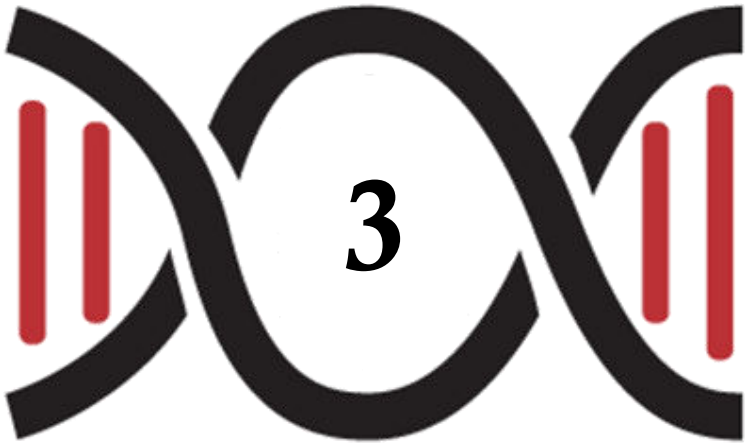
LONDON SCIENCE COLLEGE

AQA A2 BIOLOGY

TOPIC 6

ORGANISM RESPONSE TO THE ENVIRONMENT



1 (a) Describe the part played by each of the following in myofibril contraction.

(i) Tropomyosin

.....

.....

.....

.....

.....

(2)

(ii) Myosin

.....

.....

.....

.....

.....

(2)

(b) The table shows features of fast and slow muscle fibres.

Feature	Fast muscle fibre	Slow muscle fibre
Type of respiration	Mainly anaerobic	Mainly aerobic
Glycogen	High concentration	Low concentration
Capillaries	Few	Many

Use information from the table to suggest and explain **one** advantage of:

(i) the high glycogen content of fast muscle fibres

.....

.....

.....

.....

(2)

(ii) the number of capillaries supplying slow muscle fibres.

.....

.....

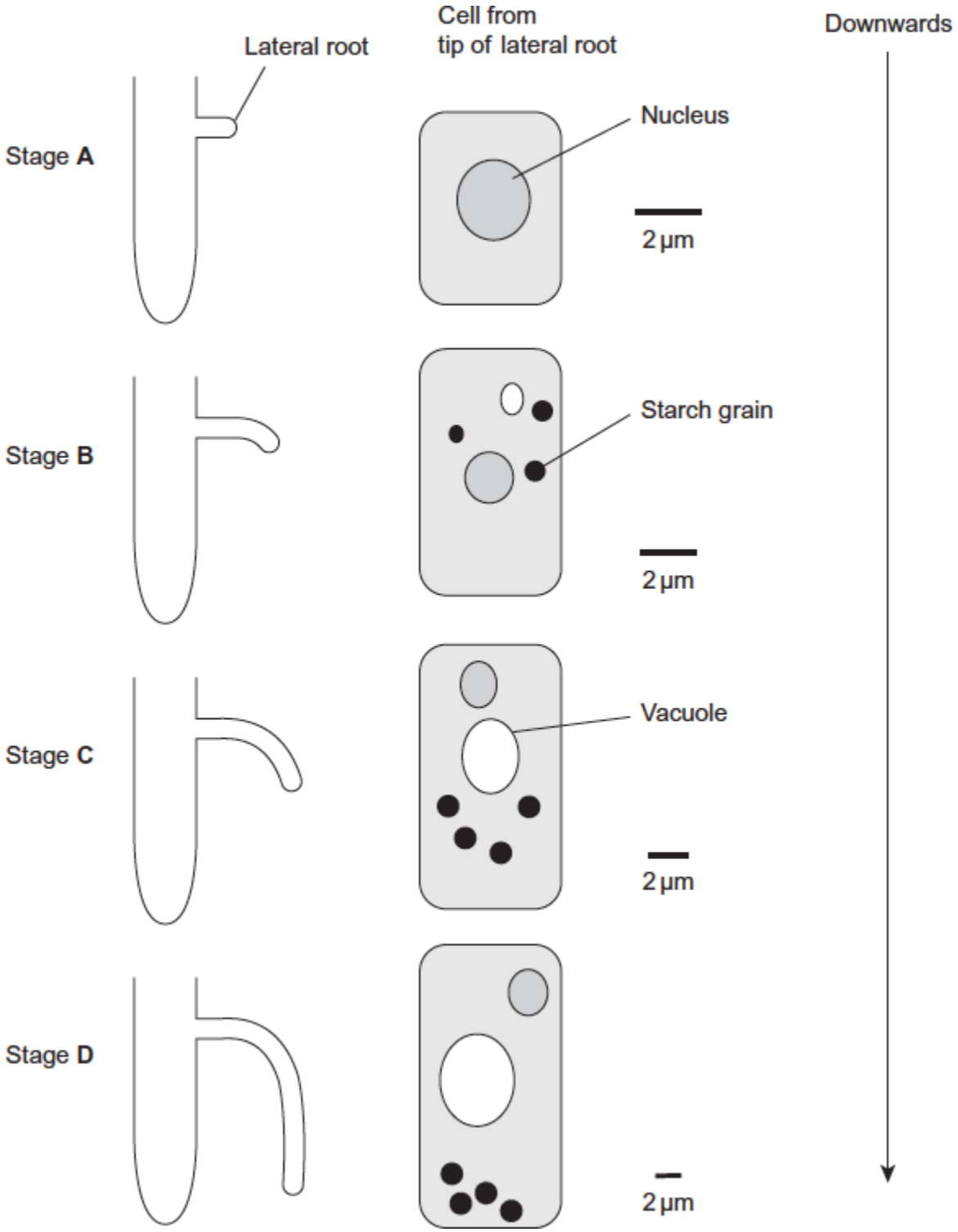
.....

