

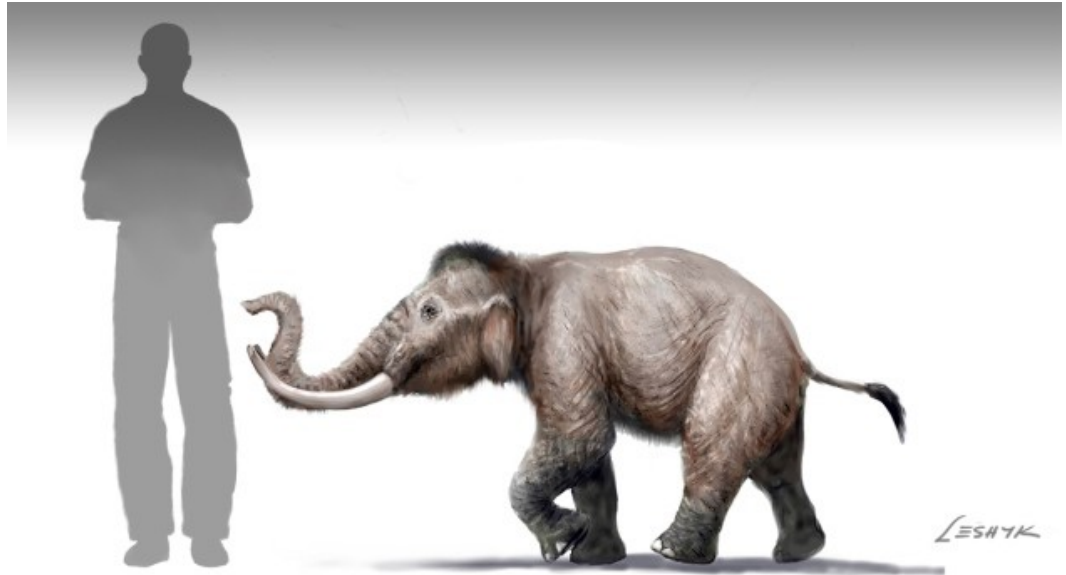
- Don't forget Lecture quiz
- First midterm in 1 week (look for email announcements)

Evolution (recap)

- Descent with modification; genetic (allele frequency) change in populations of organisms over generations.
- Natural selection was the mechanism emphasized by Darwin and Wallace
- However, several other forces of evolution can cause changes in populations of living things

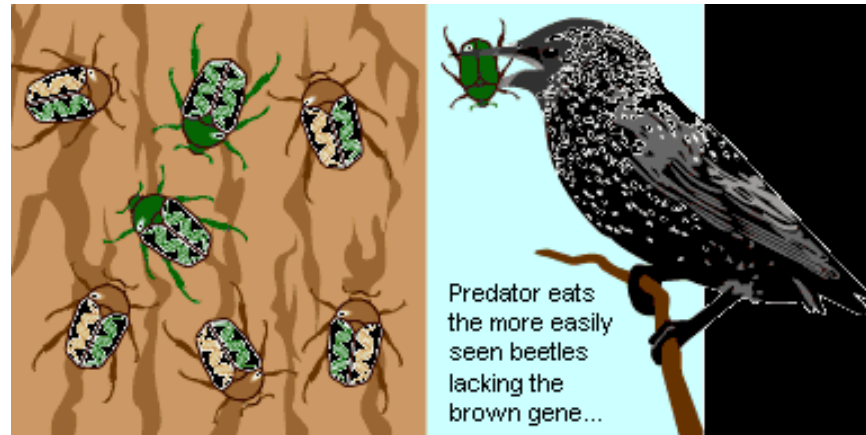
Forces of **Evolution?** (evolutionary agents)

- Forces of Evolutionary Change in a population include:
 - Natural Selection
 - Sexual Selection (often considered a kind of nat. selec.)
 - Genetic Drift
 - Gene Flow
 - Mutation



