AP BIOLOGY • EXERCISE SHEET

7.5 Hardy-Weinberg Equilibrium

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

Objective

Build the skills to answer exam questions on **Hardy-Weinberg equilibrium**.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

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.

Working from the recessive phenotype

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

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%).

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.

2 Practice

Now apply the methods above.

2.1 Write the two Hardy-Weinberg equations. [2]

2.2 If $q = 0.3$, find p. [1]

2.3 What genotype does q^2 represent? [1]

3 Exam-style questions

3.1 In Hardy-Weinberg, the frequency of heterozygotes is [1]

- **A** p^2
- **B** q^2
- **C** $2pq$
- **D** $p + q$

3.2 In a population, 9% of individuals show a recessive trait.

(a) Find q and p. [3]

(b) Find the frequency of heterozygotes. [2]

3.3 State two conditions that must hold for a population to stay in Hardy-Weinberg equilibrium. [2]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **7.5 Hardy-Weinberg Equilibrium** lesson on the **Learn** page;
- read the **Hardy-Weinberg Equilibrium** section of the AP Biology handout on the **Know** page.

Solutions

2.1 $p + q = 1$ and $p^2 + 2pq + q^2 = 1$.

2.2 $p = 1 - 0.3 = 0.7$.

2.3 Homozygous recessive.

3.1 C —$2pq$.

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

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