

AQA A2 BIOLOGY

TOPIC 7

GENETICS/POPULATION/EVOLUTION/ECOSYSTEMS



1

Schizophrenia is a mental illness. Doctors investigated the relative effects of genetic and environmental factors on the development of schizophrenia. They used sets of identical twins and non-identical twins in their investigation. At least one twin in each set had developed schizophrenia.

- Identical twins are genetically identical.
- Non-identical twins are not genetically identical.
- The members of each twin pair were raised together.

The table shows the percentage of cases where both twins had developed schizophrenia.

Type of twin	Percentage of cases where both twins had developed schizophrenia
Identical	50
Non-identical	15

(i) Explain why both types of twin were used in this investigation.

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(2)

(ii) What do these data suggest about the relative effects of genetic and environmental factors on the development of schizophrenia?

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(1)

(iii) Suggest **two** factors that the scientists should have taken into account when selecting the twins to be used in this study.

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(2)

(Total 5 marks)

2

The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

(a) Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

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(2)

(b) Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

(i) Complete the genetic diagram for this cross.

Phenotypes of parents	red-eyed female		white-eyed male
Genotype of parents	×
Gametesand.....	and.....
Phenotypes of offspring	red-eyed females	and	red-eyed males
Genotype of offspring

(3)

(ii) The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

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(1)

- (c) Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

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(2)
(Total 8 marks)

3

A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	B	C	D	E
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

(a) Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

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(3)

(b) The diversity of animal species is higher at **E** than **A**. Explain why.

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(2)

(c) The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

(i) Give **two** conditions for results from mark-release-recapture investigations to be valid.

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(2)

(ii) Calculate the number of sand lizards on this area of moorland. Show your working.

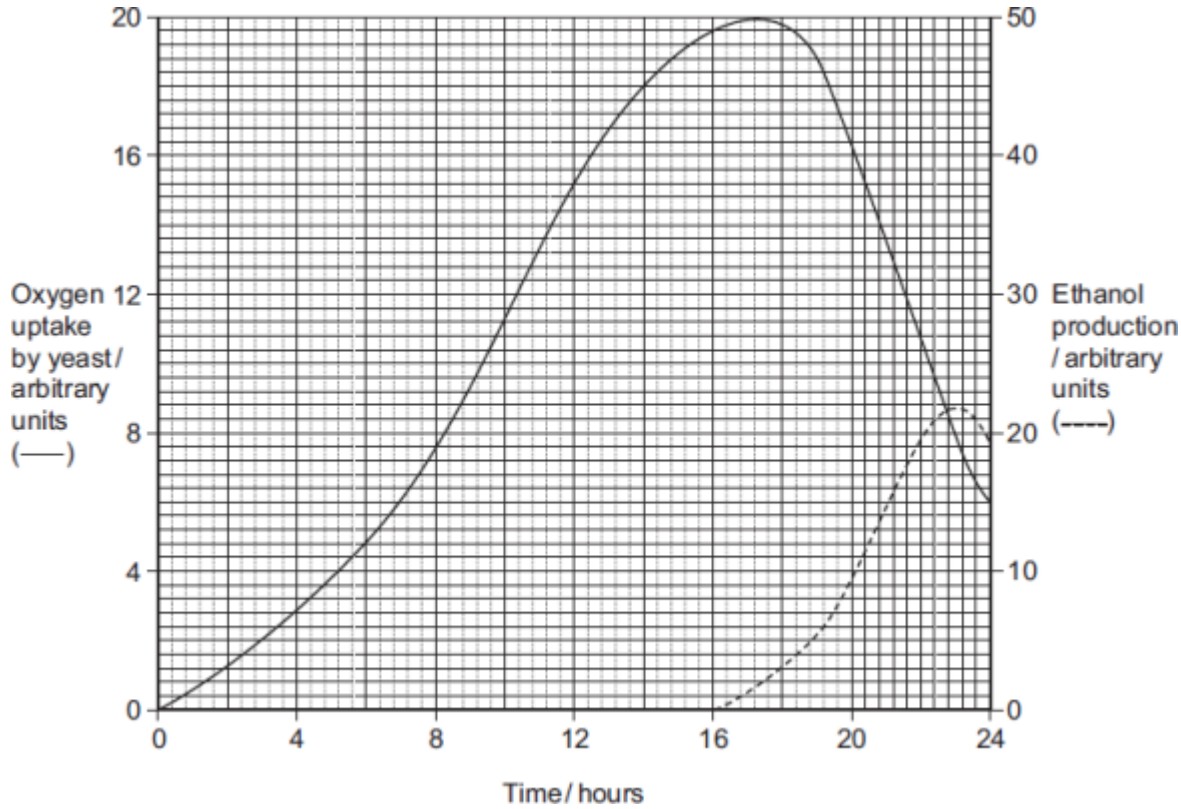
Answer =

(2)

(Total 9 marks)

4

Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



(a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

Answer arbitrary units per hour

(1)

(b) (i) Use the information provided to explain the changes in oxygen uptake during this investigation.

