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Biology
Standard level
Paper 2

Wednesday 11 May 2022 (afternoon)

Candidate session number

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1 hour 15 minutes

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 one question.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[50 marks]**.



Please **do not** write on this page.

Answers written on this page
will not be marked.



Section A

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

1. Three-toed sloths (*Bradypus variegatus*) are placental mammals that live in trees in Central and South America. They eat leaves and fruit and get almost all their water from succulent plants.



[Source: Adapted from Laube, S., 2003. Three-toed-sloth (*Bradypus variegatus*), Lake Gatun, Republic of Panama. [image online] Available at: <https://meta.wikimedia.org/wiki/User:Bradipus#/media/File:Bradypus.jpg>]

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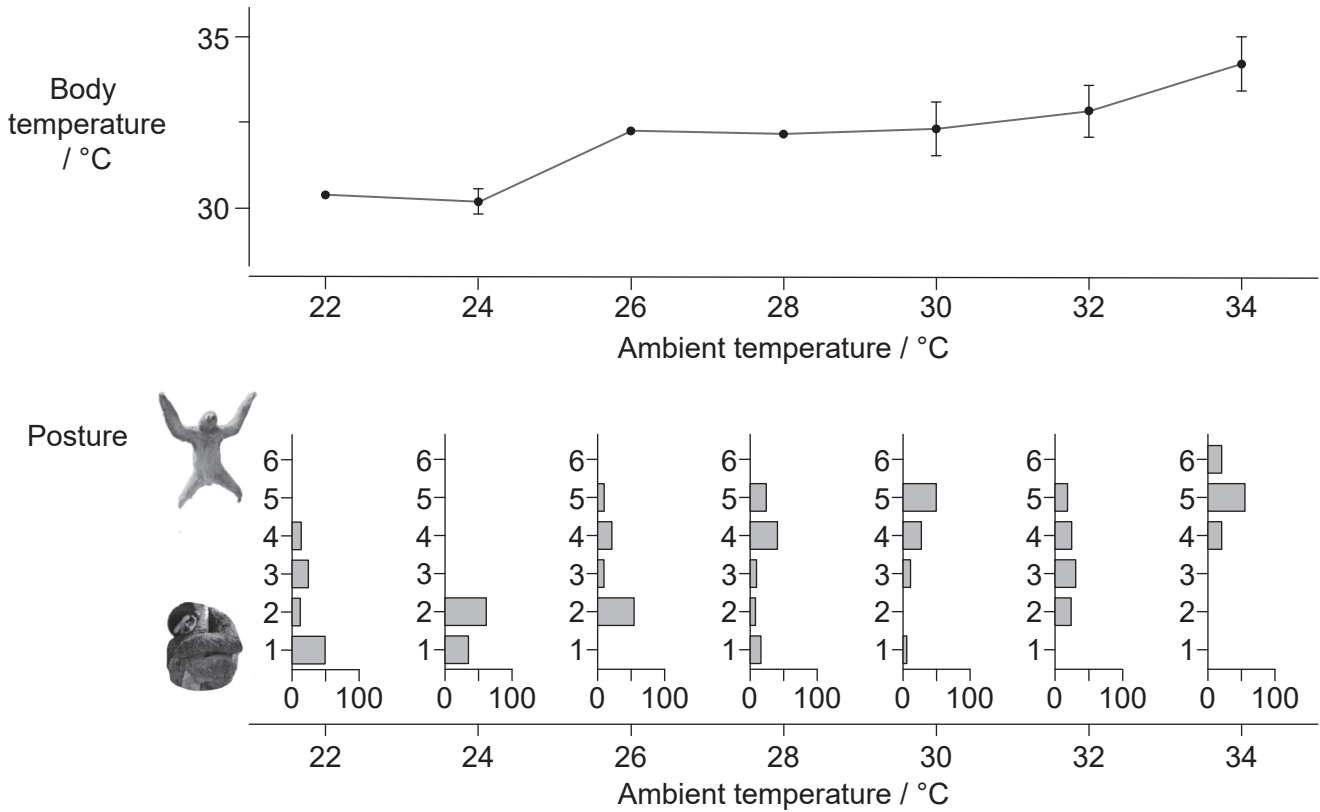


