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**BIOLOGY
HIGHER LEVEL
PAPER 2**

Wednesday 16 November 2011 (afternoon)

2 hours 15 minutes

Candidate session number

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Examination code

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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.
- Write your answers in the boxes provided.



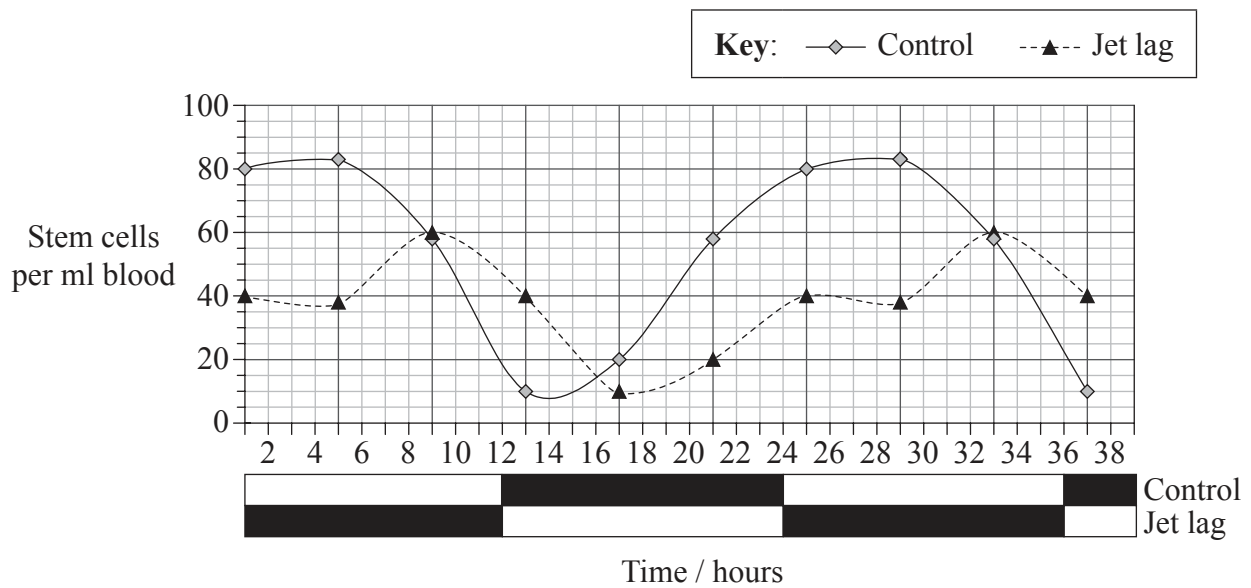
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SECTION A

Answer **all** questions. Write your answers in the boxes provided.

- 1. Stem cells in the bone marrow can be forced into blood vessels in a process called mobilization. Mobilization of stem cells from the bone marrow into the blood vessels represents the basis for modern bone marrow transplantation procedures.

To test the effect of light on the mobilization of stem cells, mice were subjected to a simulated “jet lag” by advancing the light-dark cycle by 12 hours. This was done by subjecting mice to a 24-hour light period before the results shown in the graph were recorded. The results were compared to the stem cells in control mice under normal conditions of 12 hours of light (□) and 12 hours of darkness (■).



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- (a) (i) State the maximum number of stem cells per ml blood in the control mice. [1]

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- (ii) Determine the number of hours of light needed to release the maximum number of stem cells in blood in control mice. [1]

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(Question 1 continued)

- (b) Distinguish between the trends shown in the number of stem cells per ml blood by the mice subjected to jet lag and the control mice. [2]

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- (c) Other studies suggest that a greater number of blood stem cells for transplantation may be obtained if they are harvested during darkness. Evaluate this hypothesis. [2]

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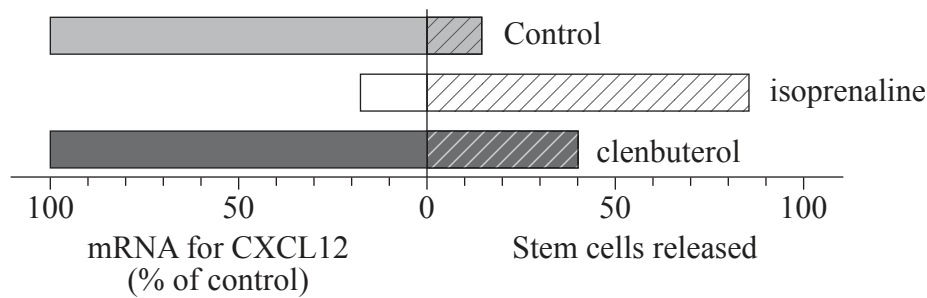
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(Question 1 continued)

One important chemical in the mobilization of stem cells is a protein, CXCL12, which maintains the stem cells inside the bone marrow. The breakdown of CXCL12 causes the mobilization of stem cells to the blood vessels.

