Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

Monday 14 May 2018 (afternoon)

2 hours 15 minutes

Candidate session number

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 **[72 marks]**.

20 pages

2218 – 6008

International Baccalaureate
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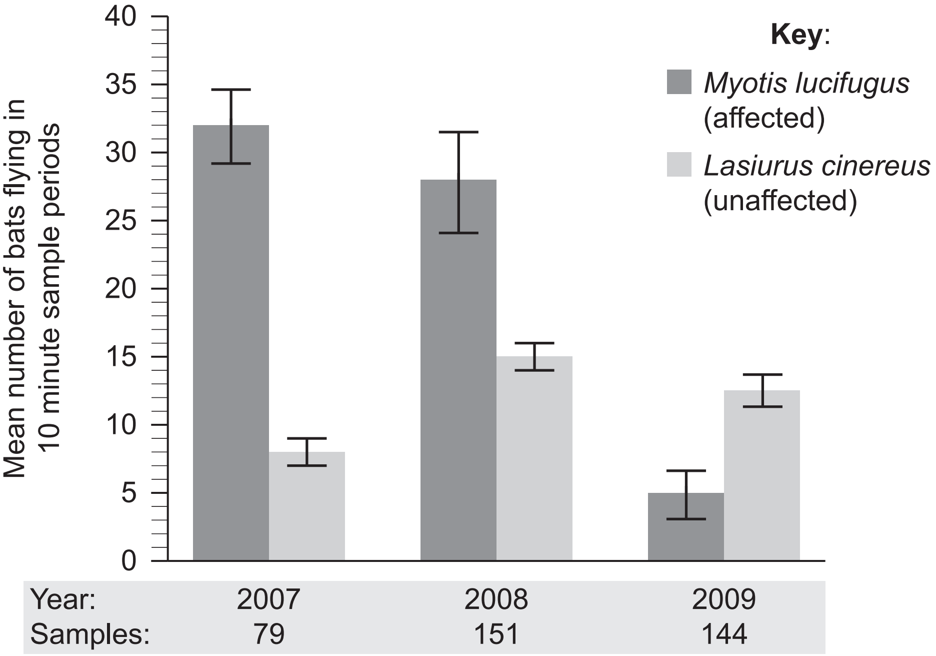
Section A

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

1. White-nose syndrome (WNS) is a disease caused by the fungus *Geomyces destructans*. This kills bats from many species during their winter hibernation. Scientists used echolocation to record the number of bat flights over a station in 10 minute sample periods during the summers of 2007 to 2009. The graph shows the mean number of flights and number of recording samples for little brown bats (*Myotis lucifugus*), a species affected by the fungus, along with those of hoary bats (*Lasiurus cinereus*), which are not affected.



[Source: Adapted from Dzal, Yvonne, *et al.*, Going, going, gone: the impact of white-nose syndrome on the summer activity of the little brown bat (Myotis lucifugus), *Biology Letters* (2011), 7, p. 393. http://rsbl.royalsocietypublishing.org/content/7/3/392. Permission conveyed through Copyright Clearance Center, Inc.]

(a) Calculate the total number of *M. lucifugus* flights that were recorded in the summer of 2007. [1]

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(b) Suggest **one** limitation of this recording method in determining the accurate mean number of individual bats flying. [1]

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(This question continues on the following page)

(Question 1 continued)

(c) (i) Calculate the percentage decline in the mean number of *M. lucifugus* flights for 2009 when compared to 2008. [1]

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(ii) Evaluate the conclusion that the decline in the population of *M. lucifugus* is due to infection by the fungus. [2]

