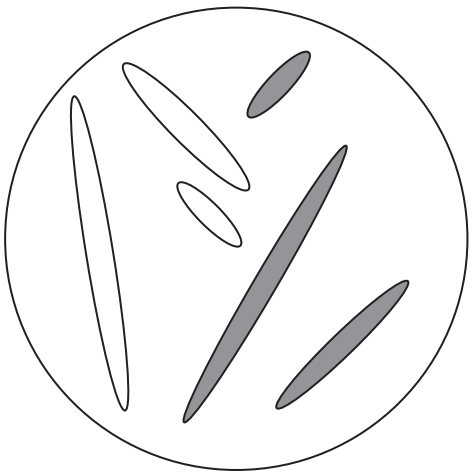
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(1 mark)

Do not write outside the box

1 (b) **Figure 2** shows three pairs of homologous chromosomes in a cell at the end of cell division.

Figure 2



1 (b) (i) The appearance of each chromosome in **Figure 2** is different from those shown in **Figure 1**. Explain why.

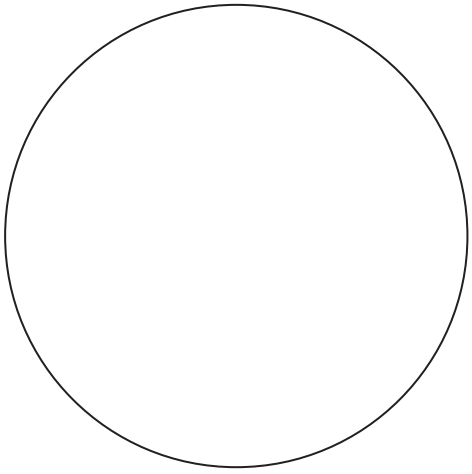
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(1 mark)

1 (b) (ii) Complete the diagram to show the chromosomes in one cell that could be produced from the cell in **Figure 2** as a result of meiosis.



(2 marks)

1 (b) (iii) Other than independent segregation, give **one** way in which meiosis allows the production of genetically different cells.

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(1 mark)

8

Turn over ▶

Do not write outside the box

2 (a) What is a *species*?

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(2 marks)

2 (b) Scientists investigated the diversity of plants in a small area within a forest. The table shows their results.

Plant species	Number of individuals
Himalayan raspberry	20
Heartwing sorrel	15
Shala tree	9
Tussock grass	10
Red cedar	4
Asan tree	6
Spanish needle	8
Feverfew	8

The index of diversity can be calculated by the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

Do not write outside the box

2 (b) (i) Use the formula to calculate the index of diversity of plants in the forest. Show your working.

Answer .....

(2 marks)

2 (b) (ii) The forest was cleared to make more land available for agriculture.

After the forest was cleared the species diversity of insects in the area decreased. Explain why.

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(3 marks)

(Extra space) .....

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7

Do not write outside the box

3 Organisms can be classified using a hierarchy of phylogenetic groups.

3 (a) Explain what is meant by:

3 (a) (i) a hierarchy

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(2 marks)

3 (a) (ii) a phylogenetic group.

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(1 mark)

3 (b) Cytochrome c is a protein involved in respiration. Scientists determined the amino acid sequence of human cytochrome c. They then:

- determined the amino acid sequences in cytochrome c from five other animals
- compared these amino acid sequences with that of human cytochrome c
- recorded the number of differences in the amino acid sequence compared with human cytochrome c.

The table shows their results.

Animal	Number of differences in the amino acid sequence compared with human cytochrome c
A	1
B	12
C	12
D	15
E	21

Do not write outside the box

3 (b) (i) Explain how these results suggest that animal **A** is the most closely related to humans.

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(2 marks)

3 (b) (ii) A student who looked at these results concluded that animals **B** and **C** are more closely related to each other than to any of the other animals.

Suggest **one** reason why this might **not** be a valid conclusion.

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(1 mark)

3 (b) (iii) Cytochrome c is more useful than haemoglobin for studying how closely related different organisms are. Suggest **one** reason why.

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(1 mark)

7

Turn over for the next question

Do not write outside the box

4 (a) DNA helicase is important in DNA replication. Explain why.

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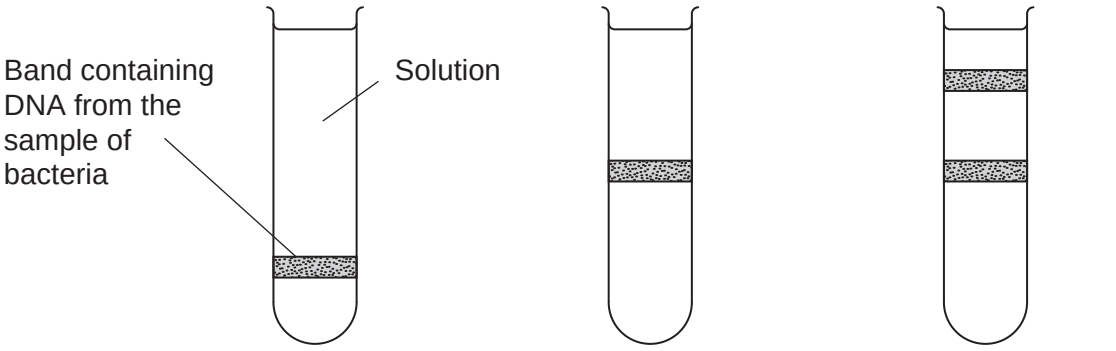
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(2 marks)

Scientists investigating DNA replication grew bacteria for several generations in a nutrient solution containing a heavy form of nitrogen (^{15}N). They obtained DNA from a sample of these bacteria.

The scientists then transferred the bacteria to a nutrient solution containing a light form of nitrogen (^{14}N). The bacteria were allowed to grow and divide twice. After each division, DNA was obtained from a sample of bacteria.

The DNA from each sample of bacteria was suspended in a solution in separate tubes. These were spun in a centrifuge at the same speed and for the same time. The diagram shows the scientists' results.



Sample **1**	Sample **2**	Sample **3**
Bacteria grown for several generations in a nutrient solution containing ^{15}N	Bacteria grown in a nutrient solution containing ^{14}N for one cell division	Bacteria grown in a nutrient solution containing ^{14}N for two cell divisions

Do not write outside the box

4 (b) The table shows the types of DNA molecule that could be present in samples **1** to **3**. Use your knowledge of semi-conservative replication to complete the table with a tick if the DNA molecule is present in the sample.

	Type(s) of DNA molecule present in each sample		
Sample	^{15}N ^{15}N 	^{15}N ^{14}N 	^{14}N ^{14}N 
1			
2			
3			

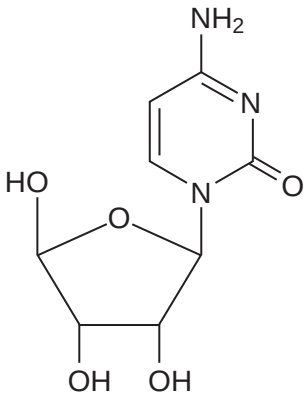
(3 marks)

Question 4 continues on the next page

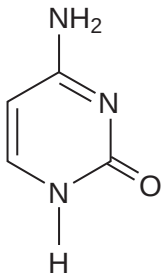
Do not write outside the box

4 (c) Cytarabine is a drug used to treat certain cancers. It prevents DNA replication. The diagram shows the structures of cytarabine and the DNA base cytosine.

cytarabine



cytosine



4 (c) (i) Use information in the diagram to suggest how cytarabine prevents DNA replication.

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(2 marks)

4 (c) (ii) Cytarabine has a greater effect on cancer cells than on healthy cells. Explain why.

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(1 mark)

8

Do not write outside the box

5 (a) (i) Give **one** way in which antibiotics can prevent the growth of bacteria.

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(1 mark)

5 (a) (ii) Describe how bacteria can become resistant to antibiotics by *vertical* gene transmission.

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(1 mark)

Question 5 continues on the next page

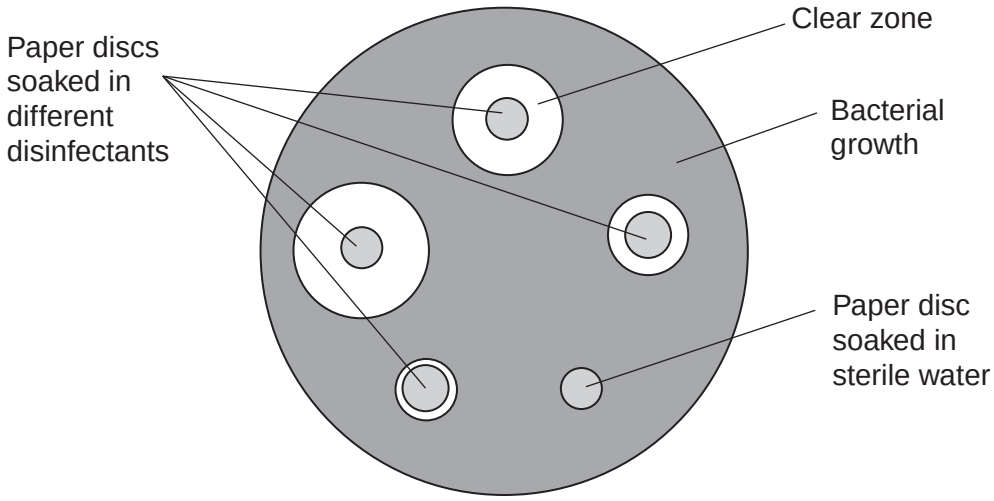
Do not write outside the box

Pseudomonas aeruginosa is a bacterium that can cause infections in hospital patients suffering from burns. Disinfectants are substances used to kill bacteria on non-living objects, such as medical equipment. Doctors in one hospital investigated how effective four disinfectants were at killing *P. aeruginosa*.

The doctors:

- took samples from many patients in the hospital
- isolated *P. aeruginosa* from those samples
- suspended the *P. aeruginosa* in a solution
- spread many samples of this solution on nutrient jelly in many Petri dishes.

The doctors then placed five small paper discs on the jelly in each dish. Each disc had been soaked in a different disinfectant or sterile water. The doctors left the plates for 24 hours to allow bacteria to grow and divide. The diagram shows a typical Petri dish after 24 hours.



5 (b) The doctors used samples of this bacterium taken from many patients in the hospital. Explain why this was important.

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(1 mark)

Do not write outside the box

After 24 hours, the doctors measured the diameter of any clear zones around each paper disc. They then calculated the mean diameter of the clear zone for each disinfectant. The table shows their results.

Disinfectant	Mean diameter of clear zone / mm (± standard deviation)
Chlorhexidine	22.8 ± 3.9
Cetrimide-C	9.1 ± 2.6
Hypochlorite	26.9 ± 5.2
Micro 10	6.6 ± 1.5

5 (c) Do these data support the conclusion that hypochlorite was the most effective at killing this bacterium? Explain your answer.

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(3 marks)

(Extra space) .....

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5 (d) Doctors in a different hospital repeated this investigation. They found that hypochlorite had little effect on samples of *P. aeruginosa* they obtained. Suggest how this different result may have arisen.

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(2 marks)

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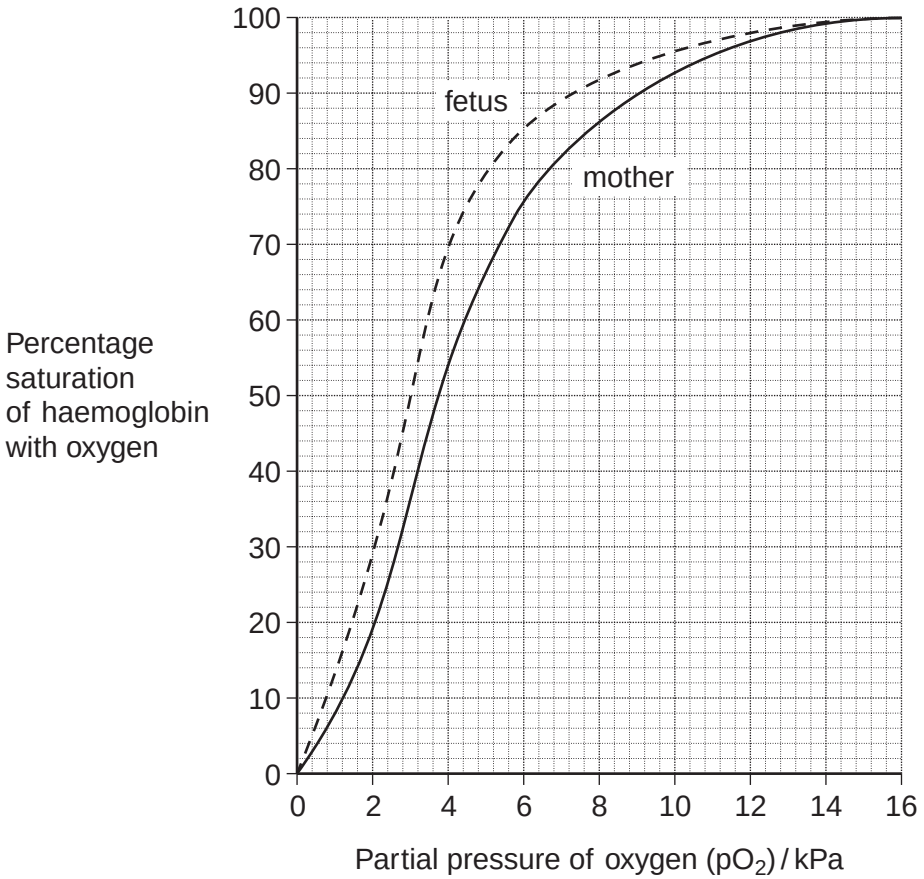
Do not write outside the box

6 (a) The table shows three statements about some biological molecules. Complete the table with a tick in each box if the statement is true for haemoglobin, cellulose or starch.

Statement	Haemoglobin	Cellulose	Starch
Has a quaternary structure			
Formed by condensation reactions			
Contains nitrogen			

(3 marks)

The graph shows oxygen dissociation curves for the haemoglobin of a mother and her fetus.



Do not write outside the box

6 (b) What is the difference in percentage saturation between the haemoglobin of the mother and her fetus at a partial pressure of oxygen (pO_2) of 4 kPa?

(1 mark)

6 (c) The oxygen dissociation curve of the fetus is to the left of that for its mother. Explain the advantage of this for the fetus.

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(2 marks)

6 (d) After birth, fetal haemoglobin is replaced with adult haemoglobin. Use the graph to suggest the advantage of this to the baby.

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(2 marks)

6 (e) Hereditary persistence of fetal haemoglobin (HPFH) is a condition in which production of fetal haemoglobin continues into adulthood. Adult haemoglobin is also produced.

People with HPFH do not usually show symptoms. Suggest why.

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(1 mark)

9

Do not write outside the box

7 The Amish are a group of people who live in America. This group was founded by 30 Swiss people, who moved to America many years ago. The Amish do not usually marry people from outside their own group.

One of the 30 Swiss founders had a genetic disorder called Ellis-van Creveld syndrome. People with this disorder have heart defects, are short and have extra fingers and toes. Ellis-van Creveld syndrome is caused by a faulty allele.

In America today, about 1 in 200 Amish people are born with Ellis-van Creveld syndrome. This disorder is very rare in people in America who are not Amish.

7 (a) Use the information provided and your knowledge of the founder effect to explain why Ellis-van Creveld syndrome occurs at a higher frequency in the Amish population than in people in America who are not Amish.

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(3 marks)

(Extra space) .....

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Do not write outside the box

7 (b) In America today, there are approximately 1250 Amish people who have Ellis-van Creveld syndrome. Use the information provided to calculate the current Amish population of America.

Amish population .....

(1 mark)

7 (c) The faulty allele that causes Ellis-van Creveld syndrome is the result of a mutation of a gene called *EVC*. This mutation leads to the production of a protein that has one amino acid missing.

7 (c) (i) Suggest how a mutation can lead to the production of a protein that has one amino acid missing.

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(2 marks)

7 (c) (ii) Suggest how the production of a protein with one amino acid missing may lead to a genetic disorder such as Ellis-van Creveld syndrome.

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(2 marks)

8

Do not write outside the box

8 (a) Explain how water enters xylem from the endodermis in the root and is then transported to the leaves.

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(6 marks)

(Extra space) .....

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Do not write outside the box

Large insects contract muscles associated with the abdomen to force air in and out of the spiracles. This is known as 'abdominal pumping'. The table shows the mean rate of abdominal pumping of an insect before and during flight.

Stage of flight	Mean rate of abdominal pumping / dm^3 of air kg^{-1} $hour^{-1}$
Before	42
During	186

8 (b) Calculate the percentage increase in the rate of abdominal pumping before and during flight. Show your working.

Answer ..... %

(2 marks)

8 (c) Abdominal pumping increases the efficiency of gas exchange between the tracheoles and muscle tissue of the insect. Explain why.

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(2 marks)

8 (d) Abdominal pumping is an adaptation not found in many small insects. These small insects obtain sufficient oxygen by diffusion.

Explain how their small size enables gas exchange to be efficient without the need for abdominal pumping.

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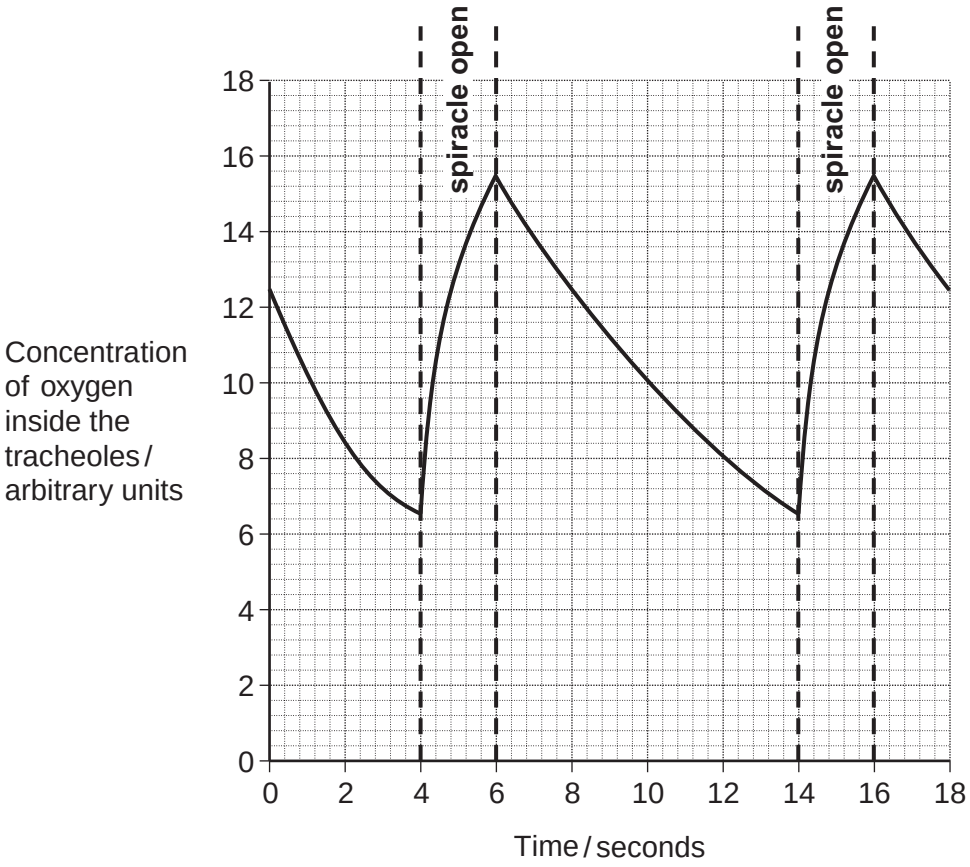
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(1 mark)

Question 8 continues on the next page

Do not write outside the box

The graph shows the concentration of oxygen inside the tracheoles of an insect when at rest. It also shows when the spiracles are fully open.



8 (e) Use the graph to calculate the frequency of spiracle opening. Show your working.

Frequency ..... times per minute
(2 marks)

8 (f) The insect opens its spiracles at a lower frequency in very dry conditions.
Suggest **one** advantage of this.

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(1 mark)

Do not write outside the box

8 (g) The ends of tracheoles connect directly with the insect's muscle tissue and are filled with water. When flying, water is absorbed into the muscle tissue. Removal of water from the tracheoles increases the rate of diffusion of oxygen between the tracheoles and muscle tissue. Suggest **one** reason why.

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(1 mark)

15

Turn over for the next question

Do not write outside the box

9 Snakes are predators that lay eggs. Scientists investigated courtship behaviour in male garter snakes in response to:

- the body length of the female
- lipids secreted on the skin of the female.

For each trial, the scientists selected 10 male snakes at random. They placed the snakes into a large cage. The scientists then placed one of the following into the cage with the male snakes:

1. a short female snake
2. a long female snake
3. a piece of filter paper containing lipids from the skins of short females
4. a piece of filter paper containing lipids from the skins of long females.

After 5 minutes, the scientists recorded how many males were showing courtship behaviour. Each trial was repeated several times using different male and female snakes.

9 (a) Apart from the size of the female, suggest **two** factors that should have been kept constant in order to obtain reliable results.

1 .....

2 .....

(2 marks)

9 (b) The male snakes used for each trial were selected at random. Explain why this was important.

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(1 mark)

9 (c) The scientists used different male snakes in each trial. Suggest why.

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(1 mark)

9 (d) What should the scientists have placed in the cage as a control, to show that males were responding to lipids from females?

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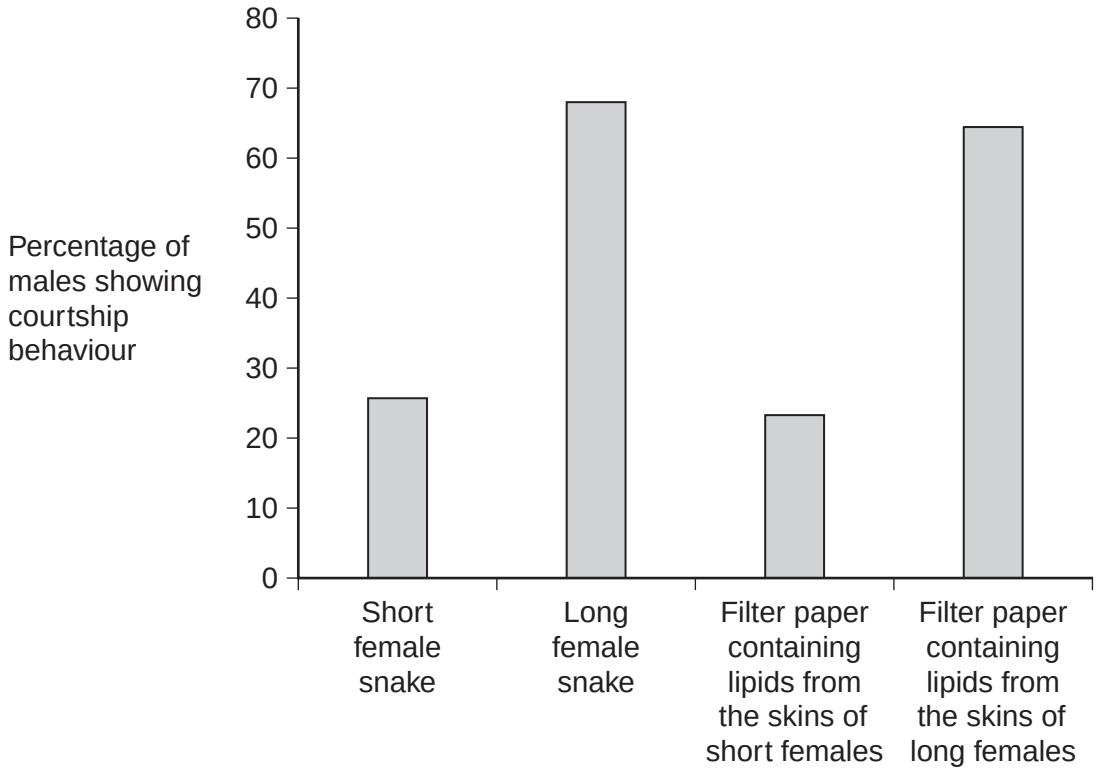
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(1 mark)

Do not write outside the box

Figure 3 shows the scientists' results.

Figure 3



9 (e) The scientists concluded that male snakes showed more courtship behaviour towards long female snakes and to lipids from the skins of long females.

Explain **one** other conclusion that can be made from the data.

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(2 marks)

Question 9 continues on the next page

Do not write outside the box

9 (f) Suggest **two** advantages of male snakes courting with longer females.

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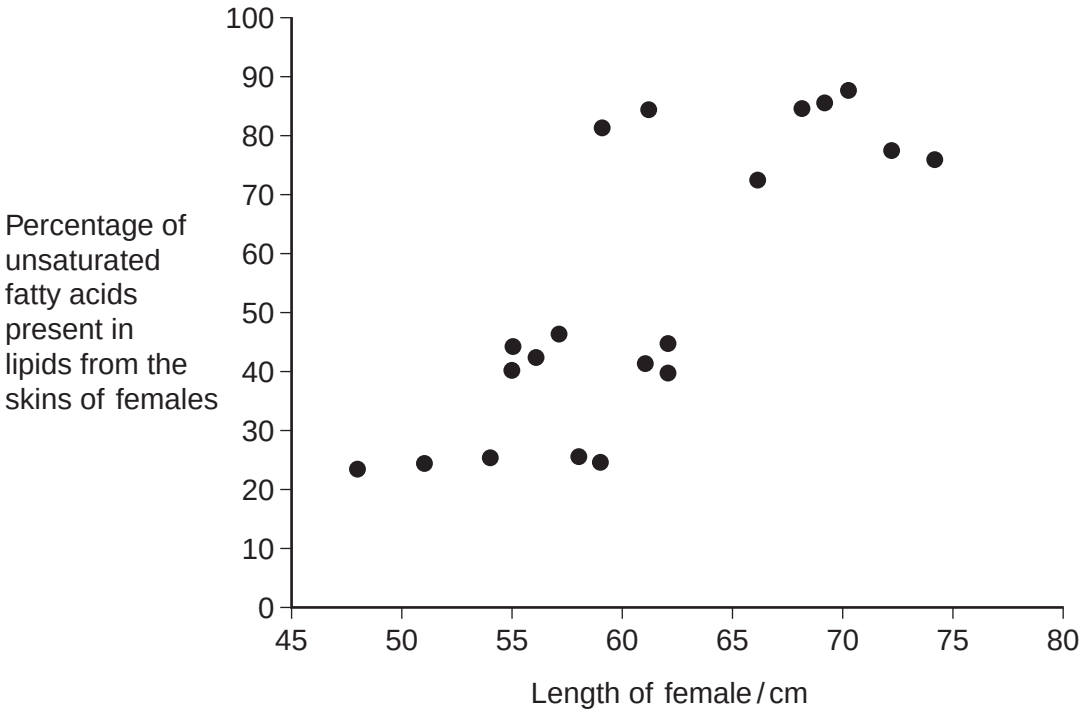
2. .....

