# Do Now 2/28

- I will come around to grade your foldables so make sure they are attached on page 90
- Begin your next Do Now on page 91

# #1

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In 1831, Charles Darwin visited the Galapagos Islands. While observing the giant land tortoises that lived on these islands, Darwin noted that the shape of the tortoise shell varied depending on which island the tortoise lived. Tortoises on one island had round shells, for example, whereas tortoises on a neighboring island had more flattened, saddle-shaped shells. Which statement BEST summarizes Darwin's explanation for these differences?

A) Random mutations caused the shape of the shells to fluctuate periodically.

B) The shape of the tortoise shell varied because the predators on the islands were all similar.

C) The particular shape of the shell was best suited for the island on which the tortoise was living.

D) Tortoises who used their shells in special ways caused the shells to become larger, rounder, or flatter.

The wing of a bird and the leg of a horse are very different looking structures. Although they look different, bird wings and horse legs are very similar in the arrangement of the bones that make up the limb. Which term is used by scientists to describe structures that look different on the outside but are actually similar in construction and develop from the same embryonic tissues?

A) common descent

B) ancillary anatomy

C) vestigial structures

D) homologous structures

### Species DNA Sequence

| Species | Number of Differences from Human Sequence |
| --- | --- |
| *Gorilla gorilla (gorilla)* | 1 |
| *Hylobates lar (gibbon)* | 3 |
| *Lemur catta (lemur)* | 30 |
| *Macaca mulatta (Rhesus monkey)* | 8 |
| *Saimiri sciureus (squirrel monkey)* | 11 |

The amino acids for beta hemoglobin found in five species were compared to the amino acids found in human (Homo sapiens) beta hemoglobin. The number of sequence differences was recorded.

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Based on the molecular data, which species is most closely related to humans?

A) *Lemur catta* (lemur)

B) *Hylobates lar* (gibbon)

C) *Gorilla gorilla* (gorilla)

D) *Macaca mulatta* (Rhesus monkey)

# THE PEPPERED MOTH CASE STUDY!

# BEFORE THE INDUSTRIAL REVOLUTION

# AFTER

# HARDY-WEINBERG PRINCIPLE & Natural Selection

Biology 101B

# Vocabulary Review

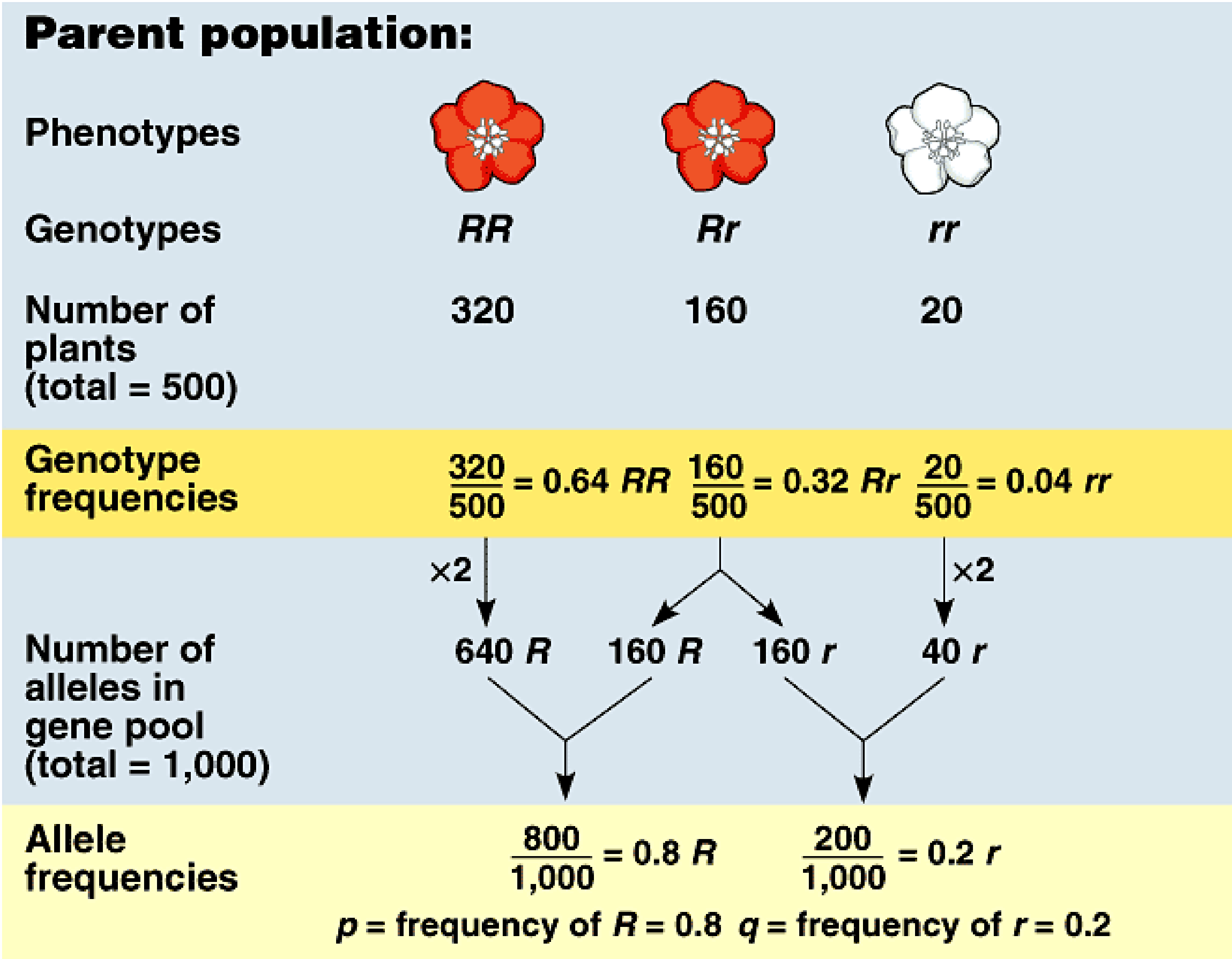
- *Allele-* a variation in a trait (F- furred & f- furless)
- *Genotype-* gene combination- one gene from mom, one from dad (FF, Ff, ff)
- *Phenotype-* physical appearance- furred or furless
- *Gene frequency-* how common an allele is in a population.

