AP Biology—Chapter 23 Lecture Notes

Population Genetics and Evolution

--microevolution is the change in the genetic makeup of a population; it is *not* speciation
--Darwin dealt mostly with *quantitative* characters while Mendel dealt with *discreet* characters
--the *gene pool* is all the genes in a population at any one time
--page 456 has a good description of allele frequencies within a hypothetical flower population

Hardy-Weinberg
--their theorem describes gene pools that are *not* evolving
--assumes the frequencies of alleles remains constant as long as Mendelian segregation and recombination of alleles are at work (this doesn't happen in populations that are changing)
--the following conditions are needed for Hardy-Weinberg:

1. Extremely large population size
2. No gene flow—from one population to another
3. No mutations
4. Random mating
5. No natural selection

***Please review the section on Hardy Weinberg on pages 457-458**

Darwin didn't know what the source of variation in populations was—it is mutations and genetic recombination
*Only mutations that occur in gametes can be passed on to offspring
*Not all mutations are "bad." Some make the individual better adapted for that particular phenotype than others
--gene duplication is a major source of variation (see p. 459 for an example)
--mutation rates vary with the organism and with the type of genetic material—HIV mutates rapidly because it's a retrovirus
--sexual recombination that is a result of independent assortment and crossing over is a more important source of variation from generation to generation
*Keep in mind that mutations result in the variations in genes that get "mixed up" during independent assortment and crossing over

Factors that Affect Allele Frequencies

1. Natural Selection—due to variations, some organisms are better adapted and survive to pass on their genes

   ***This is the most significant reason for evolution! Only this will adapt a population to its environment.**
2. Genetic Drift—results from the fact that populations are not infinite and some may be small; deviations from expected genetic outcomes due to the randomness of sexual reproduction result in genetic drift; there are two major factors that increase the likelihood genetic drift will impact populations:

a. The Bottleneck Affect—a random event kills off many members of the population—like they were passed through a bottleneck; this randomly eliminates some alleles from the population (see fig. 23.8)\
b. The Founder Affect—a few individuals become isolated from a larger population and establish a new population there; allele frequencies are less due to lack of numbers (like finches coming to a new island)

3. Gene Flow—genes are lost or gained by movement of fertile individuals into or out of a population; this tends to reduce differences between two different populations because gene pools are being mixed between the two (human alleles today are much more mixed than they were in the past due to increased travel)

*Remember that natural selection acts directly on phenotype and that phenotype is not completely determined by genetics; individuals can modify their phenotypes and the environment has effects on phenotype
*Only the genetic component of variations can have evolutionary consequences as a result of natural selection

Variation Within a Population
--discrete characters are "either-or" type traits; phenotypic polymorphisms occur with discrete characters; number of polymorphisms can be measured by determining the amount of heterozygosity
--quantitative characters vary along a continuum

Populations exhibit **geographic variation**, where gene pools differ in separate populations in different locations; this can be acted upon by natural selection; some geographic variation results in **clines**, graded changes in a trait along a geographic axis, like latitude or longitude, or elevation

Fitness
--the contribution any individual makes to the population's gene pool of the next generation in comparison to the contribution of other individuals
***Keep in mind that the entire organism must be considered with natural selection; this means that alleles that may be maladaptive get passed on to the next generation if other alleles make the individual more fit**
***Fitness is zero for an individual that doesn't reproduce, no matter how well-adapted it is**

Types of Selection (see figure 23.12)
1. Directional—favors phenotypic variants at one extreme of a distribution of phenotypes; results from environmental change or migration of population members to another environment
2. Disruptive—conditions favor individuals on both extremes of a phenotpye range over intermediate phenotypes
3. Stabilizing—favors intermediate variants; acts *against* extreme phenotypes; keeps a particular phenotype stable

Preserving Variation

--diploid organisms can hide variation in recessive alleles

--balancing selection occurs when natural selection maintains stable frequencies of two or more phenotypic forms in a population (balanced polymorphism); there are two forms of this:

1. Heterozygote Advantage—heterozygotes have greater fitness that homozygotes (see page 466 for an example of this)
2. Frequency-dependent Selection—the fitness of one morph declines if it becomes too common in the population (see the experiment on figure 23.14); rare individuals are going to have an advantage because others may be so common they are easy for predators to find

Sexual Selection

--natural selection for mating success

--can result in sexual dimorphism, where males and females of the same species differ from each other; this can include differences in size colors, and behaviors

--there are two types of sexual selection:

1. Intrasexual Selection—direct competition among members of one sex for individuals of the opposite sex; usually occurs in males
2. Intersexual Selection (Mate Choice)—individuals of one sex (usually females) are choosy in selecting their mates; many male birds have showy feathers, exhibit courtship dances, and sing for the females; this puts males at risk to predation more than females (it doesn't seem to be adaptive)

Evolution and Sexual Reproduction

--sexual reproduction is not as good as asexual at increasing population numbers

--it must enhance reproductive success somehow:

1. sexual reproduction preserves future genetic variation; however, natural selection acts in the here and now
2. sexual reproduction preserves variation for resistance to disease

Ideas About Natural Selection:

1. Evolution is limited by historical restraints—each species shares the genetic legacy of their ancestors
2. Adaptations are often compromises—adaptations make organisms fit their environments but many organisms utilize several environments (humans evolved to walk on two legs, but their ancestors walked on four; we are prone to back and knee problems)
3. Chance and natural selection interact—random events can affect the fate of organisms in a positive or negative way that would not normally be expected
4. Selection can edit only existing variations—new alleles don't arise on demand