Mechanisms of Evolution
Individuals don't evolve...

Individuals survive or don't survive...

Individuals are selected

Populations evolve
Variation and Natural Selection

**Variation** is the raw material for natural selection.

- There have to be differences within population.
- Some individuals must be more fit than others.
Where does variation come from?

- **Mutation**
  - Random changes to DNA.
  - Errors in mitosis and meiosis.
  - Environmental damage.

- **Sexual Reproduction**
  - Mixing of alleles
    - Recombination of alleles.
      - New arrangements in every offspring.
    - New combinations = new phenotypes.
  - Spreads variation
    - Offspring inherit traits from parent.
5 Agents of Evolutionary Change

- Mutation
- Gene Flow
- Non-random mating
- Genetic Drift
- Selection
Mutation and Variation

- Mutation creates **variation**.
  - New mutations are constantly appearing.

- Mutation **changes DNA sequence**.
  - Changes amino acid sequence.
  - Changes protein’s:
    - Structure
    - Function
  - Changes in protein may change phenotype and therefore change fitness.
Gene Flow

Movement of individuals and alleles in and out of populations.

- Seed and pollen distribution by wind and insect.
- Migration of animals.
  - Sub-populations may have different allele frequencies.
  - Causes **genetic mixing** across regions.
  - Reduce differences between populations.
Human Evolution Today

Gene flow in human populations is increasing today.

- Transferring alleles between populations.

Are we moving towards a blended world?
Non-random Mating

Sexual selection
Genetic Drift

Definition: a process in which chance events cause unpredictable fluctuations in allele frequencies from one generation to the next.

- Occurs in small populations.
- Examples: founder effect, bottleneck effect.
Genetic Drift: Founder Effect

When a new population is started by only a few individuals.

- Some rare alleles may be at high frequency; others may be missing.
- Skew the gene pool of new population.
  - Human populations that started from small group of colonists
  - Example: colonization of New World
Distribution of Blood Types

Distribution of the **O type** blood allele in *native* populations of the world reflects original settlement.
Genetic Drift: Bottleneck Effect

When large population is drastically reduced by a disaster.

- Famine, natural disaster, loss of habitat…
- Loss of variation by chance even.t
  - Alleles lost from gene pool.
    - Not due to fitness.
    - Narrows the gene pool.
Bottleneck Effect: Cheetahs

- All cheetahs share a small number of alleles.
  - Less than 1% diversity
  - As if all cheetahs are identical twins.

- Two bottlenecks
  - 10,000 years ago
    - Ice Age
  - Last 100 years
    - Poaching
    - Loss of habitat
Conservation issues

Bottlenecking is an important concept in conservation biology of endangered species.

- Loss of alleles from gene pool.
- Reduces variation.
- Reduces adaptability.

Breeding programs must consciously outcross.
Natural selection

Differential survival and reproduction due to changing environmental conditions.

- **Changing Environment**
  - Climate change
  - Food source availability
  - Predators, parasites, diseases
  - Toxins

- **Combinations of alleles** that provide **“fitness”**
  - **increase** in the population.
  - Adaptive evolutionary change.
Types of Selection

- **Directional Selection**
  - Before Selection
  - After Selection
  - Examples: giraffe neck, horse size

- **Stabilizing Selection**
  - Before Selection
  - After Selection
  - Examples: human birth weight

- **Disruptive Selection**
  - Before Selection
  - After Selection
  - Examples: rock pocket mice
Any Questions??