FOR OFFICIAL USE

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

   _____

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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

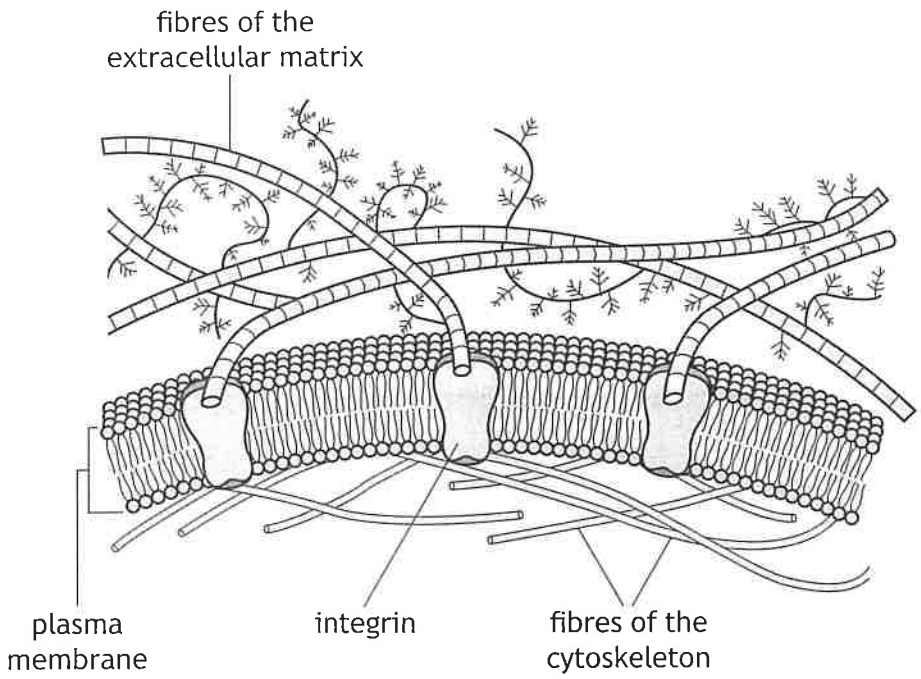
2. The Golgi apparatus is an organelle where proteins are processed. These proteins include integrins that are essential signal transductors embedded in the plasma membrane. Integrins are also involved in holding cells together within tissue such as bone.

(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

MARKS | DO NOT WRITE IN THIS MARGIN

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

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[Turn over

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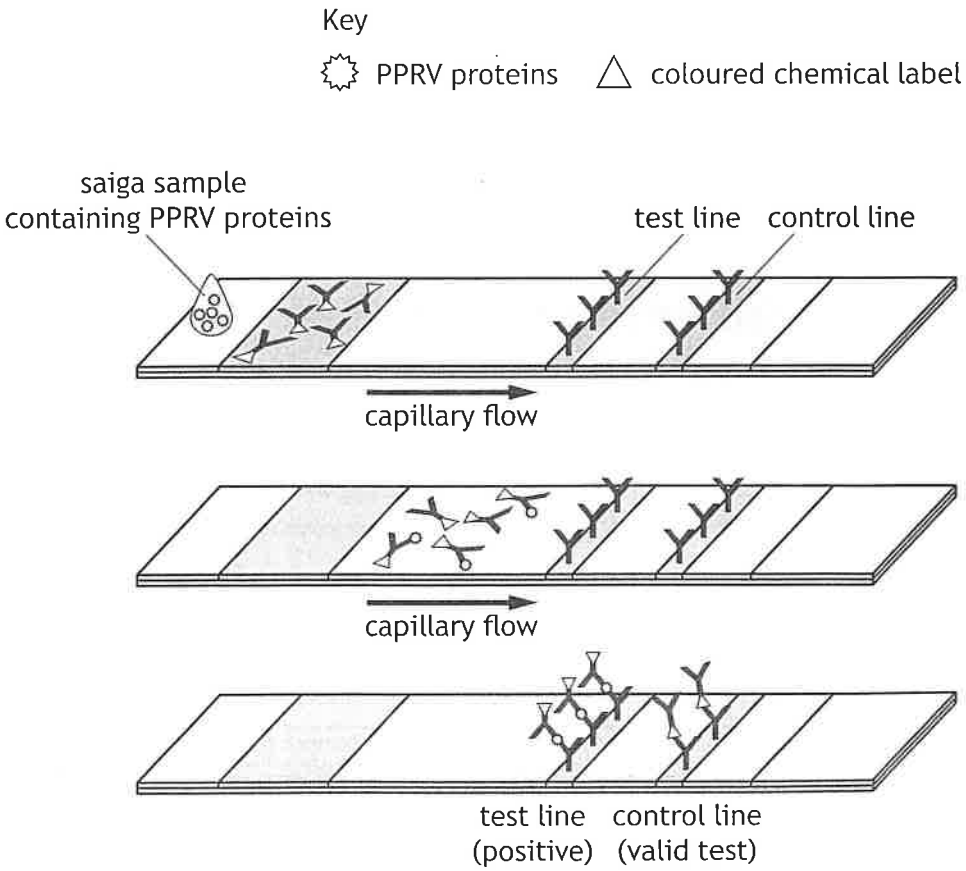
3. The saiga (*Saiga tatarica*) is a species of antelope found in central Asia. This species is considered a conservation success story following a rapid population recovery due, in part, to early detection of disease in the population.

