Notes KEY: EVOLUTION OF POPULATIONS: Population Genetics and Patterns of Evolution (17 and 19.2 and 19.3)

How do we study Evolution? 17-1

- **Species**- A group of similar organisms that are capable of producing fertile organisms.
- **Population** - a localized group of a species in a defined area. We study evolution as **genetic change** in a population.We study evolution as genetic change in a population.

Genes and Variation 17-1

Inheritable traits are coded for by genes, and the different forms of a gene are called alleles. There exists variation within a population for many of these alleles. We can figure out what the frequency of a particular allele is by calculating the number of times that allele appears in that population compared to others in the entire **gene pool.**

- **gene pool** - consists of all of the genes present in a population.
- The relative **frequency** of an allele in a population is often expressed in a percentage.

Example: Fur color in the gene pool for a population of mice. How many genes are in the gene pool? What is the frequency of the black alleys? What is the frequency of the brown allele?

- **Microevolution** - A change in the relative frequency of an allele occur ing in in a population. "Change over time " has occurred, and this is evolution on a small scale. EX: Polydactyly in the gene pool."

Sources of Genetic Variation 17-1 p.484

- **Mutations**- new alleles can arise only if a mutation occurs and a new sequence of DNA makes a new form of gene.
- **Gene shuffling**- independent assortment of chromosomes and crossing over during gamete formation produce millions of possibly arrangements of your genes! There is not change in a frequency when genes are shuffled, but that is why there is so much variation

Selection on a Single-Gene trait p. 485

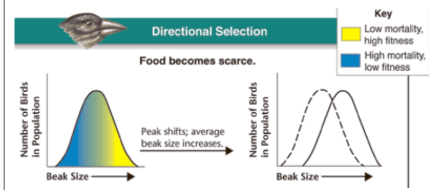
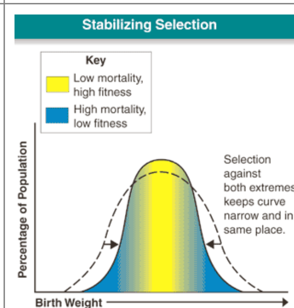
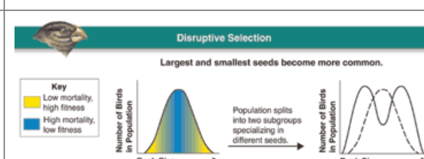
A **single-gene trait** with two alleles will show two phenotypes. A change in frequency is easy to see in a population. Example: see pg. 485

Selection on a Polygenic Trait p. 486

- **Polygenic trait** - is one that is controlled by more than one gene.

Things such as height in humans are polygenic traits. If you were to graph out the frequencies of the phenotypes, you would get a **bell shaped** curve.

Evolution as Genetic Change in Populations (17.2 p 489)

Type of selection	**Which part of the phenotype spectrum is selected for?**	**Example**	**Graphical Representation**
Directional Selection	occurs when individuals at one end of the curve (with phenotypes at ne end of the spectrum) are advantaged, and selection against the other end occurs. The individuals with the higher fitness, or ability to survive and reproduce, will succeed. Over time, the population will shift in its phenotypes to one direction.	Food becomes scarce for a population of birds and large beaks are most efficient at eating the available food.	
Stabilizing selection	occurs when individuals in the middle of the curve are more advantaged, or have a higher fitness, than individuals at the ends. This causes the frequency of the mid-phenotypes to increase, and the ends to decrease.	Birth weight in humans.	
Disruptive Selection	occurs when individuals at the ends of the curve are more advantaged, or have a higher fitness, than individuals at the middle of the curve. This is less common. A single curve will appear to split in two.	Larger and smaller seeds become more common and so larger or smaller beaks are both advantages.	

Evolution vs Genetic Equilibrium p. 491- 492

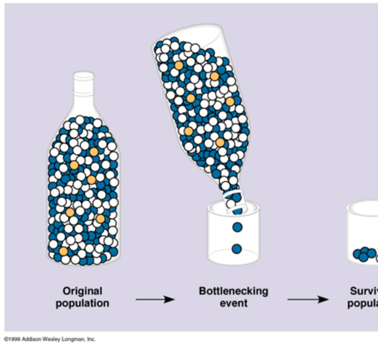
We study evolution as genetic change by comparing to a population that is not evolving. There are 5 criteria for a NON-evolving population (Hardy-Weinberg principle)

1. **Need Random mating**- all members of the population have an equal shot at mating, and selecting mates based on traits does not occur. Non-Random mating is selecting mates based on heritable traits such as size, strength, or coloration: known as "sexual selection." This interferes with genetic equilibrium.
2. **No genetic drift**- genetic drift is a random change of frequency of an allele because the population is small. Natural selection effects small populations much more than large ones.
3. **No immigration or emigration**- no new individuals can add to the gene pool.
4. **No mutations**- mutations are the ultimate source of genetic change, so a non-evolving population would have no mutations.
5. **No natural selection**- all individuals have the same ability to survive and reproduce.

Does this happen in nature? This **RARELY** applies in nature because of all of the disruptive circumstances that occur in nature and alter the allele frequencies of the population.We can calculate genetic change using the Hardy-Weinberg equation comparing allelic frequencies. We will solve some tomorrow.

Genetic Drift p. 490 (17.2) Slide 28.

