Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology A (Salters Nuffield)

Advanced

Paper 1: The Natural Environment and Species Survival

Additional Specimen Paper for first teaching September 2016

Time: 2 hours

Paper Reference **9BN0/01**

You must have:
Calculator, HB pencil, 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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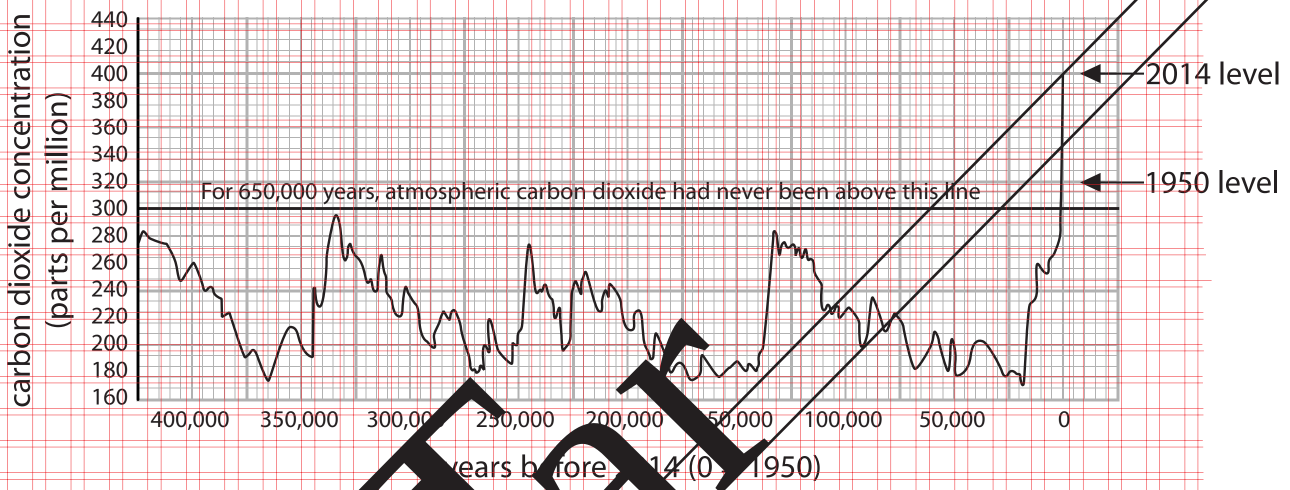
Answer ALL questions.

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 An increase in carbon dioxide concentration in the Earth's atmosphere has been linked to climate change.

(a) The graph shows the change in atmospheric carbon dioxide concentration for the past 500 000 years.



(i) What is the percentage increase in carbon dioxide concentration from 1950 to 2014?

(1)

☐ **A** 8.5%

☐ **B** 21%

☐ **C** 27%

☐ **D** 4[illegible]%

(ii) There is a correlation between the carbon dioxide concentration in the atmosphere and the temperature of the Earth's surface.

Which of the following statements best describes this correlation?

(1)

☐ **A** an increase in carbon dioxide concentration causes an increase in the temperature of the Earth's surface

☐ **B** every increase in carbon dioxide concentration will be linked to a decrease in the temperature of the Earth's surface

☐ **C** in general as carbon dioxide concentration increases the temperature of the Earth's surface increases

☐ **D** there is no link between carbon dioxide concentration and the temperature of the Earth's surface

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(iii) Which of the following is a reason for uncertainty in climate change predictions?

(1)

- ☒ **A** an absence of information on current greenhouse gas concentration
- ☒ **B** an absence of information on historic greenhouse gas concentration
- ☒ **C** future greenhouse gas concentrations are obtained by extrapolating from current and past data
- ☒ **D** knowledge that increased greenhouse gas concentrations are linked to increased surface temperatures

(b) The distribution of polar bears in Alaska and Canada has been affected by climate change.

Explain why climate change might affect the distribution of organisms in a particular geographical region.

(3)

(Total for Question 1 = 6 marks)

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Exemplar

2 Mammals have a circulation system consisting of a heart and blood vessels.

(a) Explain how the structure of the heart helps to maintain a supply of oxygen to muscle tissue.

(4)

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(b) Explain how the structure of the aorta helps to maintain blood pressure during diastole.

(3)

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(Total for Question 2 = 7 marks)