.....

(2)
(Total 8 marks)

2 Scientists investigated the response of lateral roots to gravity. Lateral roots grow from the side of main roots.

The diagrams show four stages, **A** to **D**, in the growth of a lateral root and typical cells from the tip of the lateral root in each stage. All of the cells are drawn with the bottom of the cell towards the bottom of the page.



(a) Describe **three** changes in the root tip cells between stages **A** and **D.**

1.....

.....

2.....

.....

3.....

.....

(3)

(b) The scientists' hypothesis was that there was a relationship between the starch grains in the root tip cells and the bending and direction of growth of lateral roots.

Does the information in the diagram support this hypothesis? Give reasons for your answer.

.....

.....

.....

.....

.....

.....

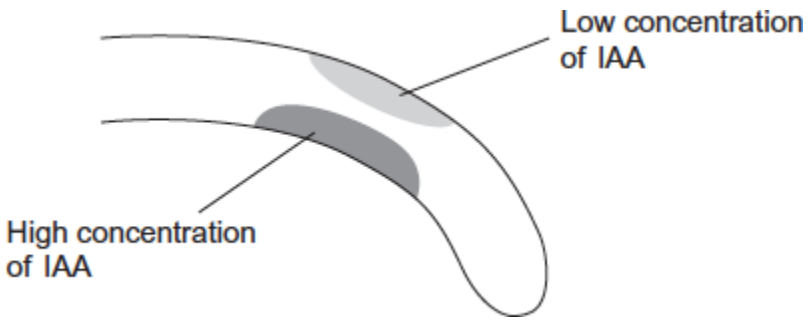
(Extra space).....

.....

.....

(3)

(c) The diagram shows the distribution of indoleacetic acid (IAA) in the lateral root at Stage **B.**



Explain how this distribution of IAA causes the root to bend.

.....

.....

.....

.....

.....

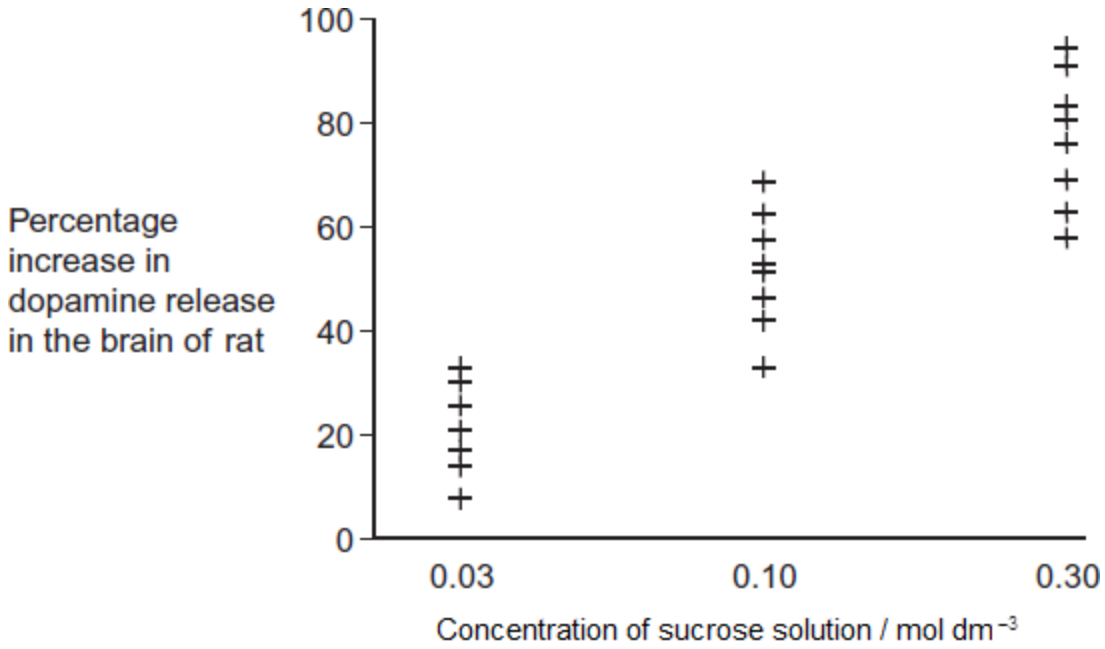
(2)
(Total 8 marks)

3 The release of a substance called dopamine in some areas of the brain increases the desire to eat.

Scientists measured increases in the release of dopamine in the brains of rats given different concentrations of sucrose solution to drink.

