Quiz 3 Review - Population Genetics

1. What equations can you use if the population is NOT in Hardy-Weinberg equilibrium?

$q = f(a/a) + ½ f(A/a)$
$p = f(A/A) + ½ f(A/a)$
$p + q = 1$
$f(A/A) + f(A/a) + f(a/a) = 1$

2. Assume you have a Hardy-Weinberg population of individuals with a constant mutation rate of 10^{-5}. The population is made up of individuals with alleles for short height and tall height. Normally, the short individuals have a harder time reaching food out of cupboards and have a 60% chance of surviving starvation during childhood.

a) If the allele for short height is rare **autosomal recessive**, calculate the short height allele frequency. Show the steady-state equation you would use.

$S = .4$
$1 - S = .6$
$\Delta q \text{ sel} = -S q^2$
$-Sq^2 = \mu = 0$
$Sq^2 = \mu$
$.4q^2 = 10^{-5}$
$q = \surd 2.5\times 10^{-5}$

b) If the allele for short height is rare **autosomal dominant**, calculate the short height allele frequency. Show the steady-state equation you would use.

$\Delta q \text{ sel} = \frac{1}{2} (-2S\, q)$
$-Sq + \mu = 0$
$Sq^2 = \mu$
$-.4q + 10^{-5} = 0$
$q = 2.5\times 10^{-5}$

c) If the allele for short height is rare **X-linked recessive**, calculate the short height allele frequency. Show the steady-state equation you would use.

$\Delta q \text{ sel} = 1/3\ (-S\, q)$
$\Delta q \text{ sel} + \Delta q \text{ mut} = 0$
$-Sq/3 + \mu = 0$
$q = 3\mu / s = (3 \times 10^{-5}) / .4$

d) Take the same population from 2. A group of man-eating mountain lions are introduced into the environment and the short elderly individuals have a 25% chance of being eaten by these predators. If the allele for short height is rare **autosomal recessive**, calculate the short height allele frequency. Show the steady-state equation you would use.

This answer is the same as for "**part a**". Fitness should not change since elderly individuals are past reproductive age.

e) Take the same population from part 2. Suppose a strain of flesh-eating bacteria is introduced into the environment, but this strain of flesh-eating bacteria is sensitive to a protein excreted by cells on the surface of the skin of individuals who are heterozygous for the short height allele. These heterozygotes have 95% better chance of surviving an infection by the flesh-eating bacteria. If the allele for short height is rare **autosomal recessive,** calculate the short height allele frequency. Show the steady-state equation you would use.

$\Delta q = -Sq^2 + hq + \mu\ 10^{-5} = 0$ [μ at 10^{-5} is small and can be removed from the equation]

$Sq^2 + hq = 0$

$q = h/s = .95/.4$

3. Assume you have a population in Hardy-Weinberg equilibrium. Suddenly, some inbreeding begins to take place among members of the population. How does inbreeding affect allele frequency, in the following situations? (increase, decrease, or stay the same)

a) For an autosomal recessive allele, with fitness = 1.0? <u>Stays the same since a/a individuals are at no disadvantage</u>

b) For an autosomal recessive allele, with fitness = 0? <u>Decrease since more a/a individuals are born and will die without reproducing</u>

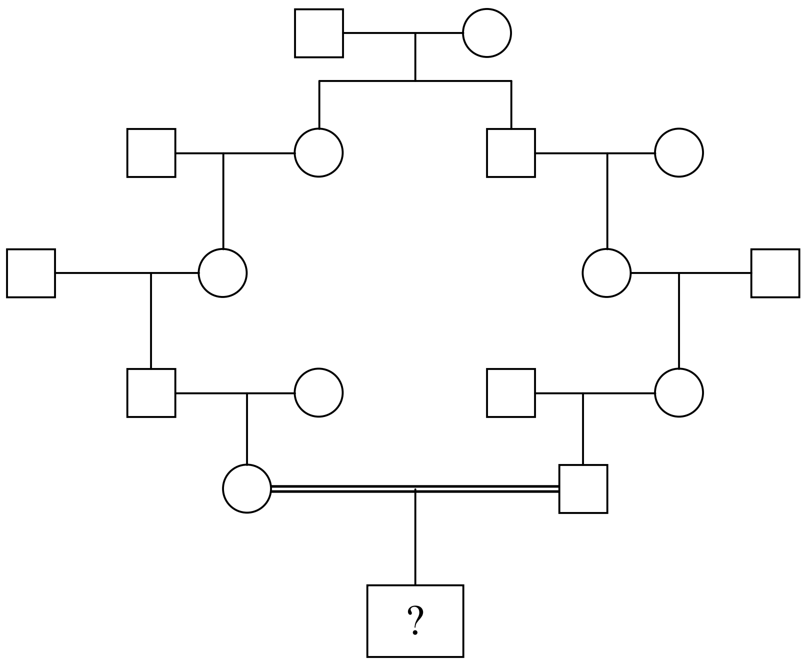
c) For an autosomal dominant allele, with fitness = 0.1? <u>Stay the same since inbreeding doesn't affect dominant disease alleles</u>

4. Draw a pedigree below that shows a mating between two relatives that would correspond to an inbreeding coefficient that equals 0.00390625.

$(1/2)^n = F$

$(1/2)^n = .00390625$

$n = 8$



5. A ship carrying 7,000 passengers is about to land on an island that has 33,000 occupants. Each of these two populations is at Hardy-Weinberg equilibrium before the ship's landing, and each population contains an equal number of males and females. Of the 7,000 ship passengers, only 21 are displaying the X-linked recessive trait "huge toes" (and all 21 are male). Of the 33,000 island occupants, only 6 have huge toes (and all 6 are male). When answering the following parts, show all of your calculations.

(a) On the ship before landing, what is your best estimate of the allele frequency for the allele that causes huge toes?

(b) If you select a female child at random from the island (before the ship lands), what would the probability be that she is a carrier of the allele for huge toes?

(c) Now the ship lands on the island, and the passengers and island occupants mate together randomly to produce the next generation "G2". What is your best estimate of the allele frequency for the allele that causes huge toes in generation "G2"?

(d) If you select one child from generation "G2" at random, what would the <u>total</u> probability be that it has huge toes? (Take both males and females into account.)

a) For an X-linked disease -

q = affected males / total males

$q = 21 / (\frac{1}{2} \times 7000) = .006$

b) $f(A/a) = 2pq = 2\,(6/16500) \times (1 - 6/16500) = .00073$

c) Allele frequency won't change under HW conditions. Before random mating,

$q = (6 + 21) / (3500 + 16500) = .00135$. After random mating, q will be .00135.