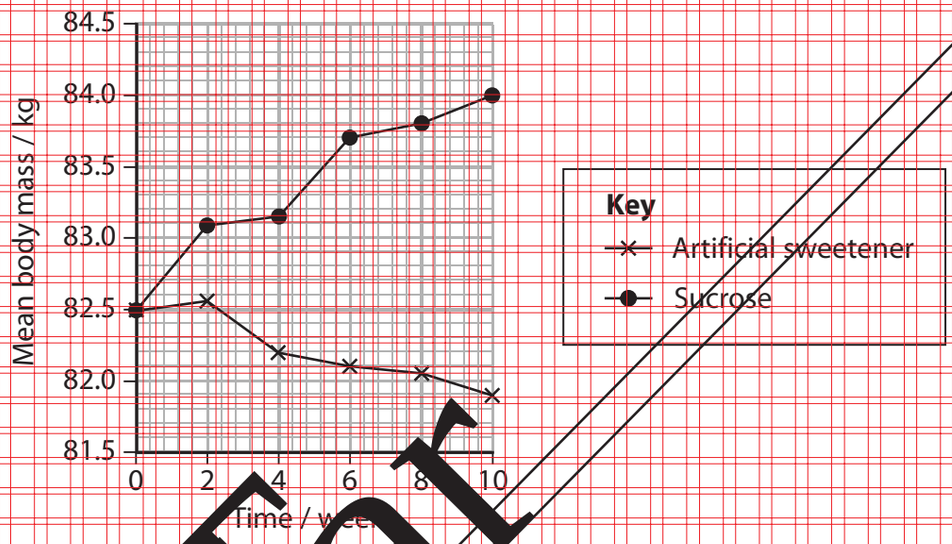
DRAFT Exemplar

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3 The use of sucrose as a sweetener in drinks has been linked to obesity in several studies. Obesity is linked to cardiovascular disease.

(a) In one study the effect of replacing sucrose with an artificial sweetener was investigated.

One group of individuals was provided with food and drinks sweetened with sucrose. A second group was provided with food and drinks sweetened with an artificial sweetener.



(i) Describe the structure of sucrose.

(2)

(ii) Calculate the rate of increase in body mass for the first six weeks for the group consuming sucrose sweetened drinks.

(2)

Answer ..... kg day^{-1}

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DRAFT

(iii) Deduce the effect of replacing sucrose with this artificial sweetener on mean body mass.

(3)

(b) Overweight and obese individuals are at increased risk of raised blood pressure. This can increase the risk of developing atherosclerosis.

Explain how replacing sucrose with artificial sweeteners can reduce the risk of atherosclerosis.

(4)

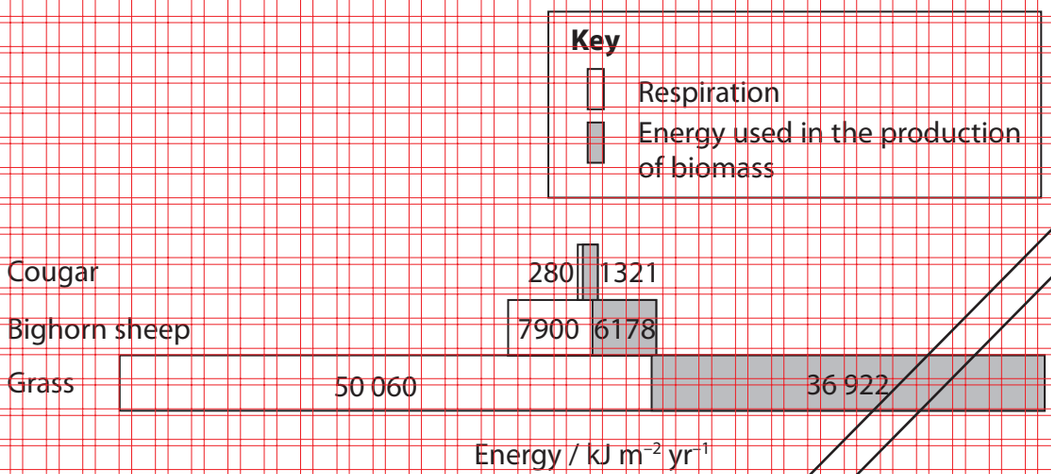
(Total for Question 3 = 11 marks)

Exemplar

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4 The bighorn sheep is a mammal native to North America.

(a) A pyramid of energy can be used to show the transfer of energy within an ecosystem. The pyramid of energy for part of an ecosystem is shown in the diagram.



(i) What is the gross productivity of grass in kJ m^{-2} yr^{-1}?

(1)

- ☒ **A** 0.74
- ☒ **B** 1.36
- ☒ **C** 13 138
- ☒ **D** 86 982

(ii) What is the efficiency of energy transfer from grass to bighorn sheep?

(1)

- ☒ **A** 16%
- ☒ **B** 17%
- ☒ **C** 24%
- ☒ **D** 36%

(iii) In the pyramid of energy shown, grass, bighorn sheep and cougar

(1)

- ☒ **A** are all consumers
- ☒ **B** belong to different trophic levels
- ☒ **C** belong to the same trophic level
- ☒ **D** occupy the same niche

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Exemplar

(b) Data have been collected on the time spent grazing by the same group of female bighorn sheep when they had lambs and when they did not have lambs.

