BIOLOGY 100
SOLUTIONS TO PROBLEMS

POPULATION GENETICS

1. If beak length in Robins is controlled by a single pair of alleles with long beak associated with the presence of a dominant allele, what are the frequencies of dominant and recessive alleles if a population consists of 64 long beaked birds and 36 short beaked birds? Estimate the percentage of the population that is homozygous for the dominant (long beak) allele.

Important concepts:
Recessive phenotype (short beak) must have the homozygous recessive genotype
Frequency (f) of dominant allele + frequency (f) of recessive allele = 1
f(recessive allele) x f(recessive allele) = f(recessive allele)^2 = f(recessive genotype)

$$f(\text{recessive phenotype}) = \frac{\text{number of recessive phenotypes}}{\text{total}} = \frac{36}{100} = 0.36 = 36\%$$

f(recessive genotype) = f(recessive phenotype) = 0.36 = 36%

$$f(\text{recessive allele}) = \sqrt{f(\text{recessive genotype})} = \sqrt{0.36} = 0.6 = 60\%$$

f(dominant allele) = 1 – f(recessive allele) = 1 – 0.6 = 0.4 = 40%

f(homozygous dominant genotype = f(dominant allele)^2 = $(0.4)^2$ = 0.16 = 16%.

Approximately 16% of the population is homozygous for the long beak (dominant) allele.

2. If red flower color in hawkweed is caused by the presence of a dominant allele and a population of hawkweed plants is 75 percent red flowered, what are the frequencies of the dominant and recessive alleles?
See concepts outlined in question #1.

If 75% are red flowered (dominant phenotype), then 25% will have the recessive phenotype, a frequency of 0.25.

Frequency (f) of the recessive genotype = f(recessive phenotype) = 0.25

$$f(\text{recessive allele}) = \sqrt{f(\text{recessive genotype})} = \sqrt{0.25} = 0.5 = 50\%$$

f(dominant allele) = 1 – f(recessive allele) = 1 – 0.5 = 0.5 = 50%

3. In mice, dark fur color is due to the presence of a dominant allele. If the frequency of recessive phenotype for fur color in a population of mice is 0.09, what is the dominant allele frequency?

See concepts outlined in question #1.

Frequency (f) of recessive genotype = f(recessive phenotype) = 0.09 = 9%

f(recessive allele) = $\sqrt{\text{f(recessive genotype)}}$ = $\sqrt{0.09}$ = 0.3 = 30%

f(dominant allele) = 1 – f(recessive allele) = 1 – 0.3 = 0.7 = 70%

4. If a population is large and there is natural selection against heterozygotes, how will the frequencies of dominant and recessive alleles change with time?

Since heterozygotes are composed of a dominant and recessive allele, natural selection against the heterozygous phenotype will remove an equal number of dominant and recessive alleles. There should b no change in the frequency of alleles provided that there is a large population.

5. Would you expect the allele frequencies to change faster with selection against dominant phenotypes or recessive phenotypes? Explain your logic.

Individuals with dominant phenotypes can be either homozygous (HH) or heterozygous (Hh). When a recessive (hh) is selected against, a reservoir of recessive alleles remains in the heterozygotes (Hh) of the dominant phenotype. When a dominant phenotype is selected against, however, there is no reservoir for the dominant allele. Therefore, we would expect selection against the dominant phenotype to alter the frequencies of alleles more rapidly.