InkBiology

ANSWER BOOK

Hardy–Weinberg: what alleles do in a population when nothing acts on them

Inheritance and population genetics · Unit B16

AQA 3.7.2 · OCR A 6.1.2 · Edexcel A not listed · CAIE 17.2

6 questions · 22 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** the gene pool is all the alleles of all the genes present in a population at a given time. **B1** an allele frequency is the proportion of all the alleles of that gene in the pool that are of one particular kind. [2]

SECTION B · Standard, 3 to 5 marks

B1 **M1** the affected people are the homozygous recessives, so $q^2 = 450 \div 5000 = 0.09$. **M1** take the square root to get the allele frequency: $q = 0.3$, and since $p + q = 1$, $p = 0.7$. **A1** the heterozygotes are $2pq = 2 \times 0.7 \times 0.3 = 0.42$. **A1** $0.42 \times 5000 = 2100$ people, and a check that 2450 homozygous dominant plus 2100 plus 450 comes back to 5000. [4]

B2 **M1** each snail carries two alleles, so the sample holds $2 \times 200 = 400$ alleles, and the count of C is $2 \times 98 + 84 = 280$. **A1** $p = 280 \div 400 = 0.7$ for C, and $q = 120 \div 400 = 0.3$ for c, which add to 1 as they must. **M1** the expected number of heterozygotes is $2pq$ multiplied by the number of individuals: $2 \times 0.7 \times 0.3 \times 200$. **A1** 84, which is exactly the number observed, so the sample is in Hardy-Weinberg equilibrium. [4]

B3 **B1** dominance describes which allele is expressed in a heterozygous individual, and says nothing about how often the allele occurs in the gene pool. **B1** the two alleles of a heterozygote are equally likely to enter a gamete, because they separate at meiosis independently of which one is expressed. **B1** the Hardy-Weinberg principle predicts that with a large population, random mating, no selection, no mutation and no migration, allele frequencies stay constant from one generation to the next whatever the dominance relationships. **A1** the evidence agrees: polydactyly is caused by a dominant allele and is rare, while the recessive allele for blood group O is the commonest of the three. [4]

B4 **B1** at least one of the five conditions for Hardy-Weinberg equilibrium is not being met by this population. **B1** an excess of homozygotes and a shortage of heterozygotes points to non-random mating, such as inbreeding, or to a sample that is really two separate populations counted together. **B1** a shortage of one homozygous class points to selection acting against that genotype, so that fewer of those individuals survive to reproduce. **A1** the principle works as a null model, so a change in allele frequency between generations is evidence that something is acting on the population, which is one standard definition of evolution. [4]

B5 **B1** heterozygotes are more resistant to malaria than either homozygote, which is a heterozygote advantage. **B1** where malaria is common the heterozygotes therefore survive and reproduce better than the homozygous dominant individuals, so copies of the sickle-cell allele keep being passed on. **B1** selection against the affected homozygotes pushes the frequency down at the same time, so the allele settles at a stable intermediate frequency rather than disappearing. **A1** there is no malaria in northern Europe, so the heterozygote has no advantage there; selection acts only against the affected homozygotes and the allele frequency stays low. [4]