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.

This document consists of **22** printed pages and **2** lined pages.

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CAMBRIDGE International Examinations

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.

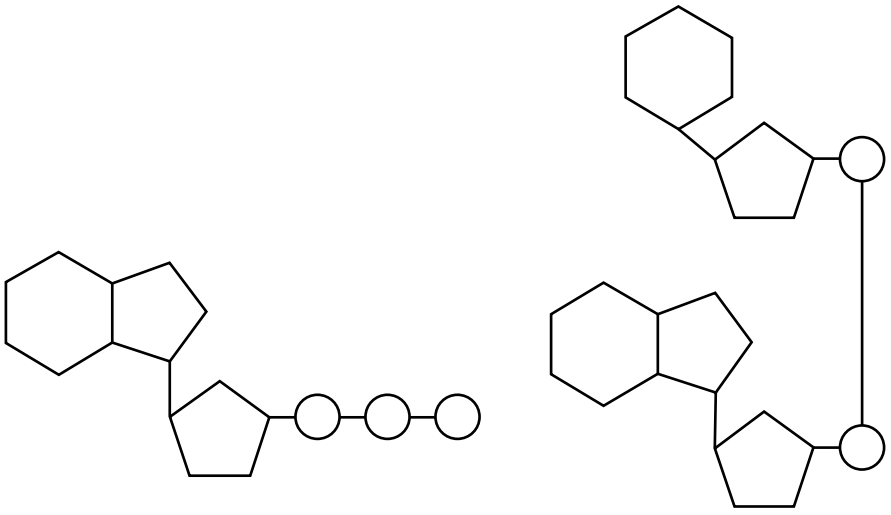


Fig. 1.1

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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[Turn over

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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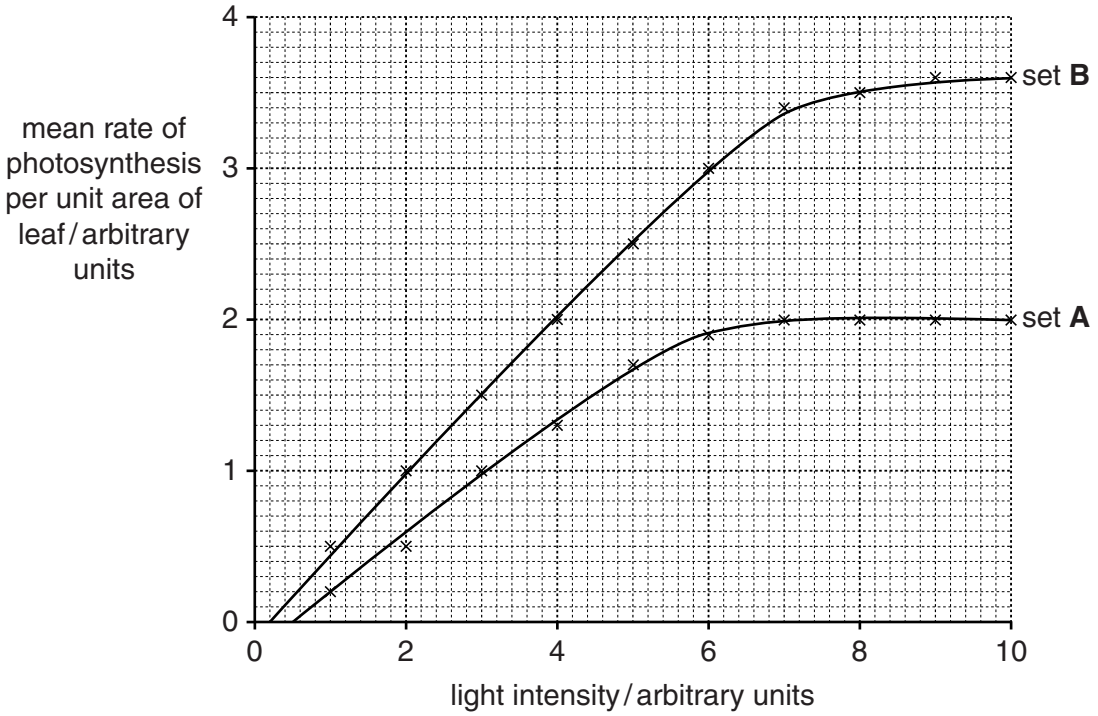


Fig. 2.1

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

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(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.

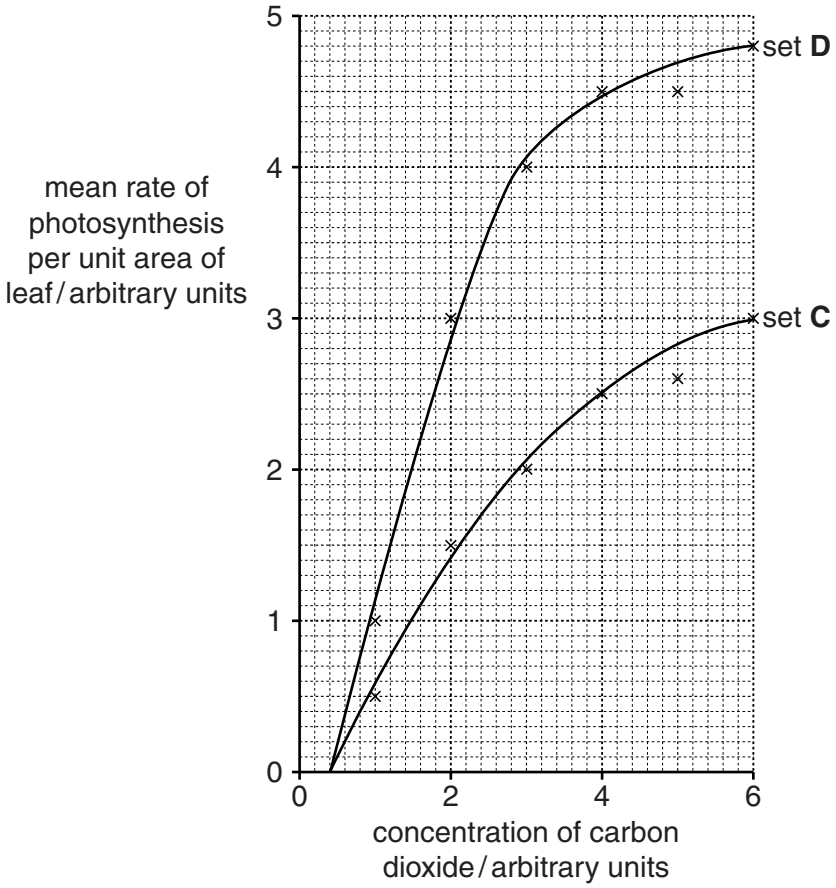


Fig. 2.2

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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[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.

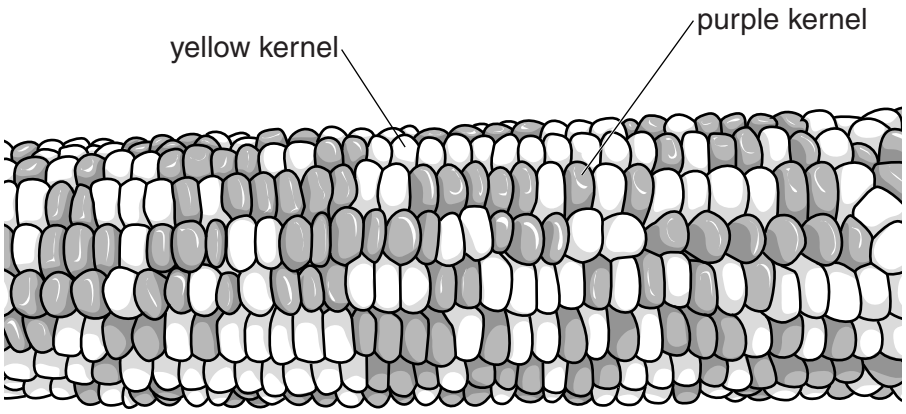


Fig. 4.1

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).

