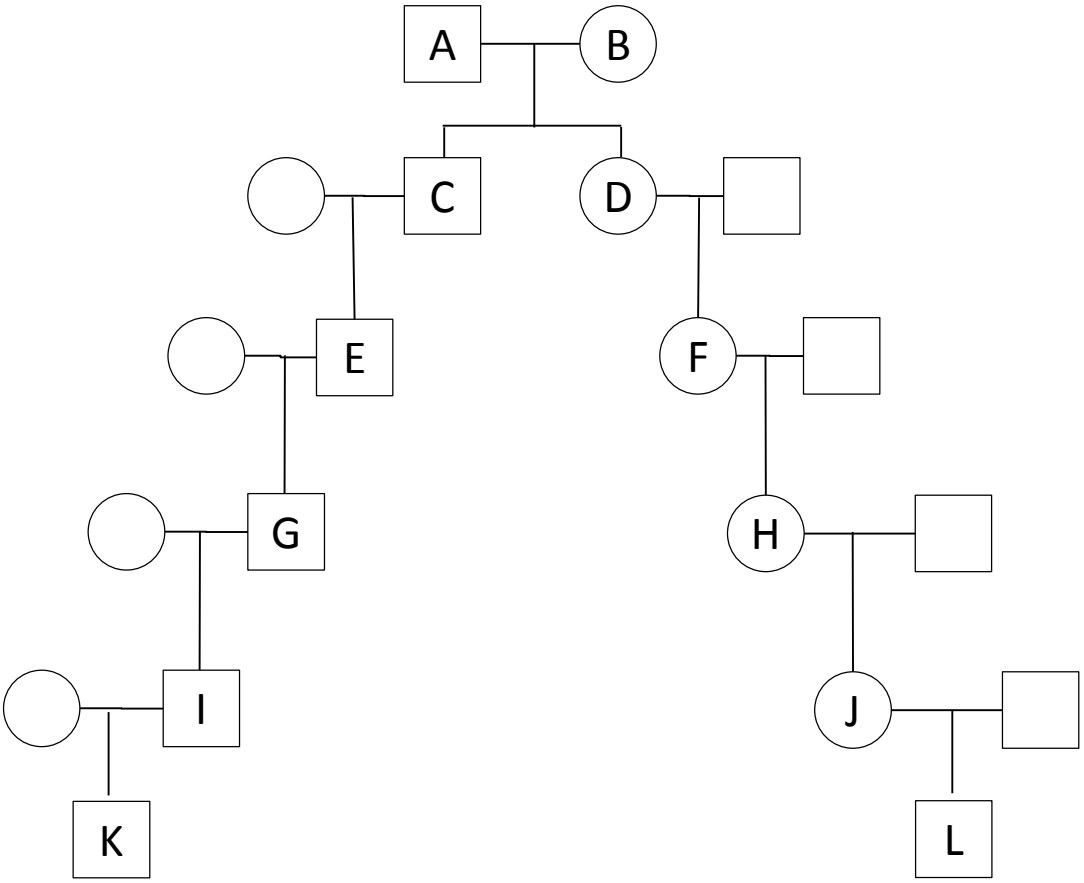
# 7.03 Problem Set 6

Due before 5 PM on Monday, May 2

Hand in answers in recitation section or in the box outside of 68-120

**1.** Consider the following pedigree.

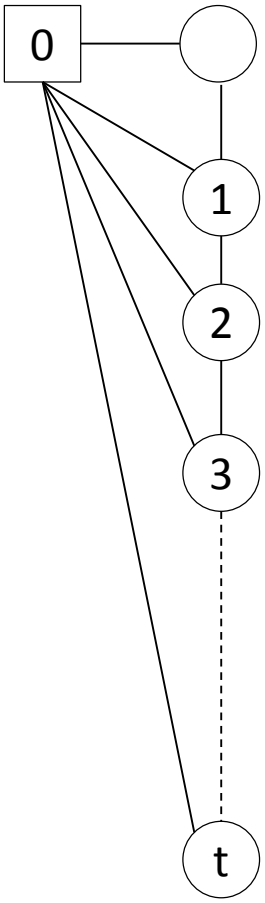



**a)** "Once removed" refers to a difference of one generation, "twice" removed for two generations and so on. A person with whom you share a grandparent, is your first cousins. Taken together, a "first cousin once removed" is either a child of a first cousin or a first cousin of a parent (G and F are first cousins once removed; so are E and H). By the same reasoning E and J are "first cousin twice removed" and so are F and I). What is the inbreeding coefficient (F) in mating between two "first cousins once removed" and in mating between two "first cousins twice removed"?

