Homeostasis – A2 9700 Biology June 2022

1. June/2022/Paper_41/No.6

(a) In mammals, the blood glucose concentration must be maintained within narrow limits so that the body cells can function efficiently.

Name the mechanism by which the blood glucose concentration is maintained within narrow limits.

..... [1]

(b) Glucagon is released by the alpha (α) cells of the pancreas when the blood glucose concentration decreases below the set point.

Fig. 6.1 outlines the response of liver cells to glucagon.

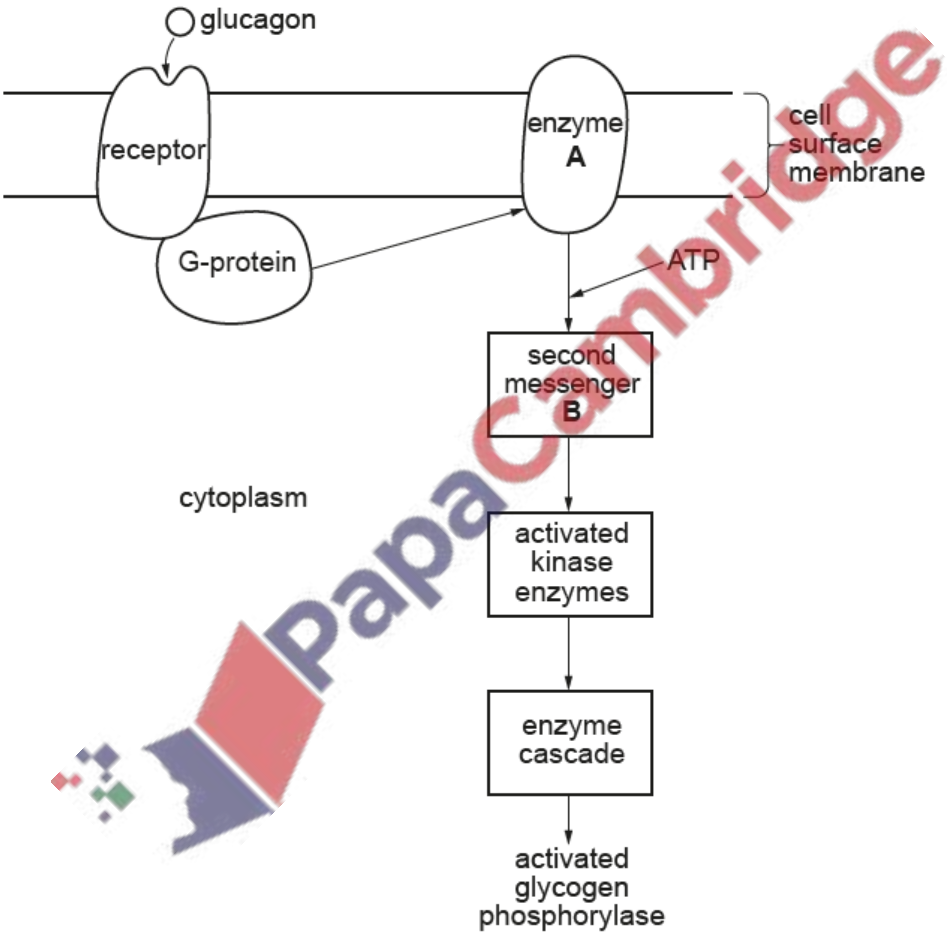

Fig. 6.1

(i) State how glucagon reaches the liver cells.

..... [1]

(ii) With reference to Fig. 6.1, name enzyme **A** and second messenger **B**.

A .....

B .....

[2]

(iii) State the role of the enzyme cascade.

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..... [1]

(iv) State the function of the final enzyme in the pathway, glycogen phosphorylase.

..... [1]

(c) A biosensor is used to measure blood glucose concentration to check that it is within the normal range.

Describe how a glucose biosensor works.

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..... [4]

[Total: 10]

2. June/2022/Paper_42/No.9

(a) Ultrafiltration in the kidney takes place between the glomerulus and the Bowman's capsule. The afferent blood vessel carrying blood to the glomerulus has a wider lumen than the efferent blood vessel.

Explain why the lumen of the afferent blood vessel needs to be wider than the lumen of the efferent blood vessel.

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..... [2]

(b) Fig. 9.1 is a diagram of part of the glomerulus and Bowman's capsule.