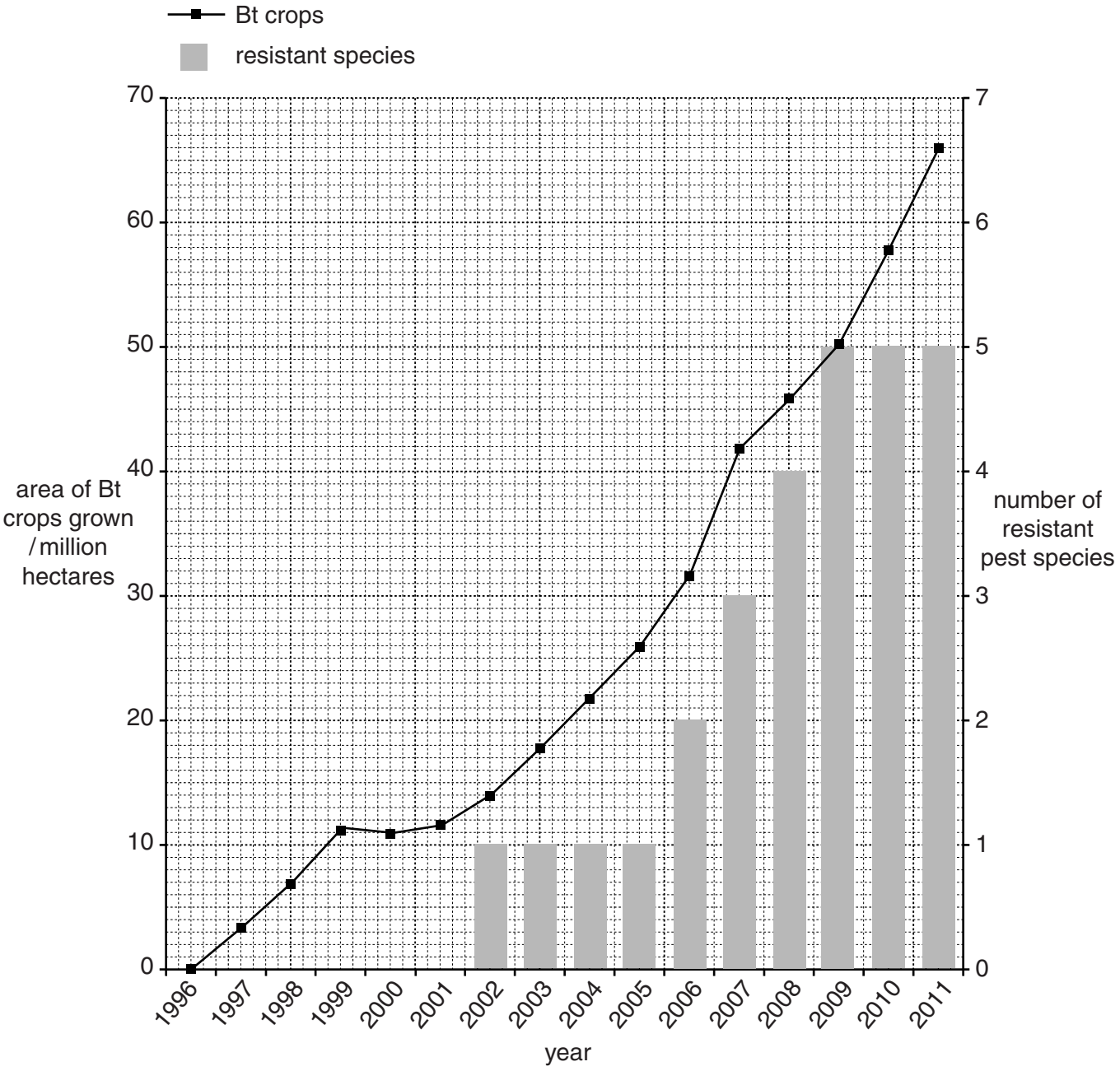


Fig. 4.2

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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]

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

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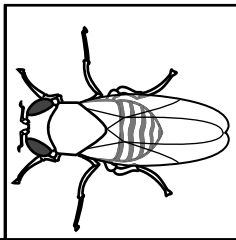
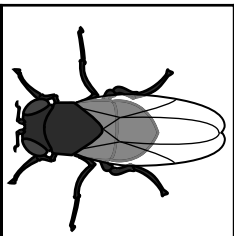
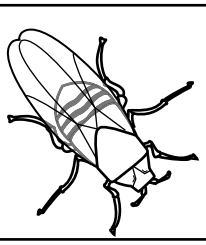
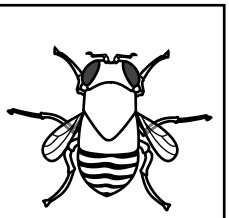
[Total: 10]

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.

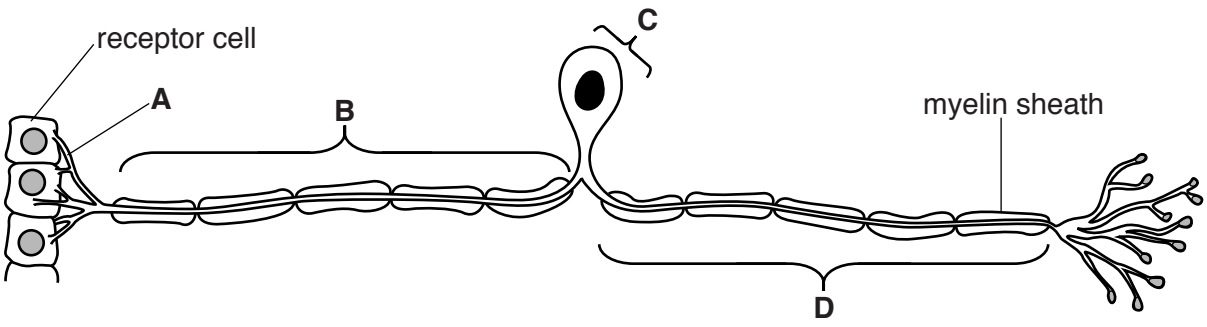


Fig. 8.1

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.

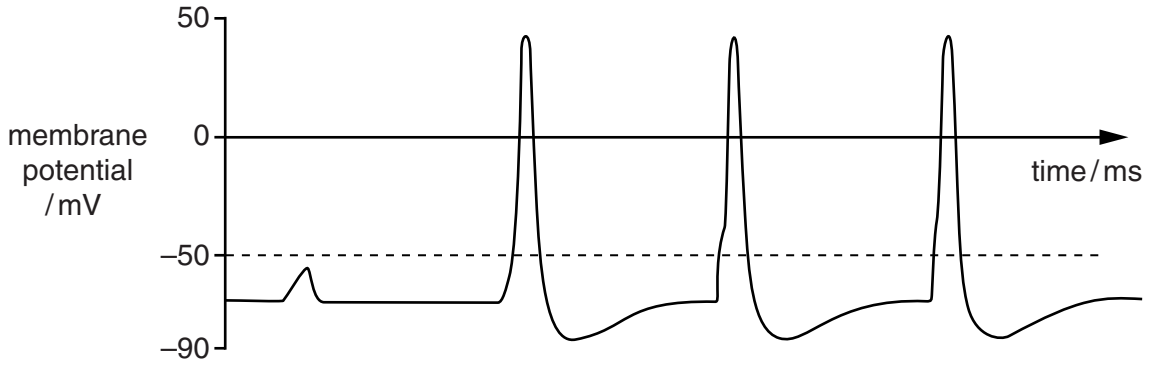


Fig. 8.2

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

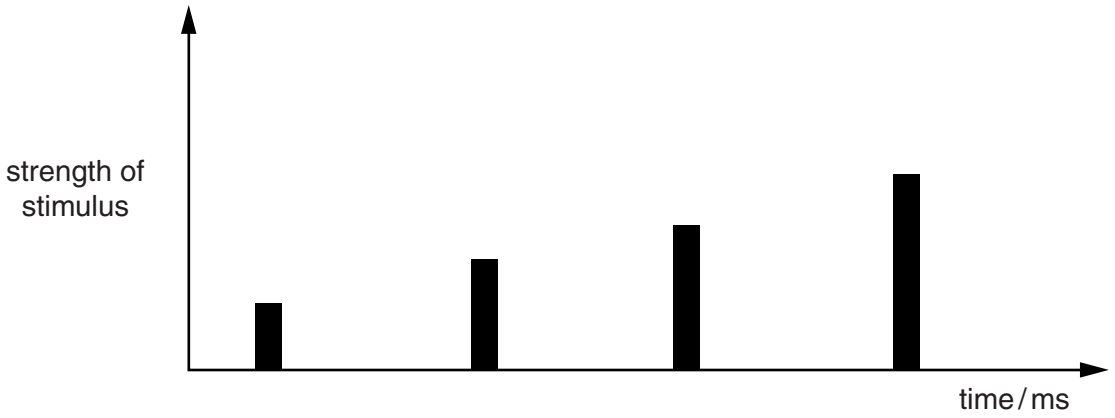


Fig. 8.3

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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[Turn over

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Section A

Answer **all** the questions.

