

Biology
Higher level
Paper 2

Specimen paper

Candidate session number

2 hours 30 minutes

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Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.



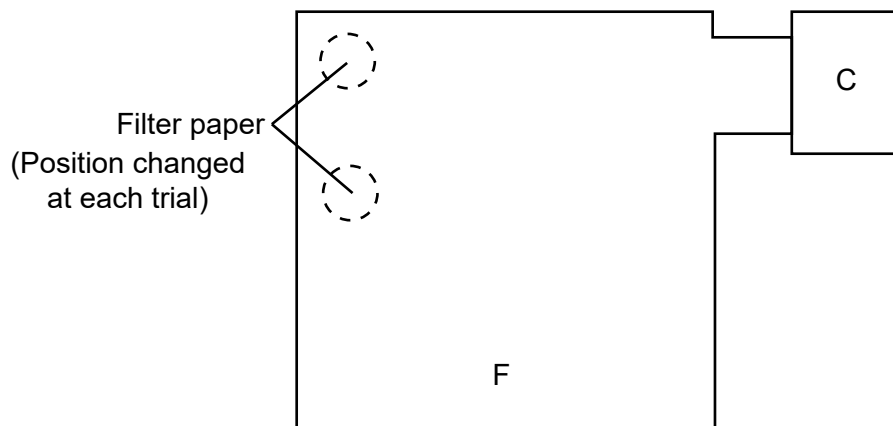
Section A

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Squirrels (small mammals) have evolved several defences against predators. One method adopted by California ground squirrels (*Otospermophilus beecheyi*) against rattlesnakes (*Crotalus oreganus*) is to chew moulted rattlesnake skins, then lick their own fur so they take on the scent of a rattlesnake.

An experiment tested the amount of time rattlesnakes spent studying and flicking their tongue at filter papers soaked in different liquids. The snakes were released from chamber C into foraging area F and observed for 30 minutes. There were two filter papers in area F. One was a control paper soaked in distilled water. The other was soaked in one of three types of scent:

- squirrel scent
- a mixture of squirrel and rattlesnake scent
- rattlesnake scent.

