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**Biology**  
**Standard level**  
**Paper 2**

Thursday 9 May 2019 (afternoon)

Candidate session number

1 hour 15 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 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]**.

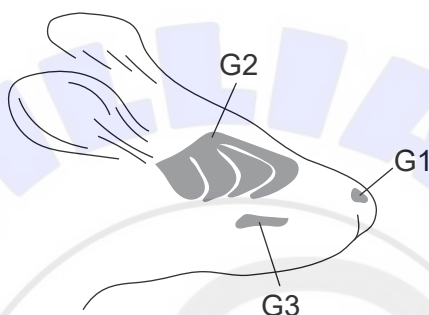


### Section A

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

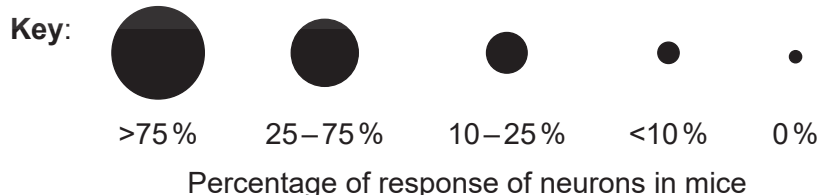
1. Mice (*Mus musculus*) have various defence systems against predators such as foxes (*Vulpus vulpus*) or stoats (*Mustela erminea*). The mice release specific alarm compounds when under threat that serve as danger signals for other mice. Predators also release scents that the mice can detect.

In one study, mice were exposed to paper soaked in compounds taken from other mice, foxes or stoats in a test chamber. The scientists then measured the reaction of three different groups of neurons used in smelling: G1, G2 and G3, as shown in the diagram.



The percentage of G1, G2 and G3 neurons responding to the mouse, fox and stoat compounds, as well as a control compound, are shown in the chart.

	Mouse alarm compound	Fox scent	Stoat scent	Control
G1	●	●	●	●
G2	●	●	●	●
G3	●	●	●	●



[Source: Julien Brechbühl, *et al.*, (2013), *PNAS*, **110** (12), pages 4762–4767]

(This question continues on the following page)



**(Question 1 continued)**

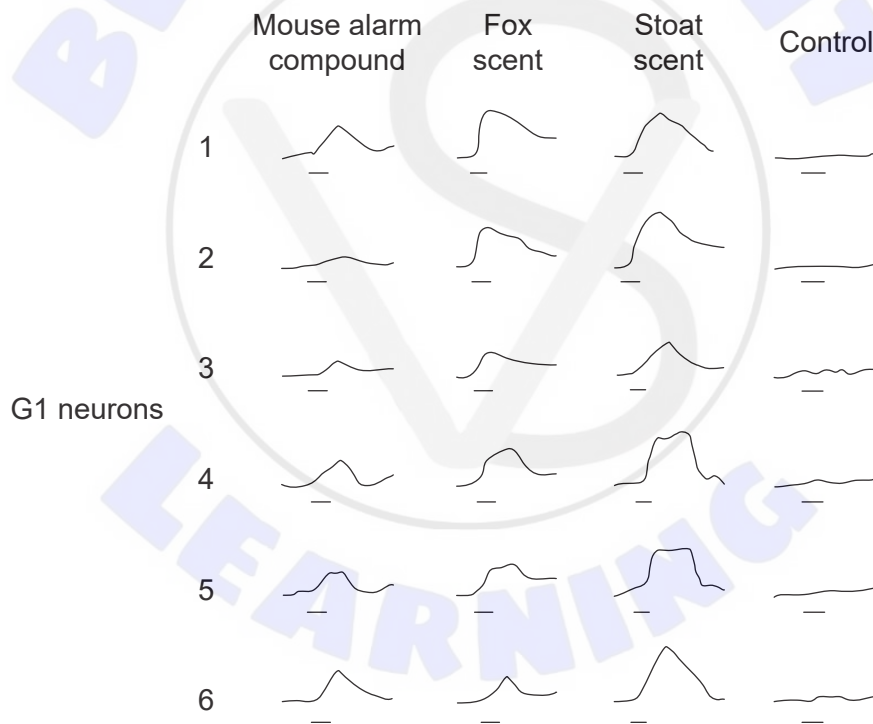
(a) State the percentage of G2 neurons in the mice that respond to the fox scent. [1]

..... %

(b) Using evidence from the chart, identify, giving a reason, which group of neurons responded most to the chemicals. [1]

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The scientists recorded the neural traces (action and resting potentials) of six G1 neurons exposed to the compounds from the different animals. The horizontal bar beneath each trace corresponds to the time of exposure to the test compound.