  # of F alleles/total number of alleles

  50/77 = .65 = 65% of population has F alleles

# Gene Frequency

- Imagine a population of 500 people, 50 of whom cannot roll their tongue. Of the 450 who can, 250 are heterozygotes and 200 are homozygotes.
  - How many people are there in this population?
  - What are the genotype frequencies?
  - How many alleles are there in this population?
  - What are the allele frequencies? In other words, how often will the recessive allele show up and how often will the dominant allele show up?




(a) Gene pool of parent population

# What is the Hardy Weinberg Theorem?

- Describes a non-evolving population
- States that the frequencies of alleles and genotypes in a population's gene pool remain the same unless it is altered by some external factor.
- This principle helps determine whether or not gene frequencies have changed in a population and whether evolution has occurred.

# Assumptions of the Hardy-Weinberg Theorem

- Very large population size
- no migration
- no net mutations
- random mating
- no natural selection
- All organisms breed & produce same # offspring
- If a population deviates form the Hardy-Weinberg theorem, it is usually because that population is evolving.

# Hardy-Weinberg Equilibrium Equation

- Used to determine probable genotype frequencies in a population.
- p = dominant traits (A)
- q = recessive traits (a)
- $p + q = 1$
- $p^2 + 2pq + q^2 = 1$

(AA)+ (Aa)+ (aa) = 1

# Example

- Albinism occurs in 1/20,000 in North America.
- AA & Aa = normal          aa = albinism
- Problem… we don't know who/what the gene frequency is for homo. dominant and who is heterozygous for normal skin pigment.
- We don't know "p" but we do know "q"…

- $q^2$ = aa (albinism) = 1/20,000 = 0.00005
- Take square root of q…
  - $\sqrt{q^2}$ = 0.00005
  - q =0.007
  - The **frequency** of the **recessive** allele for albinism is **.007**
- To find p…
  - p + q = 1 (you have to manipulate this equation to solve for p)
  - p = 1 – q
  - p = 1 - 0.007
  - p = 0.993
  - The **frequency** of the **dominant** allele for normal is **.993**
- Now that you know "p" and "q" you can solve equation…

- $p^2 + 2pq + q^2 = 1$
- p = 0.993 and q = 0.007 (just plug in to equation)
- $(0.993)^2 + 2(0.993)(0.007) + (0.007)^2 = 1$
- 0.986 + 0.014 + 0.00005 = 1
- $p^2$ = predicted frequency of homo dominant individuals = 0.986 x 100 = 98.6%
- 2pq = predicted frequency of heterozygous = 0.014 x100 = 1.4%
- $q^2$ = predicted frequency of homo recessive individuals (albinos) = 0.00005 x100 = .005%

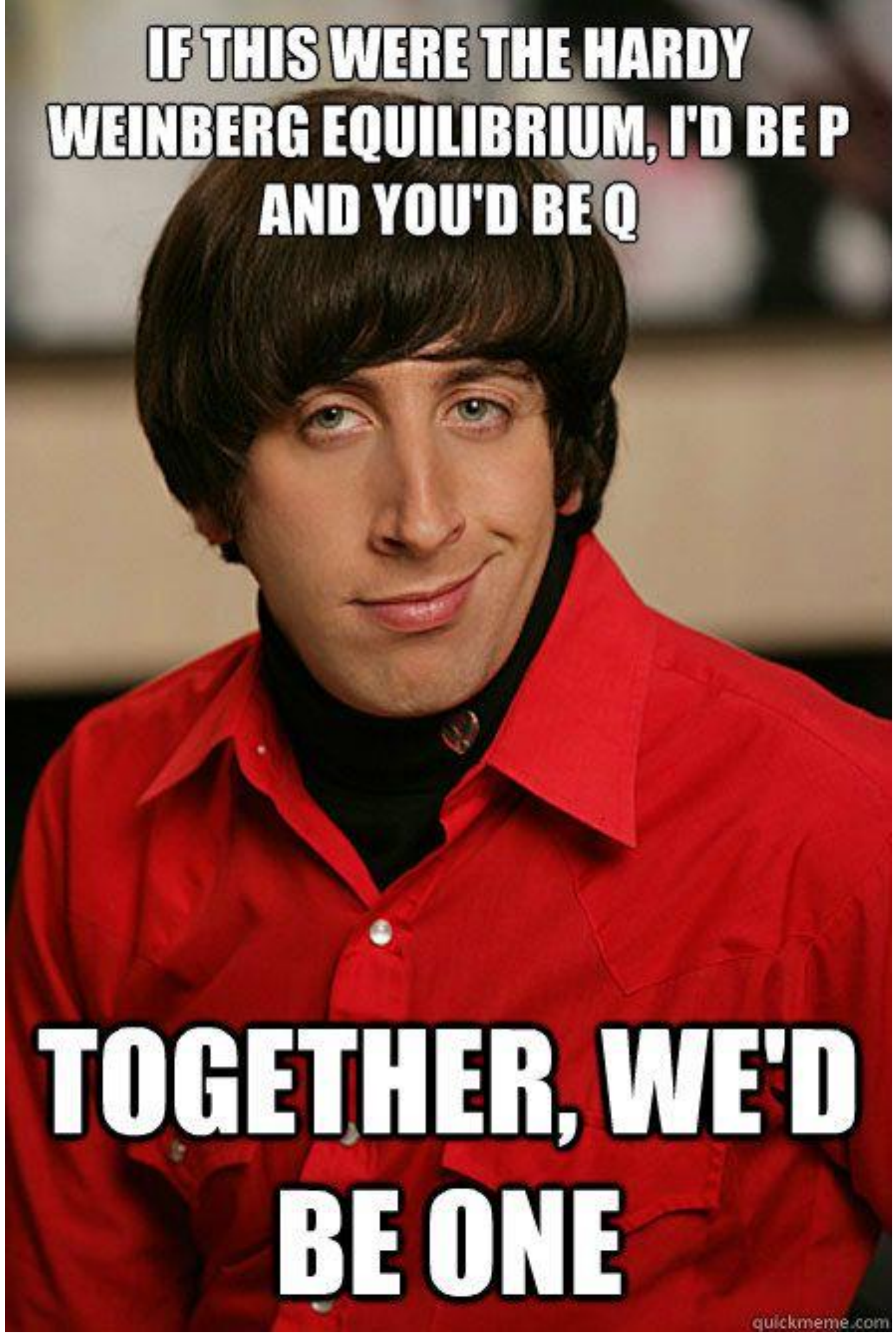
# Can you do these?