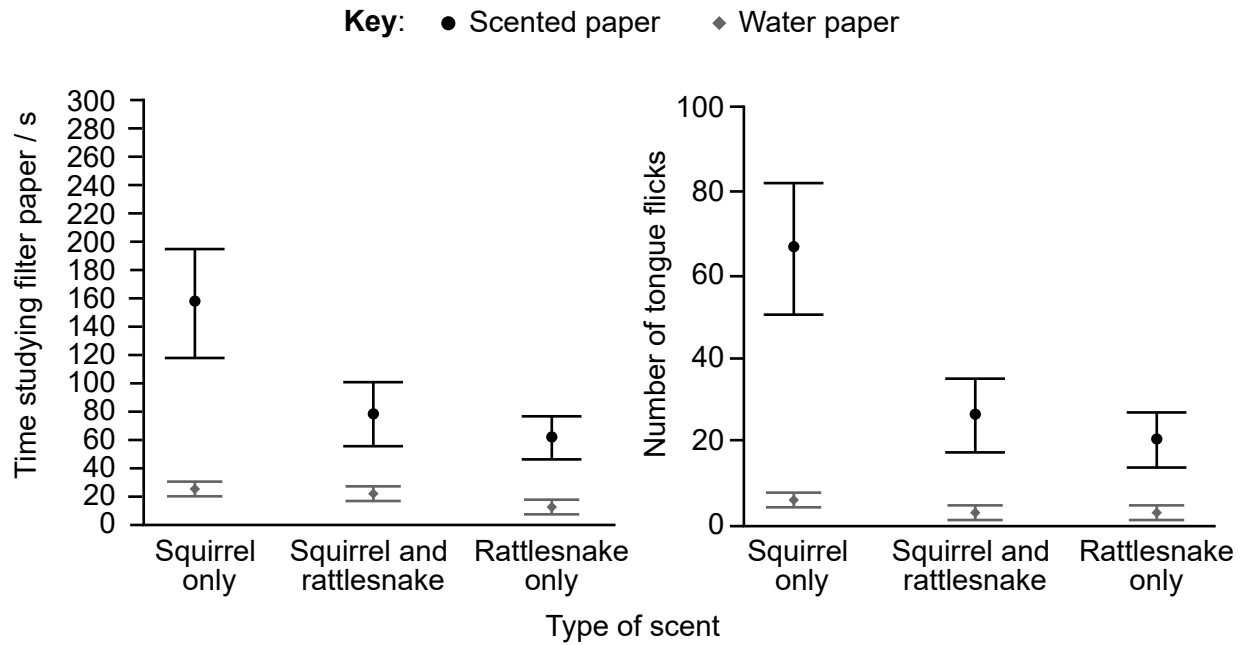


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(Question 1 continued)

The graphs show the results of the experiment.



[Source: adapted from Clucas, B., Owings, D.H. and Rowe, M.P., 2008. *Proc Biol Sci*, 275(1636), pp.847–852. <https://doi.org/10.1098/rspb.2007.1421> REDACTED.]

- (a) Calculate the difference in mean time spent studying squirrel-scented filter paper with and without rattlesnake scent. [1]

- (b) Outline the conclusions that can be drawn from the control results. [2]

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(Question 1 continued)

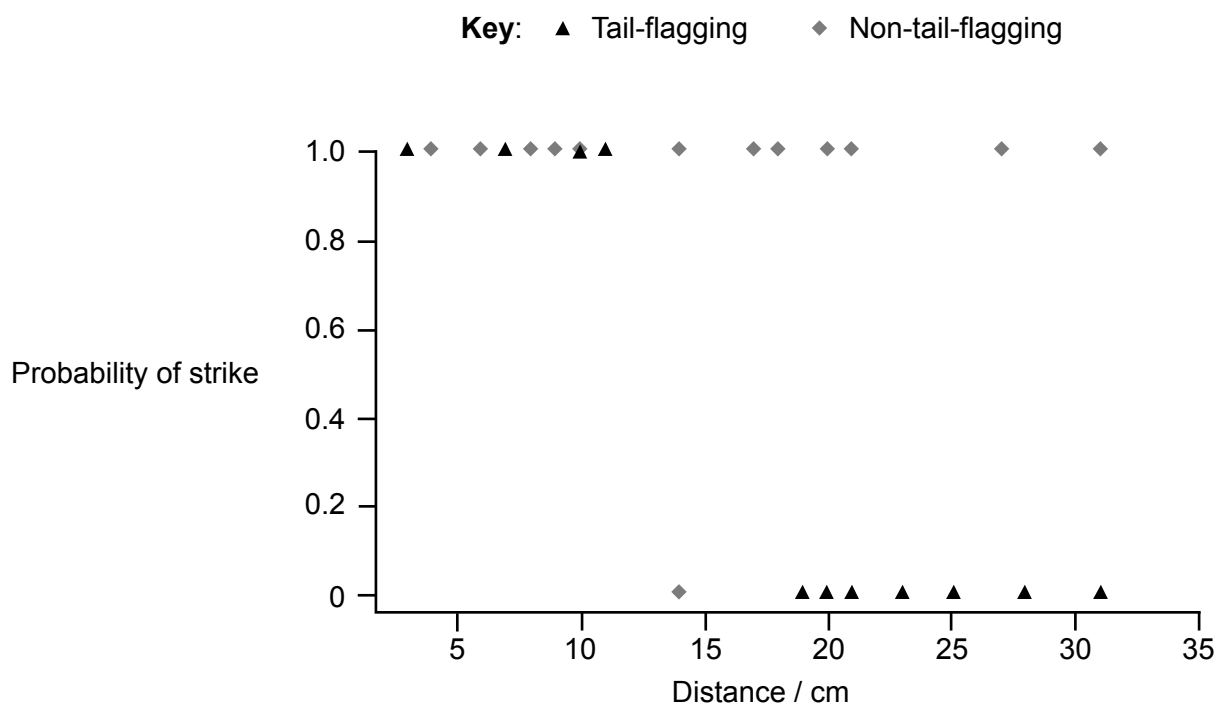
- (c) The positions of the filter papers were changed for every trial. Outline **one** reason that this was necessary. [1]