20EP03

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(Question 1 continued)

Three-toed sloths change their body posture in response to the temperature of their environment (ambient temperature). Researchers assessed posture on a scale from 1 to 6, with 1 being when the sloth was curled into a tight ball and 6 when it had all limbs spread. The percentage of time the sloths were observed in each position was recorded at ambient temperatures from 22 °C to 34 °C. The researchers also measured the body temperature of the sloths over the same range of ambient temperatures.



[Source: Adapted from Cliffe, R.N., Scantlebury, D.M., Kennedy, S.J., Avey-Arroyo, J., Mindich, D. and Wilson, R.P., 2018. The metabolic response of the Bradypus sloth to temperature. *PeerJ*, [e-journal] 6: e5600. <http://dx.doi.org/10.7717/peerj.5600>. Licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/>.]

(a) (i) State the relationship between sloth body temperature and ambient temperature. [1]

.....
.....

(ii) Explain how this relationship differs from that in humans. [1]

.....
.....

(This question continues on the following page)



(Question 1 continued)

(b) (i) Describe the trend in body posture as ambient temperature rises from 22 to 34 °C. [1]

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(ii) Suggest reasons for this trend. [2]

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(This question continues on the following page)



(Question 1 continued)

As part of research into locomotion in placental mammals, the total amount of energy used per day and the maximum speed of three-toed sloths were measured, together with their body mass. These data, with the same measurements for other species of placental mammal, are shown in the graphs. Each point shows the mean value for one species. Two points on the graphs are marked with a letter. The point marked S shows data for the three-toed sloth.

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(c) Outline the relationship between body mass and daily energy use for placental mammals. [1]

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(d) State how the daily energy use of the sloth differs from the trend for other mammals. [1]

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(This question continues on the following page)



(Question 1 continued)

- (e) Discuss whether it can be concluded that point X shows the body mass and maximum speed of the three-toed sloth.

[2]

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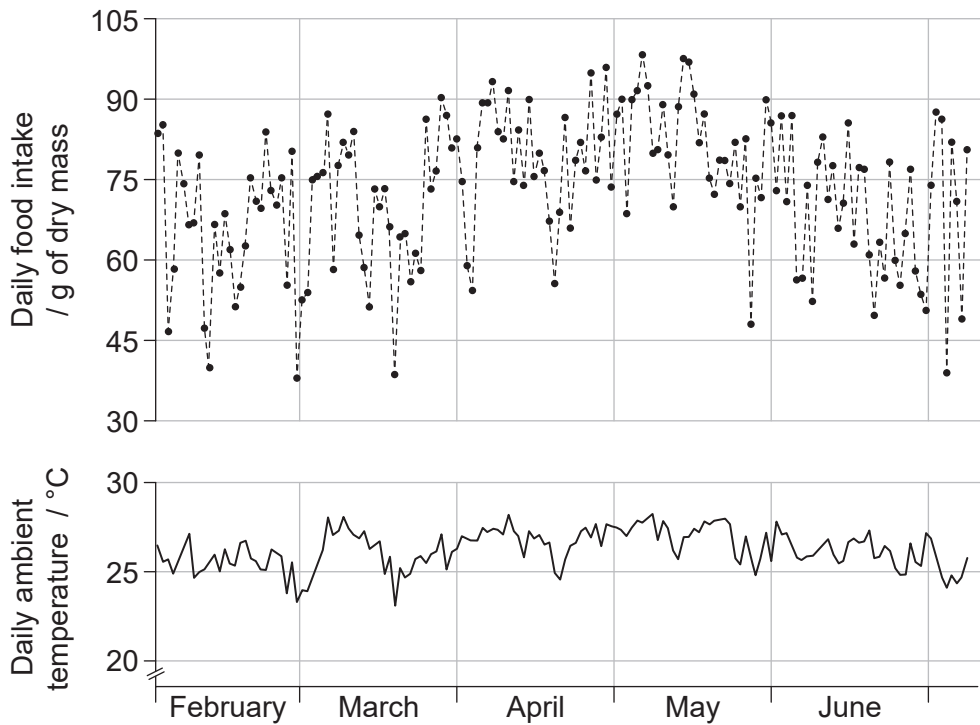
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(Question 1 continued)

