Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER			

0267398221

BIOLOGY **9700/41**

Paper 4 A Level Structured Questions **May/June 2016**

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 on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer **one** question.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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.

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Section A

Answer **all** the questions.

1 **(a)** ATP and NAD both play important roles in respiration. Both compounds are nucleotides.

Fig. 1.1 represents the molecular structures of ATP and NAD.

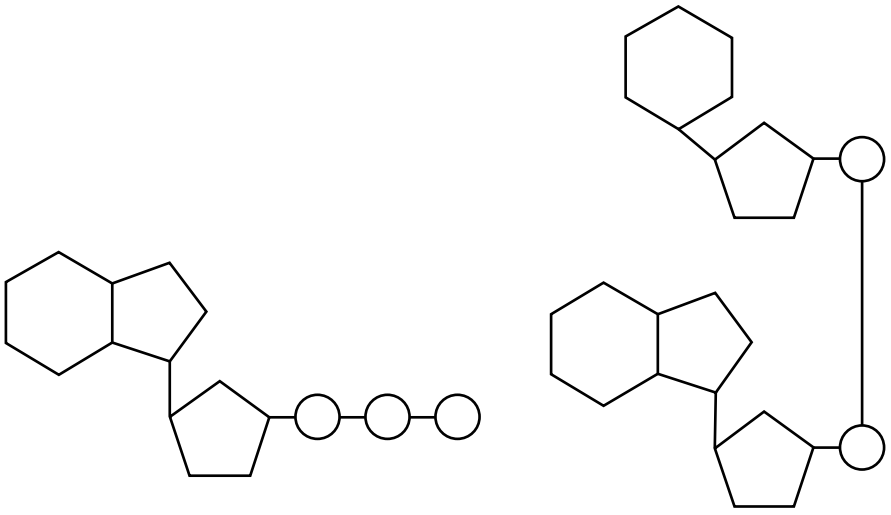


Fig. 1.1

Using Fig. 1.1, compare the structures of ATP and NAD.

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..... [3]

(b) ATP provides an immediate energy source for metabolic processes such as anabolic reactions.

State two examples of anabolic reactions in a **mammal** that require ATP as an energy source.

1 .....

2 ..... [2]

(c) Name the type of chemical reaction by which ATP is made during the Krebs cycle.

..... [1]

(d) Outline the roles of NAD in the **cytoplasm** of a cell.

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..... [2]

(e) Carbohydrates and lipids are used as respiratory substrates.

Table 1.1 shows the energy values of carbohydrates and lipids.

Table 1.1

respiratory substrate	energy value / kJ g^{-1}
carbohydrate	15.8
lipid	39.4

Explain why lipids have a higher energy value than carbohydrates.

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..... [2]

[Total: 10]

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2 The concentration of carbon dioxide in the atmosphere and the light intensity often limit the rate of photosynthesis.

(a) Explain what is meant by a *limiting factor* in relation to photosynthesis.

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..... [2]

(b) Investigations were carried out in Florida, USA, into the effect of different concentrations of atmospheric carbon dioxide and of light intensity on the rate of photosynthesis of soybean plants.

Plants were grown from seed in outdoor, computer-controlled growth chambers at different concentrations of carbon dioxide. The upper parts of the chambers were transparent so that the plants received natural sunlight.

After the seedlings emerged, the air in the soil was separated from the air around the leaves by a gas-tight seal in each chamber.

Suggest why the air in the soil and the air around the leaves of the plants were separated.

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..... [2]

(c) In one investigation, two sets of plants, **A** and **B**, were grown from seed at different concentrations of carbon dioxide:

- **A** – normal atmospheric concentration of carbon dioxide (0.033%)
- **B** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

Then, keeping each set of plants in its particular concentration of carbon dioxide, measurements were made of their rates of photosynthesis at different light intensities.

The results are shown in Fig. 2.1 on page 5.