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- (d) Suggest a reason for rattlesnake scent lowering the chances of snake attacks on squirrels. [1]

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The researchers observed that when squirrels saw a rattlesnake, they waved their tail from side-to-side so that they were more visible to the rattlesnakes (tail-flagging). The graph shows the probability of a snake strike at different distances on tail-flagging and non-tail-flagging squirrels.



[Source: adapted from Barbour, M.A. and Clark, R.W., 2012. *Proceedings of the Royal Society B*, [e-journal] <https://doi.org/10.1098/rspb.2012.1112> REDACTED.]

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(Question 1 continued)

- (e) Compare and contrast the effect of tail-flagging with non-tail-flagging on strike probability. [2]

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- (f) Estimate the distance between squirrel and snake where there is a 50 % chance of a strike at a tail-flagging squirrel. [1]

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- (g) Suggest a reason for the behaviour of snakes towards tail-flagging squirrels. [1]

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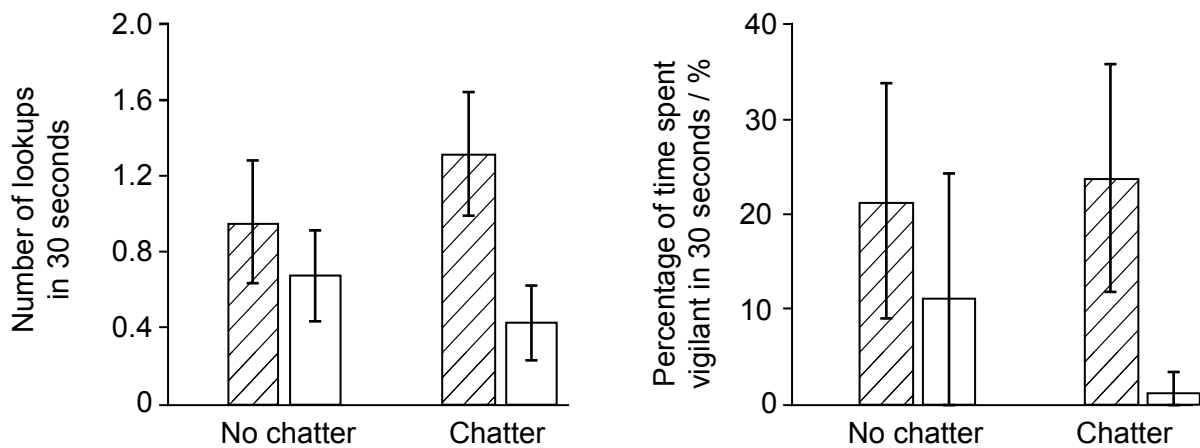


(Question 1 continued)

When played a recording of the call of a red-tailed hawk (*Buteo jamaicensis*), foraging grey squirrels (*Sciurus carolinensis*) in the wild became more vigilant and looked up from their feeding more often. In the habitat of the squirrels, there are also sounds made by songbirds which chatter to each other when there is no imminent threat. The charts show the response of the squirrels in the 30 seconds immediately after the scare of hearing hawk sounds and after 3 minutes, both with and without bird chatter playing.

Key:

-  Response immediately after hearing hawk sounds
-  Response after 3 minutes



[Source: adapted from Lilly, M.V., Lucore, E.C. and Tarvin, K.A., 2019. *PLoS ONE*, 14(9): e0221279. <https://doi.org/10.1371/journal.pone.0221279>. REDACTED.]

