



National
Qualifications
SPECIMEN ONLY

S807/77/02

Biology
Section 1 — Questions

Date — Not applicable

Duration — 2 hours 30 minutes

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet S807/77/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

You must leave your answer booklet on your desk; if you do not, you could lose all the marks for this paper.



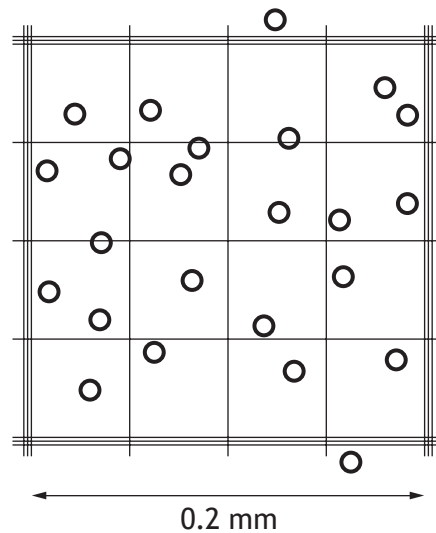
SECTION 1 — 20 marks

Attempt ALL questions

1. A hydrophobic amino acid has an R group that is

- A polar
- B not polar
- C negatively charged
- D positively charged.

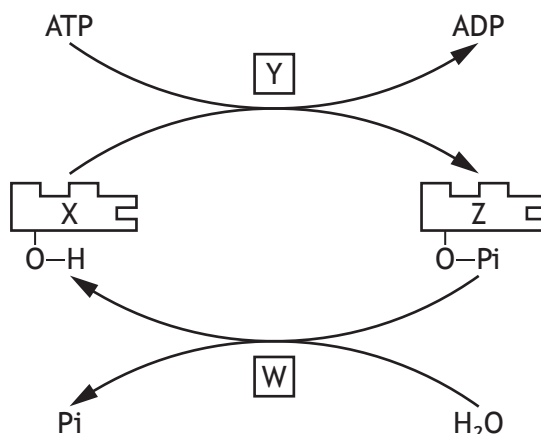
2. The diagram shows a haemocytometer grid that was used to estimate the number of cells in a 10 cm^3 microbial culture. The depth of the counting chamber is 0.2 mm .



The number of cells in the 10 cm^3 culture was

- A 2.75×10^7
- B 2.5×10^7
- C 2.25×10^7
- D 1.6×10^3

3. The diagram shows how phosphate is used to modify the conformation of an enzyme, phosphorylase, and so change its activity.



Which row in the table identifies the labels?

	Kinase	Phosphatase	Phosphorylase
A	Y	Z	W
B	W	Y	Z
C	X	Y	W
D	Y	W	Z

4. A student is preparing media for an experiment to investigate the effect of an inhibitor on cell growth. Flask 1 contains a control medium with no inhibitor.

The concentration of the stock inhibitor solution used to prepare the final solution is **80%**.

Flask	Inhibitor volume (cm ³)	Glucose volume (cm ³)	FBS volume (cm ³)	Buffer volume (cm ³)	Final inhibitor concentration (%)
1	0.00	1.00	5.00	19.00	0
2		1.00	5.00		20

What volumes of inhibitor and buffer should be added to flask 2 to give 25 cm³ of medium with an inhibitor concentration of 20%?

- A 4.75 cm³ inhibitor + 20.25 cm³ buffer
 B 4.75 cm³ inhibitor + 14.25 cm³ buffer
 C 6.25 cm³ inhibitor + 18.75 cm³ buffer
 D 6.25 cm³ inhibitor + 12.75 cm³ buffer

[Turn over

5. Type 1 diabetes is caused by

- A insufficient production of insulin
- B loss of insulin receptor function
- C excessive production of insulin
- D failure of GLUT4 to respond to insulin binding.

6. Following digestion, the sugar fructose is absorbed from inside the intestine into the cells that line the intestine. Fructose moves from a high concentration to a low concentration into the intestinal cells via a transmembrane protein. Fructose binds directly to the protein causing a conformational change that moves the fructose molecule through the membrane and releases it inside the cell.

Which of the following matches the mechanism of fructose transport described?

- A Facilitated diffusion via a channel
- B Active transport via a transporter
- C Facilitated diffusion via a transporter
- D Facilitated diffusion via a symporter

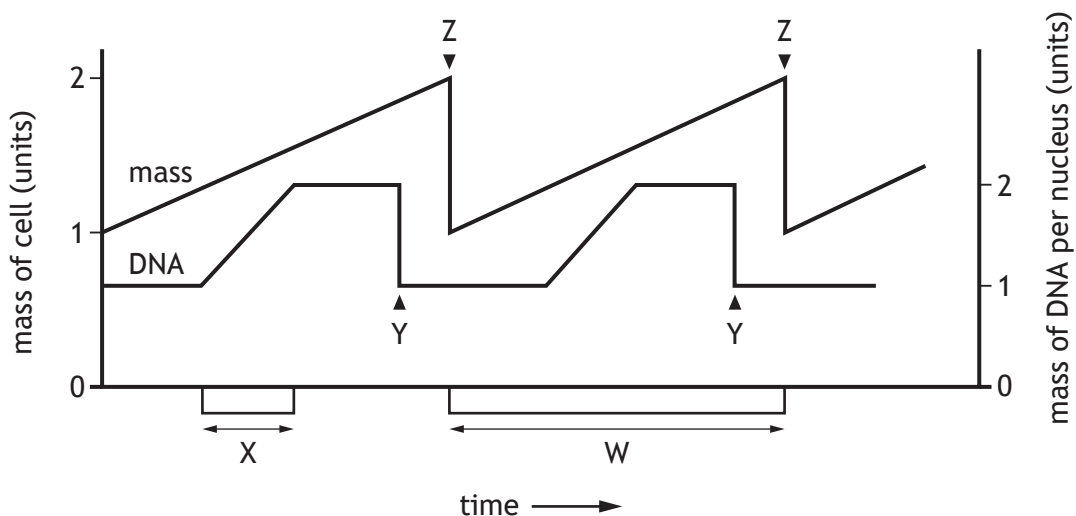
7. The statements outline stages in signal amplification following the absorption of a single photon of light by rhodopsin.

- Photoexcited rhodopsin activates molecule R.
- Activated molecule R activates molecule S.
- Active molecule S breaks down molecule T.
- Reduction in concentration of molecule T affects the ion channels in the membrane of rod cells.

Which row in the table identifies molecule R, molecule S, and molecule T?

	Molecule R	Molecule S	Molecule T
A	cyclic GMP	phosphodiesterase	transducin
B	cyclic GMP	transducin	phosphodiesterase
C	transducin	cyclic GMP	phosphodiesterase
D	transducin	phosphodiesterase	cyclic GMP

8. The diagram shows the changes in cell mass and DNA content in a cell during two mitotic cell divisions.



Which row in the table identifies the cellular events labelled W, X, Y or Z in the diagram?

	Telophase	Cytokinesis	DNA replication
A	X	Y	W
B	Y	Z	W
C	Y	Z	X
D	Z	W	X

9. A student planned to measure the activity of catalase by using an oxygen probe to measure oxygen production. As part of their pilot study, the student used a standard sample with an oxygen concentration of 22.00% to test the accuracy and precision of the probe.

Four readings of the standard sample were taken and the results obtained are shown in the table.

	Reading			
	1	2	3	4
Oxygen concentration (%)	20.94	20.93	20.93	20.94

The results indicate the measurements taken were

- A accurate and precise
- B accurate but not precise
- C precise but not accurate
- D neither accurate nor precise.

