

**Biology**
Higher level
Paper 2

Wednesday 6 May 2015 (morning)

Candidate session number

2 hours 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 two questions.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[72 marks]**.

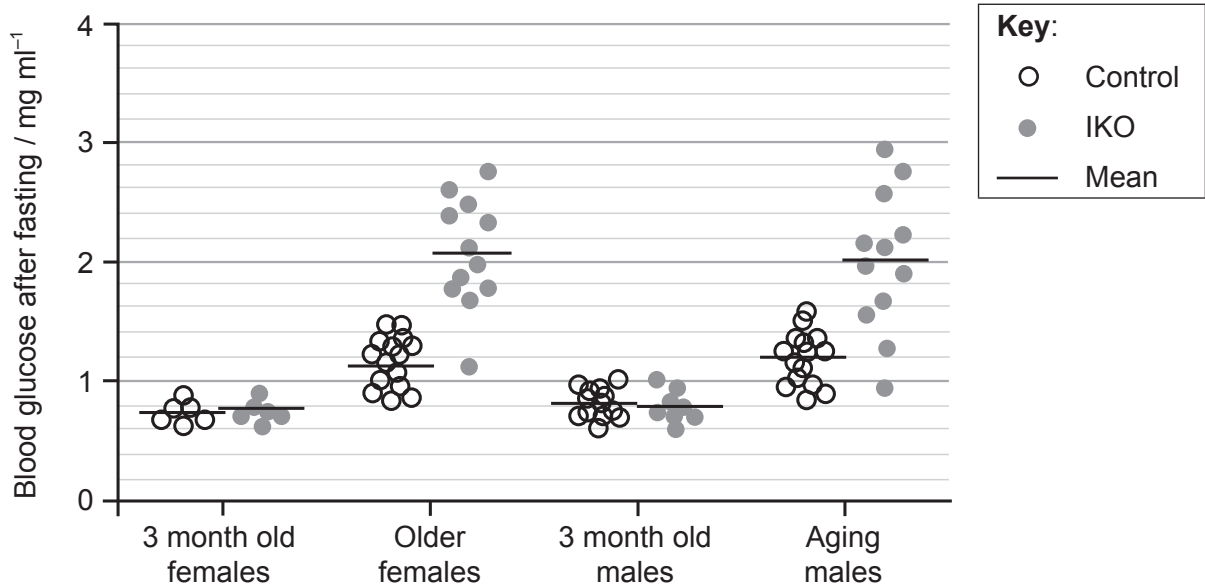


Section A

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

- Diabetes is often associated with the failure of the β (beta) cells in the pancreas, but it is unclear what actually causes this failure. FoxO1 is a protein which acts as a transcription factor to regulate the expression of genes involved in cell growth. FoxO1 also regulates increase in number and differentiation in cells such as pancreatic β cells.

A study was conducted using mice lacking the gene for FoxO1 in β cells (IKO) as well as normal (control) mice. Blood glucose levels after fasting were compared for four groups of mice: young (3 months old) male mice, young (3 months old) female mice, older females (who have had several pregnancies) and aging males (16–20 months).



[Source: Chutima Talchai, Shouhong Xuan, Hua V. Lin, Lori Susse, Domenico Accili, "Pancreatic β Cell Dedifferentiation as a Mechanism of Diabetic β Cell Failure", *Cell*, Volume 150, Issue 6, 14 September 2012, Pages 1223–1234]

- Compare blood glucose levels after fasting in young control mice and young IKO mice without FoxO1.

[2]

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(Question 1 continued)

- (b) Aging and having pregnancies are considered to be physiological stresses. Deduce the effect of stress on blood glucose levels.

[2]

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- (c) Outline the relationship between blood glucose levels after fasting and lack of FoxO1 in the mice studied.

[2]

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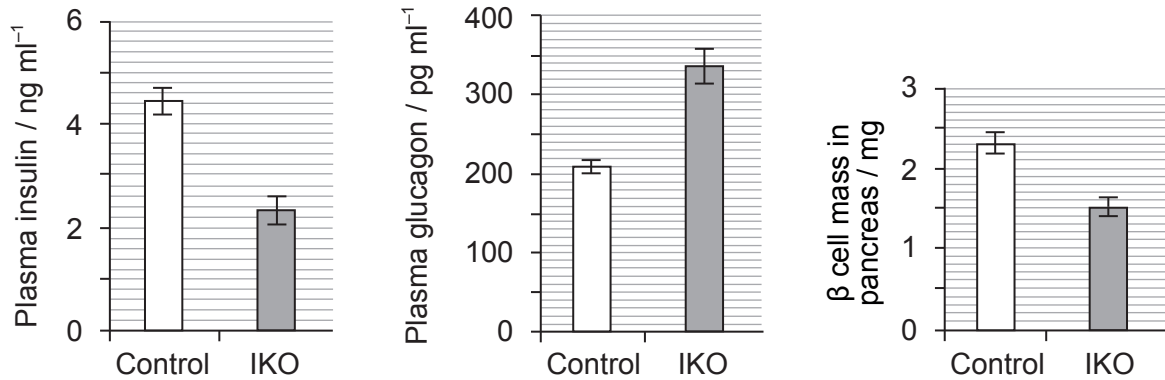
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(Question 1 continued)

