IBO IB DIPLOMA PROGRAMME
PROGRAMME DU DIPLÔME DU BI
PROGRAMA DEL DIPLOMA DEL BI

BIOLOGY
HIGHER LEVEL
PAPER 3

Candidate number

Wednesday 12 May 2004 (morning)

1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your candidate number in the box above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options in the spaces provided. You may continue your answers on answer sheets. Write your candidate number on each answer sheet, and attach them to this examination paper and your cover sheet using the tag provided.
- At the end of the examination, indicate the letters of the Options answered in the candidate box on your cover sheet and indicate the number of answer sheets used in the appropriate box on your cover sheet.

Option D – Evolution

D1. A meteorite that struck near Murchison, Australia was analyzed for the presence of amino acids. Similar studies have been carried out on liquid samples taken from the Miller-Urey discharge experiment. The table below summarizes the results from both sources. Each dot represents a relative amount of a particular amino acid, with one dot representing a small amount and eight dots representing a large amount.

Amino Acid	Murchison Meteorite	Miller-Urey Experiment
Glycine	• • • • • • • •	• • • • • • • •
Alanine	• • • • • • • •	• • • • • • • •
α-amino-*N*-butyric Acid	• • • • • •	• • • • • • • •
α-aminoisobutyric Acid	• • • • • • • •	• • • •
Valine	• • • • • •	• • • •
Norvaline	• • • • • •	• • • • • •
Isovaline	• • • •	• • • •
Proline	• • • • • •	• •
Pipecolic Acid	• •	•
Aspartic Acid	• • • • • •	• • • • • •
N-ethylglycine	• • • •	• • • • • •
Sarcosine	• • • •	• • • • • •

[Source: C Mitchell, *Life in the Universe*, (1995), W H Freeman, pages 46–47]

(a) State the theory for which the Murchison meteorite provides evidence. *[1]*

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(b) Compare the amino acids found on the meteorite with those produced in the Miller-Urey experiment. Refer to named examples. *[3]*

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(This question continues on the following page)

(Question D1 continued)

    (c)   Suggest a conclusion from your comparison.   *[1]*

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    (d)   Outline **two** roles of RNA molecules during the pre-biotic Earth.   *[2]*

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D2. Tay-Sachs disease is an autosomal recessive disorder of the enzyme hexosaminodase. The disorder causes a build-up of fatty deposits in the brain. A child affected by the disease usually dies by the age of four. The frequency of Tay-Sachs disease (tt) in a Mediterranean population is 0.0003.

    (a)   Calculate the frequencies in the population of allele t and genotype Tt.   *[2]*

allele t: . . . .

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genotype Tt: . . . .

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    (b)   State **two** conditions required for the Hardy-Weinberg equation to be valid.   *[2]*

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D3. (a) Discuss the anatomical and biochemical evidence which suggests that humans arose from a species of ape. *[6]*

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(b) Outline the causes of variation in a population. *[3]*

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Option E – Neurobiology and Behaviour

E1. Canaries *(Serinus canarius)* search for seeds lying on the ground. Researchers investigated the average rate at which canaries found seeds on two different types of ground (grass and bare earth).

The graphs below show the mean intake rates and the percentage of time spent searching on grass or bare earth at different seed densities. Searching behaviour was defined as holding the head below the horizontal.