Sucrose stimulates taste receptors on the tongue.

The graph shows their results. Each point is the result for one rat.



(a) The scientists concluded that drinking a sucrose solution had a positive feedback effect on the rats' desire to eat.

How do these data support this conclusion?

.....

.....

.....

.....

.....

.....

(Extra space).....

.....

.....

(3)

(b) In this investigation, the higher the concentration of sucrose in a rat's mouth, the higher the frequency of nerve impulses from each taste receptor to the brain.

If rats are given very high concentrations of sucrose solution to drink, the refractory period makes it impossible for information about the differences in concentration to reach the brain. Explain why.

.....

.....

.....

.....

.....

(2)

(c) In humans, when the stomach starts to become full of food, receptors in the wall of the stomach are stimulated. This leads to negative feedback on the desire to eat. Suggest why this negative feedback is important.

.....

.....

.....

.....

.....

(Extra space).....

.....

.....

(3)
(Total 8 marks)

4 Serotonin is a neurotransmitter released in some synapses in the brain. It is transported back out of the synaptic gap by a transport protein in the pre-synaptic membrane.

(a) Serotonin diffuses across the synaptic gap and binds to a receptor on the post-synaptic membrane.

Describe how this causes depolarisation of the post-synaptic membrane.

.....

.....

.....

.....

.....

(2)

(b) It is important that a neurotransmitter such as serotonin is transported back out of synapses. Explain why.

.....

.....

.....

.....

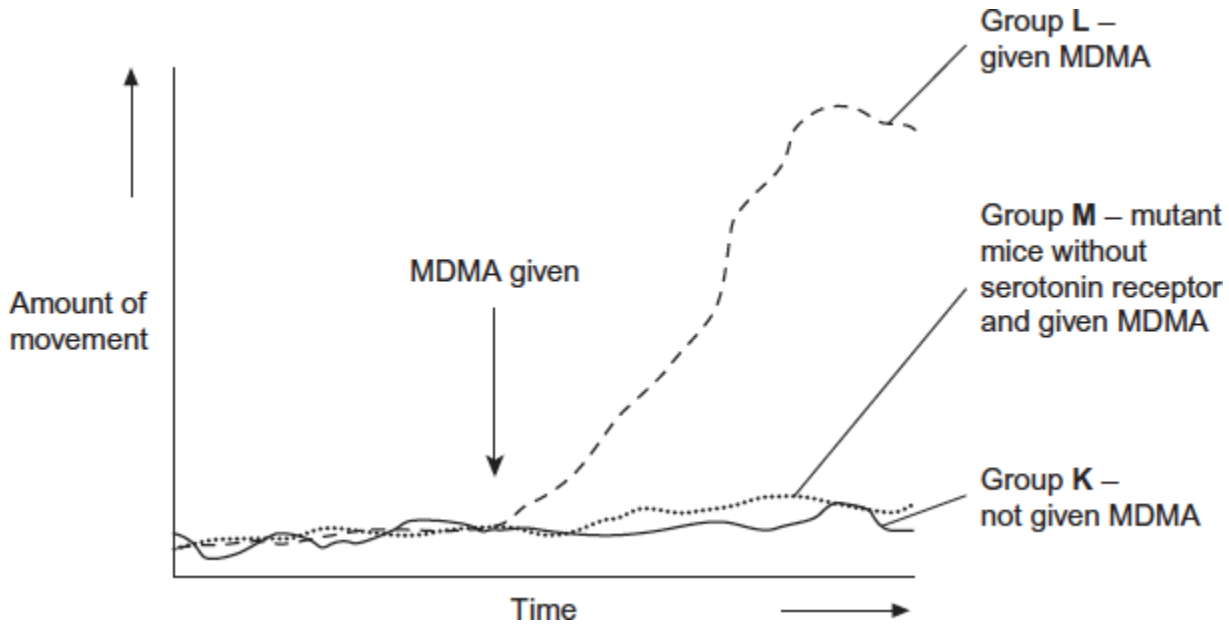
.....

(2)

(c) Scientists investigated the effect of a drug called MDMA on movement of mice. They measured the amount of movement of three groups of mice, **K, L** and **M.**

- Group **K,** mice not given MDMA.
- Group **L,** mice given MDMA.
- Group **M,** mutant mice that did not produce a serotonin receptor on their post-synaptic membranes and were given MDMA.