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(2 marks)

The scientists analysed the lipids produced on the skins of females of different lengths. They found the percentage of unsaturated fatty acids present in the lipids. Their results are shown in **Figure 4**.

Figure 4



9 (g) Use **Figure 3** and **Figure 4** to suggest why male garter snakes show greater courtship behaviour to longer female snakes.

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(2 marks)

Do not write outside the box

9 (h) Describe how **Figure 4** could be used to predict the percentage of unsaturated fatty acids produced by female garter snakes of body length greater than 75 cm.

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(2 marks)

9 (i) Using **Figure 4** to predict the percentage of unsaturated fatty acids produced by female garter snakes of body length greater than 75 cm might not give a true value.
Suggest why.

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(1 mark)

9 (j) The females of other species of snake secrete lipids on their skin. These lipids also contain unsaturated fatty acids. Male garter snakes do not show courtship behaviour towards these females. Suggest why.

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(1 mark)

15

END OF QUESTIONS

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General Certificate of Education (A-level)
June 2013

Biology BIOL2

(Specification 2410)

Unit 2: The Variety of Living Organisms

Final

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Question	Marking Guidance	Mark	Comments
1(a)(i)	Centromere;	1	Accept: if phonetically correct Reject: centriole
1(a)(ii)	1. Holds chromatids together; 2. Attaches (chromatids) to spindle; 3. (Allows) chromatids to be separated/move to (opposite) poles / (centromere) divides/splits at metaphase/ anaphase;	2 max	3. **Q** Neutral: chromosomes or chromatids split/halved/divided 3. Reject: reference to homologous chromosomes being separated Accept 'chromosomes' instead of 'chromatids' Ignore incorrect names for **X**
1(a)(iii)	(Homologous chromosomes) carry different alleles;	1	Accept alternative descriptions for 'alleles' eg different forms of a gene / different base sequences Neutral: reference to maternal and paternal chromosomes
1(b)(i)	(In **Figure 2**) 1. Chromatids have separated (during anaphase); 2. Chromatids have not replicated; 3. Chromosomes formed from only one chromatid;	1 max	1. **Q** Neutral: split/halved/divided 1. Reject: reference to homologous chromosomes being separated 1. & 2. Accept 'chromosomes' instead of 'chromatids' Accept converse arguments for **Figure 1** Ignore references to the *cell* not dividing as in the question stem Ignore: named phases
1(b)(ii)	1. Three chromosomes; 2. One from each homologous pair;	2	Ignore shading Only one mark for three chromosomes shown as pairs of chromatids

1(b)(iii)	Crossing over / alleles exchanged between chromosomes or chromatids / chiasmata formation / genetic recombination;	1	Accept: description of crossing over eg sections of chromatids break and rejoin Neutral: random fertilisation Reject: reference to sister chromatids **Q** Neutral: genes exchanged Neutral: mutation

Question	Marking Guidance	Mark	Comments
2(a)	1. Group of similar organisms / organisms with similar features / / organisms with same genes/chromosomes; 2. Reproduce / produce offspring; 3. That are fertile;	2 max	1. Accept: same number of chromosomes 1. Accept: smallest taxonomic group 1. Reject: genetically identical. Only allow 1 max if mentioned 1. **Q** Neutral: similar genes/chromosomes 2. Accept: breed/mate 3. Neutral: that are 'viable' 'Produce fertile offspring' = 2 marks
2(b)(i)	Correct answer of 6.97 to 7 = 2 marks; One mark for 6320 as numerator or 906 as denominator;	2	
2(b)(ii)	1. Decrease in variety of plants / fewer plant species; 2. Fewer habitats/niches; 3. Decrease in variety of food / fewer food sources; 4. Aspect of clearing forest (killing insects) eg machinery, pesticides;	3 max	1. Accept: reference to monoculture or description 1. Neutral: fewer plants 2. Neutral: fewer homes/less shelter 3. Neutral: less food 3. Accept: less variety of prey 4. Neutral: clearing forest unqualified

Question	Marking Guidance	Mark	Comments
3(a)(i)	1. Groups within groups; 2. No overlap (between groups);	2	1. Accept: idea of larger groups at the top / smaller groups at the bottom
3(a)(ii)	(Grouped according to) evolutionary links/history/relationships / common ancestry;	1	Neutral: closely related Neutral: genetically similar
3(b)(i)	1. (Only) one amino acid different / least differences / similar amino acid sequence / similar primary structure; 2. (So) similar DNA sequence/ base sequence;	2	
3(b)(ii)	1. Compared with humans / not compared with each other; 2. Differences may be at different positions / different amino acids affected / does not show where the differences are (in the sequence);	1 max	Accept: degenerate code / more than one triplet (codes) for an amino acid
3(b)(iii)	1. All organisms respire/have cytochrome c; 2. (Cytochrome c structure) is more conserved / less varied (between organisms);	1 max	Accept: converse arguments for haemoglobin 1. Accept 'more' instead of 'all' 1. Accept 'animals' instead of organisms' 2. Neutral: cytochrome c is conserved

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>4(a)</td><td>1. Separates/unwinds/unzips strands/helix / breaks H-bonds;
2. (So) nucleotides can attach/are attracted / strands can act as templates;</td><td>2</td><td>1. Q Neutral: strands/helix split
1. Accept: unzips bases
2. Q Neutral: bases can attach
2. Neutral: helix can act as a template</td></tr>
<tr><td>4(b)</td><td><table><tr><td rowspan="2">Sample</td><td colspan="3">Type(s) of DNA molecule present in each tube</td></tr><tr><td>$^{15}N/^{15}N$</td><td>$^{15}N/^{14}N$</td><td>$^{14}N/^{14}N$</td></tr><tr><td>1</td><td>✓</td><td></td><td></td></tr><tr><td>2</td><td></td><td>✓</td><td></td></tr><tr><td>3</td><td></td><td>✓</td><td>✓</td></tr></table></td><td>3</td><td>One mark for each correct row</td></tr>
<tr><td>4(c)(i)</td><td>1. Similar shape/structure (to cytosine) / added instead of cytosine / binds to guanine;
2. Prevents (complementary) base pairing / prevents H-bonds forming / prevents formation of new strand / prevents strand elongation / inhibits/binds to (DNA) polymerase;</td><td>2</td><td>1. Accept: idea that only one group is different
1. Reject: same shape
2. Accept: prevents cytosine binding
Neutral: ‘prevents DNA replication’ as given in the question stem
Neutral: ‘competitive inhibitor’ unqualified
Neutral: inhibits DNA helicase</td></tr>
<tr><td>4(c)(ii)</td><td>(Cancer cells/DNA) divide/replicate fast(er)/ uncontrollably;</td><td>1</td><td>Accept: converse argument for healthy cells</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
5(a)(i)	Prevent cell wall formation / cause (cell) lysis / inhibit ribosomes / inhibit protein synthesis / prevent DNA replication / affect function of cell membrane;	1 max	Accept: weaken the cell wall Neutral: damage/break down the cell wall **Q** Reject: if in context of a cellulose cell wall Accept: bind to ribosomes
5(a)(ii)	(Plasmid/genes transmitted through) cell division/reproduction/replication/generations;	1	Accept: multiply Accept: binary fission Reject: within generations Reject: reference to horizontal gene transmission Reject: mitosis Ignore reference to immunity
5(b)	Representative/typical/reliable / different types of bacteria;	1	Neutral: accurate Neutral: reference to anomalies **Q**: Neutral: different strands of bacteria
5(c)	(Yes) 1. Largest clear zone/diameter/mean (so more bacteria killed); (No) 2. Standard deviations of chlorhexidene overlap/share values; 3. (Overlap means difference) is not significant / is due to chance;	3	Ignore references to methodology 2. Neutral: diameters overlap/share values 3. Can still be awarded if SD overlap or non-overlap is correctly interpreted 3. Accept: (difference) is not real/not reliable 3. Neutral: spread is not reliable
5(d)	1. Mutation (in bacterium); 2. Gene/allele for resistance;	2	1. Neutral: different strains 2. Reject: if in the context of 'immunity' 2. Accept: resistant gene/allele

<table>
<tr><th>Question</th><th>Marking Guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>6(a)</td><td>
<table>
<tr><th>Statement</th><th>Haemo-globin</th><th>Cellulose</th><th>Starch</th></tr>
<tr><td>Has a quaternary structure</td><td>✓</td><td></td><td></td></tr>
<tr><td>Formed by condensation reactions</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Contains nitrogen</td><td>✓</td><td></td><td></td></tr>
</table>
</td><td>3</td><td>One mark for each correct row</td></tr>
<tr><td>6(b)</td><td>16;</td><td>1</td><td></td></tr>
<tr><td>6(c)</td><td>1. Higher affinity / loads more oxygen;
2. At low/same/high partial pressure/pO_2;
3. Oxygen moves from mother/to fetus;</td><td>2 max</td><td></td></tr>
<tr><td>6(d)</td><td>1. Low affinity / oxygen dissociates;
2. (Oxygen) to respiring tissues/muscles/cells;</td><td>2</td><td>Assume ‘it’ is adult haemoglobin
1. Accept: converse if ‘fetal haemoglobin’ is clearly stated
2. Q: Neutral ‘respirate’</td></tr>
<tr><td>6(e)</td><td>Enough adult Hb produced / enough oxygen released / idea that curves/affinities/Hb are similar / more red blood cells produced;</td><td>1</td><td>Neutral: ‘adult Hb is also produced’ as in the question stem
Reject: curves/affinities/Hb are the same</td></tr>
</table>

Question	Marking Guidance	Mark	Comments
7(a)	1. Population formed by a small number of founders/people /30 people; 2. (Founders show) less genetic diversity / small(er) gene pool / less variety of alleles; 3. Individuals breed within group / do not breed with outsiders; 4. High(er) chance of inheriting <u>allele</u> (than in non-Amish population);	3 max	Accept: converse arguments for the non-Amish population 2. **Q** Neutral: fewer alleles 3. Accept: inbreeding for 'individuals breed within group' 3. Accept: do not interbreed 3. **Q** Reject: interbreeding for 'individuals breed within group' 4. Do not award for 'allele passed on' only
7(b)	250 000;	1	
7(c)(i)	Loss of 3 bases/triplet = 2 marks;; Loss of base(s) = 1 mark;	2	'Stop codon/code formed' = 1 mark max unless related to the last amino acid eg triplet for last amino acid is changed to a stop codon/code = 2 marks 3 bases/triplet forms an intron = 2 marks Accept: descriptions for 'intron' eg non-coding DNA 'Loss of codon' = 2 marks
7(c)(ii)	1. Change in tertiary structure/ active site; 2. (So) faulty/non-functional protein /enzyme;	2	Neutral: change in 3D shape/ structure Accept: reference to examples of loss of function eg fewer E-S complexes formed

Question	Marking Guidance	Mark	Comments
8(a)	(In the root) 1. Casparian strip blocks apoplast pathway / only allows symplast pathway; 2. Active transport by <u>endodermis</u>; 3. (Of) ions/salts into xylem; 4. Lower water potential in xylem / water enters xylem by osmosis /down a water potential gradient; (Xylem to leaf) 5. Evaporation / transpiration (from leaves); 6. (Creates) cohesion / tension / H-bonding between water molecules / negative pressure; 7. Adhesion / water molecules bind to xylem; 8. (Creates continuous) water column;	6 max	Assume all points are in the correct location unless context suggests otherwise 4. **Q** Neutral: 'along' a water potential gradient 'Transpiration pull' = 2 marks (5. & 6.) 6. Accept 'pulling' 6. **Q** Neutral: 'suction'
8(b)	Correct answer of 342.8-343 = 2 marks;; Credit incorrect answers that show the numerator as 144 (or 186-42) or denominator as 42 for 1 mark;	2	
8(c)	1. More air/oxygen enters / air/oxygen enters quickly/quicker; 2. (So) maintains/greater diffusion or concentration <u>gradient</u>;	2	1. Accept: converse for carbon dioxide 1. Can be in any correct context eg insect, tracheoles, muscle 1. Neutral: air/oxygen enters
8(d)	Large(r) SA:VOL / short(er) <u>diffusion</u> distance (to tissues);	1	Accept: thin diffusion pathway
8(e)	6 / 6.6 / 6.7 / 7 / 7.5 / 8 = 2 marks;; Award 1 mark for incorrect answers that have divided 60 by any number;	2	Different answers given for different interpretations of the graph

8(f)	Less/no water lost / (more) water retained;	1	Accept: less dehydration / less evaporation **Q** Reject: less 'transpiration' **Q** Reject: less water lost by osmosis

8(g)	1. Greater <u>surface area</u> exposed to air; 2. Gases move/diffuse faster in air than through water; 3. Increases volume/amount of air;	1 max	Neutral: shorter diffusion distance 2. **Q** Neutral: 'harder to diffuse' 2. Accept gases diffuse directly, rather than through water

Question	Marking Guidance	Mark	Comments
9(a)	Any two suitable suggestions eg 1. Volume/concentration of skin lipid; 2. Age/sexual maturity; 3. Species of snake; 4. Size of male; 5. Colour; 6. Temperature; 7. Light; 8. Time of day/year/breeding season; 9. Duration/length of time observing; 10. Diet; 11. Filter paper; 12. Size of cage;	2 max	1. Accept: amount Neutral: environment / health / body mass / number of snakes
9(b)	To avoid bias;	1	
9(c)	1. To avoid change in (courtship) behaviour (due to past experience); 2. To observe a typical/general/representative (response);	1 max	Accept: ethical arguments eg causing distress to snakes Neutral: reference to anomalous results
9(d)	Filter paper without (skin) lipids / untreated filter paper / filter paper with water / (female) snakes with lipids removed;	1	Accept: filter paper qualified eg *only* filter paper Neutral: reference to using male snakes/lipids from male snakes
9(e)	1. Similar response to lipids and (whole) snakes; 2. (So males are) responding to lipids; 3. (So males are) not responding to (whole) snakes/visual clues;	2 max	Neutral: greater response to long snakes and lipids from long snakes as in the question stem

9(f)	(Parent/offspring) 1. Produce more/larger offspring/eggs; 2. Better predators / fitter / more successful at gaining food / less likely to be eaten / more able to protect offspring/eggs; 3. (More) sexually mature / fertile; 4. Have more food stores for offspring/eggs;	2 max	3. Neutral: mature
9(g)	1. (Males) respond to/sense (unsaturated) <u>fatty acids</u>; 2. (Long females) produce/have more fatty acids / positive correlation;	2	1. Reference to courtship behaviour on its own is not sufficient Reference to 'lipids/fats' is neutral for both mark points. However, if fatty acids are mentioned for either mark point, accept lipids/fats = fatty acids for the other mark point
9(h)	1. Draw a line of best fit; 2. Extrapolation / extend line;	2	
9(i)	Results vary for a particular body size/% / values overlap / small sample size / idea of reaching maximum/100%/ a plateau;	1	Neutral: reference to inaccurate line of best fit Neutral: 'results vary'
9(j)	(Other females/species) produce different fatty acids;	1	Must refer to fatty acids rather than just 'lipids/fats' Accept: lack of receptors

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2012

Biology BIOL2

Unit 2 The variety of living organisms

Wednesday 18 January 2012 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

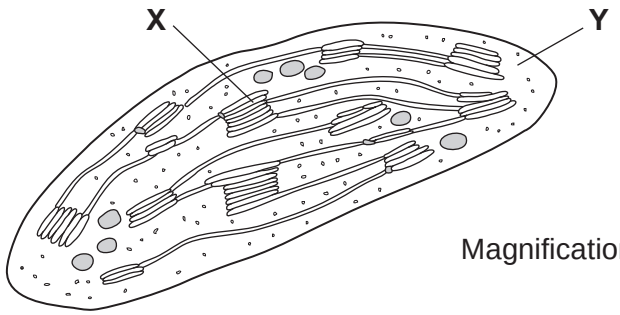
Question 1 starts on the next page

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Answer **all** questions in the space provided.

1 The diagram shows a chloroplast as seen with an electron microscope.



Magnification × 30 000

1 (a) Name **X** and **Y**.

X .....

Y .....

(2 marks)

1 (b) Describe the function of a chloroplast.

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(2 marks)

1 (c) Calculate the maximum length of this chloroplast in micrometres (µm). Show your working.

Answer ..... µm

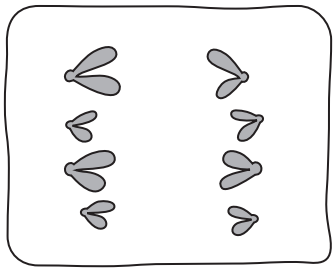
(2 marks)

6

Turn over ▶

Do not write outside the box

2 (a) The diagram shows a stage of mitosis in an animal cell.



2 (a) (i) Name this stage.

.....

(1 mark)

2 (a) (ii) Describe what happens during this stage that results in the production of two genetically identical cells.

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(2 marks)

2 (b) A sample of epithelial tissue from the small intestine of an animal was analysed. Some of the cells had 8.4 units of DNA, others had only 4.2 units.

2 (b) (i) Use your knowledge of the cell cycle to explain why some cells had 8.4 units of DNA and others had only 4.2 units.

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(2 marks)

Do not write outside the box

2 (b) (ii) How many units of DNA would you expect to be present in a gamete formed in this animal as a result of meiosis?

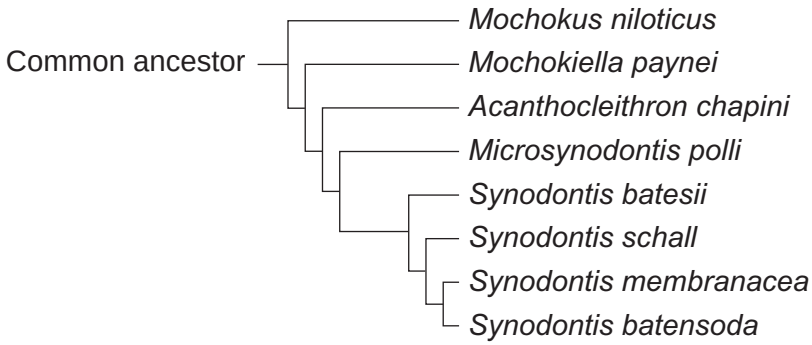
(1 mark)

6

Turn over for the next question

Do not write outside the box

3 There are over 200 species of catfish. All catfish evolved from a common ancestor. The diagram shows how some species of catfish are classified. This diagram is based on the evolutionary links between these species.



3 (a) (i) Which species of catfish is most closely related to *Synodontis membranacea*?

.....

(1 mark)

3 (a) (ii) Which species of catfish is most distantly related to *Synodontis membranacea*?

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(1 mark)

3 (b) How many different genera are shown in this diagram?

(1 mark)

Do not write outside the box

3 (c) (i) A scientist carried out breeding experiments with catfish from different populations. Describe how the results could show that the catfish belong to the same species.

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(1 mark)

3 (c) (ii) The variety of colours displayed by catfish is important in courtship. Give **two** ways in which courtship increases the probability of successful mating.

1 .....

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2 .....

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(2 marks)

6

Turn over for the next question

Do not write outside the box

4 Phenylketonuria is a disease caused by mutations of the gene coding for the enzyme PAH. The table shows part of the DNA base sequence coding for PAH. It also shows a mutation of this sequence which leads to the production of non-functioning PAH.

DNA base sequence coding for PAH	C	A	G	T	T	C	G	C	T	A	C	G
DNA base sequence coding for non-functioning PAH	C	A	G	T	T	C	C	C	T	A	C	G

4 (a) (i) What is the maximum number of amino acids for which this base sequence could code?

(1 mark)

4 (a) (ii) Explain how this mutation leads to the formation of non-functioning PAH.

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(3 marks)

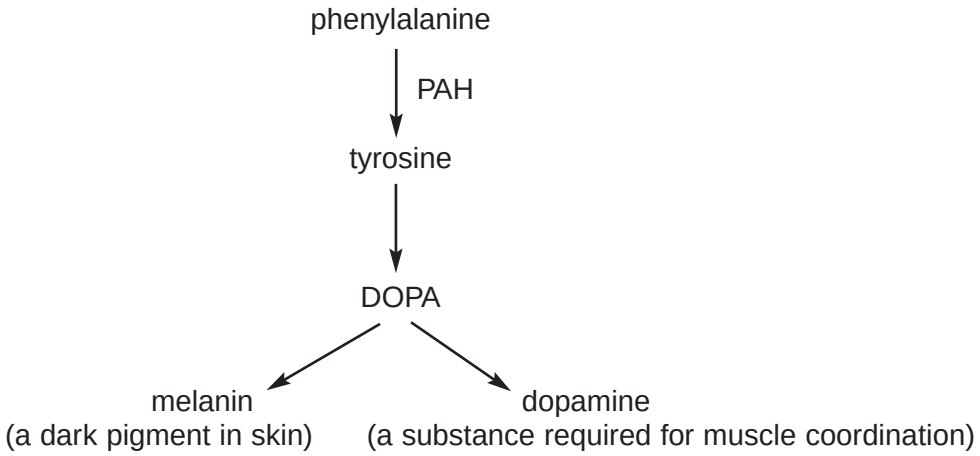
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PAH catalyses a reaction at the start of two enzyme-controlled pathways. The diagram shows these pathways.



4 (b) Use the information in the diagram to give **two** symptoms you might expect to be visible in a person who produces non-functioning PAH.

1 .....

2 .....

(2 marks)

4 (c) One mutation causing phenylketonuria was originally only found in one population in central Asia. It is now found in many different populations across Asia. Suggest how the spread of this mutation may have occurred.

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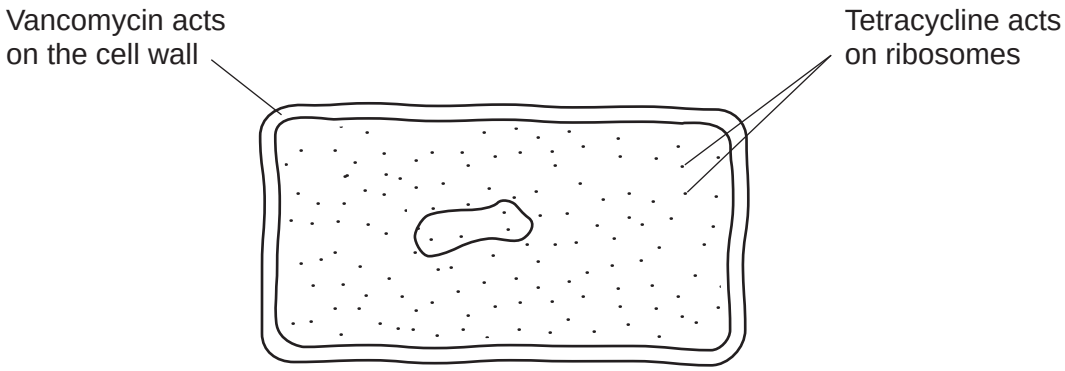
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(1 mark)

7

Do not write outside the box

5 The diagram shows the structure of a bacterium and the sites of action of two antibiotics.



5 (a) (i) Use information in the diagram to explain why vancomycin does **not** affect human cells.

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(1 mark)

5 (a) (ii) Use information in the diagram to explain how tetracycline prevents bacterial growth.

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(1 mark)

Do not write outside the box

5 (b) Frequent treatment with vancomycin can result in resistant strains of bacteria. Explain how.

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(3 marks)

(Extra space) .....

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5 (c) The gene for resistance to vancomycin is very common in the bacterium *Enterococcus faecalis*. The same gene has now been found in the bacterium *Staphylococcus aureus*.

Use your knowledge of gene transmission to explain how the gene was passed from one species of bacterium to another.

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(3 marks)

(Extra space) .....

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8

Do not write outside the box

6 (a) Scientists can use protein structure to investigate the evolutionary relationships between different species. Explain why.

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(2 marks)

6 (b) Comparing the base sequence of genes provides more evolutionary information than comparing the structure of proteins. Explain why.

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(2 marks)

Do not write outside the box

6 (c) The proteins of different species can be compared using immunological techniques. The protein albumin obtained from a human was injected into a rabbit. The rabbit produced antibodies against the human albumin. These antibodies were extracted from the rabbit and then added to samples of albumin obtained from four different animal species. The amount of precipitate produced in each sample was then measured. The results are shown in the table.

Species from which albumin was obtained	Amount of precipitate / arbitrary units
Rat	23
Chimpanzee	96
Marmoset	65
Trout	11

What do the results suggest about the evolutionary relationship between humans and the other species?

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(2 marks)

6

Turn over for the next question

Do not write outside the box

7 (a) A student investigated the diversity of plants at several sites on a golf course. At each site she took a large number of random samples.

7 (a) (i) Explain the importance of taking a large number of samples at each site.

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(1 mark)

7 (a) (ii) Explain the importance of taking samples at random.

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(1 mark)

The student collected data from one part of the golf course and calculated an index of diversity.

The table shows her data.

Species	Number of plants per m^2
Sheep's fescue	11
Creeping buttercup	6
Clover	5
Dandelion	2
Sheep's sorrel	1
Lady's bedstraw	7
Stemless thistle	4

The index of diversity can be calculated from the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

Do not write outside the box

7 (b) Use the formula to calculate the index of diversity for the plants on this part of the golf course. Show your working.

Answer .....

(2 marks)

7 (c) The golf course was surrounded by undeveloped grassland from which it had been produced.
The golf course had

- some areas of very short grass which was cut frequently
- some areas of longer grass which was cut less frequently
- some areas of long grass and shrubs which were never cut.

The index of diversity for the insects on the golf course was higher than that for the surrounding undeveloped grassland.

