Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology A (Salters Nuffield)

Advanced

Paper 2: Energy, Exercise and Coordination

Additional Specimen Paper for first teaching September 2016

Time: 2 hours

Paper Reference

9BN0/02

You may need a ruler.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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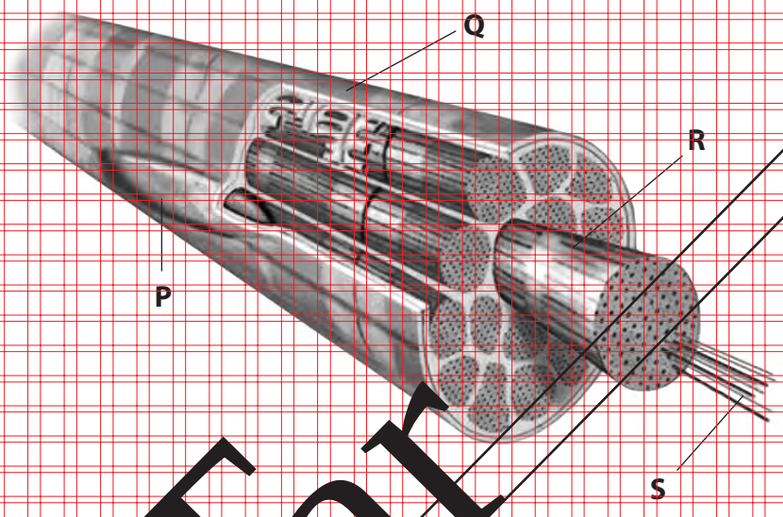
Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Skeletal muscle is made up of different types of muscle fibre.

(a) The diagram shows a part of a muscle fibre.



(i) Which label shows a myofibril?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(ii) Which label shows a myofilament?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

(iii) Which of the labelled structures is the sarcolemma?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** S

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(b) Skeletal muscle contains slow twitch and fast twitch muscle fibres.

Explain the differences in the structure of these muscle fibres.

(3)

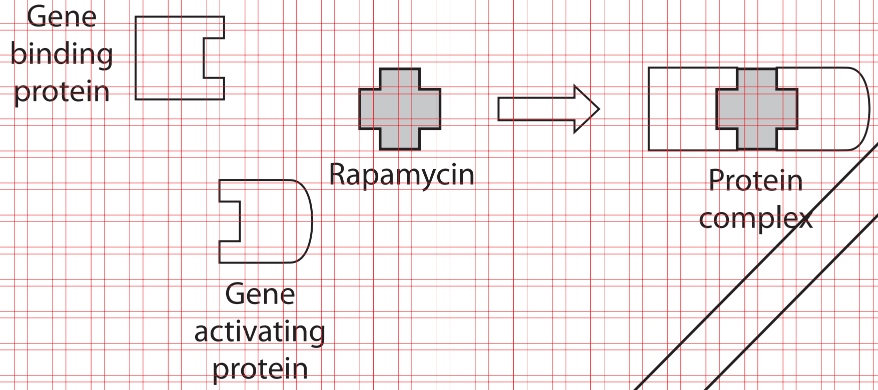
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2 Some mice have been genetically modified and have had the gene for producing a growth factor called HGF introduced into their genome. This gene is activated when these mice are given a drug called rapamycin.

Genes for two other proteins have been introduced into the mouse DNA. One of these proteins is able to bind to the HGF gene and the other causes the gene to be activated.

HGF is produced when rapamycin binds these two molecules together into a protein complex, as shown in the diagram.



(a) What name is given to the type of molecule that can activate a gene?

(1)

- ☒ **A** operator
- ☒ **B** promoter
- ☒ **C** start codon
- ☒ **D** transcription factor

(b) Describe the events following formation of the protein complex that result in the production of messenger RNA that codes for HGF.

(3)

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(c) Explain how the rate of HGF production could be controlled in these mice.

(2)

(Total for Question 2 = 6 marks)

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3 Drugs such as MDMA affect the nervous system.

(a) Explain the effect of MDMA on a synapse.

(3)

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(b) Many toxins also affect the nervous system of mammals. These toxins can interfere with the synapses of motor neurones. The toxin may prevent muscle contraction (paralysis) or it may cause a muscle to be fully contracted for a long period of time (tetany).