Fossil pygmy mammoths illustrate
rapid evolution on islands

NATURAL SELECTION

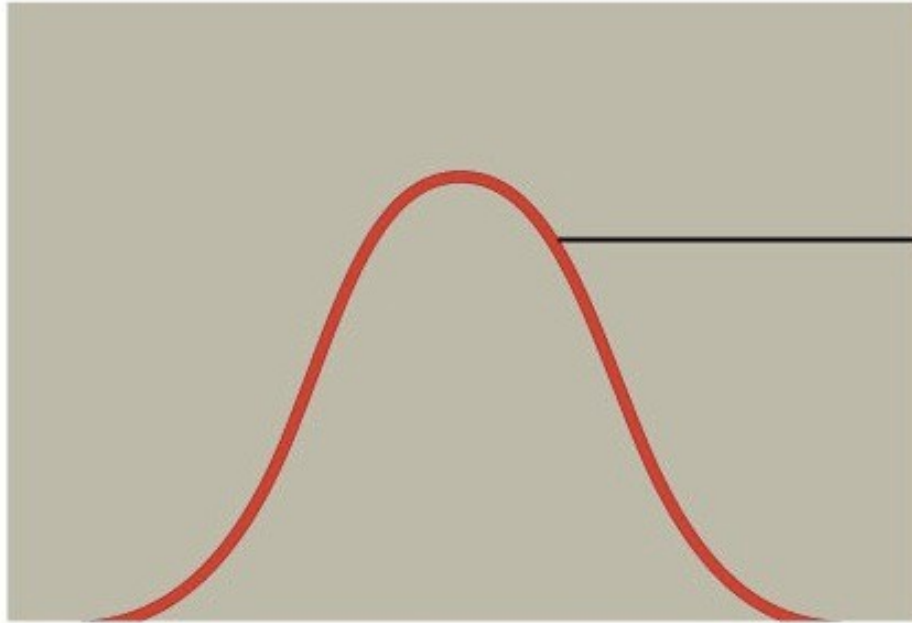


Natural selection accumulates and maintains favorable genotypes (higher fitness) in a population- leading to adaptation

Modes of natural selection:

- Stabilizing selection
- Directional selection
- Disruptive selection

Frequency of
individuals ↑



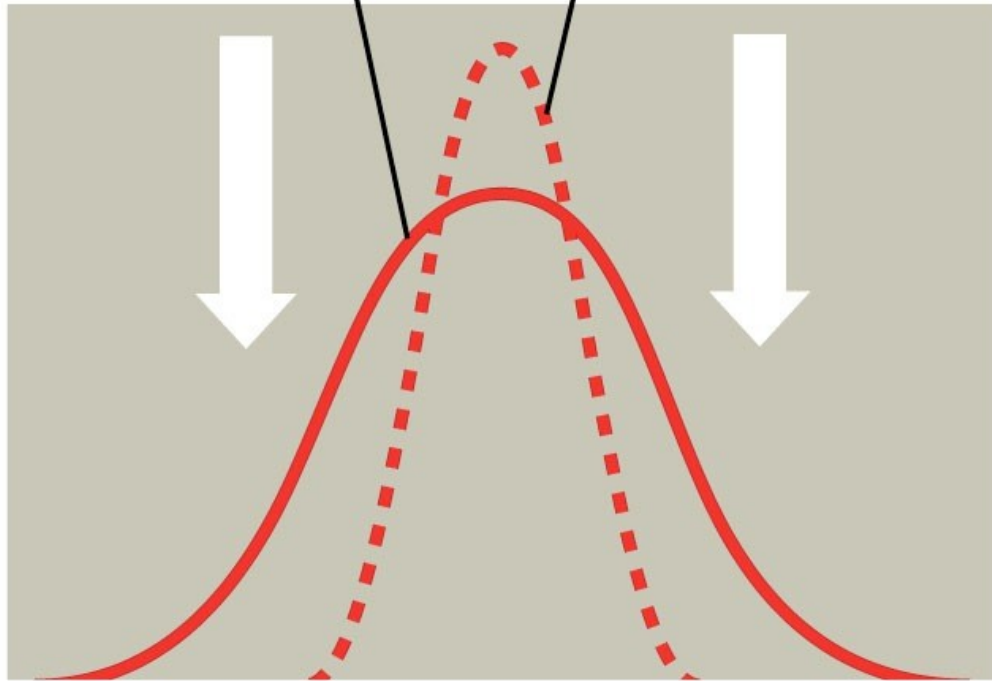
Original population



Phenotypes (fur color)

