Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

Monday 14 May 2018 (afternoon)

Candidate session number

2 hours 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 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]**.

2218 – 6014

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. *Arabidopsis* is a small flowering plant in the mustard family (Brassicaceae) that is widely used in basic research. It has a short life cycle, flowers quickly producing a large number of seeds and is easy to cultivate. It forms a circle of leaves known as a rosette that lies close to the soil. Flowers form at the end of short stems.

[Source: Adapted from a reproduction of a painting by the Swedish botanist C. A. M. Lindman (1856–1928), taken from his book(s) *Bilder ur Nordens Flora* (first edition published 1901–1905, supplemented edition 1917–1926), https://commons.wikimedia.org/wiki/File:Arabidopsis_thaliana_backtrav.jpg.]

(This question continues on the following page)

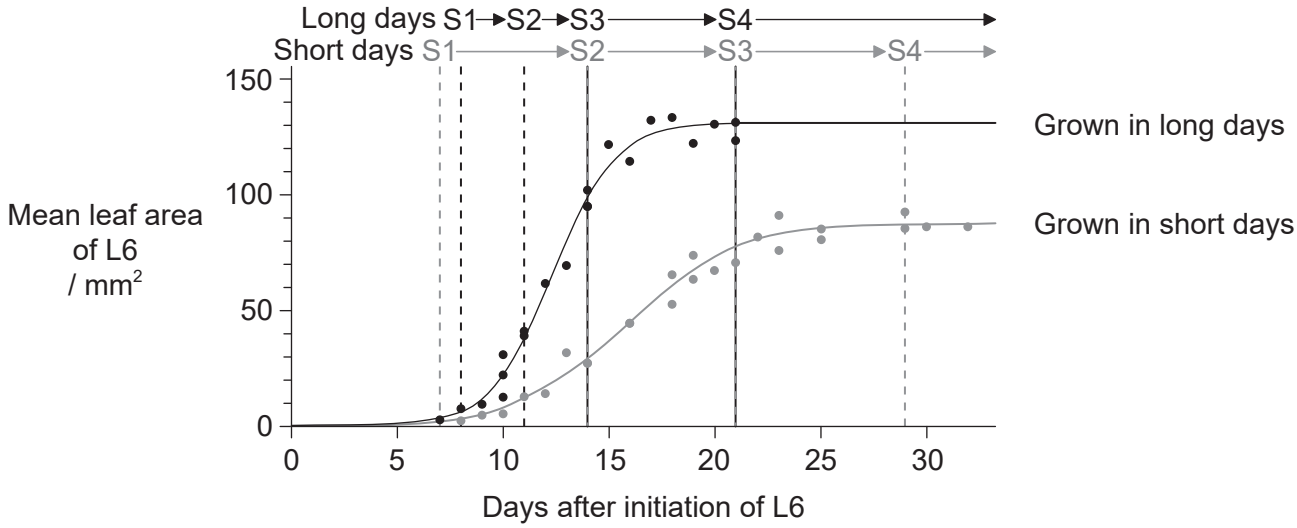
(Question 1 continued)

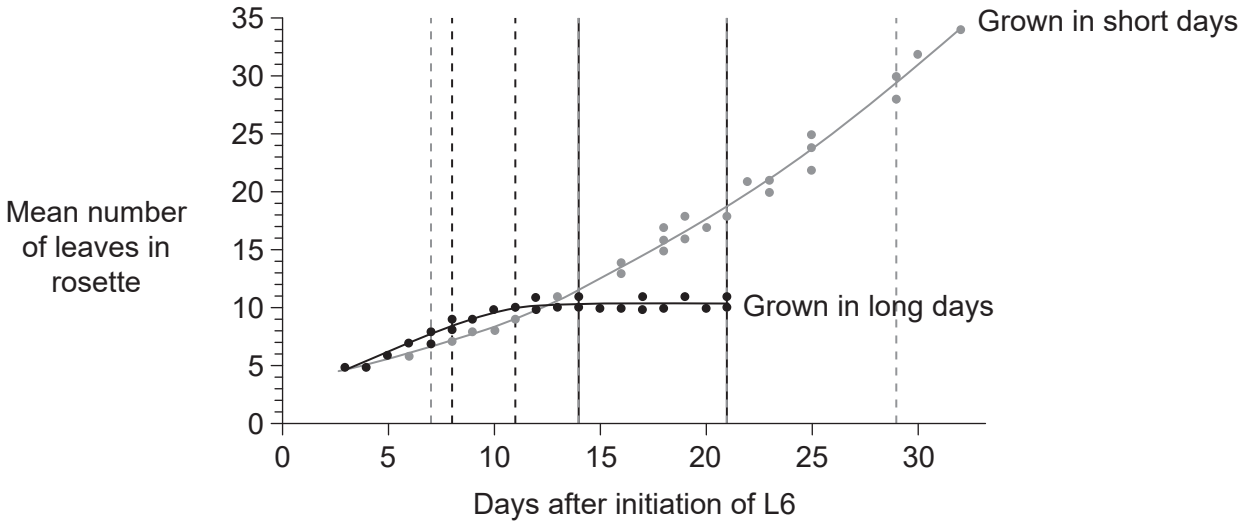
A study was carried out of differences in development between *Arabidopsis* plants grown in long days (16 hours light, 8 hours dark) or short days (8 hours light, 16 hours dark). The sixth leaf (L6) to emerge in the rosette of each plant was used in all investigations.