For each of these effects, explain one way in which the toxin could affect the normal functioning of a synapse.

(i) Paralysis

(2)

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(ii) Tetany

(2)

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(Total for Question 3 = 7 marks)

Exemplar

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4 Dormant seeds begin to grow when conditions are suitable. This process of breaking dormancy is called germination.

(a) Some seeds convert starch into maltose during germination.

(i) What is the name of the process by which maltose is formed from starch?

(1)

☒ **A** anabolism

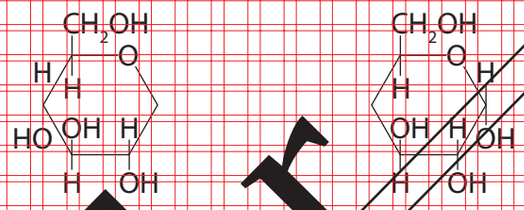
☒ **B** condensation

☒ **C** glycolysis

☒ **D** hydrolysis

(ii) Complete the diagram to show the molecular structure of maltose that is formed from two glucose molecules.

(1)



(iii) What is the name of the bond between the two glucose molecules?

(1)

☒ **A** ester

☒ **B** glycosidic

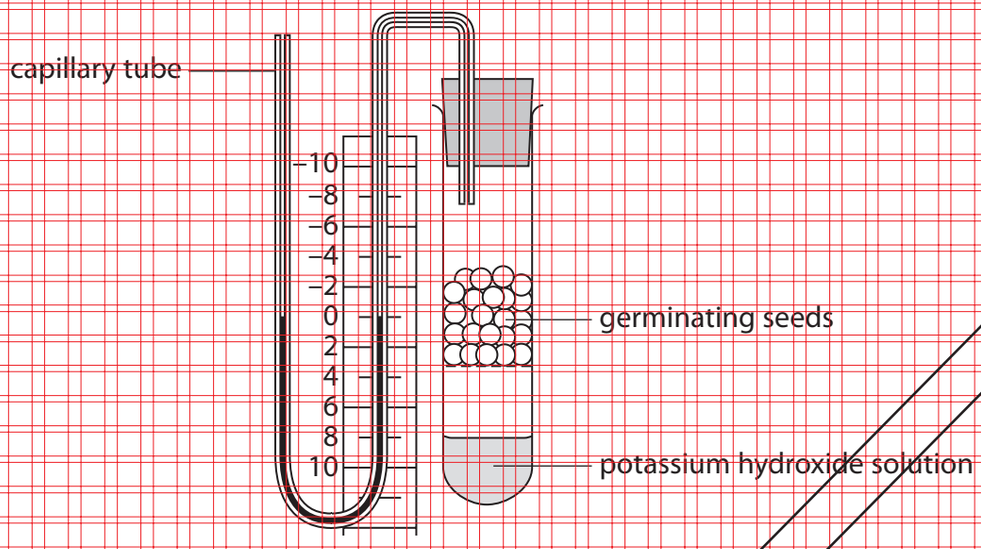
☒ **C** hydrogen

☒ **D** peptide

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(b) Respiration in germinating seeds was investigated using the apparatus shown in the diagram.



The position of the fluid against the scale was recorded at five-minute intervals.

The results are shown in the table.

Time / mins	Position of fluid in capillary tube
0	0
5	0
10	–2
15	–3
20	–4

(i) Explain why the movement of fluid in the capillary tube can be used to measure the rate of respiration in the seeds.

(2)

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*(ii) Explain how this apparatus could be modified and used to measure anaerobic respiration in germinating pea seeds.

(6)

(Total for Question 4 = 11 marks)

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5 Studies to determine the structure of DNA investigated the arrangement of organic bases in the DNA molecule.

The table shows measurements of the proportions of the four bases found in the DNA from the genomes of a range of organisms. The structural formula of each base is also shown.

Source of DNA	**Percentage of organic base in DNA**				**Ratio**	
	Adenine	**Cytosine**	**Guanine**	**Thymine**	**A+G:C+T**	**A+T:C+G**
Human	31.0	18.4	19.1	31.5	1.00	1.67
Salmon	29.7	20.4	20.8	29.1	1.02	1.43
Wheat plant	27.3	22.8	22.7	27.2	1.00	**E**
Bacterium	24.6	25.6	25.5	24.3	1.00	**F**

(a) Calculate values for the ratios of adenine and thymine to cytosine and guanine for the wheat plant (**E**) and the bacterium (**F**).