Sheep	Time spent grazing (%) Without lamb, (y_1)	With lamb, (y_2)	Difference $D(y_1 - y_2)$	Difference – mean difference $D - \bar{D}$	$(D - \bar{D})^2$
A	72.00	55.50	16.50	23.35	545.25
B	62.35	43.80	18.55	25.40	645.19
C	55.77	66.80	–11.03	–4.18	17.47
D	59.98	68.00	–8.02	–1.17	1.37
E	51.60	57.88	–6.28	0.57	0.33
F	61.48	61.90	–0.42	6.43	41.35
G	52.57	45.40	7.17	14.02	196.58
H	52.50	56.67	–4.17	2.68	7.19
I	56.43	73.30	–16.87	–10.02	100.39
J	48.60	63.53	–14.93	–8.08	65.28
K	42.90	54.50	–11.60	–4.75	22.56
L	52.50	55.05	–2.30	4.55	20.71
M	40.43	61.00	–20.57	–13.72	188.22
N	47.[illegible]	64.08	–16.95	–10.1	102
O	50.08	71.40	–21.32	–14.47	209.36
P	[illegible]	71.50	–17.37	–10.52	110.66
		Mean ($\bar{D}$)	–6.85		
		Sample size (n)	16		
		$\sum D$	–109.61	$\sum(D - \bar{D})^2$	2273.89

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(i) Calculate the t value for the paired samples using the formula:

(2)

$$t = \frac{\overline{D} \times \sqrt{n}}{\sqrt{\frac{\Sigma(D - \overline{D})^2}{n - 1}}}$$

t = ...

(ii) The null hypothesis for this study was:

There will be no difference between the time spent grazing by the sheep with or without lambs.

The table shows some of the critical values for the t-test.

df	Significance level		
	$p = 0.1$	$p = 0.05$	$p = 0.01$
15	1.75	2.13	2.95
16	1.75	2.12	2.92
20	1.72	2.09	2.85
25	1.71	2.06	2.79
30	1.70	2.04	2.75
32	1.69	2.04	2.74
35	1.69	2.03	2.72

Determine the conclusion that can be drawn from these data using the t value you have calculated.

(2)

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(c) Bighorn sheep feed their lambs with milk that contains approximately 8% triglyceride.

(i) Which of the following is the correct structure of a triglyceride molecule?

(1)

☒ **A** one fatty acid linked to a glycerol molecule by an ester bond

☒ **B** one fatty acid linked to a glycerol molecule by a glycosidic bond

☒ **C** three fatty acids linked to a glycerol molecule by ester bonds

☒ **D** three fatty acids linked to a glycerol molecule by glycosidic bonds

(ii) Explain why sheep with a lamb spend more time grazing than sheep without a lamb.

(2)

(Total for Question 4 = 10 marks)

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5 Enterobacteria are a type of Gram negative bacteria responsible for many infections of the digestive system in humans.

(a) Enterobacterial infections can be treated with antibiotics.

An antibiotic sensitivity test is carried out in hospital laboratories to determine the best antibiotic to use.

Devise a suitable procedure for the incubation of Enterobacteria in a hospital laboratory.

(3)

(b) Antibiotic resistance is a significant problem in the treatment of bacterial infections.

Penicillin is an antibiotic with a beta-lactam structure.

Beta-lactams block the cross-linking of peptidoglycans involved in the formation of the bacterial cell wall.

Explain why penicillin acts as an antibiotic.

(3)

DRAFT

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(c) Some Enterobacteria are resistant to penicillin.

In one type of antibiotic resistance the bacteria produce an enzyme, beta-lactamase, that breaks down beta-lactam.

(i) Explain how resistance to penicillin can develop within a population of Enterobacteria.

(3)

(ii) Describe how the information required to make beta-lactamase can be carried by a plasmid.

(3)

(Total for Question 5 = 12 marks)

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Example

6 RUBISCO is an enzyme found in plants.

(a) Describe the role of RUBISCO in plants.

(2)

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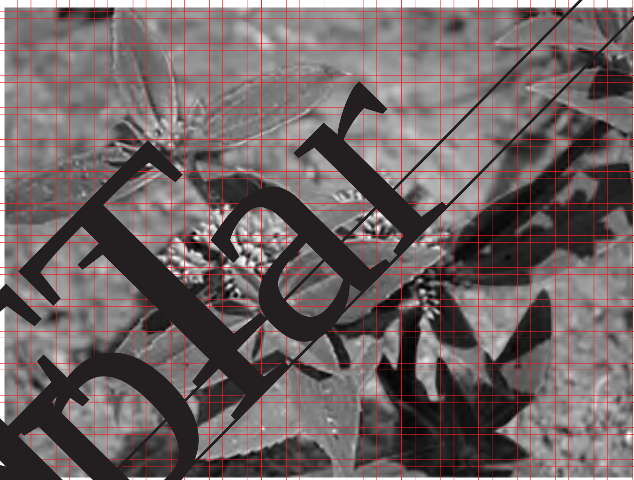
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(b) The plant *Flaveria bidentis* is frequently used in investigations of photosynthesis.