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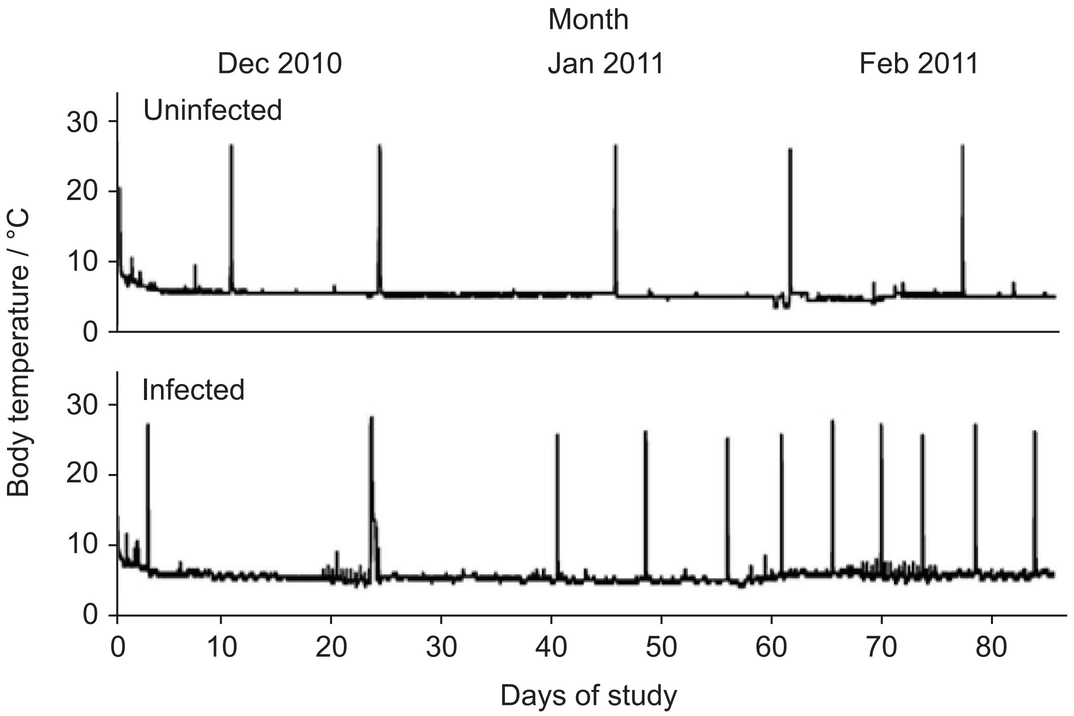
(Question 1 continued)

Scientists have hypothesised that bats affected by WNS could be more likely than unaffected bats to emerge from hibernation during the winter. Bats occasionally undergo short interruptions in hibernation accompanied by an increase in body temperature. Scientists used sensors attached to *M. lucifugus* to monitor the temperature of a group infected with the fungus over the winter months. A second uninfected group was also monitored. The graphs show the results for two typical individuals.



[Source: L Warnecke, *et al.* (2012), Inoculation of bats with European Geomyces destructans supports the novel pathogen hypothesis for the origin of white-nose syndrome, *PNAS* 109, p. 7000.]

(d) Distinguish between the patterns of hibernation of the uninfected and infected bats. [1]

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(This question continues on the following page)

(Question 1 continued)

(e) Based on the data and your biological knowledge, suggest how the infection could lead to premature death in a bat. [3]

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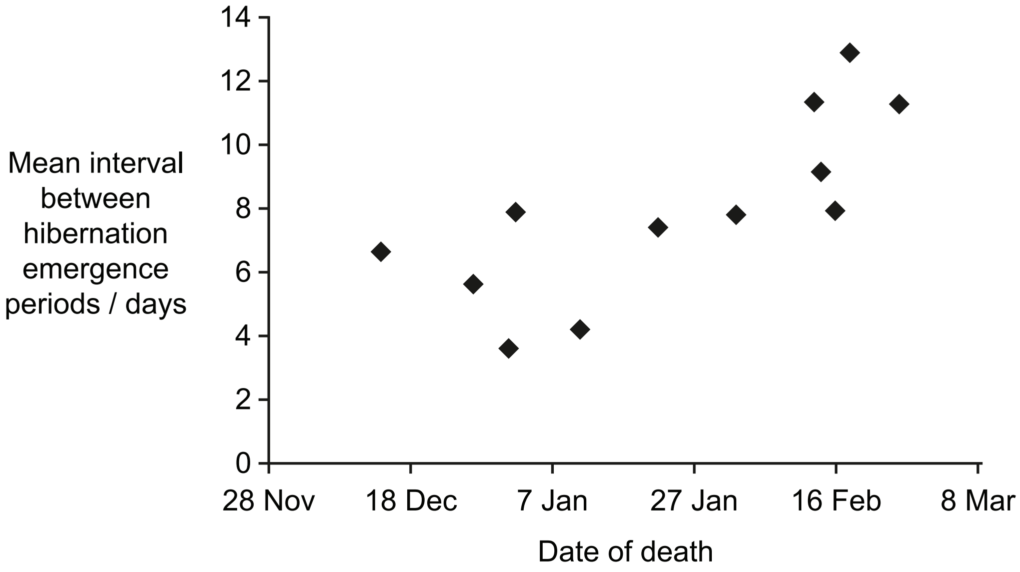
The graph shows data from a small group of infected bats that died during hibernation. The average time interval between hibernation emergence periods and the date of death were recorded using temperature sensors for these bats.