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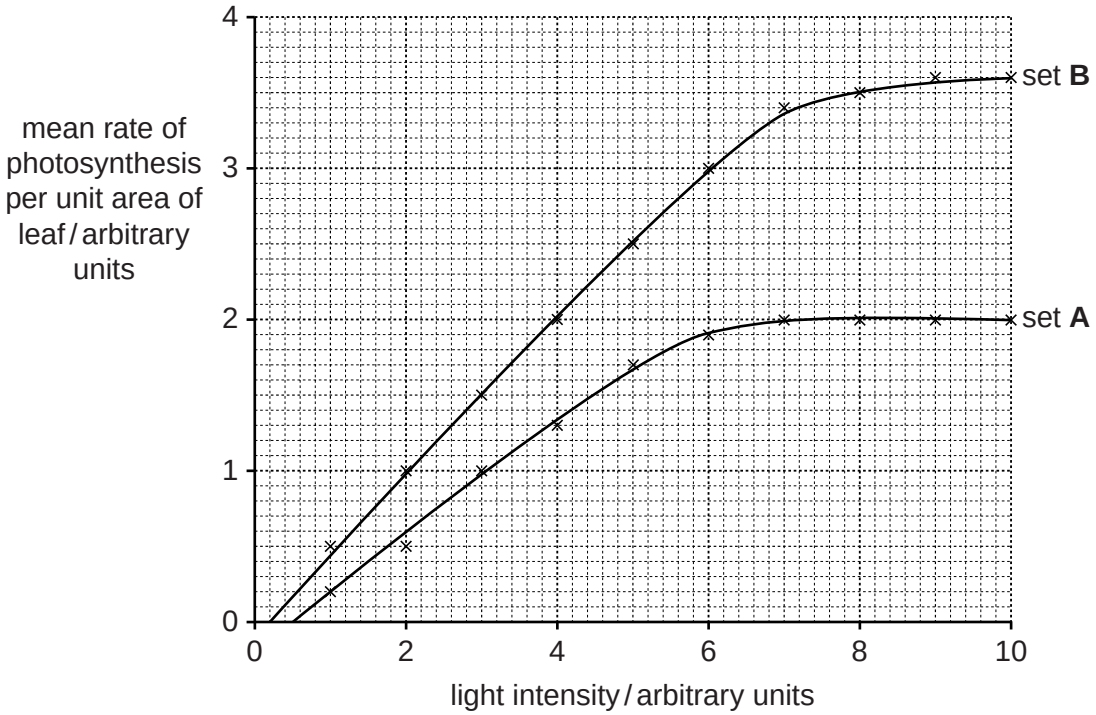


Fig. 2.1

With reference to Fig. 2.1:

(i) describe and explain, in terms of limiting factors, the results from the plants in set **A**

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..... [3]

(ii) explain the difference between the results of set **A** and set **B** at high light intensities.

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..... [2]

(d) In a second investigation, two sets of plants, **C** and **D**, were grown from seed, as before, in different carbon dioxide concentrations:

- **C** – normal atmospheric concentration of carbon dioxide (0.033%)
- **D** – normal atmospheric concentration of carbon dioxide ×2 (0.066%).

When the plants matured, conditions in the growth chambers were changed to investigate the rate of photosynthesis of each set of plants in different concentrations of carbon dioxide.

The results are shown in Fig. 2.2.

