National Qualifications 2026

X807/77/02

Biology
Section 1 — Questions

TUESDAY, 28 APRIL

9:00 AM – 12:00 NOON

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X807/77/01.

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.

X8077702

Qualifications Scotland
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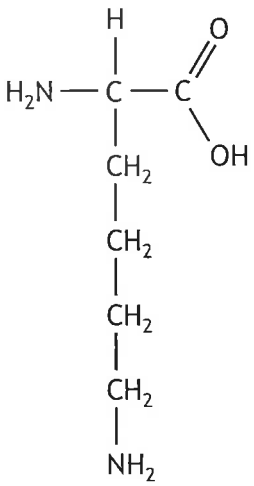
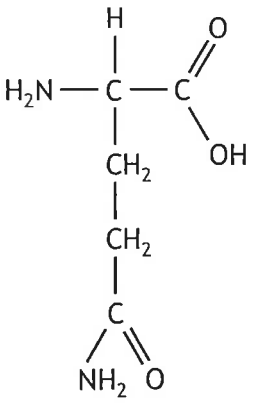
SECTION 1 — 20 marks

Attempt ALL questions

1. Four amino acids are shown.



1



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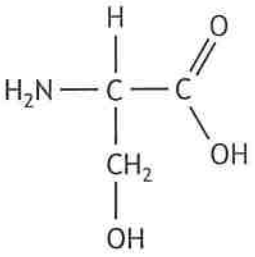

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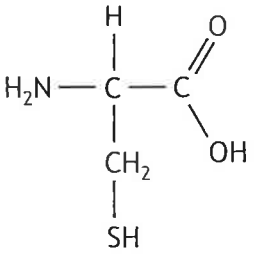


4

Which of the amino acids could form a hydrogen bond with another amino acid in the chain to stabilise the secondary structure?

A 1 and 3 only

B 1, 2 and 3 only

C None of above

D All of the above

2. Which statement is **not** correct for bright-field microscopy?

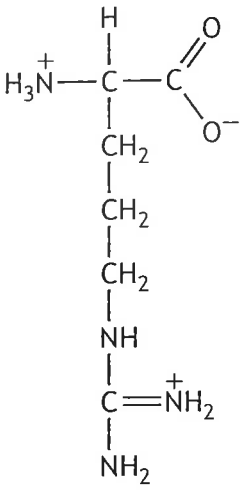
A Can be used to visualise some whole organisms or parts of organisms.

B Can be used to visualise cells in culture.

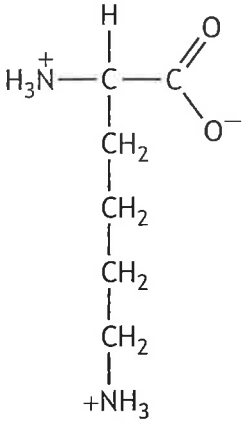
C Uses only visible light for illumination.

D Can be used to visualise fluorescently labelled molecules in thin sections of dissected tissue.

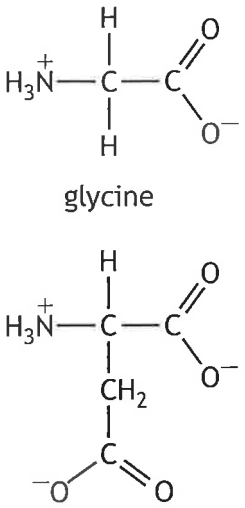
3. A solution containing the peptide **arg–asp–gly–lys** was treated with peptidases to release the amino acids.



arginine



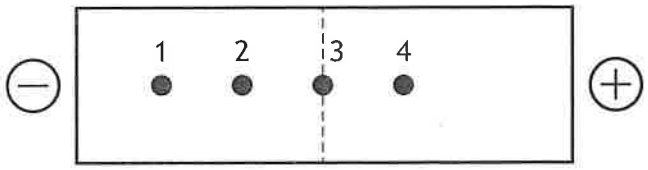
lysine



glycine

aspartate

The amino acids were separated using native gel electrophoresis. The amino acids were all loaded at the central dashed line in the diagram.

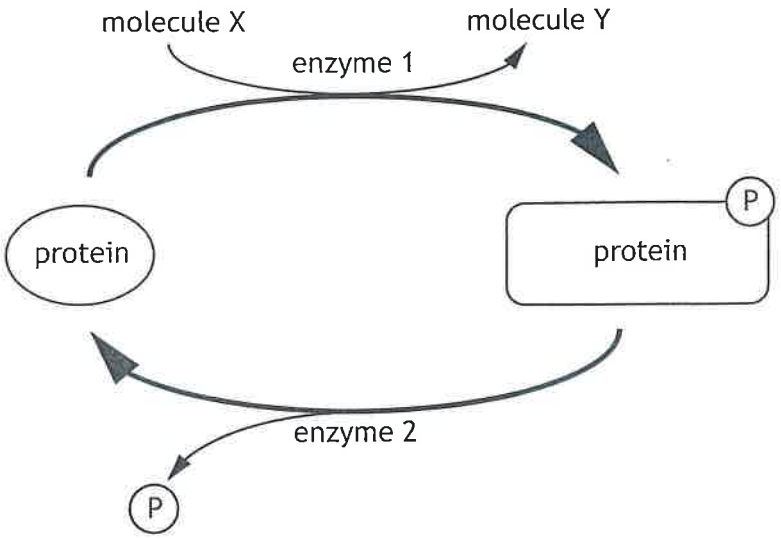


Which row in the table identifies the amino acids?

	Amino acid			
	Lysine	**Arginine**	**Glycine**	**Aspartate**
A	1	2	3	4
B	2	1	3	4
C	2	4	1	3
D	4	3	2	1

[Turn over

4.



In the figure

A enzyme 1 is a phosphatase, enzyme 2 is a kinase, molecule X is ATP

B enzyme 1 is kinase, molecule Y is ATP, molecule X is ADP

C enzyme 2 is a phosphatase, molecule Y is ADP, molecule X is ATP

D enzyme 2 is a kinase, enzyme 1 is a phosphatase, molecule Y is ATP.

5. DDT was widely used in the UK as an insecticide from the 1940s to the 1960s.

Experiments have shown that DDT causes a neuron to be depolarised for longer during an action potential.

This observation could be explained by DDT

A blocking voltage-gated sodium channels

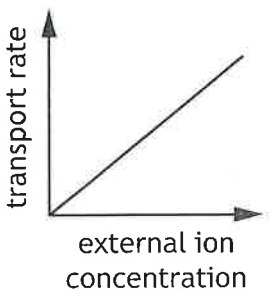
B inhibiting the inactivation of voltage-gated sodium channels

C increasing the opening of voltage-gated potassium channels

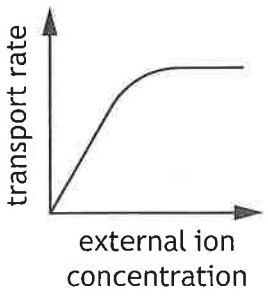
D activating the sodium-potassium pump.

6. Which graph best represents ion transport through open membrane channels when the number of channels is not affecting the transport rate?

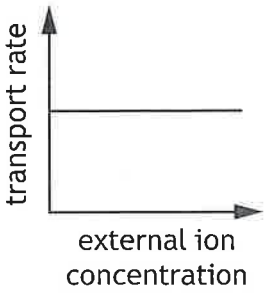
A



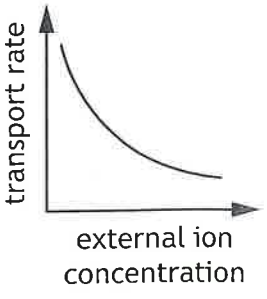
B



C



D



7. *Water potential* quantifies the tendency of water to move from one area to another by osmosis. In plants, the water potential of a cell (Ψ) can be calculated using the equation:

$$\text{water potential } (\Psi) = \text{solute potential } (\Psi_s) + \text{pressure potential } (\Psi_p)$$

Solute potential (Ψ_s): water potential of solute in vacuole

Pressure potential (Ψ_p): pressure caused by cell wall pressing inwards against cytoplasm

Pure water has a water potential of zero, and water will always diffuse from a region of higher water potential to a region of lower water potential.

Two plant cells, which are next to each other, have the solute and pressure potentials shown in the table.