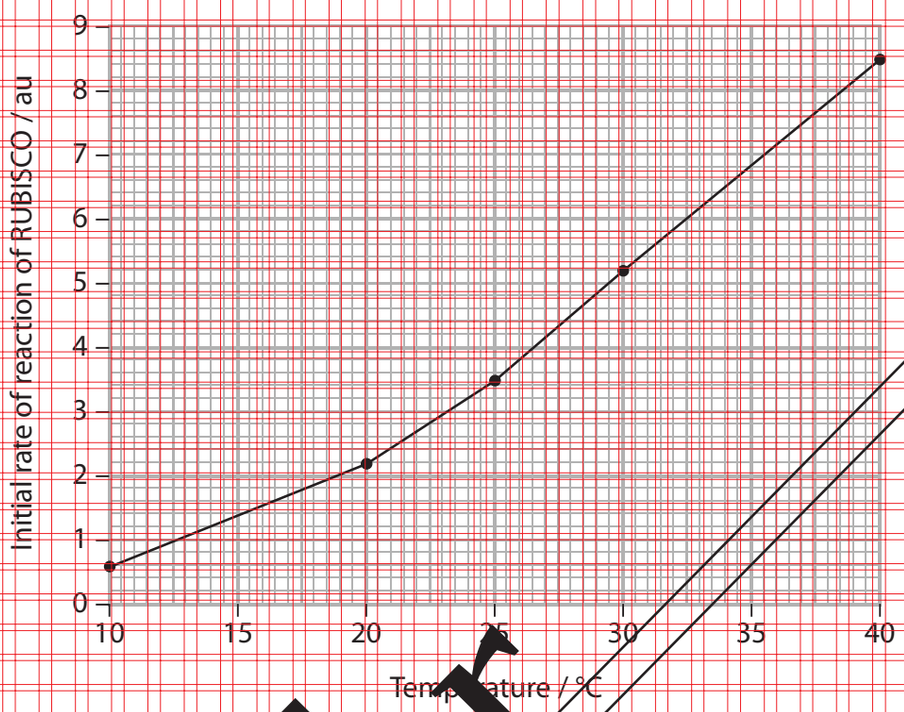


F. bidentis

DRAFT Exemplar

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The graph shows data from an investigation of the initial rate of reaction of RUBISCO in *F. bidentis*.



(i) Explain how the initial rate of reaction of RUBISCO could have been measured.

(2)

(ii) Explain the effect of increasing temperature on the initial rate of reaction of RUBISCO.

(3)

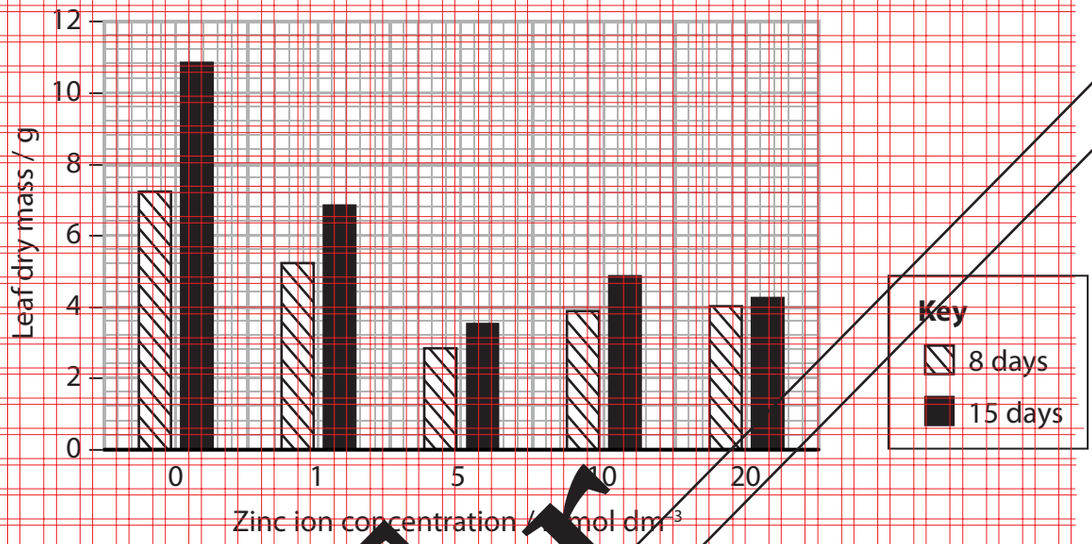
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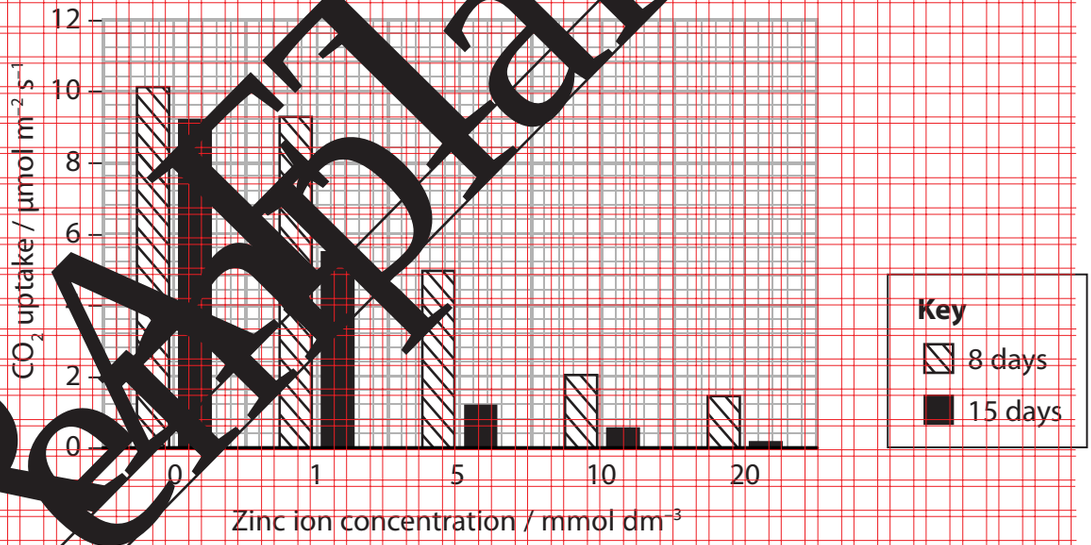
*(c) Some soils are contaminated with a high concentration of zinc ions.