- Genetic drift is the change in a population's allele frequencies due to chance.
- There are 2 situations in which a population is shrunk and genetic drift can take place:



1. **The Bottleneck Effect p. 490 -** a change in allele frequencies that are different from those of the original gene pool. It results from a change in allele frequency following a dramatic reduction in the size of a population, maybe due to a disaster due to a disease which kills many individuals in the population.
   - This can greatly reduce genetic variability.
2. **The Founder Effect p. 490**
   - Genetic Drift where a few individuals colonize a new habitat. The founding individuals may contain genes that are different in frequency from the main population. The new gene pool may start out with allele frequencies different from those of the parent gene pool.
   - There is very little genetic variety in the gene pool because not all genes from the original population are represented.

- How might the bottleneck effect and the founder effect negatively affect a forming population?

These changing allele frequencies become common simply by chance. Over time, Over time, a series of chance occurrences can cause an allele to become more or less common in a population. Because so many alleles have been eliminated from the gene pool, the new population has very little genetic variety in its gene pool because not all of the original gene pool is represented. This causes the gene pool to be susceptible to disease, disaster, etc. and possibly, survival of the new population.

<u>Speciation (17.3 p. 494)</u>

First of all what is a species?

- As defined by Ernst Mayr- the Biological Species Concept states: "Species are groups of actual or potentially interbreeding natural populations which are reproductively isolated from other such groups."
- When natural selection acts on a population, certain characteristics are **favored** and others are not. What causes **new species** to arise? They must be separated and no longer be able to produce **fertile offspring**, or become **reproductively isolated**, in order to become officially a different **species**. This is called **speciation**. **Speciation** may be phyletic (one species evolving into another) or divergent (one species splitting into two distinct species).

<u>Types of Reproductive Isolating Mechanisms (RIMs) 17.3 pp. 494-495:</u>

- **Prezygotic** (prevent mating or fertilization)
    1. Geographical isolation- Geographical isolation- different habitats or rarely encounter each other.
    2. Temporal isolation- Breed or Flower at different times of the year or day.
    3. Behavioral isolation- Differences in mating/courting; usually a result of sexual selection. (Eastern Meadowlark and Western Meadowlark don't mate due to different mating songs.)
    4. Mechanical isolation- anatomically incompatible sex organs on plants or animals.
- **Postzygotic** (reduce viability of hybrids)
    1. Hybrid inviability- Hybrids do not develop or are less likely to survive.
    2. Hybrid sterility- F1 Hybrids develop, but cannot reproduce.
    3. Hybrid breakdown- F1 Hybrids are viable, but F2's are not.

<u>How did speciation occur in the Galapagos? p. 472-473; 496-497</u>

1. Because the Galapagos are a group of islands, there are separate ecosystems on each.
2. Founder populations arrived on an island from the mainland of South America.
3. Reproductive isolation occurred (geographic).
4. Frequencies of different traits changed in that population over time because of natural selection, based on food source, soil types, predators, etc.
5. Eventually, over a long period of time, the original population and the founder population on the second island are very different and are considered different species.

<u>The Origin of Life (19.3) pp. 553-563.</u>

We will never truly know for sure how life began on Earth but scientists have tested two different ideas:

- **<u>Biogenesis</u>** – The hypothesis that living matter arises only from other living matter.

a. For the first three quarters of evolutionary history, life on earth was microscopic and unicellular.
b. **(19.3 - Pp. 553, 554)** In 1953, two scientists, Miller and Urey, recreated what was believed to be the early conditions on Earth.
    - It is believed that the atmosphere consisted of hydrogen, methane, ammonia, and water.
    - In the early atmosphere, energy was provided by intense light and UV radiation.
    - The scientists were able to create organic (carbon containing) compounds present today with just those conditions. The First Organic Molecules.
    - These organic compounds gave rise to cyanobacteria, which evolved into bacteria.
    - (P. 556) Eukaryote cells are believed to have come from the process of **endosymbiosis** (one bacteria cell absorbed another bacteria cell and it thrived in the new environment). This absorbed bacteria eventually evolved into organelles found today in eukaryote cells like mitochondria and chloroplasts. DNA similarities provide evidence that this is how eukaryote cells were formed. **"The Endosymbiotic Theory"**

Patterns of Evolution (19-2)

- **Increasing complexity of cellular life p. 546-** The **evolution of Biological complexity** is one of the outcomes of the process of evolution. "Macroevolution" is the term that refers to large-term evolutionary patterns and processes that occur over long periods of time and have resulted in the increasing complexity of cellular life. Although there has been an increase in the maximum level of complexity over the history of life, there has always been a large majority of small and simple organisms and the most common level of complexity (the mode) appears to have remained relatively constant. Five important topics in macroevolution are extinction, adaptive radiation, convergent radiation, coevolution, punctuated equilibrium, and changes in developmental genes.
- **Extinction p. 548**- a species or group that has died out or has no living relatives. 99% of all species that have ever lived are now extinct. In the struggle for existence, species compete for resources, and some lose, and die (via the slow but steady process - gradualism p. 549 - of Natural Selection). EX: The dodo bird has been extinct for several hundred years after humans introduced predators to their habitat
- **Adaptive Radiation p. 550**- several vastly different species arise from a single species to fill available niches.
- **Convergent Evolution p. 551**- unrelated organisms come to resemble each other because their adaptations resemble each other. Penguins are birds, dolphins are mammals, and they have modified structures that are like that of a fish for swimming! They are structures with the same functions, but are not on related animals are called **analogous structures (also on p 469).**
- **Coevolution p. 551**- two species evolve along with each other based on a close relationship with each other. Plants and their pollinators, parasites with their hosts, etc.
- **Punctuated equilibrium p. 549**- long periods of time with stable species broken with rapid period of change.