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(3)

(ii) Use the information provided to explain the changes in production of ethanol during this investigation.

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(2)

- (c) Sodium azide is a substance that inhibits the electron transport chain in respiration. The student repeated the investigation but added sodium azide after 4 hours. Suggest and explain how the addition of sodium azide would affect oxygen uptake and the production of ethanol.

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(3)
(Total 9 marks)

5

- (a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

(5)

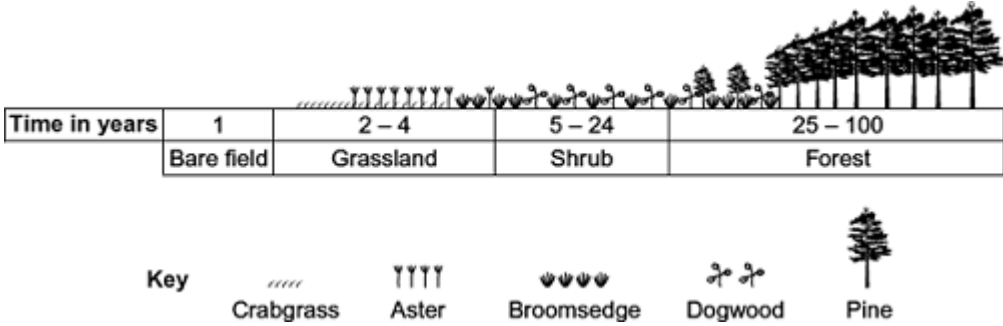
- (b) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

(5)
(Total 10 marks)

6

The diagram shows the dominant plants in communities formed during a succession from bare soil to pine forest.



(a) Name the pioneer species shown in the diagram.

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(1)

(b) The species that are present change during succession. Explain why.

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(2)

(c) The pine trees in the forest have leaves all year. Explain how this results in a low species diversity of plants in the forest.

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(1)
(Total 4 marks)

7

In a species of snail, shell colour is controlled by a gene with three alleles. The shell may be brown, pink or yellow. The allele for brown, C^B , is dominant to the other two alleles. The allele for pink, C^P , is dominant to the allele for yellow, C^Y .

(a) Explain what is meant by a *dominant* allele.

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(1)

(b) Give **all** the genotypes which would result in a brown-shelled snail.

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(1)

(c) A cross between two pink-shelled snails produced only pink-shelled and yellow-shelled snails. Use a genetic diagram to explain why.

(3)

(d) The shells of this snail may be unbanded or banded. The absence or presence of bands is controlled by a single gene with two alleles. The allele for unbanded, B , is dominant to the allele for banded, b .

A population of snails contained 51% unbanded snails. Use the Hardy-Weinberg equation to calculate the percentage of this population that you would expect to be heterozygous for this gene. Show your working.

Answer %

(3)

(Total 8 marks)

8

(a) Explain what is meant by the ecological term community

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(1)

(b) Scientists investigated the distribution of three species of fish in a lake. They recorded the range of depths where each species was found. The table shows their results.

Species of fish	Range of depths /m
White bass	0 to 8.4
Walleye	6.8 to 10.0
Sauger	7.2 to 14.6

(i) Use information from the table to give the range of depths at which all three species of fish may be found living together.

Answer m

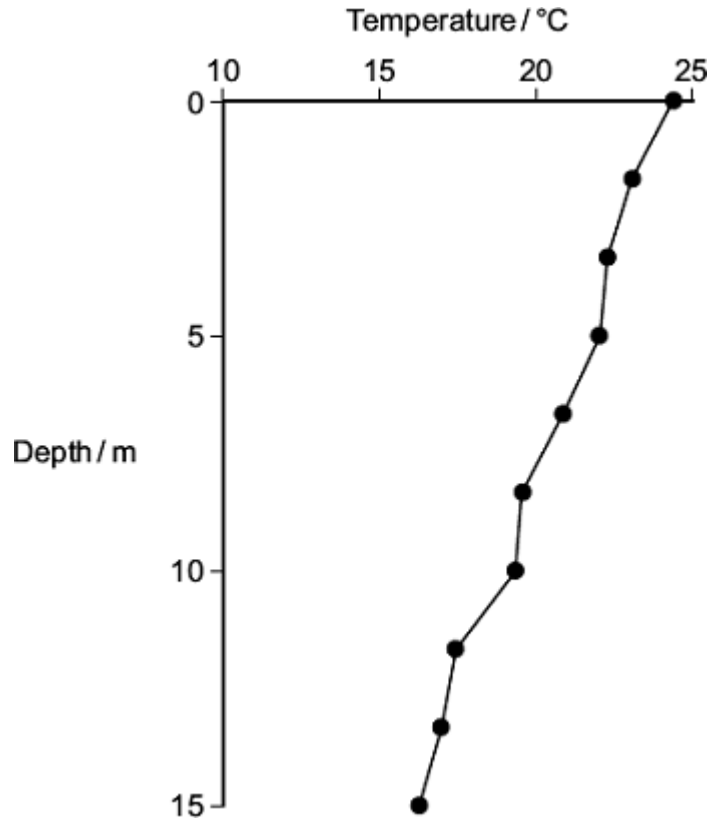
(1)