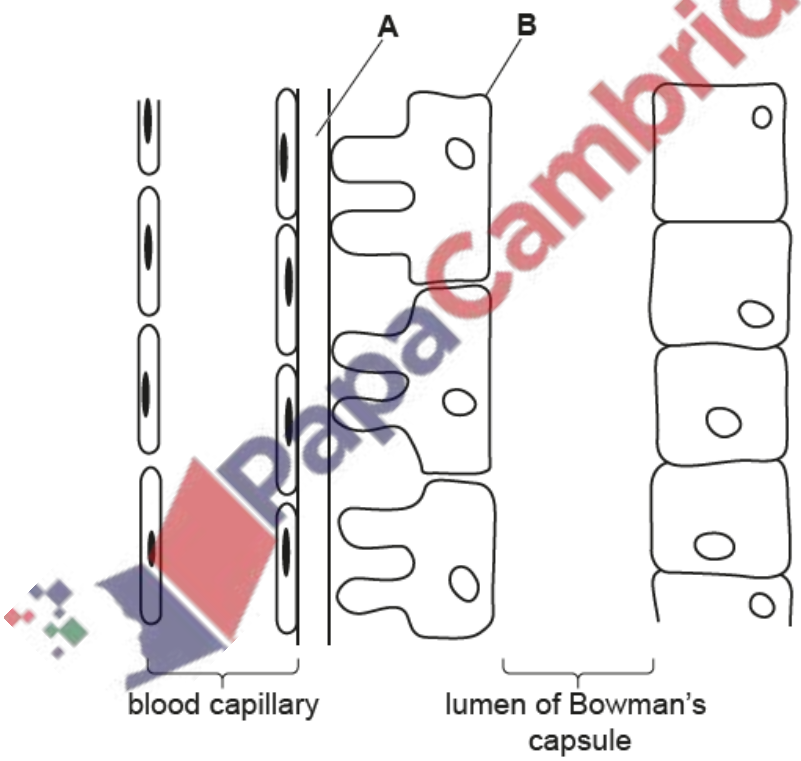

Fig. 9.1

(i) Name **A** and **B**.

A .....

B .....

[2]

(ii) Describe the roles of **A** and **B** in the formation of the glomerular filtrate.

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..... [3]

[Total: 7]

3. June/2022/Paper_43/No.1(a, b,)

(a) The water potential of mammalian blood needs to be maintained within narrow limits so that cells function efficiently. This process is called osmoregulation.

The relative medullary thickness (RMT) indicates the proportion of a kidney that is composed of medullary tissue.

$$\text{RMT} = \frac{\text{thickness of medulla}}{\text{kidney size}} \times 10$$

Table 1.1 shows the relationship between the RMT and the concentration of urine produced by four mammals from different habitats.

Table 1.1

mammal	habitat	RMT	urine concentration / arbitrary units
beaver	rivers and lakes	1.4	0.90
warthog	savannah	2.8	2.35
human	variable	3.2	2.50
kangaroo rat	desert	8.6	10.50

(i) Name the parts of the nephron that are located in the medulla.

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..... [2]

(ii) Name a hormone involved in osmoregulation.

..... [1]

(iii) Describe the relationship between the RMT and the concentration of urine produced **and** explain the differences between the data for the beaver and the kangaroo rat.

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(b) The warthog, *Phacochoerus africanus*, is a member of the pig family. The warthog lives in dry savannah areas of sub-Saharan Africa.

Fig. 1.1 shows a warthog.

Fig. 1.1

A warthog and a human have similar values of RMT and concentration of urine. A human can survive only a few days without drinking water, whereas a warthog can live for several months without drinking water.

Suggest how a warthog is able to survive several months without drinking water.

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[Total: 9]

4. June/2022/Paper_43/No.10

(a) Insulin has an important role in the maintenance of blood glucose concentration.

An investigation measured how blood glucose concentration and blood insulin concentration changed after a glucose-rich meal had been eaten.

The results are shown in Fig. 10.1.

