UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/42**

Paper 4 Structured Questions A2 Core **October/November 2009**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces provided at the top of this page.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.
Circle the number of the Section B question you have answered in the grid below.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
9 or 10	
Total	

This document consists of **18** printed pages, **3** lined pages and **3** blank pages.

Section A

Answer **all** the questions.

1 All living organisms are divided into five kingdoms.

The table below lists some features possessed by living organisms and some processes that they carry out.

Place a tick or a cross in the table to indicate the presence or absence of the feature or process in any or all members of the kingdom.

The first row has been done for you.

feature or process	kingdom				
	Prokaryotae	Protoctista	Fungi	Plantae	Animalia
80s ribosomes	✗	✓	✓	✓	✓
cell walls contain chitin					
circular DNA					
endoplasmic reticulum					
most species unicellular					
autotrophic					
heterotrophic					

[6]

[Total: 6]

2 **(a)** A recent study of the house mouse, *Mus musculus*, on the island of Madeira resulted in the following observations.

- There are six distinct populations.
- The mice are associated with human settlements.
- The populations are located in different valleys separated by steep mountains.
- Each population has a different diploid number of chromosomes.

As a result of these observations it has been suggested that speciation is taking place.

Fig. 2.1 is a map of Madeira showing the distribution of the six populations.

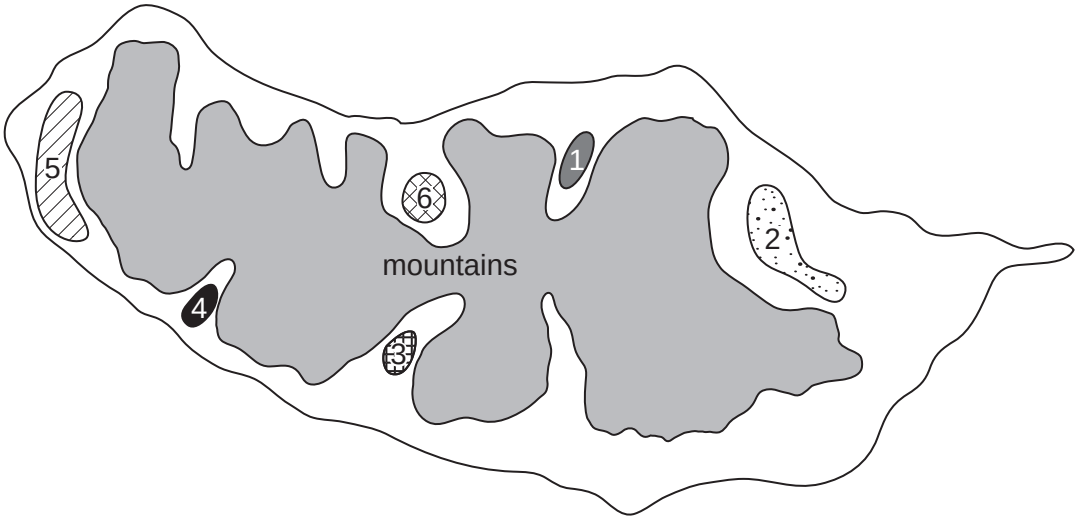

Fig. 2.1

Using the information in Fig. 2.1, state the likely isolating mechanism and the type of speciation taking place.

isolating mechanism .....

type of speciation .....[2]

(b) Explain how speciation is occurring in the house mouse populations of Madeira.

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.....[5]

[Total: 7]

3 **(a)** Cell walls of bacteria contain peptidoglycans. Peptidoglycans are long chains of the sugars N-acetylmuranic acid (NAM) and N-acetylglucosamine (NAG) which alternate along the chain. A short peptide chain of three to five amino acids is attached to each NAM and these form cross-links with similar peptide chains from adjacent strands.

Fig. 3.1 shows a diagram representing part of a peptidoglycan structure.