- (h) State the conditions that led to the squirrels making the least mean number of lookups. [1]

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(Question 1 continued)

- (i) Discuss briefly whether the sound of bird chatter represents a significant difference in the vigilance of squirrels immediately after they have heard the sound of a hawk. [2]

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- (j) Using the data in the bar charts, analyse the effect of bird chatter on the behaviour of squirrels. [3]

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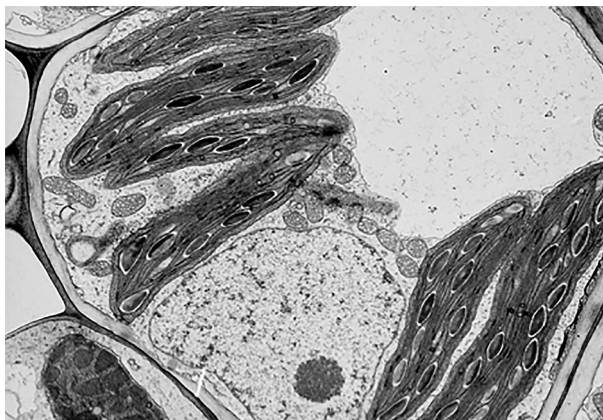
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2. The cytoplasm in eukaryotic cells is compartmentalized into membrane-bound organelles, as seen in this electron micrograph of a plant cell.



- (a) State **two** membrane-bound organelles that are common to both plant and animal cells. [2]

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- (b) (i) State **one** organelle that is found in a plant cell but not in an animal cell. [1]

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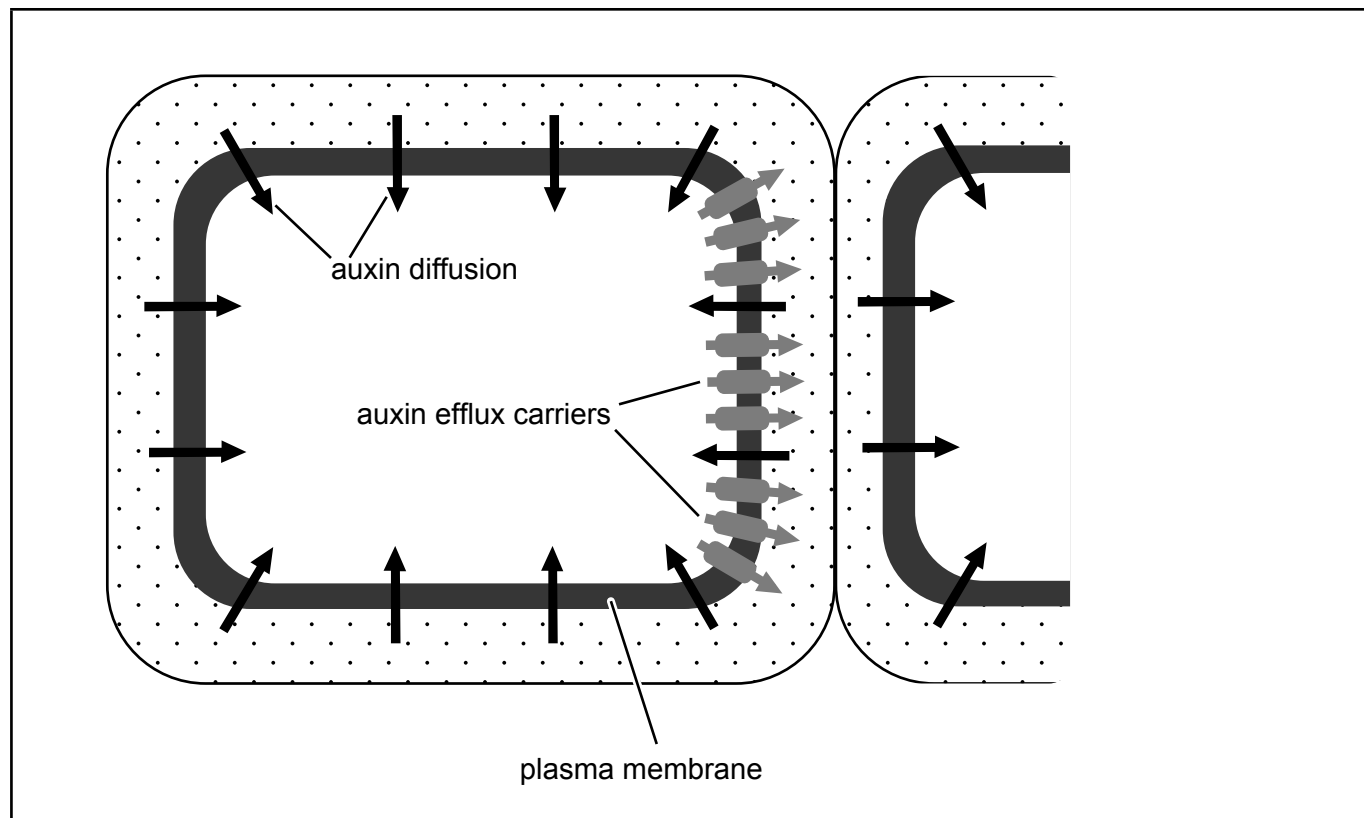
- (ii) State **one** organelle that is common to prokaryotic and eukaryotic cells. [1]

