

Darwinian Evolution Basics

1. Individuals in a population exhibit variety in physical traits.
2. Some traits are better adapted to the environment than others, enhancing the ability to survive and reproduce
3. These adaptations may be passed on to future generations
4. Cumulative changes in a population over time is evolution, aka descent with modification
5. All biological diversity can be explained by evolution
6. Natural selection affects individuals, but populations evolve

Darwin was missing an **Inheritance Mechanism!** **Genetics!**

The Modern Synthesis

Combines field of population genetics with Darwin's theory of evolution by natural selection.

Population Genetics

- **Population:** Localized group of individuals of the same species
- **Species:** Group of populations whose individuals can potentially interbreed
- **Gene Pool:** Total aggregate of alleles in a population at one time. The genetic diversity of a population.
- **Allele:** an alternative form of a gene.
- **Homozygous:** have 2 identical alleles for a given trait (dominant or recessive) (e.g. AA or aa)
- **Heterozygous:** have 2 different alleles for a given trait (e.g. Aa or aA)

Why aren't all individuals of one species identical to each other?

Genetic variation is extensive in most populations.



Where does genetic diversity come from?

It is the product of

- **A. Mutation**
- **B. Sexual reproduction (genetic recombination)**
 - These processes provide **alternative alleles** that may or may not be useful with changes in environment.
 - This creates variation, which is a prerequisite for evolutionary adaptation

A. Mutation

- random, **heritable change** in DNA that introduces new alleles into a gene pool.
- **Most mutations are harmful, but very very rarely they are not...**

Mutations are the only source of genetic variation in asexually reproducing organisms

- Microorganisms with high replication rates can generate genetic variation very rapidly.

- Offspring have same alleles as parents (haploid). So non-lethal mutations are directly passed to the next generation.



B. Sex also Generates Variation

HOW?

VIA Random events:

- Crossing over
- Independent assortment
- Random fertilization

THE RESULT:

Offspring have different combinations of alleles than parents.



Genetic Variation is a key element of evolution

- Evolution is simply a change in the allele frequencies within a population of organisms.
→ Can have evolution without natural selection
- Natural Selection 'chooses' among the possible phenotypic variations to get the best fit for a certain time and place. - IF these differences have a genetic basis, THEN, there is evolution as a result of N.S.
- BUT, you can have N.S. without evolutionary change if there is no heritable basis to the traits.

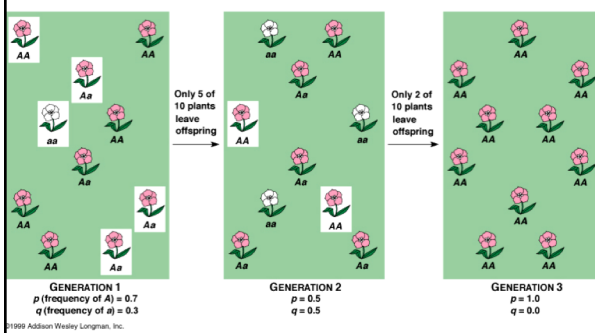
MICROEVOLUTION

Generation to generation change in a population's allele frequencies.

Causes of Microevolution:

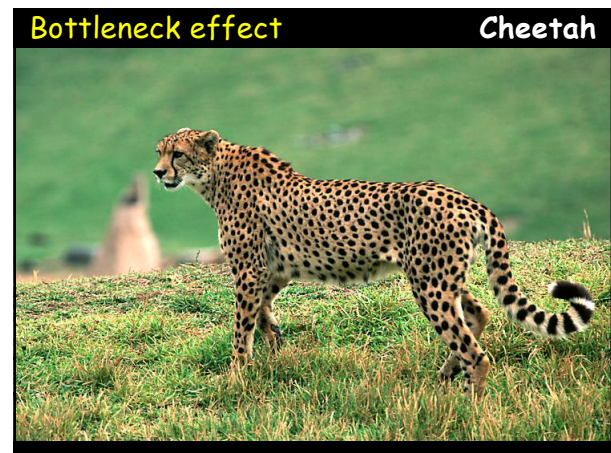
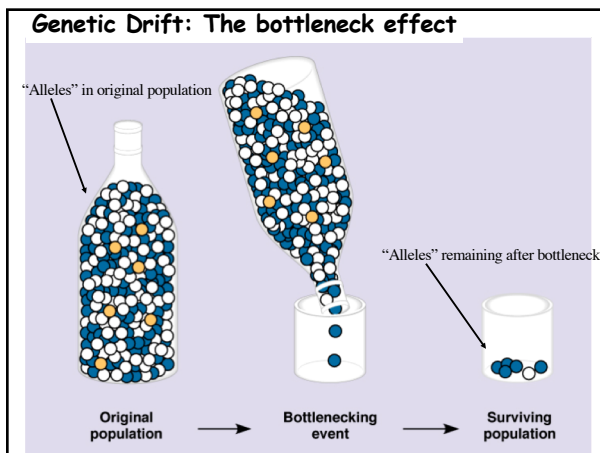
- Genetic Drift
- Natural Selection