(ii) Suggest and explain **one** advantage to the fish of occupying different depths in the lake.

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(2)

- (c) The graph shows the relationship between the depth and the temperature of the water in the lake.



A student concluded that the temperature of the water in the lake determined the depth at which the species of fish were found. Use the table and the graph to evaluate this conclusion.

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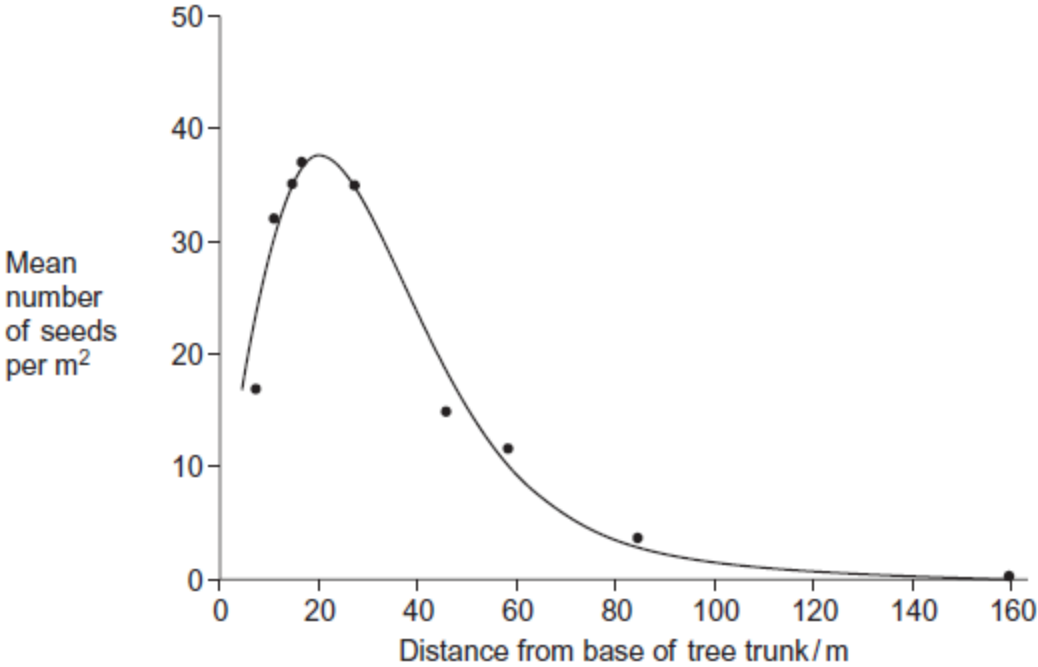
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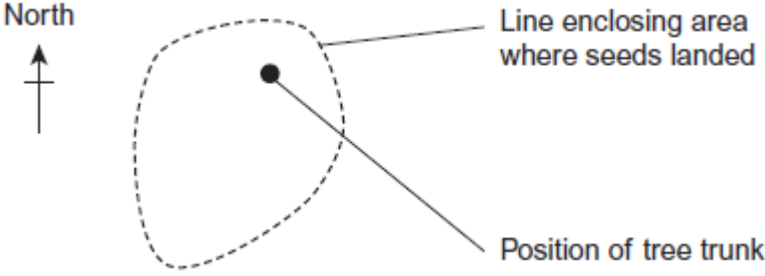
(3)
(Total 7 marks)

9

A 75 m tall tree released very large numbers of small seeds. Ecologists used quadrats along a transect to measure the number of these seeds at different distances from the tree. Their results are shown on the graph.



The seeds of this tree are dispersed by wind. The diagram shows the pattern of seed dispersal from this tree.