The daily food intake of three-toed sloths and daily ambient temperatures were monitored over a 160-day period from February to early July. The graphs show the mean results.



[Source: Cliffe et al. (2015), Sloths like it hot: ambient temperature modulates food intake in the brown-throated sloth (*Bradypus variegatus*). *PeerJ* 3:e875; DOI 10.7717/peerj.875 Licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/>.]

- (f) The mean daily food intake fluctuated from day to day. State the month that contains the day on which the mean intake of food was highest. [1]

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- (g) Outline the relationship between ambient daily temperature and food intake in March. [2]

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(Question 1 continued)

(h) Suggest, with a reason, how the activity of the sloth varies with ambient temperature. [1]

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(i) State **one** feature of the sloth that would indicate it is a mammal. [1]

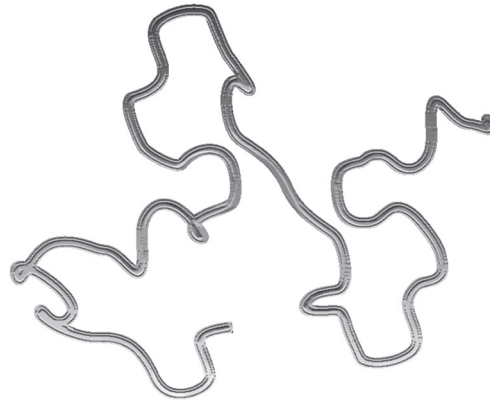
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2. The diagrams represent the structure of a protein before and after it has become denatured.



Native protein



Denatured protein

(a) State how many different types of amino acid there are, which can become part of a polypeptide when mRNA is translated.

[1]

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(b) Outline **one** cause of denaturation in proteins.

[1]

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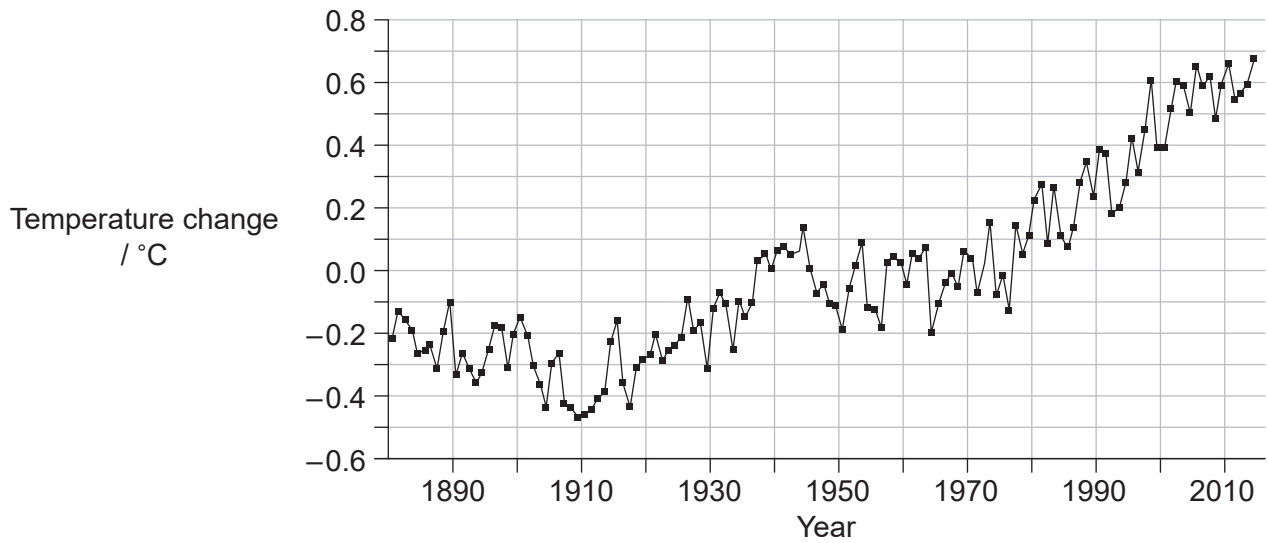
(c) Explain how denaturation affects the activity of an enzyme.