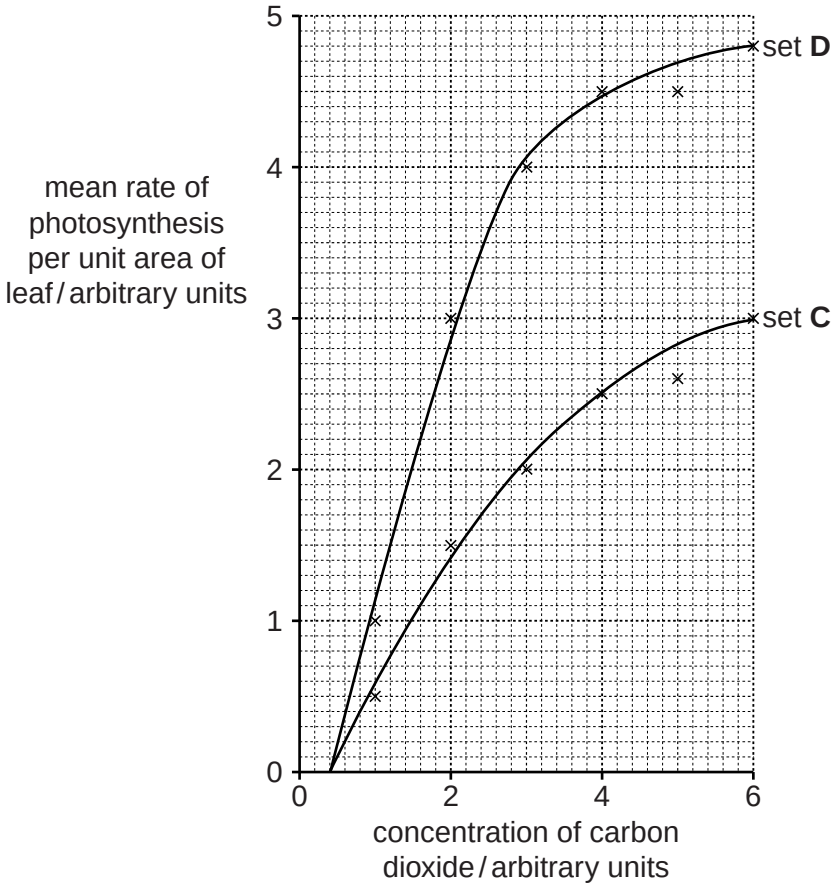


Fig. 2.2

Suggest explanations for the higher rate of photosynthesis **per unit area of leaf** shown by the plants in set **D** compared with those in set **C**.

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..... [4]

[Total: 13]

3 Malaria is a serious and often fatal infectious disease caused by *Plasmodium*. Drugs such as chloroquine are widely used to decrease the risk of getting malaria and also to treat people who have become infected. However, in many parts of the world, *Plasmodium* populations have become resistant to chloroquine.

Sequencing the genome of *Plasmodium* and the application of bioinformatics has provided several new targets for the development of anti-malarial drugs.

(a) (i) Define the term *bioinformatics*.

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..... [2]

(ii) Outline how sequencing the genome of *Plasmodium* **and** the use of bioinformatics can suggest new targets for anti-malarial drugs.

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..... [3]

(b) In parts of the world where *Plasmodium* is resistant to chloroquine, one of the most effective anti-malarial drugs currently in use is artemisinin. Artemisinin works by binding to an enzyme in *Plasmodium* called PfATP6, acting as an inhibitor.

A substance called curcumin, which has long been used as a spice and yellow food colouring in India and other countries, is also known to act against chloroquine-resistant *Plasmodium*. A group of researchers predicted that curcumin acts by binding to the same enzyme as artemisinin.

In order to test this hypothesis, and to try to find similar substances that might work even better than curcumin, the researchers used theoretical modelling to:

- look at the chemical structures of various molecules with a similar structure to curcumin (curcumin analogues)
- generate a three-dimensional model of the structure of the enzyme PfATP6
- investigate whether each curcumin analogue could bind to PfATP6.

The researchers predicted that several of the curcumin analogues would bind more strongly than curcumin to PfATP6.

(i) Suggest advantages of using theoretical models in this research, rather than testing possible drugs in the laboratory.

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(ii) Suggest why theoretical modelling cannot completely replace laboratory trials in the search for new drugs.

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..... [2]

[Total:10]

4 Maize is an important food crop that has been improved both by selective breeding and by genetic modification.

(a) Outline how selective breeding has been used to improve maize.

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..... [4]

(b) Fig. 4.1 shows part of a maize cob. The cob is made up of many individual seeds called kernels. Each kernel results from a separate fertilisation of a male and a female gamete. Some kernels are yellow and some are purple.

