# Chapter 23.

## Evolution of Populations


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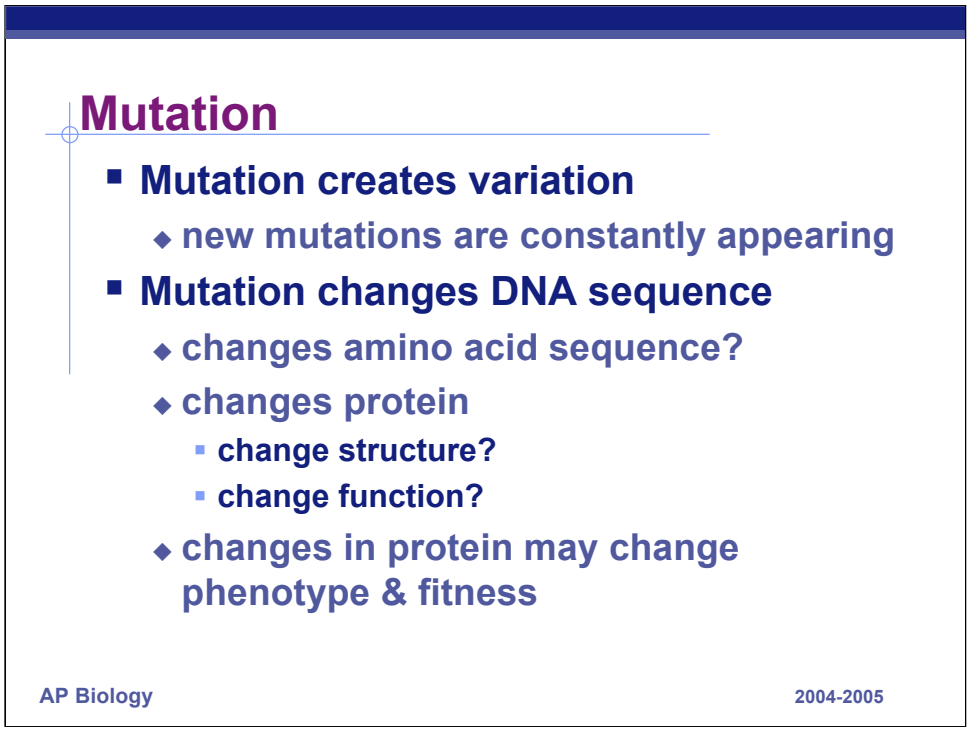
## Populations evolve

- Natural selection acts on individuals
  - differential survival
    - "survival of the fittest"
  - differential reproductive success
    - bear more offspring
- Populations evolve
  - populations of organisms change over time
  - traits which offer greater fitness become more frequent in the population

## Individuals DON'T evolve!!!!!

## Variation

- Natural selection requires a source of variation within the population
  - there have to be differences
  - some individuals must be more fit than others




Every individual has hundreds of mutations

1 in 100,000 bases copied

3 billion bases in human genome

But most happen in introns, spacers, junk of various kind

Not every mutation has a visible effect.

Some effects on subtle.

May just affect rate of expression of a gene.

## Sex

- Sex spreads variation
  - one ancestor can have lots of descendants
  - sex causes recombination
  - offspring have new combinations of traits = new phenotypes
- Sexual reproduction recombines alleles into new arrangements in every offspring

## Changes in populations

- Evolution of populations is really measuring changes in allele frequency
  - all the genes & alleles in a population = gene pool
- Factors that alter allele frequencies in a population
  - natural selection
  - genetic drift
    - founder effect
    - bottleneck effect
  - gene flow

# Natural selection

- Natural selection adapts a population to its environment
  - a changing environment
    - climate change
    - food source availability
    - new predators or diseases
  - combinations of alleles that provide “fitness” increase in the population

# Genetic drift

- changes in gene frequencies from 1 generation to another because of chance events
  - examples:
    - 1 family has a lot of children & grandchildren
      - therefore has a greater impact on the genes in the population than other families
    - a small group splinters off & starts a new colony = founder effect
    - famine reduces population to small number & then population recovers & expands = bottleneck

## 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 the new population
    - human populations that started from small group of colonists
    - example: white people!