The graph shows their results.



The scientists concluded that MDMA affects movement by binding to serotonin receptors.

How do these results support this conclusion?

.....

.....

.....

.....

.....

.....

(Extra space).....

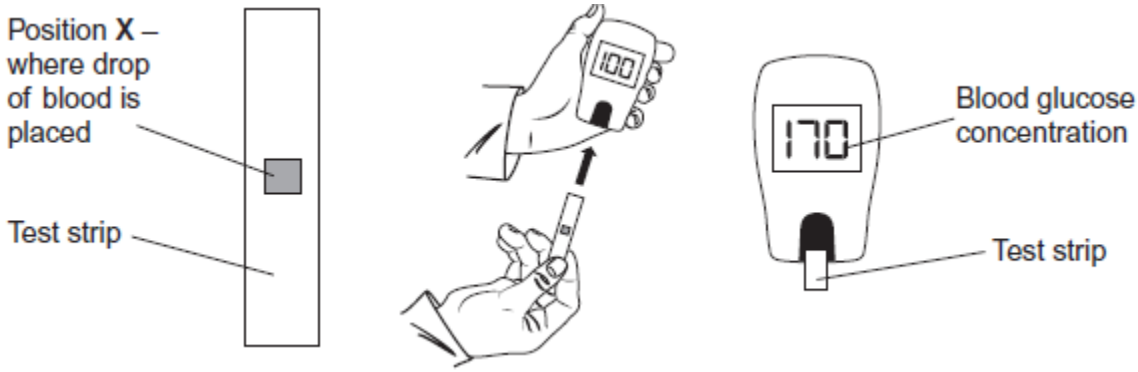
.....

.....

(3)
(Total 7 marks)

5 A glucometer is a device used to measure blood glucose concentration. A person uses a test strip that goes into the glucometer. They put a drop of blood onto the test strip. There are substances on the test strip that produce a colour change with glucose. The higher the concentration of glucose, the deeper the colour produced. The glucometer measures the depth of colour produced and converts this into a glucose concentration. A new test strip is used for each blood test.

Figure – glucometer and test strip



The following equations show how the substances on the test strip produce a colour change.

$$\text{Glucose + oxygen} \xrightarrow{\text{Glucose oxidase}} \text{gluconic acid + hydrogen peroxide}$$

$$\text{Hydrogen peroxide + dye with colour A} \xrightarrow{\text{Peroxidase}} \text{dye with colour B + water}$$

Non-diabetics have no glucose in their urine. Diabetics have glucose in their urine if their blood glucose concentration rises above about 170 mg 100 cm^{-3}.
Before the glucometer was available, diabetics used test strips to measure the concentration of glucose in their urine as a means of measuring their blood glucose concentration. When testing urine, the colour of the test strip is compared against a colour chart which gives a glucose concentration range for the colour produced.

(a) Identify all the substances located at position **X** on the test strip before a drop of blood is added.

.....

.....

.....

.....

.....

(2)

(b) Before the glucometer was available, diabetics used test strips to measure the concentration of glucose in their urine as a means of measuring their blood glucose concentration.

Give **two** reasons why this method of testing urine would **not** give an accurate measurement of blood glucose concentration.

1 .....

.....

2 .....

.....

(2)
(Total 4 marks)

6 There are two types of diabetes: type 1 and type 2.

- People with type 1 diabetes do not produce enough insulin.
- People with type 2 diabetes do produce insulin but have cells which do not respond to insulin.

Doctors use a glucose tolerance test to help diagnose people with diabetes. They start each test after a person has not eaten overnight. They measure a person's blood glucose concentration. The person then drinks a solution containing 75 g of glucose. The doctors measure the person's blood glucose concentration 2 hours later. During the test, the person remains at rest.

Figure 1 shows three diagnoses that can be made from the results of the test.