Explain the effect of developing this golf course on the index of diversity of insects.

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(3 marks)

(Extra space) .....

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7

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8 (a) Root pressure moves water through the xylem. Describe what causes root pressure.

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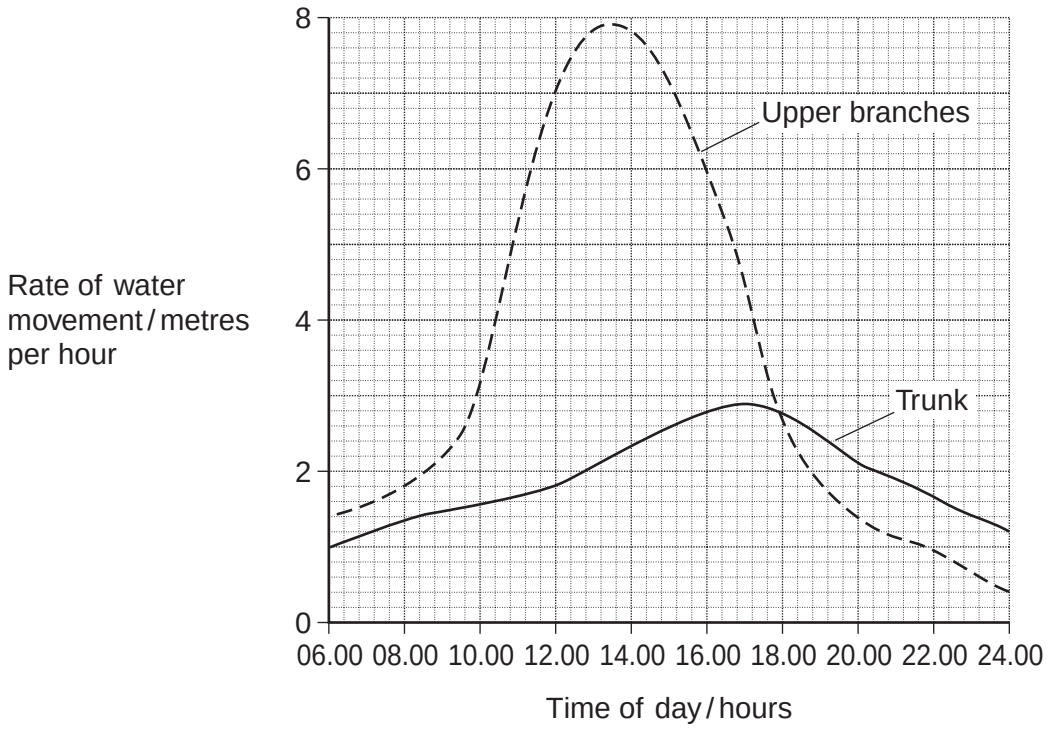
(3 marks)

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8 (b) A biologist investigated the rate of water movement during the day in different parts of a tree. The results are shown in the graph.



Do not write outside the box

8 (b) (i) Describe how the rate of water movement in the upper branches changed over the period shown in the graph.

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(2 marks)

8 (b) (ii) The rate of water movement in the upper branches was different from the rate of water movement in the trunk. Describe how.

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(2 marks)

8 (b) (iii) The results of this investigation support the cohesion tension theory. Explain how.

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(2 marks)

9

Do not write outside the box

9 (a) Explain how oxygen is loaded, transported and unloaded in the blood.

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(6 marks)

(Extra space) .....

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Do not write outside the box

Midges are very small insects. The early stages of the life cycle of midges are called larvae. Midge larvae live in water. A biologist investigated the uptake of oxygen by the larvae of two species of midge. He measured the rate of uptake of oxygen by the larvae in water containing different concentrations of oxygen. The table shows his results.

Concentration of oxygen in water / $cm^3\ dm^{-3}$	**Mean rate of oxygen uptake / $cm^3\ g^{-1}\ h^{-1}$**	
	Chironomus longistylus	*Tanytarsus brunnipes*
1	220	141
2	285	246
3	304	342
4	313	362
5	320	367
6	318	430
7	320	469

9 (b) The larvae in this investigation were kept at a temperature of 17 °C. Why was it important that the larvae of both species were kept at the same temperature?

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(2 marks)

9 (c) Describe the effect of an increase in oxygen concentration on the mean rate of oxygen uptake in *Chironomus longistylus*.

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(2 marks)

Question 9 continues on the next page

Turn over ▶

Do not write outside the box

9 (d) *Chironomus longistylus* lives in still water whereas *Tanytarsus brunnipes* lives in fast running streams. The water in fast running streams has a higher concentration of oxygen than in still water. Use the table on page 19 to suggest how *Chironomus longistylus* is better adapted than *Tanytarsus brunnipes* to living in still water.

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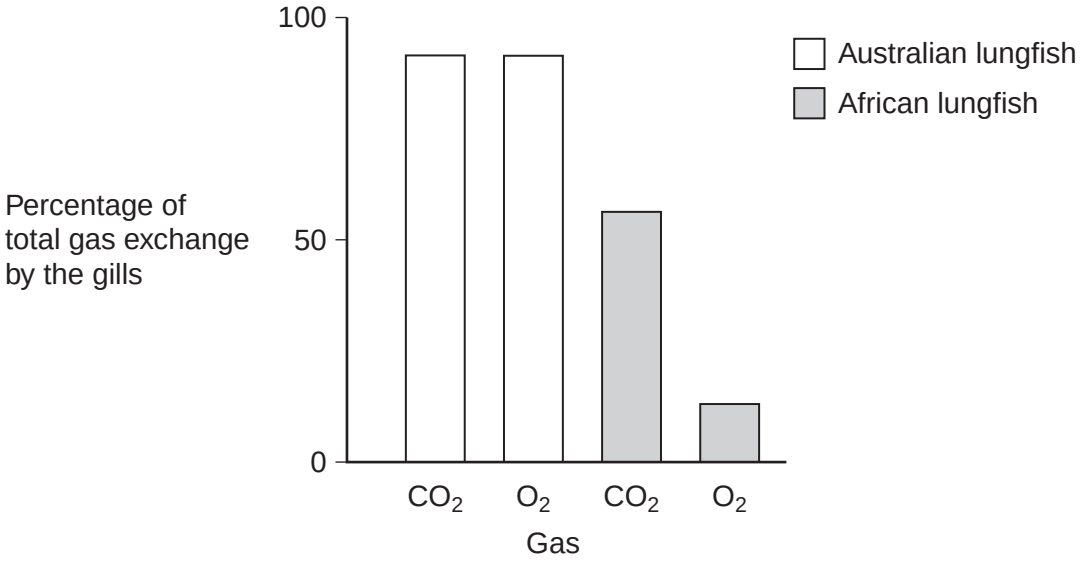
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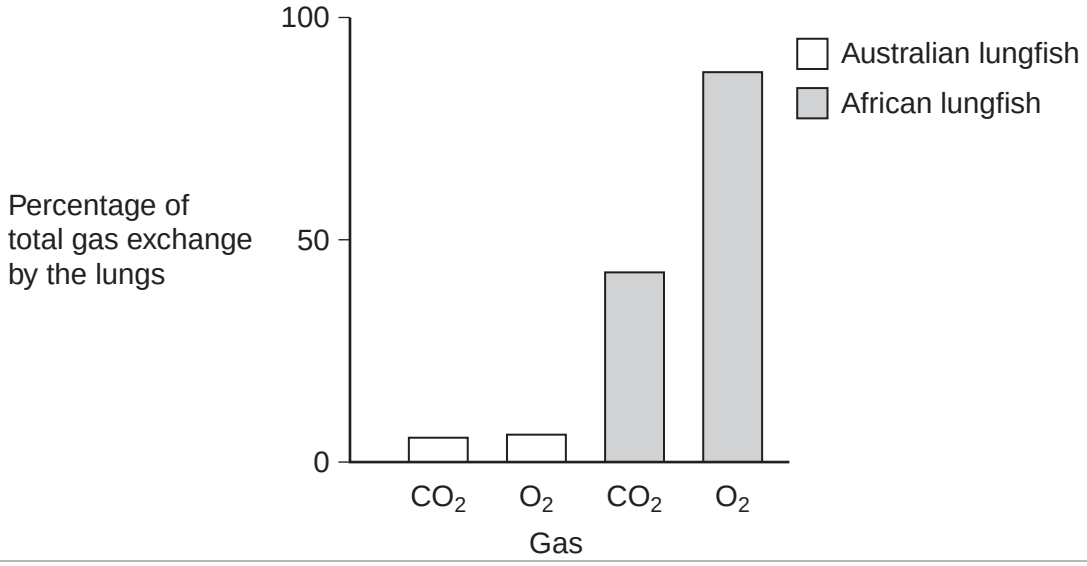
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(2 marks)

9 (e) Lungfish are freshwater fish which have gills and lungs. Scientists investigated how Australian and African lungfish use their lungs and gills for gas exchange. The graphs show the results of this investigation.





Do not write outside the box

9 (e) (i) Describe the difference in the way carbon dioxide is lost from the body of an Australian lungfish and an African lungfish.

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(1 mark)

9 (e) (ii) African lungfish are likely to survive for longer than Australian lungfish when living in pools that dry up. Explain why.

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(2 marks)

15

Turn over for the next question

Do not write outside the box

10 Scientists investigated the effect of drinking tea and coffee on reducing the risk of developing one type of brain cancer. The investigation involved 410 000 volunteers and was conducted in 10 European countries over a period of 8.5 years.

10 (a) (i) Apart from age, suggest **two** factors that the scientists should have considered when selecting volunteers for this trial.

1 .....

2 .....

(2 marks)

10 (a) (ii) Give **two** features of the design of this investigation that would ensure the reliability of the results obtained.

1 .....

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2 .....

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(2 marks)

10 (b) The incidence for this type of brain cancer is 6 cases per 100 000 per year.
Use this information to calculate the expected number of volunteers developing this cancer during the 8.5 year period of this investigation. Show your working.

Answer .....

(2 marks)

10 (c) In analysing the results of this investigation, the scientists took into account the age of the volunteers. Suggest why.

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(1 mark)

Do not write outside the box

10 (d) During the investigation, the volunteers were asked to estimate the volume of tea and/or coffee that they drank each day. The types of tea and coffee consumed in different countries varied. When the data from all the countries were collected there was a correlation between drinking more than 100 cm^3 of tea or coffee each day and a reduced risk of developing this type of brain cancer.

Tea and coffee contain caffeine. A newspaper reported the results of this investigation under the headline 'Caffeine helps cut cancer risk'. Explain why scientists could **not** support this view solely on the basis of this investigation.

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(4 marks)

(Extra space) .....

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Question 10 continues on the next page

Do not write outside the box

10 (e) Another group of scientists investigated the effect of caffeine on blood flow to certain parts of the brain. Volunteers were given different concentrations of caffeine solution to drink. A control group was also set up.

10 (e) (i) Describe how the control group should have been treated.

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(2 marks)

10 (e) (ii) Volunteers who drank the same concentration of caffeine solution often had different concentrations of caffeine in their blood. Suggest **one** reason for the difference in concentration of caffeine in the blood of volunteers.

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(1 mark)

10 (e) (iii) The investigation showed that caffeine reduces the blood flow to certain parts of the brain. Suggest **one** way in which this could lead to a reduced risk of brain cancers.

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(1 mark)

15

END OF QUESTIONS

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Version 1.0



General Certificate of Education (A-level)
January 2012

Biology BIOL2

(Specification 2410)

Unit 2: The Variety of Living Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidelines	Mark	Comments
1(a)	1. Granum/grana/thylakoid; 2. Stroma;	2	1. Ignore references to membranes, stacks or discs. Allow phonetic spellings.
1(b)	1. Absorbs/traps/uses light; 2. For photosynthesis; 3. Produces carbohydrates/sugars/ lipids/protein;	2 max	1. Light dependent reaction = marking point 1. 3. Accept any named product of photosynthesis for marking point 3. Reference to light dependent and light independent reactions = two marks
1(c)	Correct answer in range of 2.53 – 2.66;; Any length divided by 30000 = 1 mark;	2	

Question	Marking Guidelines	Mark	Comments
2(a)(i)	Anaphase	1	
2(a)(ii)	1. Sister/identical chromatids/ identical chromosomes; 2. To (opposite) poles/ends/sides;	2	1. Reject: Homologous chromosomes separate. 1. Allow any reference to chromatids/ chromosomes being identical e.g. same DNA
2(b)(i)	1. 8.4/cells with twice DNA content = replicated DNA / late interphase / prophase / metaphase / anaphase; 2. 4.2 = DNA not replicated / (early) interphase / telophase / cell just divided / finished mitosis;	2	1. Any reference to interphase must suggest towards end of interphase. 1. 'Chromosomes replicate' is not enough for DNA replicates.
2(b)(ii)	2.1;	1	

Question	Marking Guidelines	Mark	Comments
3(a)(i)	*Synodontis batensoda* / *S. batensoda;*	1	Ignore spellings
3(a)(ii)	*Mochokus niloticus*;	1	Ignore spellings
3(b)	5;	1	
3(c)(i)	Fertile offspring produced;	1	Allow suitable description of offspring being fertile.
3(c)(ii)	1. Attracts/recognises same species; 2. Attracts/recognises mate/opposite sex; 3. Indication of sexual maturity/ fertility / synchronises mating; 4. Stimulates release of gametes; 5. Form pair bond;	2 max	Attracts mate of the same species = two marks. 3. Allow 'ready to mate'.

Question	Marking Guidelines	Mark	Comments
4(a)(i)	4;	1	
4(a)(ii)	1. Change in amino acid/(sequence of) amino acids/primary structure; 2. Change in hydrogen/ionic/ disulphide bonds; 3. Alters tertiary structure/active site (of enzyme); 4. Substrate not complementary/cannot bind (to enzyme/active site) / no enzyme-substrate complexes form;	3 max	1. Reject = different amino acids are 'formed' 3. Alters 3D structure on its own is not enough for this marking point.
4(b)	1. Lack of skin pigment / pale/light skin / albino; 2. Lack of coordination / muscles action affected;	2 max	
4(c)	Founder effect / colonies split off / migration / interbreeding;	1	Allow description of interbreeding e.g. reproduction between individuals from different populations

Question	Marking Guidelines	Mark	Comments
5(a)(i)	(Human cells) don't have a cell wall;	1	Accept "they" refers to human cells.
5(a)(ii)	(Affects) protein synthesis;	1	Allow description e.g. 'amino acids not joined together / translation. Reject: affects transcription.
5(b)	1. Mutation present/occurs; 2. Resistance gene/allele; 3. Resistant bacteria (survive and) reproduce; 4. Vertical (gene) transmission / Horizontal (gene) transmission / conjugation;	3 max	Ignore antibiotic causes mutation. 1. Reference to immunity disqualifies first credited marking point. 2. Must clearly state marking point 2. Do not award by implication e.g. resistance passed on by vertical gene transmission = one mark (marking point 4) Reference to mitosis negates marking point 3 or 4 (not both marks).
5(c)	1. Horizontal (gene) transmission; 2. Via conjugation/pilus; 3. Plasmid/Gene/DNA replicated/copied; 4. Plasmid transferred (to *S.aureus)*;	3 max	Ignore reference to mitosis

Question	Marking Guidelines	Mark	Comments
6(a)	1. Amino acid sequences / primary structure; 2. Closer the (amino acid) sequence the closer the relationship; 3. (Protein structure) related to (DNA) base/triplet sequence;	2 max	More closely related (species) have more similarities in amino acid sequence/primary structure = two marks; Amino acid sequence is related to (DNA) base/triplet sequence = two marks;
6(b)	1. Reference to base triplets/triplet code / more bases than amino acids / longer base sequence than amino acid sequence; 2. Introns / non-coding DNA; 3. Degeneracy of code / more than one code for each amino acid;	2 max	Different (base) triplets code for same amino acids = 2 marks; Degeneracy of triplet code = 2 marks Ignore reference to codon. 3. Allow 'more than one base sequence can code for a protein';
6(c)	1. Most closely related to chimpanzee; 2. Least closely related to trout;	2	

Question	Marking Guidelines	Mark	Comments
7(a)(i)	Produces a more reliable mean/average / makes sure sample was representative / reduce effect of extreme values / identify anomalies;	1	Ignore references to chance
7(a)(ii)	Removes bias;	1	
7(b)	Two marks for correct answer of 5.8;; One mark for incorrect answer that clearly shows denominator as 216;	2	
7(c)	1. Increase in variety of plants/shrubs/grass; 2. More habitats/niches; 3. Greater variety of food sources / more food sources;	3	3. Answers only referring to 'more food' should not be credited

Question	Marking Guidelines	Mark	Comments
8(a)	1. Active transport by endodermis; 2. ions/salts into xylem; 3. Lowers water potential (in xylem); 4. (Water enters) by osmosis;	3 max	4. Allow mark point 4 in any context of water movement in the root e.g. into root hair.
8(b)(i)	1. Increases then decreases; 2. Peak/maximum at 13.00/14.00 (hours)/ 7.8 – 8.0;	2	Allow peak/maximum at any time between 13.00 – 14.00 or 7.8 – 8.0;
8(b)(ii)	1. Maximum/overall rate is higher (in branches); 2. Reaches maximum/peak earlier (in the day) (in branches); 3. Starts higher / ends lower (in branches)	2	Allow converse for all marking points.
8(b)(iii)	1. Movement starts/peaks earlier in branches/higher up; 2. Creates tension/'negative pressure'/'pull';	2	

Question	Marking Guidelines	Mark	Comments
9(a)	1. Haemoglobin carries oxygen / has a high affinity for oxygen / oxyhaemoglobin; 2. In red blood cells; 3. Loading/uptake/association in lungs; 4. at <u>high p.O_2</u>; 5. Unloads/ dissociates / releases to respiring cells/tissues; 6. <u>at low p.O_2</u>; 7. Unloading linked to higher carbon dioxide (concentration);	6 max	7. Ignore reference to incorrect pH in relation to effect of higher carbon dioxide concentrations for marking point 7.
9(b)	1. Allows comparison; 2. (Different temperature) affects enzymes; 3. (Different temperature) affects respiration/metabolism; 4. (Different temperature) affects amount of dissolved oxygen;	2 max	Do not credit 'temperature affects results' on its own; 2. Allow reference to denaturation of enzymes.
9(c)	1. Increases then levels out / stops increasing / fluctuates slightly; 2. At 5 (cm^3 dm^{-3}) / 320 (cm^3 $g^{-1}h^{-1}$);	2	Allow description of 'fluctuates slightly' in terms of candidate quoting figures after 320.
9(d)	1. *Chronimus longistylus* has high<u>er</u> uptake at low (oxygen) concentrations; 2. (Higher uptake) up to 2 cm^3 dm^{-3};	2	*Chronimus longistylus* has higher uptake to (oxygen concentration of) 2 / lower uptake after 2;; (= 2 marks) 2. Award mark if candidate uses figures from table e.g. higher at concentration 1 (220) <u>or</u> concentration 2 (285). Higher uptake at concentration 1 <u>or</u> 2 = 2 marks.
9(e)(i)	More (than in African) lost via gills in Australian lungfish / less (than African) lost via lungs in Australian lungfish;	1	

9(e)(ii)	1. More/most exchange is via lungs (in African lungfish); 2. Gills will not function/function less efficiently (in air);	2	1. Allow converse for first point. 2. Allow water is required for gills to function.

Question	Marking Guidelines	Mark	Comments
10(a)(i)	1. Sex; 2. Lifestyle; 3. Body mass; 4. Health; 5. Ethnicity; 6. Genetic factors / family history;	2 max	Stress, smoking, diet etc are examples of lifestyle. 3. Allow weight for mark point 3. Reject: height.
10(a)(ii)	1. Large sample/number / 410 000; 2. Long time period / 8.5/many years; 3. Different countries / more than one country;	2	Reject: random
10(b)	Correct answer of 209/209.1 = 2 marks;; Incorrect answer but multiplies by 8.5 = 1 mark;	2	Answer of 210 = one mark
10(c)	Age affects risk of cancer;	1	Must relate to cancer not just to illness
10(d)	1. Correlation does not mean causal relationship; 2. Tea/coffee contains other substances; 3. Contain different amounts of caffeine; 4. Estimated intake (of tea/coffee); 5. No control group; 6. Only one type of cancer studied; 7. Further studies required / only one investigation/study/group;	4 max	1. Reject casual for point 1. Reference to ‘due to other factors’ on its own is not enough for a mark
10(e)(i)	1. Treated the same; 2. No caffeine;	2	2. Accept decaffeinated 2. Reject ‘placebo.

10(e)(ii)	1. Absorb different amounts; 2. Broken down by enzymes/digested; 3. Different blood volumes; 4. Differences in metabolism; 5. Caffeine from a different source;	1 max	Reject: Different body masses

10(e)(iii)	1. Less oxygen/glucose to (cancer) cells; 2. Less carcinogens; 3. Reduces spread of cancer (cells);	1 max	'Reduces cell division' on its own should not be credited.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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7	
8	
9	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2012

Biology BIOL2

Unit 2 The variety of living organisms

Monday 21 May 2012 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 45 minutes

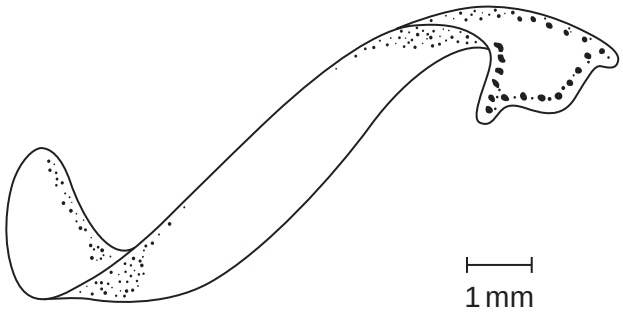
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- You are expected to use a calculator, where appropriate.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) Flatworms are small animals that live in water. They have no specialised gas exchange or circulatory systems.
The drawing shows one type of flatworm.



1 (a) (i) Name the process by which oxygen reaches the cells inside the body of this flatworm.

.....

(1 mark)

1 (a) (ii) The body of a flatworm is adapted for efficient gas exchange between the water and the cells inside the body.
Using the diagram, explain how **two** features of the flatworm's body allow efficient gas exchange.

1 .....

.....

2 .....

.....

(2 marks)

1 (b) (i) A leaf is an organ. What is an organ?

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(1 mark)

Do not write outside the box

1 (b) (ii) Describe how carbon dioxide in the air outside a leaf reaches mesophyll cells inside the leaf.

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(3 marks)

(Extra space) .....

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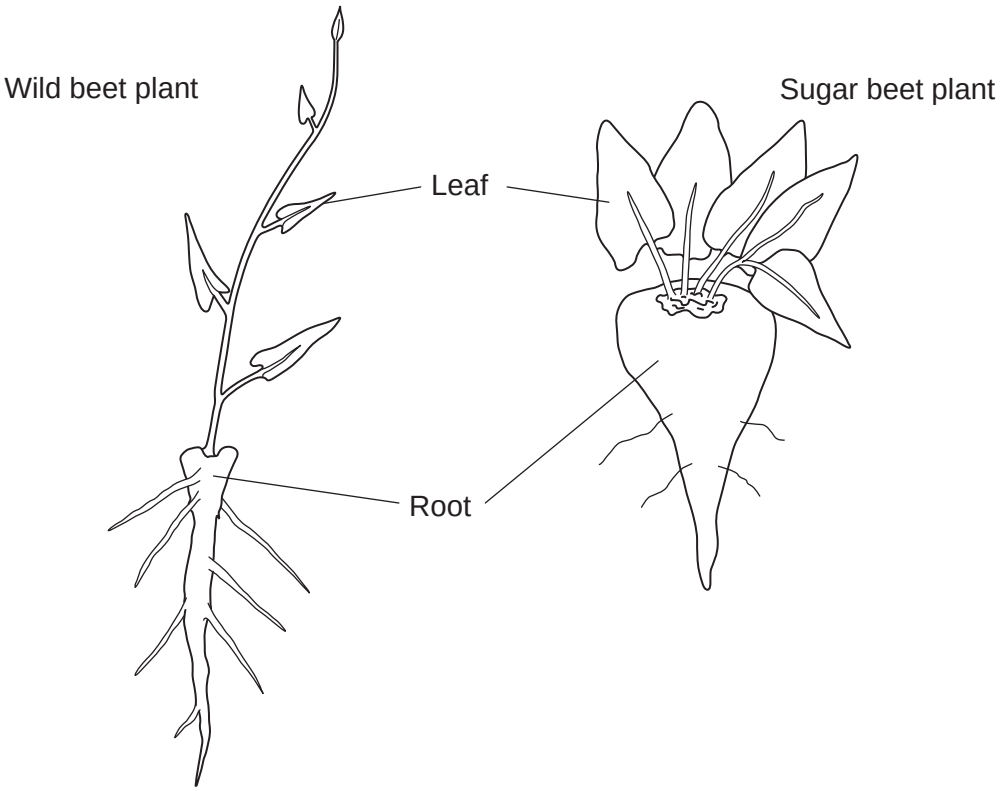
7

Turn over for the next question

Do not write outside the box

2 Sugar beet is a crop grown for the sugar stored in its root. The sugar is produced by photosynthesis in the leaves of the plant. Plant breeders selected high-yielding wild beet plants. They used these plants to produce a strain of sugar beet to grow as a crop.

The drawings show a wild beet plant and a sugar beet plant. The drawings are to the same scale.



2 (a) Use the drawings to describe **two** ways in which a sugar beet plant is different from a wild beet plant.

Explain how each of these differences would give an increased yield of sugar.

Difference 1 .....

.....

Explanation .....

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Difference 2 .....

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Explanation .....

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(4 marks)

Do not write outside the box

2 (b) Sugar beet plants have been selected for a faster rate of growth.

Suggest how the faster rate of growth may increase profit for a farmer.

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(1 mark)

2 (c) Describe and explain how selection will have affected the genetic diversity of sugar beet.

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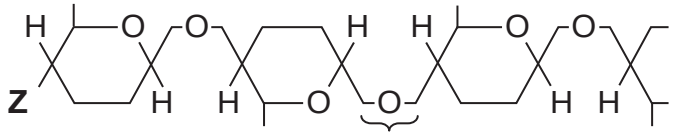
(2 marks)

7

Turn over for the next question

Do not write outside the box

3 The diagram shows one end of a cellulose molecule.



3 (a) (i) Name the monomers that form a cellulose molecule.