**Original
population**

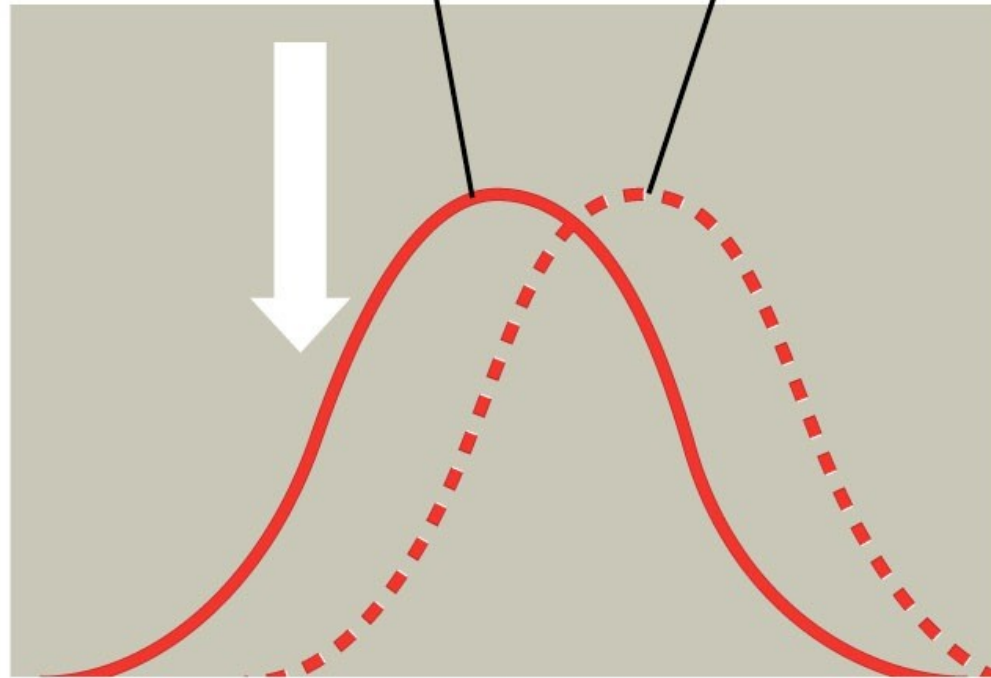
**Evolved
population**



(c) Stabilizing selection

**Original
population**

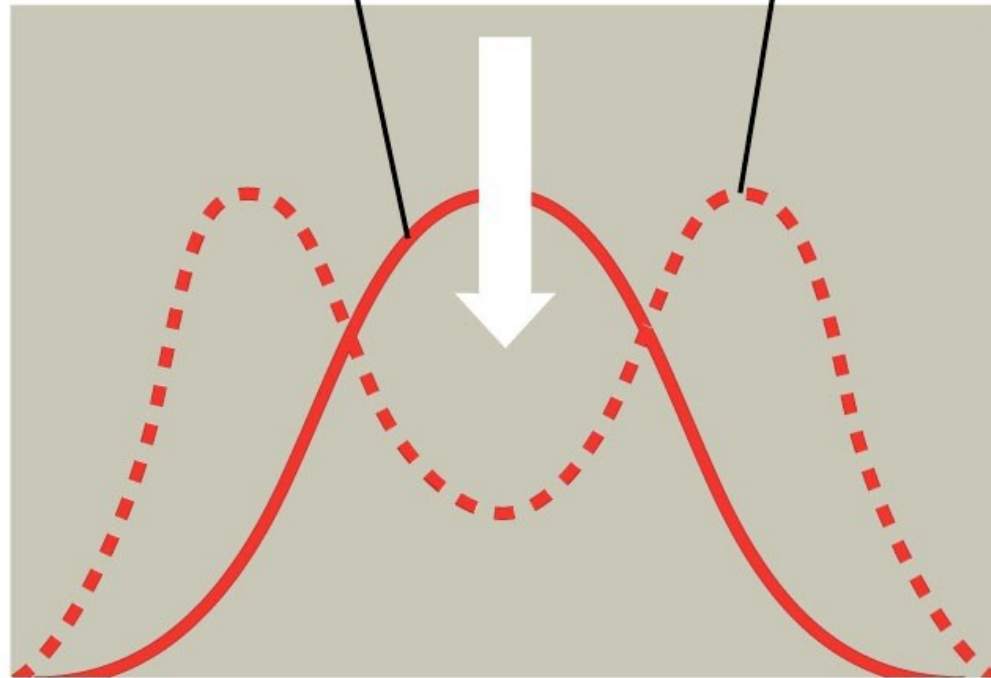
**Evolved
population**



(a) Directional selection

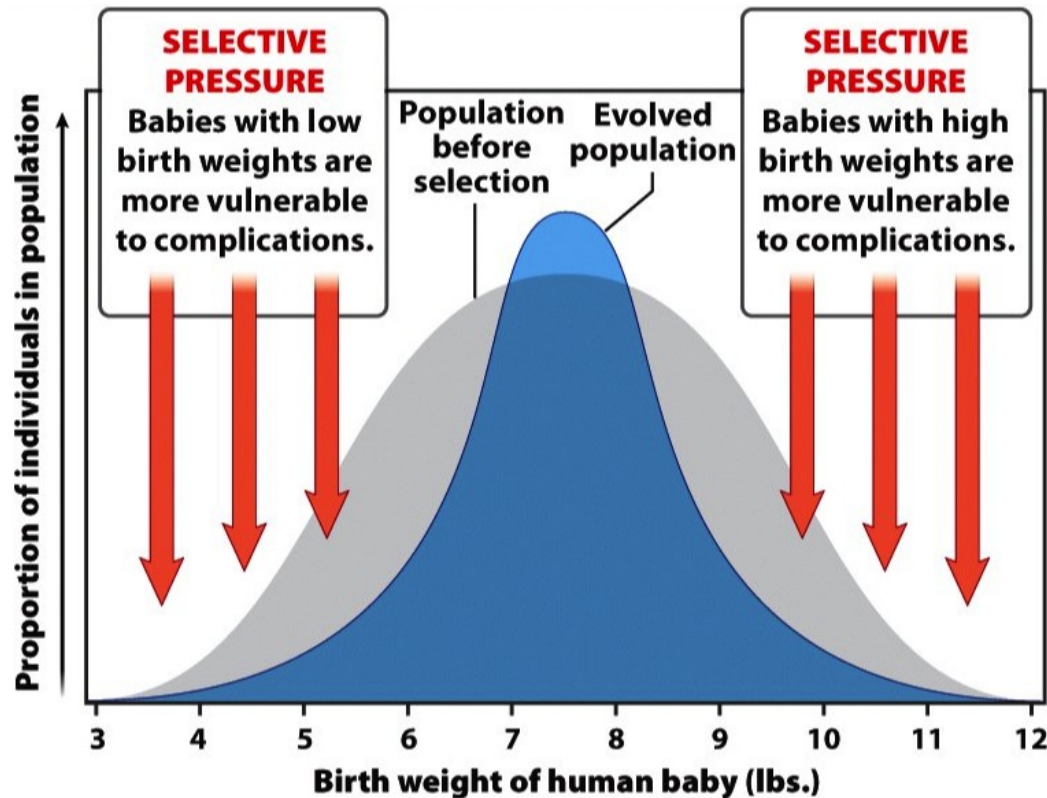
**Original
population**

**Evolved
population**



(b) Disruptive selection

Example: Stabilizing Selection

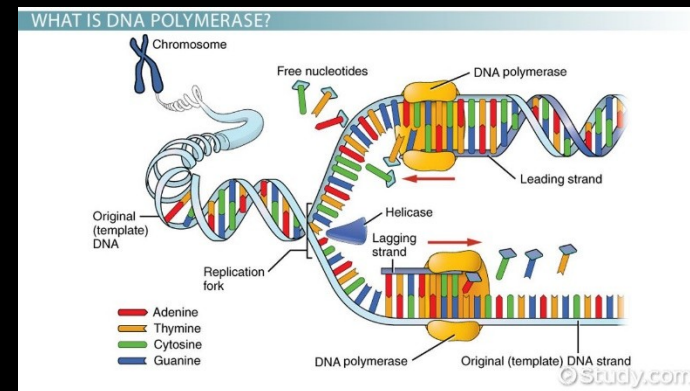


Mutation

- Mutations produce new variation
- Often caused by **DNA polymerase*** errors in DNA synthesis (or DNA repair)

(*the enzyme that helps duplicate DNA)