[Source: Reeder, D M, *et al.* (2012), Frequent Arousal from Hibernation Linked to Severity of Infection and Mortality in Bats with White-Nose Syndrome. *PLoS ONE*, 7(6), p7.]

(f) Outline the relationship between date of death and the mean interval between hibernation emergence periods. [1]

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(This question continues on the following page)

(Question 1 continued)

(g) Discuss whether the data in the graph show that there is a causal link between the date of death and the interval between hibernation emergence periods. [2]

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(h) Suggest **one** reason, other than the interval between hibernation emergence periods, for some infected bats surviving longer than others. [1]

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(i) Using all of the data, predict the effect of WNS on bat populations. [3]

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2. (a) State **two** features that are found only in mammals. [2]

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(b) Birds, bats and humans are all vertebrates with pentadactyl limbs. Birds and bats use their forelimbs to fly whereas humans can use them to lift and manipulate objects. Outline how the bird, bat and human forelimb can be used to illustrate the concept of homologous structures. [2]

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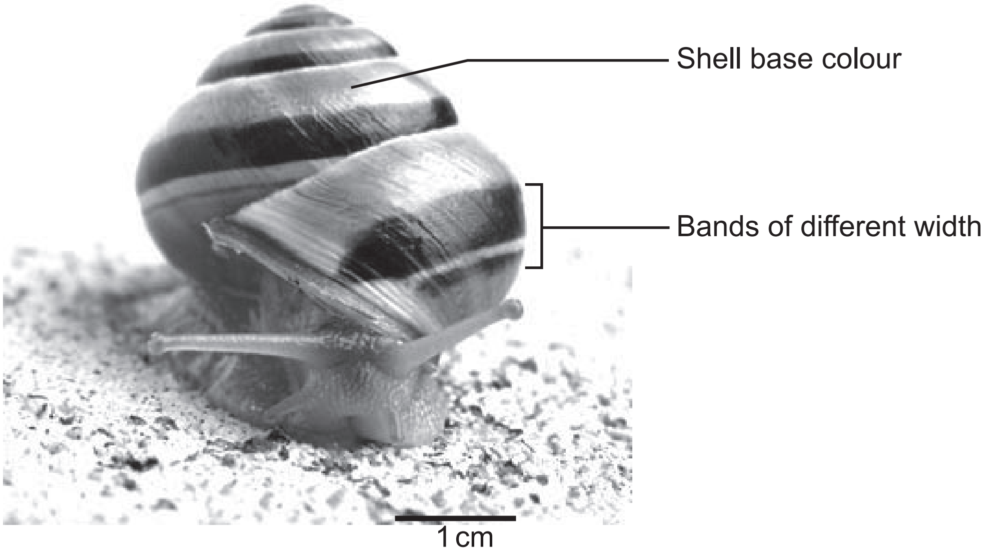
3. The land snail *Cepaea nemoralis* is very common in North America and in Europe. The base colour of its shell varies between brown, pink and yellow, and also in its intensity. Some shells are unbanded, but most show one to five bands of different width on top of the shell base colour.