[Source: Julien Brechbühl, *et al.*, (2013), *PNAS*, **110** (12), pages 4762–4767]

(c) State the name of the instrument used to make these traces. [1]

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**(This question continues on the following page)**



**(Question 1 continued)**

- (d) Distinguish between the effects of the mouse alarm compound and the effects of the control compound on the G1 neurons. [1]

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- (e) Compare and contrast the effects of the mouse alarm compound and stoat scent on the G1 neurons. [2]

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- (f) Deduce whether there is a correlation between the neural traces and the percentage of responding G1 neurons. [2]

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- (g) The molecular structures of the mouse alarm compound and fox scent are very similar. Suggest an evolutionary advantage for this chemical similarity. [1]

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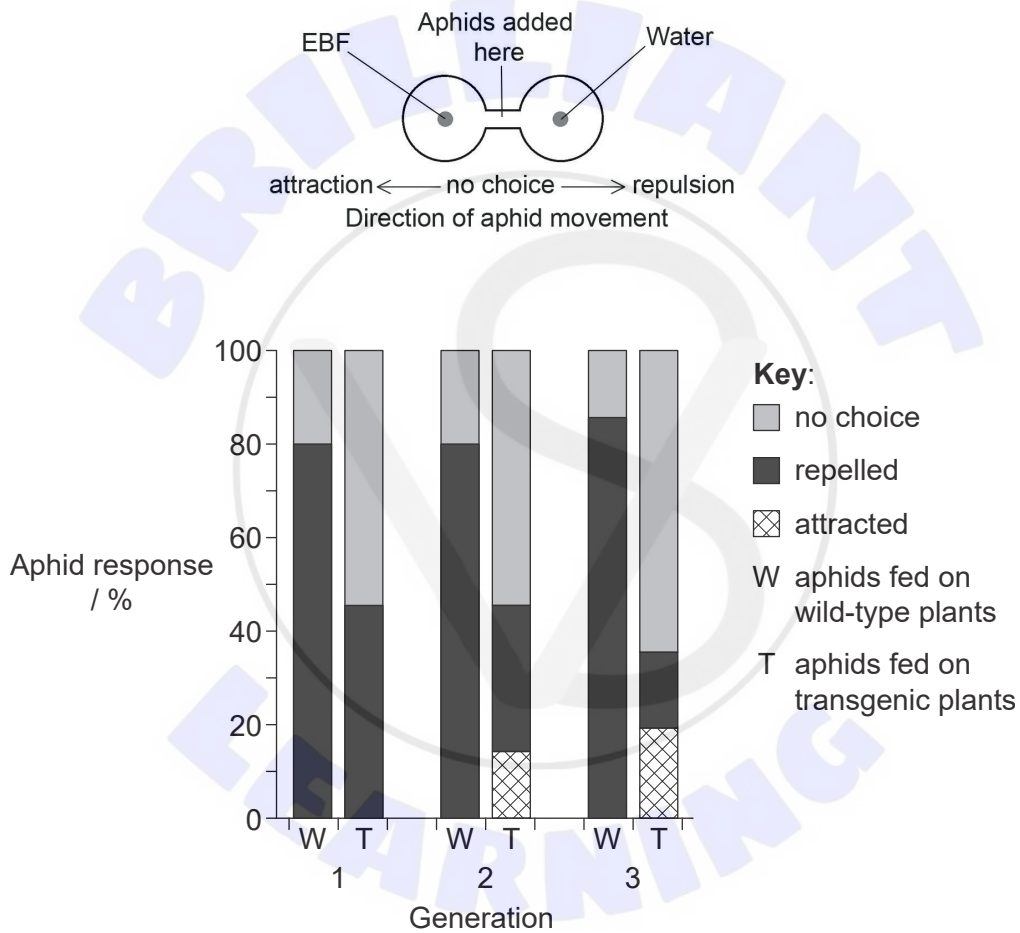
**(This question continues on the following page)**



