1 Organisms respond to changes in their internal environment. These responses are controlled by nervous and hormonal mechanisms.

(a) The concentration of blood glucose is regulated by hormones.

Complete the passage below, using the **most suitable** term in each case.

The pancreas releases hormones directly into the blood and these regulate the concentration of blood glucose. The pancreas, therefore, acts as an

..... gland.

When the blood glucose concentration increases, insulin is released from the beta cells in the regions of the pancreas known as the

..... .

A different hormone, glucagon, is released from the alpha cells of the pancreas and this hormone causes ..... to be broken down into glucose, in a process known as ..... . **[4]**

(b) The heart rate is controlled by both nervous and hormonal mechanisms.

(i) Name **one** hormone which will **increase** the heart rate.

..... **[1]**

(ii) State **one** way in which the nervous system **decreases** the heart rate.

.....

..... **[1]**

[Total: 6]

2 Growth and development in organisms is controlled by a number of mechanisms that operate at the cellular level. The control elements involved in these mechanisms include hormones, the second messenger molecule cyclic AMP and regulatory genes.

- In eukaryotes the most important regulatory genes contain homeobox sequences and are called homeotic genes.
- The regulatory genes of the *lac* operon in prokaryotes are studied to help us to understand how regulatory genes and their products interact to switch structural genes on and off.

(a) Use your understanding of the biochemical identity and interactions of these control elements to complete Table 5.1 by putting a tick (✓) or a cross (✗) **in each box**.

Some of the boxes have been completed for you.

Control element	Made of protein	Binds with a protein	Codes for protein
insulin		✓	
cyclic AMP			✗
lac I (inhibitor) gene		✓	
lac O (operator) gene	✗		
homeotic gene product		✗	

[5]

Table 5.1

(b) RNA polymerase and DNA polymerase are both enzymes. RNA polymerase is involved in the action of some control elements, whereas DNA polymerase is not.

Describe and explain the difference between the **functions** of these two enzymes.

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.....

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.....

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..... **[4]**

(c) Another mechanism that can act to change the body plan of an organism during its development is **programmed cell death**.

Fill in the gaps in the following passage describing this process and the importance of its regulation.

Programmed cell death is known as ..... . Firstly, the fine network of protein filaments and microtubules known as the ..... , which gives structure to the cell, is broken down and digested by ..... .

The plasma (cell surface) membrane then changes, forming small bulges called 'blebs'. The cell breaks into membrane-bound fragments that are removed by the process of ..... so that harmful substances are not released into surrounding tissues.

Programmed cell death is a controlled process. However, mutation in a gene called p53 can prevent programmed cell death. When this occurs, the rate at which somatic cells are produced by the process of ..... becomes greater than the rate at which cells die, resulting in the formation of a mass of cells known as a ..... .

[6]

[Total: 15]

3 Animals respond to frightening or stressful stimuli in their environment.

This question is about the 'fight or flight' response in mammals.

Fig. 2.1 (**on the insert**) shows a husky dog in a calm state.

Fig. 2.2 (**on the insert**) shows a different husky displaying external signs of the 'fight or flight' response.

(a) Describe **three** features in the external appearance of the husky in Fig. 2.2 that are due to the 'fight or flight' response.

1 .....

.....

2 .....

.....

3 .....

..... **[3]**

(b) The 'fight or flight' response is brought about by the hormone adrenaline and the autonomic nervous system working together. As well as causing external differences in appearance, the 'fight or flight' response causes numerous changes in the functioning of the internal organs.

Complete Table 2.1 to describe how **two** internal organs would function differently in a calm mammal compared to a frightened mammal.

Table 2.1

internal organ	calm mammal	frightened mammal

[6]

(c) The differences you described in part **(b)** are coordinated by the **autonomic** nervous system. The autonomic nervous system has two divisions, each of which uses a different neurotransmitter to bring about effects in the internal organs.

In the table below, state which division of the autonomic nervous system will be active in each case, and name the **neurotransmitter** that will be secreted by neurones into the organs.

	calm mammal	frightened mammal
division of the autonomic nervous system activated		
name of neurotransmitter secreted by neurones		

[4]

(d) State precisely where in the body adrenaline is produced.

..... **[2]**

(e) The adrenaline molecule is not lipid-soluble, therefore it cannot pass directly through the cell surface membrane. In order to bring about changes inside the cell, adrenaline relies on a second messenger system.

(i) Describe the events that occur after adrenaline reaches the cell surface membrane that then result in changes in metabolism inside the cell cytoplasm.

.....

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.....

..... **[4]**

(ii) The second messenger system is a multi-step mechanism. It enables large changes in cell metabolism to occur rapidly, although only relatively small numbers of adrenaline molecules are involved.

Suggest how having a number of steps in the signalling pathway enables a small number of adrenaline molecules to rapidly cause large effects.

.....

.....

.....

..... **[2]**

[Total: 21]

4 **(a)** Excretion and secretion are two processes that take place in the body of a mammal.

Complete the table below to compare the processes of excretion and secretion.

	excretion	secretion
one difference		
one example of a product		
one similarity		

[3]

(b) Aerobic respiration may be summarised by the following equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

Although carbon dioxide and water are products of aerobic respiration, the equation is an over-simplification of the process.

State **and** explain **one** way in which this equation is an over-simplification.

.....

.....

.....

..... **[2]**

(c) Over 2.3 million people in the UK are known to have diabetes. It is also estimated that a further 0.5 million people have the condition but are unaware of it.

(i) Explain how **Type 1** diabetes is caused.

.....

.....

.....

..... **[2]**

(ii) Describe **three** factors that increase a person's risk of developing **Type 2** diabetes.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

[Total: 10]