[Turn over

10. In a population that is in Hardy-Weinberg equilibrium, the frequency of the recessive allele for a particular trait is 0.7.

The proportion of individuals heterozygous for this trait is

- A 0.09
- B 0.21
- C 0.42
- D 0.49

11. A population of chafer beetles were damaging the tees and greens of a golf course. Results from a mark and recapture study suggested a population size that was too small to account for the extent of the damage caused.

One possible reason for this is that

- A the white paint used to mark the beetles washed off some of them before the recapture
- B the white paint used to mark the beetles made them more visible to predators than unmarked beetles
- C the total number of beetles in the recaptured sample was less than the number first captured and marked
- D the marked beetles did not have enough time, after release, to spread out and mix with the rest of the population.

12. Some invertebrate species can be used as indicator species to assess the level of pollution by organic waste in freshwater systems. Species within the taxa *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies) and *Trichoptera* (caddisflies) are particularly sensitive to pollution. These taxa are referred to collectively as EPT taxa.

The presence of these species can be used to assess water pollution levels by calculating an EPT index using the formula shown. The value obtained allows the water quality to be assessed using Table 1.

$$\text{EPT index} = \frac{\text{total number of EPT taxa present} \times 100}{\text{total number of taxa present}}$$

Table 1

EPT index	Water quality
>50%	excellent
35–49%	good
25–34%	moderate
<25%	poor

A study sampled the invertebrate species in a stretch of river and the results are shown in Table 2.

Table 2

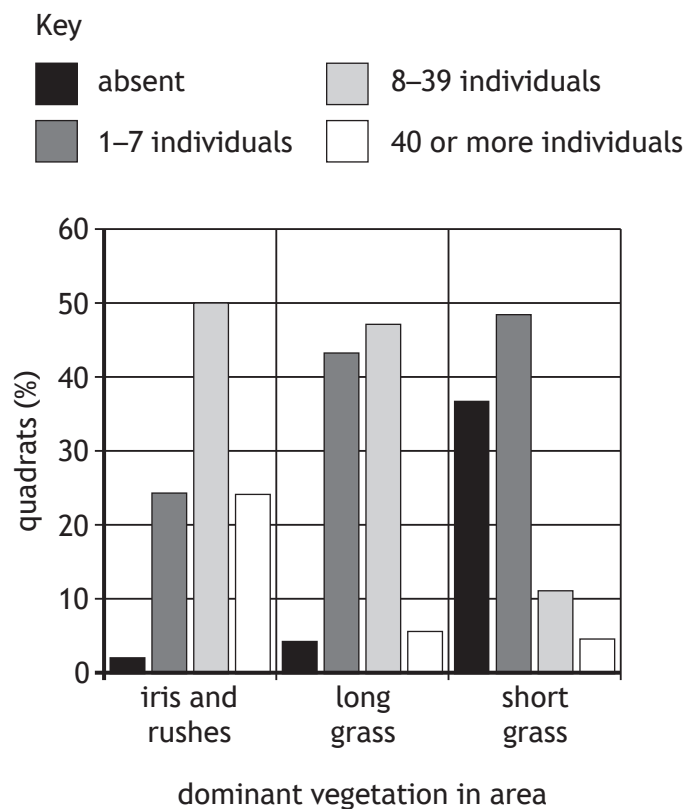
Taxa	Number of individuals
Striped stonefly	6
Dragonfly	5
Simulid blackfly	9
Net-spinning caddisfly	6
Bloodworm	8
Flathead mayfly	3
Damselfly	7

The data suggests the water quality of this river is

- A excellent
- B good
- C moderate
- D poor.

[Turn over

13. The population of the snail *Vertigo antivertigo* was investigated at a small site in Wales. Equal numbers of quadrat samples were taken in three areas with different dominant vegetation and the number of individual snails in each was recorded. The results are shown in the chart.

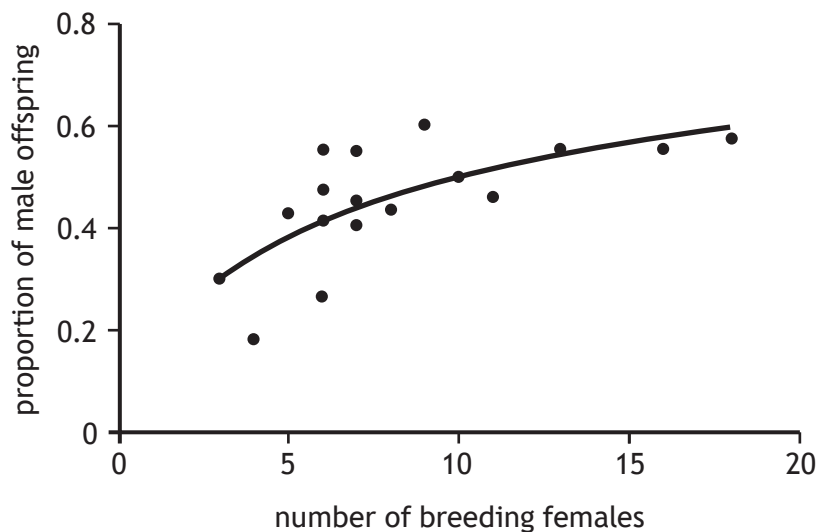


The information in the chart indicates that this species of snail prefers

- A short grass to long grass
 - B irises and rushes to long grass
 - C long grass to irises and rushes
 - D short grass to irises and rushes.
14. Which row in the table applies to r-selected species?

	Many offspring produced	Prolonged parental care
A	yes	yes
B	yes	no
C	no	yes
D	no	no

15. The scatterplot shows how the proportion of male offspring produced each year may depend on the number of breeding females present in a population of small mammals in a given area.



Which of the following predictions is consistent with the data shown?

- A The sex ratio in litters will not be affected by the density of breeding females.
 - B When breeding female density is low, producing male offspring will increase fitness.
 - C When breeding female density is high, the proportion of male offspring will be reduced.
 - D Only at intermediate density of breeding females will the sex ratio be in line with the expected ratio if female breeding density had no effect.
16. The black grouse male is larger and more brightly coloured than the female and competes with other males at leks.

Which of the following pairs of features are characteristic of this species?

- A Monogamy and sexual dimorphism
- B Polygamy and sexual dimorphism
- C Monogamy and reversed sexual dimorphism
- D Polygamy and reversed sexual dimorphism

[Turn over

17. Eggs of the parasitic liver fluke *Leucochloridium paradoxum* are found on vegetation and can be eaten by marsh snails, *Succinea putris*. Inside snails, eggs develop into larvae which move to the ends of their tentacles. The tentacles become swollen and brightly coloured, resembling striped caterpillars. Infected snails become more active during daylight when predatory birds mistake the abnormal tentacles for caterpillars and eat them. The larvae within the tentacles complete their life cycle within the birds' bodies. Eggs are passed out of the birds in faeces.

Which items on the list represent part of the extended phenotype of the parasite?

- 1 Prey selection by birds
 - 2 Modification of snail tentacles
 - 3 Changed activity of snails
 - 4 Feeding method of snails
-
- A 1 and 2 only
 - B 1 and 3 only
 - C 2 and 3 only
 - D 3 and 4 only

18. A species of parasitic wasp (*Nasonia vitripennis*) lays its eggs in the larvae of flies where the eggs develop. This species displays a behaviour called 'superparasitism' where, following the laying of eggs by one wasp, a second wasp may superparasitise the same host by also laying its eggs.

Researchers investigated the effects of superparasitism on the brood size and sex ratio of offspring in this species. Results were compared to a control that had been parasitised only once. Researchers were able to distinguish between the offspring of the first and second wasp.

Results are shown in the table.

