1.8 Meiosis and the Causes of Variation: 30-minute Pack

Total Marks

EDEXCEL 4BI1 · Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A DNA mutation changes a gene in a population of beetles. State how this can introduce genetic variation.

(Total for Question 1 is 1 mark)

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2 Describe, for the topic of meiosis in 4BI1, how the chromosome number is halved during the division process in a diploid cell.

(Total for Question 2 is 2 marks)

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3 Explain why it is necessary for meiosis to halve the chromosome number before fertilisation in sexual reproduction, referencing zygote chromosome number.

(Total for Question 3 is 2 marks)

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4 Interpret the following histogram data for height in a plant population in a school biology class experiment. Heights (cm): 10 plants at 6-8 cm, 20 plants at 8-10 cm, 30 plants at 10-12 cm, 20 plants at 12-14 cm, 10 plants at 14-16 cm. (a) State whether this distribution is continuous or discontinuous. (b) Describe the shape of the histogram and what it suggests about typical plant height.

(Total for Question 4 is 3 marks)

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5 Define mutation, in the context of genetic variation, and state whether mutations are usually harmful, beneficial or neutral.

(Total for Question 5 is 2 marks)

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6 A species has 40 chromosomes in its body cells. One gamete has 20 chromosomes and another has 21. If they fuse, state the zygote chromosome number and how it compares with the usual number.

(Total for Question 6 is 2 marks)

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7 In an illustrative survey, a gardener records flower colour and plant height in one population. Most plants have red flowers, but flower colour occurs in red or white categories; plant heights range from 12 cm to 31 cm. Interpret these observations by identifying the type of variation for each trait and one likely cause of height differences.

(Total for Question 7 is 3 marks)

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8 In an illustrative study, two separate groups of 30 seedlings from the same seed variety are grown. In bright light, 18 seedlings have leaves longer than 5 cm; in dim light, 9 do. Calculate the difference between these counts. Calculate how many seedlings in dim light have leaves 5 cm or shorter. State one conclusion about light level and leaf growth supported by the observations.

(Total for Question 8 is 3 marks)

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9 A student wants to investigate whether different amounts of fertiliser affect the height variation of identical fast-growing bean plants. Describe a simple method for this investigation, including the independent variable, dependent variable and two control variables to make the test fair.

(Total for Question 9 is 3 marks)

10 Explain the causes of variation between organisms of the same species. In your answer include genetic causes and environmental causes, and explain how these together produce the variation seen in a population.

(Total for Question 10 is 6 marks)

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Mark scheme · 1.8 Meiosis and the Causes of Variation: 30-minute Pack

Question 1

It can create a different allele (or version of the gene) **B1**

Answer: It can create a different allele.

Question 2

the cell divides twice (two successive divisions) **B1**

sister chromatids or homologous chromosomes are separated so daughter cells have half the chromosomes **B1**

Answer: The cell undergoes two divisions so homologous chromosomes/sister chromatids are separated, producing cells with half the chromosome number

Question 3

halving prevents chromosome number doubling every generation **B1**

fertilisation restores the diploid number so the zygote has the correct chromosome number **B1**

Answer: Halving prevents chromosome number doubling each generation, because two haploid gametes fuse at fertilisation to restore the correct diploid zygote chromosome number

Question 4

identifies the distribution as continuous **B1**

describes the shape as roughly bell-shaped or symmetric with a peak in the 10-12 cm class **B1**

states that most plants are around 10-12 cm (the mode), suggesting a typical or average height in that range **B1**

Answer: a) Continuous. b) Roughly bell-shaped with a peak at 10-12 cm, so most plants are around 10-12 cm tall

Question 5

a change in the DNA sequence (or gene) of an organism **B1**

most mutations are neutral or harmful, with beneficial mutations being rare **B1**

Answer: A mutation is a change in an organism's DNA sequence; most mutations are neutral or harmful, beneficial ones are rare

Question 6

The zygote has 41 chromosomes **B1**

This is one more than the usual diploid number of 40 **B1**

Answer: The zygote has 41 chromosomes, one more than the usual 40.

Question 7

Flower colour shows discontinuous variation **B1**

Plant height shows continuous variation **B1**

Height differences may be caused by genetic differences such as different inherited alleles, environmental factors such as light, water or mineral availability, or the combined effects of genes and environment **B1**

Answer: Flower colour is discontinuous and height is continuous. Differences in height may result from growing conditions such as light or water.

Question 8

Difference = 9 seedlings (18 - 9) **B1**

21 seedlings in dim light have leaves 5 cm or shorter (30 - 9) **B1**

The observations suggest that bright light is associated with more seedlings having leaves longer than 5 cm (accept an equivalent association between light level and leaf growth; no causal claim required) **B1**

Answer: The difference is 18 - 9 = 9 seedlings. In dim light, 30 - 9 = 21 seedlings have leaves 5 cm or shorter. Bright light is associated with more seedlings having leaves longer than 5 cm in this study.

Question 9

identifies independent variable: amount or concentration of fertiliser and how to vary it (e.g. none, low, medium, high) **B1**

identifies dependent variable: plant height measured after a fixed time **B1**

states two control variables, e.g. same light, same soil type and volume, same watering schedule, same number and age of seeds **B1**

Answer: Vary fertiliser amount (e.g. none, low, medium, high) as independent variable; measure plant height after a set time as dependent; keep seed type, soil, light and water the same as control variables

Question 10

Level 1 Simple statements about one or two causes of variation, with limited development. May list examples without clear explanation. **1-2**

Level 2 Clear explanation of genetic and environmental causes with some linking showing how they produce differences in traits. Some correct use of terminology. **3-4**

Level 3 Detailed explanation covering genetic causes, mutation and random fertilisation, plus environmental influences, and a coherent synthesis of how these factors interact to produce the range of variation in a population **5-6**

Indicative content:

- Genetic causes: different alleles inherited from parents determine traits
- Meiosis produces different combinations of alleles and gametes are genetically different
- Random fertilisation of gametes mixes alleles from two parents producing new combinations
- Mutation introduces new alleles or changes to genes that can alter traits
- Environmental causes: factors such as nutrition, light, temperature, disease, and exercise can change phenotype without changing the genotype
- Interaction: the same genotype can give different phenotypes in different environments, and genetic variation provides the raw material on which environmental selection acts, producing the observed range of traits in a population

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