1. Mendel did a series of crosses and found ratios like 3:1 or 1:2:1. Why don’t we see ratios like Mendel’s in natural populations?

2. If you sample a population and find 36% of the population is homozygous for one of two alleles and 28% are heterozygous, do the genotypic frequencies appear to suggest that the population is mating randomly? Explain why or why not.

3. Given a population with the following genotypic frequencies among offspring at birth $f(BB) = 0.04, f(Bb) = 0.32, f(bb) = 0.64$, and the following fitness values $W_{BB} = 1.0, W_{Bb} = 1.0$ and $W_{bb} = 0.5$,
   a. what will be the frequency of each genotype after selection?
   b. What are the allele frequencies after selection?
   c. What genotypic frequencies are expected at birth in the next generation?
   d. How much change has there been in the frequency of the $b$ allele in one generation?

4. Given a population with the following genotypic frequencies among offspring at birth $f(BB) = 0.64, f(Bb) = 0.32, f(bb) = 0.04$, and the following fitness values $W_{BB} = 0.5, W_{Bb} = 0.5$ and $W_{bb} = 1.00$,
   a. what will be the frequency of each genotype after selection?
   b. What are the allele frequencies after selection?
   c. What genotypic frequencies are expected at birth in the next generation?
   d. How much change has there been in the frequency of the $B$ allele in one generation?

5. In a randomly mating laboratory culture of fruit flies the frequency of a deleterious dominant allele decreases from 0.4 in the first generation to 0.3 in the second generation. What is the relative fitness of the dominant phenotype?

6. Given a population with the following genotypic frequencies among offspring at birth $f(BB) = 0.64, f(Bb) = 0.32, f(bb) = 0.04$, and the following fitness values $W_{BB} = 0.5, W_{Bb} = 1.0$ and $W_{bb} = 0.6$,
   a. what will be the frequency of each genotype after selection?
   b. What are the allele frequencies after selection?
   c. What genotypic frequencies are expected at birth in the next generation?
   d. How much change has there been in the frequency of the $B$ allele in one generation?

7. Given a population with the following genotypic frequencies among offspring at birth $f(BB) = 0.20, f(Bb) = 0.49, f(bb) = 0.31$, and the following fitness values $W_{BB} = 0.5, W_{Bb} = 1.0$ and $W_{bb} = 0.6$,
   a. What will be the frequency of each genotype after selection?
   b. What are the allele frequencies after selection?
   c. What genotypic frequencies are expected at birth in the next generation?
   d. How much change has there been in the frequency of the $B$ allele in one generation?
   e. What allele frequencies would you expect to find after 1000 more generations if fitness values did not change?

8. Given a population with the following genotypic frequencies among offspring at birth $f(BB) = 0.20, f(Bb) = 0.49, f(bb) = 0.31$, and the following fitness values $W_{BB} = 0.8, W_{Bb} = 1.0$ and $W_{bb} = 0$,
   a. What will be the frequency of each genotype after selection?
   b. What are the allele frequencies after selection?
   c. What genotypic frequencies are expected at birth in the next generation?
   d. How much change has there been in the frequency of the $B$ allele in one generation?
   e. What allele frequencies would you expect to find after 1000 more generations if fitness values did not change?

9. For a gene with two alleles, if deleterious recessive allele results in a 25% reduction in fitness relative to the dominant phenotype, and if the mutation rate for conversion of the dominant allele
to the recessive allele is $1 \times 10^{-5}$, what is the expected frequency of the two alleles in any population that have reached an equilibrium between selection and mutation? What proportion of newborns should have the recessive phenotype?

10. For a gene with two alleles, if deleterious recessive allele results in a 5% reduction in fitness relative to the dominant phenotype, and if the mutation rate for conversion of the dominant allele to the recessive allele is $1 \times 10^{-5}$, what is the expected frequency of the two alleles in any population that have reached an equilibrium between selection and mutation? What proportion of newborns should have the recessive phenotype?

11. In central Africa, malaria and sickle cell anemia are both common and modern medicine brings little relief. In that region, homozygotes for the sickle cell allele (which is recessive) all die of anemia before reproduction. In the same region homozygotes for the nonsickle cell allele have a 30% higher mortality rate (due to malaria) than do those heterozygous for the two alleles. If the population was allowed to come to equilibrium between the two forces of selection, what should be the frequency of the two alleles, and how many newborns should there be in each generation of each genotype.

12. Using the information in the previous question, if a vaccine for malaria was developed and was completely effective, what is the expected long-term result if the mutation rate for the conversion of the non-sickle cell allele to the sickle cell allele is $1 \times 10^{-6}$?

13. For a single gene with 2 alleles, A and a, the frequency of 3 genotypes in a population is 0.33, 0.33, and 0.33. What is the inbreeding coefficient for this population?

14. For a single gene with 2 alleles, A and a, the frequency of 3 genotypes in a population is $f(AA) = 0.64$, $f(Aa) = 0.32$, and $f(aa) = 0.04$. What is the inbreeding coefficient for this population?

15. What is inbreeding depression? What causes it? How would you know it if you saw it?