	Solute potential (Ψ_s) (kPa)	Pressure potential (Ψ_p) (kPa)
Cell 1	–640	390
Cell 2	–660	340

Which statement describes the relationship between the two cells?

A The difference in water potential between the cells is 30 kPa, and water will move from cell 1 to cell 2.

B The difference in water potential between the cells is 30 kPa, and water will move from cell 2 to cell 1.

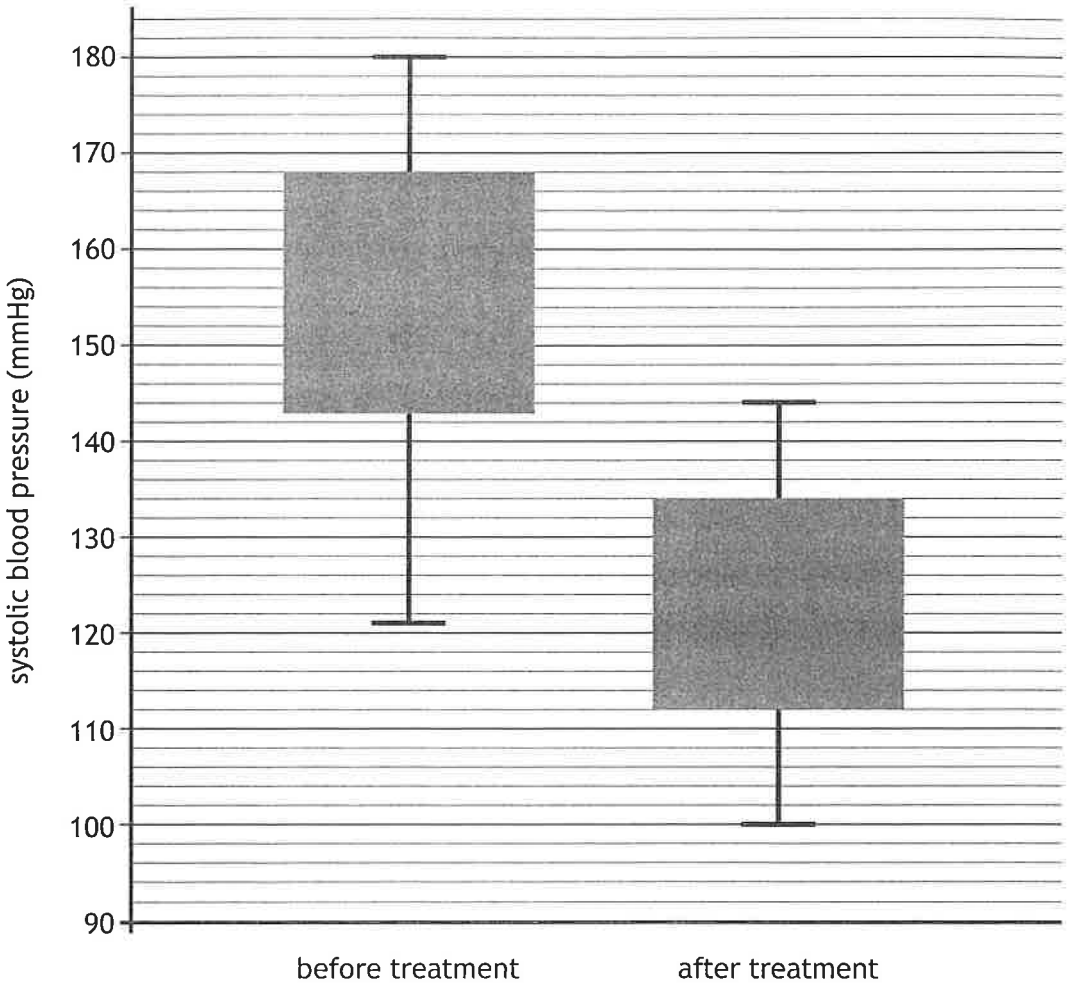
C The difference in water potential between the cells is 70 kPa, and water will move from cell 1 to cell 2.

D The difference in water potential between the cells is 70 kPa, and water will move from cell 2 to cell 1.

[Turn over

8. Systolic pressure is one of the components of a blood pressure measurement.

The box plot shows the values of systolic blood pressure for a sample of patients before and after a treatment designed to reduce blood pressure.



Which statement is correct for the data shown?

A Following treatment, the mean systolic blood pressure dropped from approximately 155 mmHg to approximately 121 mmHg.

B There is more error associated with the data for before treatment than after treatment.

C Following treatment, the lower quartile for systolic blood pressure dropped from 121 mmHg to 100 mmHg.

D There is no overlap between the interquartile ranges for before and after treatment.

9. Scientists can use phylogenetics to determine the evolutionary relationships that exist between different species.

Which of the following is used to determine these relationships?

A Analysis of protein structures within the organisms.

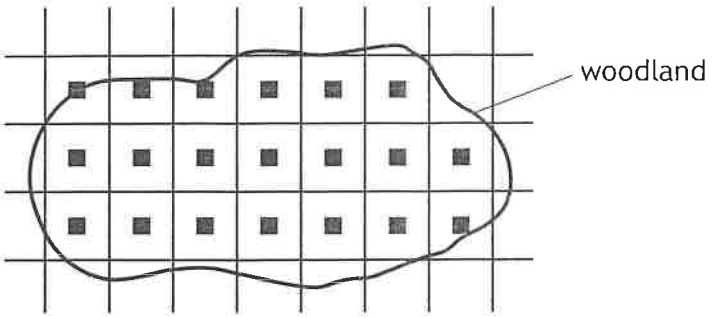
B The ecological niche inhabited by the organisms.

C The behaviours observed in the organisms.

D The physiology of the internal organs of the species.

10. As part of a survey into the population density of woodland species, investigators developed the sampling strategy shown in the map.

Each black square represents a sampling point.



The term used to describe this sampling strategy is

A random

B systematic

C stratified

D representative.

11. An event that occurs during Meiosis II is

A crossing over

B separation of sister chromatids

C independent assortment of chromosomes

D pairing of homologous chromosomes.

12. In the fruit fly *Drosophila melanogaster*, a gene affecting body colour is sex-linked. In this species, sex chromosomes for males are XY and females are XX.

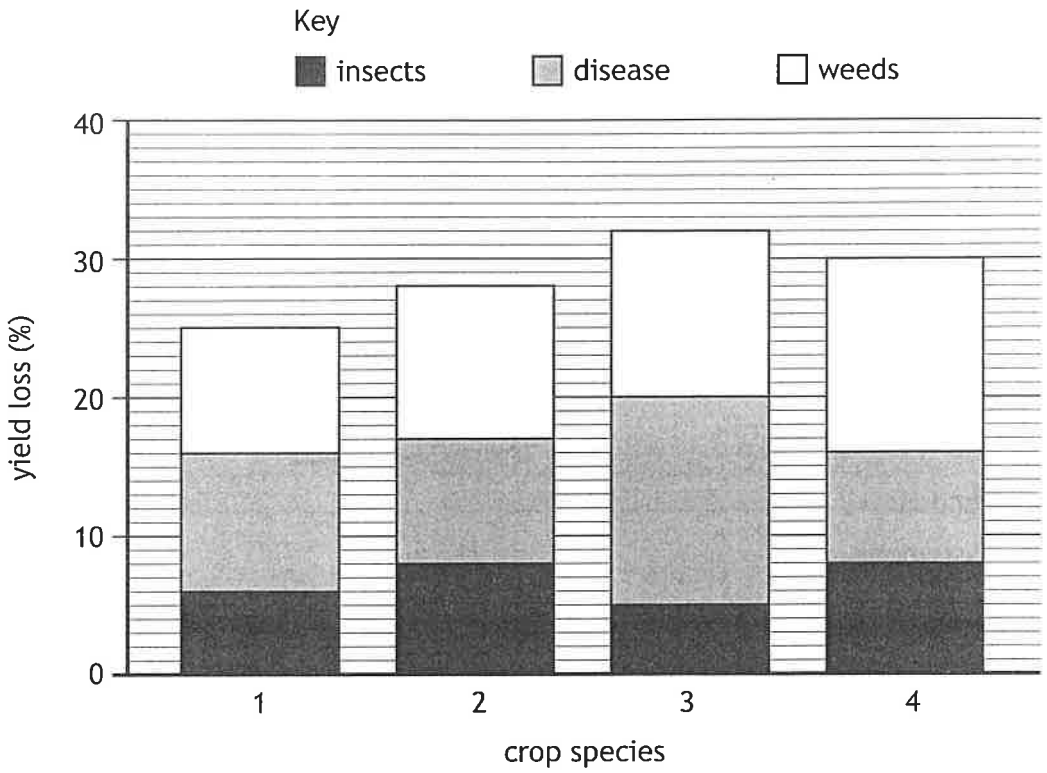
The allele for tan body is dominant to the allele for yellow body.