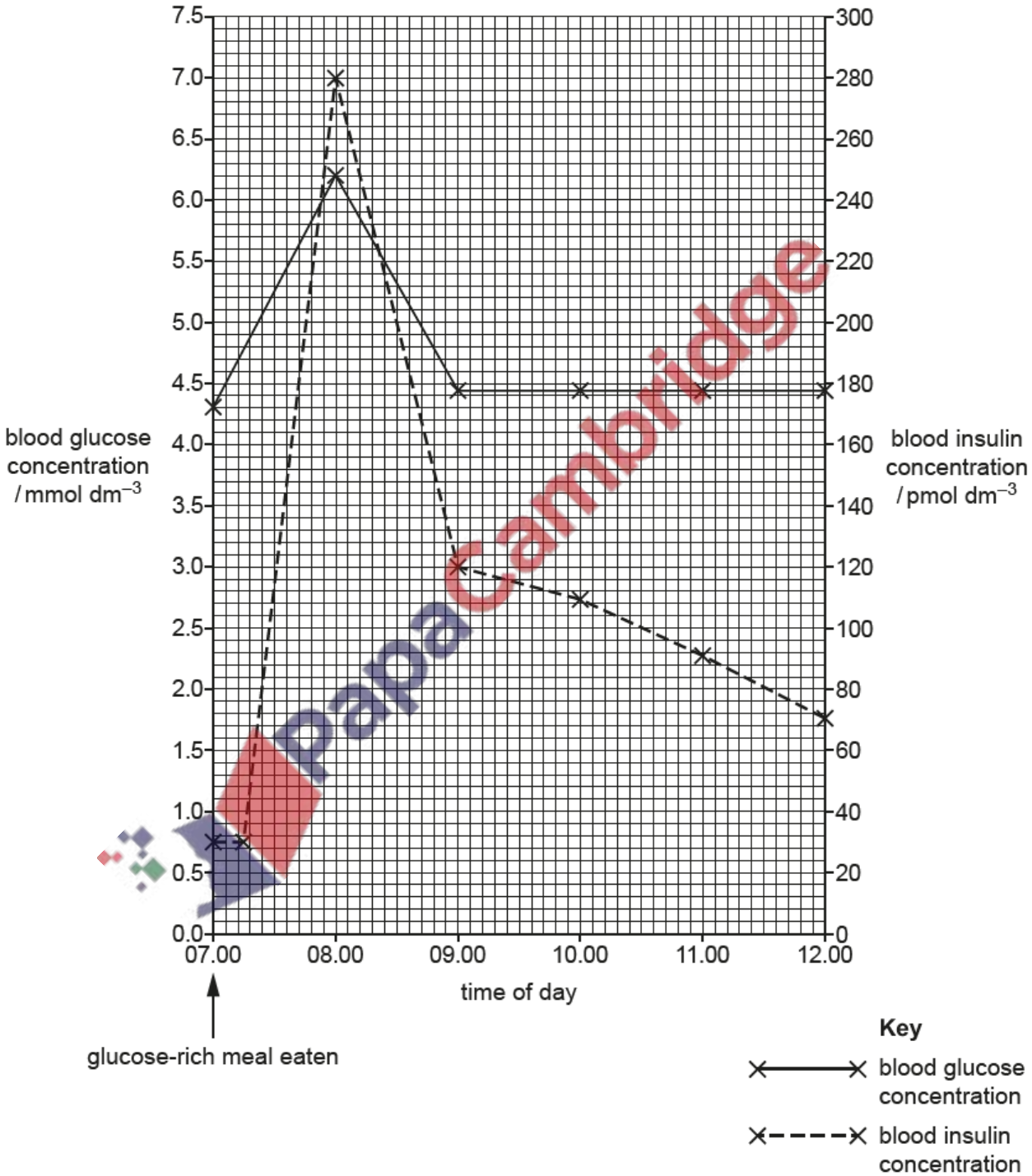

Fig. 10.1

(i) Describe **and** explain how the results shown in Fig. 10.1 indicate a relationship between blood glucose concentration and blood insulin concentration after the consumption of a glucose-rich meal.

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(ii) Suggest **and** explain how the results shown in Fig. 10.1 would change if the meal was mostly starch rather than glucose.

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(b) Glucagon is synthesised by cells in the pancreas known as alpha (α) cells. Glucagon binds to G-protein-coupled receptors in the cell surface membrane of liver cells. This results in the activation of G-proteins.

Outline the sequence of events occurring within the cell after the activation of G-proteins that helps to restore the blood glucose concentration to its set point.

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[Total: 10]