**(Question 1 continued)**

Another study was carried out on the defence systems in aphids (*Myzus persicae*) which feed on thale cress plants (*Arabidopsis thaliana*). Individual aphids release an alarm compound containing the chemical (E)- $\beta$ -farnesene (EBF) when attacked by a predator. Other aphids are repelled and leave the thale cress plant or hide.

The gene for EBF was inserted to produce transgenic (T) thale cress plants to test aphid reaction to EBF over several generations. Aphids were raised on wild type (W) thale cress and then allowed to feed for three generations on either W or T thale cress. Aphids were tested in each generation for their reaction when EBF was added to a choice chamber. The percentages of aphids attracted to or repelled by EBF and those which made no choice were recorded.



[Source: M De Vos, *et al.*, (2010), *PNAS*, **107**(33), pages 14673–14678]

(h) Identify, with a reason, the aphids that were most strongly repelled by EBF. [1]

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(This question continues on the following page)



**(Question 1 continued)**

- (i) Outline the conclusions that can be drawn from the data in the graph for the group of aphids fed for three generations on transgenic thale cress plants (T). [2]

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- (j) Discuss whether natural selection would favour the transgenic EBF-producing thale cress plants if they were released into the wild. [2]

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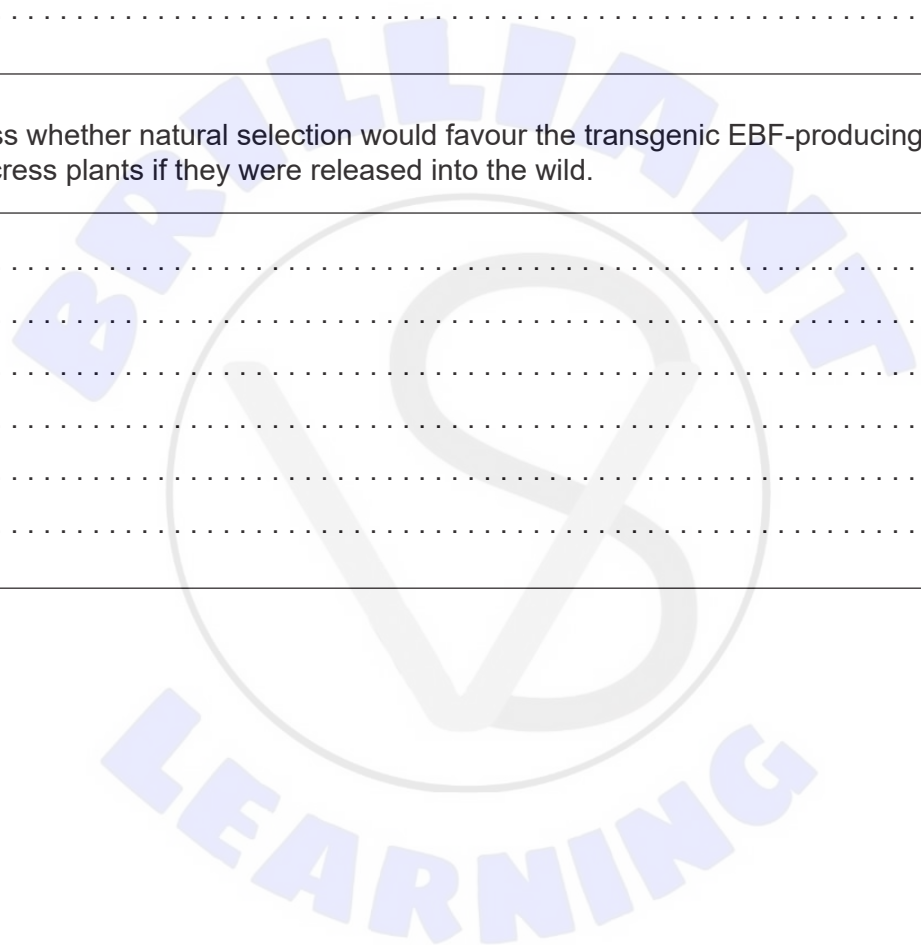
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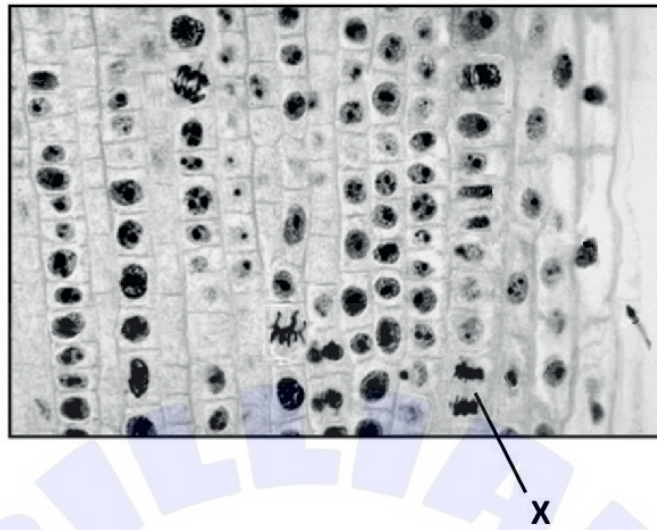
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2. (a) Identify the stage of mitosis labelled X in the image, giving a reason. [1]