A cross was performed between a yellow-bodied female and a tan-bodied male to give an F_1 generation. A male and a female from the F_1 generation were, in turn, crossed to give an F_2 generation.

Which row in the table shows the predicted phenotypic ratio of the F_2 generation?

	Tan-bodied female	Yellow-bodied female	Tan-bodied male	Yellow-bodied male
A	1	1	1	1
B	2	0	1	1
C	2	0	0	2
D	1	1	0	2

13. The chart shows the percentage loss in yield due to insects, disease, and weeds for four crop species.



Which of the following statements is correct for the data shown?

A Crop species 4 is likely to show the smallest improvement in yield if chemicals that kill insects and weeds are applied.

B Overall, using measures to prevent disease would have the greatest single benefit for yield.

C Losses from insects and disease account for at least half of all losses for all four crop species.

D Losses due to disease and weeds are greater than losses due to insects and weeds for all four crop species.

14. Which row in the table describes **costs** of internal and external fertilisation?

	Internal fertilisation	**External fertilisation**
A	fewer eggs needed	few offspring survive
B	requires direct transfer of gametes between partners	very large number of offspring can be produced
C	a mate must be located	many gametes predated
D	higher offspring survival rate	limited parental care

15. Identify an example of the specific immune response.

A The destruction of bacterial cell walls by hydrolytic enzymes in chemical secretions.

B Natural killer cells identifying and attaching to cells infected with viruses and inducing apoptosis.

C Damaged cells releasing cytokines leading to the accumulation of white blood cells at the site of infection.

D Initial exposure to a parasitic antigen leading to the production of memory lymphocyte cells.

16. In 2024 scientists reported that a strain of influenza virus, Yamagata type B, has been eliminated from the human population. No new cases have been reported since March 2020 when the coronavirus, COVID-19, became widespread and public health measures including lockdowns and successful design of coronavirus vaccination were introduced.

The most likely reason for the elimination of Yamagata type B is

A herd immunity

B reduced virulence

C reduced transmission

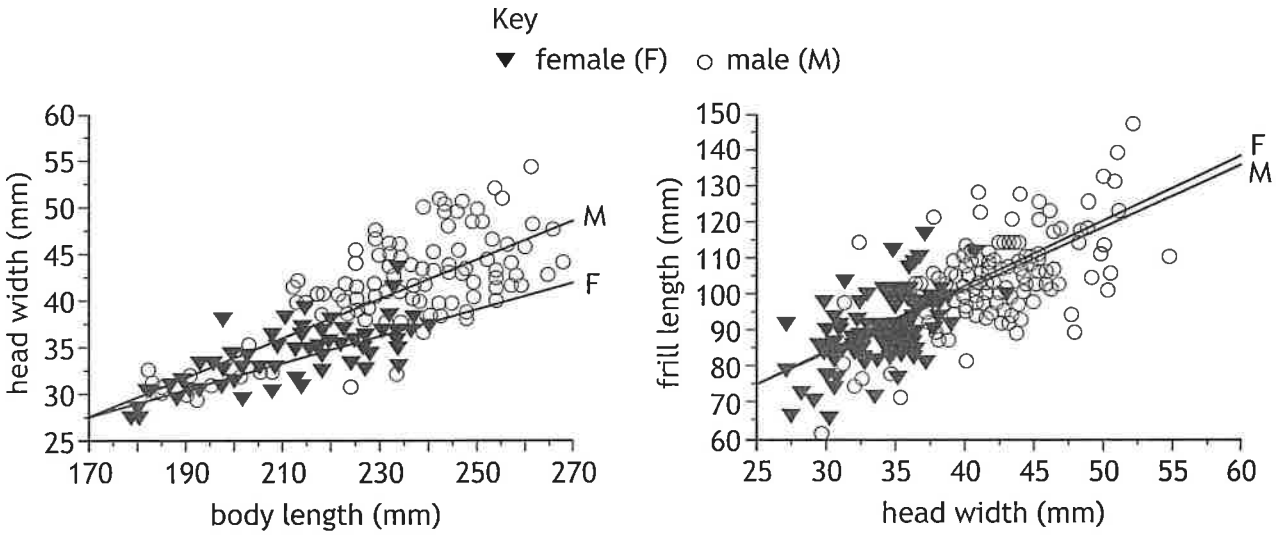
D effectiveness of coronavirus vaccination.

[Turn over

17. The frill-neck lizard (*Chlamydosaurus kingii*) is abundant throughout its range in the tropical savannahs of northern Australia.

These lizards are characterised by a fold of skin (frill), which is kept folded back against the body but can be erected during threat displays and social interactions. As part of a larger investigation, morphological data from 231 mature individuals were analysed.

These data are shown in the graphs.



Which statement drawn from these data is correct?

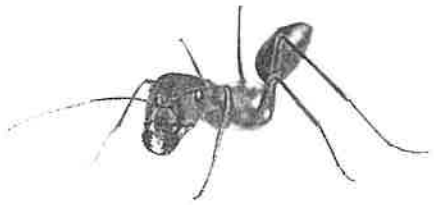
A The male with the longest body length has the longest frill.

B Males have a greater degree of variation in frill length than females.

C There is a weaker positive correlation between body length and head width in females than males.

D There is a stronger positive correlation between head width and frill length in males than females.

18. In a study of division of labour in four colonies of desert ants, the following data were collected.



Colony	Colony size	Number of workers engaged in a specific task	Number of random workers
P	1387	135	55
Q	1037	130	55
R	738	68	52
S	536	51	55

Which row in the table is a summary of the results obtained?

	Colony with greatest proportion of task-specific workers	Colony with greatest proportion of random workers
A	P	S
B	Q	S
C	P	R
D	Q	R

[Turn over

19. The following statements describe the main stages in the life history of *Schistosoma mansoni*, a parasite that causes the human disease schistosomiasis. Some terms have been replaced by letters P, Q, R, and S.

P reproduction occurs in the human Q

↓

Fertilised eggs are passed into water

↓

Fertilised eggs develop into larvae that then infect water snails

↓

R reproduction occurs

↓

This produces motile larvae that leave the snails

↓

Larvae infect humans in the water, entering the S

Which row in the table identifies the terms for P, Q, R and S?

	P	Q	R	S
A	asexual	intestine	sexual	intestine
B	sexual	bloodstream	asexual	intestine
C	asexual	bloodstream	sexual	bloodstream
D	sexual	intestine	asexual	bloodstream

20. The following statements were made by students evaluating laboratory work they had undertaken.

Which statement **cannot** be justified from the information given?

A When measuring catechol oxidase activity in bananas, a negative control was included. This control always showed zero activity, which shows confounding variables were adequately controlled.

B A refractometer was used to measure salinity of different rockpool samples. The instrument was calibrated each day using known salt concentrations, which helped ensure accurate data were collected.

C In the pilot studies, 200 μl of water was dispensed from a micropipette 10 times. The mass dispensed each time was measured and ranged from 0.26–0.28 g. This showed the pipette was precise, but not accurate.

D The abundance of different lichen species in a woodland location was observed and ranked from 1 to 5, with 1 being rare, or absent, and 5 being very common. This means both the dependent and independent variables were qualitative.

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

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National Qualifications 2026

Mark

X807/77/01

Biology
Section 1 — Answer grid and Section 2

TUESDAY, 28 APRIL
9:00 AM – 12:00 NOON

X8077701

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 — 100

SECTION 1 —20 marks
Attempt ALL questions.
Instructions for the completion of Section 1 are given on *page 02*.

SECTION 2 —80 marks
Attempt ALL questions.
A supplementary sheet for question 1 is enclosed inside the front cover of this question paper.
Question 12 contains 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.