- 1 in 1700 Caucasians in the U.S. have cystic fibrosis. Calculate the gene frequency for all individuals.
- If 9% of an African population is born with a severe form of sickle-cell anemia (ss), what percent of the population will be more resistant to malaria because they are heterozygous (Ss) for sickle-cell gene.

# Today’s Journal: (4/13)

The ability to taste PTC is due to a single dominate allele "T". You sampled 215 individuals in a biology class, and determined that 150 could detect the bitter taste of PTC and 65 could not.

- What is the predicted frequency of the recessive allele (t)?
- What is the predicted frequency of dominant allele (T)?


IF THIS WERE THE HARDY WEINBERG EQUILIBRIUM, I'D BE P AND YOU'D BE Q
TOGETHER, WE'D BE ONE
quickmeme.com

# What types of situations force evolution & upset Hardy Weinberg Equilibrium?

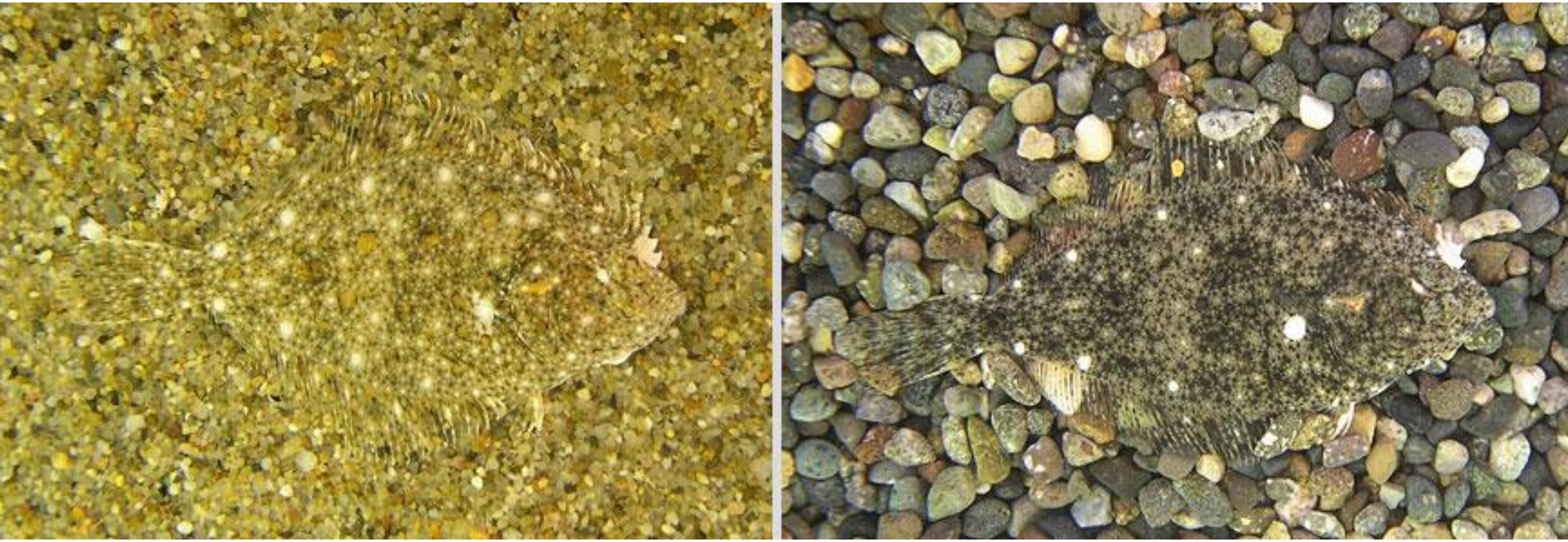
1. Natural selection
2. Genetic drift- movement of genes into or out of a population.
3. Mutations
4. Non-Random Mating= “Sexual Selection”

# 1. Natural Selection

## a. Predators

- Can cause a shift in allele frequency
- Can lead to **coevolution**
- Coevolution- two organisms evolve in response to each other.
  - Fastest antelopes escape cheetah. Faster cheetahs catch antelopes.
  - Resistant insects survive plant poison. Plant with strongest poison survives insect pests.
- Use **camouflage** to avoid predators or prey on animals
- Use **mimicry-** mimic something more harmful or undesirable to avoid predators.
- Use **warning coloration-** red, black, yellow to warn they are dangerous


