

**Individuals are selected...**

**Populations evolve!**

The graph shows the relationship between birth weight and infant mortality. The x-axis is 'Birth weight in pounds' (2-10) and the y-axis is 'Percent infant mortality' (2-100). A red curve shows that both very low and very high birth weights result in higher mortality rates, with the lowest mortality occurring at intermediate birth weights (around 7-8 pounds). A blue histogram shows the distribution of birth weights in a population, peaking at the intermediate range.

**Populations Evolve!**

- **Natural selection acts on individuals**
  - ◆ differential survival
    - “survival of the fittest”
  - ◆ differential reproductive success
    - who bears more offspring
- **Populations evolve**
  - ◆ genetic makeup of population changes over time
  - ◆ favorable traits (greater fitness) become more common

The graph shows the 'Frequency of cold-adapted allele' (y-axis, 0.0 to 1.0) versus 'Latitude (degrees North)' (x-axis, 44 to 30). The data points for Mummichog show a clear trend where the frequency of the cold-adapted allele increases as latitude increases (moving north).

**Evolutionary Fitness**

- **Survival & Reproductive success**
  - ◆ individuals with one phenotype leave more surviving offspring

Three graphs illustrate evolutionary fitness in water striders. The top graph shows 'Number of eggs laid per day' vs 'Length of adult female water strider (mm)', showing a positive linear relationship. The bottom-left graph shows 'Life span of adult female (days)' vs 'Length of adult female water strider (mm)', showing a negative relationship. The bottom-right graph shows 'Number of eggs laid during lifetime' vs 'Length of adult female water strider (mm)', showing a hump-shaped curve that peaks at an intermediate length.

**Variation & 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

Three images illustrate variation: a herd of horses with different coat colors and patterns, a collection of snails with different shell colors and patterns, and a field of purple lupines.

**Where does variation come from?**

- **Mutation**
  - ◆ random changes to DNA
    - errors in **mitosis & meiosis**
    - environmental damage
- **Sex**
  - ◆ mixing of alleles
    - **recombination of alleles**
      - ◆ new arrangements in every offspring
    - new combinations = new phenotypes
  - ◆ spreads variation
    - offspring inherit traits from parent

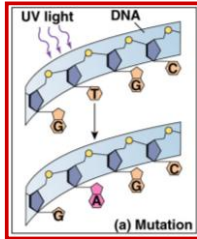
The top graph shows 'Beak depth' vs 'Year' (1977-1984) for ground finches, showing fluctuations between 'Dry year' and 'Wet year'. The bottom graph shows 'Beak depth of offspring (mm)' vs 'Mean beak depth of parents (mm)' for medium ground finches, showing a strong positive linear relationship. A photo of a white dog is also included.

**5 Agents of Evolutionary Change**

Five diagrams illustrate the agents of evolutionary change: 1. Mutation: UV light causing changes in DNA. 2. Gene Flow: pollen being carried between plants. 3. Genetic Drift: random changes in allele frequencies in a small population. 4. Non-random mating: a peacock choosing a mate based on its tail feathers. 5. Selection: a butterfly eating a leaf, representing natural selection.

### 1. Mutation & Variation

- Mutation creates **variation**
  - ◆ new mutations are constantly appearing
- Mutation **changes DNA sequence**
  - ◆ changes amino acid sequence?
  - ◆ changes protein?
    - changes structure?
    - changes function?
  - ◆ changes in protein may change phenotype & therefore change fitness



### 2. Gene Flow

- Movement of individuals & alleles in & out of populations
  - ◆ seed & pollen distribution by wind & insect
  - ◆ migration of animals
    - sub-populations may have different allele frequencies
    - causes **genetic mixing** across regions
    - reduce differences between populations



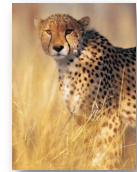
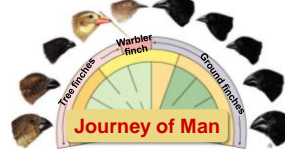
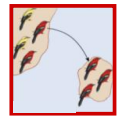
### Human Evolution Today