Offspring	Degree of parasitism		
	Superparasitism		Single parasitism control
	Wasp 1	Wasp 2	
brood size	18 ± 3	17 ± 4	20 ± 2
percentage of males	7 ± 2	22 ± 4	6 ± 1

The following statements refer to the data in the table.

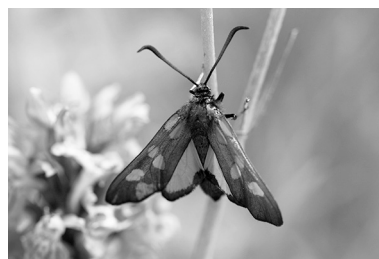
- 1 Superparasitism significantly increased the percentage of males produced by wasp 2 only.
- 2 Superparasitism significantly increased the percentage of males produced by both wasp 1 and wasp 2.
- 3 Superparasitism had no significant effect on brood size.
- 4 Superparasitism significantly decreased the brood size produced by wasps 1 and 2.

Which of these statements are valid conclusions supported by the data?

- A 1 and 3
B 1 and 4
C 2 and 3
D 2 and 4

[Turn over

19. Which of the following is a correct statement about X chromosome inactivation?
- A It is the cause of the Y chromosome being genetically inactive.
 - B In females, it prevents the expression of harmful alleles present on the X chromosome.
 - C The X chromosome inherited from the mother is active in all female cells.
 - D It ensures the amount of protein encoded by X chromosomes in females is approximately equal to that of males.
20. A project was designed to investigate the distribution and morphology of red-spotted burnet moths. These moths are glossy black, with five or six red spots on each forewing. Amateur moth enthusiasts were asked to photograph these moths and record their location and some physical characteristics for analysis.



Two of the characteristics recorded were:

- red wing area: a score of one was given to moths with only a small area of red on the wings, a score of two where around half of the wing area was red and a score of three where the majority of the wing area was red
- the number of red spots on each forewing.

Which row in the table describes the types of data that were collected?

	Red wing area	Number of red spots
A	qualitative	quantitative, discrete
B	ranked	quantitative, discrete
C	qualitative	quantitative, continuous
D	ranked	quantitative, continuous

**[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2
OF YOUR QUESTION AND ANSWER BOOKLET]**

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Mark

S807/77/01

Biology
Section 1 — Answer grid
and Section 2

Date — Not applicable

Duration — 2 hours 30 minutes



Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day

Month

Year

Scottish candidate number

Total marks — 85

SECTION 1 — 20 marks

Attempt ALL questions.

Instructions for the completion of Section 1 are given on *page 02*.

SECTION 2 — 65 marks

Attempt ALL questions.

A supplementary sheet for question 1 is enclosed inside the front cover of this question paper.

Questions 10 and 11 each contain a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Do not remove any exam materials. You must leave this booklet on your desk; if you do not, you could lose all the marks for this paper.



SECTION 1 — 20 marks

The questions for Section 1 are contained in the question paper S807/77/02.

Read these and record your answers on the answer grid on *page 03*.

Use **blue** or **black** ink. Do NOT use gel pens or pencil.

1. The answer to each question is **either** A, B, C or D. Decide what your answer is, then fill in the appropriate bubble (see sample question below).
2. There is **only one correct** answer to each question.
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample question

The thigh bone is called the

- A humerus
- B femur
- C tibia
- D fibula.

The correct answer is **B** — femur. The answer **B** bubble has been clearly filled in (see below).

A	B	C	D
☐	☒	☐	☐

Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.

A	B	C	D
☐	☒	☐	☒

If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:

A	B	C	D
☐	☒	☐	☒

 or

A	B	C	D
☐	☒	☐	☐



SECTION 1 — Answer grid



	A	B	C	D
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐
11	☐	☐	☐	☐
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
16	☐	☐	☐	☐
17	☐	☐	☐	☐
18	☐	☐	☐	☐
19	☐	☐	☐	☐
20	☐	☐	☐	☐



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SECTION 2 – 65 marks

Attempt ALL questions

Questions 10 and 11 each contain a choice

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1. Read through the supplementary sheet for question 1 before attempting this question.

- (a) Mammals have both specific and non-specific defences against parasites. Antibody production is a specific immune response.

Describe how **one** non-specific defence protects against parasites.

1

- (b) Refer to **Figure 1**.

There is a positive correlation between total blood antibody concentration before and total blood antibody concentration after measles infection.

What conclusion can be drawn about the effect of measles on the total antibody concentration in the blood?

1

- (c) (i) Refer to **Figure 2**.

Give a conclusion about the effect of infection with the measles virus on antibody diversity.

1

- (ii) Refer to **Figure 2**.

The mean age of the control group and the measles infected groups was around eight years old, but the mean age of the group vaccinated against measles was less than two years old, as this is the normal age for measles vaccination.

Suggest why the antibody diversity might be expected to increase more in younger children compared to the control children.

1



1. (continued)

- (d) (i) Refer to **Figure 3**.

Calculate the percentage decrease in the proportion of antibodies still present between the medians of the control group and the severely affected measles group.

1

Space for calculation

- (ii) Other than the differences in the median values, use the data to compare the effect of the severity of measles infections on the proportion of antibodies still present.

2

- (iii) Previous studies have suggested that loss of memory cells may contribute to the immune suppression observed after measles virus infection.

Explain how the data support this hypothesis.

1



2. Many species of bacteria can be grown in liquid culture.

(a) State the importance of aseptic technique when culturing micro-organisms.

1

(b) An experiment was carried out to compare the effects of two novel antimicrobial substances, compounds A and B, on the growth of the bacterium *E.coli*. Cultures of *E.coli* were grown in the presence of the compounds. Cell counts were carried out following vital staining with a dye that is only retained by non-viable cells.

Results from the experiment are shown in the table.

Antimicrobial compound in culture	Mean number of cells	
	Stained by vital stain	Not stained by vital stain
A	380	40
B	385	127

State which of the antimicrobial compounds is more effective at killing bacterial cells and use the data to explain your choice.

1

Most effective antimicrobial _____

Explanation _____

(c) What method, other than vital staining, can be used to determine the number of viable bacterial cells in a liquid culture?

1

(d) Benzalkonium chloride is an antimicrobial compound found in products such as handwashes. It works by disrupting the interactions between the phospholipids of the cell membrane.

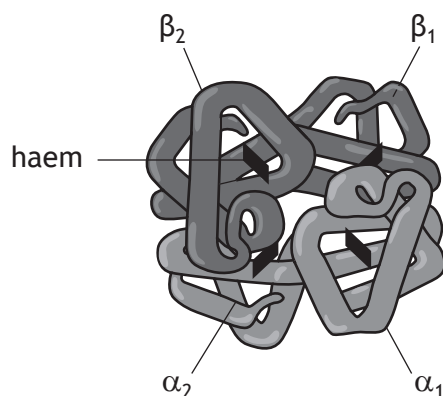
Suggest how this disruption could lead to cell death.

1



* S 8 0 7 7 7 0 1 0 7 *

3. Haemoglobin, the oxygen-carrying protein in the blood of vertebrates, consists of four subunits: two alpha (α) subunits and two beta (β) subunits. The α and β subunits have similar tertiary structure. Each subunit contains a haem group, which binds to oxygen to produce oxyhaemoglobin.



haemoglobin

- (a) Explain why haem is described as a prosthetic group.

1

- (b) Haemoglobin is affected by a number of allosteric interactions.

Allosteric interactions between the oxygen-binding sites result in co-operativity.