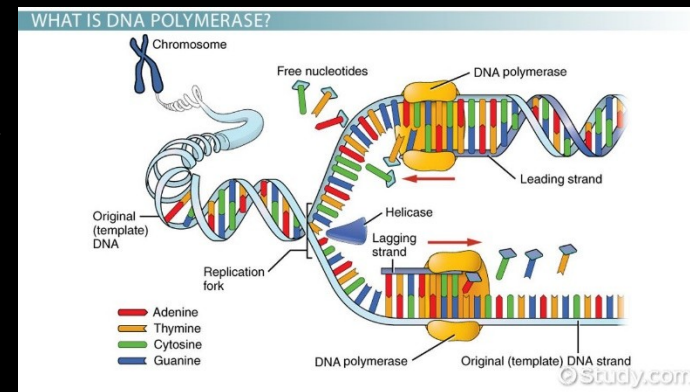
- Mutations can be spontaneous errors or caused by **mutagens**



Kinds of mutations

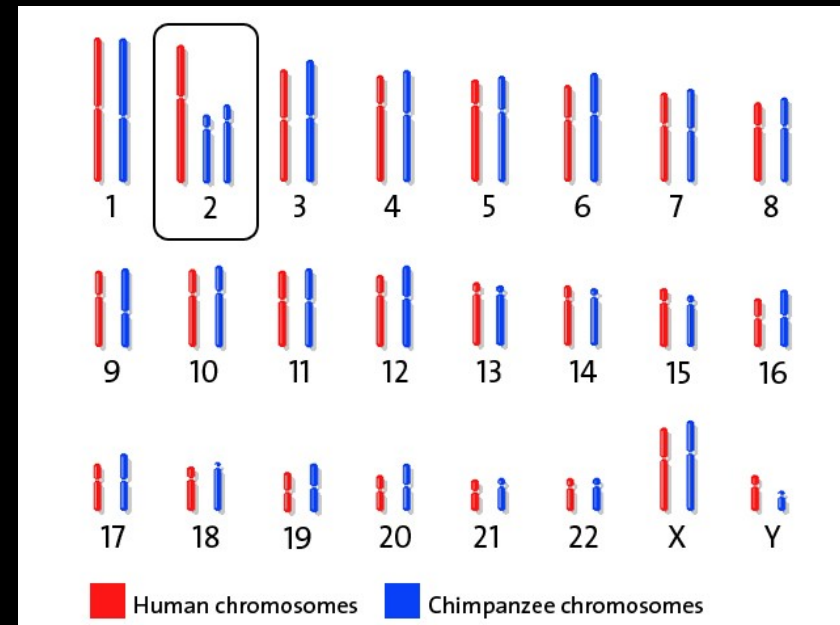
(a partial list)

- **Large scale:** large changes the number of chromosomes changes (e.g. chromosomes fused or cut in two)
- **Small scale:**, e.g. substitutions or insertions or deletions of single nucleotide pair (point mutations); or of more than one nucleotide pair



Large scale mutation

- **Large scale example:** many apes (incl. chimpanzees) have 24 pairs of chromosomes, while humans have 23 pairs
- Genetic studies show that two chromosomes fused during the evolution of the genus *Homo* to form our **Chromosome 2**



