OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

HUMAN BIOLOGY

Genetics, Control and Ageing

F225

Candidates answer on the question paper.

OCR supplied materials:
None

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Monday 13 June 2011
Afternoon

Duration: 1 hour 45 minutes

* F 2 2 5 *

* F 2 2 5 1 6 8 1 0 6 1 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **100**.

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **28** pages. Any blank pages are indicated.

Answer **all** the questions.

1 Fig.1.1 is a photomicrograph in which the white areas show damage to the endocrine tissue in a person with Type 1 diabetes mellitus.

The dark areas contain cells which release digestive enzymes. These cells are unaffected by Type 1 diabetes mellitus.

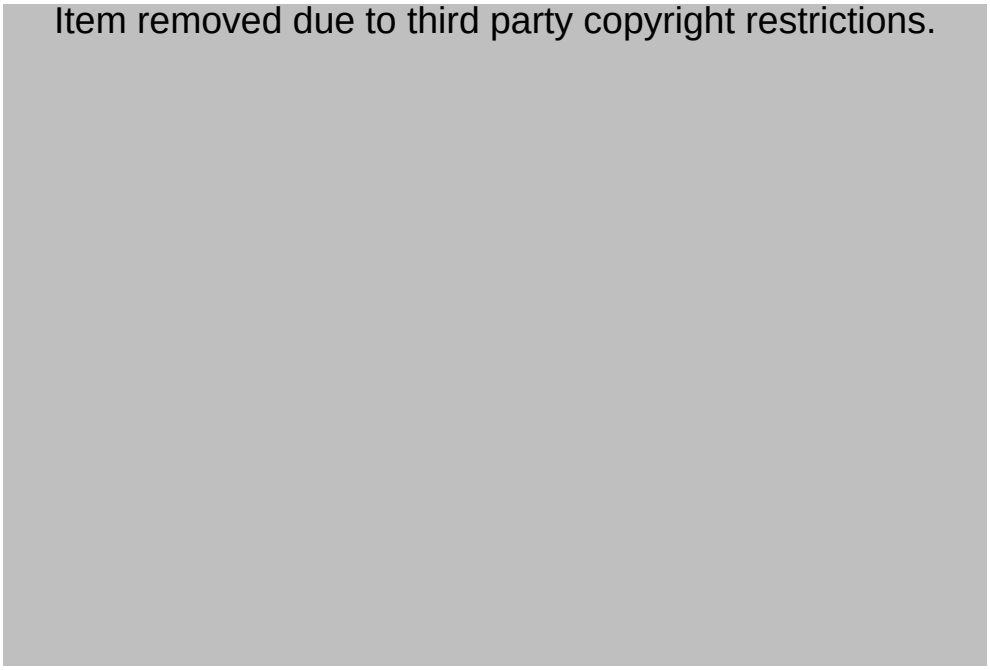

Fig. 1.1

(a) Name the organ from which the tissue sample was taken and name the cells which would normally be found in the white areas.

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(b) People with Type 1 diabetes mellitus control their blood glucose concentration by injecting the hormone insulin. Insulin is transported to its target tissues by the blood plasma.

Describe the effect of insulin on its target tissues.

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(c) Human placental lactogen (HPL) is a hormone released during pregnancy.

- HPL **decreases** the sensitivity of maternal tissues to insulin.
- HPL results in an **increase** in maternal blood glucose.
- HPL stimulates the breakdown of fats and the release of fatty acids.

A study was carried out to investigate the effect of increasing blood glucose concentration on insulin secretion in a large sample of pregnant and non-pregnant women.

Fig. 1.2 summarises the results of this study.

The data points on the graph are drawn with error bars.