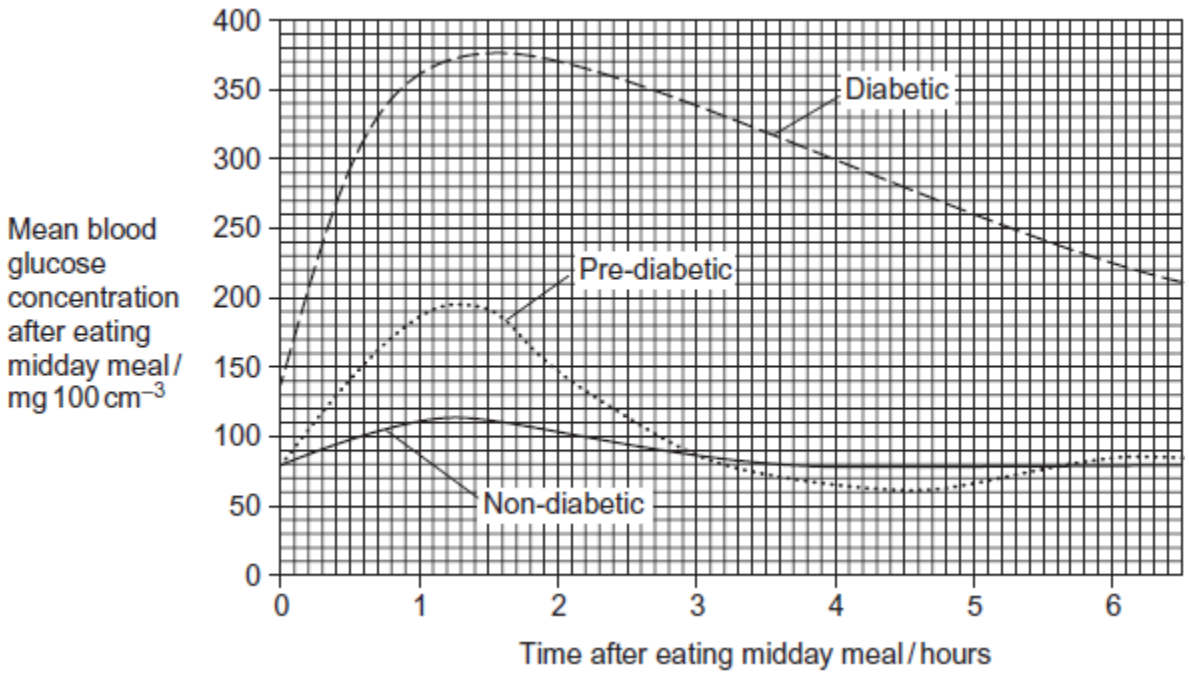
Figure 1 – glucose tolerance test results and diagnoses

Blood glucose concentration after 2 hours / mg 100 cm^{-3}	**Diagnosis**	**Comments**
≤ 110	Non-diabetic	Low risk for future diabetes
Between 140 and 200	Pre-diabetic	High risk for future diabetes. Some doctors recommend that the upper value should be lowered to 180 mg 100 cm^{-3}
≥ 200	Diabetic	Confirm by doing a second test

A researcher monitored the mean blood glucose concentration of a non-diabetic, a pre-diabetic and a diabetic after they had each eaten a midday meal.

His results are shown in **Figure 2**.

Figure 2



(a) People with type 1 diabetes are described as being insulin-dependent.
Suggest why they are described as insulin-dependent.

.....

.....

.....

(1)

(b) Some people with type 2 diabetes have cells which do **not** respond to insulin.
Explain how this leads to a reduced ability to regulate blood glucose concentration.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)

(c) During a glucose tolerance test the person remains at rest.
Why is it important that the person remains at rest?

.....

.....

.....

.....

.....

(2)

(d) Use **Figure 2** to calculate how many times the maximum mean blood glucose concentration of the pre-diabetic is greater than the maximum of the non-diabetic person.
Show your working.

Answer = ...

(2)

(e) Give **three** differences between the method used by the researcher to obtain the results in **Figure 2** and the method doctors use to carry out a glucose tolerance test.

1 .....

.....

2 .....

.....

3 .....

.....

(3)

(f) Some doctors have recommended that the upper value used in the glucose tolerance test should be lowered to 180 mg 100 cm^{-3}.
Using information from **Figure 1** and **Figure 2**, suggest why.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

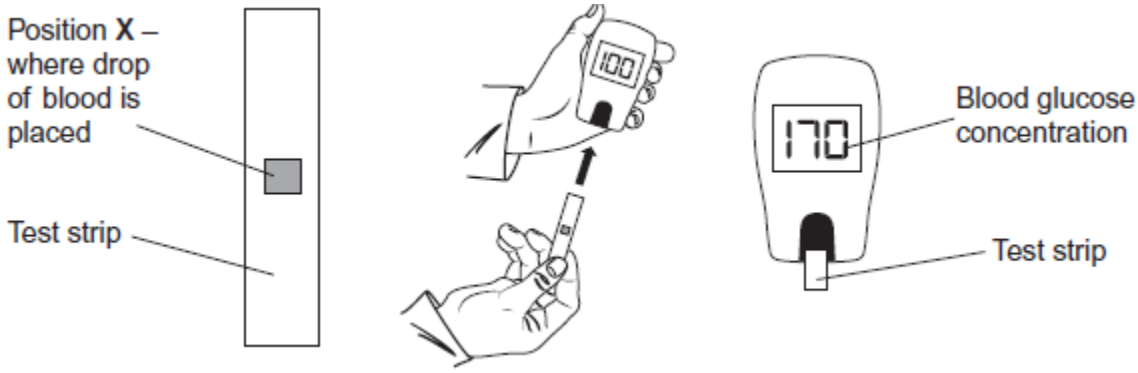
(3)
(Total 14 marks)

7

Resource A

A glucometer is a device used to measure blood glucose concentration. A person uses a test strip that goes into the glucometer. They put a drop of blood onto the test strip. There are substances on the test strip that produce a colour change with glucose. The higher the concentration of glucose, the deeper the colour produced. The glucometer measures the depth of colour produced and converts this into a glucose concentration. A new test strip is used for each blood test.