Key: ☐ grass ▨ bare earth
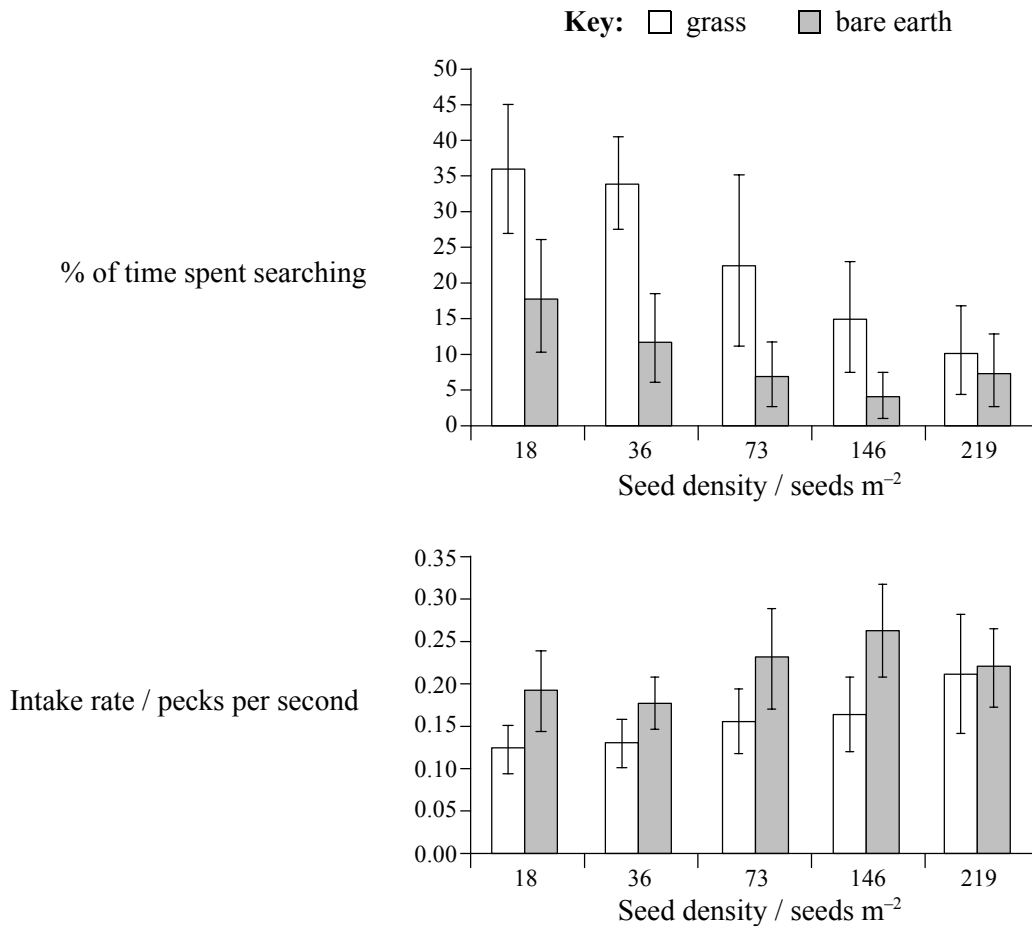
[Source: Whittingham and Markland, *Oecologia*, (2002), **130**, page 637]

(a) (i) State the relationship between the percentage of time spent searching and seed density. *[1]*

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(ii) Suggest a reason for the relationship. *[1]*

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(This question continues on the following page)

(Question E1 continued)

(b) Compare the effect of seed density on intake rate. *[2]*

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(c) Discuss the effect of surface (grass or bare earth) on the feeding behaviour of the canaries. *[2]*

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E2. (a) Distinguish between learned and innate behaviour. *[2]*

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(b) State the role of

(i) a chemoreceptor. *[1]*

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(ii) a mechanoreceptor. *[1]*

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E3. (a) Explain the role of natural selection in the development of behaviour patterns. *[6]*

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(b) Describe, giving an example, the role of altruistic behaviour in social organizations. *[4]*

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**Option F – Applied Plant and Animal Science**

F1. Glucosinolates are chemicals found in some vegetables, which are responsible for the taste of horseradish, wasabi and broccoli. There are two types of glucosinolate, aliphatic and indolyl. They have been found to have many positive health effects, including carcinogen detoxification and antioxidant properties. Different varieties of broccoli vary in their content of glucosinolates as shown in the graph below. Researchers have found that 61 % of the variation in aliphatic glucosinolate concentration is due to genetic factors compared with 12 % for indolyl glucosinolates.
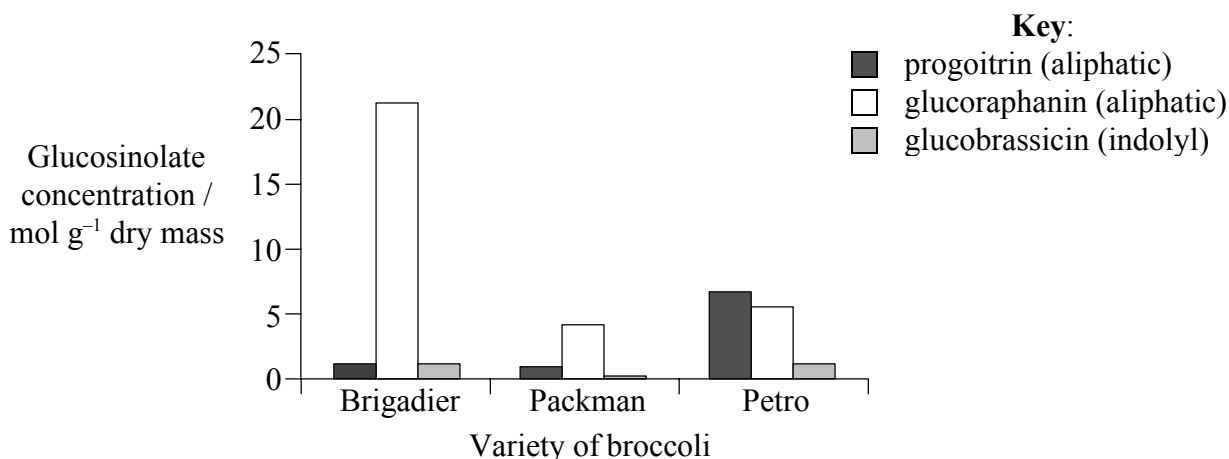
[Source: E H Jeffery *et al.*, *Nutrition Today*, (2002), **37**, page 208]