[2]

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3. The graph shows the mean annual changes in global temperatures between 1880 and 2014. The mean temperature from 1951 to 1980 was used as the value of zero change in temperature.



- (a) Calculate the increase in mean global temperature between 1880 and 2010. [1]

..... °C

- (b) Outline how changes in temperature over short time periods could give a misleading impression of changes to the Earth's climate. [1]

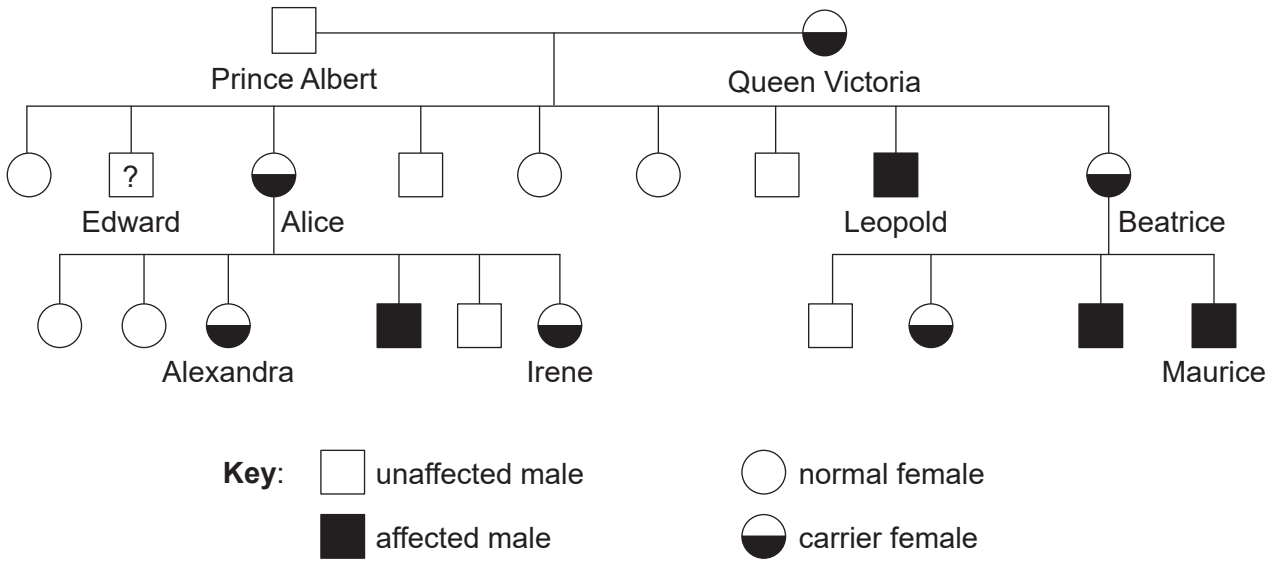
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- (c) Explain how increased carbon dioxide in the air leads to the greenhouse effect. [3]

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4. The pedigree chart shows the incidence of hemophilia in some of the descendants of Queen Victoria.