1 **(a)** ATP and coenzyme A both play important roles in respiration.

Fig. 1.1 represents the molecular structure of coenzyme A.

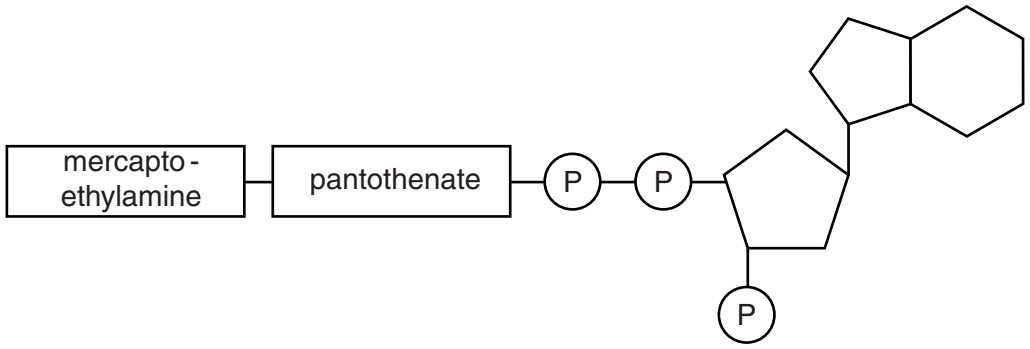


Fig. 1.1

(i) With reference to Fig. 1.1, state two structural **similarities** between coenzyme A and ATP.

1 .....

2 ..... [2]

(ii) Describe the role of coenzyme A in respiration.

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..... [3]

(b) Fig. 1.2 summarises the reactions that take place after glucose has entered a certain type of cell.

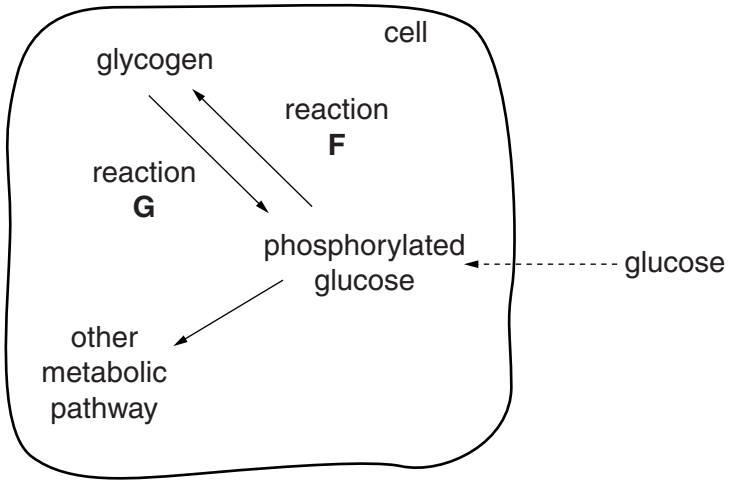


Fig. 1.2

(i) Suggest **one** type of cell in which the reactions shown in Fig. 1.2 could occur.

..... [1]

(ii) State the mechanism by which glucose enters the cell.

..... [1]

(iii) Name the type of reaction occurring at **F** and the type of reaction occurring at **G**.

F .....

G ..... [2]

(iv) With reference to Fig. 1.2, suggest **one** example of an 'other metabolic pathway' for phosphorylated glucose.

..... [1]

[Total: 10]

2 **(a)** Fig. 2.1 shows the effect of temperature on the rate of photosynthesis of a plant at low light intensity and at high light intensity.

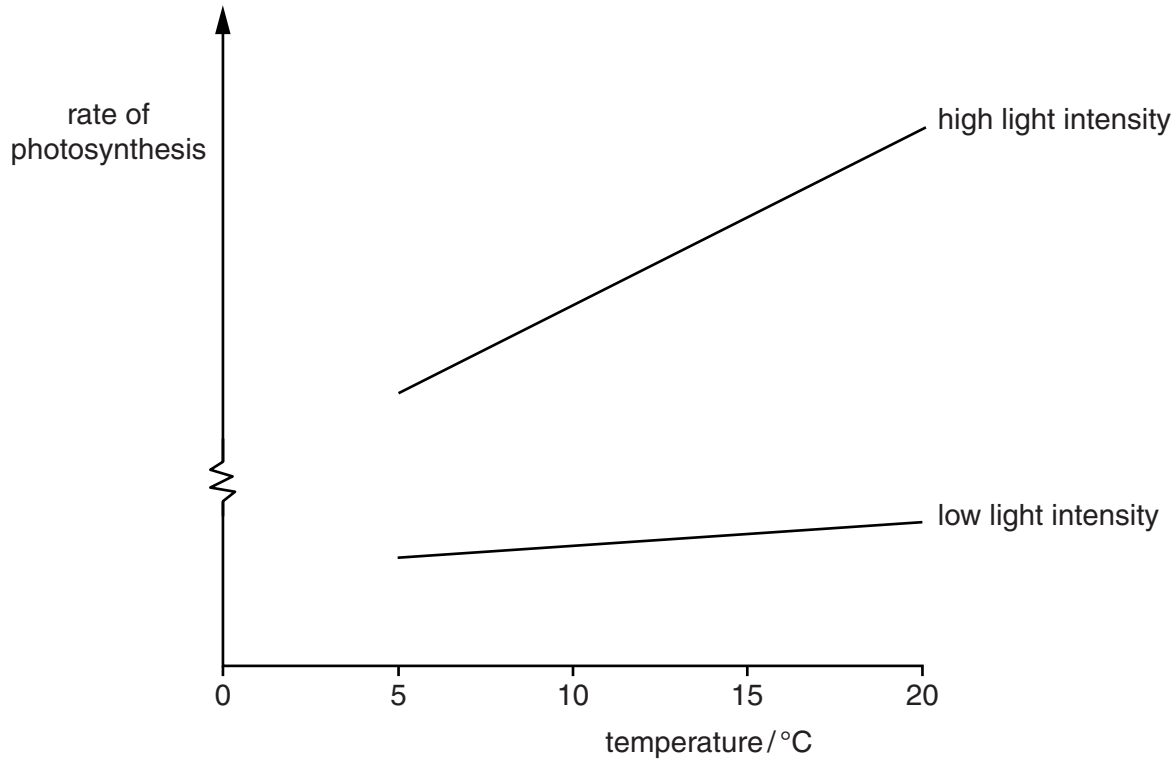


Fig. 2.1

With reference to Fig. 2.1, describe **and** explain the effect of temperature on the rate of photosynthesis.

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(b) Fig. 2.2 shows an absorption spectrum for chloroplast pigments and a photosynthetic action spectrum for the same plant.