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MARKS | DO NOT WRITE IN THIS MARGIN

SECTION 2 — 80 marks

Attempt ALL questions

Question 12 contains a choice

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

(a) Refer to **Figure 2** and **Figure 3.**

(i) Oxygen binds to haem, a tightly-bound non-protein component of myoglobin's structure.

State the term that describes a non-protein component of a protein's structure, which is essential for its function. 1

_____

(ii) A fully-grown common dolphin contains an average of 26 milligrams of myoglobin per gram of tissue.

Calculate how many times greater the myoglobin concentration is in the epaxial muscles. 1

Space for calculation

_____ times

(iii) Suggest why the epaxial and hypaxial muscle groups of dolphins have the highest level of myoglobin per 100 g. 1

_____

_____

1. (continued)

(b) The three different species of dolphin are adapted to feed at different depths.

(i) Explain how the information in **Figure 1** and the data in **Figure 4** support this conclusion. 2

(ii) It has been suggested that when the geographic range of these species overlap resource partitioning may occur.

Explain why resource partitioning may allow these species to occupy the same geographic range. 1

(c) A complete dive consists of two phases: descent and ascent.

(i) What conclusion can be drawn from **Figure 5** about the glide distances during dives that increase to a depth of 50 m? 1

(ii) Use **Figure 5** and **Figure 6** to suggest why there is a higher proportion of gliding during the descent when diving from the surface (0 m) to 100 m than from the surface (0 m) to 50 m. 2

[Turn over

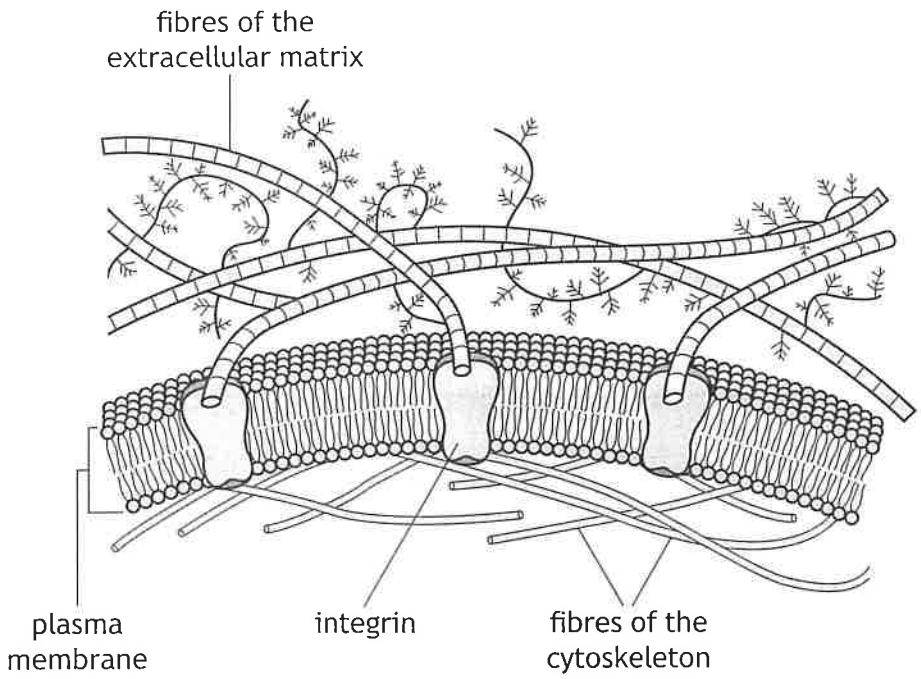
2. The Golgi apparatus is an organelle where proteins are processed. These proteins include integrins that are essential signal transductors embedded in the plasma membrane. Integrins are also involved in holding cells together within tissue such as bone.

(a) (i) Describe the structure of the Golgi apparatus. 1

(ii) State the major modification to proteins that occurs in the Golgi apparatus. 1

(b) The extracellular matrix is a network of large fibres that surround cells. These fibres are bound to proteins, such as integrins, allowing cells to attach to one another and communicate with nearby cells.

The figure shows integrins embedded in the plasma membrane of a bone cell with fibres of the extracellular matrix bound to them.



(i) Integrins are transmembrane proteins.

Describe the role of hydrophobic R-groups in holding the integrins within the membrane. 1

2. (b) (continued)

(ii) The proteins and other molecules that make up the extracellular matrix are mainly produced locally by cells within the matrix.

Golgi resident proteins are required to allow the Golgi apparatus to form vesicles and to process proteins that pass through it. Mutations in genes for several of these Golgi resident proteins cause faulty development of cartilage and bone. These symptoms are thought to be caused by failure of the extracellular matrix to form correctly in the body.

Suggest a reason why mutations in genes coding for Golgi resident proteins might result in faulty bone tissue development. 2

_____

_____

_____

[Turn over

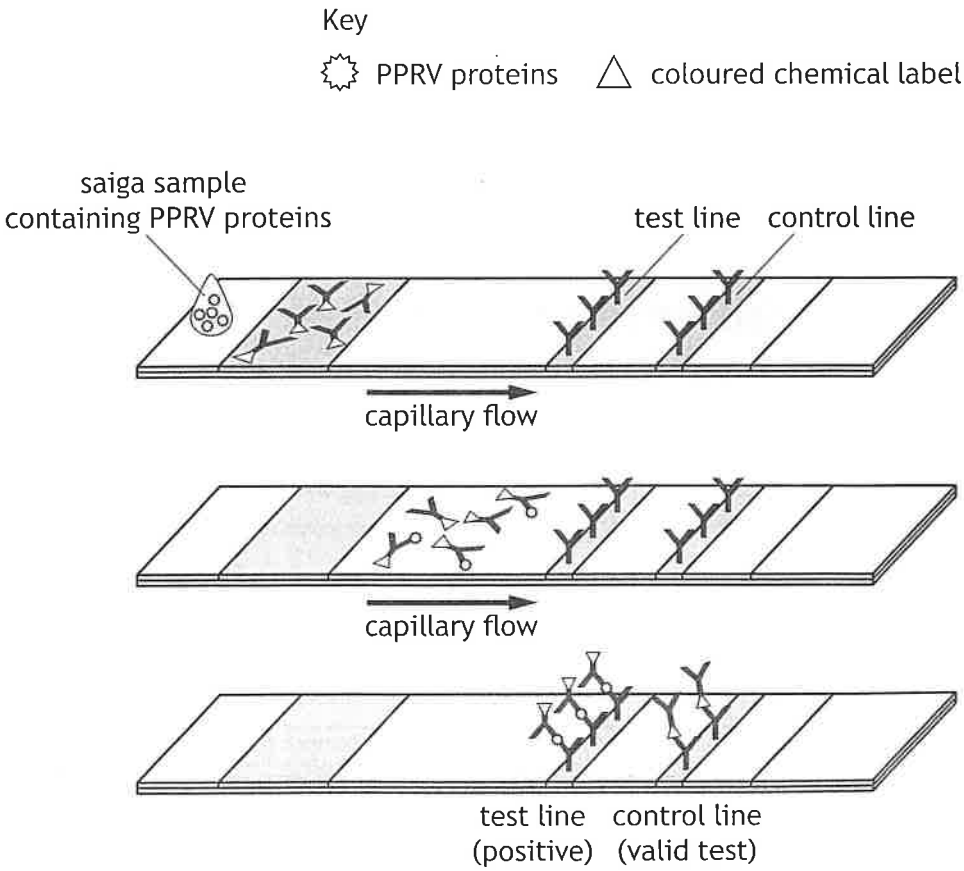
DO NOT WRITE IN THIS MARGIN

3. The saiga (*Saiga tatarica*) is a species of antelope found in central Asia. This species is considered a conservation success story following a rapid population recovery due, in part, to early detection of disease in the population.

During the 2010s there were events where herds of saiga were infected with various diseases leading to the species becoming critically endangered. One disease is Peste des petits ruminants (PPR), which is highly contagious and has a high mortality rate. This disease is caused by a virus (PPRV).

Recently a rapid test has been developed to allow scientists working in the field to detect PPRV in wild saiga by testing their saliva or faeces.

The figure shows how the test works. A valid positive test for PPRV will show a colour change at both the test line and the control line.