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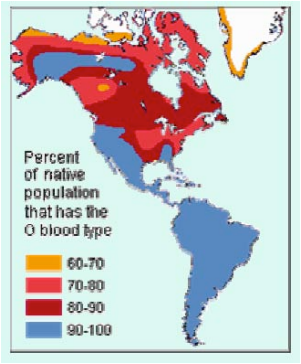
Small founder group, less genetic diversity than Africans

All white people around the world are descended from a small group of ancestors

100,000 years ago

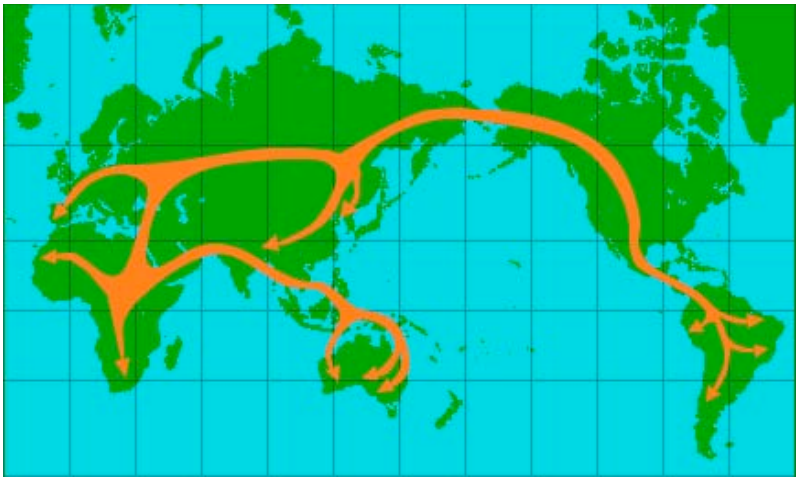
(Chinese are white people!)

# Distribution of blood types




South & Central American Indians were nearly 100% type O for the ABO blood system. Since nothing in nature seems to strongly select for or against this trait, it is likely that most of these people are descendants of a small band of closely related "founders" who also shared this blood type.

## Out of Africa



**Conjectured migration paths of humans out of Africa**

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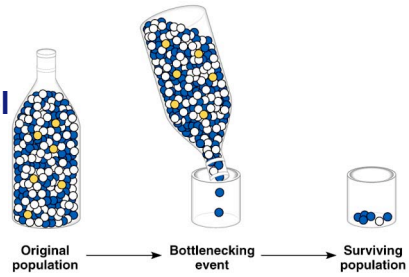
Migration Paths

According to the "Out of Africa" theory, modern humans appeared as a single African species nearly 100,000 years ago, then spread throughout the world (K.Wong, Is Out of Africa Going Out the Door?, Scientific American 281(2), August 1999).

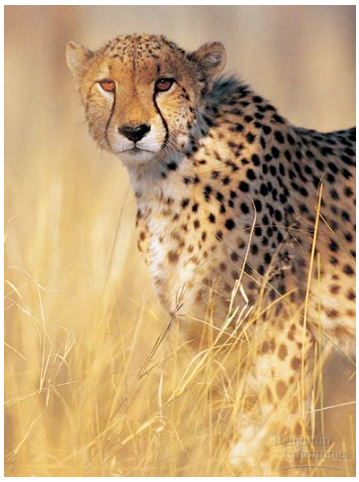
# Bottleneck effect

- When larger population is drastically reduced by a disaster
  - loss of variation
    - by chance, some alleles may be over-represented & others under-represented among survivors
    - some alleles may be eliminated altogether
    - 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**
  - **populations that have suffered bottleneck incidents have lost at least some alleles from the gene pool**
  - **this reduces individual variation & adaptability**
  - **at risk populations**

## Gene flow

- Have a population spread over a large geographic area
- Individuals can move from one area to another
- Sub-populations may have different allele frequencies
- Migrations cause mixing across regions = gene flow
  - new alleles are moving into gene pool
  - reduce differences between populations

## World wide travel

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

## Gene Flow & Human Evolution

- Are we moving towards a blended world?