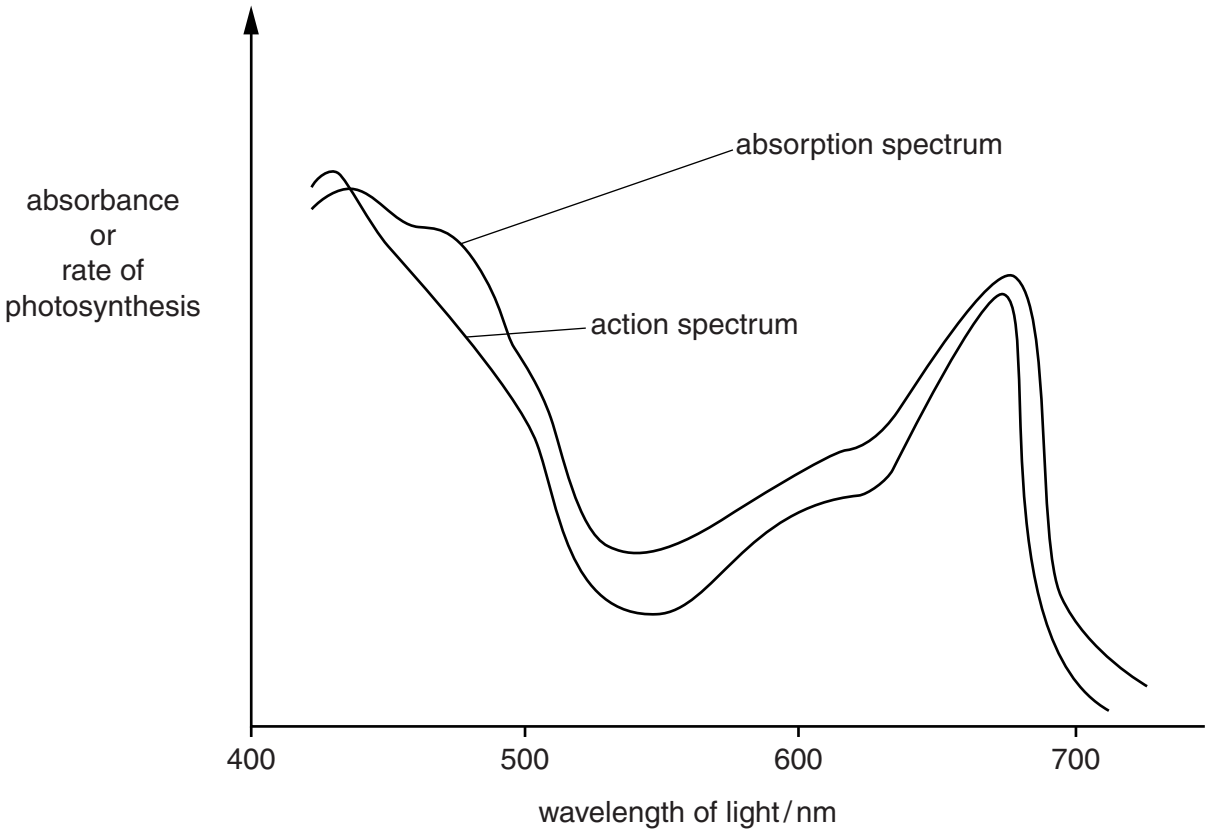


Fig. 2.2

(i) Distinguish between an absorption spectrum and an action spectrum.

absorption spectrum .....

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action spectrum .....

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..... [2]

(ii) Explain why the two curves shown in Fig. 2.2 have similar shapes.

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..... [2]

(c) Describe the role in photosynthesis of an accessory pigment, such as carotene.

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..... [2]

[Total: 10]

3 Malaria is a serious and often fatal disease that is transmitted by the mosquito *Anopheles gambiae*. One method of reducing the incidence of malaria is to control the numbers of these mosquitoes.

In mosquitoes, as in humans, males have an X chromosome and a Y chromosome, while females have two X chromosomes. Researchers investigated the possibility of producing genetically modified (GM), fertile male mosquitoes in which most of the sperm contained a Y chromosome and not an X chromosome.

They predicted that introducing these males into a population of *A. gambiae* could greatly reduce the number of females in each generation and therefore reduce the numbers of eggs laid.

(a) In order to produce the GM males, the researchers inserted the gene coding for a restriction endonuclease called I-PpoI. This restriction endonuclease was known to destroy the X chromosome of *A. gambiae*.

Explain the meaning of the term *restriction endonuclease* **and** suggest why I-PpoI destroys the X chromosome, but not the Y chromosome.

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..... [4]

(b) The researchers introduced the gene for I-PpoI and also a gene for green fluorescent protein (GFP) into one of the autosomes (a chromosome other than X or Y) of male mosquitoes.

Explain why the researchers introduced the gene for GFP, as well as the gene for I-PpoI.

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..... [2]

(c) The researchers found that I-PpoI destroyed the X chromosome during meiosis in the GM male mosquitoes. This prevented these males from producing sperm containing an X chromosome.

However, I-PpoI was still active in zygotes produced by the fusion of female gametes with sperm containing a Y chromosome.

Explain why this meant that the GM males produced no offspring at all.

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..... [2]

(d) The researchers modified the gene for I-PpoI, so that it produced a version of I-PpoI that was active **only** during meiosis in the males, and was **not** active in the zygote. They then tested the effect of introducing these GM males into a mosquito population.

- Several cages were set up. 50 adult male mosquitoes and 50 adult female mosquitoes without the I-PpoI gene were placed in each cage.
- 150 adult GM males were introduced into each cage. In half of the cages (**A**), these GM males had the normal gene for I-PpoI. In the rest of the cages (**B**), the GM males had the modified gene for I-PpoI.
- The mean number of adult female offspring per cage was determined over the next six generations.

Fig. 3.1 shows the results.

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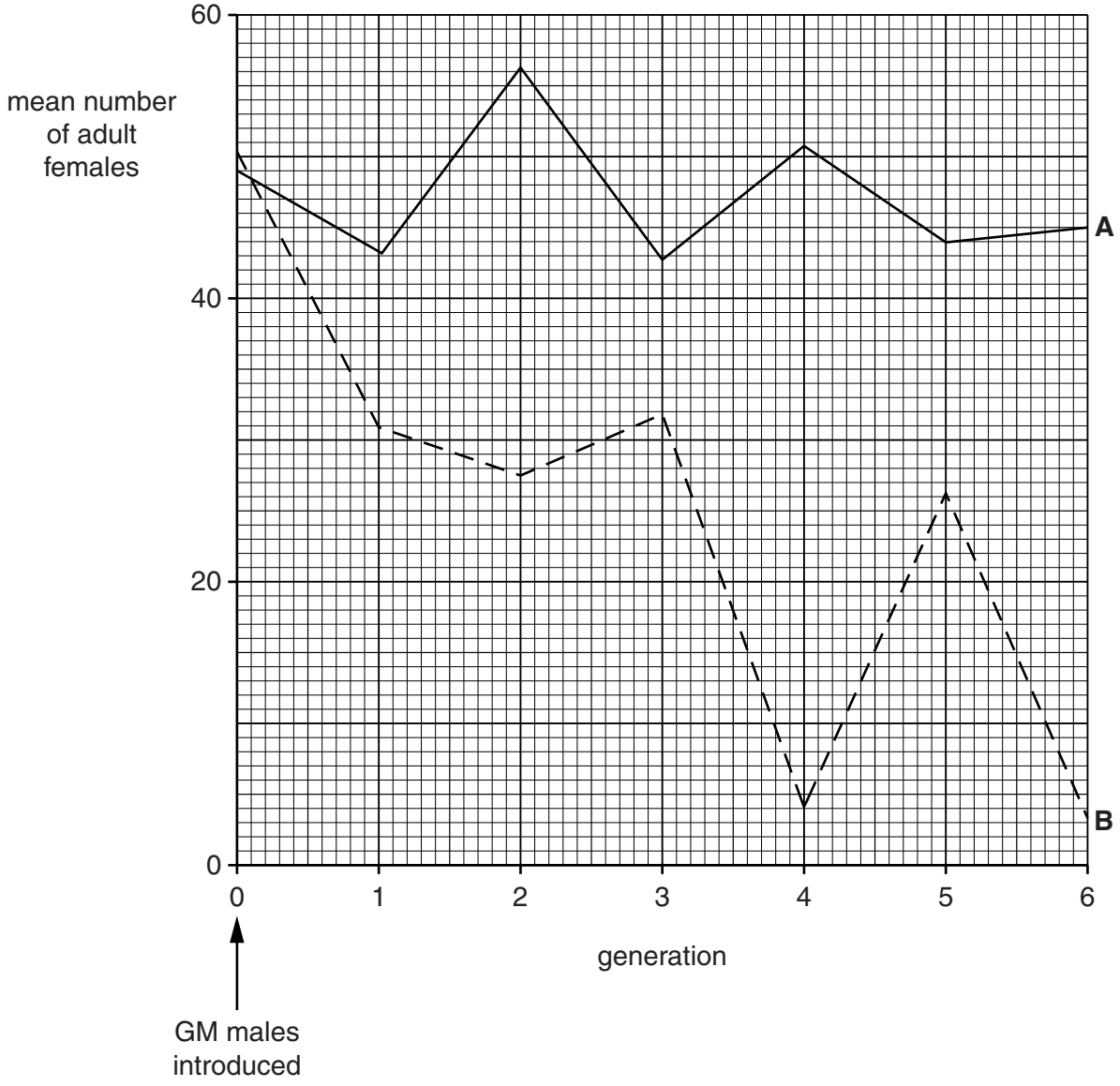