(a) Describe how the ecologists could have used quadrats and a transect to obtain the data from which the graph was drawn.

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(2)

(b) Look at the diagram showing the pattern of seed dispersal from this tree.

(i) Suggest an explanation for the shape of the line enclosing the area where the seeds landed.

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(2)

(ii) The line enclosing the area where the seeds landed would be different for trees of this species that were of a different height. Suggest why.

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(2)

(c) In an ecological succession, trees that are pioneer species often have smaller seeds than those that are part of a climax community.

(i) The species of tree in this investigation is adapted to colonising areas that have been cleared of vegetation. Use information given above to explain how.

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(2)

(ii) The seeds produced by this species of tree did **not** grow successfully in a climax community. Suggest why.

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(2)

(Total 10 marks)

10

Agricultural scientists divided a field into a number of different plots. They planted soya bean seeds in these plots at different sowing densities. The diagram shows how these plots were arranged. The numbers show the sowing densities in seeds per m^2 . The plots containing seeds sown at a density of 250 seeds per m^2 have been shaded.

250	500	1000	15	25	50	100
15	25	50	100	250	500	1000
25	50	100	250	500	1000	15
50	100	250	500	1000	15	25
1000	15	25	50	100	250	500
500	1000	15	25	50	100	250
100	250	500	1000	15	25	50

The scientists recorded the number of soya bean plants growing in each plot at different times after the start of the investigation. Their results are shown in the table.

Number of seeds planted per m^2	Mean number of plants surviving per m^2 after			
	22 days	39 days	61 days	93 days
15	15	15	15	15
25	24	24	24	23
50	47	46	46	41
100	98	96	96	87
250	246	242	204	196
500	492	486	313	124
1000	987	788	276	95

- (a) (i) In terms of rows and columns, describe how the plots containing seeds sown at a density of 250 m^2 were arranged.

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(1)

(ii) Explain the advantage of arranging the plots in this way.

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(2)

(b) The scientists would have treated the plots in the same way. Suggest **two** ways in which the scientists would have treated the plots to ensure that confounding variables would **not** affect the results.

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(2)

(c) (i) Describe the results of this investigation.

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(3)

(ii) Explain the results when 1000 seeds were planted per m².

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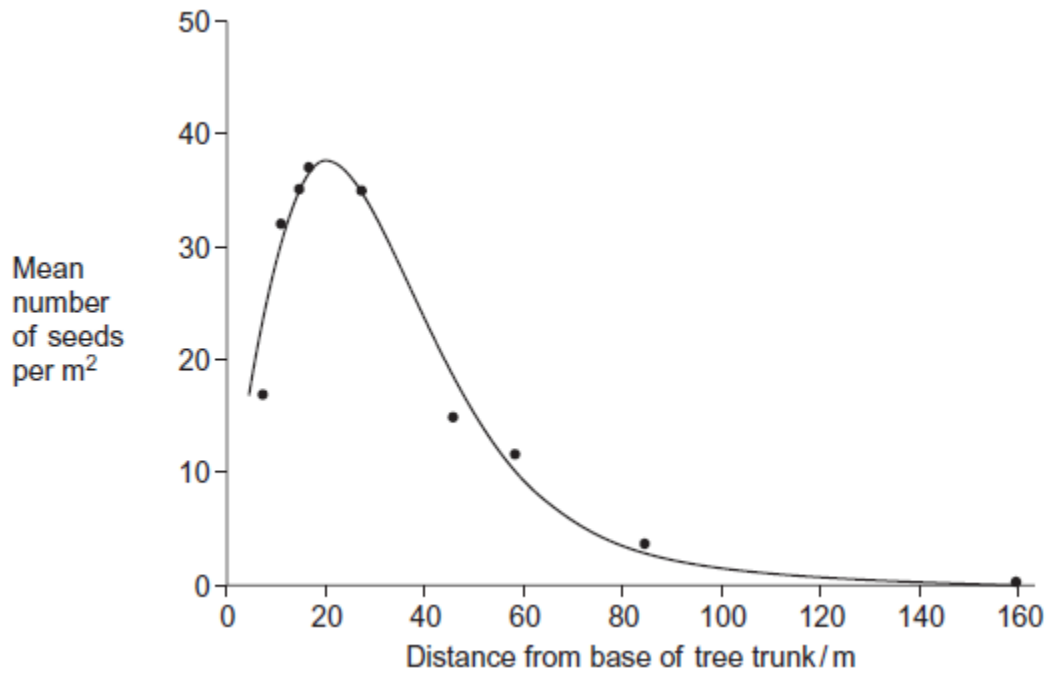
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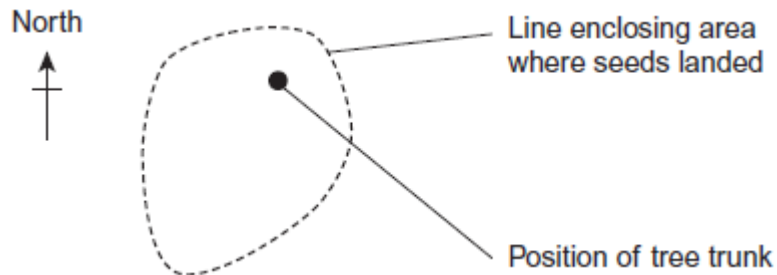
(2)
(Total 10 marks)