.....

(1 mark)

3 (a) (ii) Name bond **Y**.

.....

(1 mark)

3 (a) (iii) What chemical group is at position **Z**?

.....

(1 mark)

Do not write outside the box

3 (b) (i) Complete the table to show **two** ways in which the structure of cellulose is different from the structure of starch.

Starch	Cellulose

(2 marks)

3 (b) (ii) Explain **one** way in which the structure of cellulose is linked to its function.

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(2 marks)

7

Turn over for the next question

Do not write outside the box

4 (a) Mitosis is important in the life of an organism. Give **two** reasons why.

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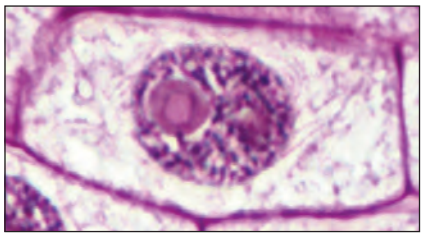
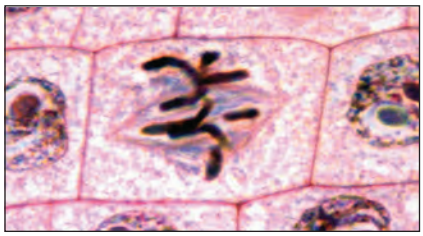
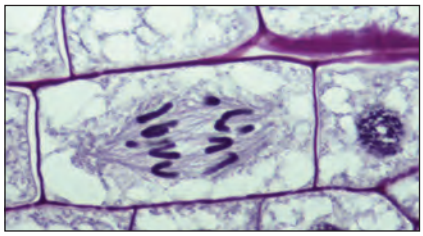
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(2 marks)

A biologist used a microscope to investigate plant tissue where some of the cells were dividing by mitosis. She examined 200 cells and counted the number of cells in interphase and in each stage of mitosis.

The table shows some of the cells she saw, and the percentage of cells in interphase and in two stages of mitosis, **A** and **B**.

Stage of cell cycle	Percentage of cells
Interphase 	90
Stage **A** 	3
Stage **B** 	1

Do not write outside the box

4 (b) (i) Explain why the biologist chose to examine 200 cells.

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(1 mark)

4 (b) (ii) Name Stage **A** and Stage **B**. Give the evidence from the photograph that you used to identify the stage.

Name of Stage **A** .....

Evidence .....

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Name of Stage **B** .....

Evidence .....

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(4 marks)

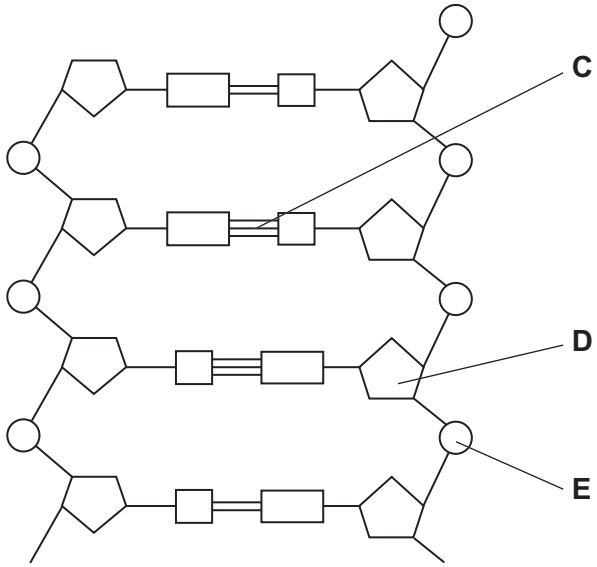
4 (c) In this tissue one complete cell cycle took 20 hours.
Using information from the table, calculate the mean time for these cells to complete mitosis. Show your working.

Answer ..... *(2 marks)*

9

Do not write outside the box

5 The diagram shows part of a DNA molecule.



5 (a) (i) DNA is a polymer. What is the evidence from the diagram that DNA is a polymer?

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(1 mark)

5 (a) (ii) Name the parts of the diagram labelled **C**, **D** and **E**.

Part **C** .....

Part **D** .....

Part **E** .....

(3 marks)

5 (a) (iii) In a piece of DNA, 34% of the bases were thymine.

Complete the table to show the names and percentages of the other bases.

Name of base	Percentage
Thymine	34
	34

(2 marks)

Do not write outside the box

5 (b) A polypeptide has 51 amino acids in its primary structure.

5 (b) (i) What is the minimum number of DNA bases required to code for the amino acids in this polypeptide?

(1 mark)

5 (b) (ii) The gene for this polypeptide contains more than this number of bases.

Explain why.

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(1 mark)

8

Turn over for the next question

Do not write outside the box

6 Hummingbirds belong to the order Apodiformes. One genus in this order is *Topaza*.

6 (a) (i) Name **one** other taxonomic group to which all members of the Apodiformes belong.

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(1 mark)

6 (a) (ii) Name the taxonomic group between order and genus.

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(1 mark)

The crimson topaz and the fiery topaz are hummingbirds.

Biologists investigated whether the crimson topaz and the fiery topaz are different species of hummingbird, or different forms of the same species.

They caught large numbers of each type of hummingbird. For each bird they

- recorded its sex
- recorded its mass
- recorded the colour of its throat feathers
- took a sample of a blood protein.

The table shows some of their results.

	Crimson topaz		**Fiery topaz**	
	Male	**Female**	**Male**	**Female**
Mean mass / g (± standard deviation)	13.6 (±1.9)	10.8 (±1.3)	14.2 (±1.6)	11.6 (±0.63)
Colour of throat feathers	Green	Grey edges	Yellowish green	No grey edges

6 (b) (i) Explain how the standard deviation helps in the interpretation of these data.

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(2 marks)

Do not write outside the box

6 (b) (ii) In hummingbirds throat colour is important in courtship. Explain the evidence in the table that shows that the crimson topaz and the fiery topaz may be different species of hummingbird.

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(2 marks)

6 (c) The biologists analysed the amino acid sequences of the blood protein samples from these hummingbirds.

Explain how these sequences could provide evidence as to whether the crimson topaz and the fiery topaz are different species.

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(2 marks)

8

Turn over for the next question

Do not write outside the box

7 Scientists investigated the species of insects found in a wood and in a nearby wheat field. The scientists collected insects by placing traps at sites chosen at random both in the wood and in the wheat field.

The table shows the data collected in the wood and in the wheat field.

Species of insect	Number of organisms of each species	
	Wood	Wheat field
Bird-cherry oat aphid	0	216
Beech aphid	563	0
Large white butterfly	20	0
Lacewing	12	3
7-spot ladybird	36	0
2-spot ladybird	9	1
Total number of organisms of all species	640	220

7 (a) The scientists collected insects at sites chosen at random. Explain the importance of the sites being chosen at random.

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(1 mark)

7 (b) (i) Use the formula

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

to calculate the index of diversity for the insects caught in the wood, where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species

Show your working.

Answer .....

(2 marks)

Do not write outside the box

7 (b) (ii) Without carrying out any further calculations, estimate whether the index of diversity for the wheat field would be higher or lower than the index of diversity for the wood.

Explain how you arrived at your answer.

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(2 marks)

7 (c) A journalist concluded that this investigation showed that farming reduces species diversity.
Evaluate this conclusion.

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(2 marks)

7 (d) Farmers were offered grants by the government to plant hedges around their fields.
Explain the effect planting hedges could have on the index of diversity for animals.

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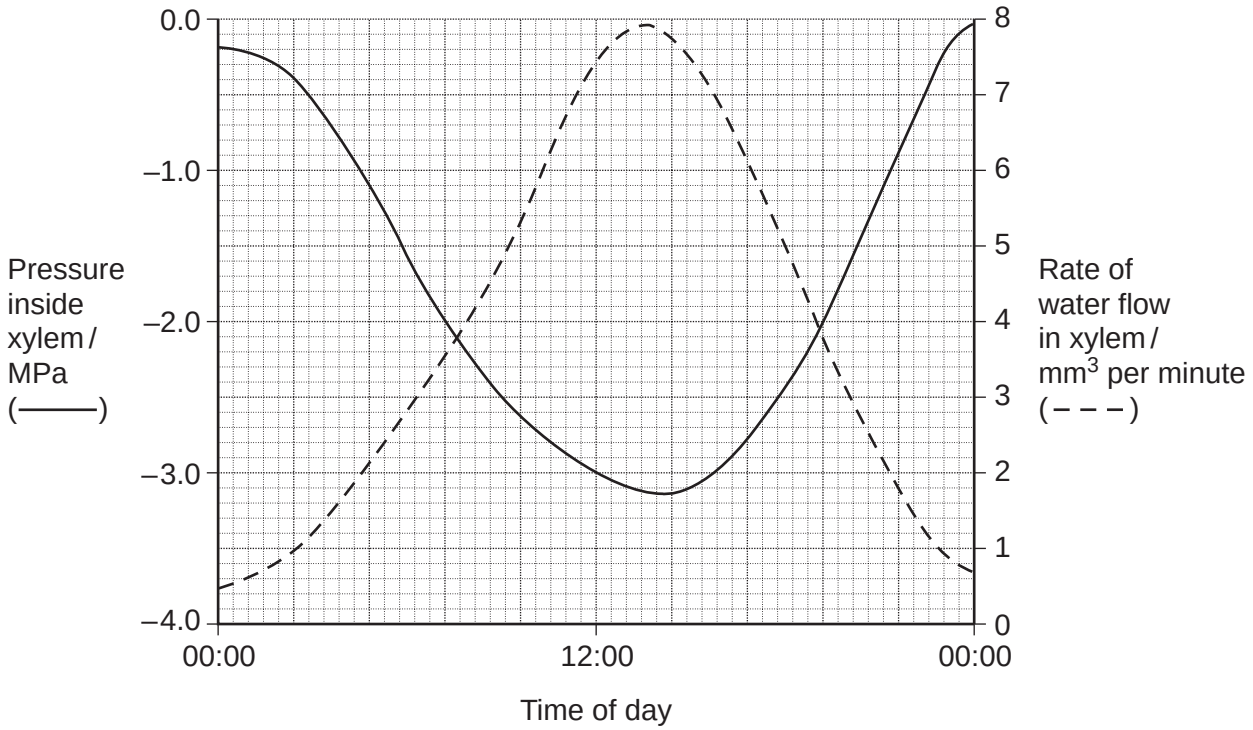
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(2 marks)

9

Do not write outside the box

8 (a) Scientists measured the rate of water flow and the pressure in the xylem in a small branch. Their results are shown in the graph.



8 (a) (i) Use your knowledge of transpiration to explain the changes in the rate of flow in the xylem shown in the graph.

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(3 marks)

(Extra space) .....

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Do not write outside the box

8 (a) (ii) Explain why the values for the pressure in the xylem are negative.

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(1 mark)

Question 8 continues on the next page

Do not write outside the box

8 (b) Doctors measured the thickness of the walls of three blood vessels in a large group of people. Their results are given in the table.

Name of vessel	Mean wall thickness / mm (± standard deviation)
Aorta	5.7 ± 1.2
Pulmonary artery	1.0 ± 0.2
Pulmonary vein	0.5 ± 0.2

8 (b) (i) Explain the difference in thickness between the pulmonary artery and the pulmonary vein.

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(1 mark)

8 (b) (ii) The thickness of the aorta wall changes all the time during each cardiac cycle. Explain why.

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(3 marks)

(Extra space) .....

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8 (b) (iii) Which of the three blood vessels shows the greatest variation in wall thickness? Explain your answer.

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(1 mark)

Do not write outside the box

8 (c) Describe how tissue fluid is formed **and** how it is returned to the circulatory system.

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(6 marks)

(Extra space) .....

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Turn over for the next question

Do not write outside the box

9 *Staphylococcus aureus* is a bacterium that causes disease in humans. Scientists carried out an investigation to find the most effective concentration of antibiotic to treat this disease.

The scientists put equal volumes of a culture of *S. aureus* in five flasks.

- They added nothing further to one flask. This was the control.
- They added different concentrations of antibiotic to the other four flasks.

The scientists incubated all the flasks at 35 ^{o}C for 3 hours. They then estimated the number of living bacteria in each flask.

9 (a) (i) The flasks were incubated at 35 ^{o}C. Suggest why they were incubated at this temperature.

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(1 mark)

9 (a) (ii) The scientist put the same volume of bacterial culture into each flask. Explain why.

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(1 mark)

9 (a) (iii) What was the purpose of the control flask?

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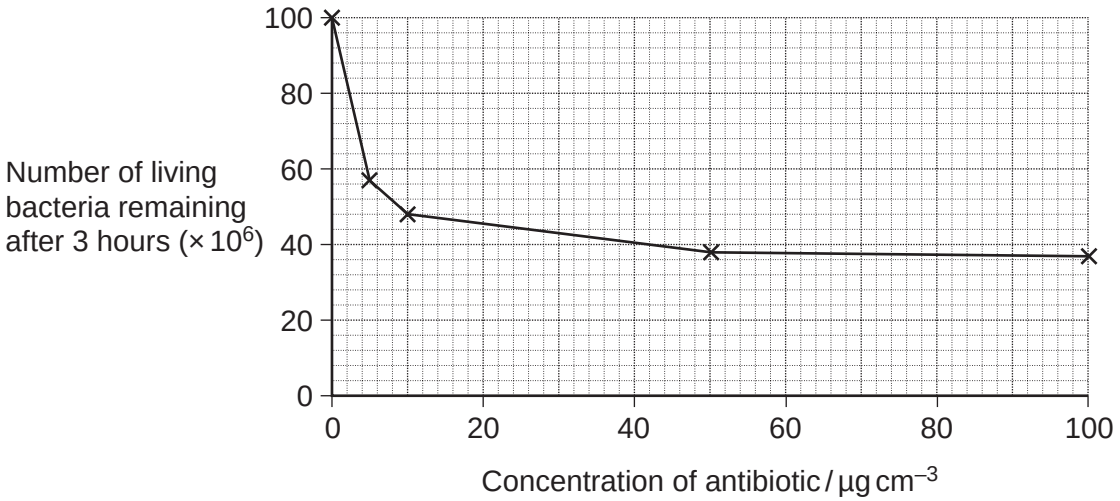
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(1 mark)

Do not write outside the box

9 (b) The graph shows the scientists' results.



9 (b) (i) Describe the pattern of results shown in the graph.

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(2 marks)

9 (b) (ii) A student concluded from these results that an antibiotic dose equivalent to 50 µg cm^{-3} would be the most effective in treating disease caused by *S. aureus*.

Evaluate his conclusion.

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(3 marks)

(Extra space) .....

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Question 9 continues on the next page

Do not write outside the box

9 (c) Give **two** ways in which a bacterium could become resistant to an antibiotic.

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(2 marks)

9 (d) *S. aureus* lives inside people's mouths. Some dentists believe that this bacterium can get into the blood of people who have had teeth extracted and infect their heart valves.

Doctors carried out a survey to find out whether there was a risk of developing infected heart valves after tooth extraction. They asked patients whether they had had any teeth extracted in the last 2 or 3 months. They collected this information from patients who had infected heart valves. They also collected this information from the same number of other patients who did not have infected heart valves.

The information is summarised in the table.

Hospital patients	**Percentage of patients who had teeth extracted within the past**	
	2 months	**3 months**
Group that had infected heart valves	16.8	23.0
Group that did **not** have infected heart valves	14.4	23.0

The people chosen to be included in the survey were all of a similar age. Suggest why.

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(1 mark)

Do not write outside the box

9 (e) Some dentists recommend a course of antibiotics when someone has a tooth extracted. Does the information in parts **(b)**, **(c)** and **(d)** support this recommendation? Explain your answer.

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(4 marks)

(Extra space) .....

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15

END OF QUESTIONS

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General Certificate of Education (A-level)
June 2012

Biology BIOL2

(Specification 2410)

Unit 2: The Variety of Living Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events, which all examiners participate in and is the scheme, which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Question	Marking Guidelines	Marks	Comments
1(a)(i)	Diffusion;	1	Ignore references to structures, membrane components etc Allow simple diffusion Reject facilitated diffusion
1(a)(ii)	1. (Thin / flat body) so short distance for diffusion / short diffusion pathway; 2. (Thin / flat body so) large surface area to volume ratio;	2	Ignore references to membrane, wall, body surface 'It' refers to flatworm's body
1(b)(i)	A group of <u>tissues</u>;	1	Ignore references to function Group = more than one
1(b)(ii)	1. (Carbon dioxide enters) via stomata; 2. (Stomata opened by) guard cells; 3. Diffuses through air spaces; 4. Down diffusion gradient;	3 max	1. Reject <u>stroma</u> 3. Allow concentration gradient. Reject along gradient unless direction made clear

Question	Marking Guidelines	Marks	Comments
2(a)	2 of the following pairs: 1. Larger leaves; 2. Photosynthesis; ***OR*** 3. Larger/bigger/thicker root; 4. Storage; ***OR*** 5. Stem shorter / absent; 6. Less energy used in stem growth / more energy for producing sugar;	4 max	Mark for explanation must be paired with correct change in structure Accept converse descriptions of leaves, root and stem: longer root, taller stem, smaller leaves Accept converse correct explanation
2(b)	Beet ready quicker / less time required / allows land to be used again / harvested earlier;	1	Allow more crops/many harvests. Ignore references to yield / profit
2(c)	1. (Diversity) reduced / fewer different alleles / less variation / smaller gene pool; 2. As <u>alleles</u> have been chosen / rejected;	2	

Question	Marking Guidelines		Marks	Comments
3(a)(i)	β/Beta glucose;		1	Accept b / B Reject any reference to alpha/α
3(a)(ii)	Glycosidic;		1	Reject references to α(1-4) glycosidic bond, but allow beta 1-4, or unspecified reference to 1-4 (1,4)
3(a)(iii)	OH / hydroxyl / HO;		1	Reject hydroxide Reject OH/HO molecule Ignore alcohol
3(b)(i)	**Starch** 1. (1,4 and) 1,6 bonds/contains 1,6 bonds /branching 2. All glucoses/ monomers same way up 3. Helix/coiled/compact 4. Alpha glucose 5. No (micro/macro) fibrils/fibres	**Cellulose** 1. 1,4 bonds / no 1,6 bonds / unbranched / straight; 2. Alternate glucoses/monomers upside down; 3. Straight; 4. Beta glucose; 5. Micro/macro fibrils/fibres;	2 max	1 mark per pair of contrasts, both starch and cellulose required Accept other comparable differences eg hydrogen bonds **within** starch but **between** cellulose molecules
3(b)(ii)	1. H-bonds / micro/macro fibrils /fibres; 2. Strength / rigidity / inelasticity;		2	Reject strong hydrogen bonds 'Strong hydrogen bonds' = 0 but 'Strong hydrogen bonds give strength (to the molecule)' = 1

Question	Marking Guidelines	Marks	Comments
4(a)	1. Growth / increase in cell number; 2. Replace cells / repair tissue / organs /body; 3. Genetically identical cells; 4. Asexual reproduction /cloning;	2 max	Ignore growth of cells Ignore repair cells Reject bacteria 3. 'Produces 2 genetically identical cells' does not reach MP1 as well as MP3 4. Allow example or description
4(b)(i)	(Ensures) representative (sample);	1	Accept find some cells in mitosis/not in interphase. Accept 'more reliable' only if linked to percentage (of cells).'Improves reliability' on its own does not gain this mark Neutral: Large sample
4(b)(ii)	1. A = metaphase; 2. Chromosome / chromatids lie on equator; 3. B = anaphase; 4. Chromatids /chromosomes separating / moving apart / moving to poles;	4	2. Reject homologous chromosomes Allow centre/middle 4. Reject homologous chromosomes
4(c)	2 hours / 120 minutes;;	2	Allow 1 mark if working shows candidate understood that mitosis would take 10%

<table>
<tr><th>Question</th><th>Marking Guidelines</th><th>Marks</th><th>Comments</th></tr>
<tr><td>5(a)(i)</td><td>Repeating units / nucleotides / monomer /molecules;</td><td>1</td><td>Allow more than one, but reject two</td></tr>
<tr><td>5(a)(ii)</td><td>1. C = hydrogen bonds;
2. D = <u>deoxy</u>ribose;
3. E = phosphate;</td><td>3</td><td>
2. Ignore sugar
3. Ignore phosphorus, Ignore molecule</td></tr>
<tr><td>5(a)(iii)</td><td><table><tr><th>Name of base</th><th>Percentage</th></tr><tr><td>Thymine</td><td>34</td></tr><tr><td>Cytosine / Guanine</td><td>16</td></tr><tr><td>Adenine</td><td>34</td></tr><tr><td>Cytosine / Guanine</td><td>16</td></tr></table></td><td>2</td><td>Spelling must be correct to gain MP1
First mark = names correct
Second mark = % correct, with <u>adenine as 34%</u></td></tr>
<tr><td>5(b)(i)</td><td>153;</td><td>1</td><td></td></tr>
<tr><td>5(b)(ii)</td><td>Some regions of the gene are non-coding / i<u>ntrons</u> / start/stop code/triplet / there are two DNA strands;</td><td>1</td><td>Allow <u>addition</u> mutation
Ignore unqualified reference to mutation
Accept reference to introns and exons if given together
Ignore 'junk' DNA/multiple repeats</td></tr>
</table>

Question	Marking Guidelines	Marks	Comments
6(a)(i)	Kingdom / phylum / class;	1	Accept Animalia /animal kingdom / Chordata / Chordates / Aves Allow phonetic spelling
6(a)(ii)	Family;	1	
6(b)(i)	1. Shows the spread of the data / how data varies; 2. Overlap = no difference / due to chance / not significant; 3. Low SD means results more reliable / repeatable;	2 max	1. Reject range. Accept varies from the mean 2. Allow converse 3. Ignore accurate/valid/
6(b)(ii)	1. Different colour/different feathers/different throat; 2. Birds don't mate/pair bond with/recognise other species;	2	2. Reference to courtship alone is not sufficient
6(c)	1. Different species would have different amino acid sequences; 2. Amino acid sequence is the result of DNA/alleles//base sequence;	2	Accept more closely related = more similar sequence References to incorrect statements about coding negates second mark

Question	Marking Guidelines	Marks	Comments
7(a)	Removes bias;	1	
7(b)(i)	1. 1.28 / 1.29 / 1.285 / 1.3;; 2. Answer incorrect but shows clear understanding of Σ;	2	1. Ignore more than 3dp 2. $\sum$ = 318250. Allow mark if denominator written out. Incorrect denominator but evidence of understanding gains mark
7(b)(ii)	Diversity index would be lower (NO MARK) 1. Fewer species / Beech aphid/Large white butterfly/7-spot ladybird absent /only three species / species diversity lower; 2. Mostly one species / mostly bird-cherry aphid; 3. Fewer plant species;	2 max	Assume wheat field if site unspecified 1. Allow species richness in context of few species 3. Allow one type of food source if clearly plant
7(c)	For: 1. Data support the claim / evidence supports claim; Against: 2. Only wheat field / only comparing with wood / one type of habitat /only insects considered;	2 max	1. Ignore reference to correlation/causation
7(d)	1. Greater variety of plants; 2. Another habitat / more habitats / places to live / niches; 3. Another food source / more food types;	2 max	3. Answers referring to 'more food' should not be credited. Allow reference to either animal or plant as foods

Question	Marking Guidelines	Marks	Comments
8(a)(i)	1. Stomata open; 2. Transpiration highest around mid-day; 3. Middle of day warmer / lighter; 4. (Increased) tension / water potential gradient; 5. Cohesion (between water molecules);	3 max	Allow converse 3. Allow 'Sun is at it's hottest' Ignore 'pull, suck' Reject increased cohesion in the context of cohesion tension
8(a)(ii)	(Inside xylem) lower than atmospheric pressure / (water is under) tension;	1	Accept cohesion tension. Ignore vacuum
8(b)(i)	High pressure / smoothes out blood flow / artery wall contains more collagen / muscle / elastic (fibres) / connective tissue;	1	Accept converse for pulmonary vein Incorrect function of artery disqualifies mark
8(b)(ii)	1. (Aorta wall) stretches; 2. Because ventricle/heart contracts / systole / pressure increases; 3. (Aorta wall) recoils; 4. Because ventricle relaxes / heart relaxes /diastole / pressure falls; 5. Maintain smooth flow / pressure;	3 max	1. Allow expand 2. Reject if MP1 wrong 3. Allow spring back Reject any reference to contract / relax in MP1 and 3 4. Reject if MP3 wrong
8(b)(iii)	Aorta 1.2 / largest SD;	1	Allow pulmonary vein provided candidate relates standard deviation to mean
8(c)	Formation 1. High blood / hydrostatic pressure / pressure filtration; 2. Forces water / fluid out; 3. Large proteins remain in capillary; Return 4. Low water potential in capillary / blood; 5. Due to (plasma) proteins; 6. Water enters capillary / blood; 7. (By) osmosis; 8. Correct reference to lymph;	6 max	2. Reject plasma, ignore tissue 7. Osmosis must be in correct context

Question	Marking Guidelines	Marks	Comments
9(a)(i)	Fastest rate of growth/division / enzymes don't denature / optimum temperature for enzymes / at or close to body temperature;	1	Do not accept optimum temperature if not qualified
9(a)(ii)	Same amount / number of bacteria / only one variable in the investigation;	1	Reject 'same volume of bacteria' Allow doesn't change concentration of antibiotic
9(a)(iii)	To show that only the antibiotic has an effect (on the bacteria);	1	Allow 'to see the effect without the antibiotic', 'reference point'
9(b)(i)	1. Falls steeply then levels out / less steep; 2. Fall is less steep after 5-10 ($\mu g\,cm^{-3}$ / levels out at / after 50 $\mu g\,cm^{-3}$;	2	Principles = trend, value Allow values from y axis (48-58) / levels off 38 / 39
9(b)(ii)	1. 50 ($\mu g\,cm^{-3}$) reduced bacterial growth more (than lower concentrations); 2. Trial did not use people; 3. Very little / no effect after 50 ($\mu g\,cm^{-3}$); 4. Other concentrations not tested;	3	1. 'Allow 50 ($\mu g\,cm^{-3}$) kills the most bacteria' NB '50 is most effective' is in stem so do not credit 2. Allow references to not being as effective in humans
9(c)	1. Mutation; 2. Horizontal transmission / conjugation;	2	Ignore reference to vertical transmission Allow description. Reject 'conjunction'
9(d)	Age affects immune system / heart / teeth;	1	Ignore any other variable

9(e)	1. Antibiotic reduces number of bacteria; 2. (Survivors have) resistant gene/allele; 3. (Resistant bacteria) reproduce/multiply; 4. Valid reference to data at 2 months; 5. (Infection) no difference at 3 months;	4 max	1. Reject reference to antibodies. Reject <u>all</u> bacteria killed Allow credit for use of figures to show effect 3. Reject 'immune bacteria' 4. Valid reference includes **either**: difference insignificant (between the two groups) **or** higher percentage of patients who had infected heart valves had teeth extracted/lower percentage of patients who did not have infected heart valves had teeth extracted 4 and 5 must refer to time 4 and 5 allow credit for use of figures

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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9	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2011

Biology BIOL2

Unit 2 The variety of living organisms

Tuesday 18 January 2011 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 85.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

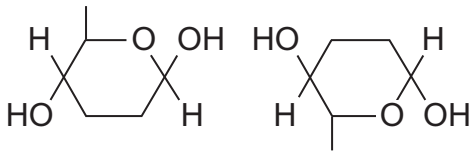
Answer **all** questions in the spaces provided.