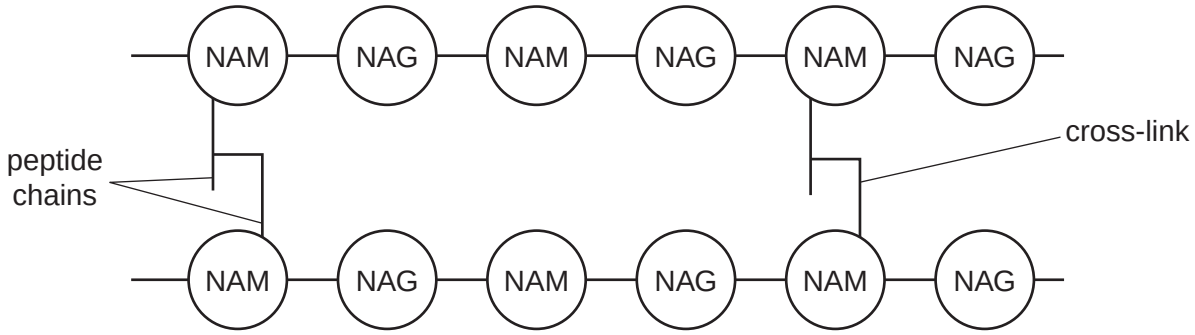

Fig. 3.1

(i) Name the type of reaction that takes place to assemble the peptide chains that form the cross-links.

.....[1]

(ii) Describe the mode of action of antibiotics, such as penicillin, on bacteria.

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(iii) Suggest the name of the type of enzyme that assembles the peptide chains that form the cross-links in peptidoglycans.

.....[1]

[Turn over

(b) State why antibiotics, such as penicillin, have no effect on viruses.

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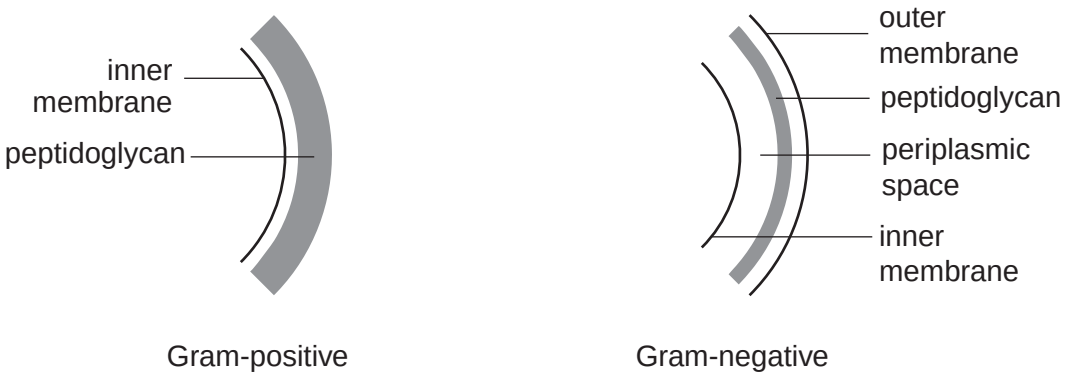
.....[1]

(c) Bacteria may be Gram-positive or Gram-negative.

Fig. 3.2 shows a diagram of part of the cell walls of both Gram-positive and Gram-negative bacteria.



Gram-positive

Gram-negative

Gram-positive bacteria cell walls have a peptidoglycan content of 50%

Gram-negative bacteria cell walls have a peptidoglycan content of 10 – 20%

Fig. 3.2

Suggest why Gram-positive bacteria are more susceptible to the action of penicillin than Gram-negative bacteria.

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.....[2]

(d) There is evidence that some bacteria have developed resistance to antibiotics.

One form of pneumonia, a serious lung disease, is caused by the bacterium *Streptococcus pneumoniae*. The Canadian Health Service has carried out a survey to show how the resistance of *S. pneumoniae* to penicillin has changed over the last 20 years.

Fig. 3.3 shows the results of this survey.

