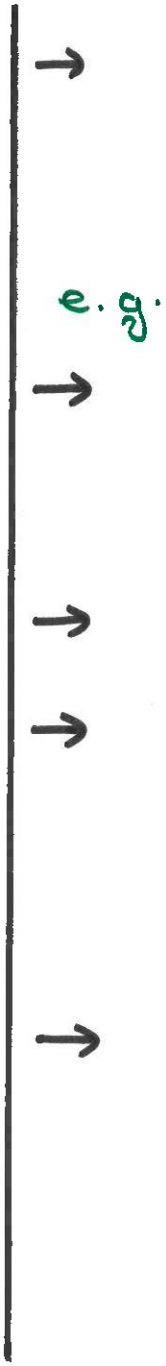
Second Messengers



Do not write outside the box

0 5 . 1 Describe the role of glucagon in gluconeogenesis.

Do **not** include in your answer details on the second messenger model of glucagon action.

[2 marks]

0 5 . 2 The gene that codes for glucagon is 9.531 kilobases in length. The DNA helix makes one complete turn every 10 base pairs. Every complete turn is 3.4 nm in length.

Use this information to calculate the length in micrometres (μm) of the gene for glucagon. Give your answer to 3 significant figures.

[2 marks]

Answer = _____ μm

Do not write outside the box

Metformin is a drug commonly used to treat type II diabetes. Metformin's ability to lower the blood glucose concentration involves a number of mechanisms including:

- increasing a cell's sensitivity to insulin
- inhibiting adenylate cyclase.

0 5 . 3 Explain how increasing a cell's sensitivity to insulin will lower the blood glucose concentration.

[2 marks]

0 5 . 4 Explain how inhibiting adenylate cyclase may help to lower the blood glucose concentration.

[3 marks]

9

Turn over ►

20 (a) **Fig. 20.1** is a flow diagram that shows the sequence of events in the body once a threat is perceived. The response is often described as the 'fight or flight' response as it prepares the body to respond physically to the threat in the short-term.