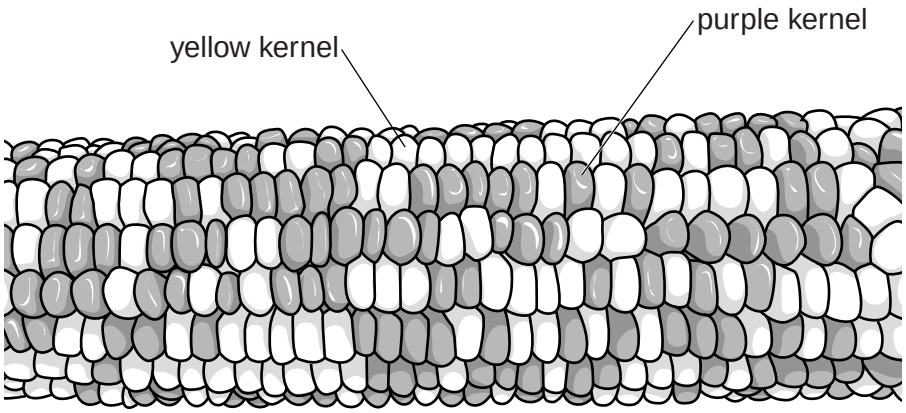


Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variation .....

explanation .....

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..... [3]

(c) Maize and other crops have been genetically modified since 1996 to produce the Bt toxin to kill insect pests.

Fig. 4.2 shows the area of Bt crops grown (plotted points) and the number of insect pest species in which resistance to Bt has been reported (bars).