New leaves are initiated by the meristem and go through four stages as they develop.

- Stage 1 (S1) – rapid cell division
- Stage 2 (S2) – cell division has ceased, cell expansion continues
- Stage 3 (S3) – decreasing cell expansion rate
- Stage 4 (S4) – leaf growth complete

The start of each stage of leaf development for plants grown in long days and short days is shown above the first graph.





[Source: Adapted from K Baerenfaller, *et al*, (2015), "A long photoperiod relaxes energy management in Arabidopsis leaf six," *Current Plant Biology*, 2, pp. 34–45. http://dx.doi.org/10.1016/j.cpb.2015.07.001. © 2015. Open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0).]

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(Question 1 continued)

(a) (i) Calculate the difference in the mean leaf area of L6 at the start of stage 4 between the leaves of plants grown in long days and short days. [1]

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(ii) Distinguish between plants grown in long days and short days in the timing of the four stages of leaf development. [2]

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(b) Distinguish between plants grown in long days and short days in the mean number of leaves per rosette during the experimental period. [2]

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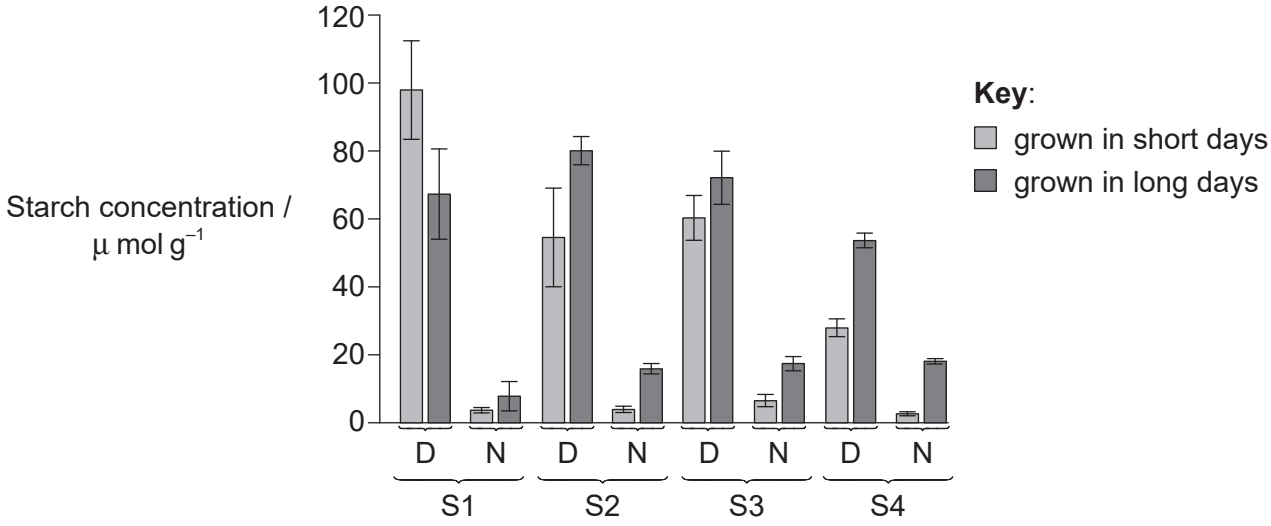
(Question 1 continued)

Leaves were removed from *Arabidopsis* plants that had been grown in long day and short day conditions and the concentration of starch within them was measured. This was done both at the end of the day (D) and at the end of the night (N) in each of the four stages of development (S1, S2, S3, S4).



[Source: Adapted from K Baerenfaller, *et al*, (2015), "A long photoperiod relaxes energy management in Arabidopsis leaf six," *Current Plant Biology*, 2, pp. 34–45. http://dx.doi.org/10.1016/j.cpb.2015.07.001. © 2015. Open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0).]