- Gene flow in human populations is increasing today
  - ◆ transferring alleles between populations



### 3. Genetic Drift

- Effect of **chance events**
  - ◆ **founder effect**
    - small group splinters off & starts a new colony
  - ◆ **bottleneck**
    - some factor (disaster) reduces population to small number & then population recovers & expands again



### Founder Effect

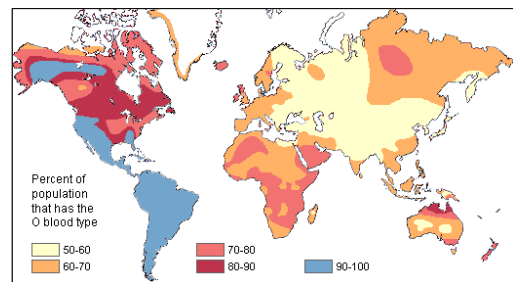
- When a new population is started by only a few individuals
  - ◆ some rare alleles may be at high frequency; others may be missing
  - ◆ skew the **gene pool** of new population
    - human populations that started from small group of colonists
    - **example:** colonization of New World

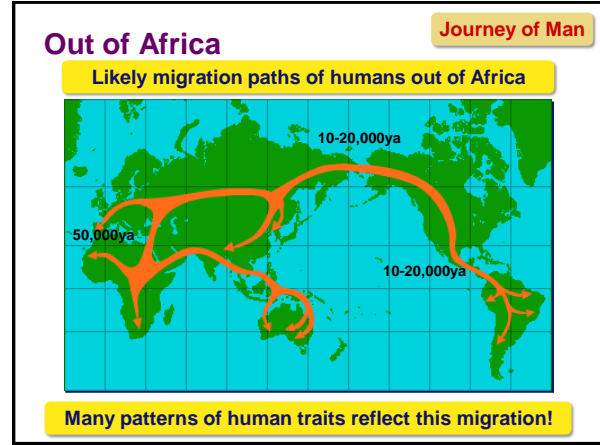
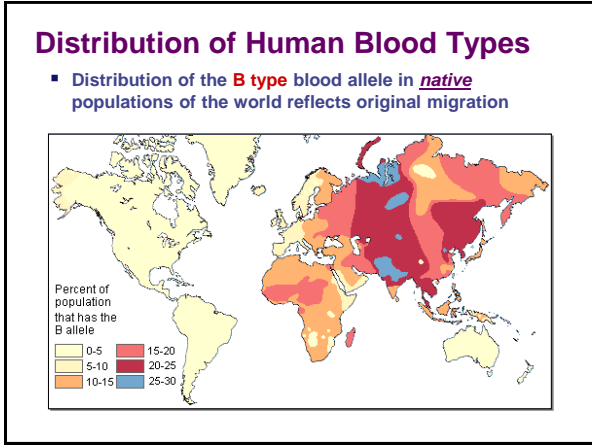


Eyes of Nye—Race!

### Distribution of Human Blood Types

- Distribution of the **O type** blood allele in **native** populations of the world reflects original settlement





### Bottleneck Effect

- When large population is drastically **reduced by a disaster**
  - ♦ famine, natural disaster, loss of habitat...
  - ♦ loss of variation by **chance event**
    - alleles lost from gene pool
      - ♦ not due to **fitness**
    - **narrows the gene pool!**

### Cheetahs

- All cheetahs share a small number of alleles
  - ♦ less than 1% diversity
  - ♦ as if **all** cheetahs are identical twins
- **2 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**

Peregrine Falcon

Golden Lion Tamarin

### 4. Non-Random Mating

- Sexual selection

### Sexual Selection

- Acting on reproductive success
  - ◆ attractiveness to potential mate
  - ◆ fertility of gametes
  - ◆ successful rearing of offspring