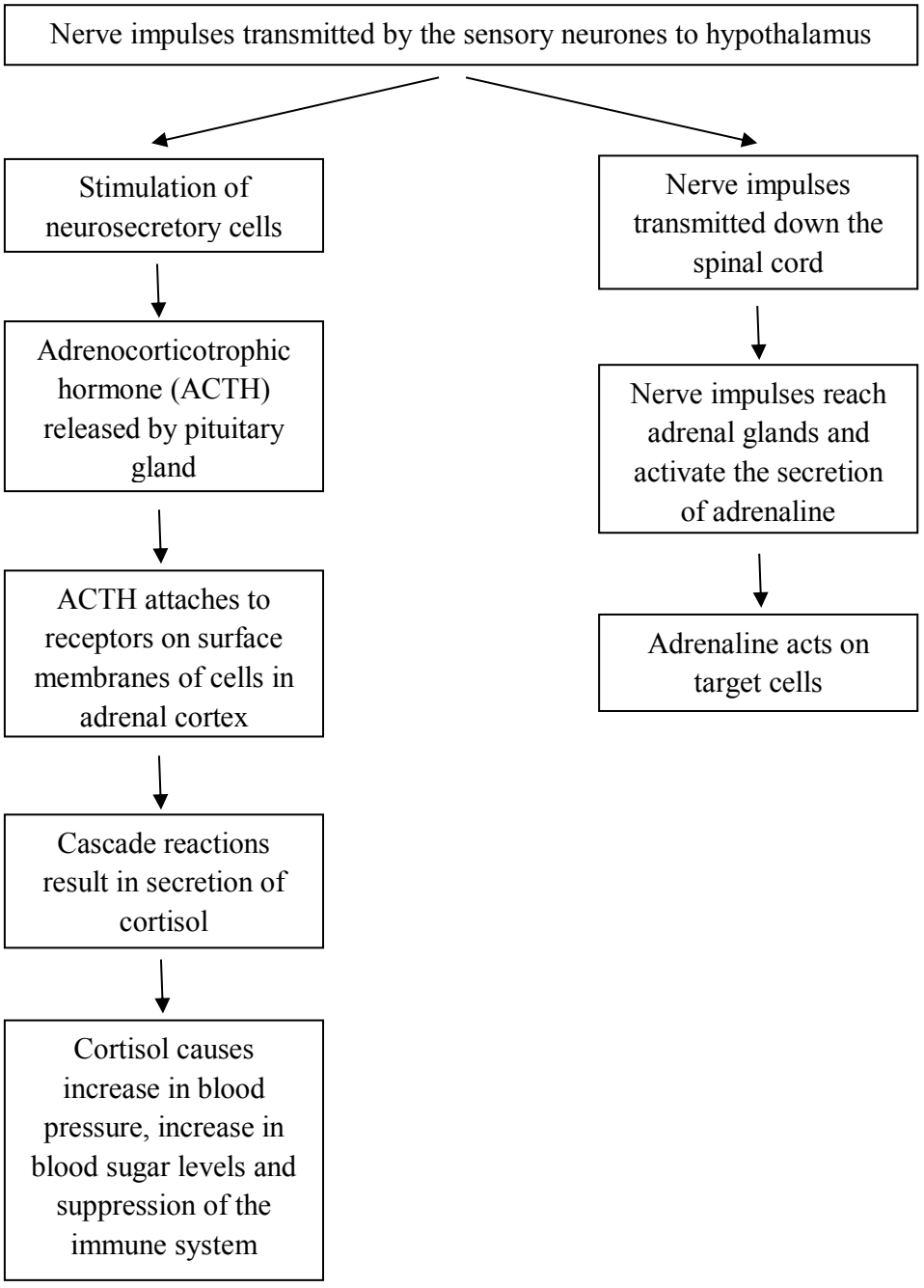


Fig. 20.1

(i) Identify **two** signalling molecules named in **Fig. 20.1**.

1……

2……

[1]

(ii) Adrenaline acts on a variety of cell types with a variety of responses.

Complete the table by stating the effects of stimulating each target cell. The first one has been completed for you.

Target cell	Response	Role in the 'fight or flight' response
Smooth muscle in bronchioles	Muscle relaxes	Bronchioles dilate and allow more oxygen to reach blood
Sino-atrial node		
Liver cell		
Erector muscle in skin		

[6]

(iii) Describe the sequence of actions that occur once adenylyl cyclase is activated in the target liver cells.

……

……

……

…… **[2]**

(iv) The response in **Fig. 20.1** also occurs when a person is subjected to stress. However, the body does not need to respond physically to the stimulus and so, for example, the bronchioles do not dilate.

From the information given and your own knowledge, suggest the long term adverse effects of continued exposure to stress on body function.

……

……

……

…… **[2]**

(b) Part of the body's response 'fight or flight' is to run away from the threat. Prolonged vigorous exercise puts high demands on the body's metabolism.

The muscle cells require an adequate supply of oxygen for respiration. If insufficient oxygen is available, the cells must respire anaerobically.

Fig. 20.2 outlines the process of anaerobic respiration in muscle cells.

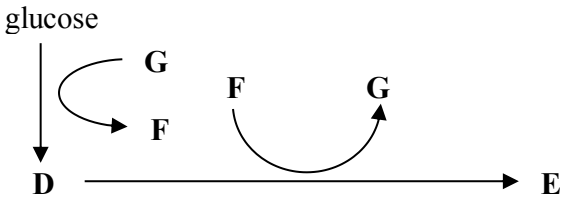


Fig. 20.2

(i) Identify the compounds labelled **D** and **E** in **Fig. 20.2**.

D……

E…….
[2]

(ii) What is the role of compound **D** in anaerobic respiration?

…….

……. **[1]**

(iii) Why is it important that compound **G** is formed during the reaction in which compound **D** is converted into compound **E** in anaerobic respiration?