(a) Using the graph, compare the amount of aliphatic glucosinolates among the different varieties of broccoli. *[3]*

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(This question continues on the following page)

(Question F1 continued)

    (b)   Using the data, explain how outbreeding could be used to develop a new variety of broccoli with increased glucosinolate content. *[3]*

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F2.   (a)   Define the term F_1 *hybrid vigor*. *[1]*

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    (b)   Describe the advantages of using intensive animal rearing techniques. *[3]*

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F3. (a) Outline the need to maintain wild plants for use in breeding programmes.   *[4]*

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(b) Discuss the ethical issues for and against the use of transgenic plants.   *[6]*

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Option G – Ecology and Conservation

G1. Logging reduced the area of old-growth redwood (*Sequioa sempervirens*) forests from 800 000 to 300 000 hectares by the 1990s. Insects, litter spiders and other arthropods can be used to distinguish between old-growth forests, second-growth forests and tree farms. Second-growth redwood forests grow in an area following logging or other disturbances that removed the old trees. Tree farms are managed areas with uniformly aged trees of one species that are harvested by clear cutting.

The graph below shows the relative abundance of litter spiders in the study area.
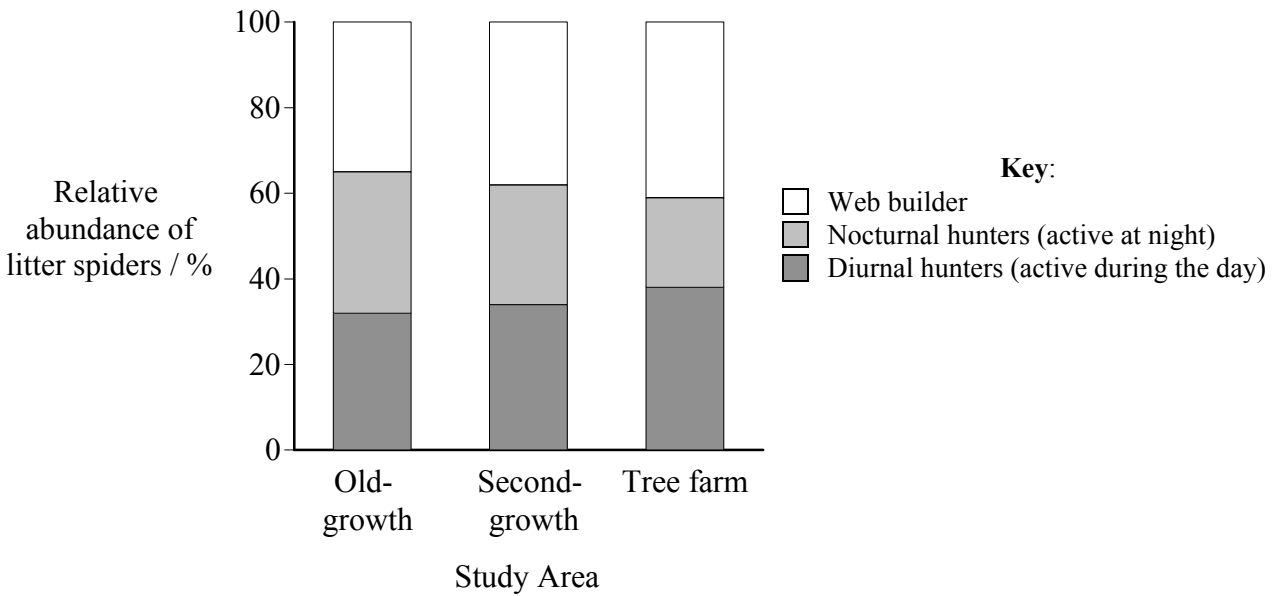
The following graph shows the relative abundance of arthropods in different trophic levels.
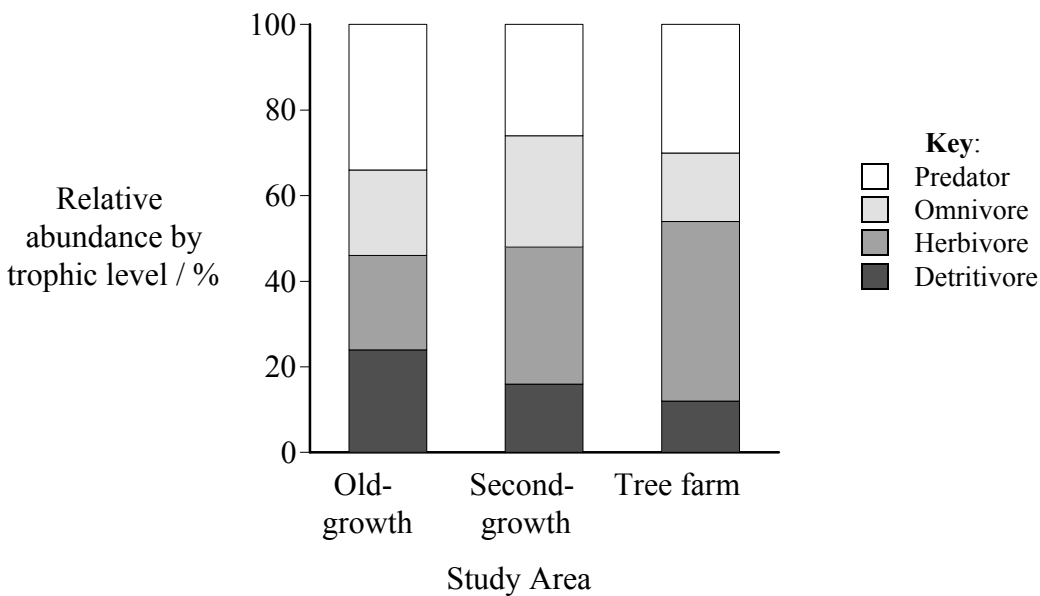
[Source: T R Willett, *Restoration Ecology*, (2001), **9**, page 410]

(This question continues on the following page)

(Question G1 continued)