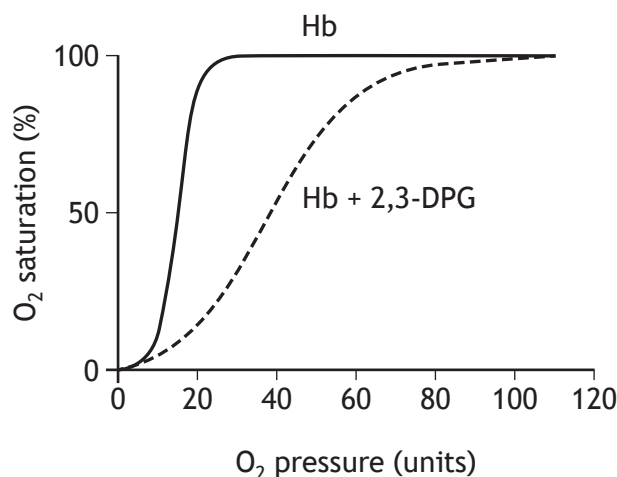
Explain what is meant by co-operativity in haemoglobin.

1

3. (continued)

- (c) The compound 2,3-diphosphoglycerate (2,3-DPG) is an allosteric modulator that binds haemoglobin (Hb).

The graph shows the effect of 2,3-DPG on the binding of oxygen.



- (i) Explain how the data show that 2,3-DPG is acting as a negative modulator.

1

- (ii) The concentration of 2,3-DPG in the blood is normally 5 mmol per litre, but this rises to approximately 8 mmol per litre in individuals living at high altitude.

Explain how this increase in 2,3-DPG concentration at high altitude would help oxygen delivery to tissue.

1

[Turn over



* S 8 0 7 7 7 0 1 0 9 *

4. Cortisol is a hydrophobic signalling molecule, produced by the human adrenal gland, that affects a number of different tissues in response to stress. It has a role in increasing blood sugar levels, in suppressing the immune system and in promoting the metabolism of fats, proteins and carbohydrates.

(a) Cortisol is a steroid hormone.

Describe the mechanism by which this type of signalling molecule causes an effect within the target cell.

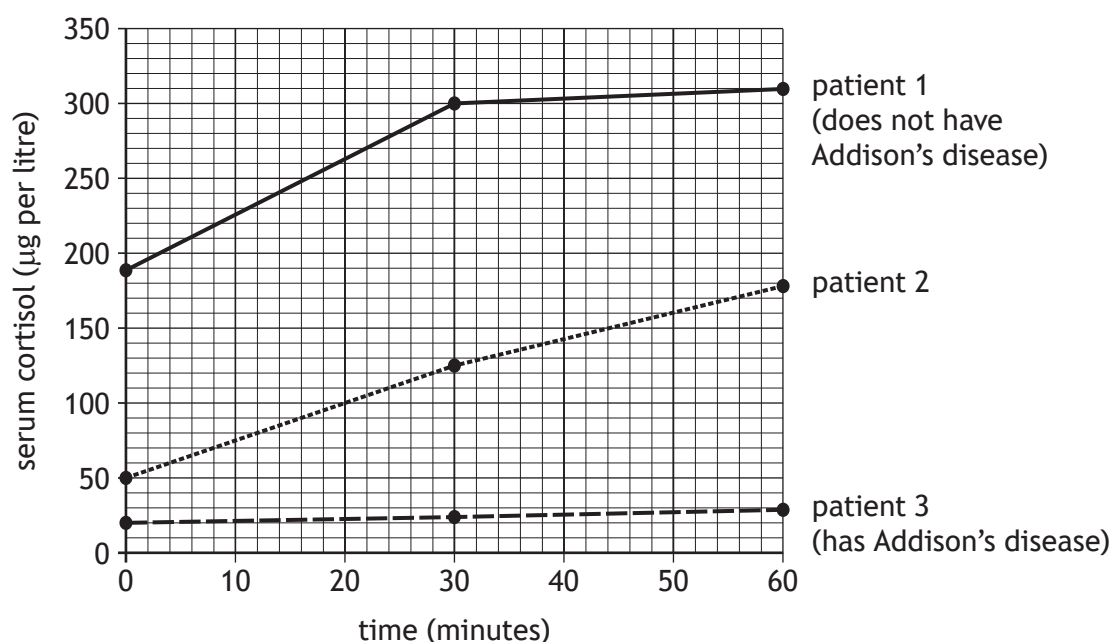
3



4. (continued)

(b) Addison's disease is a disorder in which the adrenal glands do not produce sufficient cortisol. One test for this disease is to give the patient an injection of a hormone called ACTH, which stimulates the adrenal gland to release cortisol. In a healthy person, cortisol levels should rise by at least 70 μg per litre after 30 minutes and 110 μg per litre after 60 minutes.

(i) The graph shows the results of this test on three patients who were investigated for Addison's disease.



Tick (✓) one box to show the diagnosis that would be appropriate for patient 2 and use data from the graph to justify your answer.

1

☐

Patient 2 has Addison's disease

☐

Patient 2 does not have Addison's disease

Justification _____

(ii) Give one ethical consideration that should be taken into account when conducting trials on human subjects.

1



5. As bananas ripen, the insoluble starch in the cells is converted to soluble sugars giving a sweet taste.

A student wanted to estimate the changes in soluble carbohydrate content of bananas using colorimetry. They crushed peeled banana segments in distilled water and centrifuged the resulting extract. The supernatant was pipetted off into vials and tested with Anthrone reagent. Anthrone turns a blue-green colour with carbohydrates. This coloured solution was then tested in a colorimeter measuring absorbance at 620 nm. Five bananas attached together in a bunch were used. One banana from the bunch was taken and tested each day for 5 days.

The student prepared a range of concentrations of glucose solutions and tested these in the same way as the banana extract solutions.

- (a) The student used information from a peer reviewed article to develop their method using Anthrone reagent.

Describe what happens during the peer review process.

1

- (b) (i) Identify a positive control for this experiment.

1

- (ii) Suggest why it was important to use bananas originally attached in a single bunch rather than separate bananas.

1

- (c) The student used data from the known glucose concentrations to construct a standard curve.

Describe the purpose of this standard curve.

1



5. (continued)

- (d) Anthrone reacts with both soluble and insoluble carbohydrates.

In the pilot study, the student did not use the centrifuge.

Explain why using the centrifuge is an improvement to this experimental procedure.

1

- (e) Describe a method that the student could have used when preparing the banana extract to ensure the concentration was controlled.

1

- (f) The student did not carry out an independent replicate of this experiment. State one feature of an independent replicate for this experiment.

1

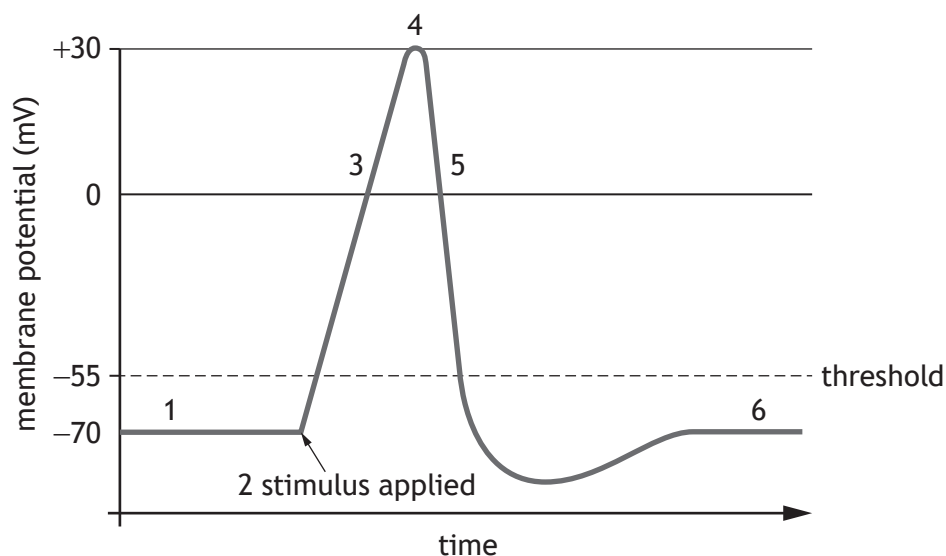
- (g) Give one reason, other than the lack of independent replication, and the extract concentration, why any results achieved might be considered invalid.