Small scale: Point mutations

Wild-type hemoglobin

Wild-type hemoglobin DNA



Sickle-cell hemoglobin

Mutant hemoglobin DNA



missense

mRNA



mRNA



Normal hemoglobin

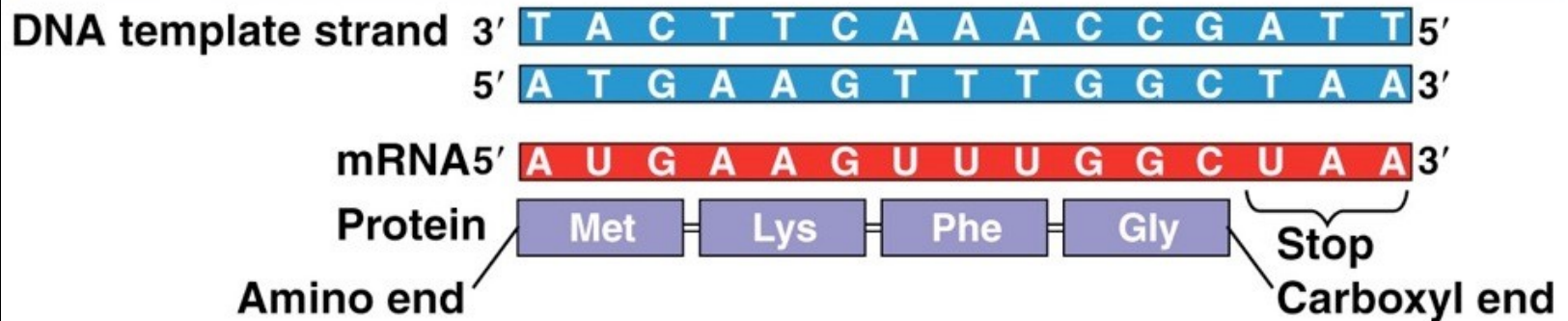


Sickle-cell hemoglobin

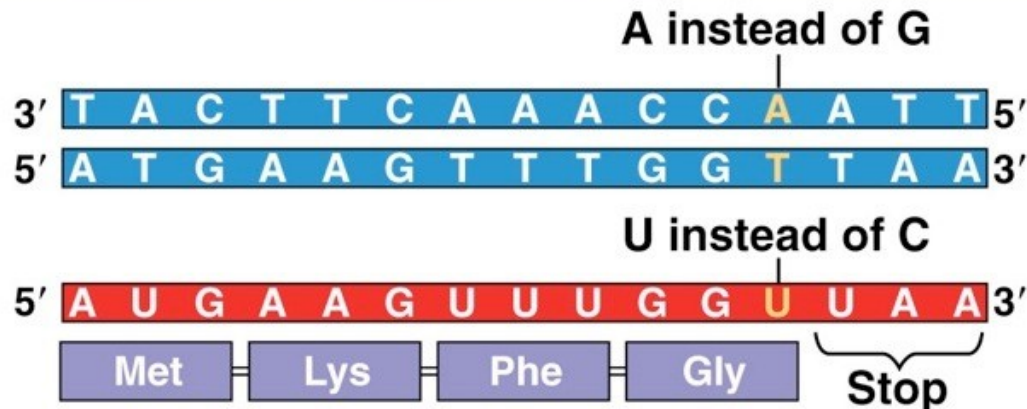


Point mutations

Wild type

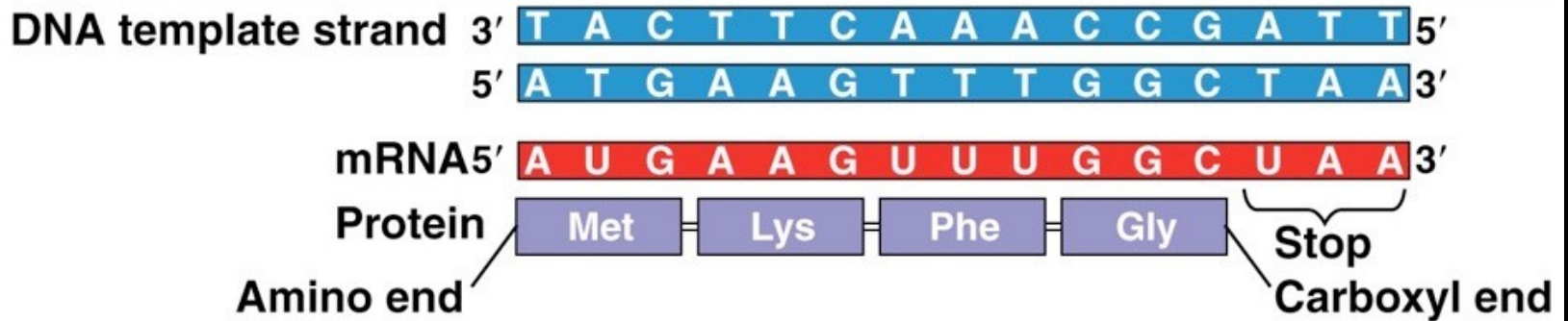


(a) Nucleotide-pair substitution: silent

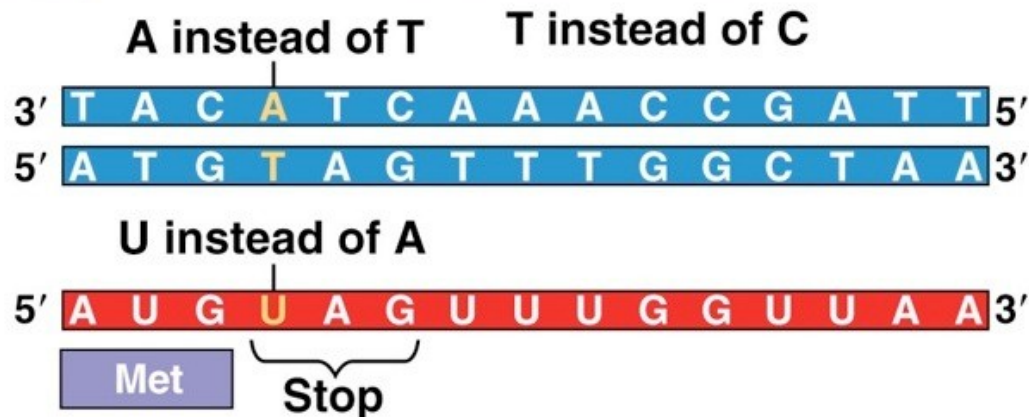


Point mutations

Wild type



(a) Nucleotide-pair substitution: nonsense

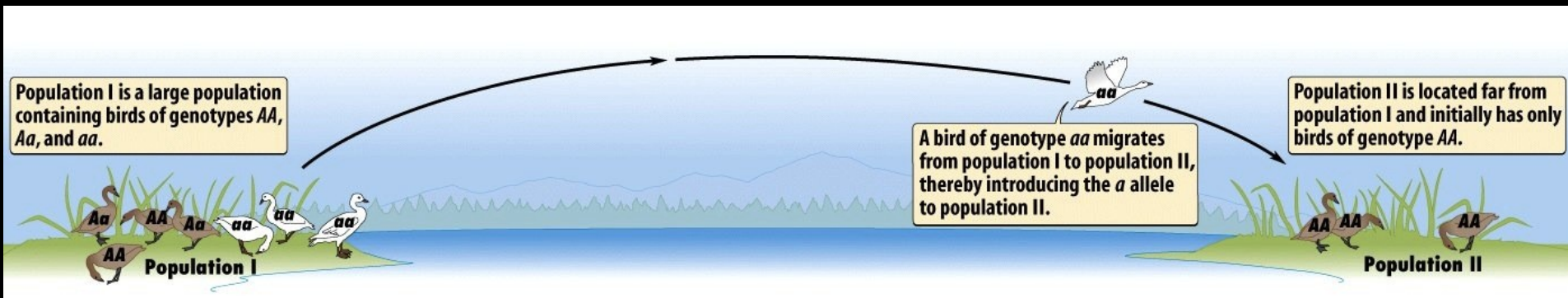


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Point mutations (deletion, insertion) can also lead to **frameshift** (subsequent codon triplets shifted and all wrong)

Gene flow

- Consists of “flow” of alleles between populations due to movement of fertile individuals (or gametes, e.g. in pollen)
- Causes populations to have more similar gene pools (can benefit pop. , but also sometimes be maladaptive)