(2)

E = ...

F = ...

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(b) Discuss to what extent these data can be used to compare the genomes of these organisms.

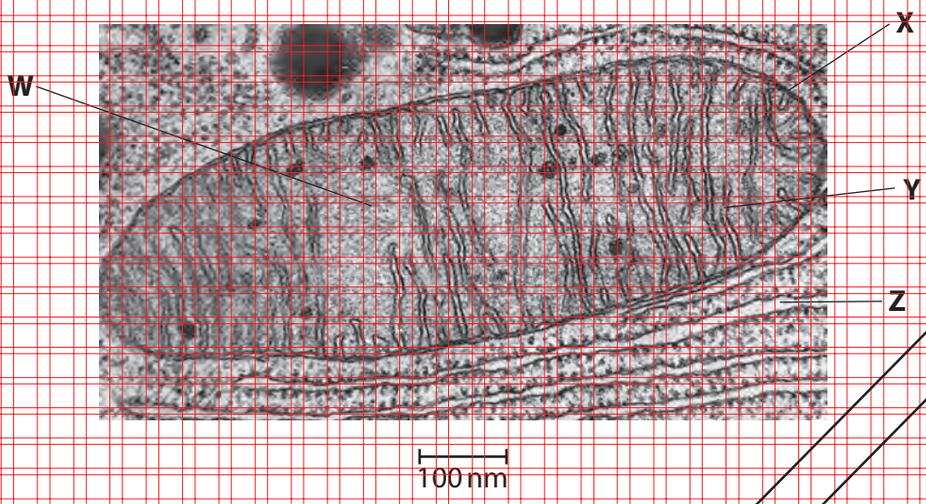
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(Total for Question 5 = 8 marks)

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Example

6 Mitochondria are involved in respiration in cells.

(a) The image shows a section through a mitochondrion.



(i) Which of the following gives the maximum length of the mitochondrion?

(1)

- ☒ **A** 0.09 µm
- ☒ **B** 0.87 µm
- ☒ **C** 0.90 mm
- ☒ **D** 0.87 mm

(ii) Which of the following labels shows where reactions of the electron transport chain occur?

(1)

- ☒ **A** W
- ☒ **B** X
- ☒ **C** Y
- ☒ **D** Z

(iii) Give reasons why the structure shown in the image can be identified as a mitochondrion.

(2)

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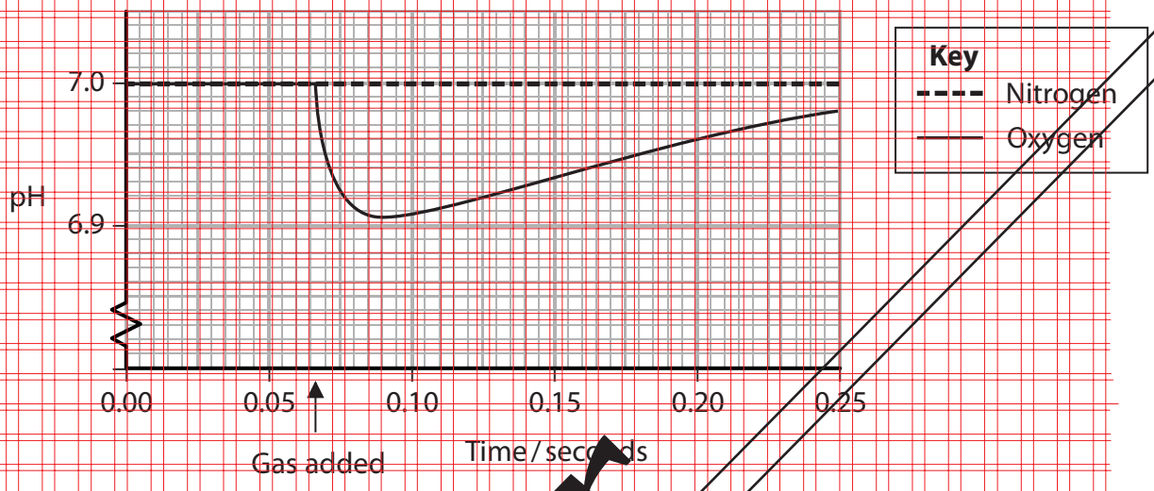
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(b) An investigation was carried out to study the role of the mitochondrial membranes in the process of aerobic respiration.