Piet Grobler 2009

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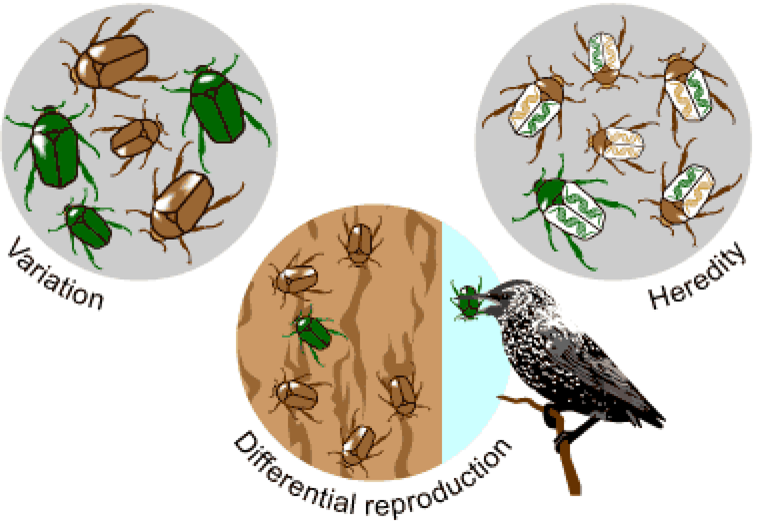
# 1. Natural Selection (cont’d)

b. Environment
- Webbed feet, water proof feathers
- Hooves for walking on hard surfaces

c. Climate
- Thick fur
- Large ears dissipate heat
- White fur- blend in with snow

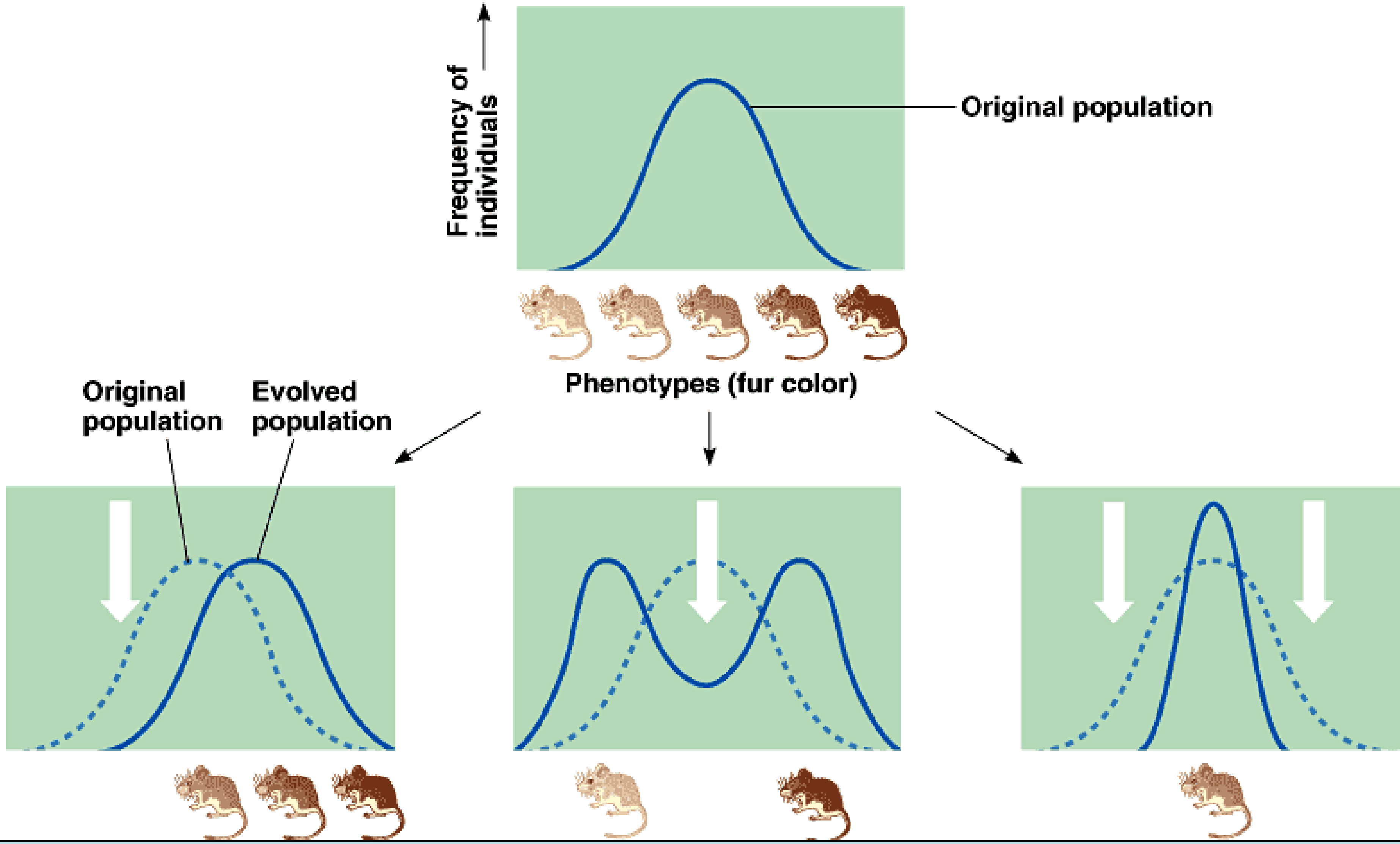
# 1. Natural Selection (cont’d)

- Natural selection does not cause genetic changes within an individual.
- *An individual cannot evolve.*
- Natural selection acts on the individual based on its traits.
- The population evolves as a consequence of differential reproduction- strongest traits will mate and pass on strong traits.