[Source: © International Baccalaureate Organization 2018]

(a) (i) *C. nemoralis* is a mollusc. Identify **two** external features that distinguish this snail from an arthropod. [2]

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(ii) State the major chemical component of the shell in molluscs. [1]

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(Question 3 continued)

(b) The genes coding for the shell base colour and the presence of banding have linked loci. Allele C causes a dark pink shell and is dominant to allele c, which codes for a dark yellow shell. Allele B codes for the absence of bands and is dominant to allele b, which codes for the presence of bands.

(i) Distinguish between sex-linked genes and genes with linked loci. [1]

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(ii) Outline how it can be shown that the genes for shell base colour (Cc) and presence or absence of bands (Bb) are linked. [3]

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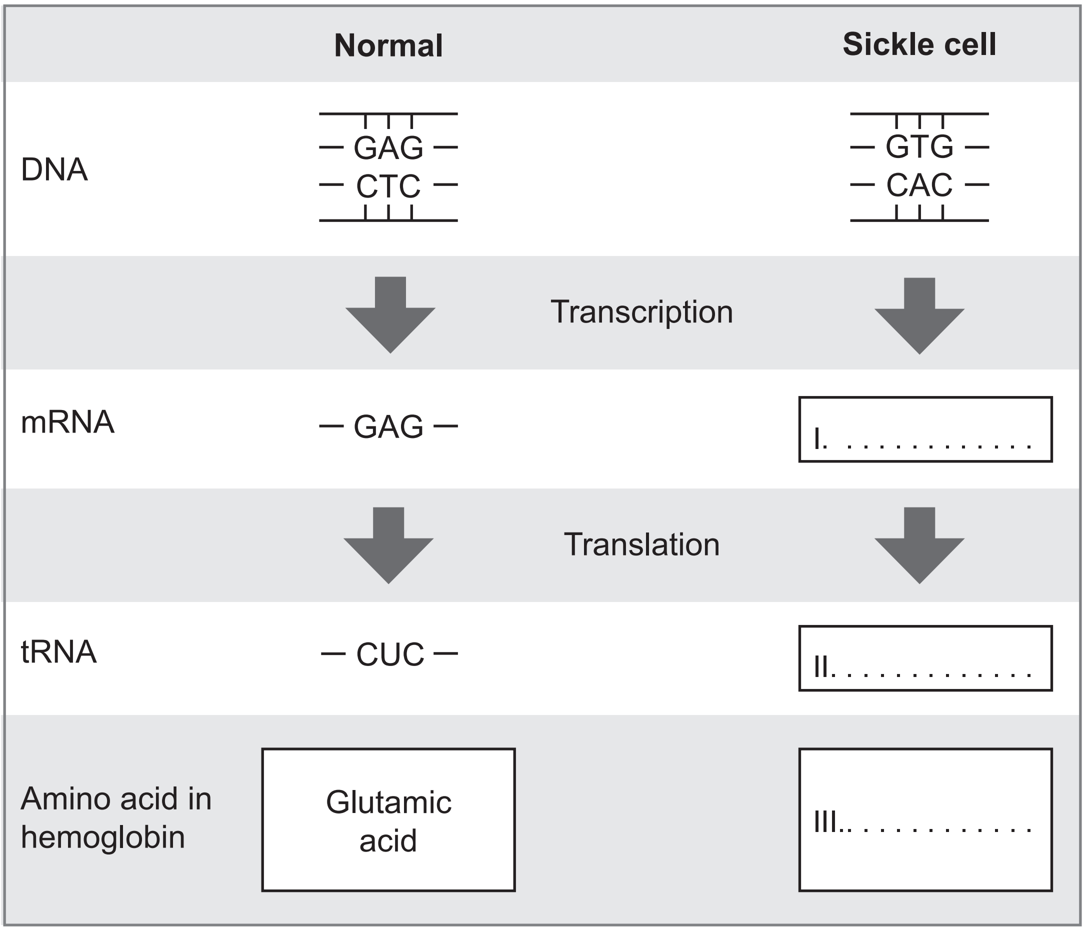
4. (a) Sickle cell anemia is due to a single base substitution in DNA. Using the diagram, outline how this translates into the production of an abnormal hemoglobin molecule by completing the spaces labelled I, II and III. [2]



[Source: © International Baccalaureate Organization 2018]

(b) DNA codes for the amino acid sequence of polypeptides. List **two** other functions of DNA. [2]