1 (a) The table shows some substances found in cells. Complete the table to show the properties of these substances. Put a tick in the box if the statement is correct.

Statement	Substance			
	Starch	Glycogen	Deoxyribose	DNA helicase
Substance contains only the elements carbon, hydrogen and oxygen				
Substance is made from amino acid monomers				
Substance is found in both animal cells and plant cells				

(4 marks)

1 (b) The diagram shows two molecules of β-glucose.



On the diagram, draw a box around the atoms that are removed when the two β-glucose molecules are joined by condensation.

(2 marks)

Do not write outside the box

1 (c) (i) Hydrogen bonds are important in cellulose molecules. Explain why.

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(2 marks)

1 (c) (ii) A starch molecule has a spiral shape. Explain why this shape is important to its function in cells.

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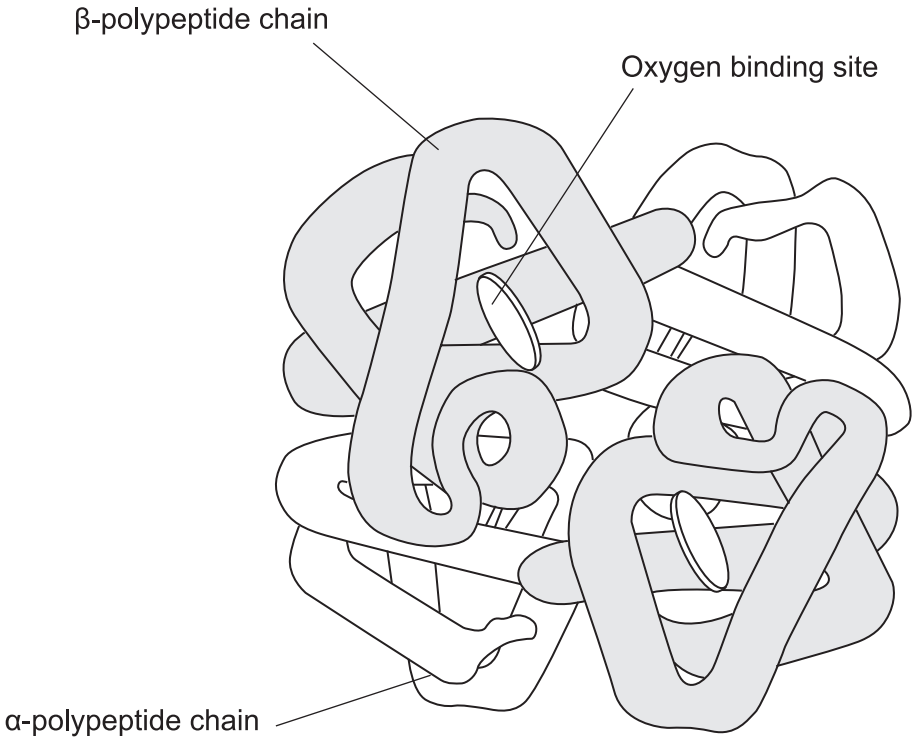
(1 mark)

9

Turn over for the next question

Do not write outside the box

2 The diagram shows a molecule of haemoglobin.



2 (a) What is the evidence from the diagram that haemoglobin has a quaternary structure?

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(1 mark)

2 (b) (i) A gene codes for the α-polypeptide chain. There are 423 bases in this gene that code for amino acids. How many amino acids are there in the α-polypeptide chain?

(1 mark)

2 (b) (ii) The total number of bases in the DNA of the α-polypeptide gene is more than 423. Give **two** reasons why there are more than 423 bases.

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2 .....

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(2 marks)

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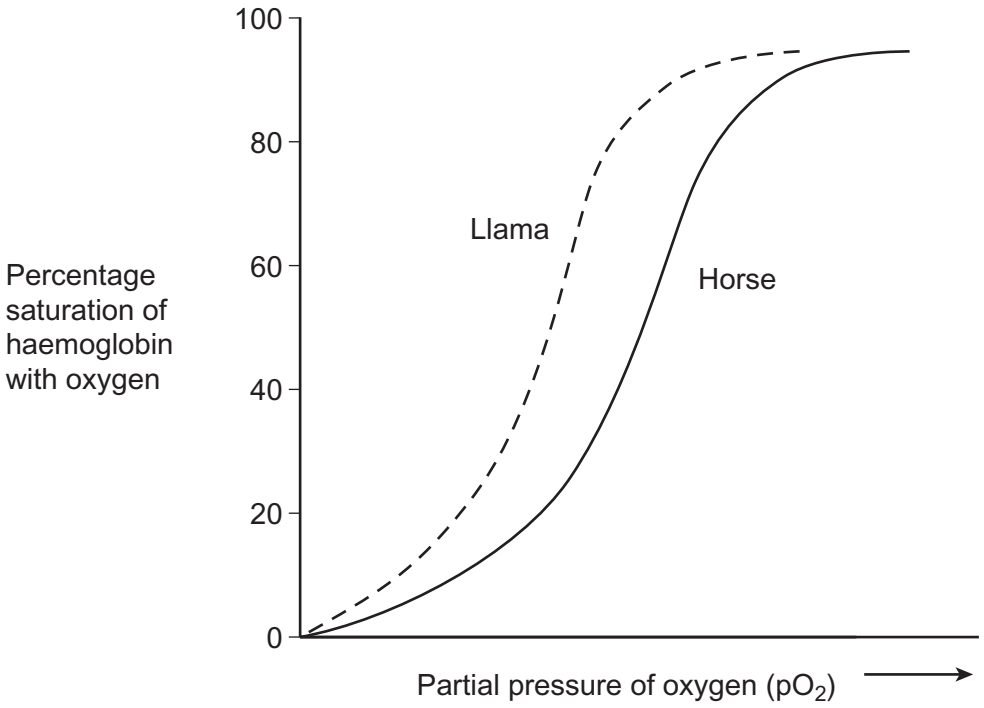
2 (c) The haemoglobin in one organism may have a different chemical structure from the haemoglobin in another organism. Describe how.

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(1 mark)

2 (d) The graph shows oxygen dissociation curves for horse haemoglobin and for llama haemoglobin. Horses are adapted to live at sea level and llamas are adapted to live in high mountains.



Use the graph to explain why llamas are better adapted to live in high mountains than horses.

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(3 marks)

(Extra space) .....

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8

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3 (a) An order is a taxonomic group. Fruit flies and mosquitoes belong to the same order of insects. Name the other **three** taxonomic groups to which fruit flies and mosquitoes both belong.

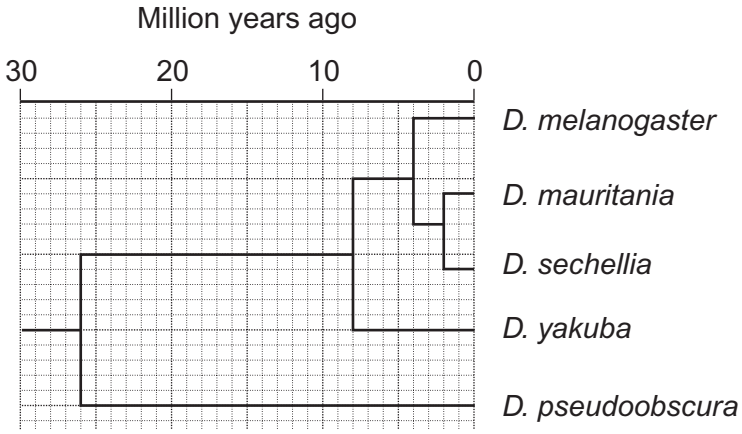
1 .....

2 .....

3 .....

(2 marks)

The diagram shows the phylogenetic relationship between five species of fruit fly that belong to the genus *Drosophila.*



3 (b) (i) Explain what is meant by a phylogenetic relationship.

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(1 mark)

3 (b) (ii) How many million years ago did *D. melanogaster* and *D. pseudoobscura* last share a common ancestor?

(1 mark)

Do not write outside the box

3 (c) Scientists used DNA hybridisation to confirm the relationship between *D. mauritania, D. sechellia* and *D. yakuba.*

3 (c) (i) They made samples of hybrid DNA using a gene that was found in all three species. Explain why it was important that they made samples of hybrid DNA from the same gene.

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(2 marks)

3 (c) (ii) The hybrid DNA formed between *D. mauritania* and *D. sechellia* separated at a higher temperature than the hybrid DNA formed between *D. mauritania* and *D. yakuba.* Explain what caused the DNA to separate at a higher temperature.

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(2 marks)

8

Turn over for the next question

Do not write outside the box

4 The table shows some differences between three varieties of banana plant.

	Variety **A**	Variety **B**	Variety **C**
Number of chromosomes in a leaf cell	22	33	44
Growth rate of fruit / cm^3 $week^{-1}$	2.9	6.9	7.2
Breaking strength of leaf / arbitrary units	10.8	9.4	7.8

4 (a) (i) How many chromosomes are there in a male gamete from variety **C**?

(1 mark)

4 (a) (ii) Variety **B** cannot produce fertile gametes. Use information in the table to explain why.

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(2 marks)

Do not write outside the box

In some countries very strong winds may occur. Banana growers in these countries choose to grow variety **B**.

4 (b) (i) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **A**.

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(1 mark)

4 (b) (ii) Use the data in the table to explain why banana growers in these countries choose to grow variety **B** rather than variety **C**.

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(1 mark)

4 (c) Banana growers can only grow new variety **B** plants from suckers. Suckers grow from cells at the base of the stem of the parent plant.

Use your knowledge of cell division to explain how growing variety **B** on a large scale will affect the genetic diversity of bananas.

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(2 marks)

7

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ANSWER IN THE SPACES PROVIDED

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5 (a) What information is required to calculate an index of diversity for a particular community?

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(1 mark)

5 (b) Farmers clear tropical forest and grow crops instead. Explain how this causes the diversity of insects in the area to decrease.

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(3 marks)

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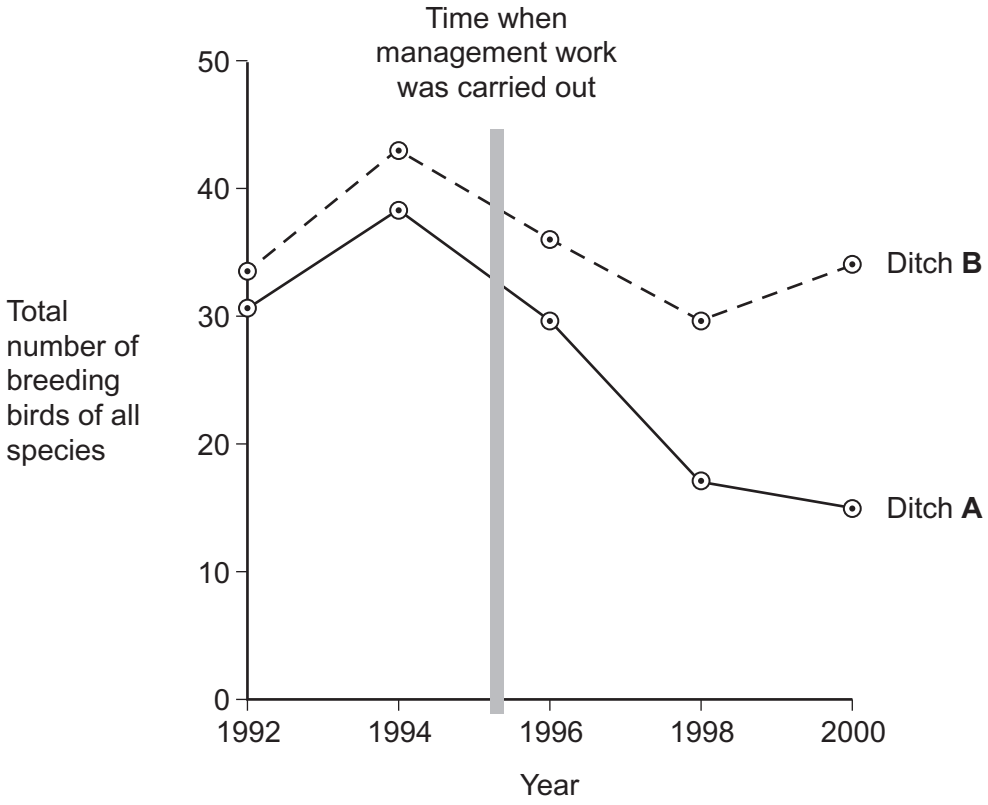
Question 5 continues on the next page

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Farmers manage the ditches that drain water from their fields. If they do not, the ditches will become blocked by plants. Biologists investigated the effects of two different ways of managing ditches on farmland birds.

- Ditch **A** was cleared of plants on both banks
- Ditch **B** was cleared of plants on one bank.

The graph shows the number of breeding birds of all species along the two ditches, before and after management.



5 (c) (i) The points on the graph have been joined with straight lines rather than with a smooth curve. Explain why they have been joined with straight lines.

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(1 mark)

5 (c) (ii) It would have been useful to have had a control ditch in this investigation. Explain why.

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(1 mark)

Do not write outside the box

5 (d) A farmer who wanted to increase the diversity of birds on his land read about this investigation.
He concluded that clearing the plants from one bank would not decrease diversity as much as clearing the plants from both banks. Evaluate this conclusion.

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(3 marks)

(Extra space) .....

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Turn over for the next question

Do not write outside the box

6 Penicillins are antibiotics. Some bacteria produce an enzyme that breaks down one sort of penicillin.

6 (a) The gene that codes for this enzyme may be passed from one species of bacteria to another species. Describe how.

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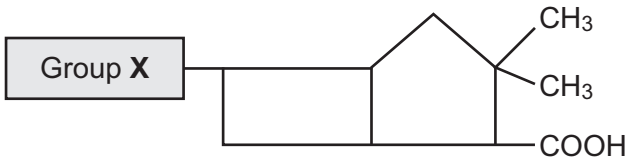
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(2 marks)

6 (b) There are different sorts of penicillin. All of these have the same basic chemical structure shown in the diagram but group **X** is different.



A bacterial infection that cannot be treated with one sort of penicillin can be treated with a different sort. Use your knowledge of enzyme action to explain why the different sort of penicillin is effective in treating the infection.

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(3 marks)

(Extra space) .....

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6 (c) Farmers often keep large numbers of cattle together. Farmers used to give cattle food which had antibiotics added to it.

6 (c) (i) Suggest how adding antibiotics to the food of the cattle increased profit for the farmers.

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(2 marks)

6 (c) (ii) Adding antibiotics to the food of cattle is now banned in many countries. Use your knowledge of selection to explain why adding antibiotics was banned.

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(2 marks)

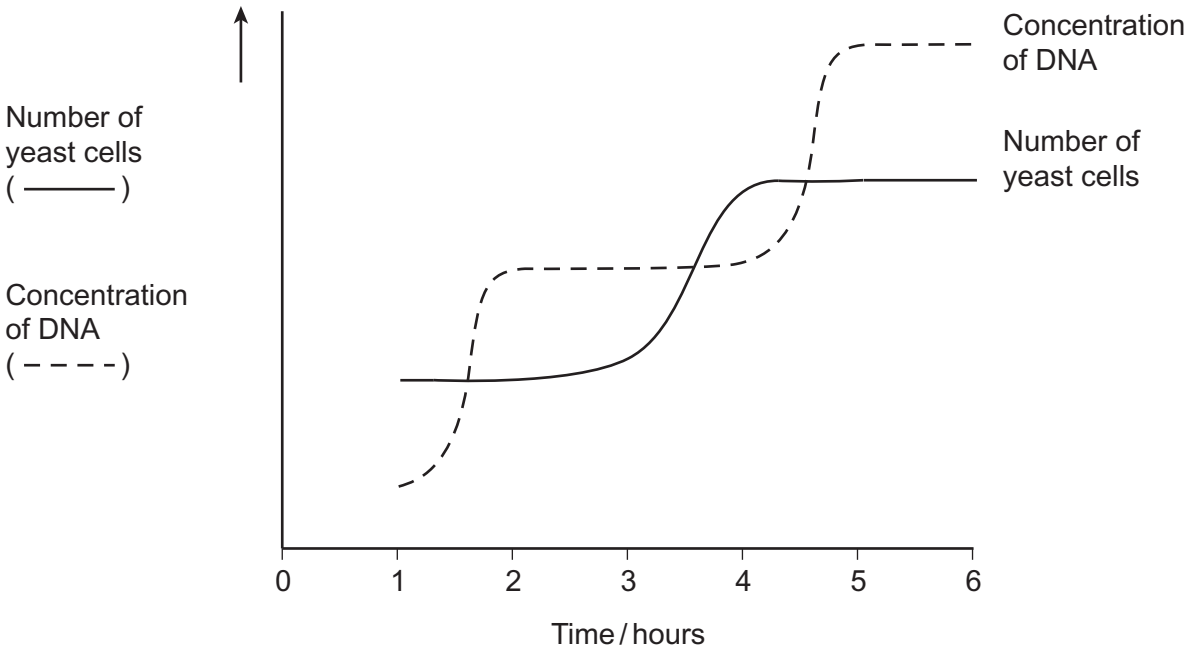
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Turn over for the next question

Do not write outside the box

7 Yeast is a single-celled eukaryotic organism. When yeast cells are grown, each cell forms a bud. This bud grows into a new cell. This allows yeast to multiply because the parent cell is still alive and the new cell has been formed.

Scientists grew yeast cells in a culture. They counted the number of cells present and measured the total concentration of DNA in the culture over a period of 6 hours. Their results are shown in the graph.



Do not write outside the box

7 (a) Use your knowledge of the cell cycle to explain the shape of the curve for the number of yeast cells

7 (a) (i) between 1 and 2 hours

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(1 mark)

7 (a) (ii) between 3 and 4 hours.

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(1 mark)

7 (b) Use the curve for the concentration of DNA to find the length of a cell cycle in these yeast cells. Explain how you arrived at your answer.

Length of cell cycle .....

Explanation .....

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(3 marks)

5

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ANSWER IN THE SPACES PROVIDED

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8 (a) Students measured the rate of transpiration of a plant growing in a pot under different environmental conditions. Their results are shown in the table.

	Conditions		Transpiration rate / g h^{-1}
A	Still air	15 °C	1.2
B	Moving air	15 °C	1.7
C	Still air	25 °C	2.3

During transpiration, water diffuses from cells to the air surrounding a leaf.

8 (a) (i) Suggest an explanation for the difference in transpiration rate between conditions **A** and **B.**

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(2 marks)

8 (a) (ii) Suggest an explanation for the difference in transpiration rate between conditions **A** and **C.**

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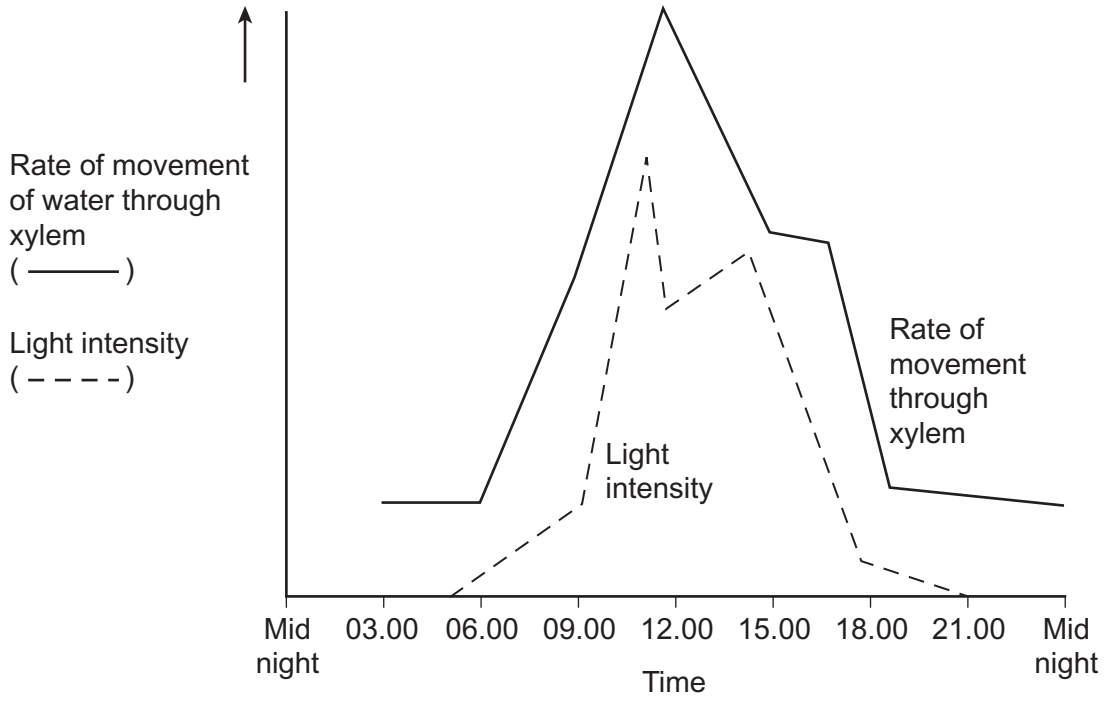
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(2 marks)

Question 8 continues on the next page

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8 (b) Scientists investigated the rate of water movement through the xylem of a twig from a tree over 24 hours. The graph shows their results. It also shows the light intensity for the same period of time.



8 (b) (i) Describe the relationship between the rate of water movement through the xylem and the light intensity.

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(1 mark)

8 (b) (ii) Explain the change in the rate of water movement through the xylem between 06.00 and 12.00 hours.

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(2 marks)

Do not write outside the box

8 (b) (iii) The scientists also measured the diameter of the trunk of the tree on which the twig had been growing. The diameter was less at 12.00 than it was at 03.00 hours. Explain why the diameter was less at 12.00 hours.

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(2 marks)

Question 8 continues on the next page

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8 (c) Arteries and arterioles take blood away from the heart.
Explain how the structures of the walls of arteries and arterioles are related to their functions.

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(6 marks)

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Question 9 starts on page 24

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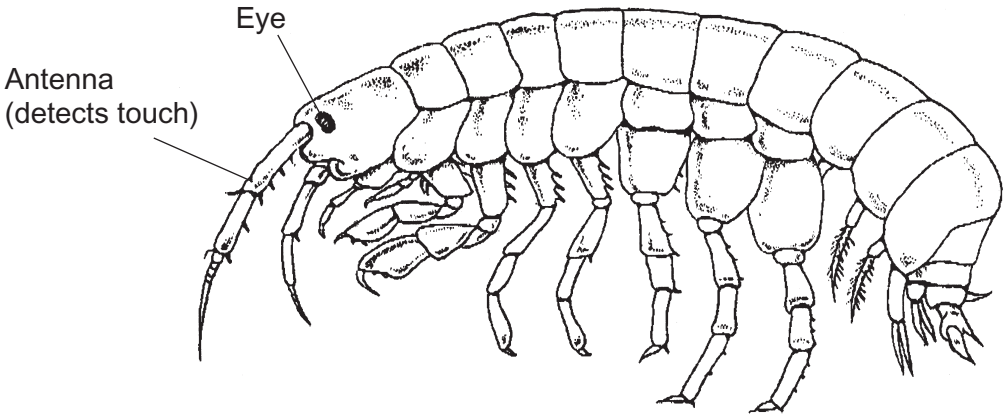
Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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9 **Figure 1** shows a fresh-water shrimp.

Figure 1



Biologists collected shrimps from a stream inside a cave and from the same stream when it was in the open.
They measured the maximum diameter of each shrimp's eye. They also measured the length of its antenna. From these measurements they calculated the mean values for each site. **Figure 2** shows their results.

Figure 2

	Shrimps from the stream	
	inside the cave	**in the open**
Mean diameter of eye / mm	0.09	0.24
Mean length of antenna / mm	8.46	5.81

9 (a) The biologists measured the maximum diameter of each shrimp's eye.
Explain why they measured the **maximum** diameter.

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(1 mark)

Do not write outside the box

9 (b) A scientist working many years earlier suggested that animals which live in caves had similar adaptations. These adaptations included

- smaller eyes
- greater use of sense organs such as those involved in detecting touch.

9 (b) (i) Do the data in **Figure 2** support this scientist's suggestion? Explain your answer.