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

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(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 ☐

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[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

3. (continued)

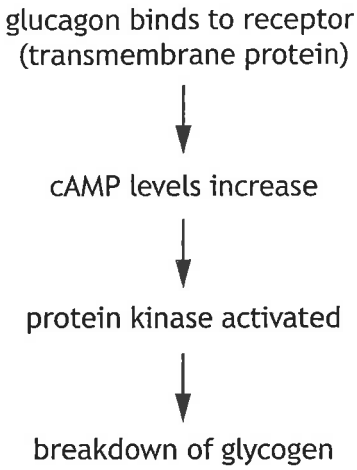
(b) Saiga are particularly vulnerable to PPRV being transmitted from domesticated cattle, goats, and sheep. One control method preventing transmission of PPRV from domestic animals to saiga was the introduction of a vaccination programme for domestic livestock.

(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

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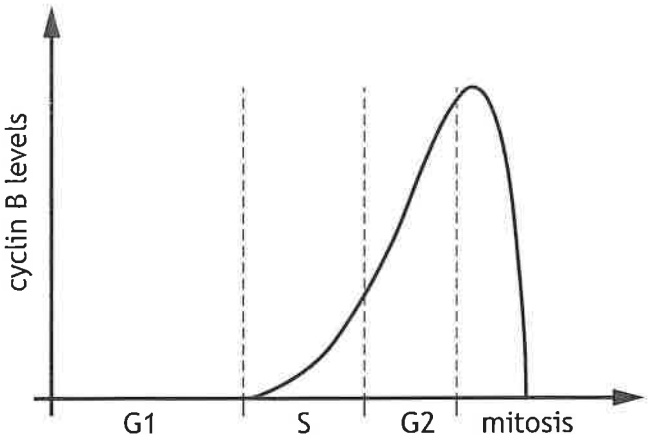
5. (continued)

(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.

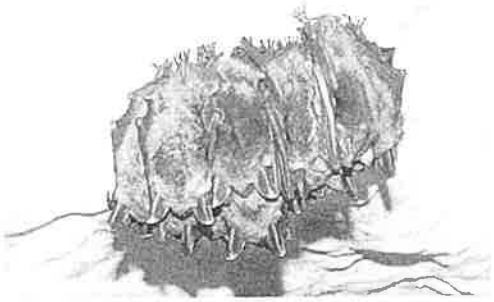
(i) What term describes this evolutionary process? 1

