



ANSWER BOOK

Natural selection: variation, selection and allele frequency

Evolution and speciation · Unit B19

AQA 3.4.3, 3.4.4 · OCR A 4.2.2, 6.1.2 · Edexcel A Topic 4 · CAIE 17.1, 17.2

6 questions · 19 marks

NAVY EDITION

SECTION A · Short, 1 to 2 marks

- A1** **B1** mutation, a change in the base sequence of DNA. **B1** crossing over in prophase I and independent assortment at metaphase I of meiosis, with random fertilisation combining any gamete of one parent with any of the other's. [2]
- A2** **B1** an individual's contribution to the gene pool of the next generation relative to other individuals in the same population, counted as offspring that themselves survive to reproduce. **B1** an individual that lives a long time and never reproduces contributes nothing to the next generation's gene pool, so survival counts only in so far as it leads to reproduction. [2]
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SECTION B · Standard, 3 to 5 marks

- B1** **B1** genetic variation was already present in the population, produced by random mutation, so a few insects carried an allele giving resistance before the insecticide was ever used. **B1** the insecticide is the selection pressure: insects without the allele are killed, while those carrying it survive. **B1** the survivors reproduce and pass the allele to their offspring, so a greater proportion of the next generation carries it. **B1** repeated over many generations the frequency of the resistance allele in the gene pool rises, and that change in allele frequency is the evolution. The spray selected among variation already present rather than causing the mutation. [4]
- B2** **B1** stabilising selection favours the mean phenotype and acts against both extremes, whereas disruptive selection acts against the mean and favours both extremes. **B1** under stabilising selection the mean is unchanged, and under disruptive selection the mean may not move either, so the mean alone does not distinguish them. **B1** stabilising selection reduces the variation, so the curve becomes taller and narrower, whereas disruptive selection increases it and the single peak splits into two with a trough between. **B1** stabilising selection is the usual mode in a stable environment, whereas disruptive selection needs two distinct resources with nothing in between, as for a finch feeding on hard seeds and on soft ones. [4]
- B3** **M1** the homozygous recessive genotype has frequency q^2 , so $q^2 = 1 \div 2500 = 0.0004$; the square root is taken of that genotype frequency, not of 2500. **A1** q is the square root of $0.0004 = 0.02$. **M1** $p = 1 - q = 0.98$, and the frequency of heterozygotes is $2pq = 2 \times 0.98 \times 0.02$. **A1** 0.0392, so 3.92 per cent of the population are carriers. [4]
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B4 **B1** with no pesticide present the allele confers no advantage, so it is no longer [3]
favoured and the individuals lacking it are no longer killed. **B1** resistance usually carries
a cost, such as a protein that does its normal job less well or energy spent running a
mechanism the insect does not need, so carriers leave slightly fewer surviving offspring
than the rest. **B1** the frequency of the allele in the gene pool therefore falls generation
by generation, which shows that fitness belongs to a genotype in a particular
environment rather than being a fixed property of it.