The graph below shows the mobilization of stem cells and the production of mRNA for CXCL12 when the bone marrow is treated with two different chemicals (isoprenaline and clenbuterol).



Méndez-Ferrer, S., Lucas, D., Battista, M. and Frenette, P.S. (2008) 'Haematopoietic stem cell release is regulated by circadian oscillations'. Nature 452: 442–447.

- (d) Explain how the amount of mRNA for CXCL12 gives an indication of the amount of protein CXCL12 produced. [1]

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- (e) Compare the effect of isoprenaline and clenbuterol with the normal release of stem cells and the production of mRNA for CXCL12. [3]

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Answers written on this page
will not be marked.



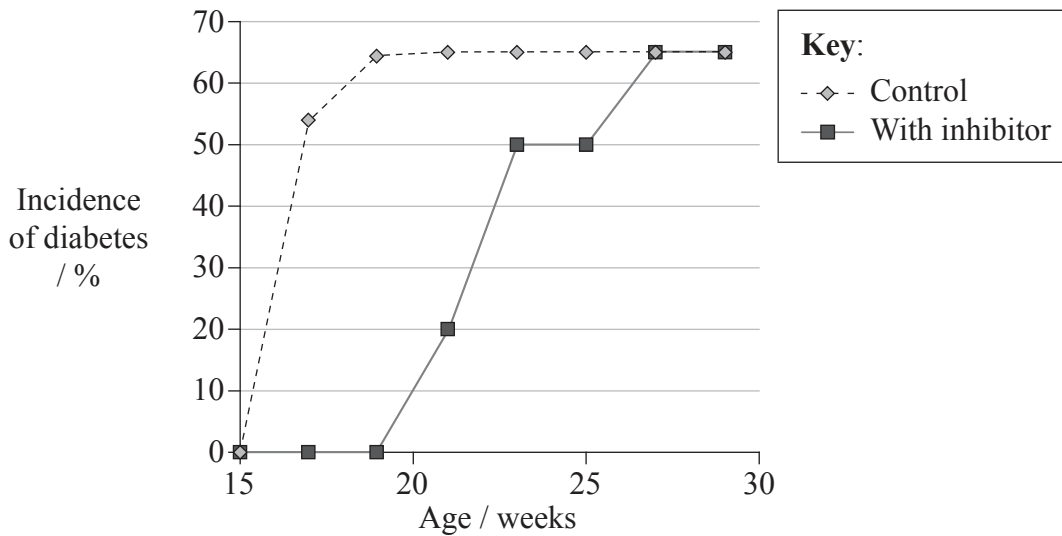
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(Question 1 continued from page 4)

Type I diabetes is an autoimmune disease resulting from destruction of the insulin-producing β cells in the islets of Langerhans. Islet regeneration can occur when stem cells reach the pancreas after leaving the bone marrow.

Studies have shown a link between CXCL12 and type I diabetes. Mice predisposed to develop the disease were given an inhibitor of CXCL12 for 3 weeks. The incidence of diabetes was measured after 28 weeks and compared to control mice that were not given the inhibitor.



[Source: adapted from Q Leng, *et al.*, (2008), *BMC Immunology*, 9, page 51]

(f) (i) Outline the effect of CXCL12 inhibition on the incidence of diabetes. [2]

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(Question 1 continued)

- (ii) Suggest how the breakdown of CXCL12 in the bone marrow may be related to diabetes. [1]

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- (g) Evaluate the possible use of isoprenaline in the treatment of diabetes. [2]

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- (h) Research is being conducted into treatment for diabetes based on stem cells. Discuss the ethical issues involved in stem cell research. [3]