3. (continued)

(a) (i) State the name for techniques used to detect and identify specific proteins. 1

_____

(ii) Describe what is meant by a monoclonal antibody. 1

_____

(iii) Explain how the rapid test shown in the figure could be used to detect PPRV infection in an antelope. 2

_____

_____

_____

_____

(iv) In the sample of one individual, a colour change occurred at the control line but not at the test line.

Indicate whether the control line in **this** test represents a positive or a negative control by ticking (✓) one box.

Justify your selection. 1

Positive ☐ Negative ☐

_____

_____

[Turn over

3. (continued)

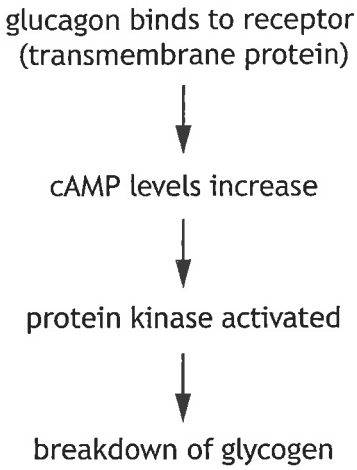
(b) Saiga are particularly vulnerable to PPRV being transmitted from domesticated cattle, goats, and sheep. One control method preventing transmission of PPRV from domestic animals to saiga was the introduction of a vaccination programme for domestic livestock.

(i) Explain why the design of a vaccine for PPRV may need to be regularly reviewed and updated. 1

(ii) Suggest why having access to these rapid tests would benefit scientists working in the field. 1

4. Glucagon is a small peptide hormone that promotes the breakdown of glycogen to glucose in the liver.

The figure shows how cyclic AMP (cAMP), which acts as a *second messenger*, is involved in the signalling pathway for glucagon.



(a) The glucagon receptor is a G-protein linked transmembrane protein.

(i) Explain why glucagon requires a receptor embedded in the plasma membrane. 1

(ii) Describe the role of G-proteins in signalling. 1

(b) (i) Glucagon is one of the hormones involved in the regulation of blood glucose concentration.

Name another hormone that is involved in regulating blood glucose levels. 1

(ii) It has been observed that people with type 2 diabetes may have higher levels of glucagon than people without this condition.

Explain why this change in glucagon levels would be expected to worsen the severity of type 2 diabetes. 1

MARKS | DO NOT WRITE IN THIS MARGIN

5. Mitosis is one of the processes that takes place during the mitotic phase (M-phase) of the cell cycle.

(a) Name the process that follows mitosis in M-phase. 1

_____

(b) Microtubules are a component of the cytoskeleton.

Describe the role of microtubules in mitosis. 3

_____

_____

_____

_____

_____

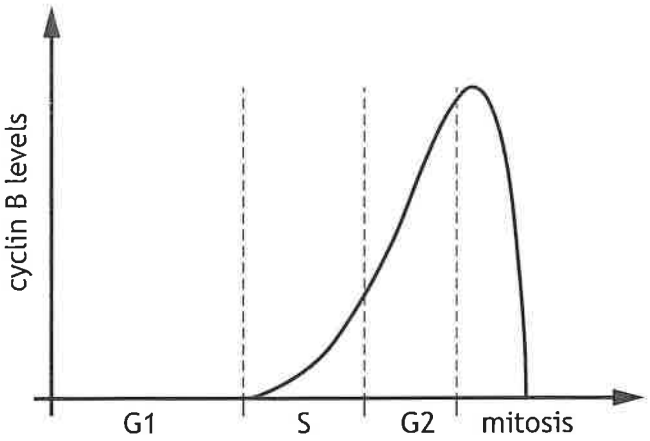
_____

5. (continued)

(c) Different cyclin proteins are involved in regulating the cell cycle.

Entry into mitosis is controlled by a protein called M-CDK, which comprises a cyclin-dependent kinase (CDK) combined with a cyclin called *cyclin B*.

The figure shows how cyclin B levels change during the cell cycle. The CDK levels remain similar throughout the cell cycle.



(i) Explain the importance of the increase in cyclin B levels to the progression of the cell cycle. 1

(ii) Elevated cyclin B levels are an indicator of tumour development.

Suggest a reason why cyclin B would be a target molecule in developing cancer treatments. 2

[Turn over

6. Carnivorous plants are a group of plants that can trap and digest prey and then use the additional nutrients to survive in challenging environments. They also carry out photosynthesis. Different species of these plants use a variety of mechanisms to trap prey.

Pitcher plants are carnivorous. They have leaves that are modified to form hollow, lidded, traps filled with liquid; many produce sweet nectar on or around the trap. It is thought that this attracts insects such as ants.

A recent study suggested that nectar of the Indian pitcher plant, *Nephenthes khasiana*, may have an additional role in trapping insects. The nectar contains a neurotoxic compound that interferes with the breakdown of acetylcholine (ACh), a neurotransmitter, after ACh has triggered a nerve impulse. Scientists propose that when ants eat the nectar it will affect their movement and balance, making them more likely to fall into the trap.

(a) The enzyme acetylcholinesterase breaks down acetylcholine (ACh) in synapses. The neurotoxic compound found in the nectar of the Indian pitcher plant inhibits this enzyme.

(i) Describe how an inhibitor, such as the neurotoxic compound found in the nectar of these plants, binding to an allosteric site could reduce an enzyme's activity. 2

(ii) Suggest how this would interfere with normal nerve transmission. 1

6. (a) (continued)

(iii) It was observed that not all ants that eat the nectar fall into the pitcher plant's trap.

Explain why natural selection might select for **pitcher plants** that produce a neurotoxin that is not potent enough to catch all the ants that eat it. 1

(b) Carnivory in plants is thought to have evolved independently in plants at least six times in areas where nutrients are scarce.

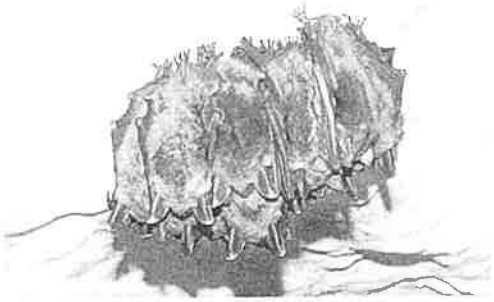
(i) What term describes this evolutionary process? 1

(ii) Explain how evidence from phylogenetics supports this hypothesis. 1

[Turn over

7. The soprano pipistrelle (*Pipistrellus pygmaeus*) is one of the most common and widespread of all British bat species. Summer roosts of soprano pipistrelles are found in crevices around the outside of buildings, in tree holes, and in bat boxes.

The photograph shows bats clustered together in a roost.



Volunteers with the Bat Conservation Trust carry out an annual series of bat surveys for the seventeen native species of bats as part of the National Bat Monitoring Programme. Two survey methods are described:

Field survey: Volunteers choose from a list of pre-selected survey sites of random 1 km grid squares. Twenty minutes after sunset, when there is still a low level of light, volunteers walk through the survey site stopping at twelve points for two minutes each to count individuals of the chosen bat species flying past.

Roost count: Volunteers position themselves beneath an identified roost exit at around sunset. They watch the exit carefully and count bats as they emerge from the roost on at least two evenings.

Both bat survey methods rely upon volunteers correctly identifying the bat species being surveyed.

(a) (i) Name a method of identification that could be used in these surveys. **1**

_____

(ii) Roost count surveys involve the observer recording all individuals seen from a fixed location.

Name this method of sampling. **1**

_____

(iii) For field surveys, volunteers are provided with a list of pre-selected survey sites.