The effect of zinc ions on the photosynthesis and growth of ryegrass has been investigated.

Ryegrass was grown for either 8 or 15 days in soil contaminated with zinc ions.

Growth was determined by measuring leaf dry mass. The rate of photosynthesis was determined by measuring the uptake of carbon dioxide.





In a different experiment the effect of zinc ions on the isolated ryegrass chloroplasts was investigated. The time taken for isolated chloroplasts to reduce (decolourise) DCPIP was determined. In a control without chloroplasts, the DCPIP decolourised after 18 minutes.

Zinc ion concentration / mmol dm^{-3}	Time to decolourise DCPIP / minutes
0	8
5	7
20	8

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*Assess the effect of zinc ions on photosynthesis in ryegrass.

(6)

(Total for Question 6 = 13 marks)

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Example

7 Diabetes is a condition in which the concentration of glucose in the blood is not controlled.

(a) The hormone insulin plays a key role in controlling blood glucose concentrations.

Insulin is synthesised by β-cells in the pancreas.

Insulin regulates blood glucose concentrations by binding to proteins called insulin receptors on the surface of cells.

Explain why insulin receptors only bind to insulin.

(3)

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Exemplar

(b) There are two types of diabetes, type I and type II.

(i) Type I diabetes is an autoimmune disease.

In type I diabetes the body's own immune system destroys insulin producing cells in the pancreas.

Explain how an immune response can take place that destroys only one type of cell.

(4)

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*(ii) Type II diabetes is much more common than type I diabetes.

In type II diabetes the pancreas produces reduced amounts of insulin and cells in the body become unresponsive to insulin.

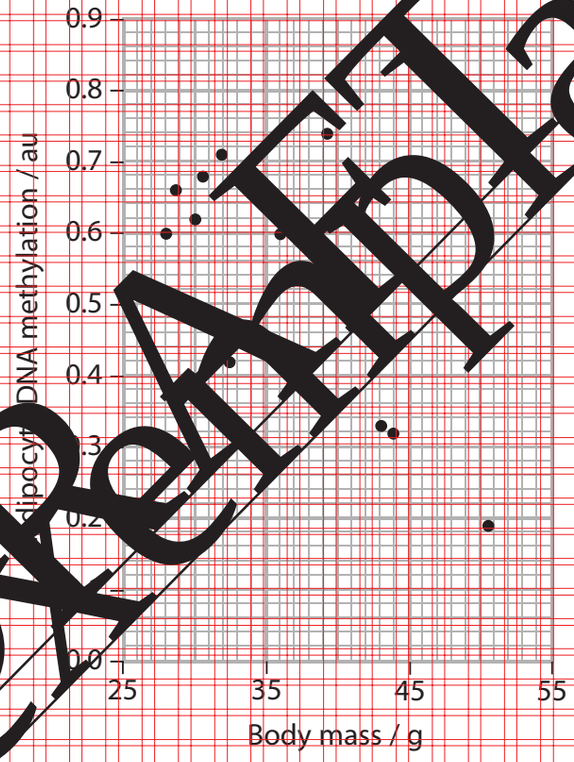
The probability of developing type II diabetes if a sibling has the condition is shown in the table.

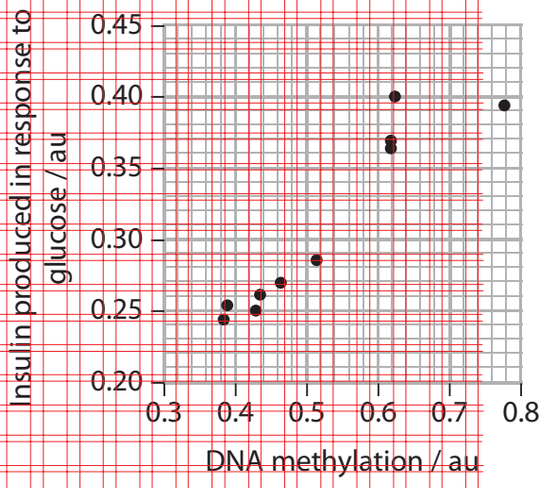
Sibling status	Probability of both siblings developing type II diabetes
Monozygotic (identical) twins	0.50
Heterozygotic (non-identical) twins	0.37
Non-twin siblings	0.22

An inbred strain of mouse, in which all mice are genetically identical, is used as a model organism for the study of type II diabetes.