Figure 1 – glucometer and test strip



The following equations show how the substances on the test strip produce a colour change.

$$\text{Glucose + oxygen} \xrightarrow{\text{Glucose oxidase}} \text{gluconic acid + hydrogen peroxide}$$

$$\text{Hydrogen peroxide + dye with colour A} \xrightarrow{\text{Peroxidase}} \text{dye with colour B + water}$$

Non-diabetics have no glucose in their urine. Diabetics have glucose in their urine if their blood glucose concentration rises above about 170 mg 100 cm^{-3}.
Before the glucometer was available, diabetics used test strips to measure the concentration of glucose in their urine as a means of measuring their blood glucose concentration. When testing urine, the colour of the test strip is compared against a colour chart which gives a glucose concentration range for the colour produced.

Resource B

There are two types of diabetes: type 1 and type 2.

- People with type 1 diabetes do not produce enough insulin.
- People with type 2 diabetes do produce insulin but have cells which do not respond to insulin.

Doctors use a glucose tolerance test to help diagnose people with diabetes. They start each test after a person has not eaten overnight. They measure a person's blood glucose concentration. The person then drinks a solution containing 75 g of glucose. The doctors measure the person's blood glucose concentration 2 hours later. During the test, the person remains at rest.

Figure 1 shows three diagnoses that can be made from the results of the test.

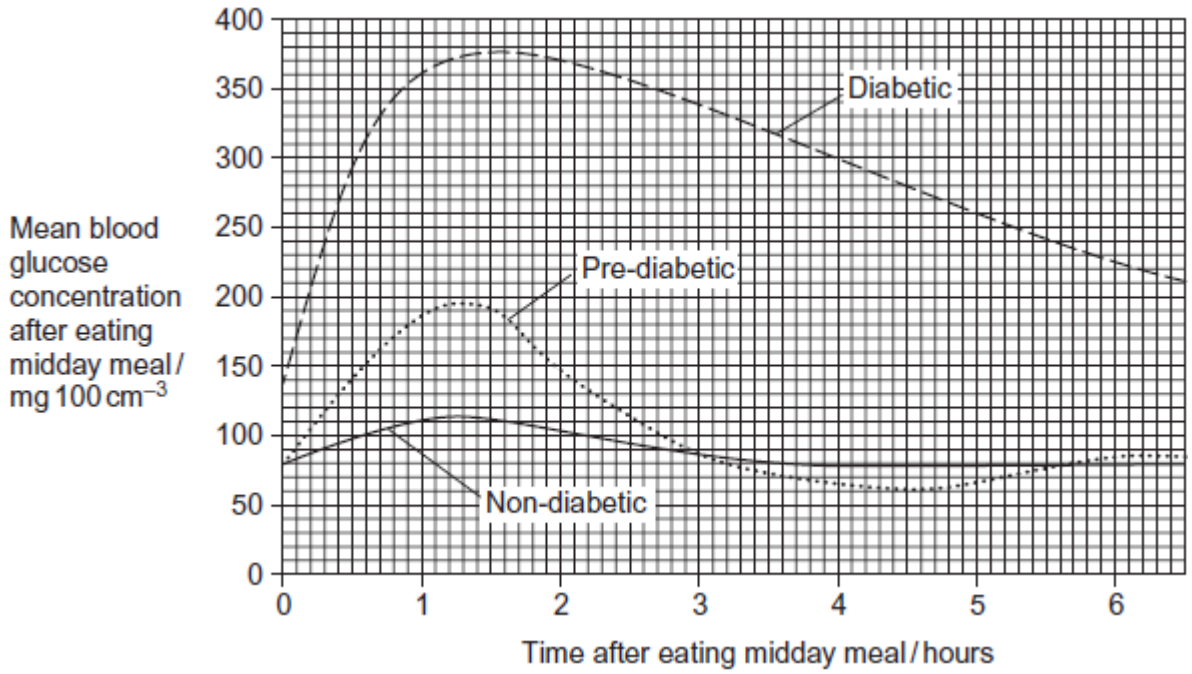
Figure 2 – glucose tolerance test results and diagnoses

Blood glucose concentration after 2 hours / mg 100 cm^{-3}	Diagnosis	Comments
≤ 110	Non-diabetic	Low risk for future diabetes
Between 140 and 200	Pre-diabetic	High risk for future diabetes. Some doctors recommend that the upper value should be lowered to 180 mg 100 cm^{-3}
≥ 200	Diabetic	Confirm by doing a second test

A researcher monitored the mean blood glucose concentration of a non-diabetic, a pre-diabetic and a diabetic after they had each eaten a midday meal.