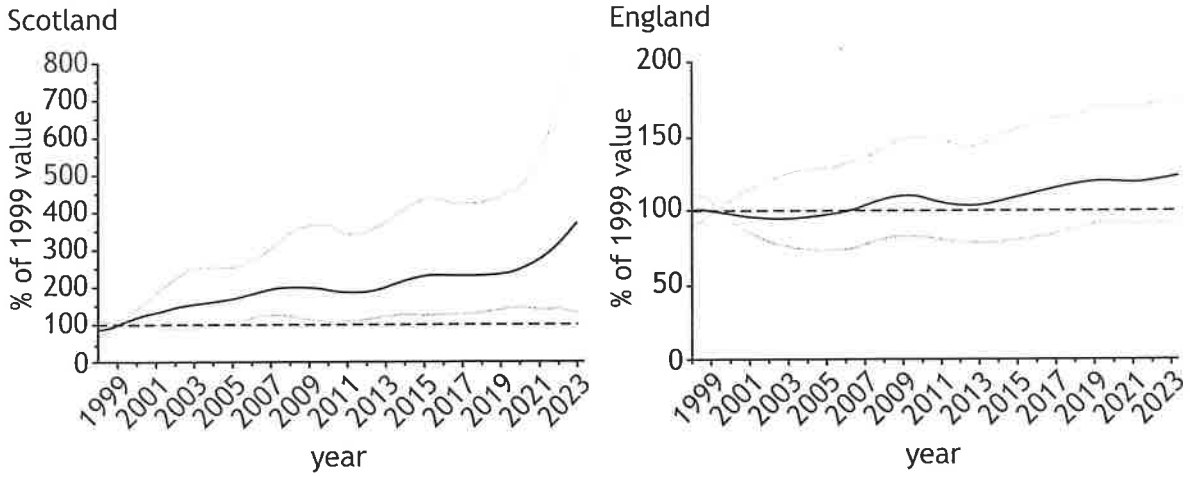
Suggest why volunteers can only choose a survey site that is on the list. **1**

_____

_____

7. (continued)

Field survey data for the populations of the soprano pipistrelle in Scotland and England are shown. The figures show the baseline value based on 1999 data as a horizontal line (dashed line). This can be compared to values from 1999 to 2023 (solid line).



Key

——— population of the soprano pipistrelles

- - - - - population of the soprano pipistrelles in 1999

------ 95% confidence intervals

The figures show the 95% confidence intervals for the data (grey lines). Confidence intervals show the variation within a set of data and can establish whether a result is statistically significant.

(b) (i) State what is meant by a statistically significant result. 1

_____

_____

(ii) The baseline value for population size was determined using the soprano pipistrelle population in 1999.

Compare the change in population size by 2023 in Scotland and England. 1

_____

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[Turn over

7. (continued)

(c) Soprano pipistrelle exhibit roost-switching, where bats abandon a roost temporarily for several weeks, months, or years before reoccupying it, or they may abandon it permanently.

Suggest why roost-switching makes a roost count survey an invalid survey method for measuring population change for this species. 1

(d) For other bat species, hibernation surveys are carried out between December and March. During these surveys volunteers may come into direct contact with bats. Therefore, to carry out a hibernation survey, volunteers must possess a bat survey license.

Suggest why a bat survey licence is required for hibernation surveys. 1

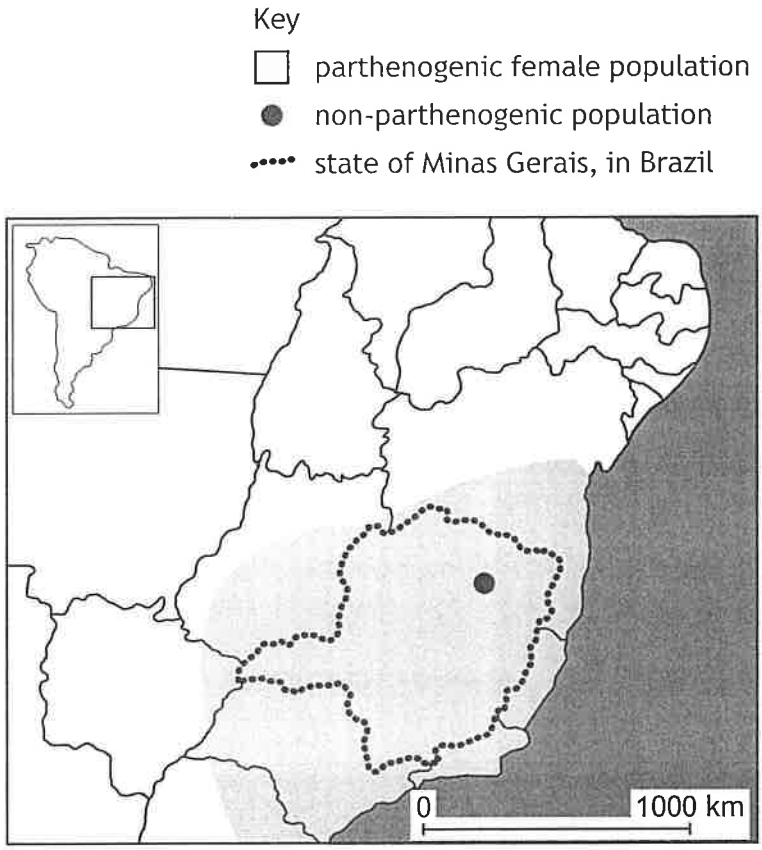
MARKS | DO NOT WRITE IN THIS MARGIN

8. Describe the effect of genetic drift on allele frequency in a population. 5

[Turn over

9. The Brazilian yellow scorpion (*Tityus serrulatus*) is the deadliest scorpion in South America. Despite originating in Brazilian grassland, it now is virtually restricted to human habitations.

A region of approximately 2000 km^2 was originally thought to contain an exclusively parthenogenic female population. Recently, a small non-parthenogenic population, that also includes males, has been found within the region.



(a) State the meaning of the term parthenogenesis. 1

(b) Explain why parthenogenic organisms are better suited to stable environments. 2

MARKS | DO NOT WRITE IN THIS MARGIN

9. (continued)

(c) Suggest how the newly found small non-parthenogenic population may have a negative impact on the parthenogenic population. 1

(d) Brazilian yellow scorpions are described as an r-selected species.

Describe the characteristics of an r-selected species in terms of parental investment. 3

[Turn over

10. *Poecilia reticulata* is a species of guppy fish that inhabits freshwater streams in South America and the Caribbean islands. They are also a popular species kept as pets in tropical aquariums.

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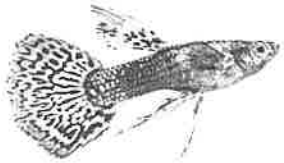
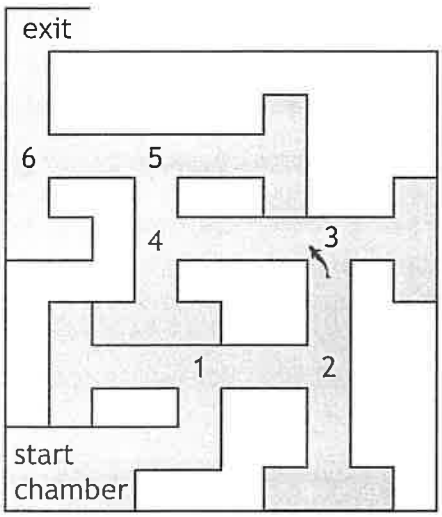


Scientists set up an investigation to determine whether male and female captive-bred guppies can learn to solve a complex maze, formed by six consecutive T-junctions.

Figure 1 shows the maze used by the scientists with each of the T-junctions labelled in the order the guppies complete the maze.

Figure 1



(a) This investigation considered the effect of training and the sex of the guppies as independent variables.

State the term for an investigation involving a combination of more than one independent variable. 1

_____

(b) Scientists caught wild guppies for a control group from a river in Trinidad. The control population sample consisted of fewer individuals than the captive population.

(i) Explain why using a wild population was a suitable control group in this experiment. 1

_____

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MARKS | DO NOT WRITE IN THIS MARGIN

(ii) The scientists chose the size of the control group based on previous studies. These studies found that during long training procedures, guppies taken from the wild sometimes showed behaviours such as becoming motionless for long periods of time or completely stopping participation in the trials.

Justify, in terms of the ethics of animal studies, why the scientists chose to use a smaller population size for the control group. 1

(c) In preparation for the investigation, both the wild and captive populations of guppies were maintained in identical conditions for two months. All fish were fed the same type of food three times per day.

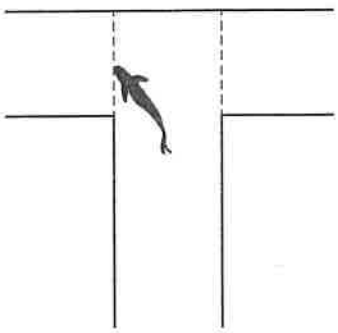
Explain why these preparations were necessary for both populations in order to increase the validity of the experimental design. 1

(d) Each individual guppy was used in 30 trials with 6 trials taking place each day.