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(2 marks)

9 (b) (ii) The data in **Figure 2** are mean values. Explain how standard deviations of these mean values would help you to interpret the data in **Figure 2.**

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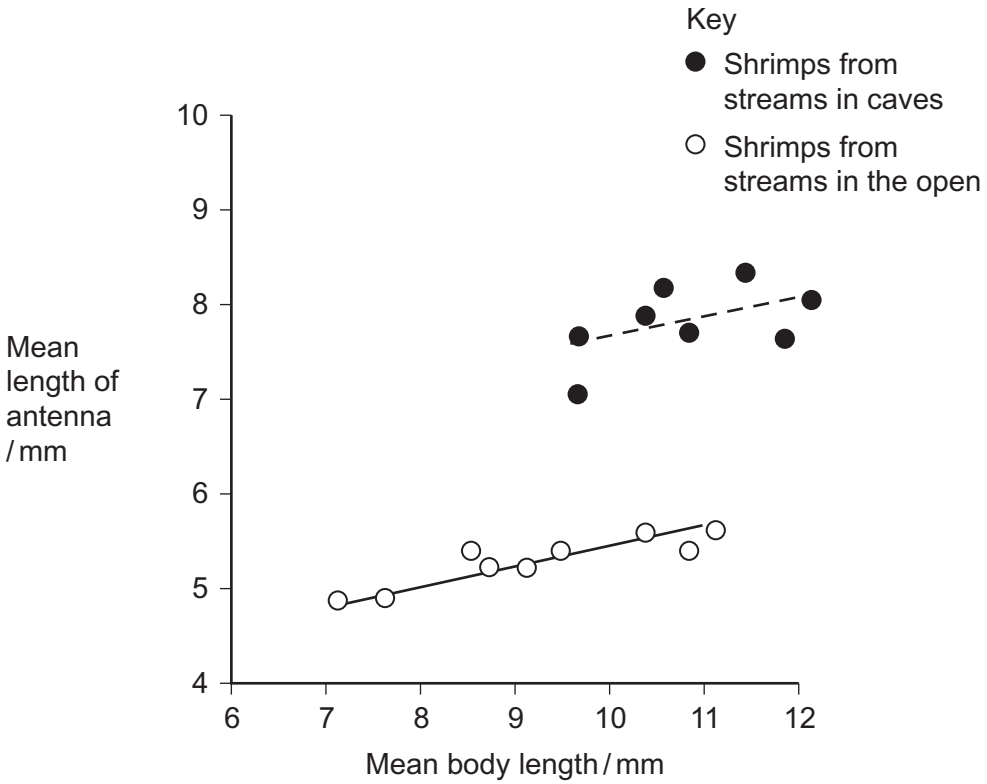
(2 marks)

Question 9 continues on the next page

Do not write outside the box

9 (c) The biologists investigated shrimps living in other streams. They measured the length of the antennae of these shrimps. They also measured their body length. **Figure 3** shows the mean antenna length plotted against mean body length for each site.

Figure 3



9 (c) (i) What does the information in the graph suggest about the body lengths of shrimps living in caves and living in the open?

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(2 marks)

9 (c) (ii) Do the data in the graph support the conclusion that shrimps with longer bodies have longer antennae? Give the reason for your answer.

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(1 mark)

Do not write outside the box

Other biologists investigated the genetic diversity of these shrimps.
Figure 4 shows some of the data they collected.

Figure 4

Gene	Allele	Percentage of shrimps with this allele in stream	
		inside a cave	in the open
PGI	**A**	0.9	2.5
	B	0.0	3.3
	C	98.2	66.4
	D	0.9	6.6
	E	0.0	21.3
ACO2	**J**	0.0	5.6
	K	0.0	76.7
	L	100.0	17.8

9 (d) The biologists concluded that the shrimps in the open had a higher genetic diversity than those in the cave. Explain how the data in **Figure 4** support this conclusion.

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(1 mark)

9 (e) The percentage of shrimps with allele **L** in the cave is different from the percentage of shrimps with allele **L** in the open. Use your knowledge of the founder effect to suggest a reason for this difference.

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(3 marks)

(Extra space) .....

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Question 9 continues on the next page

Do not write outside the box

9 (f) The biologists who studied these shrimps wanted to know if the shrimps living in the cave were the same species as those living in the open. They used breeding experiments to investigate this.

9 (f) (i) Describe how the biologists should carry out these breeding experiments.

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9 (f) (ii) The results of breeding experiments would help the biologists to decide whether the shrimps were the same species. Explain how.

.....

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(3 marks)

15

END OF QUESTIONS

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General Certificate of Education (A-level)
January 2011

Biology BIOL2

(Specification 2410)

Unit 2: The Variety of Living Organisms

Final

Mark Scheme

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the candidates" responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of candidates" scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates" reactions to a particular paper. Assumptions about future mark schemes on the basis of one year"s document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Registered address: AQA, Devas Street, Manchester M15 6EX.

Question	Marking Guidance	Mark	Comments
1(a)	<table><tr><td>✓</td><td>✓</td><td>✓</td><td></td></tr><tr><td></td><td></td><td></td><td>✓</td></tr><tr><td></td><td></td><td>✓</td><td>✓</td></tr></table>	4	One mark for each correct column Mark ticks only and ignore crosses
1(b)	1. Two marks for box round two hydrogens and one of theoxygens from OH groups on carbons 1 and 4;; 2. One mark from incorrect answer involving any two hydrogens and an oxygen from carbons 1 and 4;	2	Do not award marks if all atoms concerned are on same carbon atom or are on carbon atoms other than 1 and 4 or where the answer does not have two hydrogen and one oxygen
1(c)(i)	1. Holds chains/cellulose molecules together/forms cross links between chains/cellulose molecules/forms microfibrils; 2. Providing strength/rigidity (to cellulose/cell wall); 3. Hydrogen bonds strong in large numbers;	2 max	Principles here are first mark for where hydrogen bonds are formed and second for a consequence of this. Accept microfibres
1(c)(ii)	Compact/occupies small space/tightly packed;	1	Answer indicates depth required. Answers such as “good for storage”, “easily stored” or “small” are insufficient.

Question	Marking Guidance	Mark	Comments
2(a)	More that one polypeptide/chain;	1	Ignore references to haem/other groups
2(b)(i)	141;	1	
2(b)(ii)	1. Stop/start sequences; 2. Non coding DNA (in the gene)/introns/multiple repeats/junk DNA; 3. Two chains/a non-coding strand/complementary base pairs; 4. Addition of base by mutation;	2 max	Do not credit "some bases repeated"
2(c)	Different primary structure/amino acids/different number of polypeptide chains;	1	Question is about haemoglobin so do not credit differences in DNA
2(d)	1. Low partial pressure of oxygen; 2. In lungs; 3. (Llama) haemoglobin able to load more oxygen/(llama) haemoglobin saturated (at low/particular partial pressure of oxygen); 4. Higher affinity for oxygen;	3 max	The terms used in the graph (or near approximations) should be used in this answer. Ignore references to unloading The answer must relate to llamas

Question	Marking Guidance	Mark	Comments
3(a)	Kingdom, phylum and class;;	2	Lose 1 mark for each error (i.e. omission or incorrect response). Sequence not essential.
3(b)(i)	Shows evolutionary relationship;	1	
3(b)(ii)	26;	1	
3(c)(i)	1. Base sequence will be similar/some bases in common; 2. These bases will bind together/hydrogen bonds/complementary pairs;	2	Do not accept same here. Accept converse providing that it is clear that the converse argument is being made.
3(c)(ii)	1. Relationship is closer/more complementary bases/more base pairs; 2. More hydrogen bonds; 3. More heat energy needed (to separate bonds);	2 max	Do not allow stronger hydrogen bonds. Not higher temperature as this is in question.

Question	Marking Guidance	Mark	Comments
4(a)(i)	22;	1	
4(a)(ii)	1. Odd number of chromosomes/33 chromosomes (in leaf cell); 2. Chromosomes cannot pair/cannot undergo meiosis/would result in half chromosomes/cannot form haploid cells;	2	
4(b)(i)	Fast growth/ produces crop fast/produces large crop;	1	Do not insist on relative statement. Accept similar terms for fast. E.g. “better” growth Do not accept unqualified references to profit.
4(b)(ii)	Leaves less likely to break/higher breaking strength;	1	
4(c)	Low genetic diversity because they are produced by mitosis; Will all have the same DNA/genes/alleles/ will be genetically identical/will be clones; ***OR*** Low genetic diversity because they are not produced by meiosis; No crossing over/independent segregation/will not be genetically different;	2	Independent segregation is the specification term. Accept other such as random assortment.

Question	Marking Guidance	Mark	Comments
5(a)	Number of a/each (species);	1	Accept answers expressed differently providing they convey this information. Ignore extra information if it does not contradict answer.
5(b)	1. Lower diversity of plants/ few species of plants/less variety of plants/few plant layers; 2. Few sources/types of food/feeding sites; 3. Few habitats/ niches; 4. Fewer (species of) herbivore so few (species of) carnivores; 5. Aspect of agriculture (killing insects);	3 max	Must be a reference to species or kinds, not just fewer insects and fewer plants. Not less food.
5(c)(i)	Cannot predict/ do not know intermediate values;	1	
5(c)(ii)	To see what would happen/ compare <u>with</u> no management work/ to see if numbers fell anyway/ To show that it was not a factor;	1	Management as a term not required. Allow explanations.
5(d)	1. Total <u>number</u> of birds along ditch B/ditch with one side cleared greater than along ditch A/ditch with both sides cleared; 2. But only gives data for all birds/does not give data for species/data not about diversity; 3. Single ditch/single occasion/not repeated/no control;	3	Principles: Correct from evidence Total number not diversity Flaws in technique

Question	Marking Guidance	Mark	Comments
6(a)	1. Horizontal (gene) transmission; 2. (Gene passed by) conjugation/through pilus;	2	Vertical negates horizontal
6(b)	**Shape** 1. Different penicillin has different shape/structure/ enzyme/active site has specific shape/structure; **Binding** 2. No longer fits/binds to active site/not complementary to active site/does not form E-S complex; **Consequence** 3. (Different) penicillin not broken down;	3	Not different
6(c)(i)	1. Kills pathogenic/harmful bacteria/pathogens; 2. Disease less likely/improves health/animals healthier/reduces spread of infection; 3. Faster growth/more productive animals/more food converted to meat/greater survival/lower vet"s bills/increased yield/less energy (for „fighting infection");	2 max	Principles: Action of antibiotic Do not accept stops all disease Action on health Effect on production
6(c)(ii)	1. (Adding antibiotics) selects in favour of antibiotic resistance/resistant bacteria more likely to survive; 2. Increase in numbers/higher proportion of resistant bacteria; 3. May infect humans/may spread resistance to other species/ horizontal transfer;	2 max	Penalise immune only on the first occasion it occurs in this part of the question.

Question	Marking Guidance	Mark	Comments
7(a)(i)	Cells are in interphase;	1	Accept G phase/ S phase.
7(a)(ii)	Cells undergoing mitosis/in telophase/cytokinesis;	1	Accept all named stages but reject prophase, metaphase or anaphase on their own.
7(b)	1. 3 hours; 2. Time between beginnings/endings DNA replication/Increases/levelling outs of DNA concentration/for shape (of curve for replication) to be repeated; 3. (DNA) replication takes place once per cell cycle;	3	Allow close approximation where candidate attempts to be more accurate. Principle What is shown on the graph

Question	Marking Guidance	Mark	Comments
8(a)(i)	1. Removes water vapour/moisture/saturated air; 2. Increases water potential gradient/more diffusion/more evaporation;	2	
8(a)(ii)	1. Increases kinetic energy; 2. Water molecules move faster; 3. Increases diffusion/evaporation;	2 max	
8(b)(i)	Positive correlation/as light intensity increases so does rate of water movement/follows same pattern/directly proportional;	1	
8(b)(ii)	1. Stomata open; 2. Photosynthesis increases/transpiration increases; 3. More water pulled up; 4. Cohesion between water molecules/by cohesion tension;	2 max	
8(b)(iii)	1. Water pulled up trunk/moves up at fast rate; 2. (Water column under) tension; 3. Sticking/adhesion (between water and) cells/walls/xylem; 4. Pulls xylem in;	2 max	Adhesion is not a specification requirement. Accept cohesion in this context

8(c)	**Elastic tissue** 1 Elastic tissue stretches under pressure/when heart beats; 2 Recoils/springs back; 3 Evens out pressure/flow; **Muscle** 4 Muscle contracts; 5 Reduces diameter of lumen/vasoconstriction/constricts vessel; 6 Changes flow/pressure; **Epithelium** 7 Epithelium smooth; 8 Reduces friction/blood clots/less resistance;	6 max	Do not callow credit for expands/contracts/relaxes in this context. From a marking viewpoint ignore all specific references to arteries and arterioles. Consider all points as applying to both. 3. Do accept controls 4 – 6 Accept converse

Question	Marking Guidance	Mark	Comments
9(a)	(So results) can be compared/so measurement is the same each time/because eye is not perfectly round/uniform;	1	Accept eye opens to different amounts
9(b)(i)	1. Eye (diameter) is smaller and antennae longer; 2. Antennae detecting touch; 3. Data only refers to shrimps/data may not apply to all animals/only in one area;	2 max	The principle here is that candidate has recognised that both features confirm suggestion. Exact wording does not matter.
9(b)(ii)	1. Standard deviation gives a measure of spread/variation; 2. More standard deviations overlap, the less likely it is that differences are real/significant/the more likely they are caused by chance;	2	Do not accept range Accept converse. Although we are looking for the idea of significance, we cannot require this term.
9(c)(i)	Qualitative statement about difference in size/ difference in variation/ overlap in size; Quantitative statement about difference in size/ difference in variation/ overlap in size; Supported by relevant two sets of figures from graph;;	2	Note simplistic answer involving a quantitative statement gains 1 mark. More specific answer involving quantitative information gains 2 marks.

9(c)(ii)	(No) for same body length, antenna are longer/antenna are shorter/some with longer body have short antennae/some with shorter body length have longer antennae; ***OR*** (Yes) positive correlation in open/in cave;	1	Habitat not critical as a term. Must refer to idea of same habitat Accept description
9(d)	More alleles of each gene/shrimps in open have all the alleles;	1	Candidates are required to use the information from the table. Must therefore refer to alleles.
9(e)	1. A small number of shrimps were /went into the cave; 2. All/high proportion of shrimps had allele L; 3. Cave population descended from these/these reproduce;	3	
9(f)(i)	1. Cross shrimps from two sites/watch courtship; 2. Breed young together/observe mating; 3. Allow 1 mark for any method of improving quality of results e.g. carry out reciprocal crosses/large number of crosses/isolate beforehand;		Other valid equivalent suggestions should be accepted.
9(f)(ii)	1. If same species the shrimps would breed, producing fertile young/courtship species specific;	3	Accept any form of evidence – mating/laying eggs/giving birth to young.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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10	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2010

Biology BIOL2

Unit 2 The variety of living organisms

Tuesday 19 January 2010 1.30 pm to 3.15 pm

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 85.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Areas outside the box will not be scanned for marking

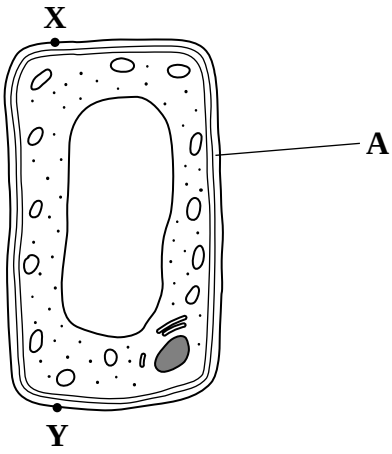
Answer **all** questions in the spaces provided.

1 (a) Name the process in which cells become adapted for different functions.

.....

(1 mark)

1 (b) Palisade cells are found in leaves. The diagram shows a palisade cell.



1 (b) (i) Name structure **A**.

.....

(1 mark)

1 (b) (ii) The real length of this cell between **X** and **Y** is 20 micrometres (μm). By how many times has it been magnified? Show your working.

Answer .....

(2 marks)

1 (b) (iii) Explain **one** way in which this cell is adapted for photosynthesis.

.....

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(1 mark)

5

Areas outside the box will not be scanned for marking

2 In 2002, biologists identified a new group of insects. They called these insects gladiators.

2 (a) (i) *Mantophasma zephyra* is one species of gladiator. Complete the table to show how this species is classified.

Kingdom	Animalia
	Arthropoda
	Insecta
	Notoptera
Family	Mantophasmatodae
Species	

(2 marks)

2 (a) (ii) This system of classification consists of a hierarchy. Explain what is meant by a hierarchy.

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(2 marks)

2 (b) In 2002, very few gladiators were available for identification. Scientists around the world used photographs to establish the relationship of gladiators to other insects. Explain how.

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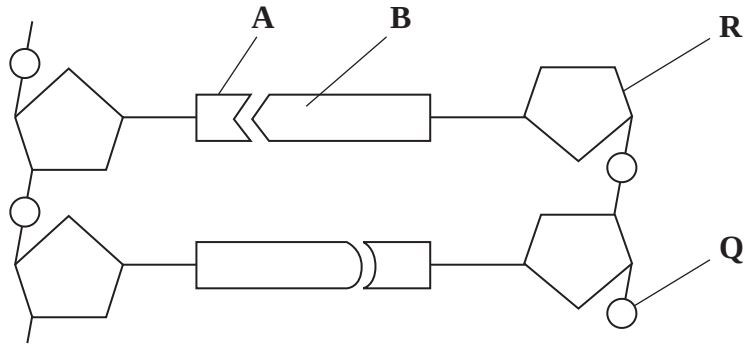
(1 mark)

5

Areas outside the box will not be scanned for marking

3 **Figure 1** shows a short section of a DNA molecule.

Figure 1



3 (a) Name parts **R** and **Q**.

3 (a) (i) **R** .....

3 (a) (ii) **Q** .....

(2 marks)

3 (b) Name the bonds that join **A** and **B**.

.....

(1 mark)

3 (c) Ribonuclease is an enzyme. It is 127 amino acids long.

What is the minimum number of DNA bases needed to code for ribonuclease?

(1 mark)

Areas outside the box will not be scanned for marking

3 (d) **Figure 2** shows the sequence of DNA bases coding for seven amino acids in the enzyme ribonuclease.

Figure 2

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

The number of each type of amino acid coded for by this sequence of DNA bases is shown in the table.

Amino acid	Number present
Arg	3
Met	2
Gln	1
Asn	1

Use the table and **Figure 2** to work out the sequence of amino acids in this part of the enzyme. Write your answer in the boxes below.

Gln						

(1 mark)

3 (e) Explain how a change in a sequence of DNA bases could result in a non-functional enzyme.

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(3 marks)

(Extra space) .....

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8

Turn over ▶

Areas outside the box will not be scanned for marking

4 (a) An increase in respiration in the tissues of a mammal affects the oxygen dissociation curve of haemoglobin. Describe and explain how.

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(2 marks)

4 (b) There is less oxygen at high altitudes than at sea level.

4 (b) (i) People living at high altitudes have more red blood cells than people living at sea level. Explain the advantage of this to people living at high altitude.

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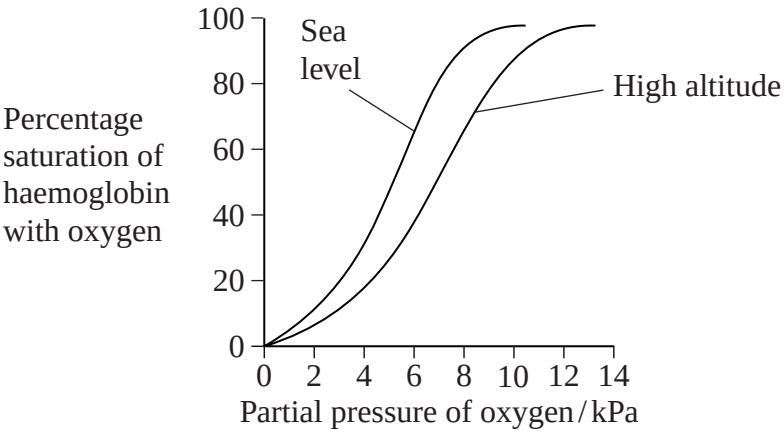
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(2 marks)

4 (b) (ii) The graph shows oxygen dissociation curves for people living at high altitude and for people living at sea level.



Explain the advantage to people living at high altitude of having the oxygen dissociation curve shown in the graph.

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(2 marks)

6

Areas outside the box will not be scanned for marking

5 A student found the number of stomata per cm^2 on the lower surface of a daffodil leaf. He removed a small, thin piece of lower epidermis and mounted it on a microscope slide. He examined the slide using an optical microscope.

5 (a) Explain why it was important that the piece of the epidermis that the student removed was thin.

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(2 marks)

5 (b) Suggest how the student could have used his slide to find the number of stomata per cm^2.

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(3 marks)

(Extra space) .....

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5 (c) The stomata on the leaves of pine trees are found in pits below the leaf surface. Explain how this helps to reduce water loss.

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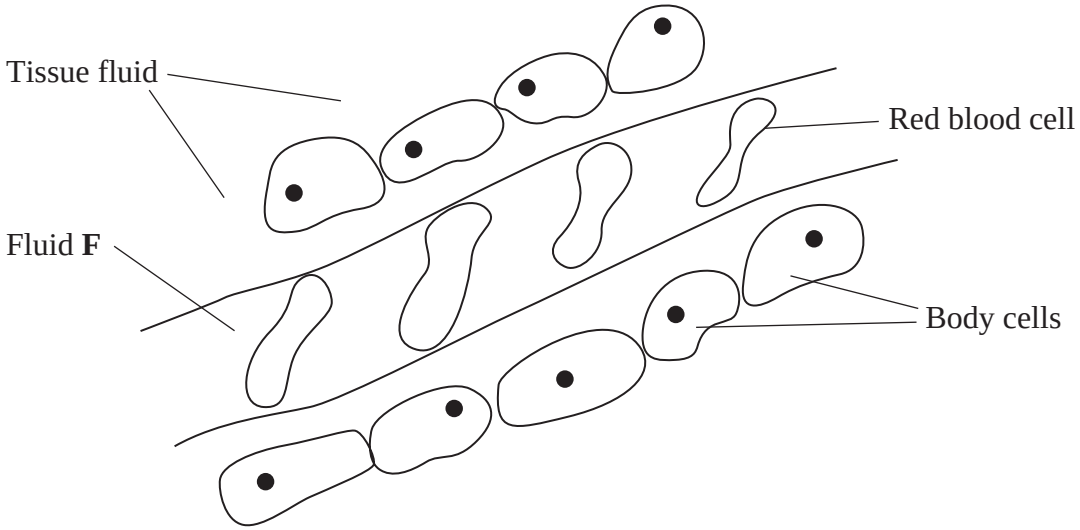
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(2 marks)

7

Areas outside the box will not be scanned for marking

6 The diagram shows tissue fluid and cells surrounding a capillary.



6 (a) Name fluid **F**.

.....

(1 mark)

6 (b) Give **one** way in which fluid **F** is different from tissue fluid.

.....

(1 mark)

6 (c) (i) The blood pressure is high at the start of the capillary. Explain how the left ventricle causes the blood to be at high pressure.

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(1 mark)

6 (c) (ii) The blood pressure decreases along the length of the capillary. What causes this decrease in pressure?

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(1 mark)

Areas outside the box will not be scanned for marking

6 (d) In children, some diets may result in a low concentration of protein in fluid **F**. This can cause the accumulation of tissue fluid. Explain the link between a low concentration of protein in fluid **F** and the accumulation of tissue fluid.

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(3 marks)

(Extra space) .....

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7

Turn over for the next question

Areas outside the box will not be scanned for marking

7 (a) Heath is a community of plants and animals. A student investigated the species diversity of plants in this community. The table shows her results.

Plant species	**Number of plants per m^2**
Heath rush	1
Bilberry	1
Sheep's sorrel	5
Ling	2
Bell heather	1
Heath bedstraw	8
Mat-grass	11

7 (a) (i) The index of diversity can be calculated from the formula

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

where

d = index of diversity
N = total number of organisms of all species
n = total number of organisms of each species.

Use this formula to calculate the index of diversity for the plants on the heath. Show your working.

Answer .....

(2 marks)

Areas outside the box will not be scanned for marking

7 (a) (ii) Explain why it may be more useful to calculate the index of diversity than to record only the number of species present.

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(2 marks)

7 (b) The demand for increased food production has led to areas of heath being used to grow wheat. Explain the effect of this on

7 (b) (i) the species diversity of plants

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(2 marks)

7 (b) (ii) the species diversity of animals.

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(2 marks)

8

Turn over ▶

Areas outside the box will not be scanned for marking

8 (a) Gas exchange in fish takes place in gills. Explain how **two** features of gills allow efficient gas exchange.

1 .....

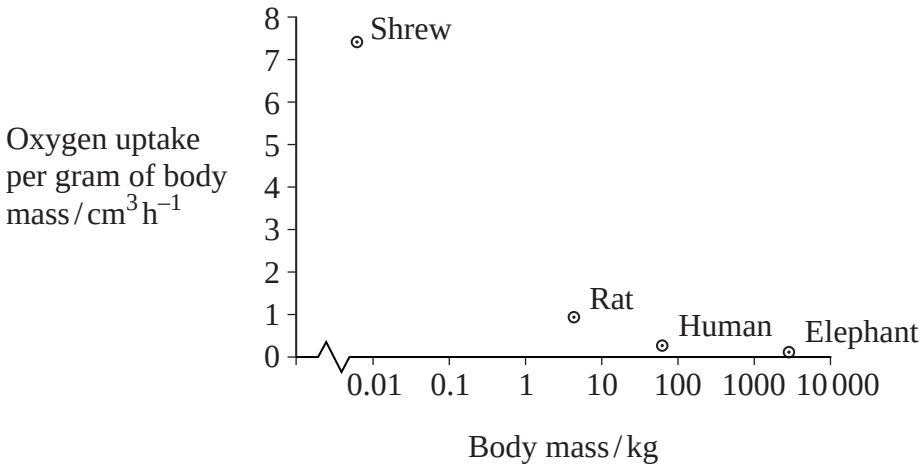
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(2 marks)

8 (b) A zoologist investigated the relationship between body mass and rate of oxygen uptake in four species of mammal. The results are shown in the graph.



8 (b) (i) The scale for plotting body mass is a logarithmic scale. Explain why a logarithmic scale was used to plot body mass.

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(1 mark)

8 (b) (ii) Describe the relationship between body mass and oxygen uptake.

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(1 mark)

Areas outside the box will not be scanned for marking

8 (b) (iii) The zoologist measured oxygen uptake per gram of body mass. Explain why he measured oxygen uptake per gram of body mass.