1

[Turn over



6. The diagram shows stages in the transmission of a nerve impulse.



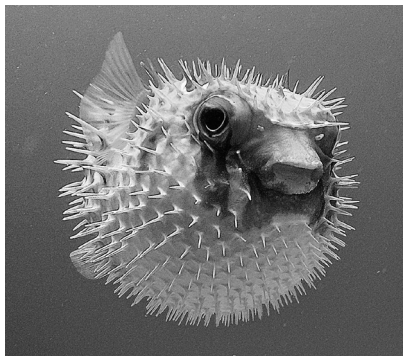
- 1 Membrane potential before nerve impulse initiated
- 2 Binding of a neurotransmitter to a ligand-gated sodium ion (Na^+) channel
- 3 Voltage gated Na^+ channels open
- 4 Voltage gated Na^+ channels become inactivated
- 5 Voltage gated potassium ion (K^+) channels open
- 6 Membrane potential after nerve impulse has passed

(a) (i) State the term that describes the membrane potential at points 1 and 6. 1

(ii) Use the information in the diagram to explain the importance of K^+ channels in nerve transmission. 2

6. (continued)

- (b) Tetrodotoxin is a poison found in some fish, such as the pufferfish, which has its effect at stage three of the process shown in the diagram.



Suggest a possible mechanism for the toxicity of this substance.

1

[Turn over



7. The dhole (*Cuon alpinus*) is an elusive, pack-hunting, social carnivore that is classified as endangered.



Scientists wanted to produce a time budget for the dhole to allow them to draw conclusions about how best to conserve the species. Their first step was to develop a checklist of behaviours for the dhole.

Part of the checklist of behaviours is shown in **Figure 1**.

Figure 1

Behaviour	Description
Resting	Lying down with eyes open or closed.
Sphinx rest	Lying on the belly with forelegs extended to the front. Head may or may not be lowered to rest on the forelegs or the ground.
Sit	Resting on folded hind legs.
Stand	Assuming an upright position with the weight of the body on all 4 legs.
Observation stand	Standing upright on the hind legs with front legs folded to observe an object of interest above eye level.

- (a) (i) State the term for a checklist of animal behaviours.

1

- (ii) Suggest why producing a checklist of animal behaviours increased the validity of the study.

1

7. (continued)

- (b) When studying the dhole behaviour, scientists used video recordings of the pack to analyse using the checklist.

When planning the study, it was decided that:

1. each individual in a pack was analysed separately
2. the same video footage was analysed separately by two scientists.

Explain why each of these aspects of experimental design would reduce error in the results.

2

1. _____

2. _____

- (c) In order to prepare a time budget, the scientists recorded the frequency and duration of each behaviour.

Choose either frequency or duration by ticking (✓) **one** box and describe what your chosen term means in animal behaviour studies.

1

Frequency ☐ Duration ☐

Description _____

[Turn over



8. The collared flycatcher (*Ficedula albicollis*) is a small, black and white songbird that breeds in southeast Europe. Adult males have a white forehead patch as shown.



- (a) Female collared flycatchers choose their mate based on the size of the male's forehead patch. Males that express a large white forehead patch have a competitive advantage over rival males.

Explain what is meant by sexual selection.

1

- (b) Sexual dimorphism exists in this species, with the female being brown in colour.

Explain why female choice would result in sexual dimorphism in collared flycatchers.

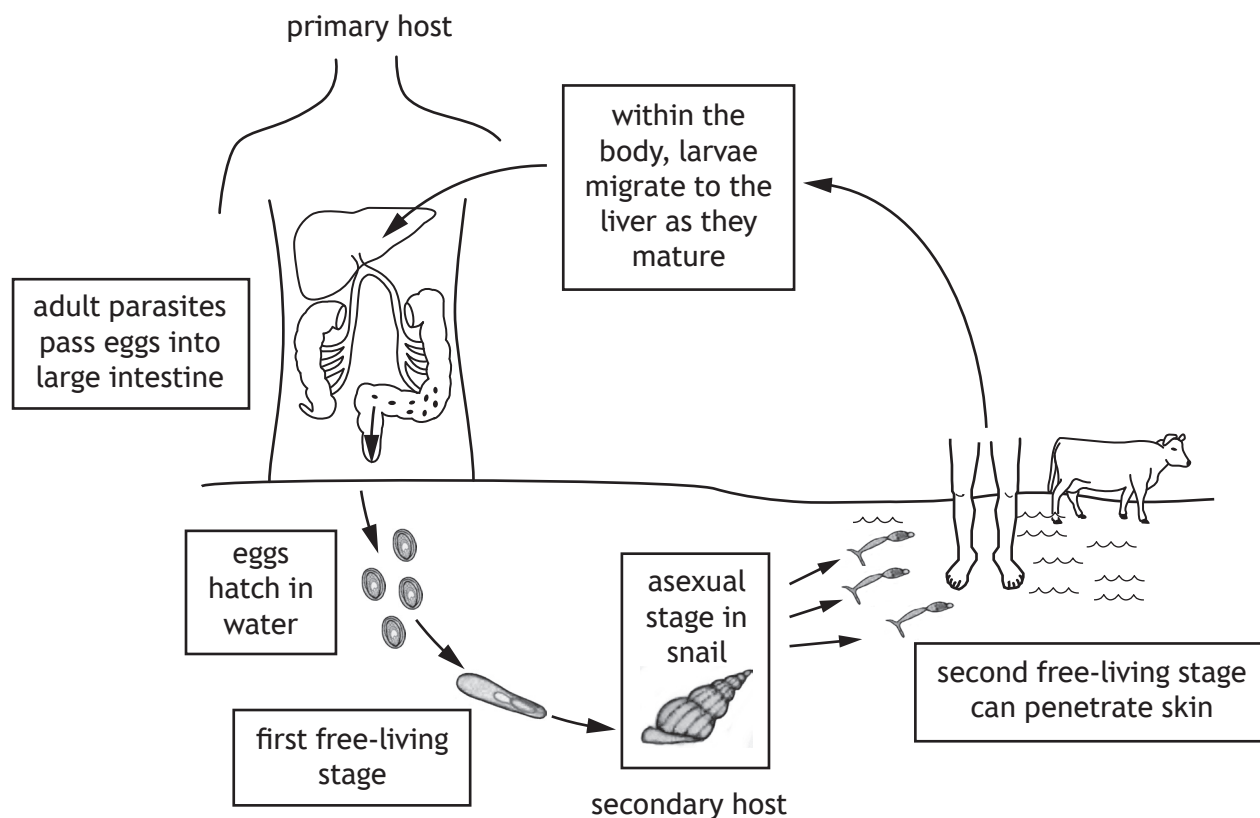
2

- (c) State the term used for traits that indicate the reproductive fitness of an individual.

1

9. The figure shows the life cycle of the macroparasitic flatworm called *Schistosoma Japonicum*. The flatworm can live for many years within a host. In humans, if untreated, it causes the disease schistosomiasis (bilharzia) that can be fatal.

