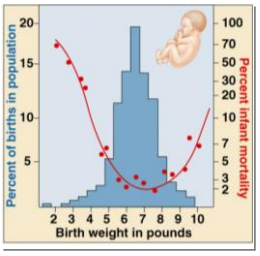
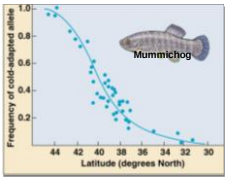
Chapter 21.2

Mechanisms of Evolutionary Change

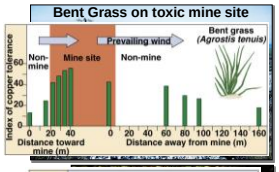


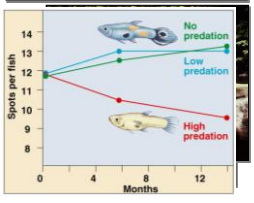
Populations Evolve!

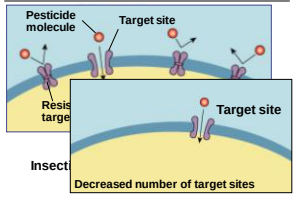
- Natural selection acts on individuals
  - differential survival
    - "survival of the fittest"
  - differential reproductive success
    - who bears more offspring
- Populations evolve
  - genetic makeup of population changes over time
  - favorable traits (greater fitness) become more common



Changes in Populations

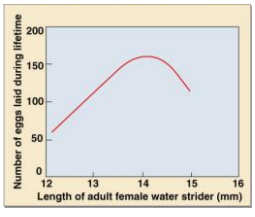




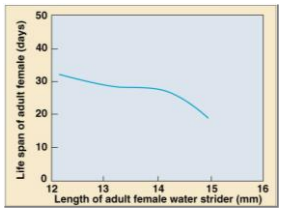


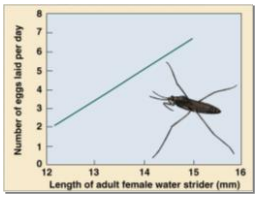
Evolutionary Fitness

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



Body size & egg laying in water striders



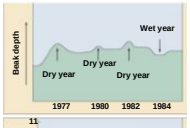


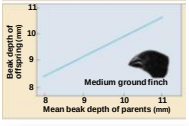
Variation & Natural Selection

- Variation is the raw material for natural selection
  - there have to be differences within population
  - some individuals must be more fit than others

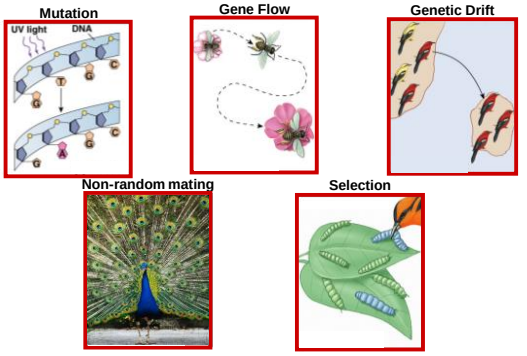
Where does variation come from?

- 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



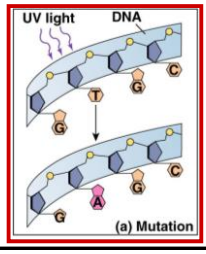


5 Agents of Evolutionary Change



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

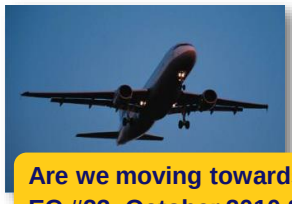


2. Gene Flow

- 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 populations
    - reduce differences between populations

Human Evolution Today

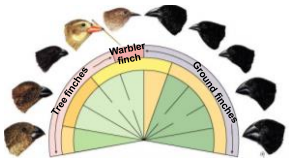
- Gene flow in human populations is increasing today
  - transferring alleles between populations



Are we moving towards a blended world?
EC #23; October 2010 Scientific American

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

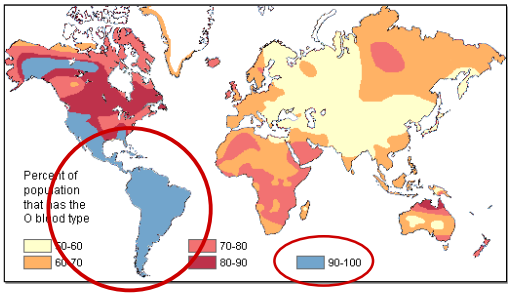
- When a new population is started by only a few individuals
  - some rare alleles may be at high frequency; others may be missing
  - skew the gene pool of new population
    - human populations that started from small group of colonists
    - example: colonization of New World

Journey of Man

Eyes of Nye—Race!