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(2 marks)

8 (b) (iv) Heat from respiration helps mammals to maintain a constant body temperature. Use this information to explain the relationship between body mass and oxygen uptake shown in the graph.

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(3 marks)

(Extra space) .....

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9

Areas outside the box will not be scanned for marking

9 Taxol is a drug used to treat cancer. Research scientists investigated the effect of injecting taxol on the growth of tumours in mice. Some of the results are shown in **Figure 3**.

Figure 3

Number of days of treatment	Mean volume of tumour / mm^3	
	Control group	Group injected with taxol in saline
1	1	1
10	7	2
20	21	11
30	43	20
40	114	48
50	372	87

9 (a) Suggest how the scientists should have treated the control group.

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(2 marks)

9 (b) Suggest and explain **two** factors which should be considered when deciding the number of mice to be used in this investigation.

1 .....

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2 .....

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(2 marks)

Areas outside the box will not be scanned for marking

9 (c) The scientists measured the volume of the tumours. Explain the advantage of using volume rather than length to measure the growth of tumours.

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(1 mark)

9 (d) The scientists concluded that taxol was effective in reducing the growth rate of the tumours over the 50 days of treatment. Use suitable calculations to support this conclusion.

(2 marks)

9 (e) In cells, taxol disrupts spindle activity. Use this information to explain the results in the group that has been treated with taxol.

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(3 marks)

(Extra space) .....

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Question 9 continues on the next page

Areas outside the box will not be scanned for marking

9 (f) The research scientists then investigated the effect of a drug called OGF on the growth of tumours in mice. OGF and taxol were injected into different mice as separate treatments or as a combined treatment. **Figure 4** and **Figure 5** show the results from this second investigation.

Figure 4

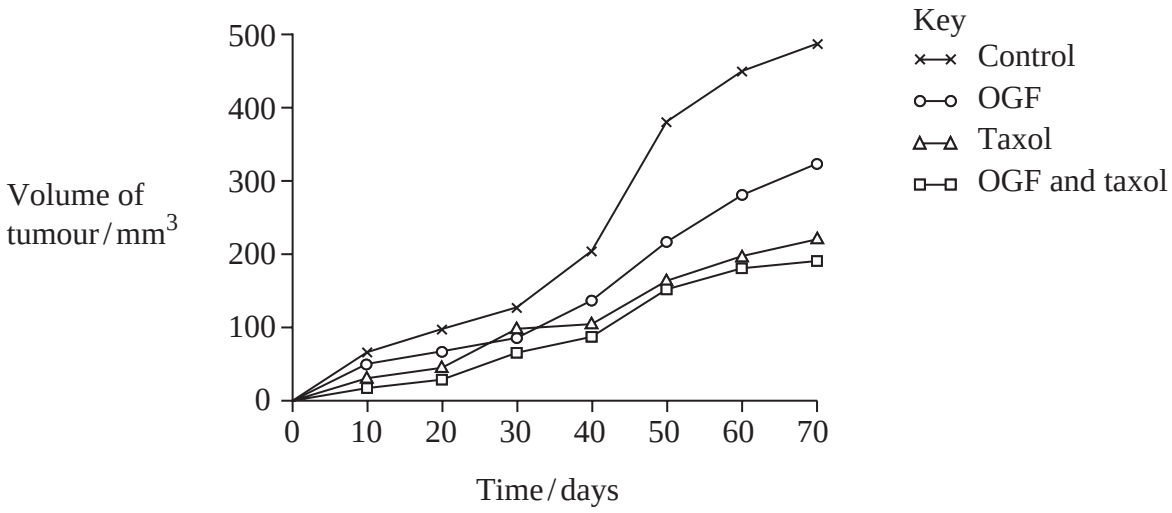


Figure 5

Treatment	**Mean volume of tumour following 70 days treatment / mm^3 (± standard deviation)**
OGF	322 (± 28.3)
Taxol	207 (± 22.5)
OGF and taxol	190 (± 25.7)
Control	488 (± 32.4)

Areas outside the box will not be scanned for marking

9 (f) (i) What information does standard deviation give about the volume of the tumours in this investigation?

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(1 mark)

9 (f) (ii) Use **Figure 4** and **Figure 5** to evaluate the effectiveness of the two drugs when they are used separately and as a combined treatment.

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(4 marks)

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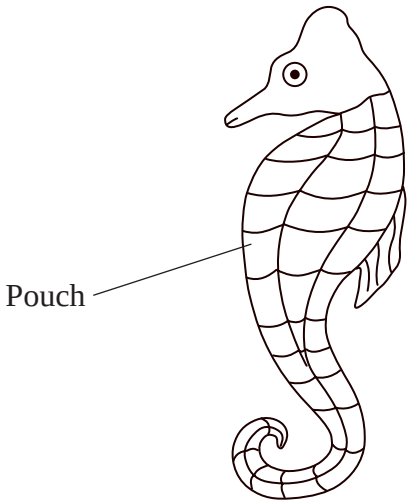
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15

Areas outside the box will not be scanned for marking

10 The diagram shows a seahorse. A seahorse is a fish. Mating in seahorses begins with courtship behaviour. After this, the female transfers her unfertilised eggs to the male's pouch.
Most male fish fertilise eggs that have been released into the sea. However, a male seahorse fertilises the eggs while they are inside his pouch. The fertilised eggs stay in the pouch where they develop into young seahorses.



10 (a) Give **two** ways in which courtship behaviour increases the probability of successful mating.

1 .....

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2 .....

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(2 marks)

10 (b) Give **one** way in which reproduction in seahorses increases the probability of

10 (b) (i) fertilisation

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(1 mark)

10 (b) (ii) survival of young seahorses.

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(1 mark)

Areas outside the box will not be scanned for marking

Scientists investigated the effect of total body length on the selection of a mate in one Australian species of seahorse. The scientists used head length as a measure of total body length.

10 (c) (i) Use the diagram to suggest why the scientists measured head length rather than total body length.

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(1 mark)

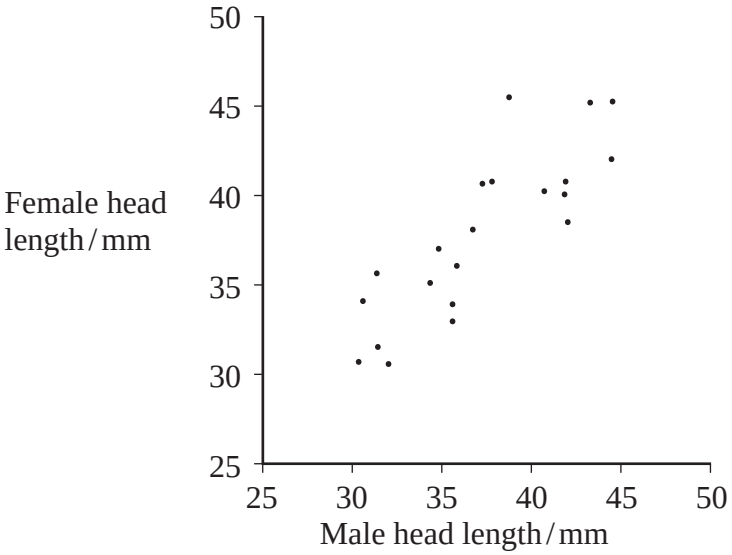
10 (c) (ii) Suggest why the scientists were able to use head length as a measure of total body length.

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(1 mark)

The scientists measured the head lengths of the female and male of a number of pairs. The results are shown in the graph.



10 (d) The scientists concluded that total body length affects the selection of a mate. Explain how the results support this conclusion.

.....

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(1 mark)

Question 9 continues on the next page

Areas outside the box will not be scanned for marking

10 (e) A female with a head length of 50 mm selected a mate. Explain how you could use the graph to predict the total head length of the mate selected.

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(2 marks)

10 (f) Scientists studied two species of North American seahorse. They thought that these two species are closely related. Describe how comparisons of biological molecules in these two species could be used to find out if they are closely related.

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(6 marks)

(Extra space) .....

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END OF QUESTIONS

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15

Version 1.0: 11/01/10

General Certificate of Education

Biology 1411

BIOL2 The variety of living organisms

Mark Scheme

2010 examination - January series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Registered address: AQA, Devas Street, Manchester M15 6EX *Dr Michael Cresswell Director General*

Question	Part	Marking Guidance	Mark	Comments
1	(a)	Differentiation/specialisation	1	
1	(b)(i)	(cellulose) Cell wall;	1	
1	(b)(ii)	Two marks for correct answer 2350– 2500;; One mark for a measured length divided by real length;	 2	Accept measured and real lengths in different units for one mark.
1	(b)(iii)	Chloroplasts absorb light; Large vacuole pushes chloroplasts to edge (of cell); Thin/permeable (cell) wall to absorb carbon dioxide;	 1 max	**Q** Do not accept chlorophyll as alternative to chloroplasts

Question	Part	Marking Guidance	Mark	Comments
2	(a)(i)	Phylum, Class, Order, Genus; Mantophasma (M)/(Mantophasma) zephyra;	 2	
2	(a)(ii)	Groups within (larger) groups; No overlap;	 2	
2	(b)	Comparison of/look for similar features/structures/appearance;	1	

Question	Part	Marking Guidance	Mark	Comments
3	(a)(i)	Deoxyribose;	1	pentose / 5C sugar = neutral
3	(a)(ii)	Phosphate/Phosphoric acid;	1	phosphorus/P = neutral
3	(b)	Hydrogen (bonds);	1	
3	(c)	381/384/387;	1	
3	(d)	(Gln) Met Met Arg Arg Arg Asn;	1	
3	(e)	Change in (sequence of) amino acids/primary structure; Change in hydrogen/ionic/disulfide bonds; Alters tertiary structure/active site (of enzyme); Substrate cannot bind / no enzyme-substrate complexes form;	3 max	**Q** Reject = different amino acids are formed

Question	Part	Marking Guidance	Mark	Comments
4	(a)	Increase in/more carbon dioxide; Curve moves to the right/depressed;	2	**Q** Any reference to haemoglobin increasing affinity for oxygen disqualifies second mark point.
4	(b)(i)	More haemoglobin; So can load/pick up more oxygen (in the lungs);	2	**Q** Second mark point must relate to idea of loading oxygen. Answers referring only to transport of oxygen should not be credited this mark.
4	(b)(ii)	(Haemoglobin) has lower affinity for oxygen / more oxygen released; In/to the cells/ tissues;	2	

Question	Part	Marking Guidance	Mark	Comments
5	(a)	Single layer of cells / few layers of cells; So that light that can pass through / cells absorb light;	2	
5	(b)	Method of determining area of field of view/area seen using microscope; Count number of stomata in field of view; Repeats and calculation of mean;	3	
5	(c)	Water <u>vapour</u> accumulates / increased humidity/ reduced air movement (around stomata); Water potential/diffusion gradient reduced;	2	

Question	Part	Marking Guidance	Mark	Comments
6	(a)	(Blood) plasma;	1	
6	(b)	More/larger proteins / less urea/carbon dioxide / more glucose/amino acids/fatty acids/oxygen/ high(hydrostatic) pressure;	1	**Q** Reference to blood cells/water potential = neutral **Q** No Protein should not be credited
6	(c)(i)	Contracts;	1	**Q** Do not accept pumping of heart/heart beating
6	(c)(ii)	Loss of fluid/volume; Friction/resistance (of capillary wall);	1 max	**Q** Reference to a narrow lumen is not sufficient to gain a mark unless friction or resistance is mentioned.
6	(d)	Water potential (in capillary) not as low/is higher/less negative / water potential gradient is reduced; More tissue fluid formed (at arteriole end); Less/no water absorbed (into blood capillary); by osmosis; (into blood capillary);	3 max	**Q** The last two marking points must be in context of movement into the blood capillary

Question	Part	Marking Guidance	Mark	Comments
7	(a)(i)	Two marks for correct answer of 4.3; One mark for incorrect answer that clearly shows understanding of ∑n(n-1) /188 as denominator;	2	**Q** An answer of 4 scores 1 mark
7	(a)(ii)	Measures number of individuals (of each species) and number of species; Some species only present in small numbers;	2	**Q** First marking point can only be awarded if there is a reference to species.
7	(b)(i)	Reduced as one crop/species grown / other species removed; Use of herbicides/weeding/ploughing; Wheat (better) competitor for named factor e.g. light/nutrients;	2 max	
7	(b)(ii)	(Reduced) as less variety of food sources; (Reduced) as fewer habitats/niches; (Reduced) by pesticides/chemicals;	2 max	**Q** Answers only referring to 'less food' should not be credited

Question	Part	Marking Guidance	Mark	Comments
8	(a)	Filaments/lamellae provide large surface area; Thin/flattened epithelium/ one/two cell layers so short diffusion pathway (between water and blood); Countercurrent/blood flow maintains concentration/diffusion gradient;	2 max	**Q** Do not credit thin cell walls/membranes
8	(b)(i)	Large/wide range of values (so can fit on graph);	1	
8	(b)(ii)	Decrease in uptake with increase in mass / negative correlation;	1	
8	(b)(iii)	Enables comparison; As animals differ in size/mass;	2	
8	(b)(iv)	Smaller animals have larger surface area to volume ratio; Lose more heat per gram of tissue; Respire more/faster (relative to body mass); Oxygen used in respiration;	3 max	Allow converse for larger animals. Allow appropriately named animal as an alternative to smaller or larger animals.

Question	Part	Marking Guidance	Mark	Comments
9	(a)	Given only saline; Otherwise treated exactly the same way;	2	
9	(b)	Ethical consideration, e.g., leads to death/suffering of mice; Large number to improve reliability / reduce sampling error; Number of mice related to cost/space available/animal husbandry;	2 max	
9	(c)	Vary in shape / do not grow uniformly;	1	**Q** Allow descriptions of variation in shape.
9	(d)	7.44 and 1.74;; 7.42 and 1.72;; (Ratio) 4.28 : 1;; (Ratio) 4.31 : 1;; (Percentage decrease) 76.6%;; (Percentage decrease) 76.8%;;	2 max	Any of the answers shown gain two marks. An answer of 23.4% or 23.2% Percentage decrease gains one mark. Correct method of calculating rate/ratio/percentage increase with an incorrect answer gains one mark.
9	(e)	Reference to Mitosis; As chromosomes cannot attach (to spindle)/ chromatids cannot separate (on spindle); Cell division/cell cycle slows down;	3	**Q** Do not penalise confusion between chromosomes and chromatids in second marking point **Q** Mitosis slows down = 2 marks **Q** Mitosis stopped = 1mark **Q** Mitosis must be spelt correctly
9	(f)(i)	(Degree of) spread/variation from the mean;	1	

9	(f)(ii)	Both chemicals (on their own) slow down growth/are effective; Taxol is more effective than OGF; Combined treatment (seems) most effective; <u>SD overlap</u> for OGF with taxol and taxol (on its own) so not conclusive/could be chance/both treatments could be equally effective;	4	**Q** Ignore all references to significance

Question	Part	Marking Guidance	Mark	Comments
10	(a)	Recognition of same species; Stimulates release of gametes; Recognition of mate/opposite gender; Indication of sexual maturity/fertility;	2 max	
10	(b)(i)	Internal fertilisation / fertilisation occurs in pouch/limited area;	1	**Q** The term fertilisation is not required in the answer but must be implied.
10	(b)(ii)	Protection from predators (developing in pouch);	1	
10	(c)(i)	Less stress caused to seahorse / quicker/more accurate method / body is curved / head is linear;	1	**Q** Do not accept “easier” unless qualified.
10	(c)(ii)	Head length proportional to body length/or described;	1	
10	(d)	Positive correlation between head/body lengths of male and female/ female and male with similar head/body lengths pair together;	1	
10	(e)	Use line of best fit; And extrapolate/extend line as required;	2	

10	(f)	(Compare) DNA; Sequence of bases/nucleotides; DNA hybridisation; Separate DNA strands / break hydrogen bonds; Mix DNA/strands (of different species); Temperature/heat required to separate (hybrid) strands indicates relationship; Compare same/named protein; Sequence of amino acids /primary structure; <u>Immunological evidence</u> – not a mark Inject (seahorse) protein/serum into animal; (Obtain) antibodies/serum; Add protein/serum/plasma from other (seahorse) species; Amount of precipitate indicates relationship;	6 max	**Q** The marks awarded for reference to DNA and sequence of bases/nucleotides must be in a different context to DNA hybridisation.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
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TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2010

Biology BIOL2

Unit 2 The variety of living organisms

Tuesday 8 June 2010 9.00 am to 10.45 am

For this paper you must have:
- a ruler with millimetre measurements.
- a calculator.

Time allowed
- 1 hour 45 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 85.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

Answer **all** questions in the spaces provided.

1 (a) Give **one** feature of starch and explain how this feature enables it to act as a storage substance.

Feature .....

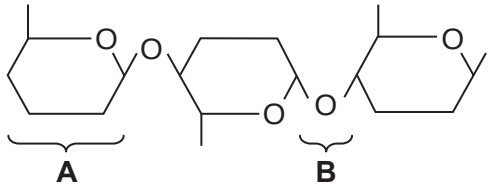
Explanation .....

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(2 marks)

1 (b) The diagram shows part of a cellulose molecule.



1 (b) (i) Name part **A**.

.....

(1 mark)

1 (b) (ii) Name bond **B**.

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(1 mark)

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1 (c) The structure of cellulose is related to its role in plant cell walls. Explain how.

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(3 marks)

(Extra space) .....

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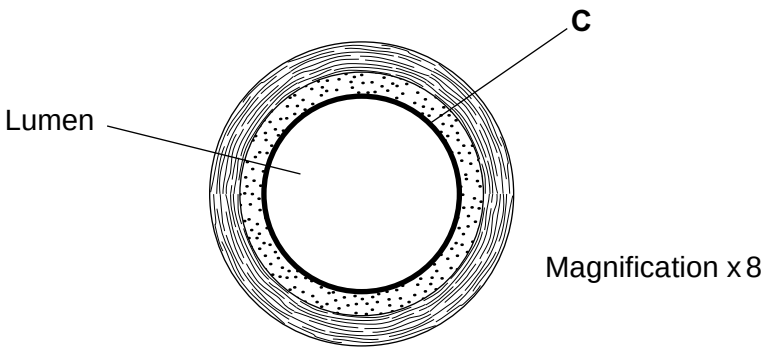
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7

Turn over for the next question

Do not write outside the box

2 The diagram shows a cross-section of a blood vessel.



2 (a) Name layer **C**.

.....

(1 mark)

2 (b) Calculate the actual diameter of the lumen of this blood vessel in millimetres. Show your working.

Answer ..... mm

(2 marks)

2 (c) The aorta has many elastic fibres in its wall. An arteriole has many muscle fibres in its wall.

2 (c) (i) Explain the importance of elastic fibres in the wall of the aorta.

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(2 marks)

2 (c) (ii) Explain the importance of muscle fibres in the wall of an arteriole.

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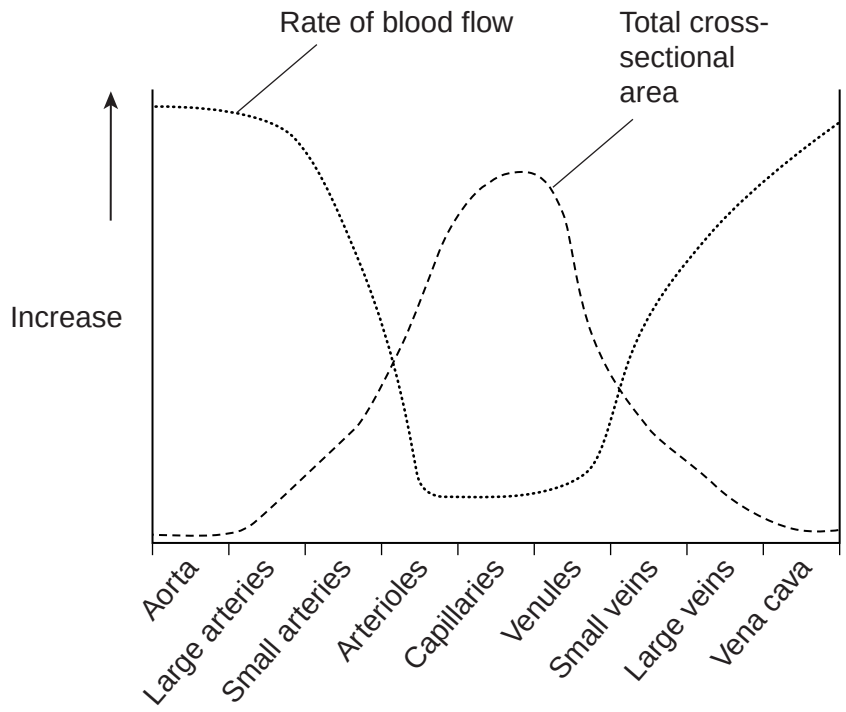
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(2 marks)

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2 (d) The graph shows the rate of blood flow in different blood vessels. It also shows the total cross-sectional area of these blood vessels.



2 (d) (i) The rate of blood flow decreases from the aorta to the capillaries. Use information from the graph to explain why.

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(1 mark)

2 (d) (ii) Efficient exchange of substances in the capillaries is linked to the rate of blood flow. Explain how.

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(1 mark)

9

Turn over ▶

Do not write outside the box

3 (a) What name is used for the non-coding sections of a gene?

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(1 mark)

Figure 1 shows a DNA base sequence. It also shows the effect of two mutations on this base sequence. **Figure 2** shows DNA triplets that code for different amino acids.

Figure 1

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Amino acid sequence												
Mutation **1** DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation **2** DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

Figure 2

DNA triplets	**Amino acid**
GGT, GGC, GGA, GGG	Gly
GTT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser
CTC, CTT, CTA, CTG	Leu

3 (b) Complete **Figure 1** to show the sequence of amino acids coded for by the original DNA base sequence. *(1 mark)*

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3 (c) Some gene mutations affect the amino acid sequence. Some mutations do not. Use the information from **Figure 1** and **Figure 2** to explain

3 (c) (i) whether mutation **1** affects the amino acid sequence

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(2 marks)

3 (c) (ii) how mutation **2** could lead to the formation of a non-functional enzyme.

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(3 marks)

(Extra space) .....

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3 (d) Gene mutations occur spontaneously.

3 (d) (i) During which part of the cell cycle are gene mutations most likely to occur?

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(1 mark)

3 (d) (ii) Suggest an explanation for your answer.

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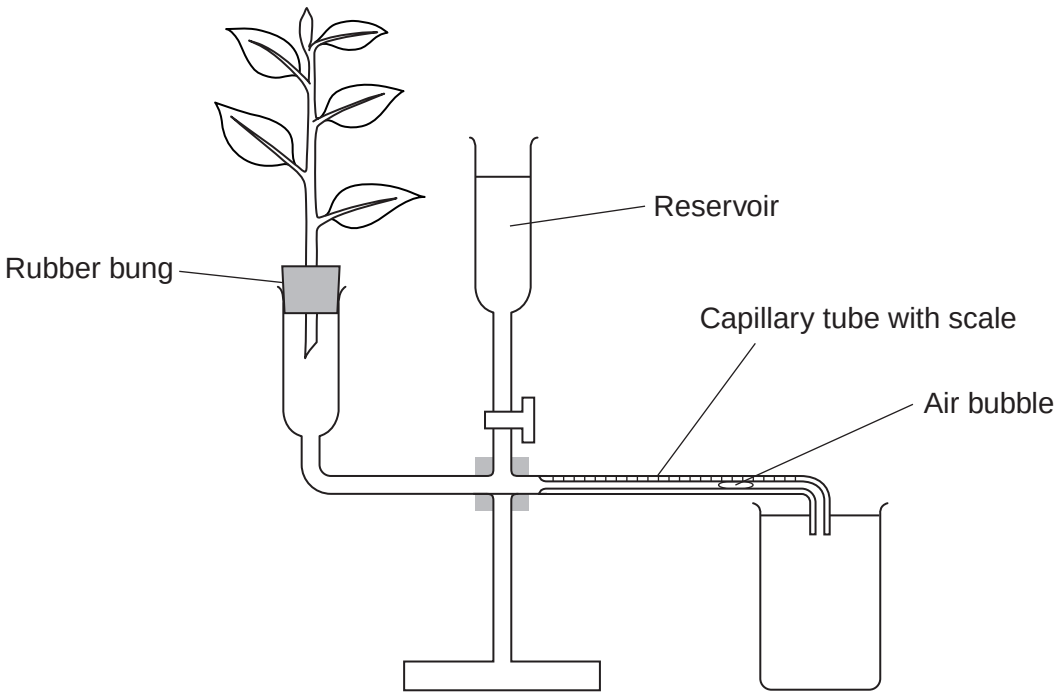
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(1 mark)

9

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4 A student investigated the rate of transpiration from a leafy shoot. She used a potometer to measure the rate of water uptake by the shoot. The diagram shows the potometer used by the student.



4 (a) Give **one** environmental factor that the student should have kept constant during this investigation.

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(1 mark)

4 (b) The student cut the shoot and put it into the potometer under water. Explain why.

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(1 mark)

Do not write outside the box

4 (c) The student wanted to calculate the rate of water uptake by the shoot in cm^3 per minute. What measurements did she need to make?

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(2 marks)

4 (d) The student assumed that water uptake was equivalent to the rate of transpiration. Give **two** reasons why this might **not** be a valid assumption.

1. .....

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2. .....

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(2 marks)

4 (e) The student measured the rate of water uptake three times.

4 (e) (i) Suggest how the reservoir allows repeat measurements to be made.

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(1 mark)

4 (e) (ii) Suggest why she made repeat measurements.

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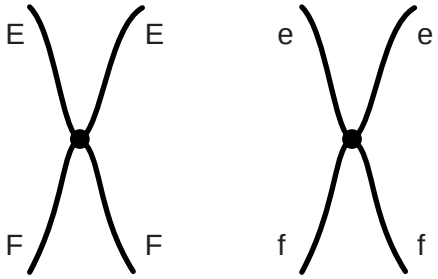
(1 mark)

8

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5 **Figure 3** shows a pair of chromosomes at the start of meiosis. The letters represent alleles.

Figure 3



5 (a) What is an allele?

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(1 mark)

5 (b) Explain the appearance of one of the chromosomes in **Figure 3**.