When fed a high fat diet, these mice become obese and develop type II diabetes.

The methylation of adipocyte DNA and the response of adipocytes to glucose have been investigated in these mice.





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*Analyse the data to evaluate the role of genetic and environmental factors in the development of type II diabetes.

(6)

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Exemplar

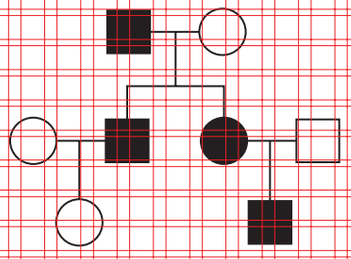
(Total for Question 7 = 13 marks)

8 Some eye diseases are inherited.

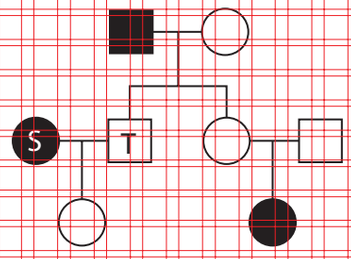
(a) Retinitis pigmentosa (RP) is an inherited, degenerative eye disease. Different inheritance patterns have been observed for RP.

Family pedigrees representing four different inheritance patterns are shown below.

A



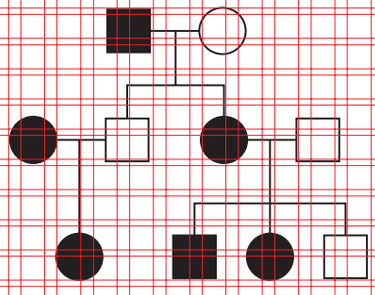
B



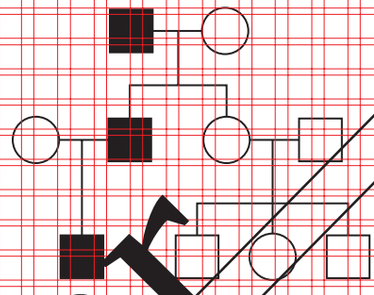
Key

- Unaffected female
- Affected female
- Unaffected male
- Affected male

C



D



(i) In one family inheritance of RP has been linked to the Y-chromosome. Which of the family pedigrees represents Y-linked inheritance?

(1)

- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

(ii) In pedigree B, what is the probability of the next child born to parents S and T having the RP phenotype?

(1)

- ☒ **A** 0
- ☒ **B** 0.25
- ☒ **C** 0.5
- ☒ **D** 1

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Exemplar

(b) Macular dystrophy is another genetic condition affecting eyesight.

The allele responsible for one form of macular dystrophy is recessive.

(i) State what is meant by the term **recessive allele**.

(2)

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(ii) In a population, nine individuals out of 324 had this form of macular dystrophy.

Use the Hardy Weinberg equation, $p^2 + 2pq + q^2 = 1$, to determine the number of individuals heterozygous at this locus.

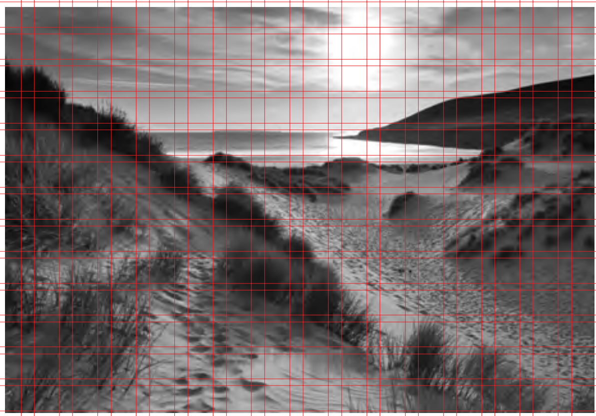
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Answer .....

(Total for Question 8 = 7 marks)

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DRAFT

9 Hairy vetch is able to grow in nutrient poor soils and is frequently found growing in the hollows between sand dunes that may be grazed by sheep.



Sand dune hollow



Hairy vetch (*Vicia villosa*)

(a) Devise an investigation to determine the effect of grazing on the distribution of hairy vetch plants.

(4)

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Exemplar

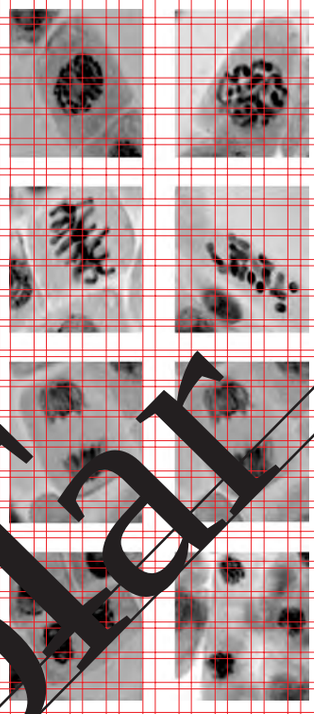
(b) Cyanamide is a chemical produced by hairy vetch that inhibits the root growth of other plants.