11

A 75 m tall tree released very large numbers of small seeds. Ecologists used quadrats along a transect to measure the number of these seeds at different distances from the tree. Their results are shown on the graph.



The seeds of this tree are dispersed by wind. The diagram shows the pattern of seed dispersal from this tree.



Agricultural scientists divided a field into a number of different plots. They planted soya bean seeds in these plots at different sowing densities. The diagram shows how these plots were arranged. The numbers show the sowing densities in seeds per m². The plots containing seeds sown at a density of 250 seeds per m² have been shaded.

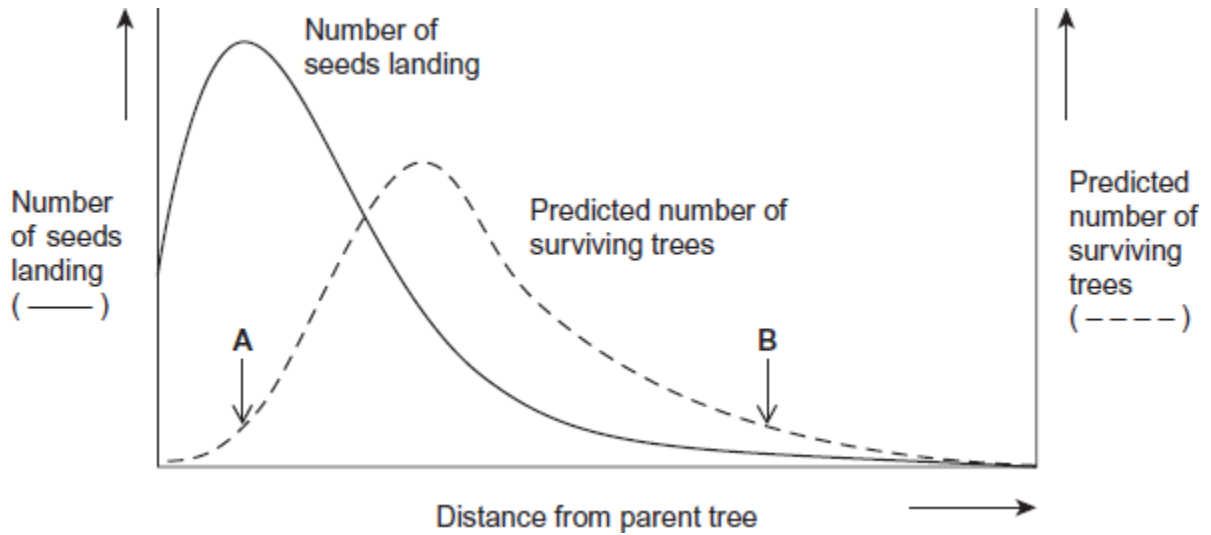
250	500	1000	15	25	50	100
15	25	50	100	250	500	1000
25	50	100	250	500	1000	15
50	100	250	500	1000	15	25
1000	15	25	50	100	250	500
500	1000	15	25	50	100	250
100	250	500	1000	15	25	50

The scientists recorded the number of soya bean plants growing in each plot at different times after the start of the investigation. Their results are shown in the table.

Number of seeds planted per m ²	Mean number of plants surviving per m ² after			
	22 days	39 days	61 days	93 days
15	15	15	15	15
25	24	24	24	23
50	47	46	46	41
100	98	96	96	87
250	246	242	204	196
500	492	486	313	124
1000	987	788	276	95

- (a) A scientist measured the number of seeds landing at different distances from a parent tree. He then produced a theoretical model. He used this model to predict how the number of new trees that grew from the seeds and survived varied with distance from the parent tree. The scales used for the two vertical axes are different.

The predictions from this model are summarised in the graph.



- (i) Explain why the model predicts a low number of surviving trees at point A

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(Extra space)

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(3)

(ii) Explain why the model predicts a low number of surviving trees at point **B**.

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(2)
(Total 5 marks)