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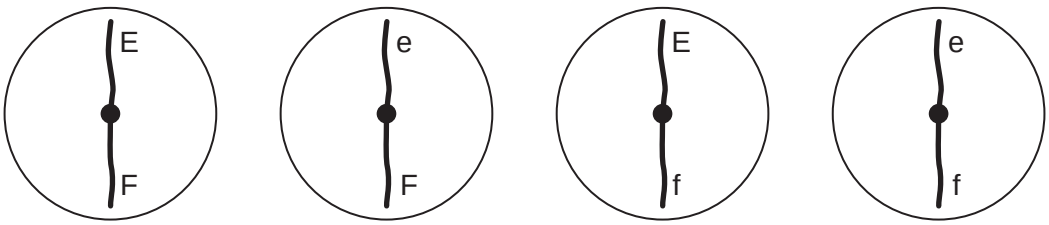
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(2 marks)

5 (c) The cell containing this pair of chromosomes divided by meiosis. **Figure 4** shows the distribution of chromosomes from this pair in four of the gametes produced.

Figure 4



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5 (c) (i) Some of the gametes formed during meiosis have new combinations of alleles. Explain how the gametes with the combinations of alleles Ef and eF have been produced.

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(2 marks)

5 (c) (ii) Only a few gametes have the new combination of alleles Ef and eF. Most gametes have the combination of alleles EF and ef. Suggest why only a few gametes have the new combination of alleles, Ef and eF.

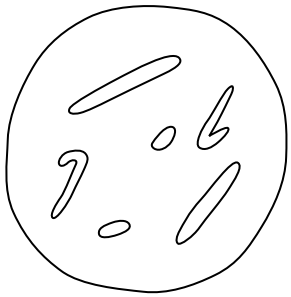
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(1 mark)

5 (d) **Figure 5** shows a cell with six chromosomes.

Figure 5



5 (d) (i) This cell produces gametes by meiosis. Draw a diagram to show the chromosomes in one of the gametes.

(2 marks)

5 (d) (ii) How many different types of gametes could be produced from this cell as a result of different combinations of maternal and paternal chromosomes? *(1 mark)*

9

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ANSWER IN THE SPACES PROVIDED

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6 Cytochrome c is a protein found in all eukaryotes. In humans it consists of 102 amino acids. Biologists have compared the amino acid sequence in some other species with that in humans. The table shows amino acids 9 to 13 in the amino acid sequences of cytochrome c from four species.

	Amino acid in this position in cytochrome c				
Species	9	10	11	12	13
Human	Ile	Phe	Ile	Met	Lys
Chicken	Ile	Phe	Val	Gln	Lys
Dogfish	Val	Phe	Val	Gln	Lys
Chimpanzee	Ile	Phe	Ile	Met	Lys

6 (a) What do the results suggest about the relationship between humans and the other three species?

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(2 marks)

6 (b) Suggest **one** advantage of using cytochrome c to determine relationships between species.

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(1 mark)

6 (c) Comparing the base sequence of a gene provides more information than comparing the amino acid sequence for which the gene codes. Explain why.

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(2 marks)

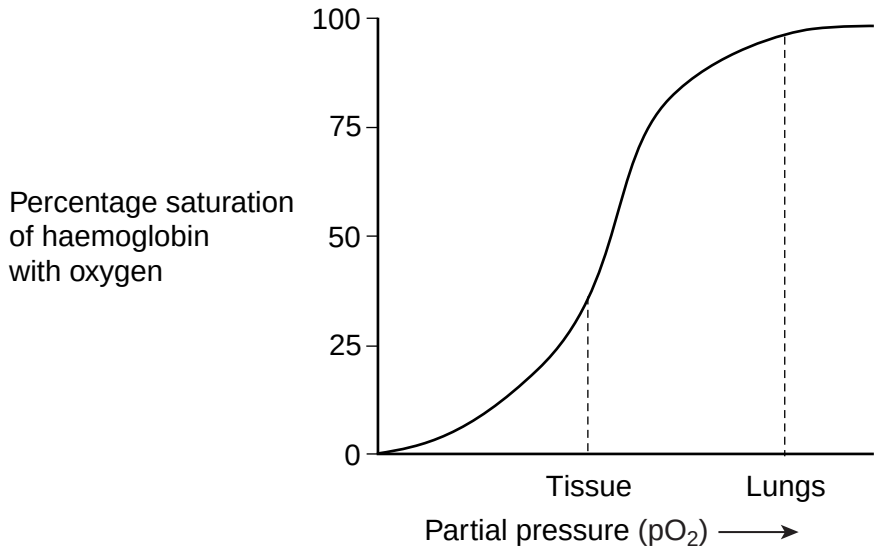
5

Turn over ▶

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7 (a) **Figure 6** shows the oxygen dissociation curve for human haemoglobin.

Figure 6



Use **Figure 6** to describe how haemoglobin loads and unloads oxygen in the body.

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(3 marks)

(Extra space) .....

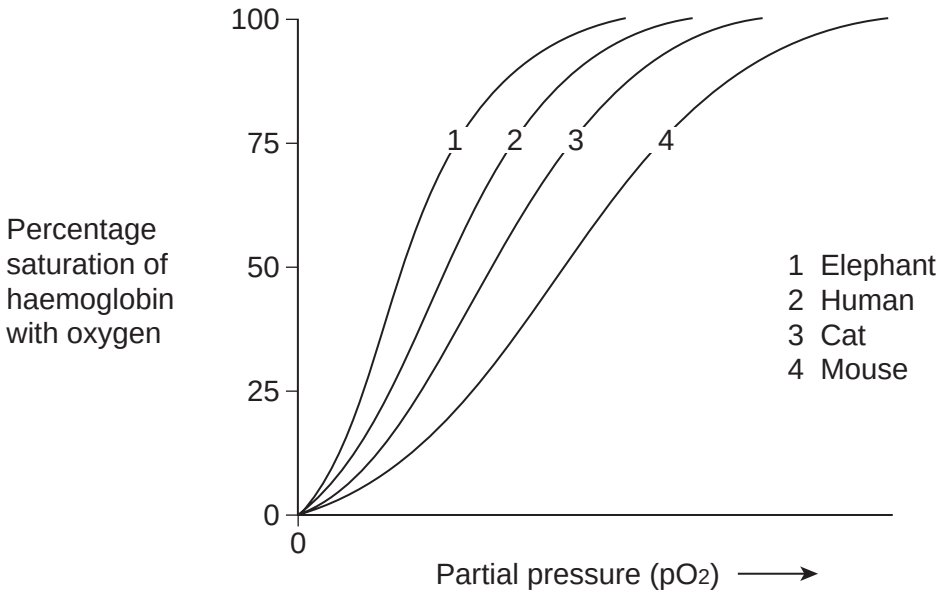
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7 (b) **Figure 7** shows oxygen dissociation curves from mammals of different size.

Figure 7



7 (b) (i) Describe the relationship between the size of mammals and the oxygen dissociation curves of their haemoglobins.

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(1 mark)

7 (b) (ii) Heat from respiration helps mammals to maintain a constant body temperature. Use this information to explain the relationship between the surface area to volume ratio of mammals and the oxygen dissociation curves of their haemoglobins.

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(4 marks)

(Extra space) .....

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8

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8 (a) The number of patients infected with the bacterium MRSA has increased in some hospitals. Scientists have suggested ways to reduce the transmission of MRSA in hospitals. Suggest **two** ways to reduce the transmission of MRSA in hospitals.

1 .....

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2 .....

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(2 marks)

8 (b) The minimum inhibitory concentration (MIC) is the lowest concentration of a substance that prevents the growth of a microorganism.

When antibiotics are prescribed for treating patients, higher doses than the MIC are recommended. Suggest **two** reasons why.

1 .....

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2 .....

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(2 marks)

Do not write outside the box

Scientists tested a new group of drugs for their effectiveness against four species of bacteria. The scientists used MICs to compare the effectiveness of four drugs. The results are shown in the table.

Drug	Minimum inhibitory concentration / μg cm^{-3}			
	Escherichia coli	*Staphylococcus aureus*	*Enterococcus faecalis*	*Pseudomonas aeruginosa*
P	0.39	0.049	0.049	3.13
Q	1.54	0.049	0.195	3.13
R	0.39	0.049	0.195	1.56
S	1.56	0.098	0.390	12.50

8 (c) Which of the four drugs is

8 (c) (i) most effective against *Enterococcus faecalis*?

(1 mark)

8 (c) (ii) least effective against all the species of bacteria used?

(1 mark)

8 (d) The effectiveness of these drugs was tested in double-blind trials using human volunteers. In a double-blind trial neither the volunteers nor the scientists know which treatment a particular volunteer is receiving.

8 (d) (i) Suggest **two** ways in which a double-blind trial improves reliability.

1 .....

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2 .....

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(2 marks)

8 (d) (ii) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1 .....

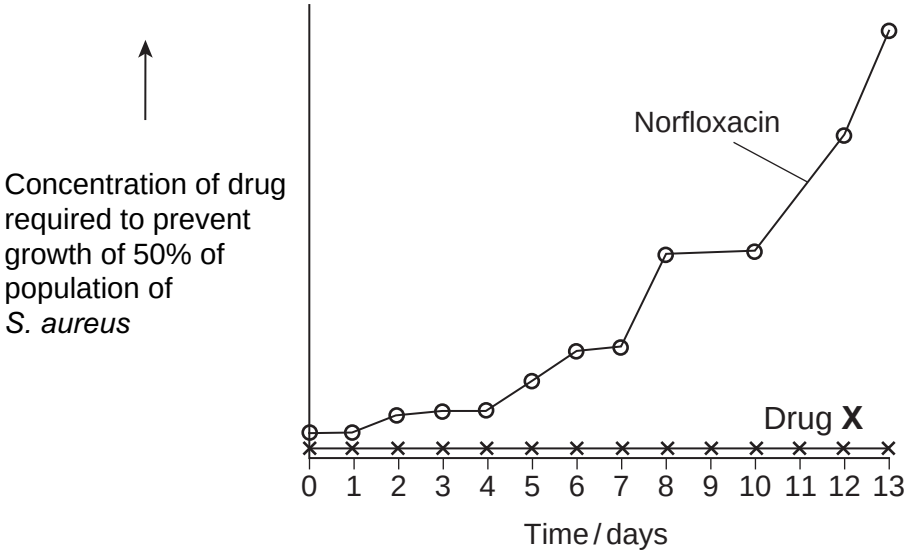
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(2 marks)

Question 8 continues on the next page

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8 (e) Scientists investigated resistance of the bacterium, *S. aureus* to the antibiotic Norfloxacin. They grew the bacteria in a medium containing a low concentration of Norfloxacin. The concentration of Norfloxacin that they added killed some of the bacteria. It did not kill all of them. Every 24 hours, they removed a sample of the bacteria from the culture. They tested the sample to find the concentration of Norfloxacin that prevented the growth of 50% of the bacteria in the sample.
The scientists then used the same method to investigate the resistance of *S. aureus* to a new drug, drug **X**. The results of both investigations are shown in the graph.



8 (e) (i) Describe the results obtained with Norfloxacin.

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(1 mark)

8 (e) (ii) Use your knowledge of resistance to explain the results obtained with Norfloxacin and drug **X**.

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(4 marks)

(Extra space) .....

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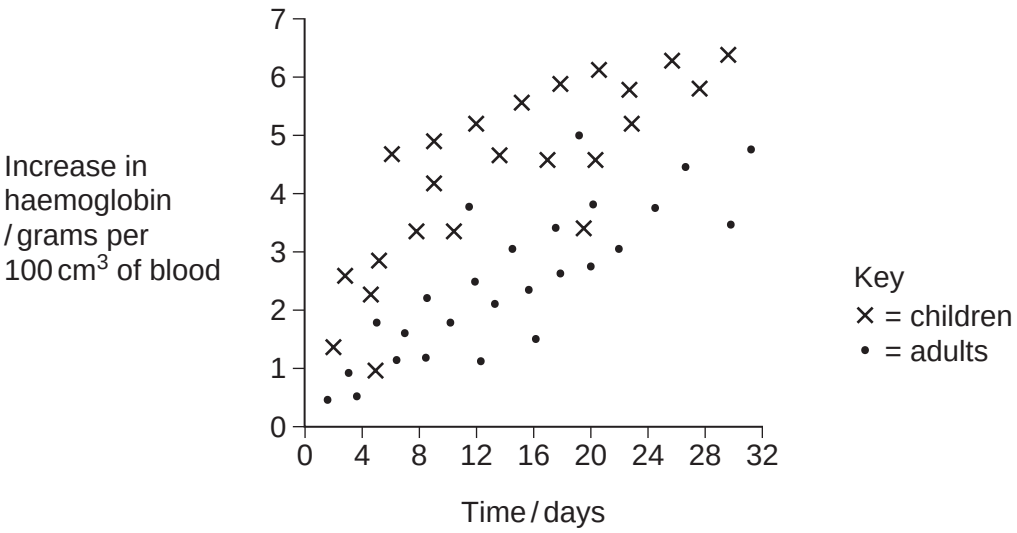
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9 (a) Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 8** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

Figure 8



9 (a) (i) Give **one** difference in the response of adults and children to this treatment.

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(1 mark)

9 (a) (ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

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(2 marks)

9 (a) (iii) Haemoglobin has a quaternary structure. Explain what is meant by a quaternary structure.

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(1 mark)

Question 9 continues on the next page

Turn over ▶

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9 (b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

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(3 marks)

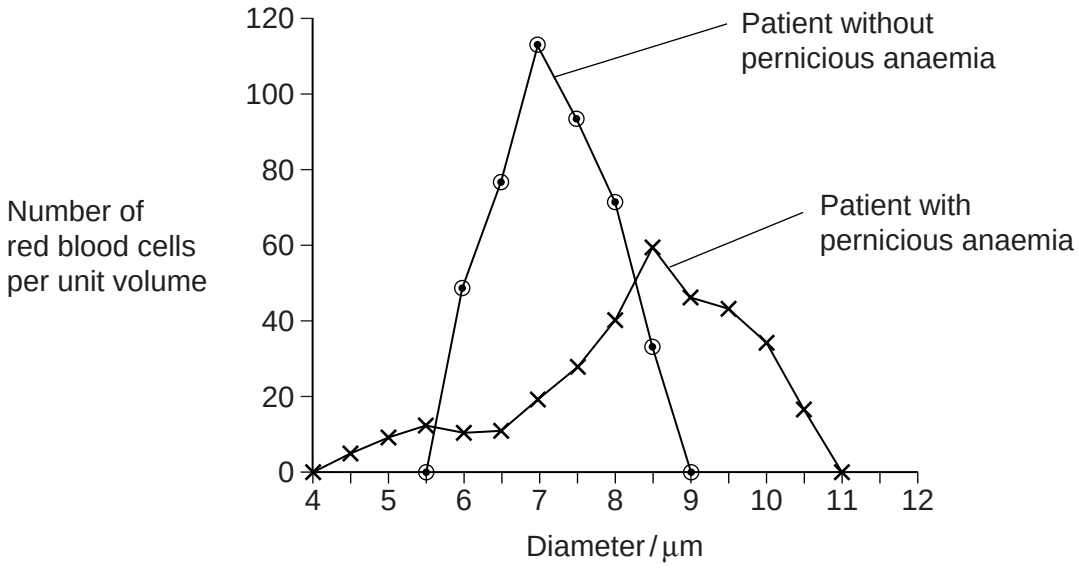
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9 (b) (ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 9** shows some of the results she obtained.

Figure 9



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Describe **two** differences between the blood samples.

1 .....

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2 .....

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(2 marks)

9 (c) Scientists' analysis of blood proteins has indicated a lack of genetic diversity in populations of some organisms. Describe the processes that lead to a reduction in the genetic diversity of populations of organisms.

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(6 marks)

(Extra space) .....

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END OF QUESTIONS

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Version 1.0: 05/2010

Version 1.0

General Certificate of Education
June 2010

Biology BIOL2

The variety of living organisms

Final

Mark Scheme

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Question	Part	Sub Part	Marking Guidance	Mark	Comments
1	(a)		Helical /spiral/coiled; Compact / description e.g. 'tightly packed'; Insoluble; Prevents osmosis/uptake of water / does not affect water potential / (starch) does not leave cell; Large molecule / long chain; Does not leave cell;	1 1 1 1 1 1	2 max Feature = one mark Explanation = one mark These must be related for both marks but can be in reverse order. Allow idea of compact/helical/spiral/coiled due to bonding for two marks.
1	(b)	(i)	β/beta Glucose;	1	**Q** Reject alpha glucose
1	(b)	(ii)	Glycosidic;	1	
1	(c)		Long/straight/unbranched chains (of glucose); (Joined by) hydrogen bonds; Form (micro)fibrils/(macro)fibrils; Provide rigidity/strength/support;	1 1 1 1	3 max **Q** Ignore reference to alpha glucose Allow suitable descriptions for last point e.g. 'prevents bursting';

Question	Part	Sub Part	Marking Guidance	Mark	Comments
2	(a)		Endothelium/epithelium;	1	Allow endothelial/epithelial Reject - epidermis/endodermis
2	(b)		Measurement divided by 8; Allow answer in range of 3-3.3 for two marks;	1 1	Correct answer gains 2 marks.
2	(c)	(i)	Stretches/'expands' under high pressure/when ventricle contracts / systole; Recoils/'springs back' under low pressure/when ventricle relaxes / diastole; Smooths blood flow / maintains blood pressure / reduces pressure surges;	1 1 1	2 max ***Q*** References to aorta contracting or relaxing negates marks for stretch and recoil. Stretch and recoil without reference to blood pressure etc. = one mark. Stretch and recoil to smooth blood flow etc. = two marks Ignore references to aorta withstanding blood pressure or not being damaged.
2	(c)	(ii)	(Muscle) contracts; (Arteriole) constricts / narrows/alters size of lumen / reduces/regulates blood flow (to capillaries);	1 1	'It' in answer = muscle Allow converse (muscle) relaxes and (arteriole) dilates etc / increase blood flow etc. Ignore references to pressure

2	(d)	(i)	Large/increase in (total) cross sectional area / friction / resistance;	1	
2	(d)	(ii)	(More) time for exchange of substances;	1	

Question	Part	Sub Part	Marking Guidance	Mark	Comments
3	(a)		Introns;	1	
3	(b)		Ile Gly Val Ser;	1	
3	(c)	(i)	Has no effect / same amino acid (sequence) / same primary structure; Glycine named as same amino acid;	1 1	***Q*** Reject same amino acid formed or produced. It still codes for glycine = two marks.
3	(c)	(ii)	Leu replaces Val / change in amino acid (sequence)/primary structure; Change in hydrogen/ionic bonds; Alters tertiary structure/active site; Substrate cannot bind / no longer complementary / no enzyme-substrate complexes form;	1 1 1 1	3 max ***Q*** Different amino acid formed or produced negates first marking point. Active site changed must be clear for third marking point but does not need reference to shape.
3	(d)	(i)	Interphase/ S/synthesis (phase);	1	
3	(d)	(ii)	DNA/gene replication/synthesis occurs / longest stage;	1	Allow ‘genetic information’ = DNA. Allow ‘copied’ or ‘formed’ = replication/synthesis

Question	Part	Sub Part	Marking Guidance	Mark	Comments
4	(a)		Light (intensity) / temperature / air movement / humidity;	1	
4	(b)		Prevent air entering / continuous water column;	1	Allow answer in context of shoot, xylem or potometer.
4	(c)		Distance and time; Radius/diameter/area (of capillary tube);	1 1	Reject 'amount bubble moves'
4	(d)		(used to provide) turgidity/support/description of; (used in) photosynthesis / (produced in) respiration; Apparatus not sealed/'leaks';	1 1 1	2 max
4	(e)	(i)	Returns bubble (to start);	1	
4	(e)	(ii)	Increases reliability (of results) / anomalous result can be identified;	1	***Q*** Ignore references to validity/precision/accuracy etc.

Question	Part	Sub Part	Marking Guidance	Mark	Comments
5	(a)		(Different) form/type/version of a gene / different base sequence of a gene;	1	
5	(b)		Two/sister chromatids; Due to DNA replication; Joined by a centromere;	1 1 1	2 max
5	(c)	(i)	Crossing over; Exchange (of alleles) between chromatids/chromosomes;	1 1	Negate first marking point for answers which refer to independent segregation. Chiasma/chiasmata = first marking point
5	(c)	(ii)	Is infrequent/rare;	1	References to it being 'random', 'occurs by chance' or 'doesn't always occur' should not be credited without a clear idea that it is rare or infrequent.
5	(d)	(i)	Three chromosomes shown; One from each homologous pair;	1 1	For first mark point allow drawings showing three chromosomes as single or double structures.
5	(d)	(ii)	8;	1	

Question	Part	Sub Part	Marking Guidance	Mark	Comments
6	(a)		Most closely (related) to chimpanzee / most recent common ancestor; Least (related) to dogfish / least recent common ancestor;	1 1	Allow 'chicken is second' to chimpanzee as equivalent to second mark point. Allow answers which compare similarity in DNA/genetic material. Marks should not be awarded for answers which only compare amino acid sequences without any indication of relationships. Allow 'monkey' for chimpanzee and 'fish' for dogfish
6	(b)		Is present in all eukaryotes;	1	
6	(c)		Reference to base triplet/triplet code / more bases than amino acids / longer base sequence than amino acid sequence; Introns/non-coding DNA; Same amino acid may be coded for / DNA code is degenerate;	1 1 1	2 max Different (base) triplets code for same amino acid = 2 marks Reject different amino acids are formed/produced. Ignore reference to codon.

Question	Part	Sub Part	Marking Guidance	Mark	Comments
7	(a)		Loading/uptake/association of oxygen at high p.O_2;	1	3 max
			In lungs (haemoglobin) is (almost) fully saturated / in lungs haemoglobin has a high affinity for oxygen;	1	Allow converse for second marking point in tissues i.e. haemoglobin has low affinity / releases most of its oxygen.
			Unloads/releases/dissociates oxygen at low p.O_2;	1	
			Unloading linked to higher carbon dioxide concentration;	1	Mark for haemoglobin having high affinity for oxygen must be 'in lungs'.
7	(b)	(i)	Larger the mammal the more to the left/steeper/'higher' is the curve / the higher the affinity for oxygen;	1	Allow converse. Ignore references to Bohr shift
7	(b)	(ii)	Smaller mammal has greater surface area to volume ratio;	1	4 max
			Smaller mammal/larger SA:Vol ratio more heat lost (per unit body mass);	1	Allow converse explanation for larger mammals or lower surface area to volume ratio.
			Smaller mammal/larger SA:Vol ratio has greater rate of respiration/metabolism;	1	Allow suitable named mammal as alternative to smaller or larger mammal.
			Oxygen required for respiration;	1	
			(Haemoglobin) releases more oxygen / oxygen released more readily / haemoglobin has lower affinity;	1	

Question	Part	Sub Part	Marking Guidance	Mark	Comments
8	(a)		Isolation / quarantine / 'kept separate'; Screening/testing (of patients/doctors etc); Sterilisation of wards/equipment / method to improve hygiene;	1 1 1	2 max Do not allow improve 'hygiene' or 'cleanliness' without named example such as 'washing hands' use of gloves etc.
8	(b)		May not all be absorbed; May be broken down /metabolised/excreted quickly; To kill the microorganisms/bacteria; Reference to antibiotic resistance;	1 1 1 1	2 max Reference to becoming 'immune' negates last marking point.
8	(c)	(i)	P;	1	
8	(c)	(ii)	S;	1	
8	(d)	(i)	Prevents bias; Vested interest (of scientists); Prevents 'placebo'/positive/negative/psychological effects/'demand characteristics' (in volunteers);	1 1 1	

8	(d)	(ii)	Age; Ethnicity; Lifestyle; Body mass; Health; Sex of person;	1 1 1 1 1 1	2 max Ignore references to same or different
8	(e)	(i)	Gradual/slight increase followed by rapid/greater increase;	1	Allow more detailed descriptions which describe similar trend of gradual increase followed by rapid increase.
8	(e)	(ii)	1. No/little resistance shown to drug X; 2. Mutation present (for antibiotic resistance); 3. Gene/allele for (antibiotic) resistance; 4. Bacteria with (antibiotic) resistance survive; 5. Vertical gene transmission; 6. Frequency of gene/allele (for resistance) increases;	1 1 1 1 1 1	max 4 Reference to horizontal gene transmission = neutral Reject mark for mutation if context suggests presence of antibiotic causes bacteria to mutate. Resistance is passed on by vertical gene transmission = two marks i.e. points 3 and 5.

Question	Part	Sub Part	Marking Guidance	Mark	Comments
9	(a)	(i)	Faster/greater/more effective response in children;	1	Do not accept children have more haemoglobin
9	(a)	(ii)	Use line of best fit; Extrapolate/extend line (and read from graph);	1 1	Allow calculation using rate of increase per day = one mark. However for both marks this must be linked to line of best fit.
9	(a)	(iii)	More than one polypeptide chain;	1	Allow many polypeptide chains. 'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.
9	(b)	(i)	Has same <u>water</u> <u>potential</u>; No (net) water movement / osmosis; Cells will not swell/burst/change size;	1 1 1	Allow converse for effect of using distilled water or a concentrated solution. No osmotic lysis = two marks
9	(b)	(ii)	Pernicious anaemia (cells) greater range/spread/variation of diameters/widths; Some pernicious anaemia (cells) wider than 9 (μm) / some less than 5.5 (μm) / / without pernicious anaemia none more than 9 (μm) / none less than 5.5 (μm); Pernicious anaemia (cells) peak/most frequent at 8.5 (μm) / peak/most frequent at higher diameter / / without pernicious anaemia peak/most frequent at 7 (μm) /peaks at lower diameter;	1 1 1	2 max There are several alternatives for marking points 2 and 3

9	(c)		1. Mark for general principle of - reduced variety/number of different alleles/DNA / reduced gene pool (in new population);	1	6 max The first marking point should not be awarded for 'fewer alleles' unless reduced variety or fewer different alleles is mentioned.
			2. Founder effect;	1	
			3. A few individuals from a population become isolated/form colonies:	1	
			4. (Genetic) bottlenecks;	1	
			5. (Significant) fall in size of population	1	
			6. Selective breeding / artificial selection;	1	
			7. Using organisms with particular alleles/traits/phenotypes/characteristics;	1	