- (a) State the probability that Edward had hemophilia. [1]

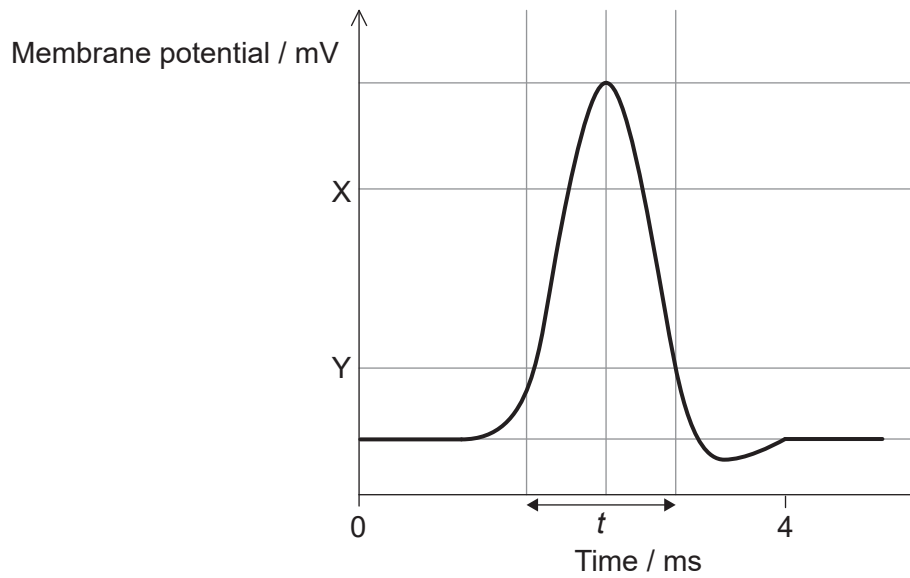
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- (b) Explain the reasons for none of the females in the pedigree chart having hemophilia. [3]

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5. The graph shows the change in the membrane potential of an axon during an action potential.



(a) State the approximate value of the membrane potential at X. [1]

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(b) Y is the threshold potential. State what happens when the threshold potential is reached. [1]

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(c) Describe the movements in ions that occur during time *t*. [2]

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(Question 5 continued)

(d) Explain how a nerve impulse is passed on to other neurons.

[3]

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Section B

Answer **one** question. Up to one additional mark is available for the construction of your answer. Answers must be written within the answer boxes provided.

6. (a) Outline reasons for the therapeutic use of stem cells. [3]
- (b) Describe how leaf cells make use of light energy. [5]
- (c) Explain how cells and cell components in the blood defend the body against infectious disease. [7]
7. (a) Draw a labelled diagram to show the structure of a single nucleotide of RNA. [3]
- (b) Distinguish between the processes of meiosis and mitosis. [5]
- (c) Explain the development of antibiotic resistance in terms of natural selection. [7]



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20EP17

Turn over

A large rectangular area containing 25 horizontal dotted lines for writing.



20EP19

Turn over

References:

1. Adapted from Laube, S., 2003. Three-toed-sloth (*Bradypus variegatus*), Lake Gatun, Republic of Panama. [image online] Available at: <https://meta.wikimedia.org/wiki/User:Bradipus#/media/File:Bradypus.jpg>.
1. (a) Adapted from Cliffe, R.N., Scantlebury, D.M., Kennedy, S.J., Avey-Arroyo, J., Mindich, D. and Wilson, R.P., 2018. The metabolic response of the Bradypus sloth to temperature. *PeerJ*, [e-journal] 6: e5600. <http://dx.doi.org/10.7717/peerj.5600>. Licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/>.
1. (f) Cliffe et al. (2015), Sloths like it hot: ambient temperature modulates food intake in the brown-throated sloth (*Bradypus variegatus*). *PeerJ* 3:e875; DOI 10.7717/peerj.875 Licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/>.
2. Dean Williams, L., 2019. *Molecular Interactions*. [online] Available at: https://ww2.chemistry.gatech.edu/~lw26/structure/molecular_interactions/mol_int.html [Accessed 20 August 2019].
3. National Aeronautics and Space Administration, n.d. GISS Surface Temperature Analysis (v3). [online] Available at: https://data.giss.nasa.gov/gistemp/graphs_v3/ [Accessed 20 August 2019].