Genetic Drift

- Random changes in allele frequencies within populations which result from chance variation in individual survival and reproduction
- Most important in small populations
- Changes can be neutral, maladaptive, or adaptive

Examples:

-Bottleneck effect

-Founder effect

Genetic drift:
Bottleneck effect (happens at near-extinction events)

- Dramatic decrease of population size leaves only part of the genetic variation
- Example: Northern elephant seals





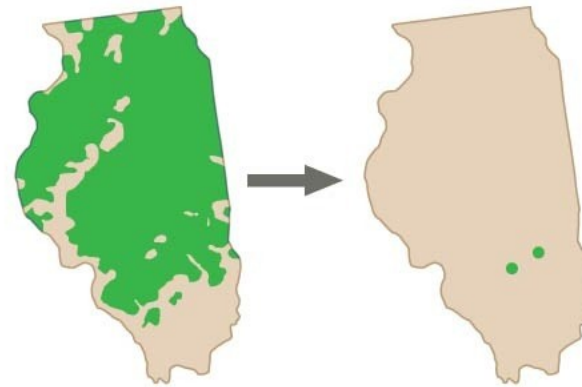
Greater prairie chicken

(a)

 **Range of greater prairie chicken**

**Pre-bottleneck
(Illinois, 1820)**

**Post-bottleneck
(Illinois, 1993)**



Location	Population size	Number of alleles per locus	Percentage of eggs hatched
Illinois 1930–1960s 1993	1,000–25,000 <50	5.2 3.7	93 <50
Kansas, 1998 (no bottleneck)	750,000	5.8	99
Nebraska, 1998 (no bottleneck)	75,000–200,000	5.8	96