…….

…….

……. **[2]**

(iv) Compound **E** is toxic and is removed from the muscle cell. It is transported to an organ in the body.

Which organ is compound **E** transported to **and** how does it reach this organ?

…….

……. **[1]**

(c) Athletic sprinters require large amounts of energy in short periods of time. Many elite sprinters can run 100 metre races in under 10 seconds.

Under normal conditions, exercise requires an increased rate of breathing. It has been observed that some of the best sprinters only take one breath at the start of the race and do not inhale again until the end of the race.

Suggest how these sprinters can expend so much energy without needing to carry out aerobic respiration.

……...

……...

……...

……. [2]

END OF QUESTION PAPER

Question	Marking Guidance	Mark	Comments
05.1	1. (Attaches to receptors on target cells and) activates/stimulates enzymes; 2. Glycerol/amino acids/fatty acids into glucose;	2	1. Reject 'produces enzymes'. 2. Reject 'glucagon converts' as context suggests enzyme action. 2. Ignore lipids/fats/proteins but reject glycogen. 2. Reject occurs in pancreas.
05.2	1. Correct answer of 3.24 = **2 marks**;; 2. Incorrect but multiplies by 34 (with decimal point in any position) = **1 mark** **OR** Incorrect but shows sequence 324 = **1 mark** **OR** 3.2 = **1 mark**;	2	
05.3	1. (More) insulin binds to receptors; 2. (Stimulates) uptake of glucose by channel/transport <u>proteins</u> **OR** Activates enzymes which convert glucose to glycogen;	2	2. Accept activates enzymes for glycogenesis. 2. Reject active transport. 2. Accept carrier proteins or GLUT 4 for channel proteins. 2. Accept insulin stimulates addition of channel proteins in membranes.
05.4	1. Less/no ATP is converted to cyclic AMP/cAMP; 2. Less/no kinase is activated; 3. Less/no glycogen is converted to glucose **OR** Less/no glycogenolysis;	3	If no indication of less/no for any of the mark points award **max 2 marks**. Accept all marks in context of adrenaline. Ignore gluconeogenesis.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>20</td><td>(a)</td><td>(i)</td><td>two of
ACTH
cortisol
adrenaline</td><td>1</td><td>Two answers required for 1 mark.</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table>
<tr><td>Sino-atrial node</td><td>increases rate of firing impulses</td><td>increased heart rate circulates blood more quickly</td></tr>
<tr><td>Liver cell</td><td>increases glycogenolysis</td><td>makes more glucose available for respiration</td></tr>
<tr><td>Erector muscle in skin</td><td>contraction of muscle</td><td>(causes hairs to be raised and so) makes animal look larger / more aggressive</td></tr>
</table></td><td>6</td><td></td></tr>
<tr><td></td><td></td><td>(iii)</td><td>catalyses synthesis of cyclic AMP from ATP
cyclic AMP activates enzymes responsible for conversion of glycogen to glucose</td><td>2</td><td></td></tr>
</table>

Question			Answer	Marks	Guidance
		(iv)	*two from* prolonged high blood pressure can lead to cardiovascular problems prolonged high blood sugar can lead to**,** problems with blood sugar regulation / diabetes suppression of the immune system can lead to susceptibility to**,** disease / infection	**2**	
	(b)	**(i)**	**D** pyruvate **E** lactate	**2**	
		(ii)	is a hydrogen acceptor / removed hydrogen from reduced NAD	**1**	
		(iii)	*two from* for glycolysis to take place**,** NAD / **G,** is needed there is a limited amount of NAD in the cell formation of**,** NAD / **G,** allows**,** glycolysis to continue / some ATP to be formed	**2**	
		(iv)	liver **and** in the blood	**1**	Both required for 1 mark.
	(c)		*two from* cells are able to tolerate**,** high levels of lactate / acidity / low pH have high phosphocreatine stores use of stored ATP	**2**	
			Total	**19**	