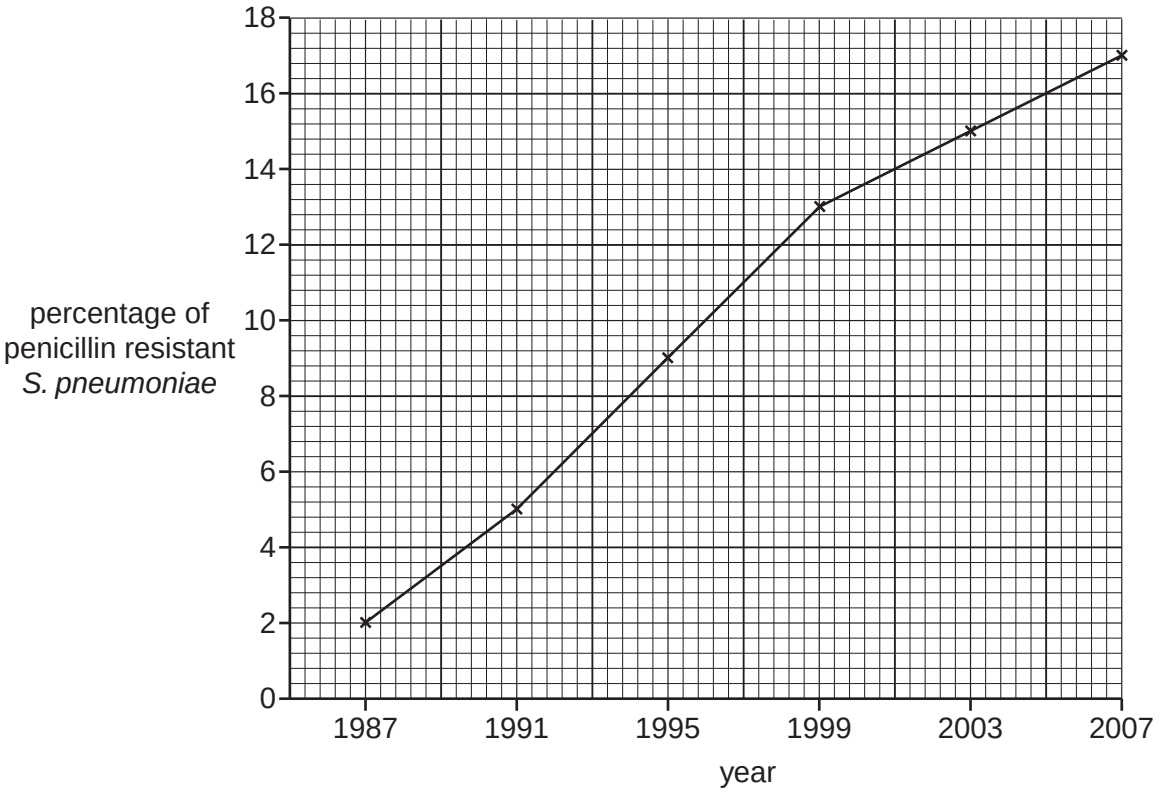

Fig. 3.3

Describe the results shown in Fig. 3.3 **and** explain how some strains of *S. pneumoniae* may have become resistant to penicillin.

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[Total: 14]

4 **(a)** In Queensland, Australia, the effect of the water-holding capacity of soil on the yield of sorghum and wheat was investigated.

- Four test plots were prepared, two with high water-holding capacity (HWC) soil and two with low water-holding capacity (LWC) soil.
- Sorghum seeds were sown on one plot with HWC soil and one plot with LWC soil.
- Wheat seeds were sown on the second plot with HWC soil and the second plot with LWC soil.
- The plots were regularly watered or irrigated throughout the growing season.
- The yield of sorghum and wheat from all four plots was measured at the end of the growing season.

Fig. 4.1 shows the results of this investigation.