**b)** What is the inbreeding coefficient in mating between second cousins (G and H)? Third cousins (I and J)? fourth cousins (K and L)?

**c)** In a given population, four cousin marriages occur at a frequency of 0.1 (10%). In this population, there is an autosomal recessive condition that causes orange fingernails. The frequency of the recessive (orange) allele is $7X10^{-6}$. How much more frequent would orange fingernails be as a result of fourth cousin marriages than of random mating in the population? What if the frequency of fourth cousin marriages was 0.01 (1%)?

**2.** Consider the following back-crossing scheme in a population of lab animals, where a single male ("0") is crossed with its daughter (1), the resulting "granddaughter" (2, produced by mating with his daughter), "great-granddaughter" (3, produced by mating with his "grand-daughter" 2), and so on. (We will assume that generation time is very short, or that the male is eternal, so this can be carried on for as many generations as we please, up to *t*).




**a)** What is the inbreeding coefficient (F) for the daughter ("1"), "grand-daughter" ("2") and "great-grand daughter ("3")? (Hint: remember that the matriarch of the whole lineage, the mother of "1", is unrelated to the male ("0") and hence does <u>not</u> contribute any alleles that can participate in inbreeding!).

**b)** What is the general formula for the inbreeding coefficient at progeny *t*?

**c)** If the lineage was reversed (consecutive generations of males backcrossed to a single matriarch), would your results be affected?

**d)** Would there be a difference between the two schemes (backcrossing to matriarch or to patriarch) if the gene in question was X-linked instead of autosomal? Explain.

**e)** Your lab animals can have a white or pink fur color, with pink color, inherited in an autosomal recessive fashion. The frequency of the (dominant) white fur allele is 0.8. If the population mated in random, what would be the frequency of white-furred animals?

**f)** Suppose in your lab population you now only inbreed males to "3" progeny (who were established through the backcrossing scheme in (a)). What will be the fraction of pink furred animals?

3. You study a population of small creatures in northern Europe, following the alleles of two genes, one affects resistance to a rabbit parasite (alleles: Res and Sen) and the other affects fur patterns (Striped and Spotty). (Both fur pattern and resistance are also affected by additional genes.)

**a)** You have collected 10,000 creature gametes from an indigenous northern European population, and obtained the following gamete number. Is the population in LD? Use a statistical test to determine your confidence. (A chart of chi-squared values is included on the next page).

| $P_{ResSpotted}$ | $P_{ResStriped}$ | $P_{SenSpotted}$ | $P_{SenStriped}$ |
|---|---|---|---|
| 560 | 40 | 8760 | 640 |

**b)** You discover that a while ago, a large population of creatures was moved to an area in South East Asia where the parasite is rampant. Intrigued by the possible effects of this different environment, you ask your colleague to send you a sample of 10,000 gametes from that population:

| $P_{ResSpotted}$ | $P_{ResStriped}$ | $P_{SenSpotted}$ | $P_{SenStriped}$ |
|---|---|---|---|
| 100 | 8500 | 1300 | 100 |

Is this population in LD? Use a statistical test to determine your confidence.

**c)** What may be the likely cause of the difference between the European and Asian populations?

**d)** What are D' and $r^2$ (allele correlation) in the Asian population? Which, if any (possibly both) of these values support your hypothesis in **c**?

**e)** What are the frequencies of striped creatures in each of the two populations?

**f)** What is the reason for the difference in striped creatures?

**g)** In a new sanctuary set up in South America, a new founder population of creatures was generated by mixing a large number from each of the European and Asian creatures, in 1:2 proportions. Assuming no specific selection by parasites, what would be D right after the admixture? (Hint: immediately upon admixture of the two populations in unequal proportions, gamete frequencies should be a weighted average).

**h)** Assuming that the recombination frequency between the two genes is r=0.1, what would be D after 30 generations?

## Critical values of the Chi-squared distribution

| P-value | 0.1 | 0.05 | 0.01 | $10^{-3}$ | $10^{-4}$ | $10^{-5}$ | $10^{-6}$ |
|---|---|---|---|---|---|---|---|
| **df=1** | 2.705544 | 3.841459 | 6.634897 | 10.82757 | 15.13671 | 19.51142 | 23.92813 |
| **df=2** | 4.60517 | 5.991465 | 9.21034 | 13.81551 | 18.42068 | 23.02585 | 27.63102 |