Fig. 3.1

(i) Describe **and** suggest explanations for the differences between the mean numbers of adult females in the two sets of cages during the experiment.

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..... [3]

(ii) Suggest possible difficulties that might arise if the technique of releasing GM male mosquitoes with the modified I-PpoI gene were used to try to control populations of *A. gambiae* that occur naturally in the wild.

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..... [2]

[Total: 13]

4 Food crops like wheat may be improved by selective breeding and genetic modification.

(a) Outline how wheat crops have been improved by selective breeding.

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..... [4]

(b) Variation in height of a strain of wheat plants in a field shows a continuous pattern of variation.

Explain what is meant by continuous variation **and** explain why this type of variation occurs in a population.

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..... [3]

(c) Wheat and other crops have been genetically modified to be resistant to the herbicide glyphosate since 1996.

Fig. 4.1 shows the area of glyphosate-resistant crops grown as a percentage of the total planted hectares (plotted points) and the number of weed species with resistance to glyphosate (bars).

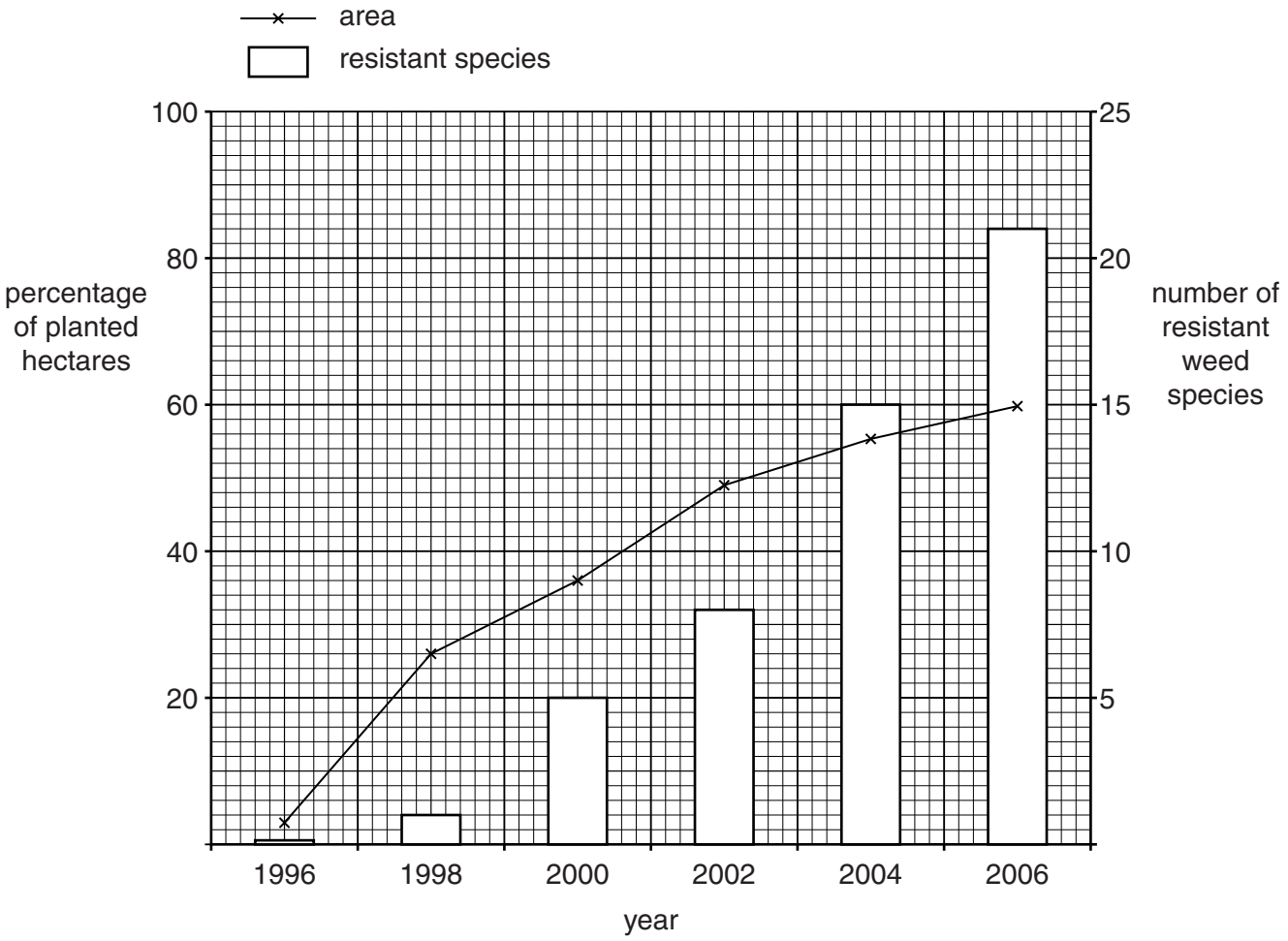


Fig. 4.1

Describe and explain the relationship between the area of glyphosate-resistant crops grown and the number of resistant weed species.

.....

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..... [4]

(d) Suggest **one** social advantage and **one** environmental advantage of growing glyphosate-resistant wheat.

social advantage .....

.....

environmental advantage .....

..... [2]

[Total: 13]

5 Fig. 5.1 shows a raccoon, *Procyon lotor*. This species is native to North America. Four individuals were released in Germany in 1934. There are now thought to be more than a million raccoons in Germany.



Fig. 5.1

(a) Urban raccoons live in towns. Although they are nocturnal their large size means they may be noticed by humans. They may be found raiding bins containing food waste, or entering buildings.

Describe a method for estimating the size of a raccoon population in a town.

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..... [3]

(b) **(i)** Raccoons are classified in the phylum Chordata of the kingdom Animalia.

Name the domain to which raccoons belong.

..... [1]

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(ii) Outline three characteristic features of members of this domain.

1 .....

.....

2 .....

.....

3 .....

..... [3]

(c) It has been suggested that raccoons may threaten biodiversity and pose a risk to human health in Germany.

Explain how raccoons could cause problems for local biodiversity **and** for human health.

local biodiversity .....

.....

.....

.....

.....

.....

human health .....

.....

.....

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..... [3]

[Total: 10]

6 The sex chromosomes of domestic chickens are known as **W** and **Z**.

- Male chickens have two **Z** chromosomes.
- Female chickens have one **W** and one **Z** chromosome.

A gene for feather colour in chickens is located on an autosome.

This gene (**C**) has two alleles
- black ($\mathbf{C^B}$)
- splashed-white ($\mathbf{C^S}$).

When a chicken with black feathers is mated with a chicken with splashed-white feathers, all the offspring will have blue feathers.

A gene for feather pattern is located on the **Z** chromosome but not on the **W** chromosome. This gene has two alleles
- barred (striped) feathers (**A**)
- non-barred feathers (**a**).