Life cycle of *Schistosoma Japonicum*



- (a) (i) Explain why the snail may **not** be described as a vector. 1

- (ii) Suggest a feature of this parasite's life cycle that can lead to an increased rate of transmission. 1

[Turn over

9. (continued)

- (b) Using the life cycle of *Shistosoma Japonicum* as an example, describe the Red Queen hypothesis.

3



MARKS | DO NOT
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10. A Discuss the synthesis and post-translational modification of membrane proteins.

9

B Discuss the role of proteins in controlling progression through the cell cycle checkpoints.

9



SPACE FOR ANSWER to question 10

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* S 8 0 7 7 7 0 1 2 2 *

11. A Discuss the formation of variable gametes during meiosis under the following headings:

(i) the activity of homologous chromosomes

7

(ii) meiosis II.

2

OR

B Discuss changes in allele frequency under the following headings:

(i) natural selection

4

(ii) genetic drift.

5



SPACE FOR ANSWER to question 11

DO NOT
WRITE IN
THIS
MARGIN

[END OF SPECIMEN QUESTION PAPER]



* S 8 0 7 7 7 0 1 2 4 *

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

DO NOT
WRITE IN
THIS
MARGIN



* S 8 0 7 7 7 0 1 2 5 *

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

DO NOT
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Question 6 (b) safwan taher/shutterstock.com
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S807/77/11

**Biology
Supplementary sheet**

Date — Not applicable

Duration — 2 hours 30 minutes

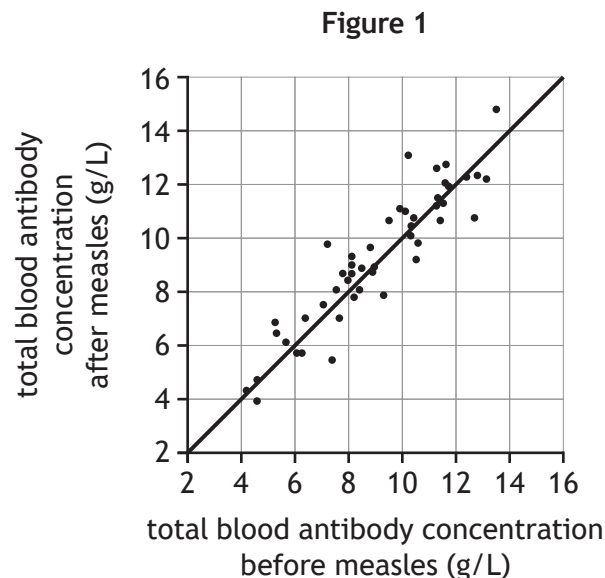
Supplementary sheet for question 1



1. Measles is a highly infectious disease, caused by the measles virus, which resulted in the death of approximately 110 000 individuals globally during 2017. It also causes suppression of the immune system; this can last for more than five years and results in further deaths from other infectious diseases.

A recent study investigated the levels of antibodies in the blood before and after measles infection. The total antibody concentration in the blood (total antibodies against all antigens to which individuals have been exposed) was measured in 50 children who became infected with the measles virus.

Measurements were taken before and after measles infection and are shown in **Figure 1**.



Antibody production is a dynamic process where individuals continuously produce new antibodies in response to exposure to new antigens.

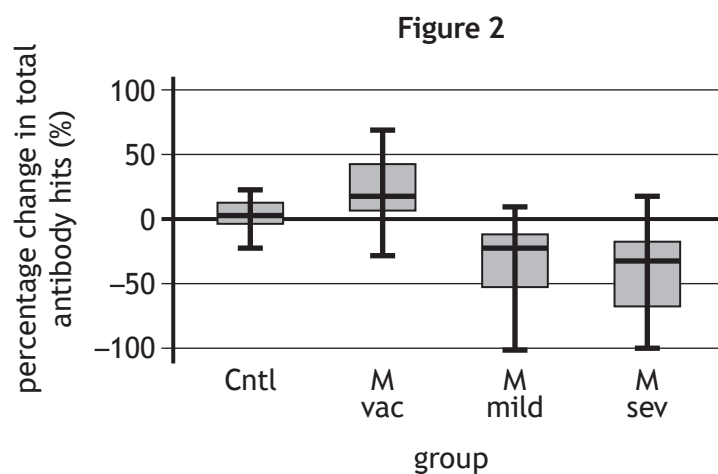
In a second study, the authors investigated the diversity of antibodies present in the blood by testing for antibodies against around 400 human pathogens. The technique used detected antibodies still present in the blood as a result of current or past viral infections. The total antibody hits, defined as the number of diseases to which each child possessed antibodies, was recorded at the two time points: once before infection or vaccination, and once afterwards.

The children were split into four groups:

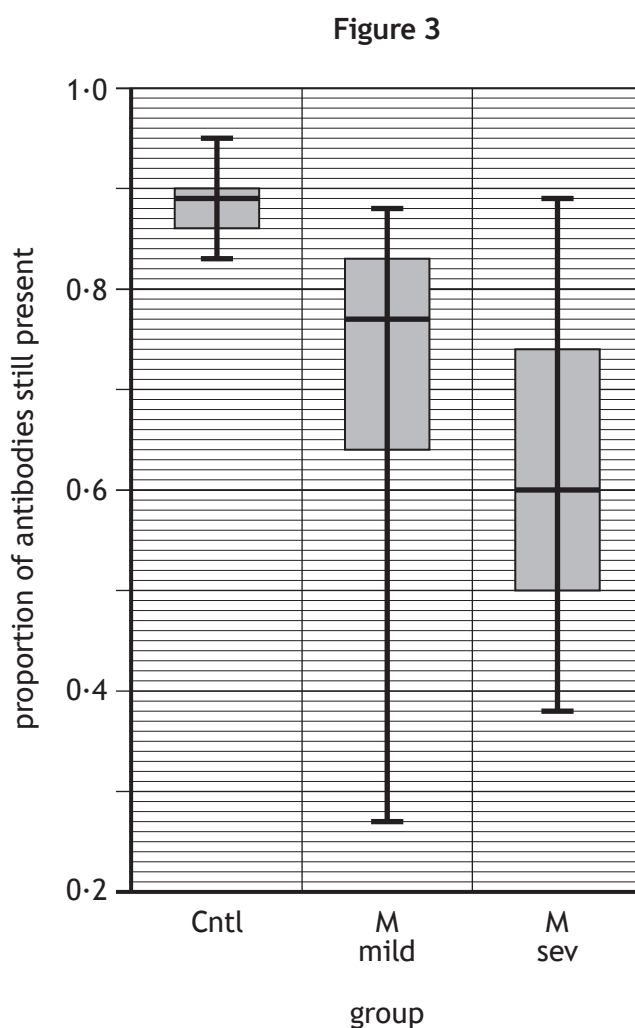
- Cntl: control with unvaccinated children who were not exposed to measles virus
- M vac: children vaccinated against measles
- M mild: unvaccinated children who contracted measles with mild symptoms
- M sev: unvaccinated children who contracted measles with severe symptoms.

1. (continued)

The percentage change in total antibody hits between the first and second time point was calculated and is shown in the box plot in **Figure 2**.



The retention of antibodies between the two time points was investigated. All types of antibodies present at the first time point were tested for again at the second time point, and the proportion of antibody types still present from one time point to the next was calculated and is shown in the box plot in **Figure 3**.



[END OF SPECIMEN SUPPLEMENTARY SHEET]



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S807/77/01

Biology

Marking Instructions

These marking instructions have been provided to show how Qualifications Scotland would mark this specimen question paper.