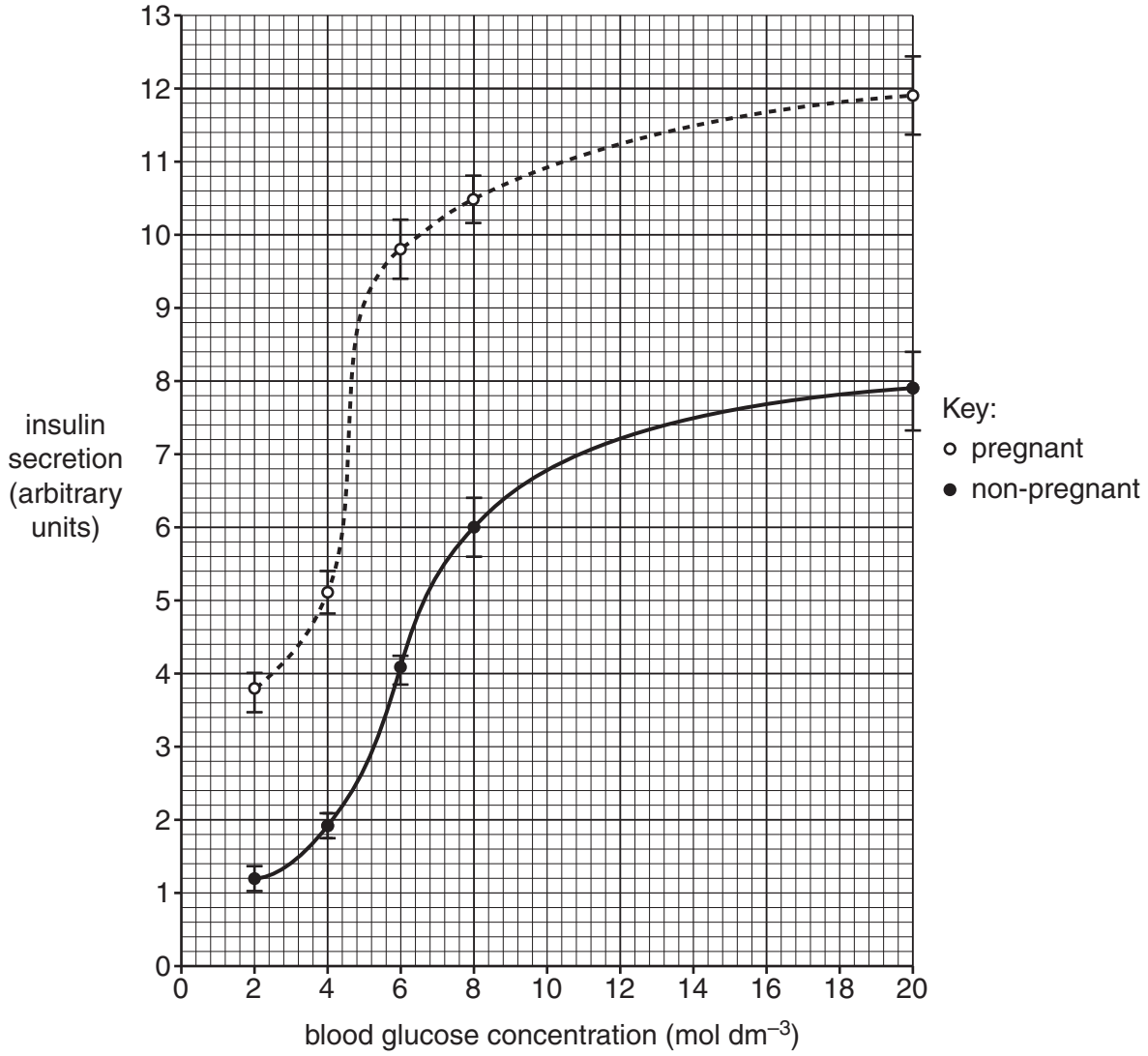

Fig. 1.2

(i) State what each data point represents and suggest what the error bars indicate about the data.

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(ii) Using Fig.1.2, compare the response to rising levels of blood glucose in pregnant and non-pregnant women.

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(iii) The effects of HPL on maternal glucose metabolism are advantageous to the fetus.

Suggest an advantage to the fetus **and** give a reason for your suggestion.

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(d) HPL can result in pregnant women displaying some symptoms of diabetes. This condition is referred to as **gestational diabetes mellitus**.

Type 2 diabetes mellitus is becoming increasingly common in the UK population.

Discuss the similarities and differences between Type 2 diabetes mellitus and gestational diabetes mellitus.

similarities .....

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differences .....

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[Total: 20]

2 Modern intensive farming techniques require the use of many types of chemicals, including insecticides.

Some insecticides work by affecting synapses in insect nervous systems and may also have a similar effect on the human nervous system.

(a) Describe the role of **acetylcholine** in synaptic transmission in humans.

In your answer you should make clear the direction of any movement of substances into and out of neurones.

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(b) A group of insecticides known as neonicotinoids act by mimicking the effect of acetylcholine at the synapse in insects.

Unlike acetylcholine, these insecticides are not broken down by acetylcholinesterase.

(i) Suggest why neonicotinoids are not broken down by acetylcholinesterase.

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(ii) Suggest why insects exposed to neonicotinoids exhibit tremors and uncoordinated movements, leading to death.