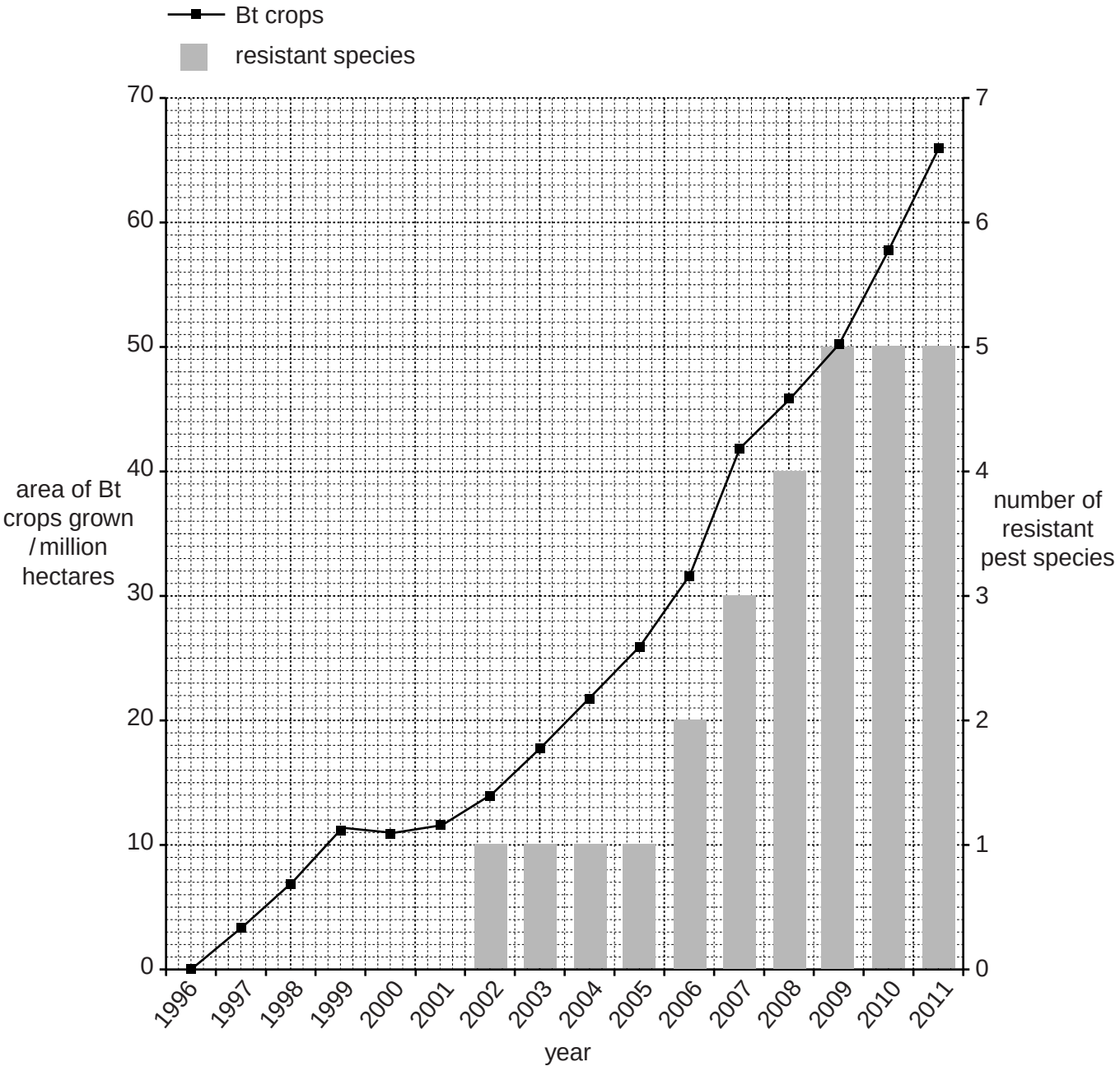


Fig. 4.2

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(i) Describe **and** suggest an explanation for the relationship between the area of Bt crops grown and the number of resistant pest species.

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..... [4]

(ii) Suggest **one** social advantage and **one** environmental advantage of growing this Bt maize.

social advantage .....

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environmental advantage .....

..... [2]

[Total: 13]

5 Fig. 5.1 shows a water vole, *Arvicola amphibius*. This species is native to Great Britain.



Fig. 5.1

The numbers of water voles are estimated to have fallen by 94% in the last century.

This is thought to be due to habitat fragmentation and also to extensive predation by mink, *Neovison vison*, shown in Fig. 5.2. Mink originated in North America but were brought to Great Britain for fur farming. Some escaped or were released into the wild, where their numbers rapidly increased.



Fig. 5.2

(a) Name **and** describe a method for estimating the abundance of water voles in a local area.

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..... [4]

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(b) Both water voles and mink are classified as class Mammalia, phylum Chordata, kingdom Animalia.

Outline two features of the **cells** of members of the kingdom Animalia that distinguish them from the cells of other multicellular eukaryotes.

1 .....

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2 .....

..... [2]

(c) **(i)** Discuss the reasons why alien species should be controlled.

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..... [3]

(ii) Suggest **one** way of controlling mink numbers in Great Britain.

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..... [1]

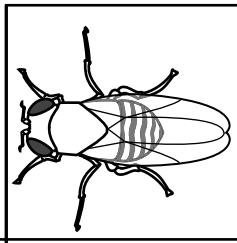
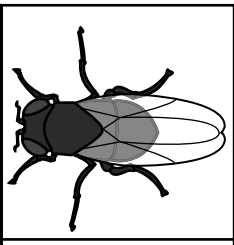
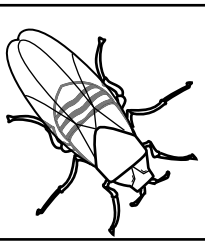
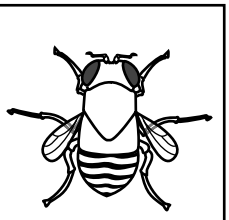
[Total: 10]

6 The fruit fly, *Drosophila melanogaster*, has eyes, a striped abdomen and wings longer than its abdomen. This is called a 'wild-type' fly.

Mutation has resulted in many variations of these features.