(c) Discuss the evidence provided in the bar chart for the hypothesis that plant leaves use up starch reserves for cell respiration during the night. [2]

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(Question 1 continued)

(d) (i) For each of the stages, identify whether the starch concentration at the end of the day is higher in the leaves grown in long day **or** short day conditions. [1]

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(ii) Suggest reasons for the difference in end of day starch concentrations in stage 2 (S2) for the plants grown in long days and short days. [2]

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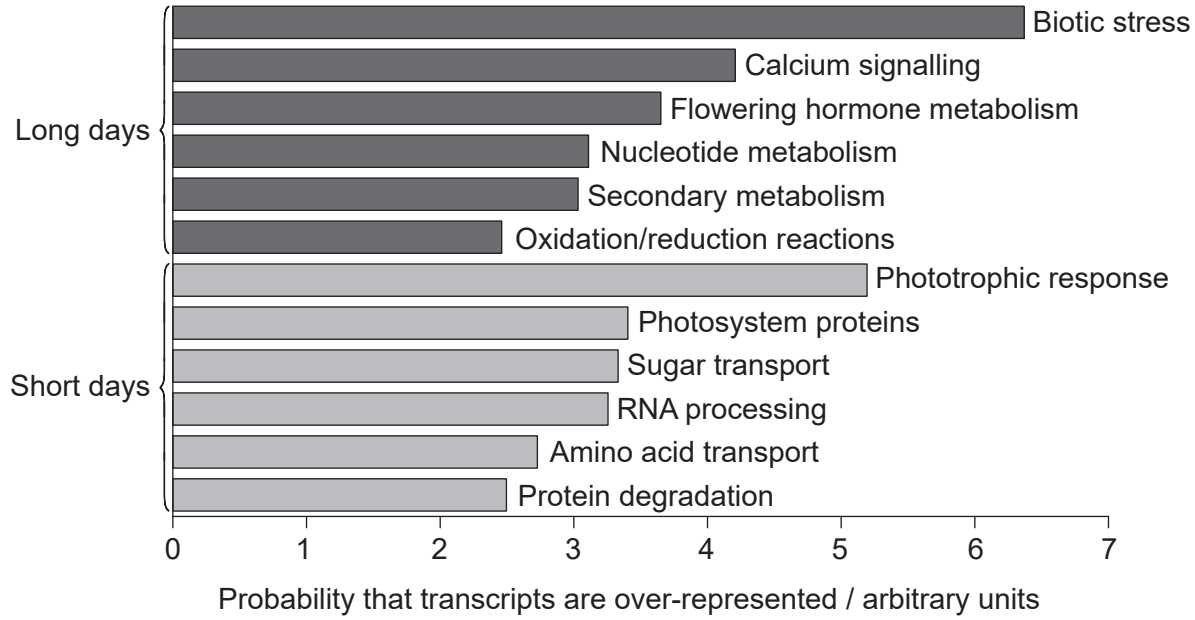
(Question 1 continued)

To account for the observed phenotypic and metabolic differences, researchers analysed mRNA transcript data. They found certain transcripts over-represented in *Arabidopsis* plants grown in long days (dark grey) compared with the amount expected due to chance. Other types of transcripts were over-represented in *Arabidopsis* plants grown in short days (light grey).



[Source: Adapted from K Baerenfaller, *et al*, (2015), "A long photoperiod relaxes energy management in Arabidopsis leaf six," *Current Plant Biology*, 2, pp. 34–45. http://dx.doi.org/10.1016/j.cpb.2015.07.001. © 2015. Open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0).]

(e) Using the data in the bar chart, discuss the evidence for *Arabidopsis* plants adapting to different daylight regimes by changing the pattern of gene expression. [3]

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(Question 1 continued)

(f) Using all relevant data in this question, deduce with reasons whether *Arabidopsis* is a long day plant **or** a short day plant in terms of flowering. [2]

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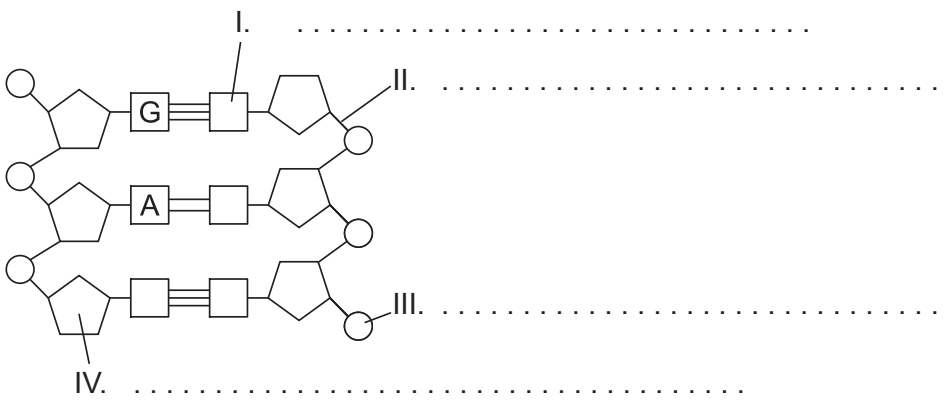
2. (a) Label the parts of the DNA diagram indicated by I, II, III and IV. [2]