(a)   Compare the relative abundance of types of litter spiders found in an old-growth forest to
        that of a second-growth forest.   *[2]*

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(b)   Compare the percentage of arthropods found in each trophic level for a second-growth forest.   *[2]*

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(c)   Explain which type(s) of organisms could be useful as indicators of old-growth redwood
        forests.   *[2]*

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G2. The following equation is the Simpson diversity index.

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

N is the total number of organisms of all species found and n is the number of individuals of a particular species.

The Simpson diversity index of two communities was measured and the results obtained are shown below.

Community A: $D = 12.3$ Community B: $D = 25.7$

(a) Outline the use of the Simpson diversity index for the above communities. *[3]*

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(b) Explain what is meant by the niche concept. *[2]*

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G3. (a) Explain the factors that affect the distribution of terrestrial animal species. *[5]*

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(b) Outline the importance of the ozone layer to living tissues and biological productivity. *[4]*

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Option H – Further Human Physiology

H1. The effect of different types of meals before exercise was tested on metabolism and performance for twelve competitive cyclists. The cyclists ingested either high fat or high carbohydrate meals before the start of exercise.

The test consisted of:
- 1 hour of cycling at half peak power (pre-load)
- followed by five × 10 minute incremental increases in intensity (load)
- and a 50 km time trial.