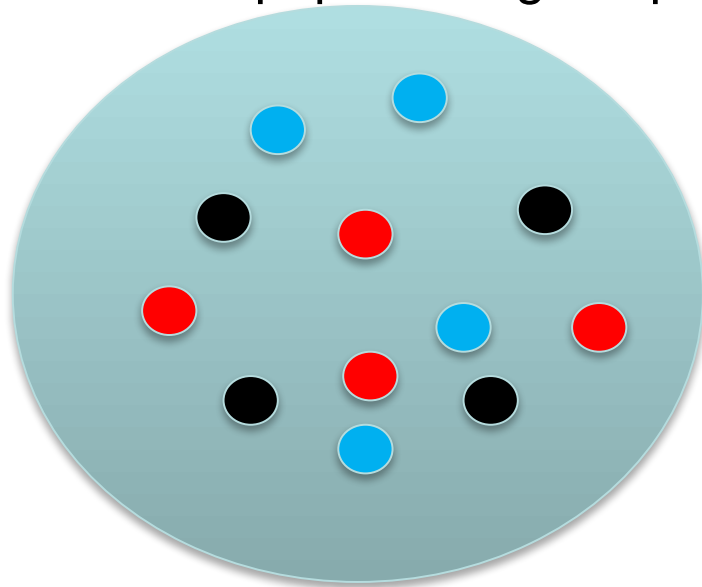
(b)

Genetic drift :

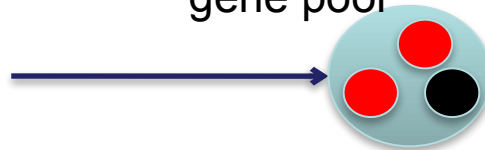
Founder effect (happens at dispersion events)

- Dispersion to small founder population can lead to random differences in allele frequencies

Mainland population gene pool



Island population
gene pool



Genetic drift:

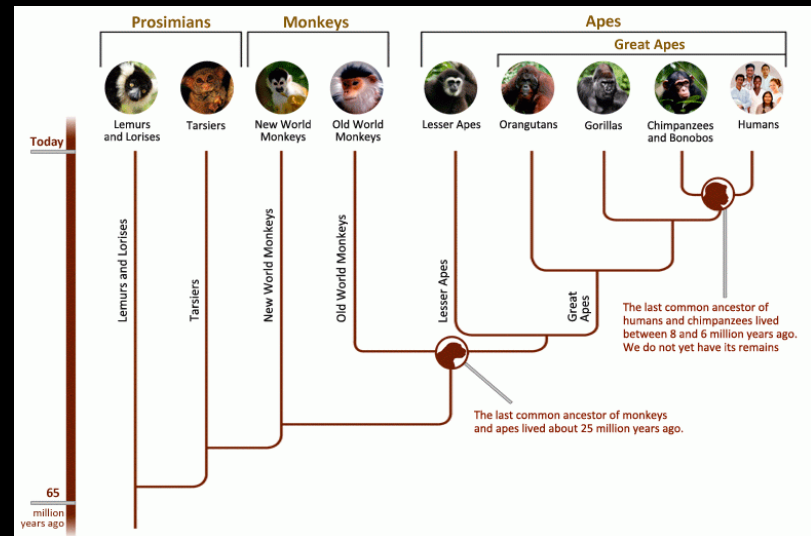
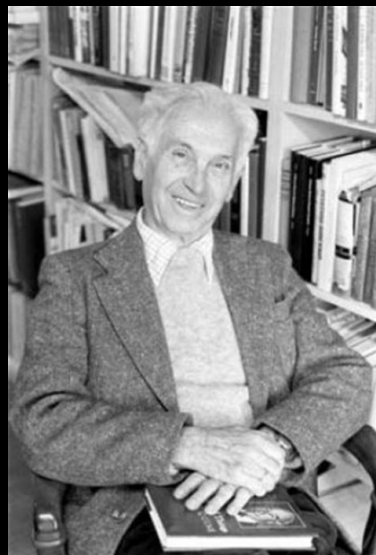
Founder effect examples

- Amish – small founder population – **EVC syndrome (Ellis Van Creveld)**; polydactyl, short-limb dwarfism
- Descendants of British colonizers of Tristan da Cunha – **retinitis pigmentosa**; blindness



The Modern Synthesis

- First half of the 20th century e.g. Ernst Mayr and Theodosius Dobzhansky
- Natural selection combined with genetics, particularly Mendel's inheritance laws (also DNA transcription, plus paleontology , speciation, and phylogenetics)



Dobzhansky 1900-1975

Mayr 1904-2005