(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**

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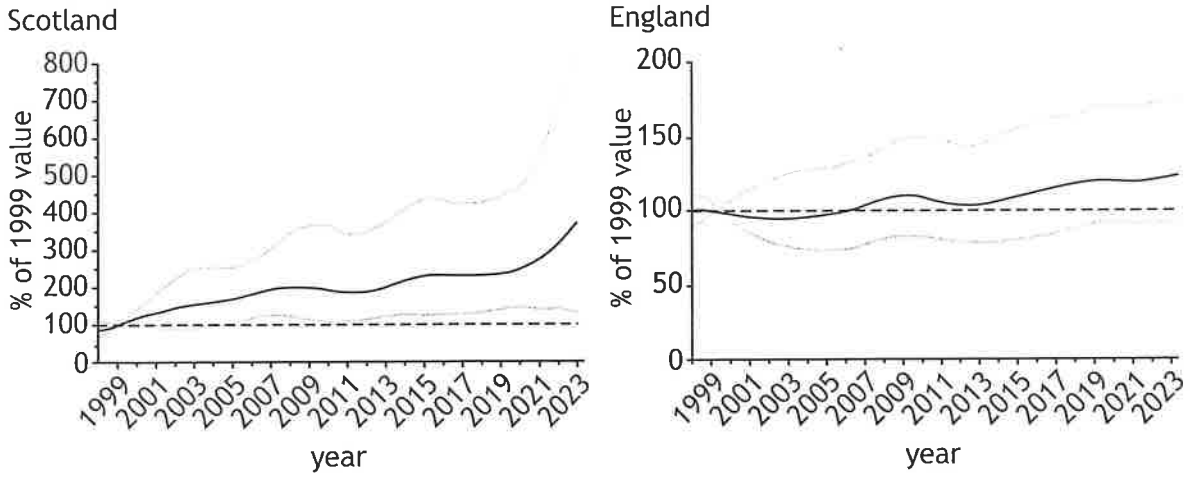
_____