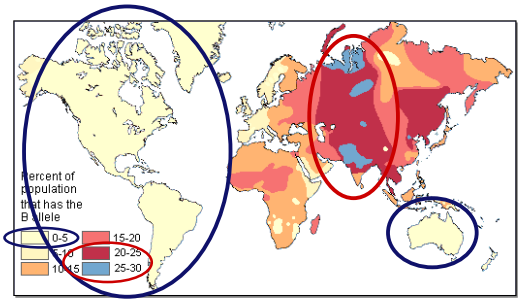
Distribution of Human Blood Types

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



Distribution of Human Blood Types

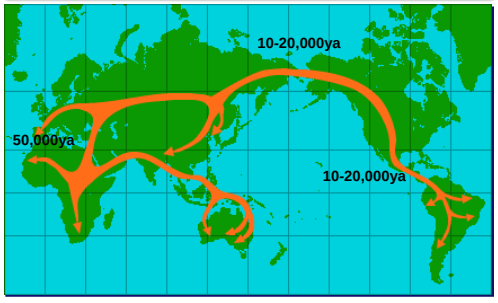
- Distribution of the **B type** blood allele in ***native*** populations of the world reflects original migration



Out of Africa

Journey of Man

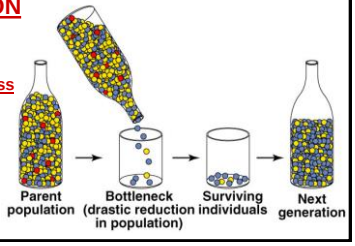
Likely migration paths of humans out of Africa



Many patterns of human traits reflect this migration!

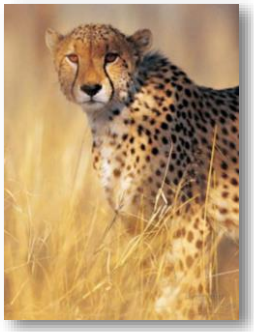
Bottleneck Effect

- When large population is drastically reduced by a disaster
  - famine, natural disaster, loss of habitat…
  - loss of variation by chance event; NOT SELECTION
    - alleles lost from gene pool
      - not due to fitness
    - narrows the gene pool



Cheetahs

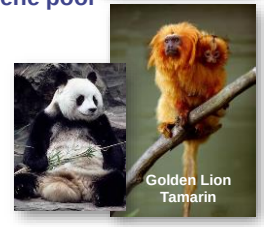
- All cheetahs share a small number of alleles
  - less than 1% diversity
  - as if all cheetahs are identical twins
- 2 bottlenecks
  - 10,000 years ago
    - Ice Age
  - last 100 years
    - poaching & loss of habitat



Conservation Issues

- Bottlenecking is an important concept in conservation biology of endangered species
  - loss of alleles from gene pool
  - reduces variation
  - reduces adaptability

Breeding programs must consciously outcross



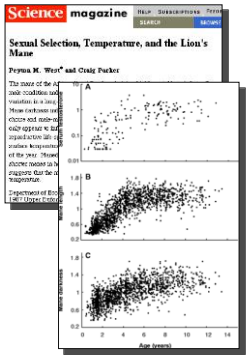
4. Non-Random Mating

- Sexual selection

Sexual Selection

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

The lion's mane…



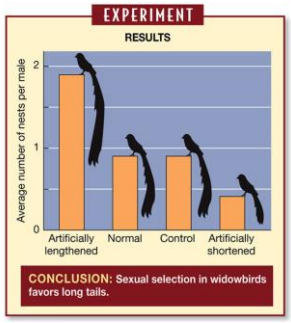
- Females are attracted to males with larger, dark manes
- Correlation with higher testosterone levels
  - better nutrition & health
  - more muscle & aggression
  - longer life
- But imposes a cost to male
  - *HOT!* Worth it??

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 artifically or naturally lengthened or shortened



5. Natural Selection

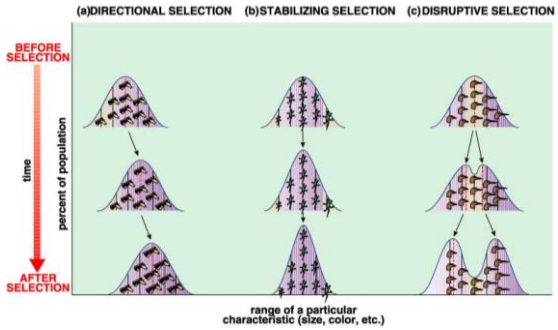
- Differential survival & reproduction due to changing environmental conditions
  - climate change
  - food source availability
  - predators, parasites, diseases
  - toxins
- combinations of alleles that provide "fitness" increase in the population
  - adaptive evolutionary change

Natural Selection

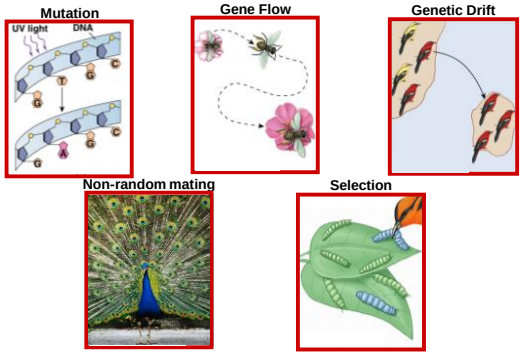
- Selection acts on <u>any</u> trait that affects survival or reproduction
  - predation selection
  - physiological selection

Effects of Selection

- Driving changes in a population



5 Agents of Evolutionary Change



Any Questions??