Mitochondria were removed from cells and kept under anaerobic conditions. The mitochondria were exposed briefly to either oxygen or nitrogen gas and the pH of the space between the outer and inner membranes was recorded.

The results are shown in the graph.



(i) Explain why the mitochondria were exposed to nitrogen gas as a control in this investigation.

(2)

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(ii) Deduce reasons for the changes in pH observed when oxygen was introduced.

(3)

(c) In a separate investigation, mitochondria were treated to increase the permeability of the inner membrane to hydrogen ions. Treated and untreated mitochondria were placed under aerobic conditions.

Untreated mitochondria produced ATP and treated mitochondria did not produce ATP.

Explain the role of the inner mitochondrial membrane in aerobic respiration.

(3)

(Total for Question 6 = 12 marks)

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7 In a study of inheritance, fruit flies with red eyes and straight wings were crossed with fruit flies that had scarlet eyes and curly wings. All of the offspring (F1 generation) had red eyes and straight wings.

(a) Explain the results of this cross for the inheritance of eye colour.

(2)

(b) Which of the following describes the genotype of the F1 offspring for wing shape?

(1)

- ☒ **A** dominant
- ☒ **B** heterozygous
- ☒ **C** homozygous
- ☒ **D** recessive

(c) Some of these F1 generation fruit flies were crossed with fruit flies that had scarlet eyes and curly wings to produce an F2 generation.

(i) Draw a genetic diagram to show the genotypes expected in the F2 generation.

(3)

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(ii) The table shows the phenotypes and numbers of fruit flies produced in the F2 generation.

Eye colour	Red	Red	Scarlet	Scarlet
Wing shape	Straight	Curly	Straight	Curly
Number of flies	138	96	101	127

A chi squared test was performed with an expected ratio of 1:1:1:1 for the four phenotypes. The calculated value from the test was 10.64.

The table shows critical values for chi squared distribution.

Degrees of freedom	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.001**	**0.0001**
1	1.64	2.71	3.84	5.41	6.63	10.83	15.14
2	3.22	4.61	5.99	7.82	9.21	13.82	18.42
3	4.64	6.25	7.81	9.84	11.34	16.27	21.11
4	5.99	7.78	9.49	11.67	13.28	18.47	23.51
5	7.29	9.24	11.07	13.39	15.09	20.51	25.74

Analyse the data to determine whether the F_2 offspring numbers differ significantly from the 1:1:1:1 ratio of phenotypes.

(3)

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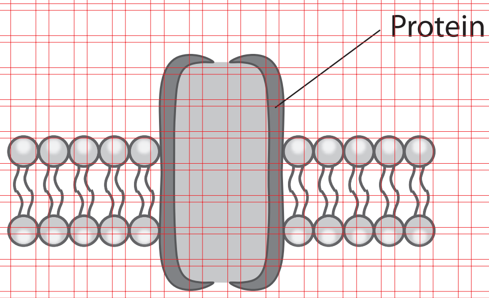
(iii) Deduce a possible explanation for the number of each phenotype in the F2 generation.

(3)

(Total for Question 7 = 12 marks)

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Exemplar

8 The diagram shows a part of the cell membrane of an axon.



(a) Explain why sodium ions and potassium ions cannot cross the phospholipid bilayer of the membrane of an axon.

(2)

(b) Explain how the protein labelled in the diagram allows ions to move across the membrane.

(3)

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(c) The table shows four membrane proteins involved in the movement of ions across the axon membrane during a nerve impulse.

(i) Complete the table to show whether the protein is involved with the movement of ions during each stage of the nerve impulse listed.

Use a tick (✓) to show that ions are crossing the membrane using the protein and a cross (✗) to show that they are not.

(3)

Protein	Stage of nerve impulse		
	Depolarisation	Repolarisation	Refractory period
Voltage-dependent potassium channels			
Voltage-dependent sodium channels			
Passive potassium channel	✓	✓	✓
Sodium-potassium pump			

(ii) Explain how passive potassium channels are involved in establishing the resting potential of an axon.