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3. The diagram shows the movement of auxin across the plasma membrane of a plant cell as well as the position of auxin efflux carriers.



- (a) (i) Annotate the diagram, using an arrow, to show the direction of the net flow of auxin through the cell. [1]
- (ii) Identify an environmental factor that causes auxin efflux carriers to be concentrated on one side of a cell. [1]

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- (b) (i) Predict the difference that could be seen using a microscope between plant meristematic cells grown in media with and without auxin. [1]

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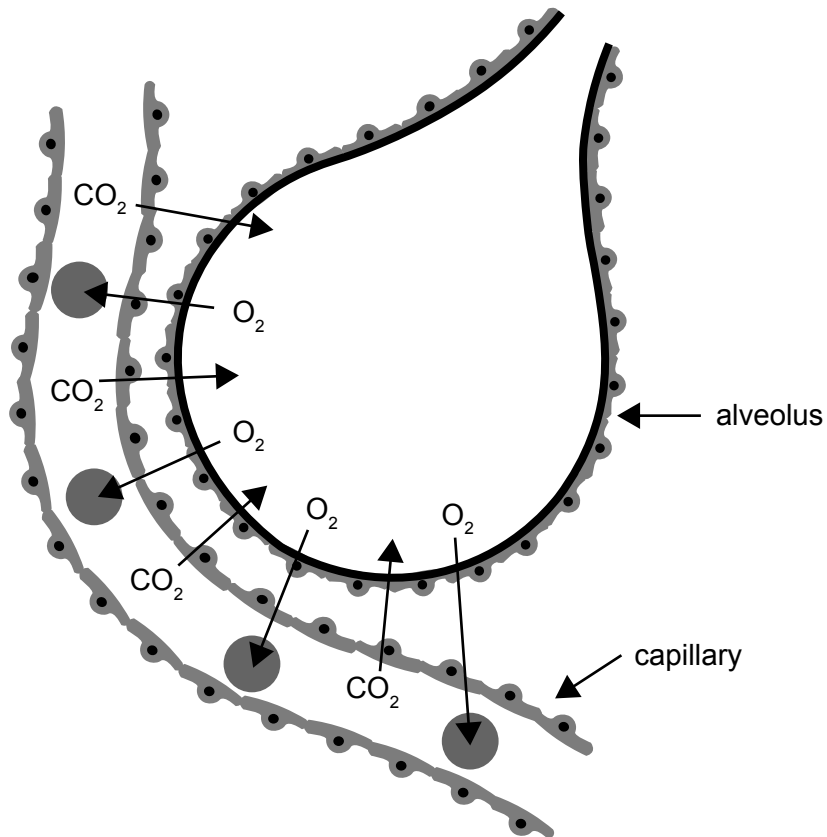
- (ii) State the hormone that interacts with auxin to integrate shoot growth. [1]

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4. Multicellular organisms need efficient exchange surfaces where molecules can move between tissues and their surroundings. In mammals, gas exchange takes place in the alveoli of the lungs.