The levels of pancreatic hormones and β cell mass in older female control mice and older female IKO mice lacking FoxO1 were then investigated.



[Source: Chutima Talchai, Shouhong Xuan, Hua V. Lin, Lori Sussel, Domenico Accili, "Pancreatic β Cell Dedifferentiation as a Mechanism of Diabetic β Cell Failure", *Cell*, Volume 150, Issue 6, 14 September 2012, Pages 1223–1234]

- (d) Calculate the percentage difference in β cell mass of the IKO mice compared to the control mice.

[2]

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- (e) State the correlation between lack of FoxO1 and pancreatic hormones in mice.

[1]

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Answers written on this page
will not be marked.



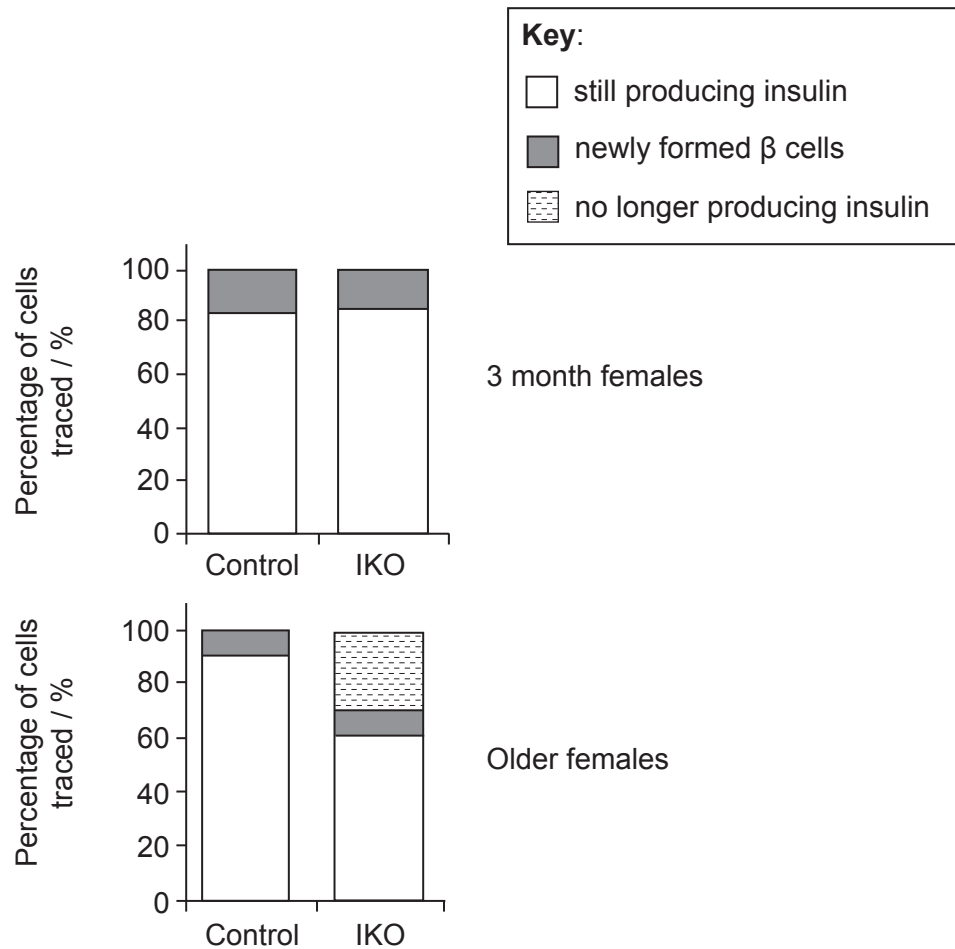
20EP05

Turn over

(Question 1 continued)

To examine whether the changes observed were due to lack of β cell function or change in β cell number, investigators traced marked cells. They were able to determine if cells were:

- still producing insulin
- newly formed β cells
- no longer producing insulin.