Growing onion roots were exposed to cyanamide.

Photographs were taken of cells at different stages of mitosis from cyanamide treated onion root tips.

Photographs were also taken of cells from untreated onion root tips as a control.

Control Cyanamide



(i) Which stage of mitosis is disrupted by cyanamide?

(1)

☒ **A** prophase

☒ **B** metaphase

☒ **C** anaphase

☒ **D** telophase

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(ii) Describe how the cyanamide exposed root tips could have been prepared to allow the examination of cells undergoing mitosis.

(4)

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(Total for Question 9 = 9 marks)

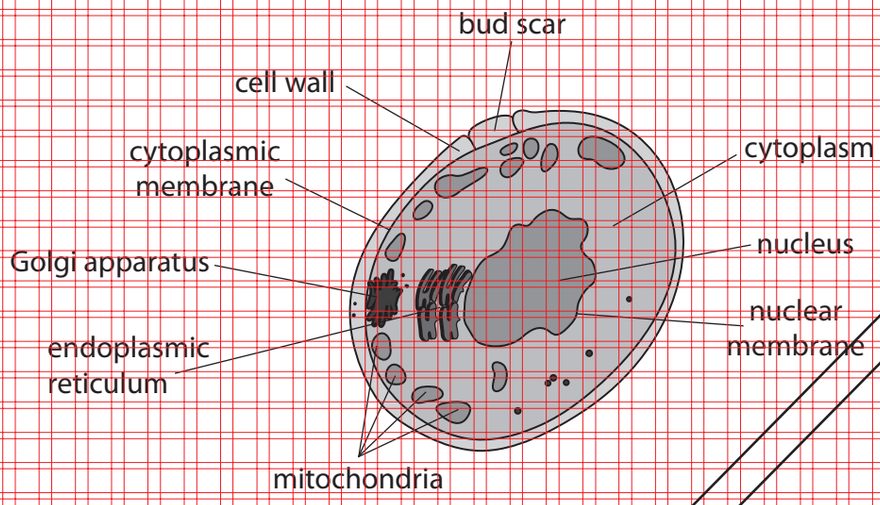
Exemplar

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10 Yeast are single celled organisms that feed on organic molecules.

The cell walls of yeast contain polysaccharides called glucans that are formed from β-glucose.

(a) A yeast cell is shown in the diagram.



Give reasons why yeast cells are considered eukaryotic but yeast is placed in a different taxonomic group from plants.

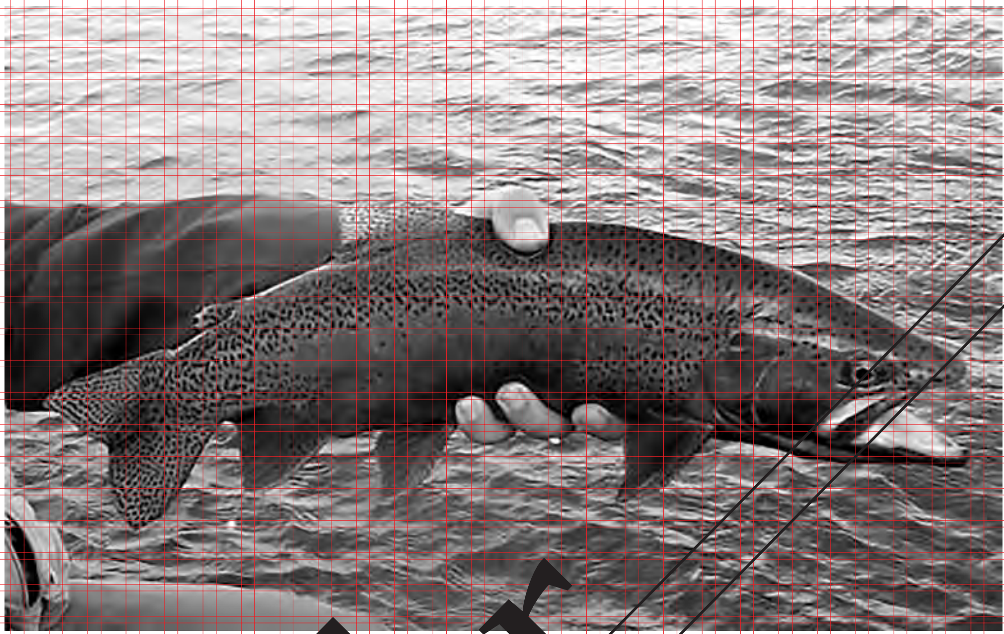
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DRAFT

(b) Glucans from yeast cell walls have been shown to affect the immune system.

Macrogard is a glucan extract prepared from the cell walls of yeast.

The effect of Macrogard on phagocytosis in rainbow trout was investigated.



