AP Biology: Hardy-Weinberg Equilibrium Practice Problems - SOLUTIONS

1. The frequency of two alleles in a gene pool is 0.19 (*A*) and 0.81(*a*). Assume that the population is in Hardy-Weinberg equilibrium.

    (a) Calculate the percentage of heterozygous individuals in the population.

    2pq = (2)(0.19)(0.81) = 0.3078   30.8%

    (b) Calculate the percentage of homozygous recessives in the population.

    $q^2 = (0.81)^2 = 0.6561$ 65.6%

2. An allele *W,* for white wool, is dominant over allele *w*, for black wool. In a sample of 900 sheep, 891 are white and 9 are black. Calculate the allelic frequencies within this population, assuming that the population is in H-W equilibrium.

$q^2 = (9/900) = 0.01$ $q = \sqrt{0.01} = 0.1$ p = 1 – q = 1 – 0.1 = 0.9

3. In a population that is in Hardy-Weinberg equilibrium, the frequency of the recessive homozygote genotype of a certain trait is 0.09. Calculate the percentage of individuals homozygous for the dominant allele.

$q^2 = 0.09$ $q = \sqrt{0.09} = 0.3$ p = 1 – q = 1 – 0.3 = 0.7 $p^2 = (0.7)^2 = 0.49$ 49%

4. In a population that is in Hardy-Weinberg equilibrium, 38 % of the individuals are recessive homozygotes for a certain trait. In a population of 14,500, calculate the percentage of homozygous dominant individuals and heterozygous individuals.

$q^2 = 0.38$ $q = \sqrt{0.38} = 0.62$ p = 1 – q = 1 – 0.62 = 0.38

$p^2 = (0.38)^2 = 0.14$ 14%

2pq = (2)(0.38)(0.62) = 0.47   47%   OR $2pq = 1 - p^2 - q^2 = 1 - 0.38 - 0.14 = 0.48$ 48%

5. Allele *T*, for the ability to taste a particular chemical, is dominant over allele *t*, for the inability to taste the chemical. Four hundred university students were surveyed and 64 were found to be nontasters. Calculate the percentage of heterozygous students. Assume that the population is in H-W equilibrium.

$q^2 = 64/400 = 0.16$ $q = \sqrt{0.16} = 0.4$ p = 1 – q = 1 – 0.4 = 0.6

2pq = (2)(0.6)(0.4) = 0.48   48%

6. In humans, the *Rh* factor genetic information is inherited from our parents, but it is inherited independently of the ABO blood type alleles. In humans, *Rh*+ individuals have the *Rh* antigen on their red blood cells, while *Rh*− individuals do not. There are two different alleles for the *Rh* factor known as *Rh*+ and *rh*. Assume that a dominant gene *Rh* produces the *Rh*+ phenotype, and that the recessive *rh* allele produces the *Rh*− phenotype. In a population that is in Hardy-Weinberg equilibrium, 160 out of 200 individuals are *Rh+*. Calculate the frequency of both alleles.

$q^2 = 40/200 = 0.2$ $q = \sqrt{0.2} = 0.45$ p = 1 – q = 1 – 0.45 = 0.55

7. In corn, kernel color is governed by a dominant allele for white color *(W)* and by a recessive allele (*w*). A random sample of 100 kernels from a population that is in H-W equilibrium reveals that 9 kernels are yellow (*ww*) and 91 kernels are white.

(a) Calculate the frequencies of the yellow and white alleles in this population.

$q^2 = 9/100 = 0.09$ $q = \sqrt{0.09} = 0.3$ $p = 1 – q = 1 – 0.3 = 0.7$

(b) Calculate the percentage of this population that is heterozygous.

2pq = (2)(0.7)(0.3) = 0.42 42%

8. A rare disease that is due to a recessive allele (*a*) that is lethal when homozygous, occurs within a specific population at a frequency of one in a million. Calculate the number of individuals in a town having a population of 14,000 can be expected to carry this allele?

$q^2 = 1/1000000 = 0.000001$ $q = \sqrt{0.000001} = 0.001$ $p = 1 – q = 1 – 0.001 = 0.999$

2pq = (2)(0.999)(0.001) = 0.001998 (0.001998)(14000) = 28

9. In a certain African population, 4 % of the population is born with sickle cell anemia (*aa*). Calculate the percentage of individuals who enjoy the selective heterozygous advantage of the sickle-cell gene (increased resistance to malaria)?

$q^2 = 0.04$ $q = \sqrt{0.04} = 0.2$ $p = 1 – q = 1 – 0.2 = 0.8$

2pq = (2)(0.8)(0.2) = 0.32 32%

Questions 10 - 12

Two Siamese and three Persian cats survive a shipwreck and are carried on driftwood to a previously uninhabited tropical island. All five cats have normal ears, but one carries the recessive allele for folded ears (his genotype is *Ff*).

10. Calculate the frequencies of alleles *F* and *f* in the cat population of this island.

$p^2 = 4/5 = 0.8$ $p = \sqrt{0.8} = 0.9$ $q = 1 – p = 1 – 0.9 = 0.1$

11. If you assume Hardy-Weinberg equilibrium for these alleles (admittedly very improbable), calculate the number of cats you would expect to have folded ears when the island population reaches 20,000?

$q^2 = (0.1)2 = 0.01$ (0.01)(20000) = 200

12. When the population actually does reach 20,000 cats, there are 300 with folded ears and 19,700 with normal ears (4,100 of which carry the recessive for folded ears). Perform a Chi-square analysis (in comparison with your prediction from #11) to determine if the population is in Hardy-Weinberg equilibrium.

Expected: (0.81)(20000) = 16200 FF (2)(0.9)(0.1)(20000) = 3600 Ff 200 ff (#11)

Observed: 19700 – 4100 = 15600 FF 4100 Ff 300 ff

	O	E	O-E	$(O-E)^2$	$(O-E)^2/E$
FF	15600	16200	-600	360000	22.2
Ff	4100	3600	500	250000	69.4
ff	300	200	100	10000	50
					141.6

Critical value for 2 degrees of freedom = 5.991

141.6 > 5.991

Reject null hypothesis

The population is NOT in Hardy-Weinberg equilibrium.