- (a) Describe how the exchange of gases is brought about between the alveoli and the blood. [3]

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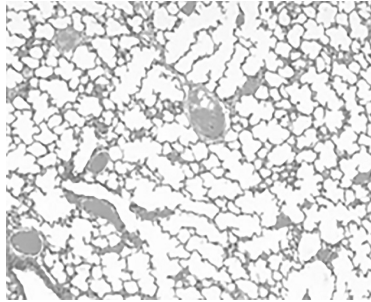
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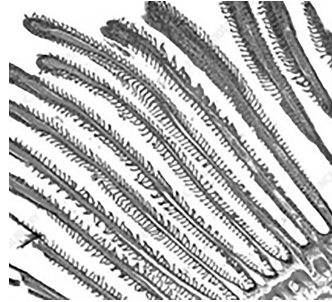


(Question 4 continued)

The images show the lungs of a human and the gills of a fish taken with a light microscope.



Alveoli in the lungs of a human



Gills from a fish

- (b) Describe **two** features common to the exchange surfaces of alveoli and gills. [2]

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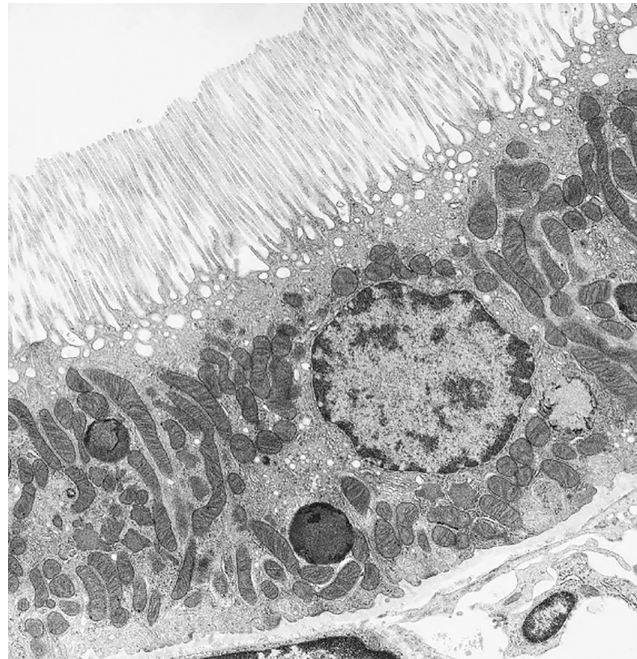
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(Question 4 continued)

The image shows cells from the wall of a proximal convoluted tubule of a rat kidney.



- (c) Outline the visible features of these cells that adapt them for reabsorption of materials from the glomerular filtrate.

[2]