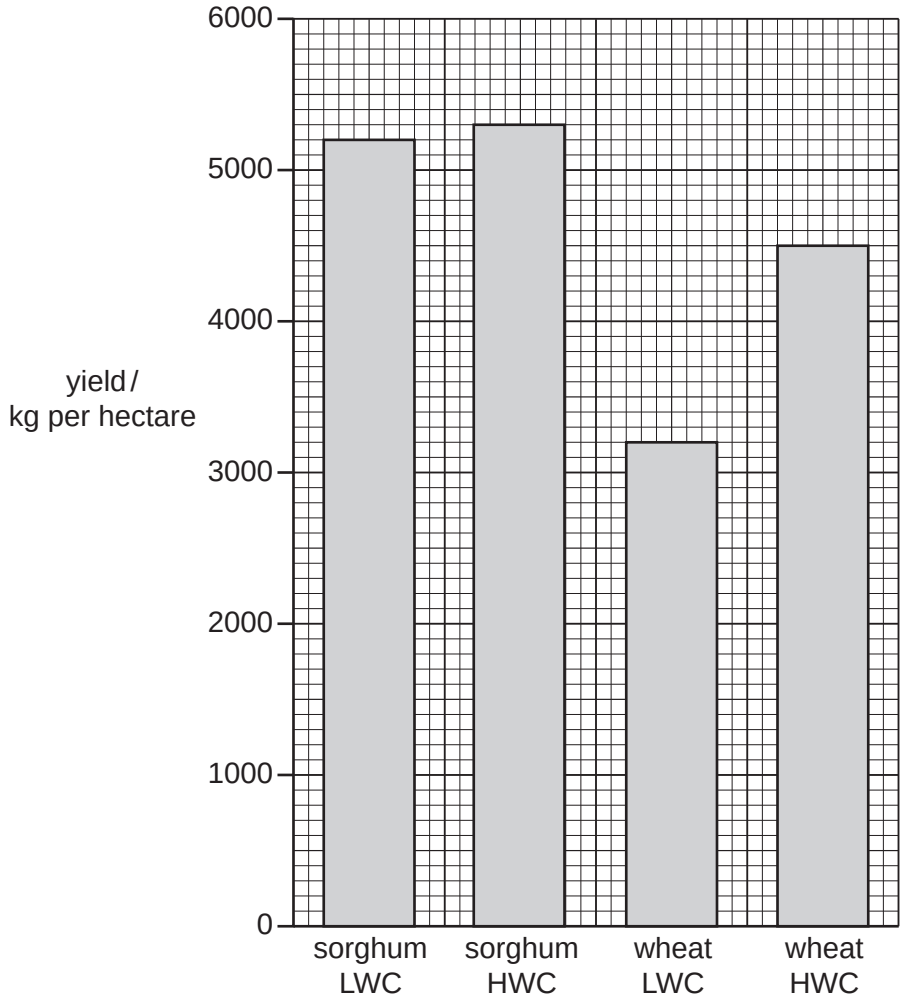

Fig. 4.1

(i) Describe **and** explain the results shown in Fig. 4.1.

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.....[4]

(ii) State two factors, other than water, light and temperature that would have to be controlled during this investigation to ensure that the results were valid.

1 .....

2 .....[2]

(b) Sorghum is able to carry out photosynthesis at high temperatures by preventing photorespiration.

Explain how sorghum is able to prevent photorespiration.

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[Total: 10]

5 **(a)** Fig. 5.1 shows a section through part of a human testis.