His results are shown in **Figure 3**.

Figure 3



A laboratory worker suspected she had type 2 diabetes but did not have a glucometer. Instead she added a drop of her blood to a test strip and used a colour chart to estimate her blood glucose concentration as 140 mg 100 cm^{-3}.

Is it valid to conclude that she did have type 2 diabetes?

Use this information, and **Resource A** and **Resource B**, to explain your answer.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(Total 3 marks)

8 Some people have a condition called *white-coat hypertension*. People with this condition develop a higher than normal heart rate and blood pressure when they are in a doctor's surgery. High heart rate is correlated with high blood pressure.

Doctors investigated differences in heart rate between men *with white-coat hypertension* and those without the condition. They measured the men's mean heart rates:

- in the doctor's surgery, by recording the pulse in the wrist for 1 minute, when the men were lying down
- at home, using a portable heart rate monitor when the men were walking around
- at home, using a portable heart rate monitor when the men were sleeping.

(a) The groups of men selected for this investigation were matched.

Other than being men, suggest **one** factor for which they should have been matched.

.....

(1)

(b) Explain why the pulse recordings in the doctor's surgery were taken when the men were lying down.

.....

.....

.....

(1)

(c) The pulse felt in the artery in the wrist can be recorded and used to measure heart rate.

Suggest why the pulse felt can be used to measure heart rate.

.....

.....

.....

.....

.....

(2)

(d) The portable heart rate monitor recorded the men's heart rates continuously. This gave more reliable mean heart rates than those obtained by recording the pulse in the wrist for 1 minute.

Suggest why it is more reliable.

.....

.....

.....

.....

.....

(2)

(e) The table shows the doctors' results.

Where and how heart rate was measured	Mean heart rate / beats per minute	
	Men with white-coat hypertension	Men without white-coat hypertension
Doctor's surgery, recording pulse when lying down	67	63
At home, walking around, using heart monitor	76	73
At home, sleeping, using heart monitor	63	60

A journalist, who saw these results, stated that they showed there is no such thing as *white-coat hypertension*.

Do these data support this statement? Give reasons for your answer.

.....

.....

.....

.....

.....

(2)
(Total 8 marks)

9 The heart controls and coordinates the regular contraction of the atria and ventricles. Describe how.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total 5 marks)

10 The black mamba is a poisonous snake. Its poison contains a toxin.

The table shows the base sequence of mRNA that codes for the first two amino acids of this toxin.

Base sequence of anticodon on tRNA						
Base sequence of mRNA	**A**	**C**	**G**	**A**	**U**	**G**
Base sequence of DNA						

Complete the table to show

(a) (i) the base sequence of the anticodon on the first tRNA molecule that would bind to this mRNA sequence

(1)

(ii) the base sequence of the DNA from which this mRNA was transcribed.

(1)

(b) The length of the section of DNA that codes for the complete toxin is longer than the mRNA used for translation. Explain why.

.....

.....

.....

(1)

(c) A mutation in the base sequence of the DNA that codes for the toxin would change the base sequence of the mRNA.

Explain how a change in the base sequence of the mRNA could lead to a change in the tertiary structure of the toxin.

.....

.....

.....

(1)

(d) The black mamba's toxin kills prey by preventing their breathing. It does this by inhibiting the enzyme acetylcholinesterase at neuromuscular junctions. Explain how this prevents breathing.

.....

.....

.....

.....

.....

.....

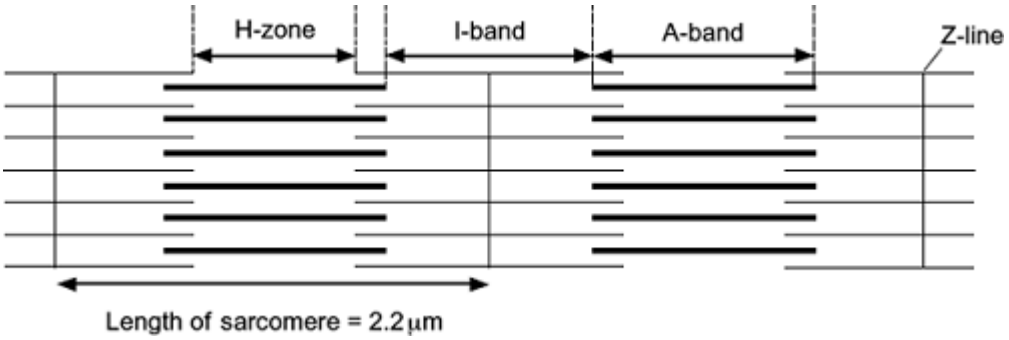
(Extra space) .....

.....

.....

(3)
(Total 7 marks)

11 The diagram shows two relaxed sarcomeres from skeletal muscle.



(a) When the sarcomeres contract, what happens to the length of

(i) the I-band

.....