(a) State the type of inheritance for feather colour and for feather pattern.

feather colour .....

feather pattern ..... [2]

(b) A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers.
All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given, draw a genetic diagram to show this cross.

parents phenotype	male, black, non-barred feathers	female, splashed-white, barred feathers
parents genotype		
gametes		
offspring genotypes		
offspring phenotypes	male, blue, barred feathers	female, blue, non-barred feathers

[5]

(c) Explain how the genotype of a male chicken with blue, barred feathers could be determined.

.....

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..... [3]

[Total: 10]

7 **(a)** In mammals, excess amino acids cannot be stored in the body.

Outline the formation of urea from excess amino acids by liver cells.

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..... [3]

(b) The mammalian kidney is composed of many nephrons.

Describe the process of ultrafiltration in the nephron.

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..... [4]

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(c) Fig. 7.1 is a diagram of a nephron.

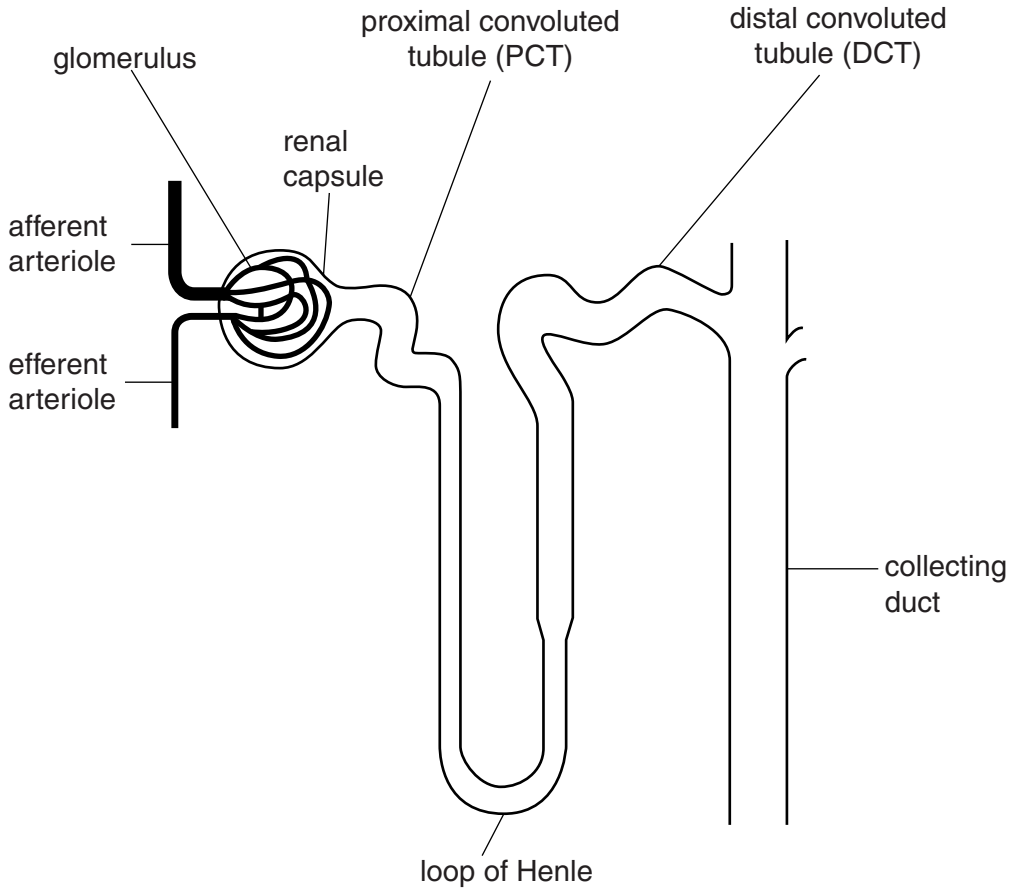


Fig. 7.1

Complete Table 7.1 by naming a part of the nephron that corresponds to each of the statements.

Table 7.1

statement	part of nephron
passes through the medulla	.....
glucose is reabsorbed into the blood	.....
ADH acts on its walls	.....
most of the water is reabsorbed into the blood	.....

[4]

[Total: 11]

8 **(a)** Fig. 8.1 is an electron micrograph of part of a cholinergic synapse.

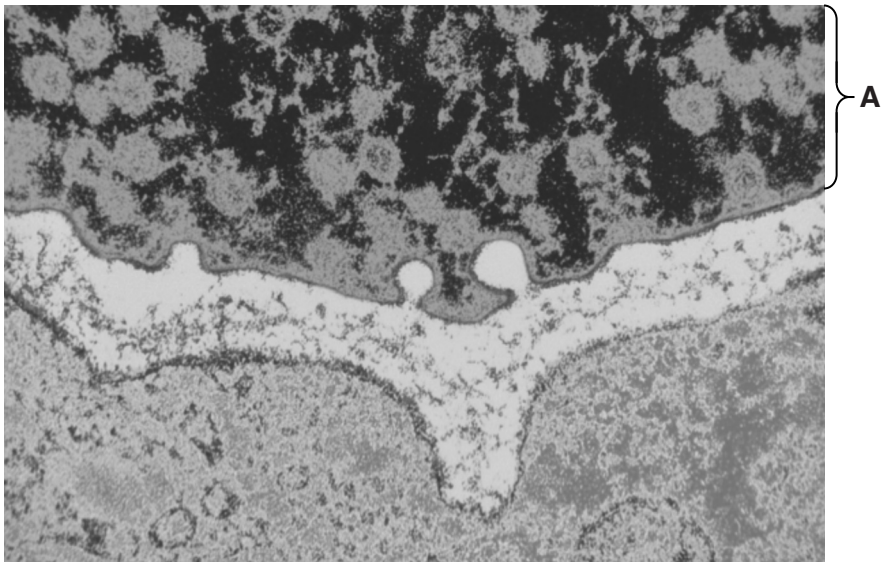


Fig. 8.1

On Fig. 8.1, use label lines and letters to label each of the following:

X – a structure that indicates that **A** is a pre-synaptic neurone

Y – an area that contains many voltage-gated Na^+ channels

Z – an area that contains both acetylcholine **and** acetylcholinesterase.

[3]

(b) Some insecticides have a similar structure to acetylcholine. Suggest how these insecticides may affect the functioning of acetylcholinesterase.

.....

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.....

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..... [3]

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(c) Outline the roles of synapses in the nervous system.

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..... [2]

[Total: 8]

Section B

Answer **one** question.

9 **(a)** Outline the process of glycolysis. [6]

(b) Describe the series of reactions that make up the Krebs cycle. [9]

[Total: 15]

10 **(a)** Explain how meiosis and fertilisation can result in genetic variation amongst offspring. [8]

(b) Describe the genetic control of protein production in a prokaryote using the *lac* operon. [7]

[Total: 15]

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[Turn over

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BIOLOGY **9700/43**

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.

This document consists of **22** printed pages and **2** lined pages.

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CAMBRIDGE International Examinations

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.

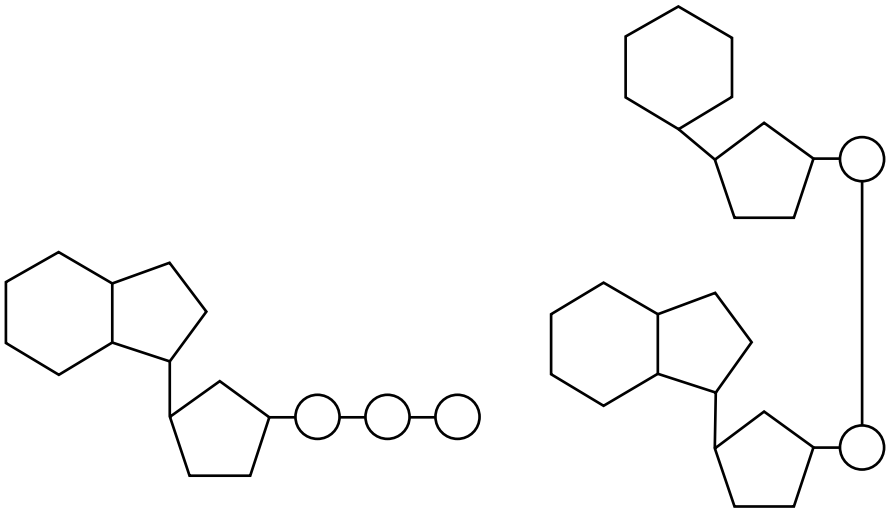


Fig. 1.1

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.