[Source: Copyright 2002, The Trustees of Indiana University]

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- (b) Outline the use of a karyogram during pregnancy. [3]

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3. (a) (i) State **two** causes of the decrease of biomass along food chains in terrestrial ecosystems.

[2]

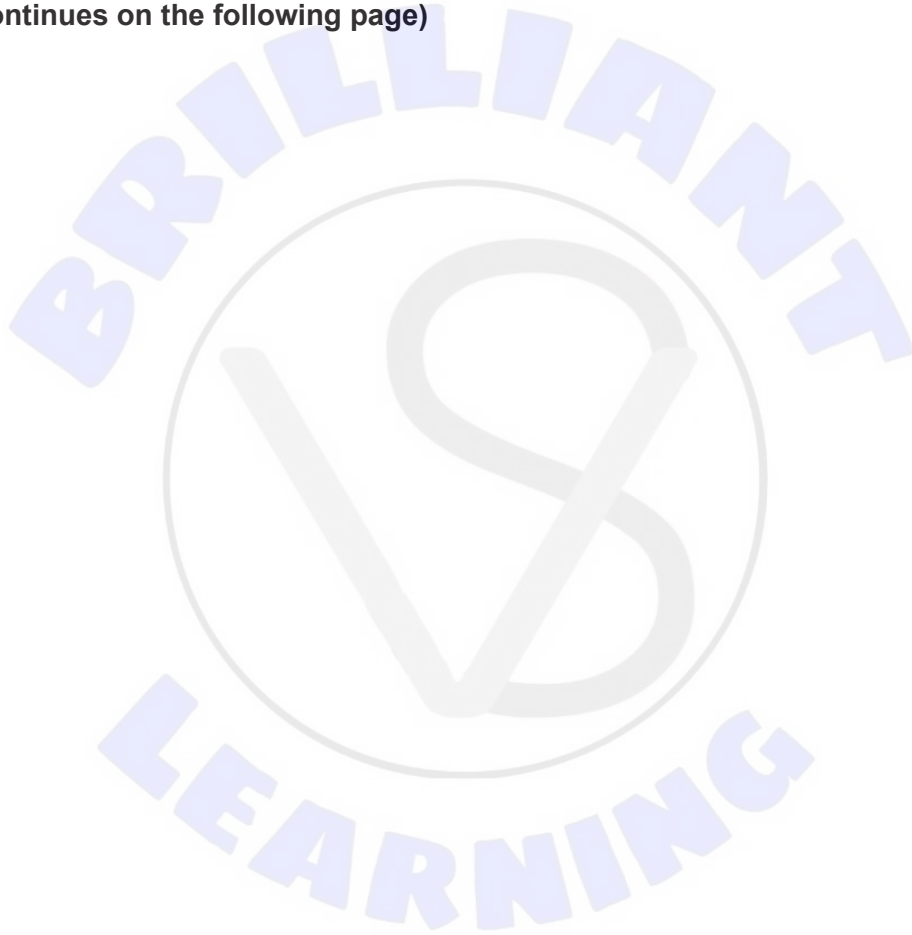
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**(Question 3 continued)**