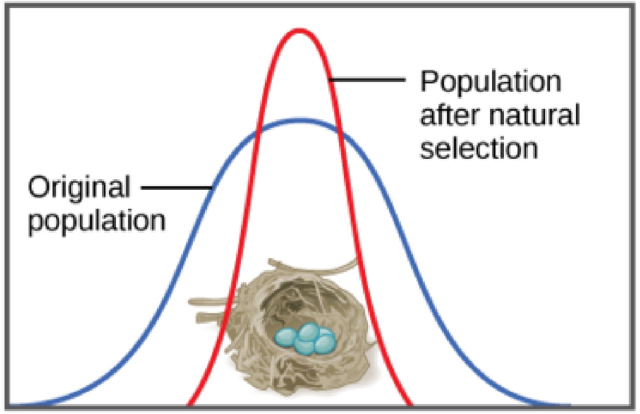
# Types of Natural Selection

a. *Directional* - shifts the phenotypic frequency in one direction or another. EX: giraffe neck length
b. *Stabilizing* - acts against extreme phenotypes and favors the more common intermediates. EX: rabbit leg length
c. *Disruptive/diversifying* - extreme phenotypes are favored. EX: squirrels and acorns



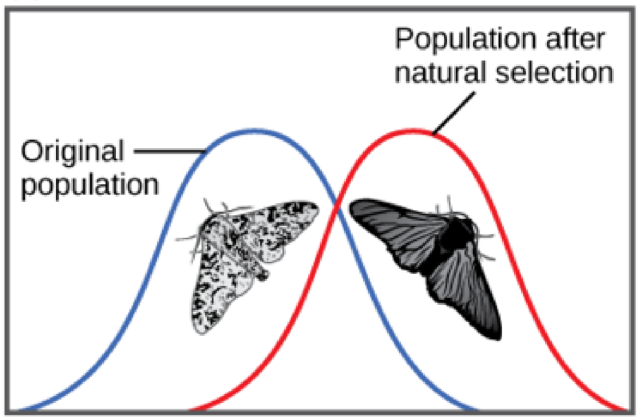
Frequency of individuals
Original population
Phenotypes (fur color)
Original population
Evolved population

(a) **Stabilizing selection**



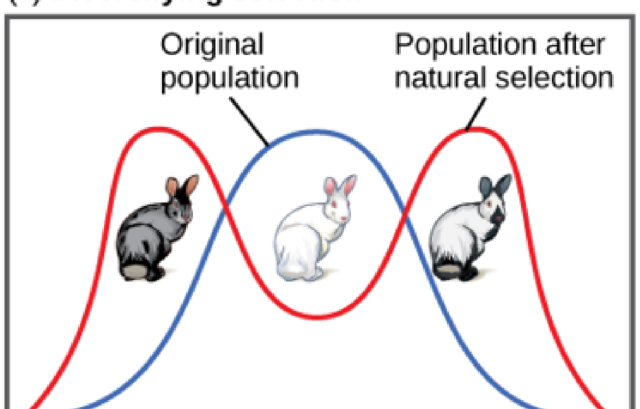

Robins typically lay four eggs, an example of stabilizing selection. Larger clutches may result in malnourished chicks, while smaller clutches may result in no viable offspring.

(b) **Directional selection**




Light-colored peppered moths are better camouflaged against a pristine environment; likewise, dark-colored peppered moths are better camouflaged against a sooty environment. Thus, as the Industrial Revolution progressed in nineteenth-century England, the color of the moth population shifted from light to dark, an example of directional selection.

(c) **Diversifying selection**

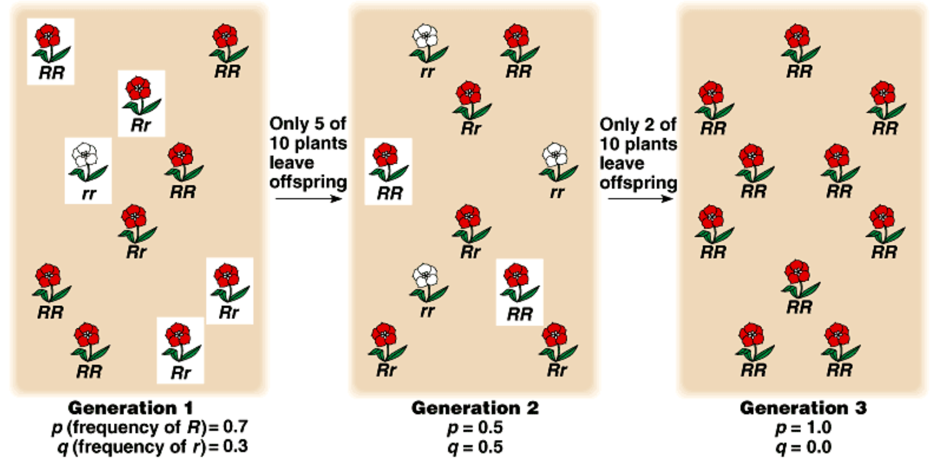



In a hyphothetical population, gray and Himalayan (gray and white) rabbits are better able to blend with a rocky environment than white rabbits, resulting in diversifying selection.