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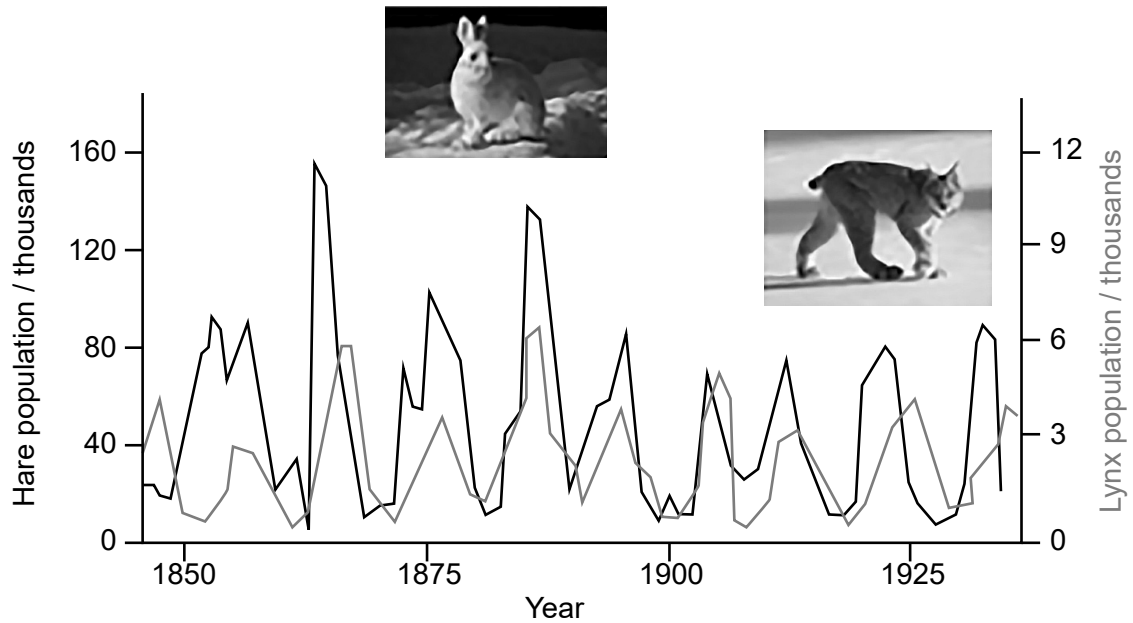
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5. Predation may result in a cyclic pattern of population changes, as for example in the case of the lynx, *Lynx canadensis* (predator), and the hare, *Lepus americanus* (prey).



- (a) The predator benefits from a predator-prey relationship by obtaining food. Suggest how the hare population could benefit from this relationship. [1]

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- (b) Outline the factors that contribute to the carrying capacity of prey organisms in a predator-prey relationship. [2]

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(Question 5 continued)

- (c) (i) Outline how the hare population size can be estimated using the mark-release-recapture method.

[2]

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- (ii) State **one** assumption that is made when using this method to estimate population size.

[1]

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6. In humans, sex is determined genetically and human populations have approximately equal numbers of males and females in each generation.

(a) Outline how sex is determined in humans.

[2]

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- (b) Down syndrome is a genetic condition in which the cells of an individual contain three copies of chromosome 21. Explain how non-disjunction leads to trisomy 21.

[3]

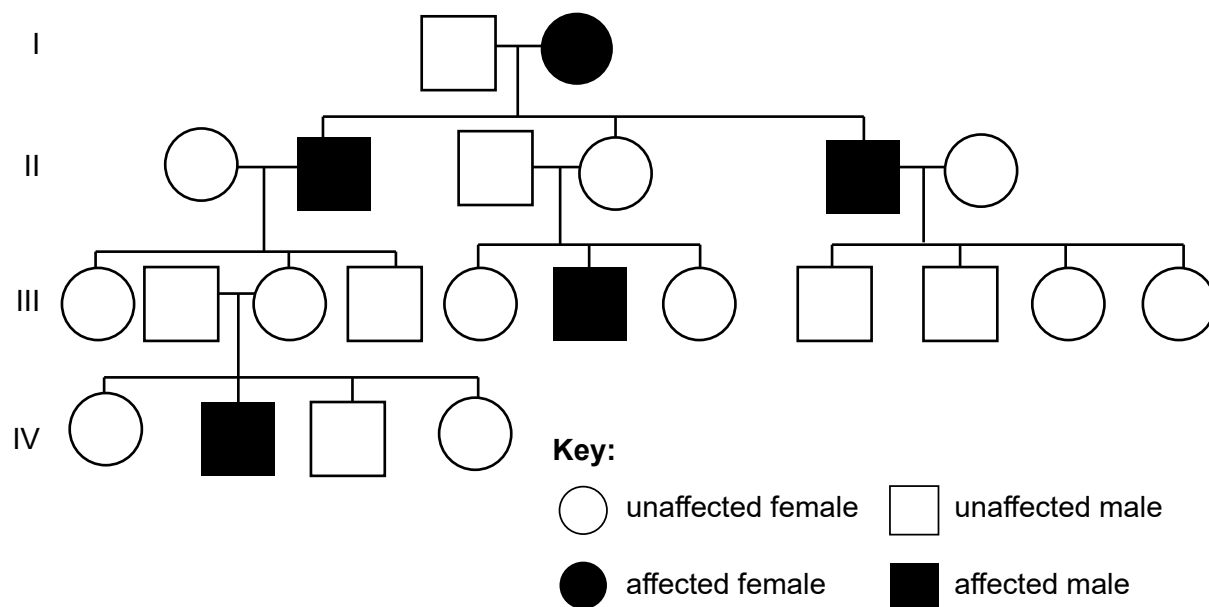
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(Question 6 continued)

