Notes

Biology 101, Fall 2007
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Topic: How Organisms Evolve **Reading:** Chapter 15

Main concepts:

- Evolution is the change in gene frequencies in a population.
- Inheritable traits are coded for by genes (which code for specific proteins), but actual expressed traits are the result of the interaction between genes and the environment.
- A genome is the entire collection of genes in an individual or a population. The term “gene pool” is also used to describe the entire collection of genes in a population.
- Godfrey Hardy and Wilhem Weinberg independently developed a model of evolutionary equilibrium. Their combined model states that no evolution will occur in a population *only* if *all* of these conditions are met:
  - No mutation
  - No migration
  - Large population
  - Random mating
  - No selection
- Because perfect Hardy-Weinberg conditions are never met with in nature, there is always change in the genome of a population from one generation to the next.
- Small mutations are the source of genetic variation in a population. These mutations are not goal-driven: that is, organisms don’t automatically get new mutations to give them traits that they “need” when the environment changes.
- Gene ratios can change when:
  - migration into or out of a population occurs, which can bring in or take away certain alleles.
  - genetic drift occurs in small populations due to random events.
  - mating preferences favor certain traits.
  - natural selection favors certain traits.
- Natural selection occurs because not all individuals in a population have the same ability to survive. The survivors do not have the same ability to reproduce. Competition, predator-prey interactions, and sexual selection can all drive natural selection.
- Selection may be directional (toward one end of a bell curve), stabilizing (favoring the average), or disruptive (favoring the extremes of a range of trait expressions). Stabilizing selection often occurs in fairly stable environments where change is less likely to be beneficial. Directional and disruptive selection may occur at the extremes of a population’s range, or during long-term environmental change.

Common misconceptions:

- “Natural selection is totally random.” By definition, selection is a non-random process. Organisms with traits that give them an advantage are more likely to survive and reproduce.
- “Natural selection is like when a chicken hatches out of a dinosaur egg.” Evolutionary change of that magnitude does not happen in a single generation. Evolutionary change is the sum total of small but significant changes over many generations.
- “Natural selection is survival of the fittest.” The phrase “survival of the fittest has been used to describe selection, but it is often misunderstood. It does not mean that the biggest, strongest organisms will always survive. To be “fit” in evolutionary terms, an organism must not only survive, but also reproduce. Many barriers exist to both, and there are many strategies to both surviving and reproducing. The biggest and strongest may be outdone by the smallest and sneakiest!
- “Traits acquired during one’s lifetime, like larger muscles from exercise, can be passed on to the next generation.” You can exercise all you want, but your larger muscles will not be passed on to your children. The theory of the inheritance of acquired characteristics was tested and discarded in the 19th century. However, there are mechanisms by which some organisms can trade genes, and thereby acquire a new inheritable trait. Only traits coded for by genes can be inherited, and only if those genes are in the sex cells.
- “Mistakes like sixth fingers show that evolution can’t be true.” Evolution by natural selection is not a process of perfecting an organism. An organism only has to survive long enough to reproduce to be “fit” in an evolutionary sense. Fatal errors are selected against over time, but selection is not a perfect process.

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Reading notes:

- I highly recommend skimming through Chapters 9 (DNA) and 12 (Patterns of Inheritance) to get a sense of what DNA is, what a gene is, and how genes are passed from one generation to the next. When we're talking about evolution, we're talking about genetics.
- Define "gene pool" and "allele frequency." Explain the difference between a gene and an allele.
- Define "evolution" in terms of alleles.
- List the conditions under which genetic equilibrium (no change) is maintained.
- What is the source of genetic variability?
- Explain what a mutation is. What do the textbook authors mean when they say that mutations are not goal directed?
- Define "gene flow." Why do changes happen much faster in small populations?
- Explain the effects of population bottlenecks and founder effect on the gene pool of a population.
- Why is mating almost never random?
- Explain antibiotic resistance using the principles of natural selection. Keep in mind that the *bacteria*, not humans, develop resistance. Also keep in mind that antibiotics don't *cause* the bacteria to develop resistant genes.
- List the key points about evolution by natural selection on page 305.
- What is the role of unequal reproduction in natural selection?
- What is a phenotype, and what does it have to do with natural selection?
- List and describe the major agents of selection.
- Describe directional selection, stabilizing selection, and disruptive selection. How do each of these affect a population?
- Explain why these statements are misconceptions about natural selection:
  - "If the environment in a region gets colder, all of the foxes in that region will develop a mutation for longer, thicker fur."
  - "Cave salamanders have small, undeveloped eyes because they don't need their eyes."
  - "Modern cheetahs have long legs because their ancestors spent used their legs a lot as they ran after prey animals."

Useful websites:

- "Understanding Evolution" (http://evolution.berkeley.edu/evolibrary/home.php) is a huge site that is full of information about evolution and the mechanisms of evolutionary change.