Genetic Drift: random changes in the gene pool of small populations due to chance; natural selection is not involved.



So genetic drift can cause fixed alleles

- A fixed allele means that only ONE allele exists for a given gene.
- There is a loss of genetic variation for the trait.
- This can be a problem because without genetic variation, a population can't evolve... can't adapt to a changing environment.



Genetic Drift: The founder effect

- Change in allele frequencies when a new population arises from only a few individuals.

e.g., only a few fish are introduced into a lake.
e.g., only a few birds make it to an island.



Gene Flow

- addition or removal of alleles due to individuals entering or leaving a population from another population.
- Continuous gene flow between populations decreases the genetic difference between the two populations.



Gene Flow



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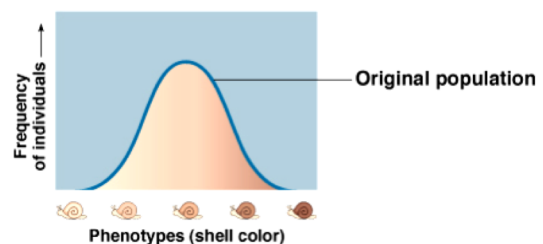
Natural Selection- individuals vary in their ability to survive and reproduce in a given environment

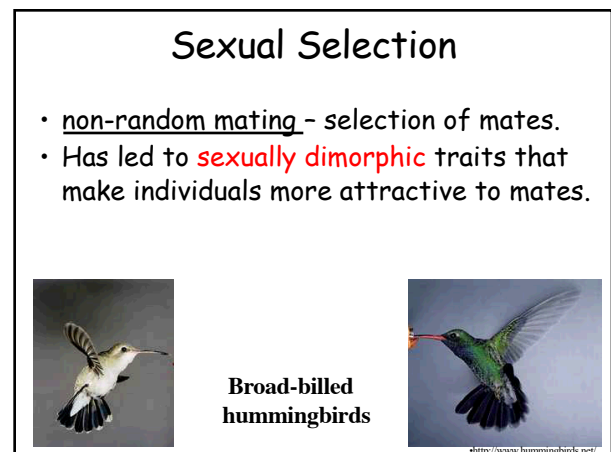
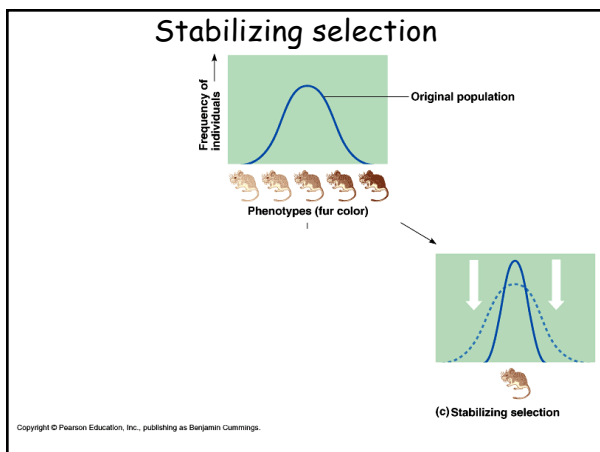
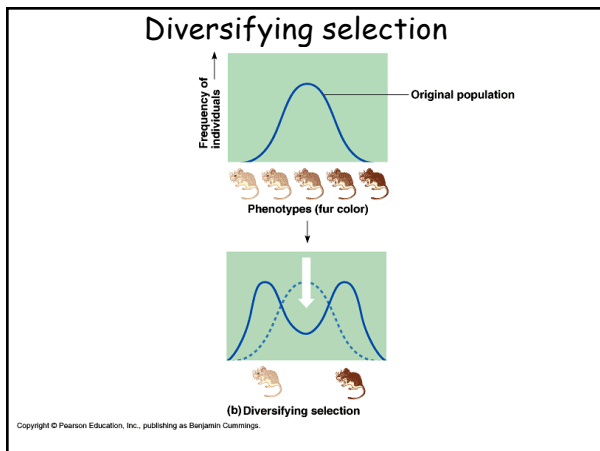
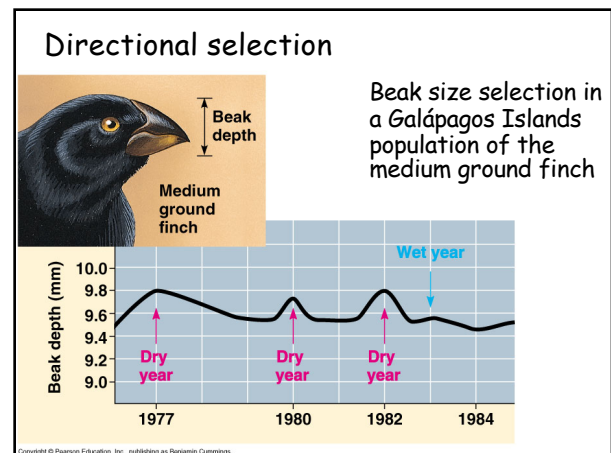
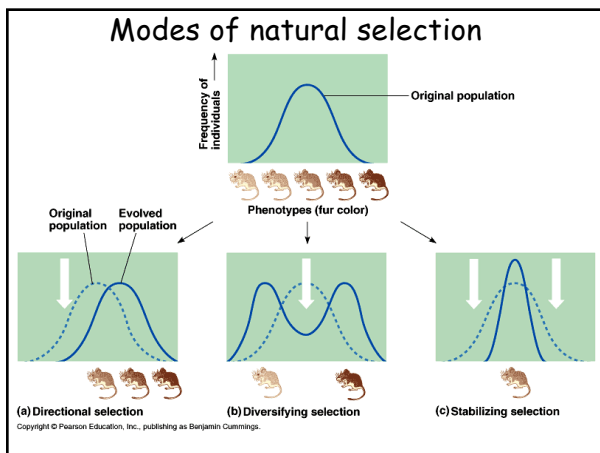
- Some individuals produce more offspring than others (due at least in part to their genetics).
- More offspring means more of that individual's genes passed on to future generations.
- Results from differences in mortality (survivorship) as well as differences in fecundity (number of offspring).

Remember:

- Natural selection doesn't change the selected individuals in any way.
- Selected individuals produce more offspring than nonselected individuals.
- Selection doesn't imply a conscious act or choice by the offspring.

A "typical" population





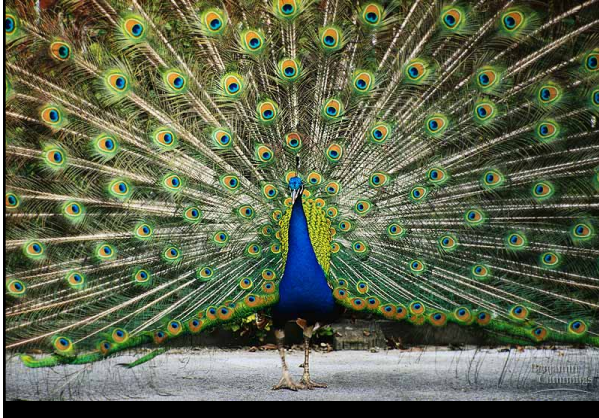
Sexual selection and the evolution of male appearance



Intrasexual selection



Intersexual Selection (mate choice)



Intersexual selection



Natural Selection does not produce perfection

- Evolution limited by historical constraints.
- Selection can only 'edit' existing variations.