.....

.....

.....

.....

.....

..... [2]

[Total: 10]

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[Turn over

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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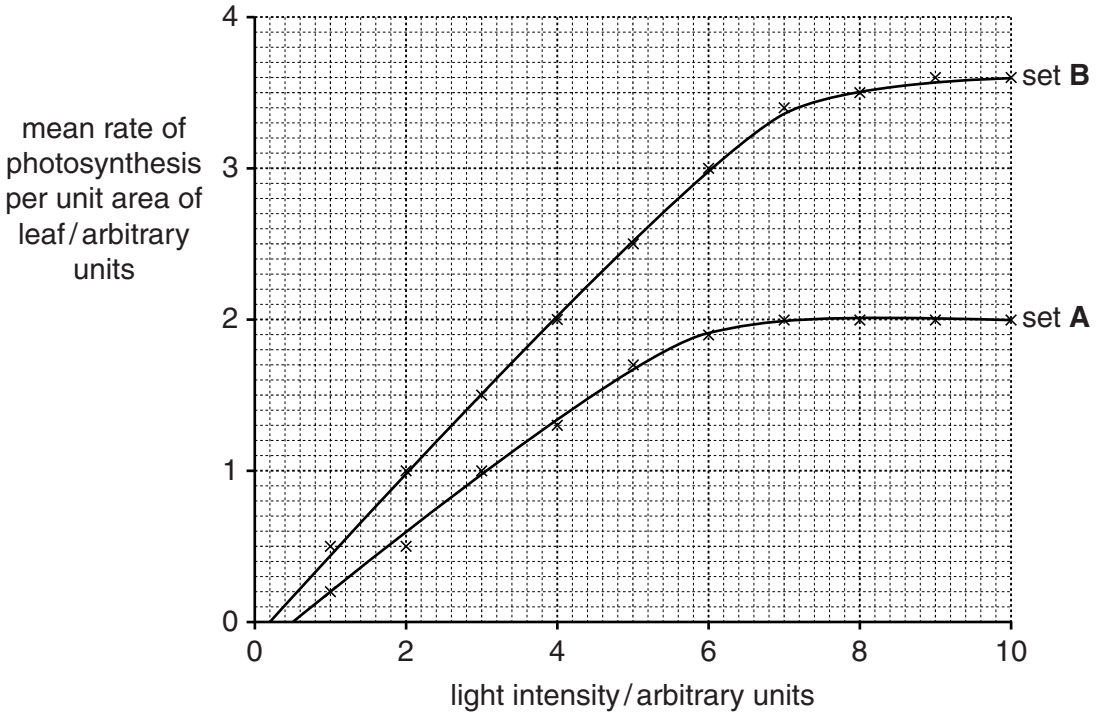


Fig. 2.1

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.

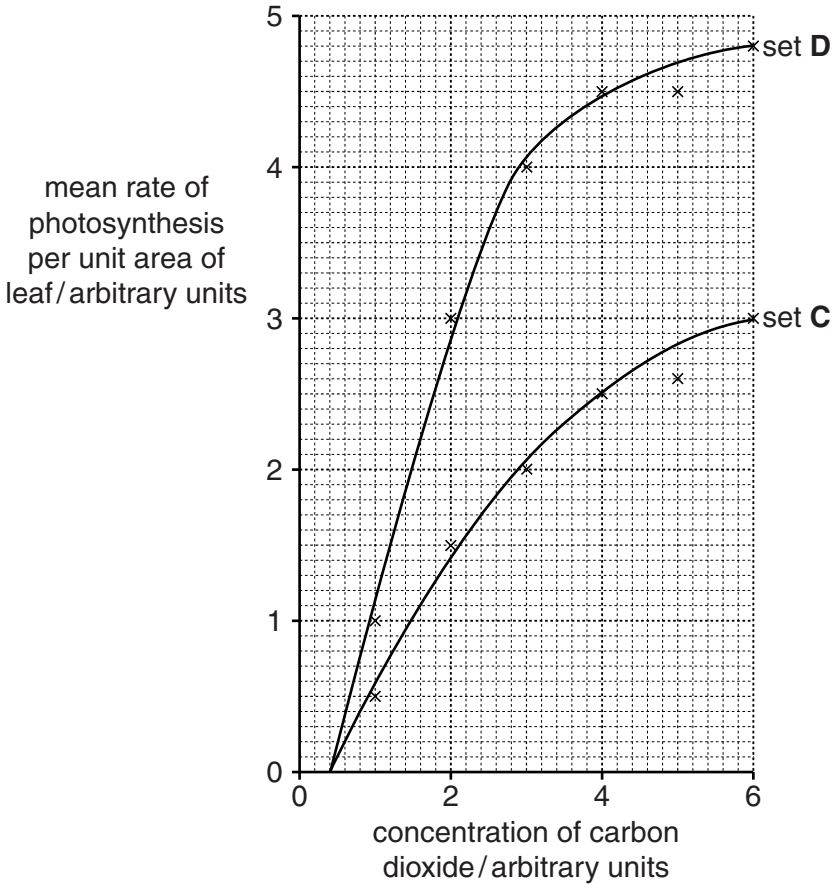


Fig. 2.2

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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..... [3]

(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.

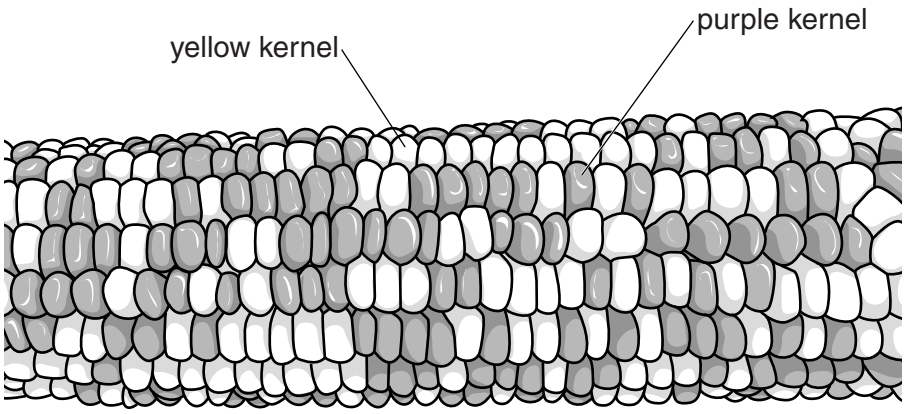


Fig. 4.1

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).

