Notes

Biology 102
Karen Bledsoe, Instructor
http://www.wou.edu/~bledsoek/

Chapter 15, sections 1 and 2

Topic: Population genetics

Main concepts:

- Mendelian genetics applies to crosses between individuals. When we consider genes across populations, we need a different approach.
- An individual's *genome* is the sum total of all alleles in the person's DNA. We can also consider the genome of a population, which is called the "gene pool" in popular media and many textbooks. (In fact, the science of genetics is giving way to the science of *genomics*.)
- In population genetics, we talk about the *frequencies* of alleles. This is the proportion of dominant to recessive alleles for any given single gene trait in the gene pool of the population. (Of course, frequencies for alleles of multi-allele and multi-gene traits can be calculated, too, but the math is much harder.) It is NOT true that the dominant allele is most frequent, nor that it will automatically become more common over time.
- Ratios between the frequencies of alleles in a population can change from generation to generation, and those changes can be measured and predicted. This change of allelic ratios over generations in a population is called *evolution*.
- An English mathematician, Godfrey Hardy, and a German physician, Wilhem Weinberg, developed mathematical models to predict the changes in allele frequencies in an population over time. The model is now known as the Hardy-Weinberg principle.
- According to the Hardy-Weinberg principle, the only condition under which no evolution takes place (that is, no changes to the allele frequencies) is when all of these conditions are met:
  - No immigration or emigration
  - Large population
  - Random mating (no sexual selection; all individuals have an equal chance of reproducing)
  - No mutations
  - No selection for or against any one allele
- Because these conditions are rarely if ever met in nature, allele frequencies do change in response to environmental changes from generation to generation. Some changes are cyclical, in response to short-term cyclical changes in the environment. Others are long-term changes in response to long-term changes in the environment.
- One example of changes over time is antibiotic resistance. This is where bacteria, over time, may develop resistance to the antibiotic. This happens as follows:
  - The bacteria population has genetic variation. Because bacteria and other soil microbes in nature carry out chemical warfare with each other (many soil fungi secrete antibiotics), bacteria may have the ability to metabolize different antibiotics and similar chemicals.
  - The ability to metabolize these chemicals varies from individual to individual.
  - If a population of bacteria is exposed to antibiotics, most of them will die. The survivors, if there are any, will be those that can metabolize the antibiotic the best.
  - The survivors found the next generation, passing their resistance on to their offspring.

Common misconceptions:

- Many students confuse "dominant allele" with "most frequent allele." Remember that in genetics, dominance refers only to the expression of an allele: the trait is expressed if at least one copy of the allele is inherited. A recessive trait only shows if two recessive alleles are inherited.
- Most students have misconceptions about how natural selection and evolution work. It helps to remember that selection can only work on inheritable traits that are already in the population. Traits are not magically bestowed on organisms that "need" them, nor will use or disuse of parts change the genetics of a population. Evolution is neither a goal-directed process where all organisms are striving to become "better," nor is it totally random. When it comes to evolution, think genetically, and on the population level.

Reading notes:

- Define: population, gene pool, allele frequency, mutation, gene flow, evolution.

- List the conditions of the Hardy-Weinberg principle that must be true if there is to be genetic equilibrium (no evolution) over time.
- State why mutations are important to the process of genetic change over time. Are all mutations harmful? (Please note that just because an organism "needs" some trait doesn't mean it will appear suddenly as a "mutation." Think genetically.)
- State why gene flow can alter the allele ratios in a population.
- Describe the difference in effects of genetic change on large versus small populations.
- Define population bottleneck and founder effect, and describe how population size is a factor in each of these. Why are population bottlenecks important to wildlife biologists who are working with endangered species?
- List some examples of non-random mating. (Thinking question: is there ever a conflict between natural selection and sexual selection?) (Another thinking question: Consider how humans select their mates, and give examples from human cultures of random and non-random mating.)
- Describe how antibiotic resistance developed in penicillin. *Read this section in the text very carefully.* Many people have misconceptions about what antibiotic resistance is and how it develops.

Useful websites:

- "How do populations change genetically..." http://w3.dwm.ks.edu.tw/bio/activelearner/18/ch18intro.html is an illustrated tutorial of the Hardy-Weinberg principle.
- "Hardy-Weinberg Equilibrium Model" http://anthro.palomar.edu/synthetic/synth_2.htm explains the mathematics of the model.