(ii) The table shows the global carbon budget over two decades; the years 1990 to 1999 and 2000 to 2009.

Carbon	Global carbon budget / $\times 10^{12}$ kg	
	1990 to 1999	2000 to 2009
Atmospheric carbon dioxide	3.0	4.0
Fossil fuel and cement	6.5	8.0
Land use change	1.5	1.0
Carbon storage in land	2.5	2.0
Carbon storage in oceans	2.0	2.5

[Source: © International Baccalaureate Organization 2019]

Using the table, explain causes of the changes in carbon flux over the two decades. [3]

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**(This question continues on the following page)**



**(Question 3 continued)**

- (b) Suggest how climate change can influence the natural selection of organisms that live in the Arctic oceans.

[3]

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4. (a) The images show parts of plants belonging to two different phyla.

Plant X



[Source: DanielCD / <https://commons.wikimedia.org/wiki/File:SoriDicksonia.jpg>]

Plant Y



[Source: tbenedict/Pixabay <https://pixabay.com/photos/pine-cones-tree-evergreen-cone-581557/>]

State the phylum of plant X and of plant Y.

[2]

X: .....

Y: .....

**(This question continues on the following page)**



**(Question 4 continued)**

(b) Explain **one** cause of mutation.

[2]

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(c) Outline the types of evidence that can be used to place a species in a particular clade.

[3]