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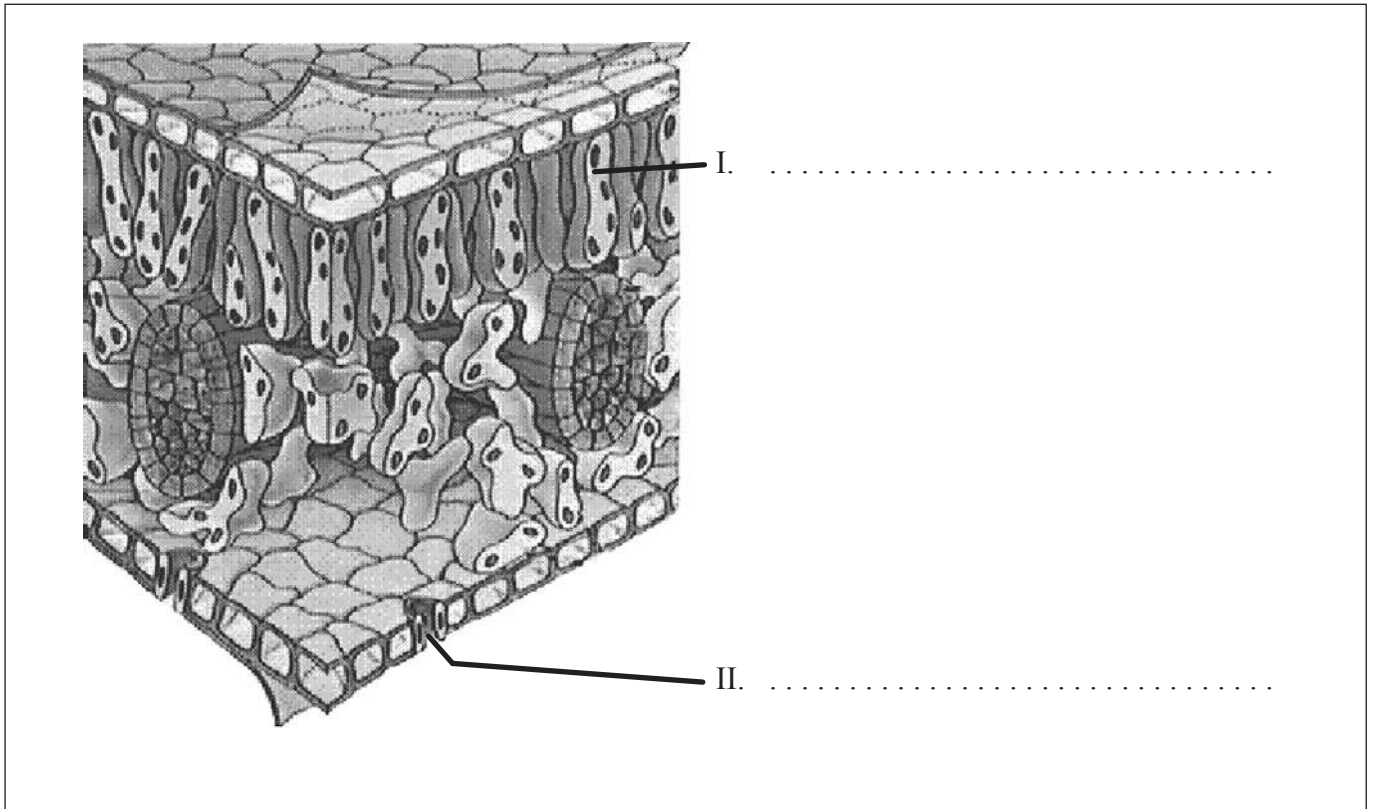
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2. (a) The diagram shows the structure of the leaf of a dicotyledonous plant. Label I and II. [2]



Purves et al. *Life: The Science of Biology, Fourth Edition* (2629-7) Figure 29.27, Page 685

- (b) Outline the function of II. [1]

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3. (a) Predict the genotypic and phenotypic ratios of the possible offspring of a male hemophiliac and a female carrier using suitable symbols for the alleles in a Punnett grid. [3]

Genotypic ratio:

Phenotypic ratio:

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- (b) Hemophilia is a disorder where the ability to control blood clotting or coagulation is impaired. Describe the process of blood clotting. [2]