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(c) Concern has been expressed about the possible effect of neonicotinoids on wildlife, particularly on honey bees. A condition known as Colony Collapse Disorder (CCD) has been attributed to the increase use of neonicotinoid insecticides.

The following statements have been made by two groups with an interest in CCD.

> Widespread colony collapse was first seen in France in July 1994, a few days after the sunflowers came into bloom. This coincided with the use of a new neonicotinoid insecticide to treat sunflower seeds. Honey production in France fell from 110000 tonnes in 1996 to 50000 tonnes in 1999. The National Union of French Beekeepers reported that a third of the country's honey bee colonies had disappeared.
>
> *Extract from Organic Growers Group Bee Briefing Sheet*

> **INDEPENDENT TRIALS CONFIRM THE SAFETY OF NEONICOTINOIDS TO BEES**
> There is strong scientific evidence to show that neonicotinoids, when used as seed or soil treatment, is completely safe to bees. Other studies show that the real negative impact on French bees has been the increase in Varroa mite parasite numbers (a lethal pest in bee hives) and unfavourable weather conditions in recent years.
>
> *Extract from Agrochemical Company Newsletter*

(i) An investigation on the impact of neonicotinoid use on honey bees is to be carried out.

Using the information provided in the two statements, identify one independent, one dependent and two control variables that need to be considered in this investigation.

independent .....

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dependent .....

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control variable 1 .....

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control variable 2 .....

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(ii) Discuss briefly the consequences for society, other than **loss of honey production**, of a decline in populations of honey bees.

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[Total: 17]

3 Phenylketonuria (PKU) is a genetic disease which results in the appearance of excessive amounts of phenylacetate in the urine. Phenylacetate is a breakdown product of the amino acid phenylalanine.

PKU is inherited as an autosomal recessive mutation of the gene coding for the enzyme phenylalanine hydroxylase (PAH).

(a) Explain what is meant by the term *autosomal recessive*.

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(b) Complete the genetic diagram below to show how two parents who do not have PKU can have some children who have PKU and some children who do not.

Use the letters **G** and **g** to represent the alleles.

parental phenotypes:	no PKU	no PKU
parental genotypes:	……..	…….
gametes:	……..	…….

children genotypes …….

children phenotypes …….

[4]

(c) Many different mutations have been described within the PAH gene.

The most common mutation leads to an exon being missed out when the messenger RNA is transcribed. The sections of mRNA (the transcripts) are then joined together (spliced) and translated.

(i) State what is meant by the term *exon*.

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(ii) Describe what difference the missing out of this exon would make to the mRNA transcript **and** suggest what effect this would have on the protein translated from this transcript.

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(iii) Some mutations of the PAH gene lead to mild forms of PKU. The mutation in the case of the mild form of PKU is a single base substitution.

The amino acid arginine is replaced by the amino acid glutamine in PAH.

Table 3.1 shows the triplet codes for the two amino acids, arginine and glutamine.

Table 3.1

amino acid	DNA triplet
arginine	GCA
arginine	GCG
arginine	GCT
arginine	GCC
arginine	TCT
arginine	TCC
glutamine	GTT
glutamine	GGC

Using the information in Table 3.1, explain how a *single base substitution* can replace arginine with glutamine in PAH.

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(d) The prevalence of some inherited diseases is known to vary in different parts of the world. One example is the prevalence of sickle cell anaemia. The prevalence of classical PKU in populations is also known to vary in different parts of the world.

- The prevalence rates for PKU in Europe is up to 10 times higher than that in areas such as Sub-Saharan Africa.
- Individuals who carry the allele for PKU are known to be more resistant to a toxin produced by a mould.
- Moulds are less common in dry regions such as Sub-Saharan Africa.

Suggest and explain the mechanism which has resulted in the prevalence of PKU being different in European and Sub-Saharan populations.

In your answer you should use the information provided to illustrate the mechanism described.

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(e) All babies born in the United Kingdom are tested for PKU. A blood sample is taken and tested in the laboratory for high levels of phenylalanine in the blood plasma.

Suggest **two** precautions that should be taken when obtaining a blood sample for a PKU test.

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[Total: 21]

QUESTION 4 STARTS ON PAGE 16

4 This question is about the organisation of the nervous system.

(a) Complete the following passage about the organisation of the human nervous system.