# Journal:

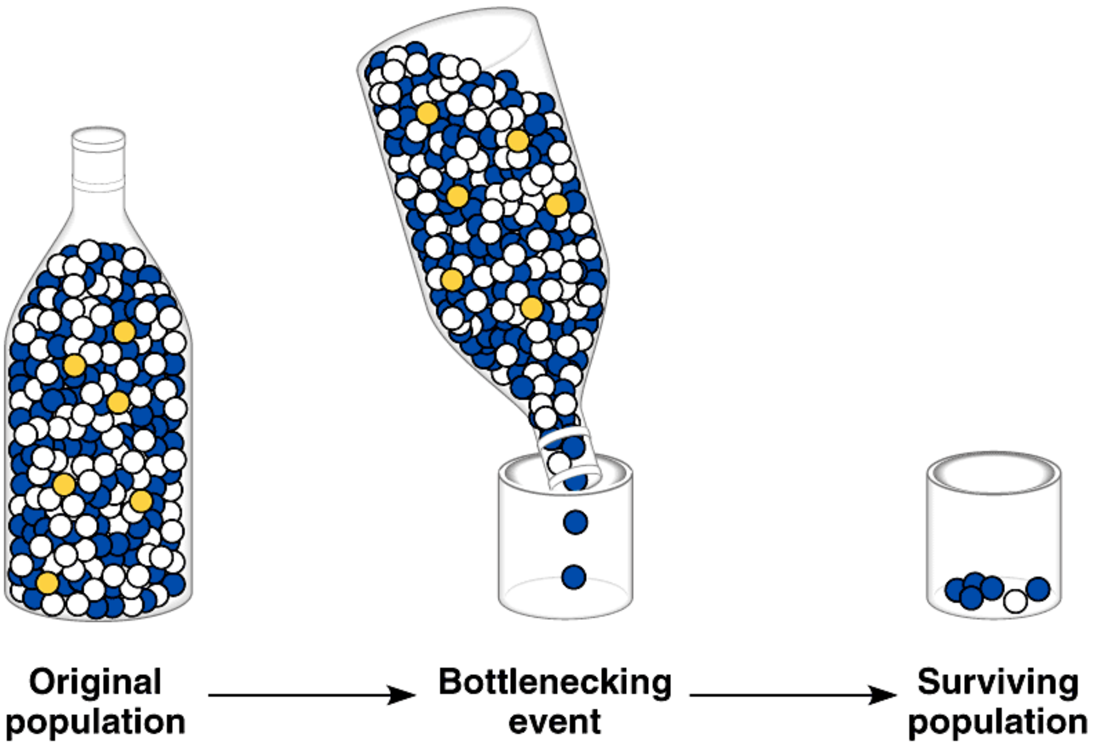
# 2. Genetic Drift

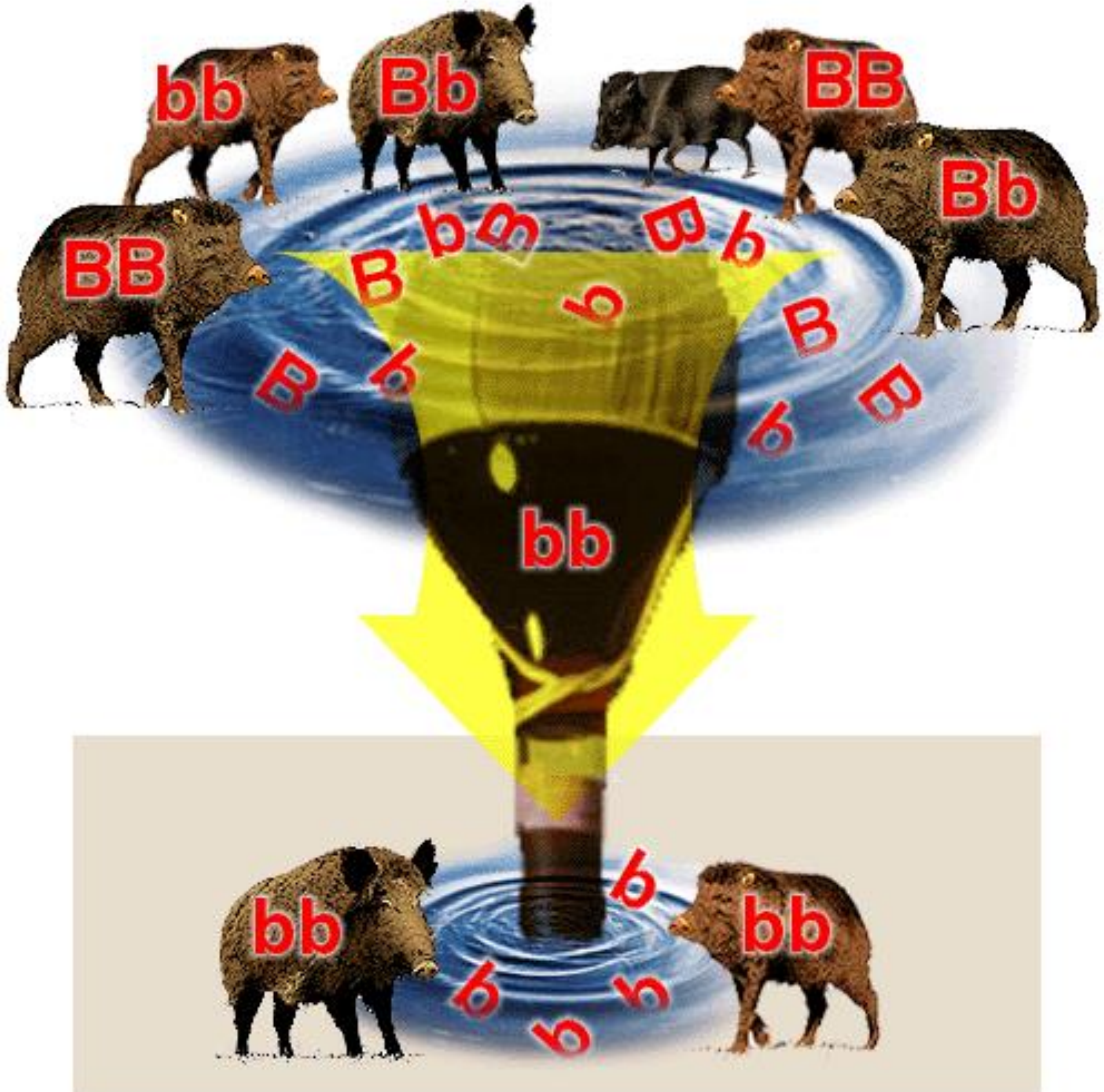
- Change in allele frequency due to <u>chance</u>.
- EX: Small population of lizards:
  - 3 WW
  - 2 Ww
  - 5 ww
  - Earthquake kills 3 WW, frequency of w allele will increase.
- Two types of genetic drift…



# *a. Bottleneck Effect*

- A change in a population's allele frequencies due to a *large reduction in population size*
- Population does not rebound as well
- Reduced biodiversity may lead to inbreeding
- Ex: Cheetahs killed due to disease or b/c they are pests- population so small they are inbreeding making species weaker so population is slow growing.
- EX: volcanoes, natural disasters