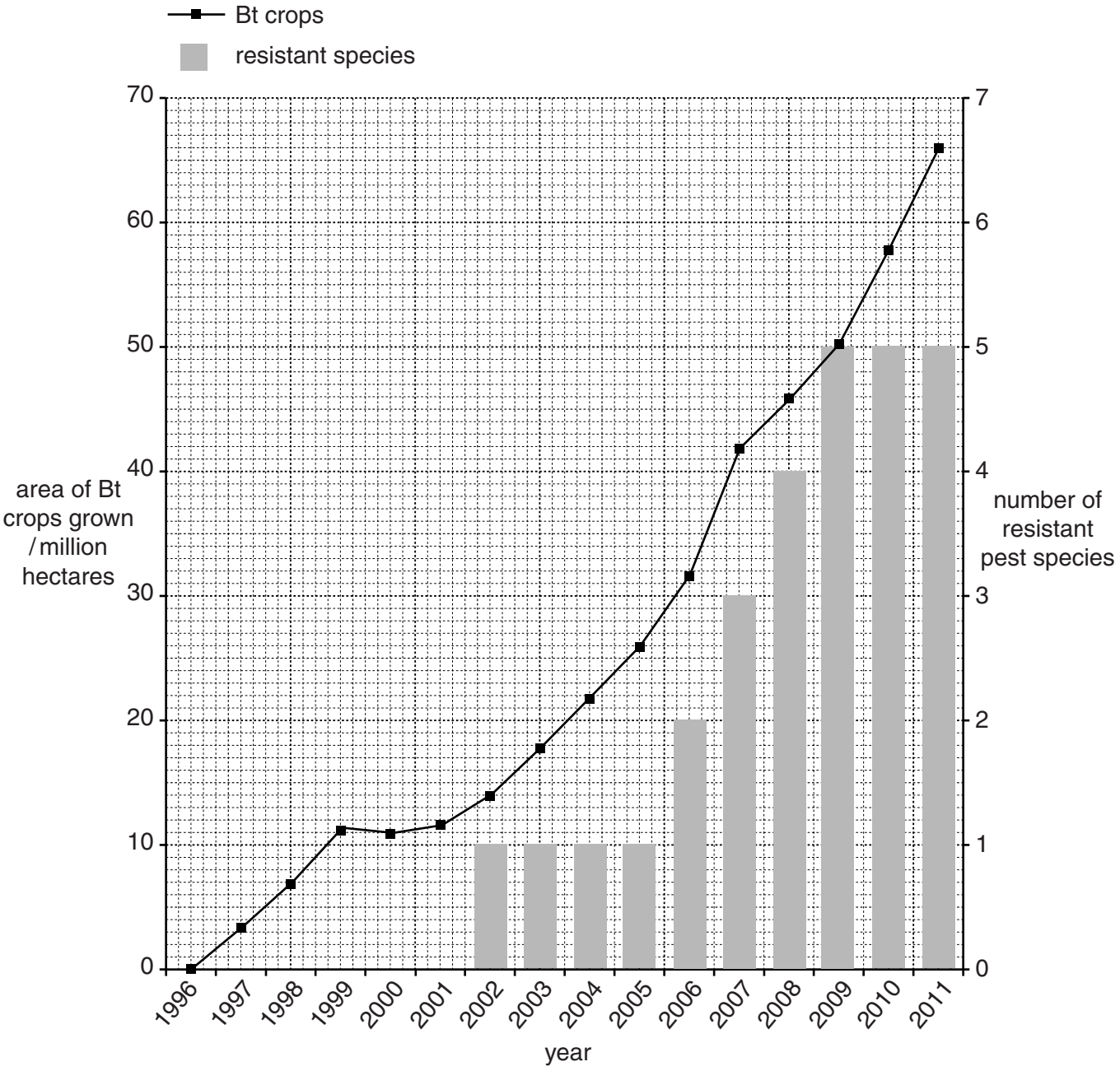


Fig. 4.2

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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 .....

.....

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]

(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 .....

.....

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]

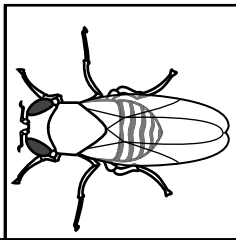
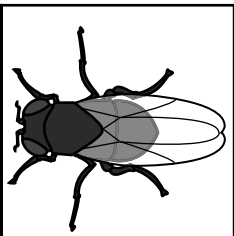
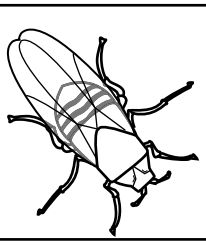
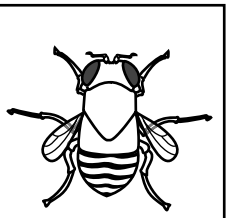
[Total: 10]

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

.....

.....

.....

.....

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.

.....

.....

.....

.....

..... [2]

[Total: 10]

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

Explain what is meant by the term *homeostasis*.

.....

.....

..... [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.

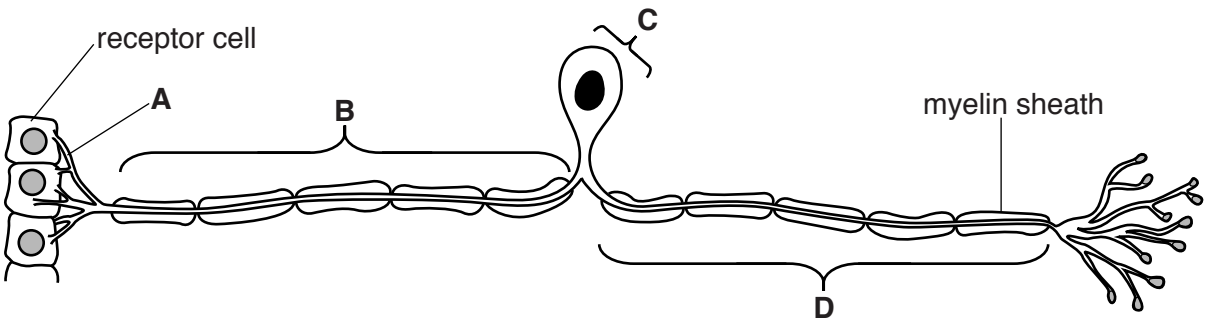


Fig. 8.1

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.

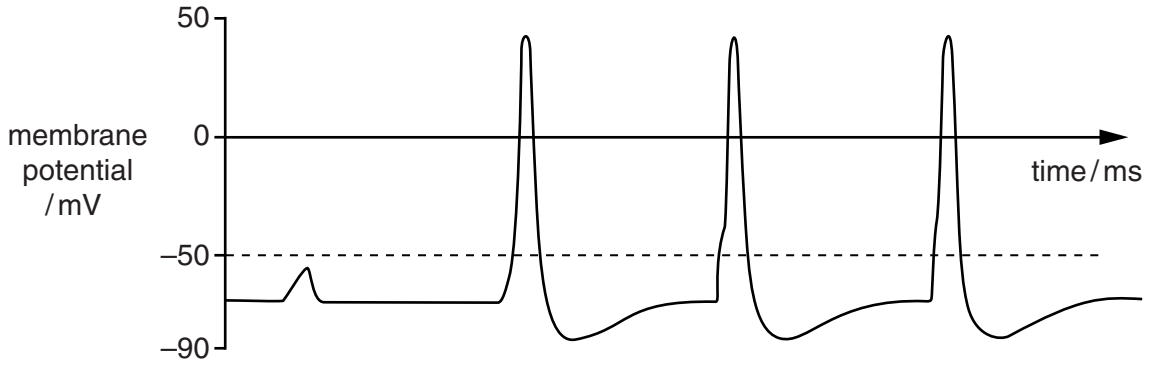


Fig. 8.2

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

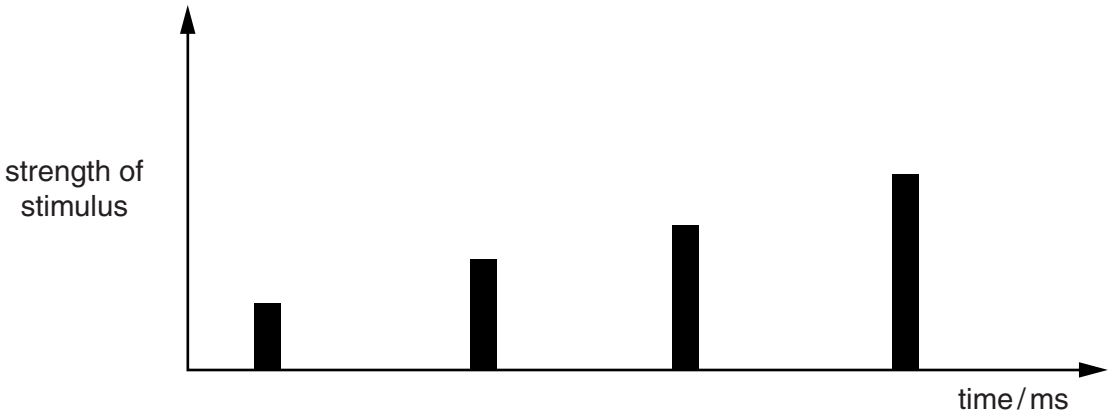


Fig. 8.3

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

.....

.....

.....

.....

.....

..... [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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