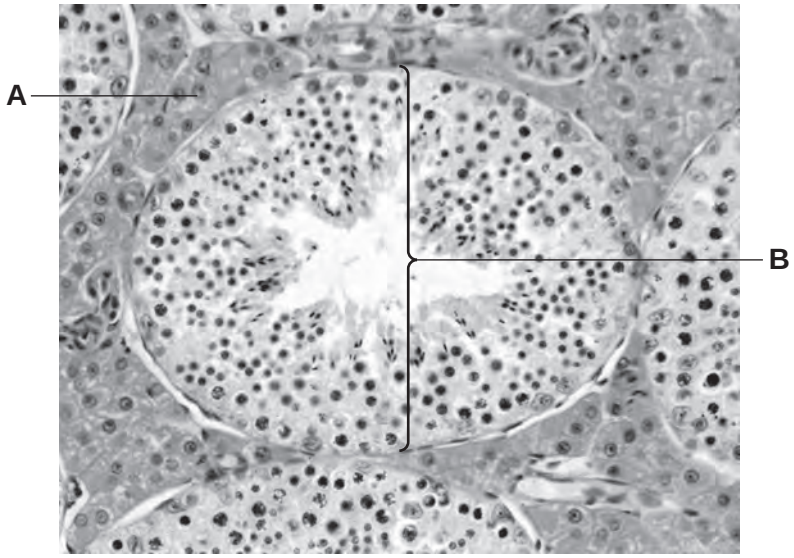

Fig. 5.1

Name structures **A** and **B**.

A ……

B …… [2]

(b) Spermatogenesis, the production of sperm, begins in the testes of a boy around the age of 11 and can continue for the rest of his life.

Fig. 5.2 outlines the sequence of events that occur during spermatogenesis.

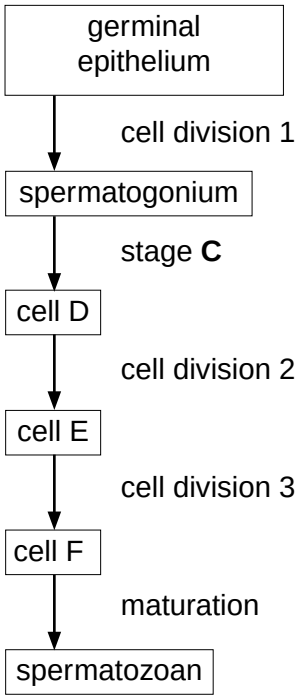

Fig. 5.2

With reference to Fig. 5.2,

(i) state which cell division is mitotic,

.....[1]

(ii) state which cells are haploid,

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.....[2]

(iii) state what is happening to the cell during stage **C**.

.....[1]

(c) The middle piece of a spermatozoan contains many mitochondria.

Suggest why a spermatozoan needs so many mitochondria.

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.....[2]

(d) Some couples have difficulty in conceiving. This could be due to a problem with either the male or female reproductive systems.

(i) Suggest reasons why a man may be infertile.

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.....[3]

(ii) *In vitro fertilisation* (IVF) is a widely used treatment for infertility.

Explain what is meant by the term *in vitro fertilisation*.

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(iii) At one IVF clinic, over 1000 treatment cycles were monitored. The number of live births was recorded as a percentage of the number of treatment cycles for each age group. The results are shown in Table 5.1.

Table 5.1

age of women/years	percentage of live births per treatment cycle
under 34	27.6
34 to 36	22.3
37 to 39	18.3
40 to 42	10.0
above 42	less than 5.0

The data in Table 5.1 show that there is a decrease in the percentage of live births per treatment cycle with increasing age.

Explain this trend.

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[Total: 16]

6 **(a)** The pancreas acts both as an exocrine and an endocrine gland.

(i) Describe the parts of the pancreas involved in its **endocrine** function.

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.....[3]

(ii) State precisely the group of compounds to which the pancreatic hormone insulin belongs.

.....[1]

(b) People with insulin-dependent (type 1) diabetes require regular injections of insulin. In the past the insulin used came from animal sources such as pigs. Diabetics now use human insulin that has been manufactured using gene technology.

Describe the advantages of treating diabetics with insulin produced by gene technology.

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.....[3]

[Total: 7]

7 Pompe disease is a rare neuromuscular disease caused by an autosomal recessive allele. This allele prevents the production of an enzyme called acid alpha-glucosidase (AG), which breaks down glycogen in muscle cells. Glycogen can build up in muscle cells causing damage to the cells. This damage leads to muscle weakness which gets worse with time.