[Source: © International Baccalaureate Organization 2018]

(b) (i) State **one** role of nucleosomes in eukaryotic cells. [1]

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(ii) Outline how Hershey and Chase's experiment provided evidence for DNA as the genetic material. [3]

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(iii) State **one** function for a region of DNA that does **not** code for proteins. [1]

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(Question 2 continued)

(c) Outline the role of the following in translation.

(i) A-site of ribosomes [1]

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(ii) tRNA activating enzymes [2]

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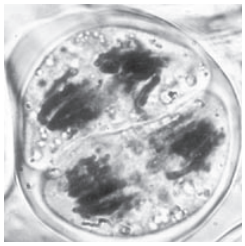
3. The micrograph shows a plant cell of *Lilium grandiflorum* during meiosis.



[Source: vcbio.science.ru.nl; thanks to Dr. J. Derksen]

(a) (i) Identify, giving reasons, the stage of meiosis shown by this cell. [2]

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(ii) Outline the law of independent assortment. [2]

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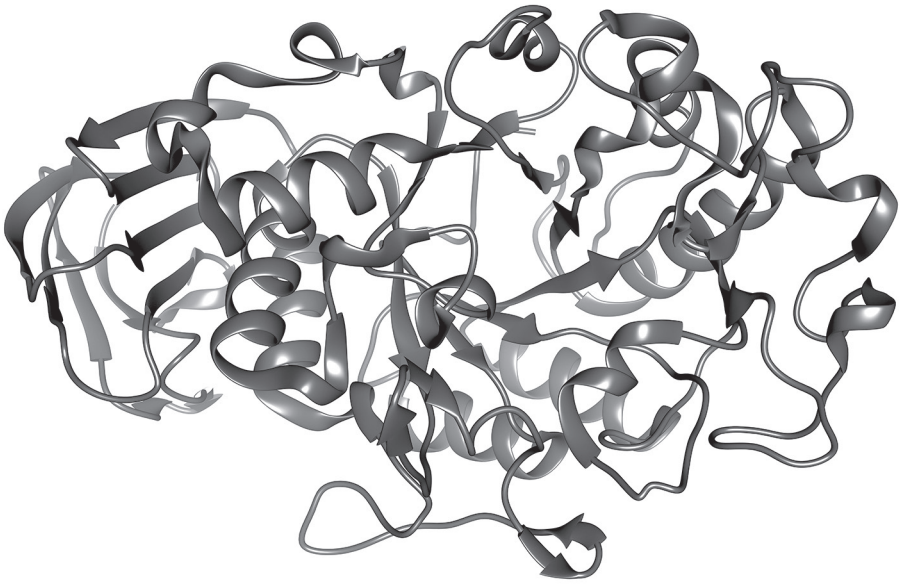
(Question 3 continued)

(b) The genes for cystic fibrosis and blood group are not linked. Two parents are heterozygous for cystic fibrosis. One parent has blood group O and the other has blood group AB. Using a Punnett square, determine the probability that their child will have both cystic fibrosis and blood group A. [3]

4. The diagram shows alpha amylase.



[Source: © International Baccalaureate Organization 2018]

(a) Explain the secondary structure of this protein molecule. [3]

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(b) Amylase is used in human digestion.

(i) State **two** sites of production of amylase. [1]

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(ii) State the function of amylase. [1]

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(Question 4 continued)

(c) Explain how enzymes catalyse chemical reactions. [3]

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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.

5. Every cell is surrounded by a cell surface membrane which regulates the movement of materials into and out of the cell.

(a) Discuss alternative models of membrane structure including evidence for or against each model. [8]

(b) Describe the processes involved in absorbing different nutrients across the cell membrane of villus epithelium cells lining the small intestine. [4]

(c) Outline the process used to load organic compounds into phloem sieve tubes. [3]

6. All living organisms depend on a continuous supply of energy.

(a) Explain the stages of aerobic respiration that occur in the mitochondria of eukaryotes. [8]

(b) Outline how ventilation in humans ensures a supply of oxygen. [4]

(c) Describe the reasons for the shape of a pyramid of energy. [3]

7. Although simple in structure, bacteria as a group show a wide range of diversity.

(a) Explain the production and role of antibodies in defense against bacterial pathogens in humans. [8]

(b) Describe the evolution of antibiotic resistance in bacteria. [4]

(c) Outline the roles bacteria play in the carbon cycle. [3]