Rainbow trout

(i) Describe how the process of phagocytosis leads to the destruction of bacteria.
(3)

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Exemplar

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(ii) Trout were provided with food containing Macrogard for one week.

Blood samples were then taken from the trout and the phagocytic activity of the white blood cells was measured.

Treatment	White blood cell count ($\times 10^3$ mm^{-3})		Phagocytic activity (number of cells ingested per phagocyte)	
	mean	range	mean	range
Control	29.6	19 – 38	5.98	4 – 7
Macrogard	26.8	18 – 36	9.32	8 – 11

It was concluded from these data that Macrogard increased phagocytic activity in trout.

Comment on the validity of this conclusion.

(2)

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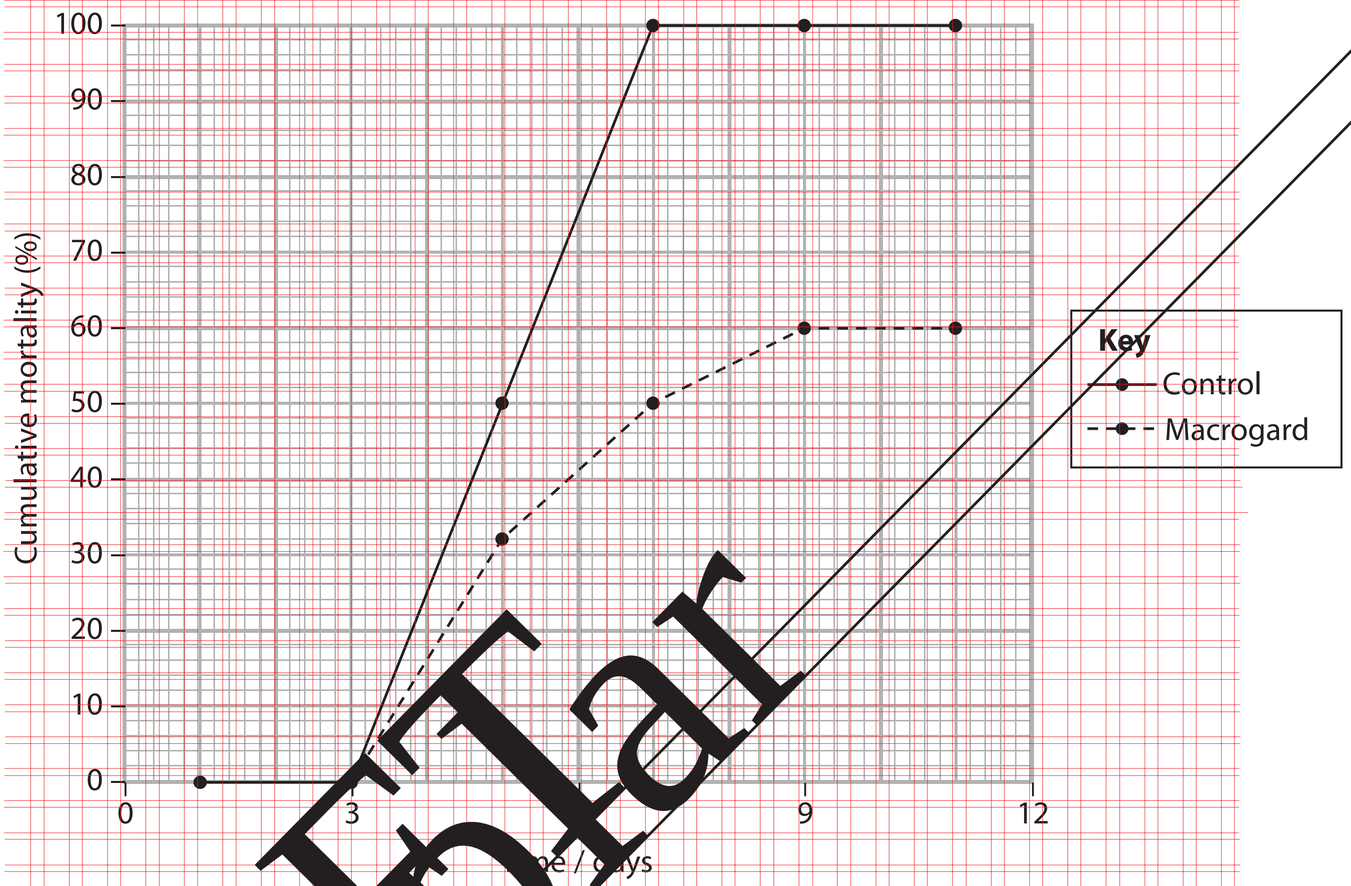
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Exemplar

(c) In a separate experiment, trout provided with Macrogard were infected with pathogenic bacteria.

The number of trout dying each day was recorded. This was used to calculate the cumulative mortality.



(i) Explain the effect of Macrogard on the cumulative mortality of these trout.

(2)

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(ii) Predict what would happen if these trout had been infected with a different bacterial pathogen.

(1)

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Exemplar

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(iii) Predict what would happen if the Macrogard had been removed from the food for several weeks before the trout were exposed to the pathogen.

(1)

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(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

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