The concentration of various hormones in the blood plasma of the cyclists was measured. The graphs below indicate the change in insulin and glucagon levels before and during the cycling test.
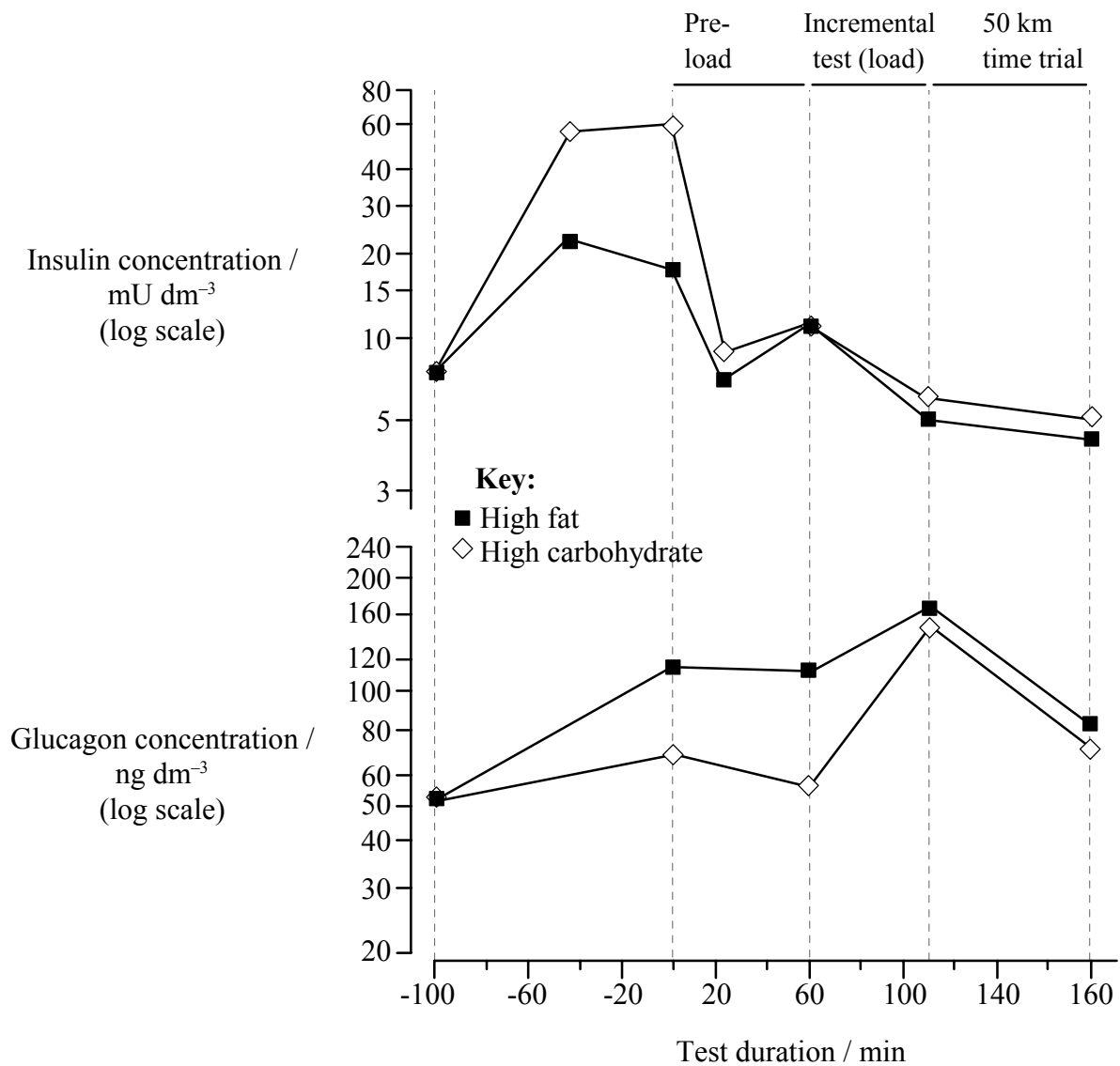
[Source: Rowlands and Hopkins, *International Journal of Sport Nutrition and Exercise Metabolism*, (2002), **12**, page 318]

(This question continues on the following page)

(Question H1 continued)

(a) Describe the changes in insulin concentration during the course of the exercise period for those cyclists who ate a high carbohydrate meal. *[2]*

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(b) Compare the changes in insulin and glucagon concentration during the pre-load and incremental test period. *[2]*

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(c) Using the data provided, outline how the changes illustrate negative feedback of insulin and glucagon. *[2]*

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H2. (a) Outline the role of the liver in the storage of nutrients. *[2]*

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(b) Explain how the body overcomes the problem of lipid digestion in the alimentary canal. *[2]*

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H3. (a) Explain the events of the cardiac cycle. *[6]*

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(b) Discuss the factors which affect the occurrence of coronary heart disease. *[4]*

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