(a) Explain how two parents, both of whom produce normal amounts of AG, can produce a child with Pompe disease.

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.....[3]

(b) One form of treatment is enzyme replacement therapy where AG is given through regular injections.

(i) Suggest how AG may be manufactured.

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.....[1]

(ii) Name the hormone that stimulates the breakdown of glycogen in **liver** cells.

.....[1]

(iii) State under what conditions glycogen would need to be broken down in liver or muscle cells.

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.....[1]

(c) The MN blood group system is based on the presence of glycoproteins M and N, on the surface membrane of red blood cells, which act as *antigens*.

State what is meant by the term *antigen*.

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.....[1]

(d) The type of MN antigen on the surface membrane of red blood cells is controlled by a single gene with two alleles, $\mathbf{L^M}$ and $\mathbf{L^N}$. The phenotypes of the MN blood group system are MM, MN and NN.

Complete the genetic diagram to show how the MN blood group is inherited.

parental phenotypes MN x MN

parental genotypes ....

gametes .....

offspring genotypes .....

offspring phenotypes ..... [3]

(e) Allele frequencies for $\mathbf{L^M}$ and $\mathbf{L^N}$ vary in different human populations throughout the world.

Table 7.1 shows the $\mathbf{L^M}$ and $\mathbf{L^N}$ allele frequencies from five populations.

Table 7.1

population	allele frequency / %	
	$\mathbf{L^M}$	$\mathbf{L^N}$
Canadian Inuit	91	9
Egyptian	52	48
German	55	45
Chinese	57	43
Nigerian	55	45

Discuss the data shown in Table 7.1.

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.....[3]

[Total: 13]

8 (a) In the majority of plants the leaf is the main photosynthetic organ.

List four ways in which the structure of a dicotyledonous leaf is adapted for gas exchange.

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2 .....

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3 .....

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4 .....

..... [4]

In an experiment to investigate the effect of light intensity on the rate of photosynthesis, the following procedure was carried out.

- Discs were cut, using a cork borer, from the photosynthetic tissue of the brown alga, *Fucus serratus*, a common seaweed of rocky shores.
- Ten discs were placed in each of four beakers containing 50 cm^3 of sea water. The discs are denser than sea water and therefore initially sink to the bottom of the beaker.
- Each beaker was illuminated with a bench lamp placed at different distances, *d*, from the beaker.
- With time the discs began to rise to the surface of the water.
- The time, *t*, in minutes, at which the fifth disc from each batch reached the surface was recorded.
- The rate of photosynthesis was determined by calculating 1000 / *t*.

A student's set of results is shown in Table 8.1.

Table 8.1

distance of beaker from lamp, *d* / cm	light intensity $1/d^2$	time for fifth disc to reach the surface *t* / min	rate of photosynthesis 1000 / *t*
5	0.04	23	43.5
10	0.01	36	27.8
15	0.004	52	19.2
20	.....	88	11.4

(b) Calculate the value for light intensity when the distance between beaker and lamp was 20 cm.

Record the value in the space in Table 8.1.
[1]

(c) Explain why the discs rise to the surface after being illuminated for a length of time.

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(d) Using the data in Table 8.1, describe the relationship between light intensity and the rate of photosynthesis.

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.....[2]

(e) The student found that there was no increase in the rate of photosynthesis when two lamps were placed 5 cm from the beaker.

Suggest why there was no increase in the rate of photosynthesis.

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.....[2]

[Total: 12]

Section B

Answer **one** question.

9 **(a)** Outline the main features of the Krebs cycle. [9]

(b) Explain the role of NAD in aerobic respiration. [6]

[Total: 15]

10 **(a)** Describe how a nerve impulse crosses a cholinergic synapse. [9]

(b) Explain the roles of synapses in the nervous system. [6]

[Total: 15]

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