**1.** Which words from the table below complete the sentence correctly?

*In the pancreas,* \_\_\_\_I\_\_\_\_ *secrete glucagon, which* \_\_\_\_II\_\_\_\_ *blood glucose levels*.

|  |  |  |
| --- | --- | --- |
|  | **I** | **II** |
| A. | α cells | raises |
| B. | β cells | raises |
| C. | α cells | lowers |
| D. | β cells | lowers |

(Total 1 mark)

**2.** This question refers to the following diagram of the digestive system.



Which organs are associated with the transformation of glucose into glycogen?

A. 1 and 4

B. 2 and 3

C. 2 and 4

D. 1 and 3

(Total 1 mark)

**3.** What are causes of type I and type II diabetes?

|  |  |  |
| --- | --- | --- |
|  | **Type I** | **Type II** |
| A. | autoimmune disease leading to reduced insulin secretion | decreased responsiveness of the body to insulin |
| B. | decreased responsiveness of the body to insulin | autoimmune disease leading to reduced insulin secretion |
| C. | increased responsiveness of the body to insulin | autoimmune disease leading to increased insulin secretion |
| D. | autoimmune disease leading to increased insulin secretion | increased responsiveness of the body to insulin |

(Total 1 mark)

**4.** Type II diabetes is having an impact on the health of many individuals worldwide. The condition is characterized by elevated levels of both insulin and glucose in the bloodstream.  
Some animals produce an insulin-degrading enzyme (IDE) which breaks down the insulin molecule. In an attempt to develop a model of type II diabetes, genetically modified mice have been developed. In these mice, both copies of the IDE gene have been removed (IDE – / –) and the enzyme is not produced. The bar chart below shows the mean concentration of insulin in the bloodstream of IDE – / – mice and that of control mice (IDE + / +).



[Source: Wesley Farris et al. 2003. “Insulin-degrading enzyme regulates the levels of insulin, amyloid B-protein, and the B-amyloid precursor protein intracellular domain in vivo”. *Proceedings of the National Academy of Sciences*. Vol 100, issue 7. Pp 4162–4167. Copyright 2003 National Academy of Sciences, USA.]

(a) Calculate the percentage increase between mean blood insulin levels in IDE + / + mice and those in IDE – / – mice.

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(1)

(b) Explain the difference in blood insulin concentrations between the two groups of mice.

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(2)

In another experiment, groups of IDE – / – and IDE + / + mice were injected with a fixed amount of glucose. The levels of blood glucose were measured at various time intervals following glucose injection. The data are shown in the graph below.



[Source: Wesley Farris et al. 2003. “Insulin-degrading enzyme regulates the levels of insulin, amyloid B-protein, and the B-amyloid precursor protein intracellular domain in vivo”. *Proceedings of the National Academy of Sciences*. Vol 100, issue 7. Pp 4162–4167. Copyright 2003 National Academy of Sciences, USA.]

(c) Distinguish between the response of the two groups of mice to the injection of glucose.

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(2)

(d) Deduce, with a reason, whether transgenic IDE – / – mice are an appropriate model of type II diabetes.

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(2)

In animals that do not have type II diabetes, insulin stimulates glucose uptake into skeletal muscle. Glucose uptake into skeletal muscle is also stimulated when skeletal muscle is exercised. Genetically modified mice have been developed in which the insulin receptor is not produced in skeletal muscle and these are known as MIRKO mice. In another experiment, the effect of insulin and exercise on glucose uptake in skeletal muscle from control and MIRKO mice was examined. The results are shown in the bar chart below.



[Republished with permission of the American Society for Clinical Investigation, from Jørgen F P Wojtaszewski, Yasuki Higaki, Michael F Hirshman, M Dodson Michael, Scott D Dufresne, C Ronald Kahn and Laurie J Goodyear. 1999. “Exercise modulates postreceptor insulin signaling and glucose transport in muscle-specific insulin receptor knockout mice”. *Journal of Clinical Investigation*. Vol 104, issue 9. Pp 1257–1264. Permission conveyed through Copyright Clearance Center, Inc.]

(e) Explain the reason for the differences in insulin-stimulated glucose uptake between control mice and MIRKO mice.

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(2)

(f) Distinguish between the effects of insulin alone and exercise alone on glucose uptake in skeletal muscle of MIRKO mice.

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(1)

(g) Evaluate, using the data, whether exercise would be an appropriate therapy for human patients with type II diabetes.

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(3)

(h) State which cells secrete insulin and the organ in which they are located.

Cells: ...........................................................................................................................

Organ: .........................................................................................................................

(2)

(i) State the name of **one** hormone other than insulin involved in the regulation of blood glucose.

......................................................................................................................................

(1)

(Total 16 marks)