1. . . . .
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2. . . . .
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(Question 4 continued)

(c) Distinguish between the purpose of free and bound ribosomes. [1]

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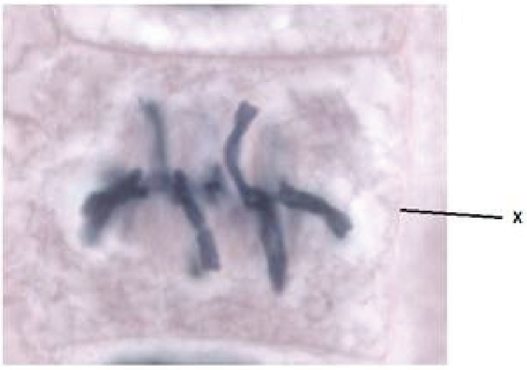
5. (a) The image shows a cell in a section of an onion root tip seen under a light microscope.



[Source: Adapted Dr. phil.nat Thomas Geier, Fachgebiet Botanik der Forschungsanstalt Geisenheim, https://commons.wikimedia.org/wiki/File:Allium-Mitose03-DM100x_BL28.jpg. Licenced under the Creative Commons Attribution-Share Alike 3.0 Unported license, https://creativecommons.org/licenses/by-sa/3.0/legalcode.]

(i) Identify the structure labelled X. [1]

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(ii) State the stage of mitosis of this cell. [1]

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(b) Compare and contrast the location of ATP synthase and the movement of protons during aerobic cell respiration and photosynthesis. [2]

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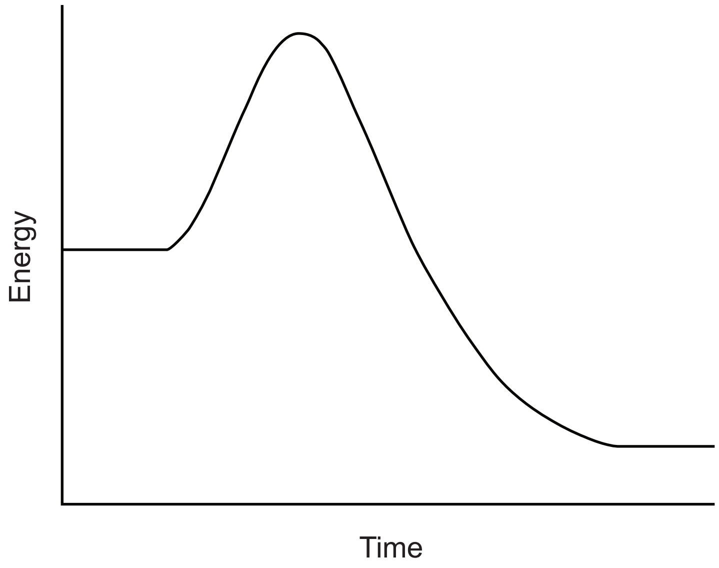
(Question 5 continued)

(c) Using the table, distinguish between the production of ATP, use of oxygen and release of CO_2 in aerobic cell respiration between the cytoplasm and the mitochondrion. [3]

	Cytoplasm	**Mitochondrion**
ATP production		
Use of oxygen		
Release of CO_2		

(d) The graph shows energy levels throughout an uncatalysed reaction. Draw a curve to show how the action of an enzyme would affect this reaction. [1]



Section B

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

6. (a) Draw a labelled diagram to show the fluid mosaic model of the plasma membrane. [4]

(b) Outline how neurons generate a resting potential. [4]

(c) Hydrogen bonds can exist both within and between molecules in living organisms and have an impact on their structure and function. Explain the importance of hydrogen bonding for living organisms. [7]

7. (a) Outline how greenhouse gases interact with radiation and contribute to global warming. [4]

(b) Outline how plants make use of the different wavelengths of light. [4]

(c) Explain how organic compounds are transported within plants. [7]

8. (a) Describe the process of spermatogenesis leading to the production of four sperm cells in a human male. [4]

(b) Outline the roles of estrogen and progesterone in females during human reproduction. [4]

(c) Explain the process of muscle contraction. [7]