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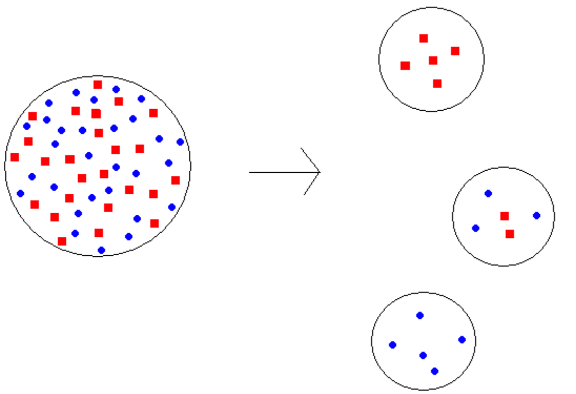
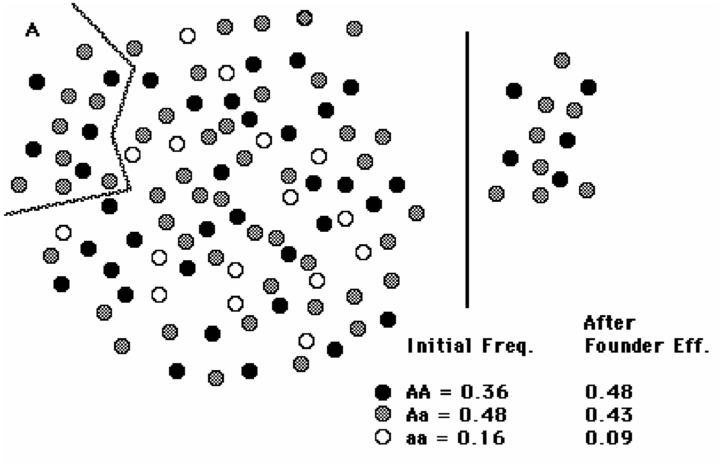
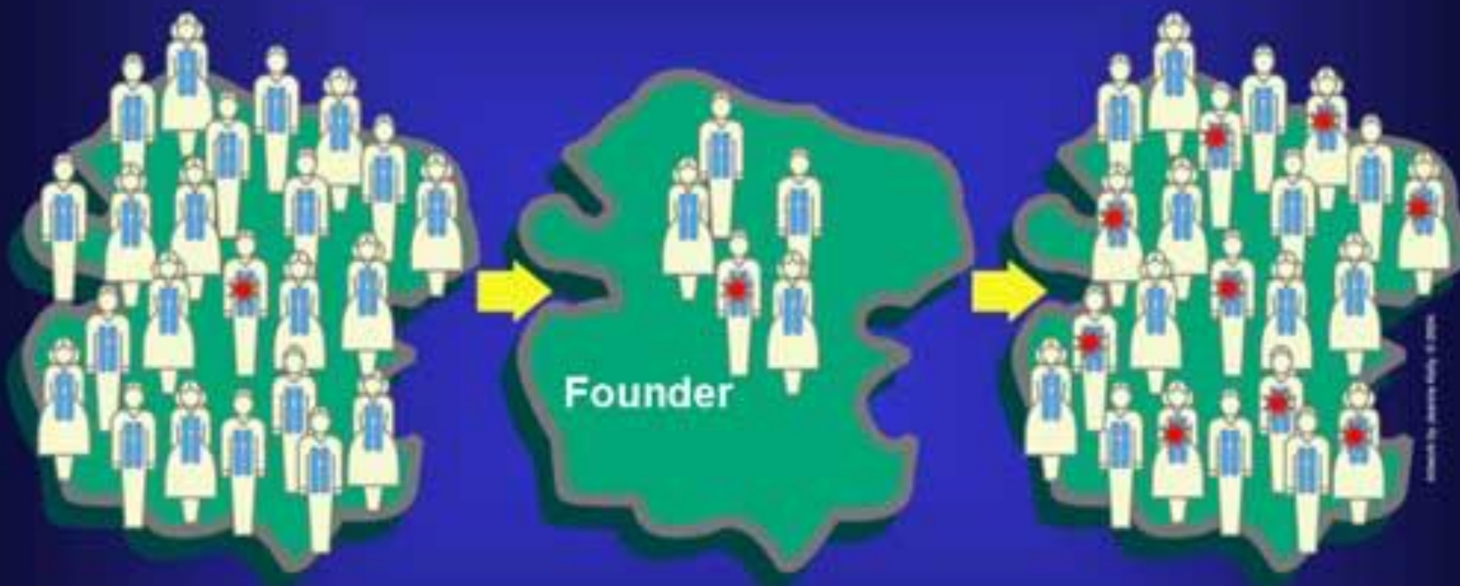
# b. Founders Effect-

- A change in a population's allele frequencies due to *<u>colonization by a small number of individuals from a larger population.</u>*
- Creates a "<u>new</u>" population elsewhere
- Allele frequency in "new" population depends on what alleles <u>migrated out</u>.
- EX: Small group of 200 Amish people migrated to US from Germany & Switzerland in 1700's. Do not marry outside religion so interbreed. Many genetic disorders (dwarfism, metabolic disorders) common in their group.





# Prevalence and Founder Effect




Original population

Marked population decrease, migration, or isolation

Generations later

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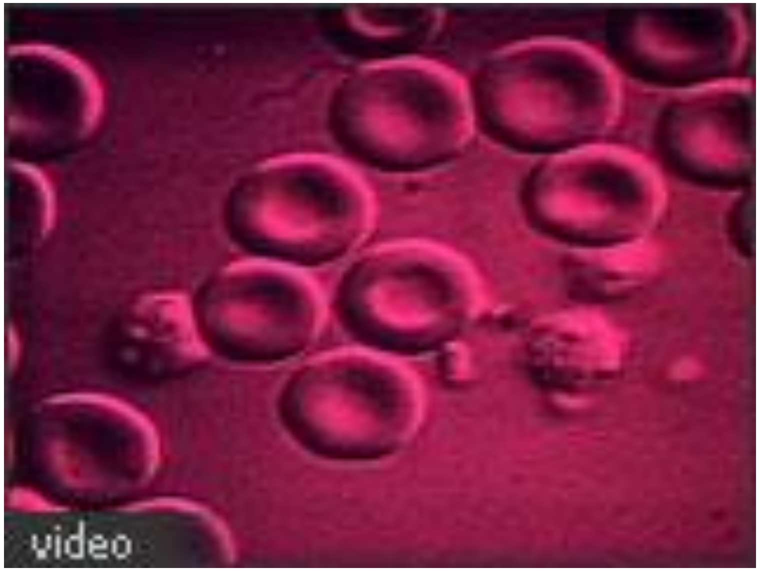
# 3. Mutations