Table 6.1 shows diagrams of a wild-type fly and three other flies, each of which shows **one** recessive mutation.

Table 6.1

				
eyes	present	present	absent	present
abdomen	striped	black	striped	striped
wing description	long	long	long	short

(a) Using appropriate symbols, complete the genetic diagram below.

symbols

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.....

parental phenotypes with eyes black abdomen X no eyes striped abdomen

parental genotypes

gametes

offspring genotypes

offspring phenotypes with eyes black abdomen; no eyes black abdomen; with eyes striped abdomen; no eyes striped abdomen

[4]

(b) State how you would carry out a test cross.

.....

..... [1]

(c) A cross was carried out between a fly heterozygous for striped abdomen and long wings and a fly with a black abdomen and short wings.

The results are shown below in Table 6.2.

Table 6.2

offspring	number
striped abdomen long wing	86
black abdomen long wing	87
striped abdomen short wing	81
black abdomen short wing	78
total	332

A chi-squared test (χ^2) was carried out on these data.

Complete Table 6.3 **and** calculate the value of χ^2.

Table 6.3

observed number (O)	expected number (E)	O − E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
86	.....	.....	.....	.....
87	.....	.....	.....	.....
81	.....	.....	.....	.....
78	.....	.....	.....	.....
332	332			

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$\sum$ = sum of...

χ^2 ..... [3]

(d) Table 6.4 shows χ^2 values.

Table 6.4

degrees of freedom	probability						
	0.50	0.20	0.10	0.05	0.02	0.01	0.001
3	2.37	4.64	6.25	7.82	9.84	11.34	16.27

Using Table 6.4, explain what conclusions can be made about the results of the χ^2 test.

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..... [2]

[Total: 10]

7 **(a)** An important function of control systems in mammals is homeostasis.

Explain what is meant by the term *homeostasis*.

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..... [1]

(b) Insulin plays a part in homeostasis. It affects muscle and liver cells to bring about a decrease in blood glucose concentration, particularly after a meal.

(i) Insulin is composed of two polypeptides which are made in β cells in the pancreas.

State precisely where in β cells polypeptide molecules are synthesised.

..... [1]

(ii) Name the process by which insulin is secreted from β cells.

..... [1]

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(iii) Describe the effects of insulin on muscle cells.

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..... [3]

(c) During periods of stress or extreme exercise more glucose needs to be released into the blood. The hormone adrenaline is released and binds to receptors on the cell surface membranes of liver cells.

Describe how the effect of adrenaline on liver cells results in an increase in blood glucose concentration.

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..... [5]

[Total: 11]

8 **(a)** Fig. 8.1 is a diagram of a sensory neurone and some receptor cells.

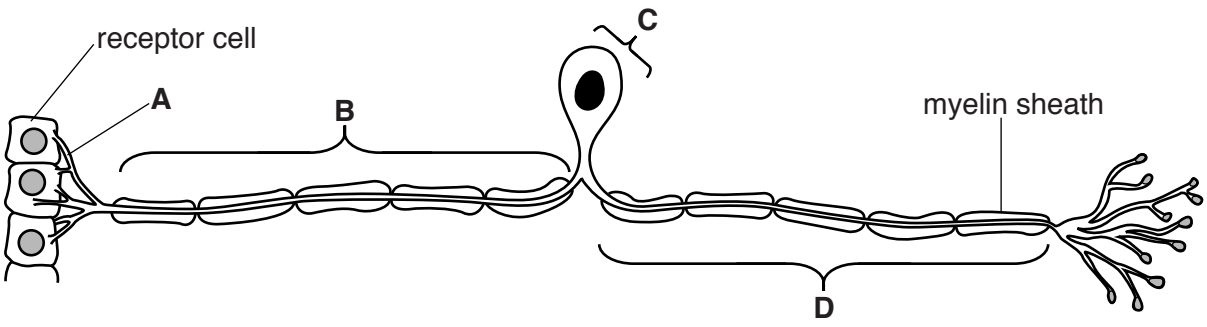


Fig. 8.1

Name the parts of the neurone labelled **A**, **B**, **C** and **D**.