### 5. Natural Selection

- Differential survival & reproduction due to changing environmental conditions
  - climate change
  - food source availability
  - predators, parasites, diseases
  - toxins
  - ◆ combinations of **alleles** that provide "**fitness**" **increase** in the population
    - adaptive evolutionary change



### Natural Selection

- Selection acts on any trait that affects survival or reproduction
  - ◆ predation selection
  - ◆ physiological selection
  - ◆ sexual selection



- Acting on predator & prey
  - ◆ behaviors & habits
  - ◆ camouflage (mimicry)
  - ◆ speed
  - ◆ defenses (physical & chemical)

### Physiological Selection

- Acting on body functions
  - ◆ fitness (food-gathering)
  - ◆ physiology efficiency (oxygen, food, water)
  - ◆ disease resistance
  - ◆ protection from injury
  - ◆ biochemical versatility



**5.5 mya The Antarctic Ocean freezes over**

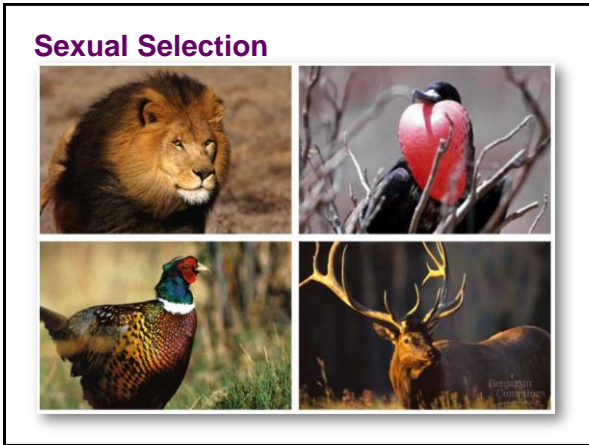
**Evolution of an antifreeze glycoprotein**

The ice-binding molecule glycoprotein (AFGP) that enables the survival of Antarctic notothenioid fishes underlies a novel strategy in the generation of environmental adaptation. The novel survival strategy probably arose from a functionally conserved protein, originating from the ancestor fish gene that duplicated an important sequence in the antifreeze protein... monomeric and dimeric glycoproteins that encode both an AFGP gene and an AFGP gene... AFGP binds to and arrests the growth of ice crystals that enter the fish, thereby preventing the fish from freezing. There are at least eight forms of the protein of different size (AFGP-1 to AFGP-8) all composed of repeats of a simple glycoprotein monomer (the AFGP unit) with a different number of repeats. The AFGP unit is a... attached to each... monomer.

### Physiological Selection

Dogs pee on trees...Why don't trees pee on dogs?





### The lion's mane...

**Sexual Selection, Temperature, and the Lion's Mane**  
 Pericus H. West\* and Craig Foster

The size of the male lion's mane varies with a long mane indicates that these males have more energy and are more likely to reproduce. The size of the mane is also related to the temperature of the year. Males with larger manes are more likely to reproduce in the wet season (the wet season is the time of the year when it rains).

- Females are attracted to males with larger, dark manes
- Correlation with higher testosterone levels
  - ◆ better nutrition & health
  - ◆ more muscle & aggression
  - ◆ better sperm count / fertility
  - ◆ longer life
- But imposes a cost to male
  - ◆ **HOT!** Worth it??

### Sexual Selection

- Sexual selection acts in all sexually reproducing species
  - ◆ “the traits that get you mates”
  - ◆ it influences morphology & behavior
  - ◆ it acts on both males and females

### Can sexual selection change populations?

- male African long-tailed widowbirds had different amounts of nests based on tail length
- either artificially or naturally lengthened or shortened
- **SIZE DOES MATTER**

Tail Length	Average number of nests per male
Artificially lengthened	~1.8
Normal	~1.0
Control	~1.0
Artificially shortened	~0.5

**CONCLUSION:** Sexual selection in widowbirds favors long tails.