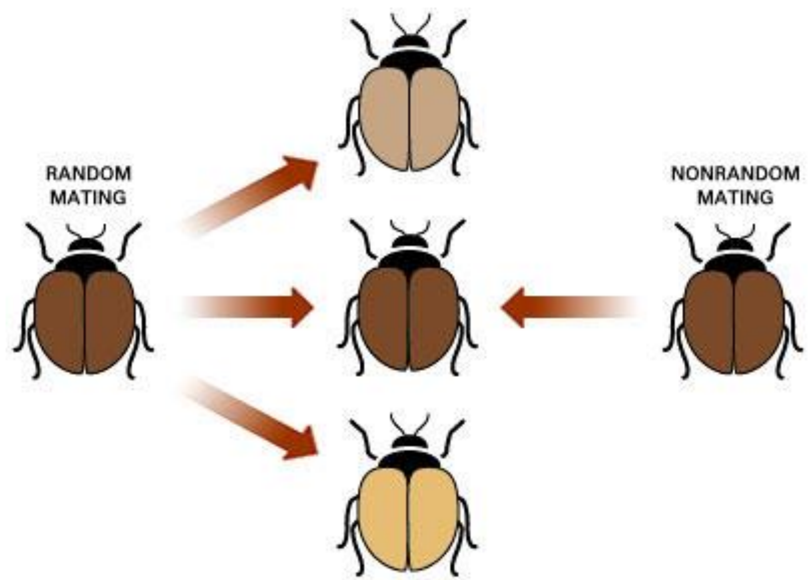
- Can change types of alleles for a gene
- Leads to change in gene frequency
- Some beneficial, some harmful

Mutation Video Clip: Sickle Cell Anemia



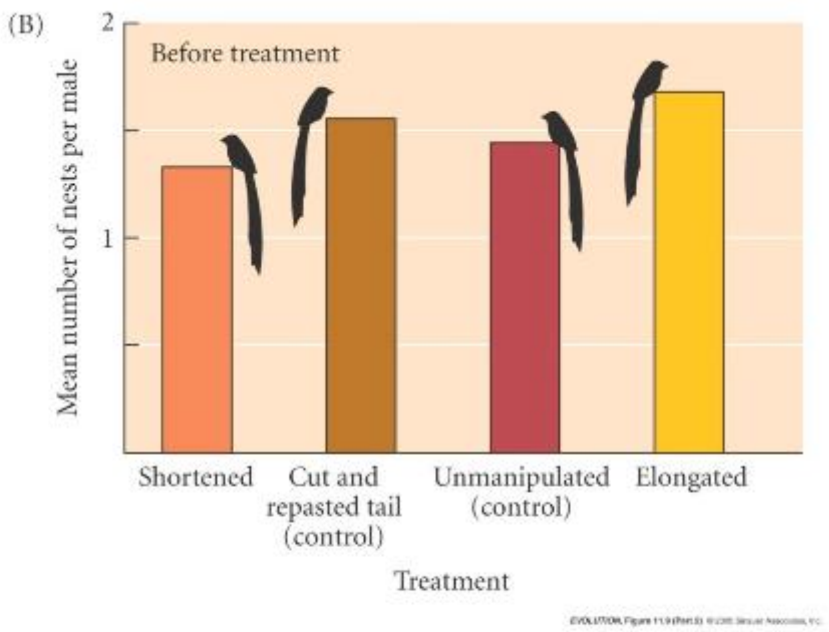
# 4. Non-Random Mating

- Most times mating is NOT random.
- Males or females CHOOSE a mate based on size, color, best song, etc- SEXUAL SELECTION
- Males & females of the same phenotype tend to mate.
- EX: large beetles mate with other large beetles.

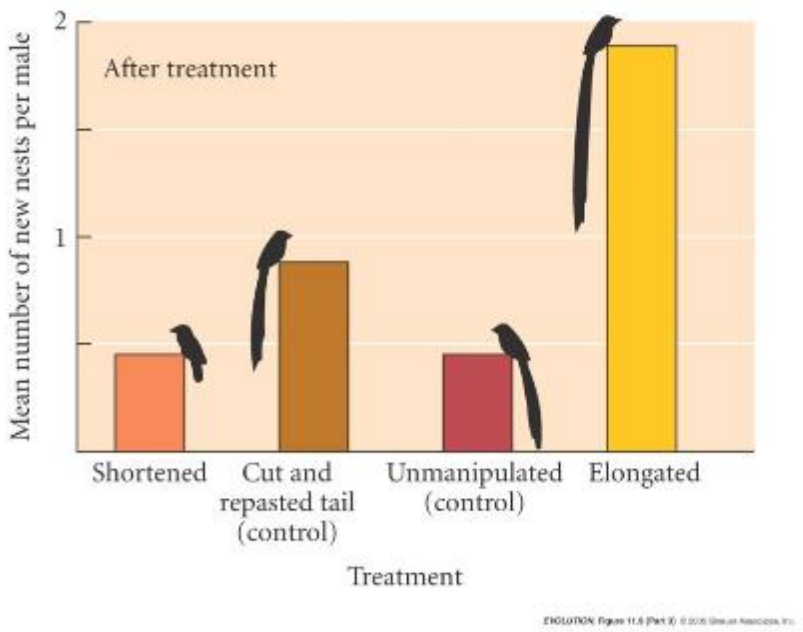


# Widowbirds

**Before Treatment**




**After Treatment**

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