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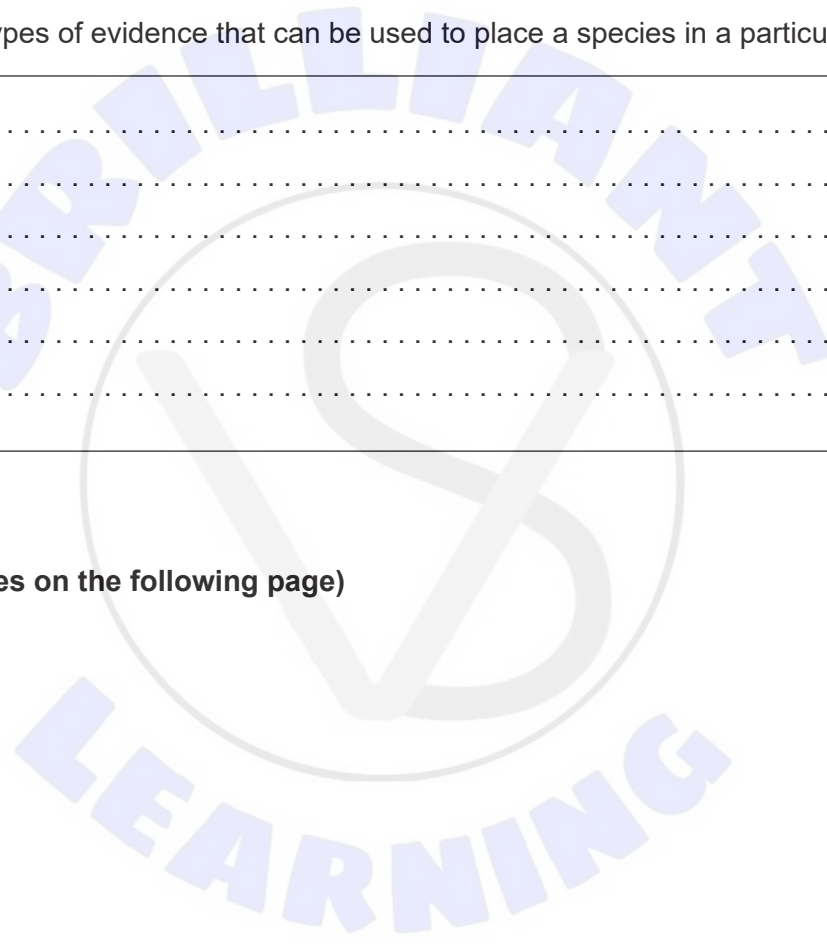
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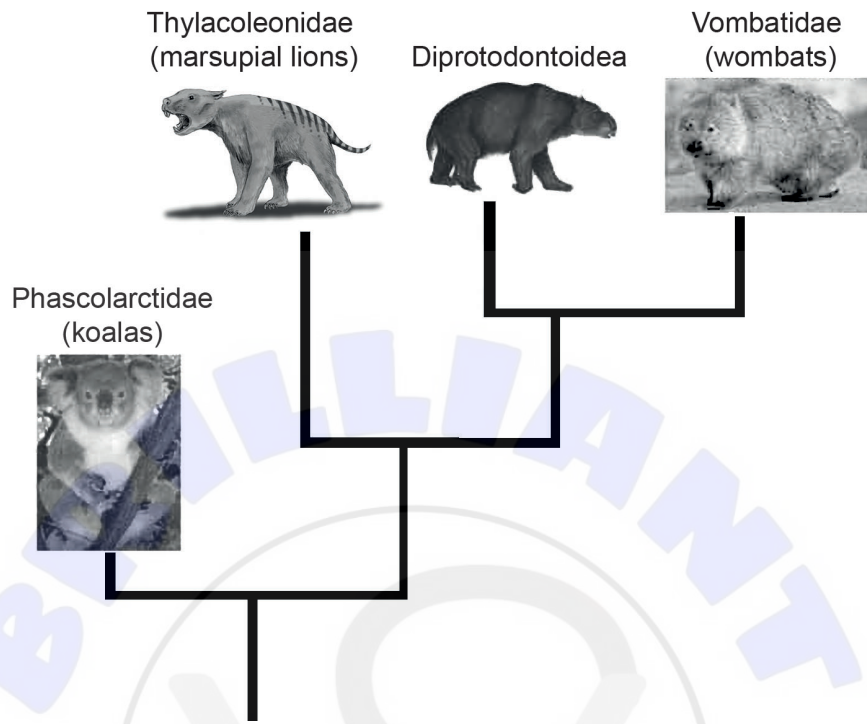
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(Question 4 continued)

(d) The cladogram includes four marsupial (non-placental mammal) families.



[Source: Koala image: Quartl, [https://commons.wikimedia.org/wiki/Phascolarctos\\_cinereus#/media/File:Friendly\\_Female\\_Koala.JPG](https://commons.wikimedia.org/wiki/Phascolarctos_cinereus#/media/File:Friendly_Female_Koala.JPG); Wombat image: JJ Harrison, [https://en.wikipedia.org/wiki/Wombat#/media/File:Vombatus\\_ursinus\\_-\\_Maria\\_Island\\_National\\_Park.jpg](https://en.wikipedia.org/wiki/Wombat#/media/File:Vombatus_ursinus_-_Maria_Island_National_Park.jpg); Marsupial lion: Nobu Tamura, [https://en.wikipedia.org/wiki/Marsupial\\_lion#/media/File:Thylacoleo\\_BW.jpg](https://en.wikipedia.org/wiki/Marsupial_lion#/media/File:Thylacoleo_BW.jpg); Diprotodontoidea image: Anne Musser]

Deduce the family that is most closely related to the Diprotodontoidea.

[1]

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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.

5. (a) Outline **four** types of membrane transport, including their use of energy. [4]
- (b) Draw the structure of a dipeptide. [3]
- (c) Explain the action of enzymes in digestion and the different roles of at least **two named** enzymes that are produced in the pancreas. [8]
6. (a) Describe briefly the endosymbiotic theory. [3]
- (b) Outline how photosynthesis produces glucose. [4]
- (c) Discuss the control of blood glucose levels and the consequences if they are not maintained. [8]