- (c) The pedigree chart shows the inheritance of hemophilia in a human family over four generations. Symbols represent the phenotype of the individual.



Explain the evidence from this chart that the condition may be sex-linked.

[2]

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7. Two alleles of a gene influence body colour in *Drosophila*. The dominant allele B results in a brown body colour while the recessive allele b codes for black body. In addition, two alleles of another gene determine wing shape; normal wings (V) are dominant over vestigial wings (v).

In a dihybrid cross between a double heterozygote for body colour and wing shape (BbVv) and a homozygous recessive for both traits (bbvv), the following offspring were obtained:

- brown body, normal wings: 29
- brown body, vestigial wings: 8
- black body, normal wings: 10
- black body, vestigial wings: 33

- (a) Identify the recombinant phenotypes amongst the offspring.

[1]

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- (b) Explain whether these results fit the predicted Mendelian ratios for this cross.

[2]

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- (c) Outline the statistical test that could be used to provide more evidence of the type of inheritance.

[2]

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Section B

Answer **two** questions. One additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

8. There are a number of advantages to specificity.
 - (a) Explain how vaccination can result in specific immunity to a viral disease. [7]
 - (b) Outline the role of membrane proteins in the movement of specific ions at specific times in the transmission of nerve impulses. [4]
 - (c) Describe the barriers that exist to hybridization between species. [4]

9. Various mechanisms can lead to inhibition in biological systems. A toxin is a substance capable of disrupting metabolic processes in organisms.
 - (a) Describe how toxins such as DDT might concentrate in the bodies of birds. [4]
 - (b) Toxins often act as inhibitors. Compare and contrast competitive and non-competitive enzyme inhibition. [7]
 - (c) Rotenone is a naturally occurring toxin that blocks the electron transport chain in insects and fish. Outline the consequences of exposure to a toxin like rotenone for cell respiration. [4]

10. Changes in the form of biological molecules lead to changes in their function.
 - (a) Outline the role of UV radiation as a mutagen. [4]
 - (b) Explain how the function of DNA is linked to its molecular structure. [7]
 - (c) Describe the use of gene knockout technology in research. [4]



References:

2. *Electron micrograph of cells from the leaf of a corn plant*, n.d. [image online] Available at: <<http://innolearn.weebly.com/bio-cell.html>> [Accessed 9 December 2020].
- 3a. Smith, R.S., 2008. The Role of Auxin Transport in Plant Patterning Mechanisms. *PLoS Biol*, 6(12): e323. <https://doi.org/10.1371/journal.pbio.0060323>.
- 4b. Left image:
[*Alveoli in the lungs of a human*], n.d. [image online] Available at: <http://medcell.med.yale.edu/histology/respiratory_system_lab.php#slides> [Accessed 9 December 2020].

Right image:
[*salt water fish gills histology*], n.d. [image online] Available at: <<https://br.pinterest.com/pin/255297872605284426/>> [Accessed 9 December 2020].
- 4c. *Transmission electron micrograph of the S1 segment of a rat proximal tubule*, n.d. [image online] Available at: <<https://abdominalkey.com/anatomy-of-the-kidney/>> [Accessed 9 December 2020].
5. Wani, n.d. [*Hare and lynx populations*]. [image online] Available at: <<https://www.cleanpng.com/png-cat-snowshoe-hare-eurasian-lynx-lotkavolterra-e-3913514/>> [Accessed 29 July 2020].