(1)

(ii) the A-band?

.....

(1)

(b) The length of each sarcomere in the diagram is 2.2 μm. Use this information to calculate the magnification of the diagram. Show your working.

Magnification .....

(2)

(c) People who have McArdle's disease produce less ATP than healthy people. As a result, they are not able to maintain strong muscle contraction during exercise. Use your knowledge of the sliding filament theory to suggest why.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)
(Total 7 marks)

12 (a) Increased intensity of exercise leads to an increased heart rate. Explain how.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

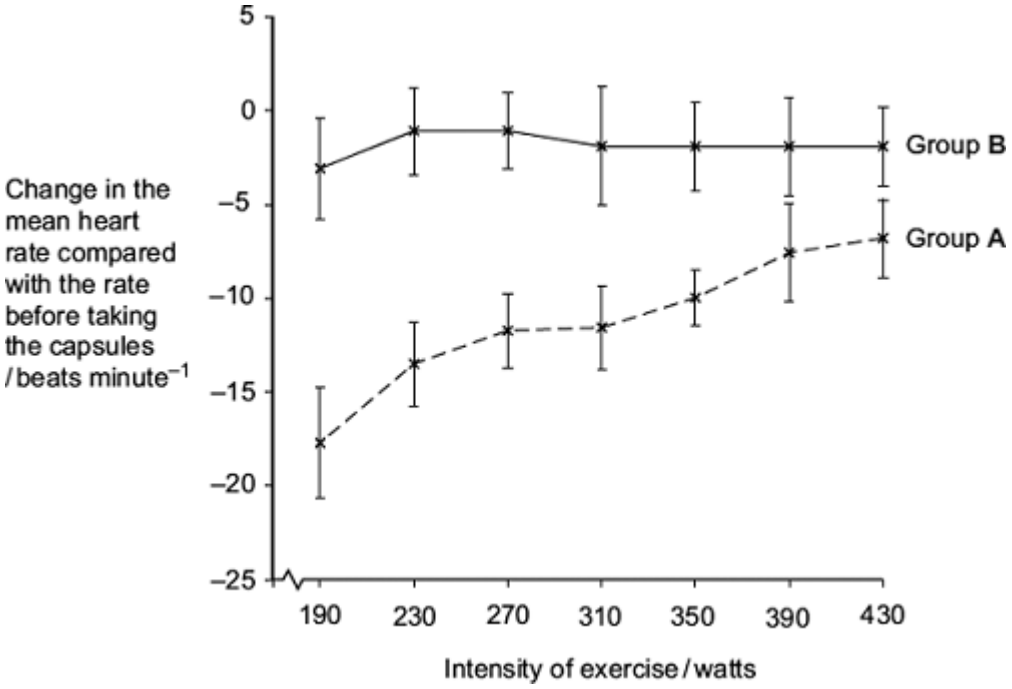
.....

(3)

(b) Scientists investigated the effect of taking omega- fatty acids in fish oil on heart rate during exercise. They recruited two large groups of volunteers, **A** and **B**. For each group, they measured the mean heart rates at different intensities of exercise. The volunteers were then given capsules to take for 8 weeks.

- Group **A** was given capsules containing omega-3 fatty acids in fish oil.
- Group **B** was given capsules containing olive oil.

After 8 weeks, they repeated the measurements of mean heart rates at different intensities of exercise. The graph shows their results. The bars represent the standard deviations.



(i) Group **B** was given capsules containing olive oil. Explain why.

.....

.....

.....

(1)

(ii) The scientists concluded that omega-3 fatty acids lower the heart rate during exercise.
Explain how the information in the graph supports this conclusion.

.....

.....

.....

.....

.....

.....

(Extra space) .....

.....

.....

(3)
(Total 7 marks)

13 (a) Adrenaline binds to receptors in the plasma membranes of liver cells. Explain how this causes the blood glucose concentration to increase.

.....

.....

.....

.....

.....

(Extra space) .....

.....

(2)

(b) Scientists made an artificial gene which codes for insulin. They put the gene into a virus which was then injected into rats with type I diabetes. The virus was harmless to the rats but carried the gene into the cells of the rats.

The treated rats produced insulin for up to 8 months and showed no side-effects. The scientists measured the blood glucose concentrations of the rats at regular intervals. While the rats were producing the insulin, their blood glucose concentrations were normal.

(i) The rats were not fed for at least 6 hours before their blood glucose concentration was measured. Explain why.

.....

.....

.....

(1)

(ii) The rats used in the investigation had type I diabetes. This form of gene therapy may be less effective in treating rats that have type II diabetes. Explain why.

.....

.....

.....

(1)

(iii) Research workers have suggested that treating diabetes in humans by this method of gene therapy would be better than injecting insulin. Evaluate this suggestion.

.....

.....

.....

.....

.....

.....

.....

.....