When the guppy entered the starting chamber it was given 30 minutes to solve the maze. The time taken and number of errors made by the guppy in solving the maze were noted. A rest period of 30 minutes was given before the start of the next trial.

(i) **Figure 2** shows the choice made by a guppy at a T-junction. Scientists added dashed lines at each T-junction on the maze. If the guppy crossed the dashed lines in the wrong direction it was considered to have made an error.

Figure 2



Explain why the use of the dashed lines would improve the judgements made by the scientists. 1

10. (d) (continued)

(ii) Trials that took longer than 30 minutes were considered null and the results of these were not included in the analysis.

Indicate whether this should be considered a positive or negative aspect of the evaluation of the scientists' results.

Justify your choice. 1

Aspect _____

Justification _____

_____

(iii) The scientists calculated a mean value to get an indication of the representative value of how long each group took to solve the maze.

Explain why it is necessary to calculate a mean to determine the representative value being measured in this study. 1

_____

_____

(e) In a follow-up investigation the scientists wanted to determine whether a series of visual cues (using different colours at some of the junctions) helped the guppies to solve the maze.

Briefly describe an investigation that could be carried out to test this aim. 2

_____

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11. Shiny cowbirds (*Molothrus bonariensis*) are brood parasites, exploiting over 200 different host species. These birds lay their eggs in the nests of host species.

Brood parasites rely on other species to rear their young, manipulating the host to raise the parasite's young as if they were its own. Some brood parasites kill all their host's offspring shortly after hatching whereas in some other types, the parasite young are reared in mixed host-parasite broods.

(a) (i) Parasitism is a symbiotic relationship.

State what is meant by the term symbiosis. 1

_____

_____

(ii) Describe one unusual feature of the shiny cowbird niche compared to the niche of many other parasites. 1

_____

_____

[Turn over

(b) A study was carried out on shiny cowbird nestlings (SCN) being reared either by house wrens or chalk-browed mockingbirds. It was found that the female shiny cowbird employs different strategies to ensure offspring success depending on the species parasitised.

Figure 1 shows the number of parental feeding visits per hour to shiny cowbird nestlings (SCN) reared alone and in mixed broods with host chicks.

Figure 1

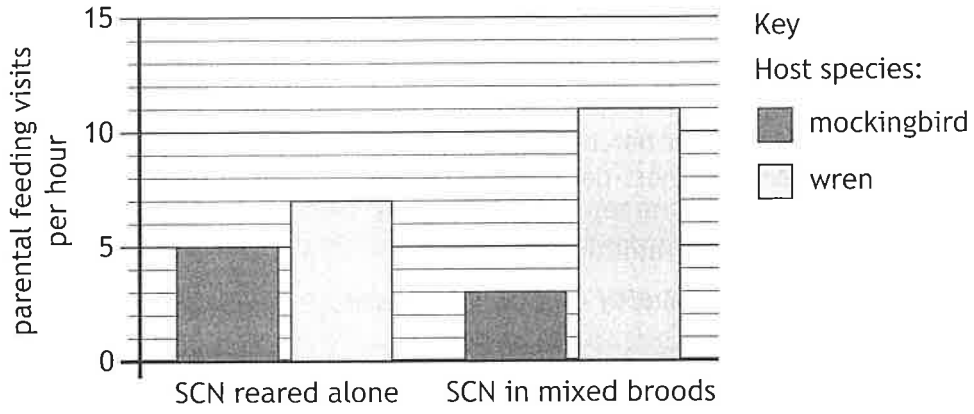
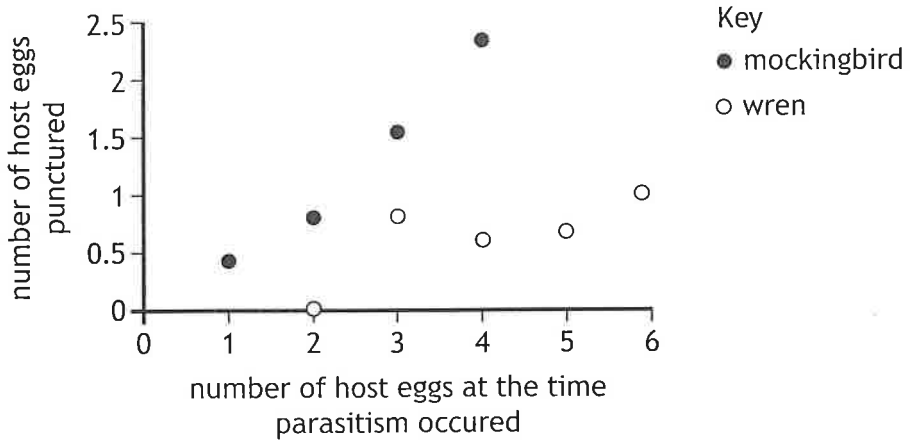


Figure 2 shows the number of host eggs punctured by the shiny cowbird female during laying of her eggs.

Figure 2



Use all the information to explain the trends shown in **Figure 2**. 2

11. (continued)

(c) A third species of bird, the red-crested cardinal, is also a good quality potential host of the cowbird.

Cardinals breed at the same time as cowbirds, have a similar body mass, and feed their young with an appropriate diet for nestling shiny cowbirds. However, the frequency of shiny cowbird brood parasitism on cardinal nests is very low.

A study identified that red-crested cardinals can recognise shiny cowbird eggs due to a slight difference in colour compared to their own eggs, and cardinals eject parasite eggs from their nest. It was hypothesised that this has evolved as an anti-parasite defence.

With reference to the Red Queen hypothesis, explain how the shiny cowbird population may evolve to overcome this anti-parasite defences in red-crested cardinals. 2

_____

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[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

12. Answer **either A or B**. Write your answer in the space below and on *page 31*.

A Discuss the sodium-potassium pump under the following headings:

(i) establishing an electrochemical gradient — 6

(ii) glucose transport in the small intestine. — 2

OR

B Discuss the vertebrate eye under the following headings:

(i) initiation of a nerve impulse by light in rod cells — 6

(ii) function of cone cells. — 2

National Qualifications 2026

X807/77/11

Biology
Supplementary sheet

TUESDAY, 28 APRIL
9:00 AM – 12:00 NOON

Supplementary sheet for question 1

X8077711

Qualifications Scotland
Teisteanasan Alba

1. Marine mammals display several physiological adaptations to their marine environment. Their cells contain the molecule myoglobin, which can associate with oxygen in a similar way to haemoglobin, providing an oxygen store within cells. Higher myoglobin concentrations in the muscles of marine mammals allows them to increase their internal oxygen stores, increasing the time available to dive.

Dolphins are marine mammals that spend much time at the surface of the oceans. They often dive to catch their prey, with the dive depth determining their prey species.

Three species of dolphin were studied to identify the levels of myoglobin in different muscles within the dolphins' bodies.

Information about the three dolphin species studied is shown in **Figure 1**.

Figure 1

- Striped dolphin (*Stenella coeruleoalba*)

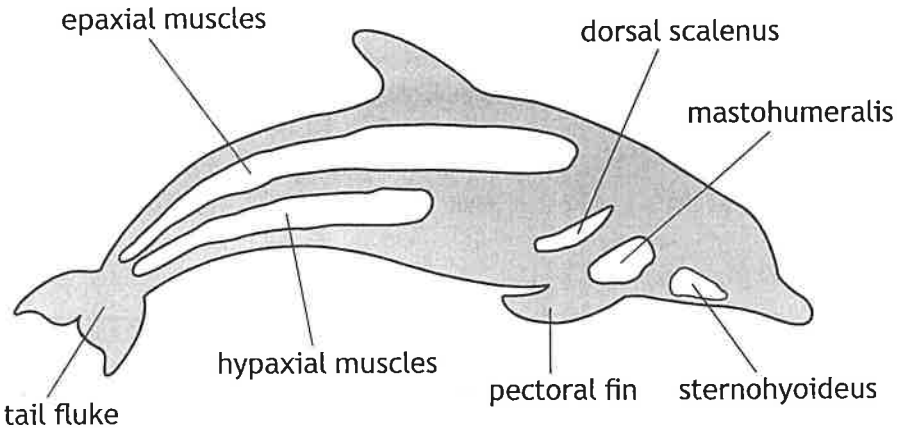
  Widely distributed across the oceans, feeding mainly in the open ocean, and can dive to depths of up to 700 m to hunt deeper dwelling prey. It can grow to 160 kg in mass.
- Atlantic spotted dolphin (*Stenella frontalis*)

  Found across the North and South Atlantic, eating mainly small fish, invertebrates and squid. It can dive up to 60 m and grow to a body mass of 140 kg.
- Common dolphin (*Delphinus delphis*)

  Lives in warmer coastal waters, eating mainly fish and squid. It dives up to 200 m and can grow to a body mass of 150 kg.