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General marking principles for Advanced Higher Biology

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

- (a) Marks for each candidate response must **always** be assigned in line with these general marking principles and the detailed marking instructions for this assessment.
- (b) Marking should always be positive. Marks should be awarded for what is correct and not deducted for errors or omissions.
- (c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you should seek guidance from your team leader.
- (d) There are no half marks awarded.
- (e) Where a candidate makes an error in the first part of a question, credit should normally be given for subsequent answers that are correct with regard to this original error. Candidates should not be penalised more than once for the same error.
- (f) Unless a numerical question specifically requires evidence of working to be shown, full marks should be awarded for a correct final answer (including units) on its own.
- (g) Larger mark allocations may be fully accessed whether responses are provided in continuous prose, linked statements or a series of discrete developed points.
- (h) In the detailed marking instructions, if a word is **underlined** then it is essential; if a word is **(bracketed)** then it is not essential.
- (i) In the detailed marking instructions, words separated by / are alternatives.
- (j) A correct answer can be negated if:
 - an extra, incorrect, response is given;
 - additional information that contradicts the correct response is included.
- (k) Where the candidate is instructed to choose one question to answer but instead answers both questions, both responses should be marked and the better mark awarded.
- (l) The assessment is of skills, knowledge and understanding in Biology, so marks should be awarded for a valid response, even if the response is not presented in the format expected. For example, if the response is correct but is not presented in the table as requested, or if it is circled rather than underlined as requested, give the mark.
- (m) Unless otherwise required by the question, use of abbreviations (eg DNA, ATP) or chemical formulae (eg CO₂, H₂O) are acceptable alternatives to naming.
- (n) If a numerical answer is required and units are not given in the stem of the question or in the answer space, candidates must supply the units to gain the mark. If units are required on more than one occasion, candidates should not be penalised repeatedly.

Marking instructions for each question

Section 1

Question	Response	Mark
1.	B	1
2.	A	1
3.	D	1
4.	D	1
5.	A	1
6.	C	1
7.	D	1
8.	C	1
9.	C	1
10.	C	1
11.	D	1
12.	B	1
13.	B	1
14.	B	1
15.	D	1
16.	B	1
17.	C	1
18.	A	1
19.	D	1
20.	A	1

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)		- epithelial tissue/skin/physical barrier blocks the entry of parasites (hydrolytic) enzymes in mucus/saliva/tears/secretions destroy bacterial cell - low pH environments/secretions denature proteins of/destroy pathogens. - signalling molecules/inflammatory response (increase blood flow) results in (more) cells of the immune system (at the area of infection). - phagocytes engulf and digest/destroy pathogens. - natural killer cells destroy/induce apoptosis in infected cells (Any 1)	1	Pathogen/bacteria = parasite. Antigen $\neq$ parasite. Example of low pH environment: stomach/vagina/sweat glands. Accept: histamine/cytokines as signalling molecules
	(b)		No effect	1	Accept: remains the same
	(c)	(i)	It decreases.	1	NOT: statement referring to either mild or severe alone NOT: big decrease for severe, small decrease for mild NOT: incorrect reference to Mvac
		(ii)	Younger children/they will have been exposed to fewer pathogens/antigens. OR They will be (more likely to be) exposed to new antigens (during the time interval) (resulting in an increase in antibody diversity).	1	Disease = infection = pathogen. Idea of: exposure to new pathogens.

Question			Expected response	Max mark	Additional guidance
1.	(d)	(i)	32.58/32.6/33	1	
		(ii)	IQR: The IQR is smaller in M mild than M sev (1) IQR M mild at 0.83 to 0.64/range of 0.19 AND IQR M sev at 0.74 to 0.50/range of 0.24 (1) OR (Full) Range: Range is greater in M mild than M sev (1) Range M mild at 0.88 to 0.27/range of 0.61 AND Range M sev at 0.89 to 0.38/range of 0.51. (1)	2	Note to markers: variability is acceptable - it will relate to the comparative statement for either IQR or full range. Accept: converse statements NOT: average = median When discussing Full Range: max one mark if response mentions error bars. Award responses that demonstrate recognition of the asymmetrical distribution of the data (1 mark) with appropriate numerical support (1 mark).
		(iii)	Antibody types are lost (after measles infection) because the memory cells that produced them are no longer present.	1	diversity/variety = type

Question			Expected response	Max mark	Additional guidance
2.	(a)		Excludes/prevents (microbial) contaminants. OR Only required cells grow/ are cultured/present/ensures a pure culture. OR Prevents (accidental) release of (harmful) micro-organisms.	1	Accept: prevents contamination
	(b)		A (Dead cells take up the stain). (A) has the highest proportion/percentage of stained cells (which are dead).	1	Accept: higher ratio of stained to unstained Accept: A had killed a higher percentage/proportion of cells
	(c)		Colony count (after serial dilution). OR Dilution plating	1	Accept: suitable description NOT: cell count/flow cytometry/fluorescence microscopy
	(d)		(Disruption of the cell membrane) would allow leakage of materials into/out of the cell. OR Disruption could (be severe enough to) lead to lysis of the cell. OR Leads to loss of function/structure of membrane proteins.	1	Accept: increases permeability Accept: lysis = bursting

Question			Expected response	Max mark	Additional guidance
3.	(a)		Non-protein group AND essential for function/carrying/ binding oxygen. OR Tightly bound.	1	
	(b)		(Changes in) binding of (oxygen) at one site/subunit affects the binding of (oxygen) at the remaining sites/subunits.	1	Do not award for an incorrect directional relationship.
	(c)	(i)	Reduces the affinity (of haemoglobin) for oxygen. OR Requires a higher O ₂ pressure to reach 100%/same saturation.	1	Binding must be linked to affinity. NOT: reference to rate/time/longer/ slower
		(ii)	(Higher concentration of 2,3-DPG) would reduce affinity for oxygen further/shift curve further to the right AND aemoglobin would then be able to release oxygen more easily (to tissue).	1	Idea of haemoglobin giving up oxygen more easily. Accept: reduce binding Must be comparative.

Question			Expected response	Max mark	Additional guidance
4.	(a)		1. hydrophobic signalling molecules/cortisol/ it diffuses through the phospholipid bilayer of the cell membrane 2. (so) binds to specific intracellular receptors/receptors in the cytosol or nucleus 3. the receptors for hydrophobic signalling molecules/cortisol are transcription factors 4. the hormone-receptor complex moves to the nucleus where it binds to hormone response elements/HREs/specific sites on DNA AND affects gene expression/influences the rate of transcription (Any 3)	3	
	(b)	(i)	Does not have Addison's; Patient 2 cortisol increases by 75 µg per litre at 30 min and increases by 125 µg per litre at 60 min.	1	Accept: • patient 2 increases by 75 µg per litre at 30 mins and a further 50 µg per litre at 60 mins With reference to between 30 and 60 mins • range of 125–130 range of 50–55 Need: Correct units (µg per litre) at least once.
		(ii)	Any from: • confidentiality • right to withdraw • informed consent	1	

Question			Expected response	Max mark	Additional guidance
5.	(a)		(Critical) evaluation by experts in the (relevant) field.	1	Review $\neq$ evaluation Idea of: reading and commenting on = evaluation.
	(b)	(i)	(Testing with) glucose/carbohydrate/sugar (solution).	1	
		(ii)	So that all the bananas would be the same age/same ripeness/reduced genetic variation/same time in transit/same conditions prior to experimentation.	1	
	(c)		Determine the glucose/carbohydrate/sugar in an unknown solution. OR Determine the concentration in banana (extract solution).	1	Must be in the context of this experiment.
	(d)		Insoluble starch/carbohydrate will (only) be in the pellet/not be in the supernatant. OR Only soluble carbohydrates will be present in the supernatant. OR Allow insoluble carbohydrates to be removed.	1	Accept: cellulose = insoluble carbohydrate
	(e)		Same mass of banana added to same volume of water.	1	
	(f)		Fresh (anthrone) solution/different bananas/different time.	1	Ignore reference to equipment.
	(g)		No control of • volume of extract • storage conditions • temperature (of experiment) • centrifuge speed/time • volume of anthrone solution used (Any 1)	1	NOT: • sample size • volume of water Ignore reference to controls.

Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	Resting (potential)	1	
		(ii)	K⁺ ion concentration is greater inside the cell (than outside) so K⁺ ions flow out of the cell (1) and return cell to resting potential. OR Restores membrane potential/polarity. (1)	2	
	(b)		Blocks/damages (voltage-gated) Na⁺ channel. (1) OR Prevents (voltage-gated) Na⁺ channel opening. (1)	1	NOT: reference to ligand-gated NOT: prevents nerve transmission alone

Question			Expected response	Max mark	Additional guidance
7.	(a)	(i)	Ethogram	1	
		(ii)	Idea of allows the data collection between sample periods/observers/populations/studies to be compared. OR Idea of reduces the variability of the interpretation of behaviour. OR Idea of reduces misidentification/misnaming/incorrect categorisation of behaviours.	1	
	(b)		1. (Analysing each individual in a pack separately means that the observer) • did not get distracted • did not miss behaviours • didn't confuse animals • didn't miss any individuals (in the pack). (1) 2. (Two scientists analysing the footage means that) • results can be compared • findings can be backed up • findings aren't only one person's opinion • One scientist can spot an error in the other scientist's work. (1)	2	NOT: independent replication NOT: avoids bias alone
	(c)		Frequency (Frequency is) the number of times a behaviour occurs within the observation period. Duration (Duration is) the length of time each behaviour occurs during the observation period.	1	Only one is required. If a box is not ticked, the term must be given in the description to award the mark.

Question			Expected response	Max mark	Additional guidance
8.	(a)		(Non-random) selection of alleles that increase the individual's chances of mating/producing offspring/reproduction.	1	Increase in frequency = selection NOT: responses that address female choice only Traits/characteristics/genetic material = alleles.
	(b)		(Idea of) female choice acts as a selection pressure on male characteristics. OR Females choose/prefer/select males with the big(gest) forehead patch. (1) (This results in the male looking physically different) because these characteristics are not selected for in the female. OR Only selected for in the male. OR This results in the forehead patches increasing in size over time. (1)	2	NOT: male-male rivalry
	(c)		Honest signal	1	

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	Does not itself actively transmit parasite to another species.	1	
		(ii)	Waterborne dispersal stage	1	
	(b)		1. co-evolution/co-evolution relationship 2. between species that interact frequently/closely 3. example from lifecycle of flatworm and host 4. change in the traits of one species can act as a selection pressure on the other species 5. species must adapt to avoid extinction (Any 3)	3	Intimate = closely NOT: snail and human

Question			Expected response	Max mark	Additional guidance
10.	A		1. synthesis/translation begins on cytosolic ribosomes 2. signal sequence is a short stretch of amino acids or signal sequence is at one end 3. signal sequence halts translation 4. (signal sequence directs) ribosome to dock with ER/to form RER 5. translation continues after docking 6. protein inserted into membrane of ER 7. vesicle (containing protein) buds off 8. vesicles move to Golgi apparatus 9. proteins move through the Golgi 10. (movement through Golgi) by vesicles budding off one disc and fusing to the next (in the stack) 11. post-translational modification occurs in the Golgi 12. major modification is the addition of carbohydrate/ glycosylation 13. various sugars added in (multiple) steps 14. vesicles leave the Golgi and transfer (the protein) to the membrane 15. vesicles move along microtubules	9	Pt 2: N-terminus = at one end. Pt 4: docks with RER. Pt 6: NOT: lumen Pt 7: must be clear this is from ER Pt. Pt12: most common = major modification.

Question			Expected response	Max mark	Additional guidance
10.	B		1. checkpoints at G1, G2, M 2. cyclins accumulate (during cell growth) 3. cyclins combine with and activate cyclin-dependent kinases (CDKs) 4. active CDKs phosphorylate proteins that regulate progression through the cell cycle/act at checkpoints 5. if phosphorylation reaches a threshold/sufficient phosphorylation progression to next stage/through a checkpoint occurs 6. retinoblastoma protein (Rb) is a tumour suppressor 7. Rb acts at G1 checkpoint 8. Rb inhibits transcription of genes encoding proteins needed for DNA replication 9. Rb phosphorylated by (G1) cyclin CDK/active (G1) CDK 10. phosphorylation inhibits Rb 11. when Rb is inhibited/ phosphorylated DNA replication takes place/cell cycle progresses (from G1 to S) 12. DNA damage activates p53 13. (p53) can arrest the cell cycle/ cause cell death/apoptosis 14. proto-oncogenes code for proteins that control/stimulate cell division 15. proto-oncogenes can mutate to form oncogenes 16. oncogenes encode proteins that deregulate the cell cycle/ promote the formation of tumours	9	Pt 2-4: accept: in context of named checkpoint. Pt 4 & Pt 5: NOT: Rb alone

Question			Expected response	Max mark	Additional guidance
11.	A	(i)	1. homologous chromosomes in diploid gametocyte 2. (homologous chromosomes) have the same size/centromere position/genes at same loci 3. (prior to meiosis) each chromosome consists of two chromatids attached at the centromere 4. pairing of homologous chromosomes 5. chiasmata form at points of contact between non-sister chromatids (of a homologous pair) 6. crossing over occurs 7. exchange of DNA between non-sister chromatids 8. (crossing over) produces genetically different recombinant chromosomes 9. homologous chromosome pairs line up randomly on equator/metaphase plate 11. independent assortment 12. separation of parental chromosomes irrespective of maternal and paternal origin (Any 7)	7	
		(ii)	a. (two) cells produced in meiosis I undergo a further division b. sister chromatids separate c. randomly distributed to the daughter cells/gametes d. four haploid gametes/cells produced (Any 2)	2	

Question			Expected response	Max mark	Additional guidance
11.	B	(i)	1. natural selection is non-random 2. (natural selection) acts on/requires genetic variation in population 3. variation (in traits)/new alleles arise as a result of mutation/new sequences of DNA 4. mutations can be beneficial/harmful (to the fitness of an individual) 5. population produces more individuals than the environment can support 6. individuals with favourable alleles/that are better adapted are more likely to survive and reproduce/produce offspring or individuals with favourable alleles/that are better adapted have higher fitness 7. increase in frequency of advantageous alleles or decrease in frequency of deleterious alleles (Any 4 from 7)	4	Pt 2: NOT: due to/caused by variation

Question			Expected response	Max mark	Additional guidance
11.	B	(ii)	a. (genetic drift occurs when) chance/random events cause unpredictable/random fluctuations in allele frequencies (from one generation to the next) b. (genetic drift) is more important in/more likely to affect small populations c. alleles are more likely to be lost from the gene pool (in small populations) d. population bottlenecks occur when a population is reduced (for at least one generation) e. founder effects occur through the isolation of a few members of a population (from a larger population) f. gene pool/allele frequency of new population is not representative of original g. alleles may be underrepresented/ over-represented (Any 5 from 7)	5	Pt a: Examples of chance events acceptable (eg natural disaster). Change = fluctuation. Idea of random change.

[END OF SPECIMEN MARKING INSTRUCTIONS]

Published: August 2026

Change since last published:

The duration of the paper has been shortened and the number of marks reduced. Some questions have been removed from the previous specimen question paper, some have been edited or updated, and some have been replaced.