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

[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

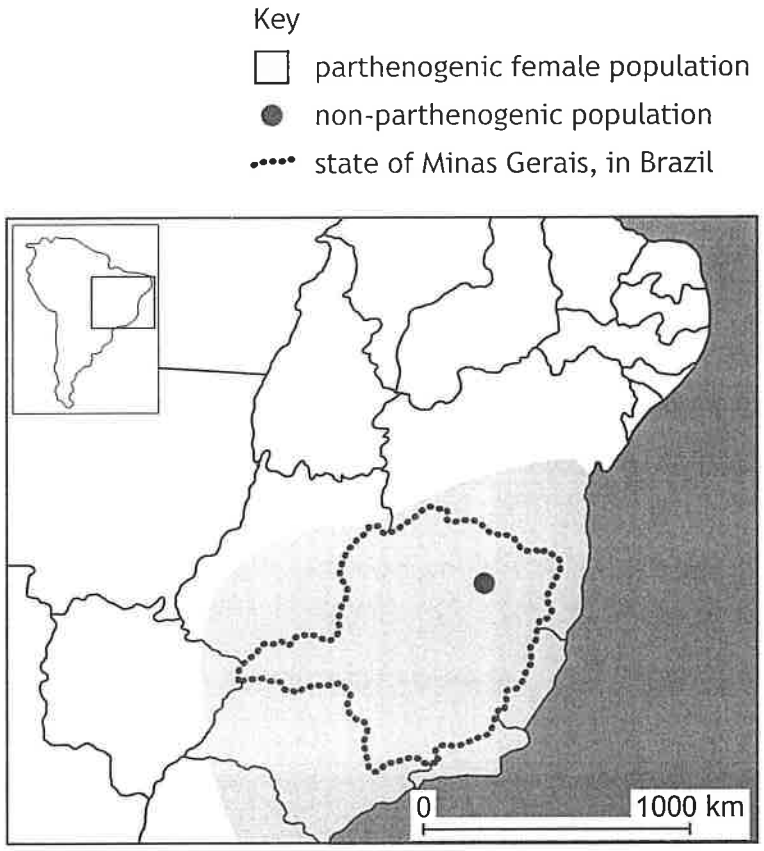
MARKS | DO NOT WRITE IN THIS MARGIN

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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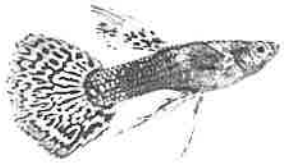
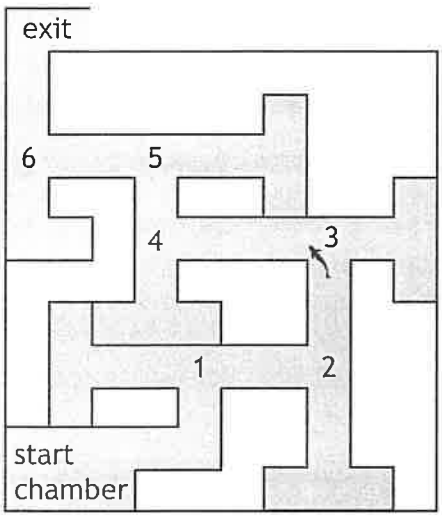


Scientists set up an investigation to determine whether male and female captive-bred guppies can learn to solve a complex maze, formed by six consecutive T-junctions.

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.

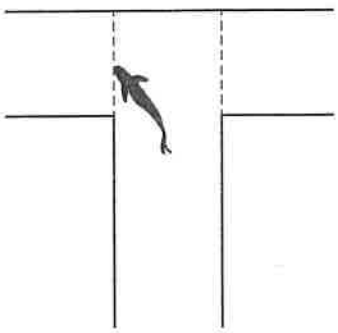
Explain why these preparations were necessary for both populations in order to increase the validity of the experimental design. 1

(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

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(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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MARKS | DO NOT WRITE IN THIS MARGIN

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

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

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[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

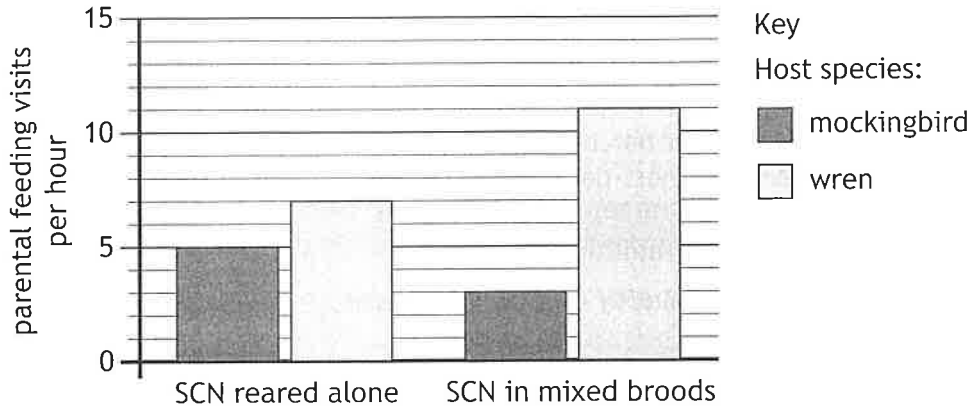
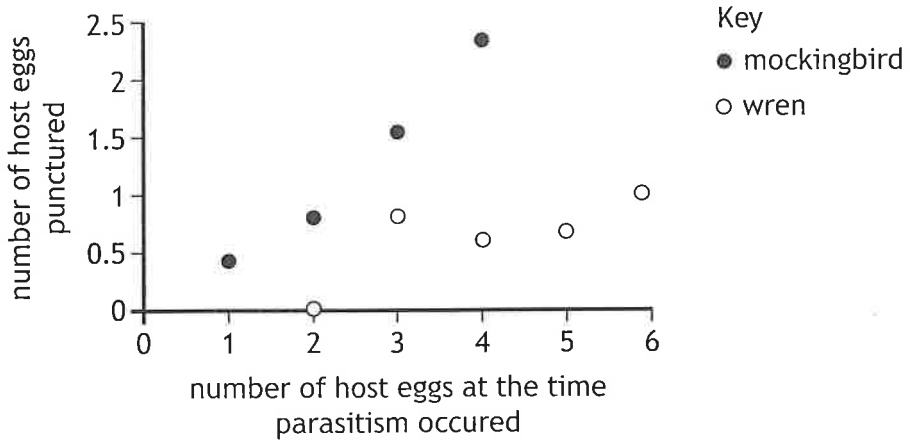


Figure 2 shows the number of host eggs punctured by the shiny cowbird female during laying of her eggs.

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**