Some dolphin muscles are shown in **Figure 2**.

Figure 2



1. **(continued)**

Samples of muscles from all three dolphin species were taken from animals that had died naturally and washed up on seashores. No live animals were tested.

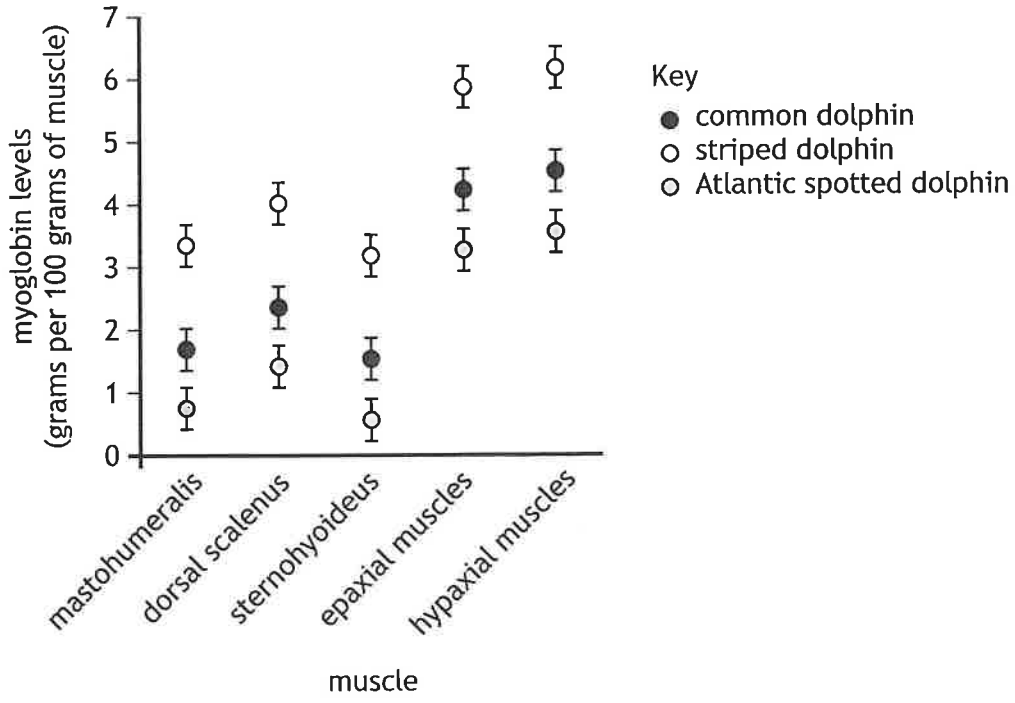
Figure 3 shows muscle functions and the mean myoglobin levels in muscle samples of the common dolphin.

Figure 3

Muscle	Muscle function	Mean myoglobin levels (grams per 100 grams of muscle)
Mastohumeralis	pectoral fin movement (steering)	1.696
Dorsal scalenus	breathing	2.357
Sternohyoideus	swallowing	1.524
Epaxial muscles	tail fluke upstroke	4.374
Hypaxial muscles	tail fluke downstroke	4.660

The mean myoglobin levels from the same muscles were also measured in Atlantic spotted and striped dolphins. The data for all three species are shown in **Figure 4.**

Figure 4



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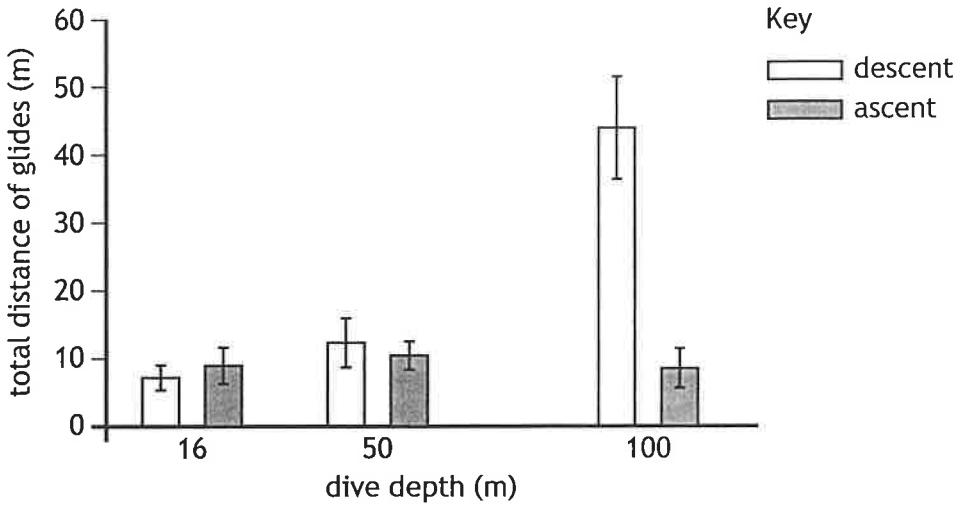
1. **(continued)**

During dives, dolphins use both epaxial and hypaxial muscles to move their tail fluke for swimming. They conserve energy by stopping the movement of their tail fluke and only gliding.

Figure 5 shows the total distance of these glides during descent (going deeper) and ascent (returning to the surface) from dives.

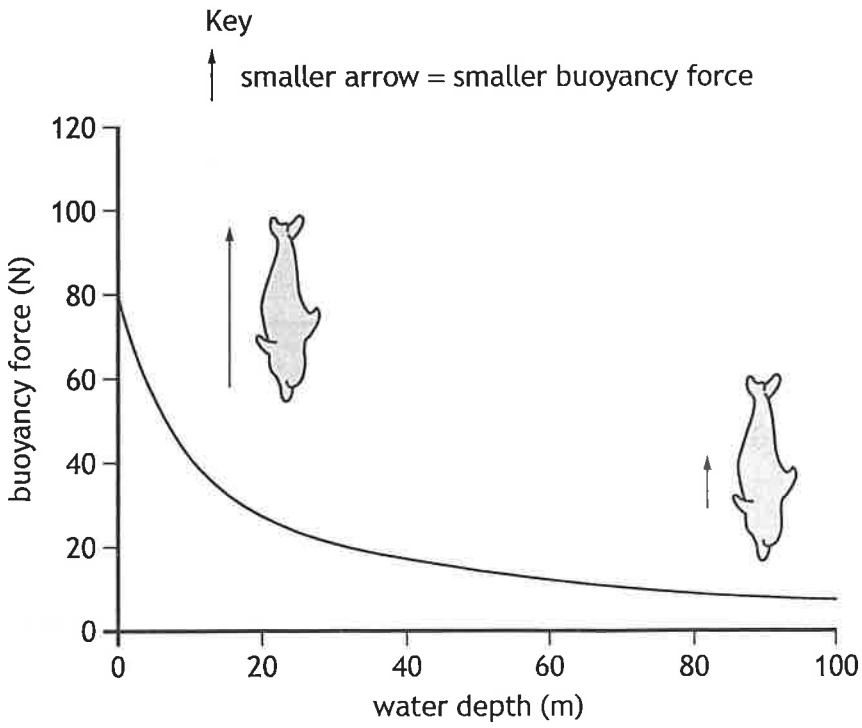
Figure 5



When diving, dolphins must overcome buoyancy forces, which would make them float towards the surface.

Figure 6 shows how the buoyancy force changes with water depth. The size of the arrow indicates the upwards buoyancy force acting on the dolphin.

Figure 6



[END OF SUPPLEMENTARY SHEET]