(4)

(Total for Question 8 = 12 marks)

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9 The biodiversity of part of a stream was measured by counting the number of organisms present. A second study of the stream was carried out several weeks later following a leak of sewage into the water. The table shows the results of the two studies.

Species	Number of individuals	
	First study	**Study following sewage leak**
Freshwater shrimp	150	127
Mayfly nymph	113	10
Ramshorn snail	2	0
Caddis-fly nymph	12	0
Midge larva	210	386
Water louse	86	197

(a) State what is meant by **biodiversity**.

(2)

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(b) The index of diversity for the stream was calculated using the formula

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

where N is the total number of individuals of all species found and n is the number of individuals of each species.

In the first study the diversity index was 3.8.

Calculate the diversity index for the stream following the sewage leak.

(3)

Answer ....

DRAFT Exemplar

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(c) Explain why some species increased in number after the sewage leak but others decreased in number.

(3)

(Total for Question 9 = 8 marks)

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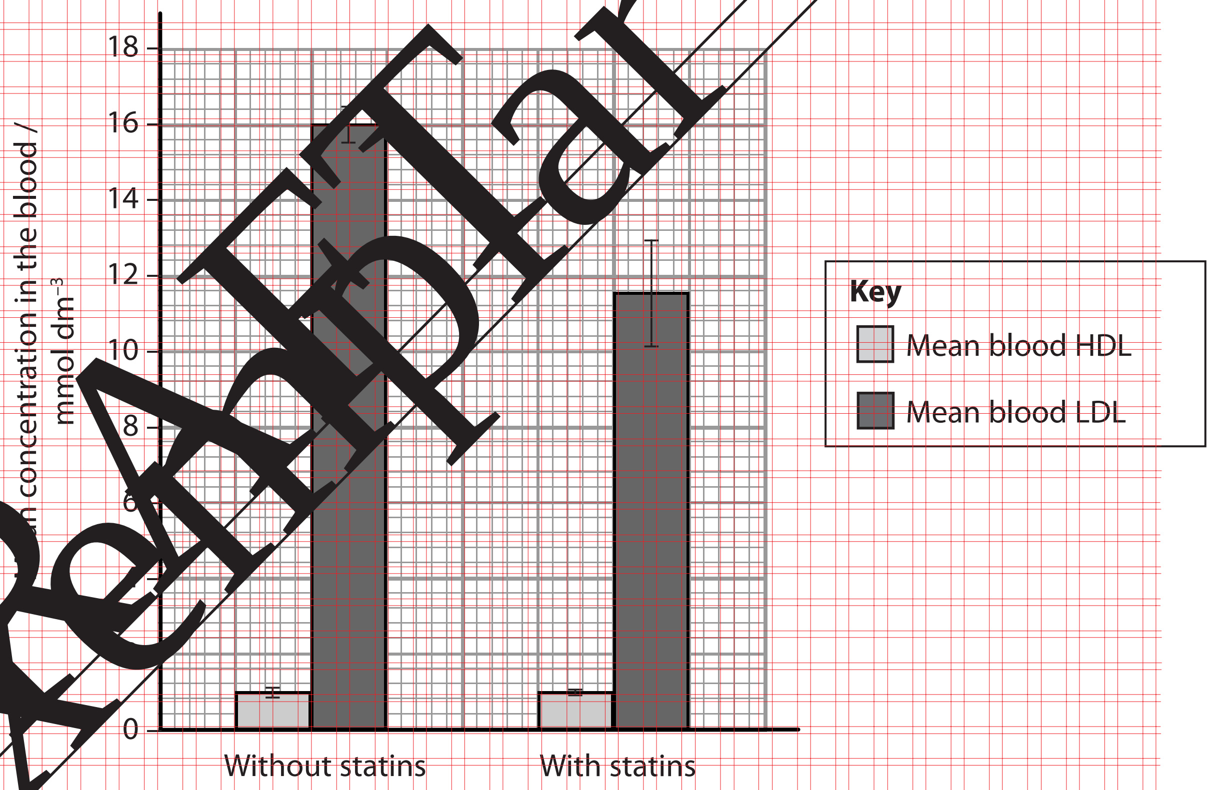
10 An inherited condition called familial hypercholesterolaemia (FH) affects the ability to remove low density lipoproteins (LDLs) from the blood stream.