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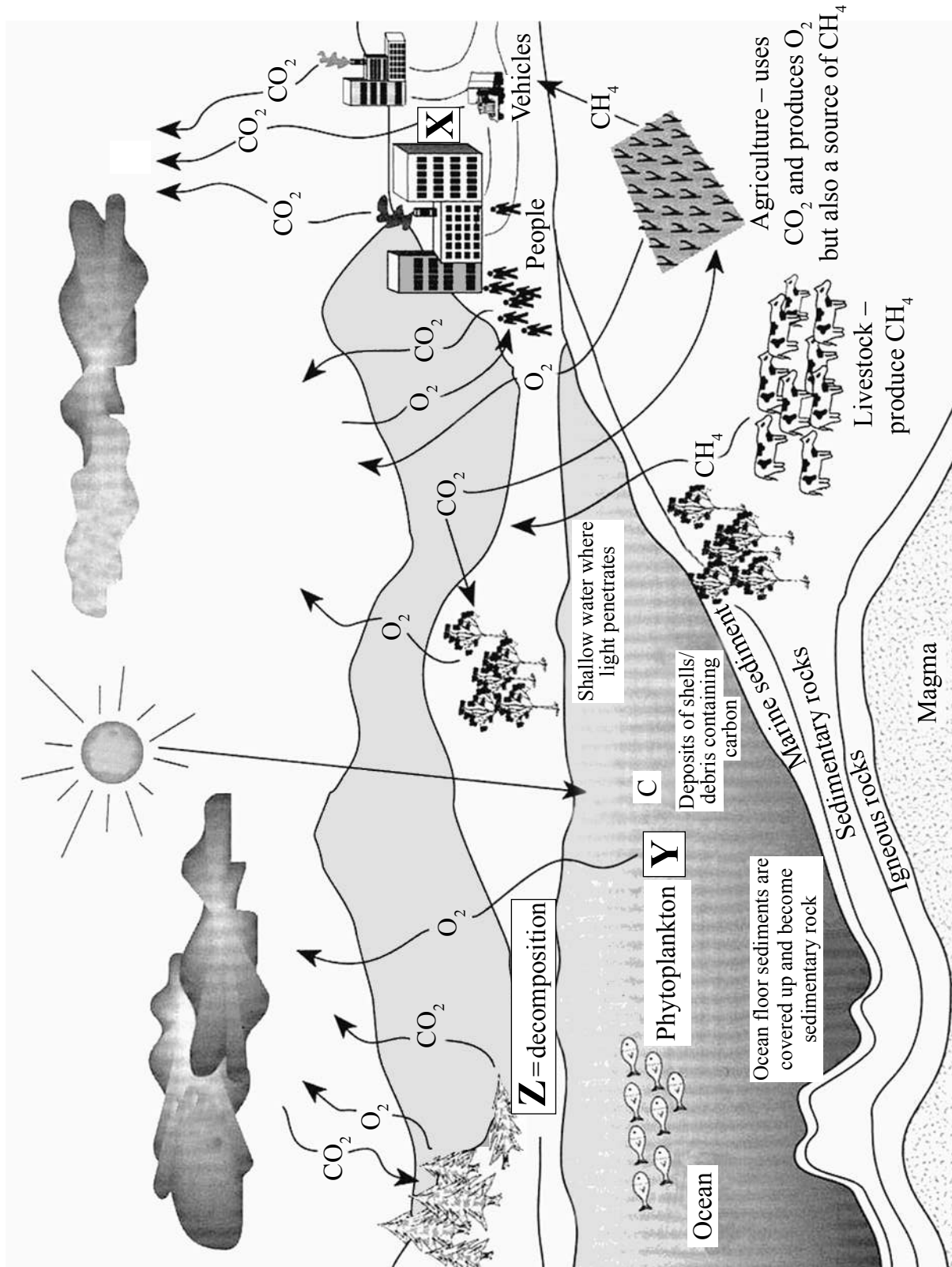
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4. The diagram below shows the carbon cycle.



[Source: adapted from www-das.uwyo.edu/~geerts/cwx/notes/chap01/carbon_cycle.jpeg]

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(Question 4 continued)

- (a) State the process occurring at X and Y. [2]

X:

Y:

- (b) Suggest **one** type of organism that can be involved in process Z. [1]

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- (c) Explain the relationship between the rise in concentration of atmospheric carbon dioxide and the enhanced greenhouse effect. [3]

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SECTION B

Answer **two** questions. Up to two additional marks are available for the construction of your answers. Write your answers in the boxes provided.

5. (a) Draw a labelled diagram of the digestive system. [4]
- (b) Many people cannot digest lactose and benefit from a diet containing no lactose. Outline the production of lactose-free milk. [6]
- (c) Explain how the kidney helps to retain useful substances in the blood and eliminate substances which the body does not need. [8]
6. (a) Describe the production of semen. [6]
- (b) Explain the structure and function of the placenta. [8]
- (c) Outline the hormonal control of birth. [4]
7. (a) Define the terms *chromosome*, *gene*, *allele* and *genome*. [4]
- (b) Compare the genetic material of prokaryotes and eukaryotes. [6]
- (c) Explain the process of DNA replication. [8]
8. (a) Draw the absorption spectrum of chlorophyll. [4]
- (b) Explain the process of photophosphorylation in chloroplasts. [8]
- (c) Outline how the glucose produced as a result of photosynthesis is transported and stored in plants. [6]



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1420

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Lined writing area containing approximately 25 horizontal dotted lines for student response.



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Turn over

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