A .....

B .....

C .....

D ..... [4]

(b) Explain how the myelin sheath increases the speed of conduction of nerve impulses.

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..... [2]

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(c) Fig. 8.2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated.

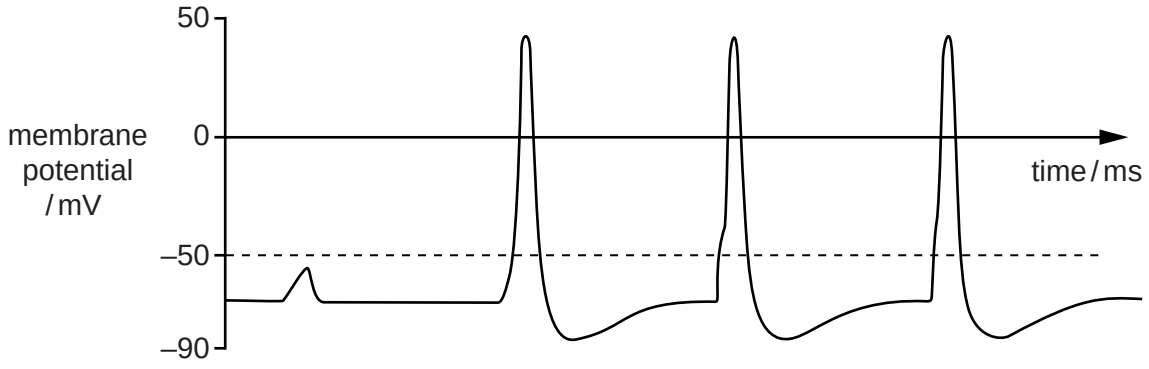


Fig. 8.2

Fig. 8.3 shows the strength of the stimuli applied to these receptor cells.

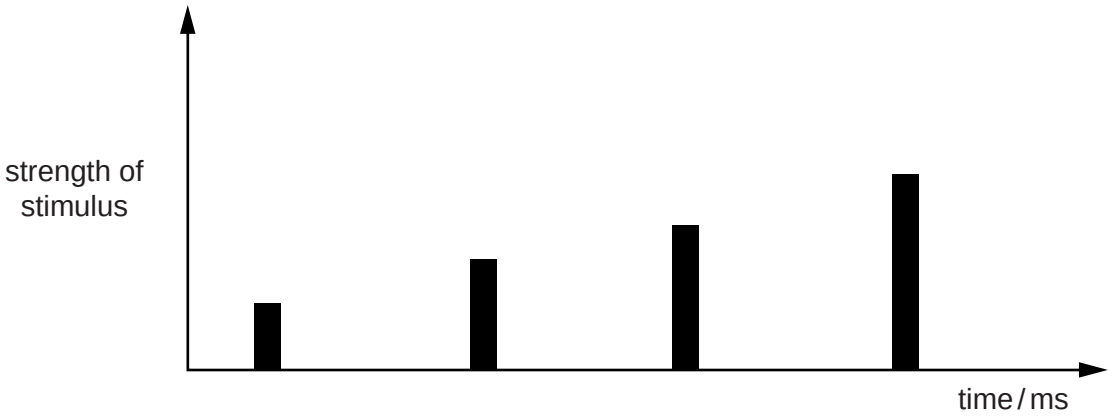


Fig. 8.3

With reference to Fig. 8.2 and Fig. 8.3, describe the relationship between the strength of the stimulus and the resulting action potential.

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..... [2]

[Total: 8]

Section B

Answer **one** question.

9 **(a)** Outline how ATP is synthesised by oxidative phosphorylation. [8]

(b) Describe respiration in yeast cells in anaerobic conditions. [7]

[Total: 15]

10 **(a)** Describe the behaviour of chromosomes during meiosis. [9]

(b) Outline the differences between structural and regulatory genes. [6]

[Total: 15]

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