People with FH have a concentration of LDL in the blood that is significantly higher than a healthy value of 3 mmol dm^{-3}.

A study monitored the health of individuals diagnosed at birth with FH. Treatment with statins was offered to those with FH when it became available in 1990.

Some of the results of the study are shown in the table and the graph.

	Without statins	With statins
Size of sample	36	113
Deaths from CVD	22	28
Mean age at death due to CVD (years)	17.7	31.7
Number of non-fatal heart attacks	6	44
Mean age at first heart attack (years)	12.8	28.3



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(a) What is the purpose of including standard deviation with mean measurements?

(1)

- ☒ **A** to show how many errors have been made
- ☒ **B** to show the probability of the data being accurate
- ☒ **C** to show the range of the measured data
- ☒ **D** to show the variability in the data

(b) Comment on the claim that statins 'reduce the risk of CVD in people affected by FH'.

(4)

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(c) Describe how the design of this study could have been changed to make any conclusions more valid.

(3)

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Exemplar

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11 The development of the visual cortex in the brain is affected by many factors.

(a) A study of chemical control during visual development tested the effects of nerve growth factor (NGF) on vision in rats.

Two groups of young rats had permeable capsules implanted into their brains.

The first group had NGF in the capsules and the second group had capsules that did not contain NGF. All of the rats were kept in the dark for 25 days.

At the end of the 25 days it was found that rats treated with NGF were able to see normally but rats without NGF had poor vision.

(i) State the term that describes the period during which visual stimuli are needed for normal development of the visual cortex.

(1)

(ii) Explain why the second group of rats had capsules without NFG implanted in their brains.

(2)

(iii) Deduce how NGF may affect brain development.

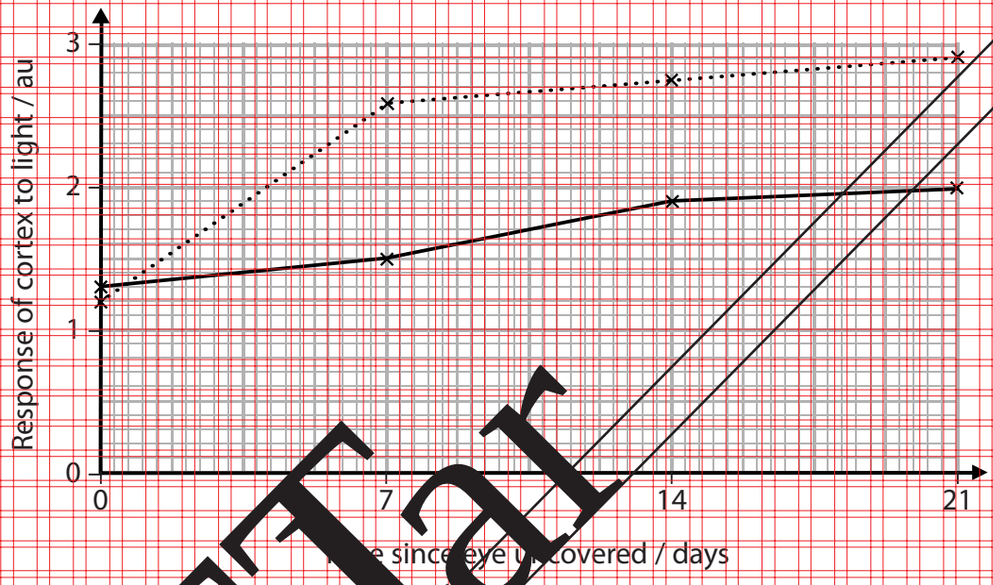
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(b) In a different study of visual development, mice had one eye covered for several weeks. When the cover was removed from the eye their brains showed reduced responses in the region related to that eye.

One group of these mice was then stimulated by being allowed to run on a treadmill and watch visual stimuli for several hours a day. Another group of these mice was confined to its home cage with no treadmill or visual stimuli.

The brain response to the eye that had been covered is shown in the graph. The normal range for response is between 2.75 au and 3.25 au.



Key

..... stimulated mice

——— non-stimulated mice

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Comment on the effects of running and visual stimulation on the visual development of these mice.

(4)

(Total for Question 11 = 10 marks)

TOTAL FOR PAPER = 100 MARKS

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