The human nervous system can be sub-divided into the peripheral nervous system and the .....…….....…… nervous system which consists of the .....…….....…… and the .....…….....…… ..... . The peripheral nervous system consists of .....…….....…… and motor neurones and the motor neurones can be further divided between the autonomic nervous system and the .....…….....…… nervous system. The autonomic nervous system carries nerve impulses to the internal organs and is responsible for the contraction of .....…….....…… muscle in organs such as the .....…….....…… in the respiratory system. The autonomic nervous system has two parts. The .....…….....…… branch acts to arouse the body while the .....…….....…… acts to relax and restore the body to normal levels of arousal. **[9]**

(b) Outline **and** explain the effects of ageing on the **peripheral** nervous system with respect to both hearing and vision.

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[Total: 14]

QUESTION 5 STARTS ON PAGE 18

5 The control of body temperature is an important part of homeostasis. The accepted value for human body temperature is 37° C. Body temperature does not vary significantly despite extreme variations in environmental temperature in different parts of the world.

(a) Explain **why** body temperature must be kept close to 37° C in humans.

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(b) An experiment was carried out to investigate how quickly humans can adapt to high environmental temperatures.

A group of fit volunteers was subjected to repeated sessions of exposure to high temperature over a period of 9 days.

- Body temperature was measured using a temperature probe inserted into the ear.
- Sweat loss was estimated by measuring the loss of body mass during the period of heat exposure.
- The time between the start of exposure to the high temperature and the onset of sweating was also measured.

(i) Explain why measuring body temperature in the ear rather than in the mouth or at the skin surface gives a more accurate value.

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(ii) Suggest why measuring loss of body mass will only provide an **estimate** of the loss of water due to sweating.

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QUESTION 5(c) STARTS ON PAGE 20

(c) Fig. 5.1 shows the results of the investigation over the nine day period.
Fig. 5.1 (a) shows the mean mass lost due to sweating.

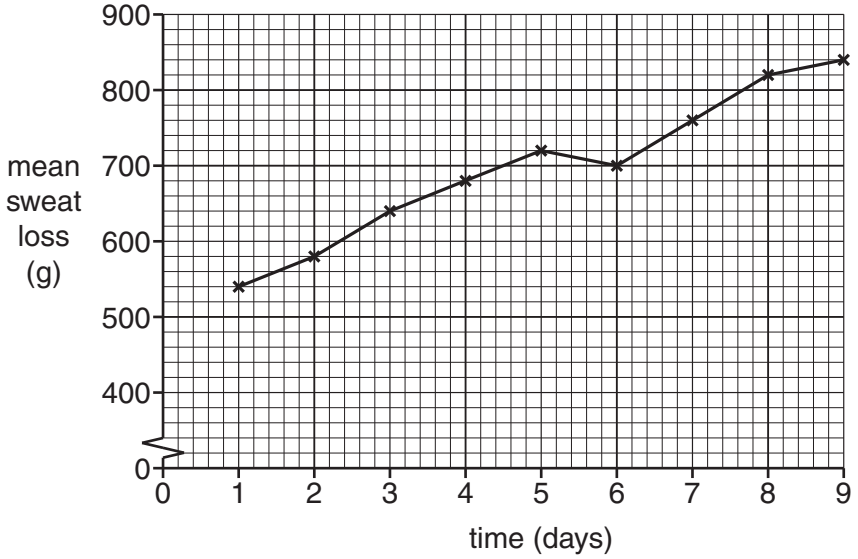


Fig. 5.1 (b) shows the mean ear temperature.