[Source: Chutima Talchai, Shouhong Xuan, Hua V. Lin, Lori Sussel, Domenico Accili, "Pancreatic β Cell Dedifferentiation as a Mechanism of Diabetic β Cell Failure", *Cell*, Volume 150, Issue 6, 14 September 2012, Pages 1223–1234]

(f) State which group of cells showed the least change in the mice studied.

[1]

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(Question 1 continued)

- (g) Deduce the effects of aging on the distribution of cell types in mice. [2]

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A hypothesis has been suggested that diabetes is caused by β cells losing their ability to act as β cells, not by the death of β cells. In other words they dedifferentiate.

- (h) Using all the information provided, discuss whether the data support this hypothesis. [2]

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- (i) When there are high blood glucose levels, more FoxO1 is found in the nucleus of the cell than in the cytoplasm. Suggest a role of FoxO1 considering this and the data. [2]

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2. A study of 600 adolescents in Sweden showed that milk consumption has a positive effect on height which shows continuous variation. However, milk contains lactose which some people can digest but some cannot.

- (a) (i) State the pattern of inheritance that contributes to continuous variation. [1]

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- (ii) Explain the production of lactose-free milk. [3]

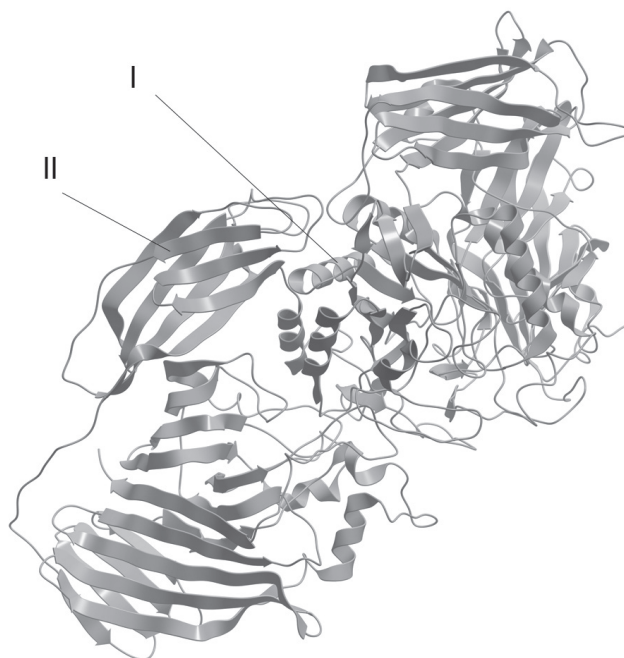
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(Question 2 continued)

- (b) The diagram below shows the structure of lactase.



[Source: Kindly provided by RL Miesfeld, The University of Arizona, Tucson, AZ USA]

- (i) Identify the protein structures indicated by I and II. [1]

I:

II:

- (ii) Describe how structure I is held together. [2]

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(Question 2 continued)

- (iii) This protein is described as a globular protein. Distinguish between globular and fibrous proteins.

[2]

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20EP11

Turn over

3. The diagram below shows a plant of the *Solanum* genus.



- (a) (i) State whether this plant is dicotyledonous or monocotyledonous. [1]

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- (ii) State **two** features visible in the diagram above that indicate this. [2]

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(Question 3 continued)

- (b) (i) Label the diagram of *Solanum* on page 12 to show the name of a structure specialised for food storage. [1]
- (ii) Outline the transport of products of photosynthesis to the storage structure. [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.

4. (a) Draw a labelled diagram of the human adult male reproductive system. [5]
(b) Compare the processes of spermatogenesis and oogenesis. [8]
(c) Describe the consequences of the potential overproduction of offspring. [5]
5. (a) Outline the processes that occur during the first division of meiosis. [6]
(b) Prior to cell division, chromosomes replicate. Explain the process of DNA replication in prokaryotes. [8]
(c) Outline outcomes of the human genome project. [4]
6. (a) Draw a labelled diagram to show the structure of a motor neuron. [4]
(b) Explain how skeletal muscle contracts. [8]
(c) Active skeletal muscle requires a good supply of oxygen. Outline the mechanism of ventilation in the lungs. [6]
7. (a) Draw a labelled diagram to show the structure of the plasma membrane. [5]
(b) The light-dependent reactions in photosynthesis take place on the thylakoid membranes. Explain the light-dependent reactions. [8]
(c) Outline **two** factors that affect the rate of photosynthesis. [5]



[illegible]



[illegible]

