Exercise walk-through

Hardy-Weinberg Equilibrium ▪ 7.5

eXercise

You must be able to

- use $p + q = 1$ and $p^2 + 2pq + q^2 = 1$
- find allele and genotype frequencies
- state the conditions for equilibrium

Method — The two equations

For a gene with alleles of frequency p and q:

$$p + q = 1, \qquad p^2 + 2pq + q^2 = 1,$$

where $p^2 =$ homozygous dominant, $2pq =$ heterozygous, $q^2 =$ homozygous recessive.

Method — Working from the recessive phenotype

The recessive phenotype's frequency is q^2. So $q = \sqrt{q^2}$, then $p = 1 - q$.

Method — A worked calculation

If 16% (0.16) show the recessive trait: $q^2 = 0.16$, so $q = 0.4$, $p = 0.6$. Heterozygotes $= 2pq = 2(0.6)(0.4) = 0.48$ (48%).

Method — The conditions

A population is in equilibrium (**not** evolving) only if: no selection, no mutation, no gene flow, random mating, and a very large population. Real deviations signal evolution.

Practice 2.1 ▪ 2 marks

Write the two Hardy-Weinberg equations.

Solution 2.1

Worked steps

$p + q = 1$ and $p^2 + 2pq + q^2 = 1$ B1 B1.

Practice 2.2 ▪ 1 mark

If $q = 0.3$, find p.

Solution 2.2

Worked steps

$p = 1 - 0.3 = 0.7$ **B1**.

Practice 2.3 ▪ 1 mark

What genotype does q^2 represent?

Solution 2.3

Worked steps

Homozygous recessive **B1**.

Exam-style 3.1 ▪ 1 mark

In Hardy-Weinberg, the frequency of heterozygotes is

A p^2

B q^2

C $2pq$

D $p+q$

Solution 3.1

A p^2

B q^2

C $2pq$ ✓

D $p + q$

Worked steps

C — $2pq$.

Exam-style 3.2 ▪ 3 marks

In a population, 9% of individuals show a recessive trait.
(a) Find q and p.
(b) Find the frequency of heterozygotes.

Solution 3.2

Method: A worked calculation

Worked steps

(a) $q^2 = 0.09$, so $q = 0.3$; $p = 1 - 0.3 = 0.7$ **M1** **M1** **A1**. (b) $2pq = 2(0.7)(0.3) = 0.42$ (42%) **M1** **A1**.

Exam-style 3.3 ▪ 2 marks

State two conditions that must hold for a population to stay in Hardy-Weinberg equilibrium.

Solution 3.3

Method: The conditions

Worked steps

Any two: no natural selection, no mutation, no gene flow (migration), random mating, very large population **B1** **B1**.