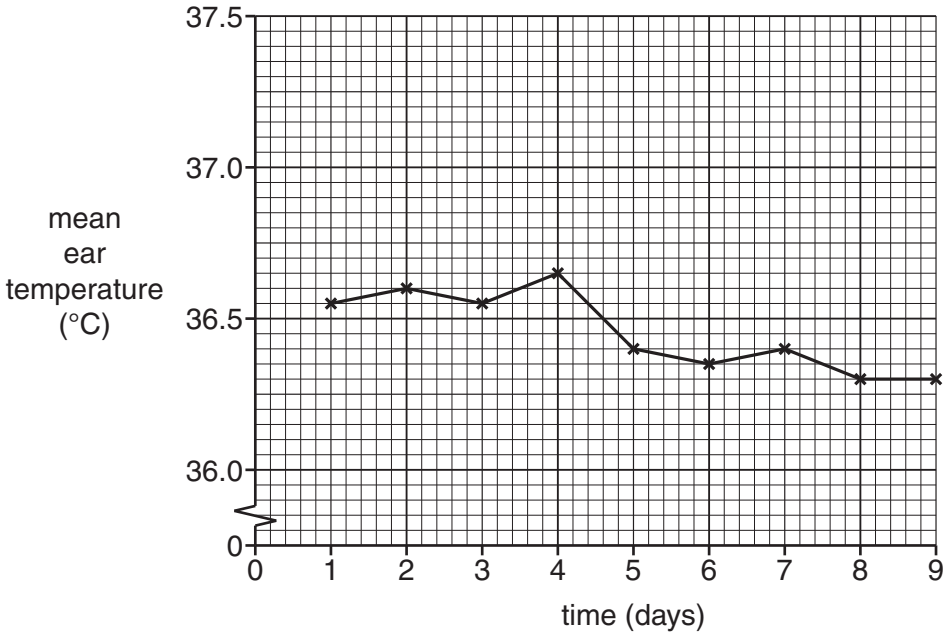
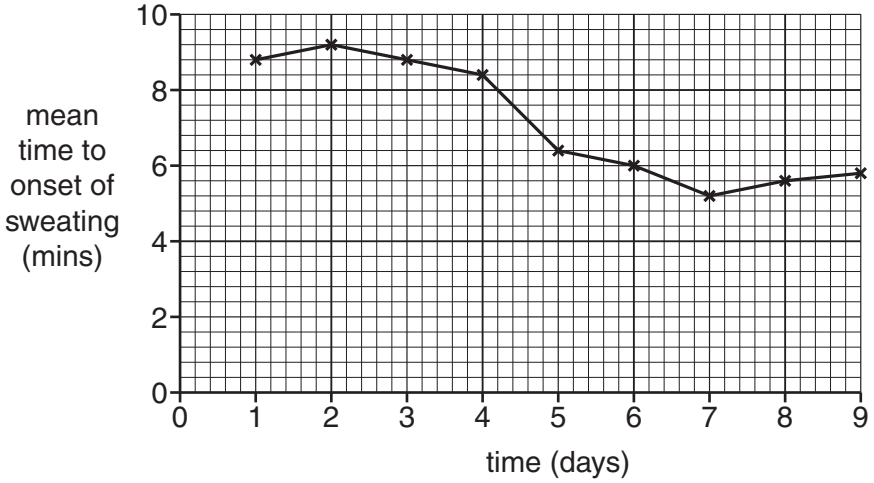


Fig. 5.1 (c) shows the mean time to the onset of sweating.



Using the information in Figs. 5.1 (a), (b) and (c), suggest how the body responds when exposed to high temperatures over a nine day period.

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(d) Two of the volunteers in the original group withdrew from the experiment on the advice of the medical supervision team. This was because they had failed to adapt successfully to repeated exposure to high temperatures.

Suggest what **signs** and **symptoms** may have been recorded by the medical supervision team that resulted in the two volunteers being advised to withdraw from the experiment.

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[Total: 14]

QUESTION 6 STARTS ON PAGE 22

6 Most nitrogenous waste is excreted from the body dissolved in urine. There are several compounds present in urine that are classed as nitrogenous waste such as uric acid, creatinine and ammonium ions.

Table 6.1 shows the effect on the composition of a person's urine after consuming one of two diets, one diet low in protein and one diet high in protein. Both diets contained the same energy content.

Table 6.1

diet	uric acid (g)	creatinine (g)	ammonium ions (g)	substance **X** (g)	total nitrogenous waste (g)
low protein	0.09	0.58	0.42	2.51	3.60
high protein	0.18	0.60	0.49	15.52	16.79

(a) (i) Name substance **X**.

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(ii) Calculate the percentage difference in the mass of substance **X** in the urine of a person consuming a diet high in protein compared to the mass of substance **X** in the urine when consuming a low protein diet.

Show your working. Give your answer to **two decimal places**.

Answer = ... % **[2]**

(b) Explain why an increase in the amount of protein in the diet leads to an increase in substance **X** in the urine.

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(c) The effects of high protein and low protein diets on the total mass of nitrogenous waste in urine were compared.

The energy content of the two diets was the same. Energy content was a control variable to ensure the validity of the investigation.

Suggest a **biological** reason for keeping the energy content of the two diets the same.

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QUESTION 6(d) STARTS ON PAGE 24

(d) One form of diabetes can result in a decrease in the **concentration** of nitrogenous waste in urine.

Identify this form of diabetes **and** explain why it results in a decrease in the concentration of nitrogenous substances in urine.

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(e) The lungs also function as an excretory organ.

Identify one **non-nitrogenous** waste product excreted by the lungs **and** the metabolic pathway from which it is produced.

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[Total: 14]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

ADDITIONAL PAGE

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