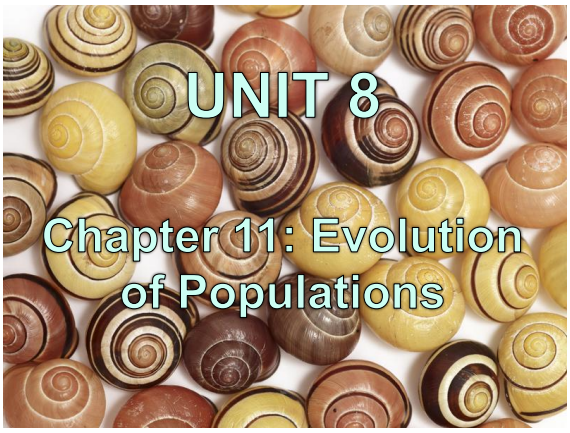
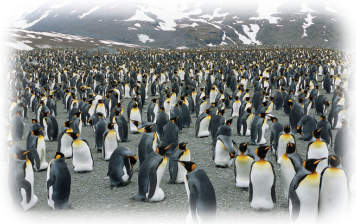


UNIT 4: EVOLUTION

Chapter 11: The Evolution of Populations

I. Genetic Variation Within Populations (11.1)

A. Genetic variation in a population increases the chance that some individuals will survive



1. Genetic variation in populations lead to differences in **Phenotypes**

2. **Natural selection** acts on **phenotype**

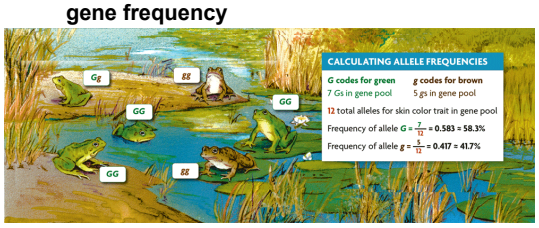
Galápagos Islands Finches

Shape of Head and Beak						
Common Name of Finch Species	Vegetarian tree finch	Large insectivorous tree finch	Woodpecker finch	Cactus ground finch	Sharp-beaked ground finch	Large ground finch
Main Food	Fruit	Insects	Insects	Cactus	Seeds	Seeds
Feeding Adaptation	Parrotlike beak	Grasping beak	Uses cactus spines	Large crushing beak	Pointed crushing beak	Large crushing beak
Habitat	Trees	Trees	Trees	Ground	Ground	Ground

3. The greater the range in phenotypes, the more likely some individuals can **survive** <u>changing environment</u>

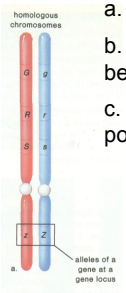
a. **Gene Pool**- genetic variation stored in population

b. Each allele exists at a certain frequency - **gene frequency**



B. Genetic variation comes from several sources

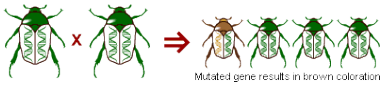
1. **Mutation**- random change in organisms DNA



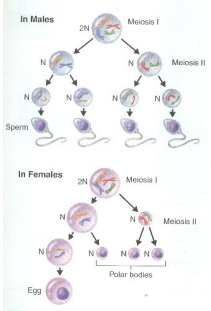
a. can form new **allele**

b. Mutations in **reproductive cells** can be passed on

c. <u>Increases</u> **genetic variation** in gene pool

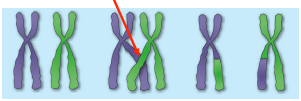


2. **Recombination**- new allele combination form in offspring



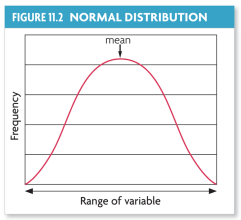
a. **Meiosis**-new combinations of parents alleles

b. **Crossing over** increases variation



II. Natural Selection in Populations (11.2)

A. Natural selection acts on distribution of traits

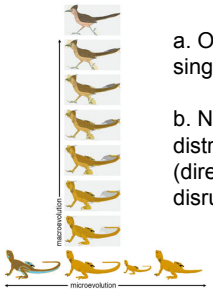


1. Normal distribution- gives classic "bell-shaped" curve

2. Environmental conditions can change and a certain phenotype may become an advantage

B. Natural Selection can change the distribution of a trait in one of three ways

1. **Microevolution**-observable change in allele frequency of a population over time



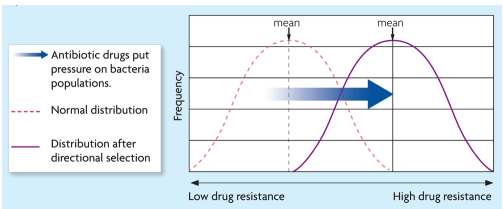
a. Occurs on small scale within single population

b. Natural selection can change distribution of a trait along **3** paths (directional, stabilizing, or disruptive selection

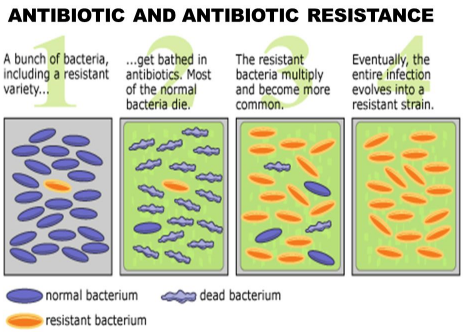
2. **Directional Selection**- causes shift in a populations **phenotypic** distribution

a. An extreme phenotype that was once rare is now more common

b. Mean value of a trait shifts in direction of the more **advantageous** phenotype



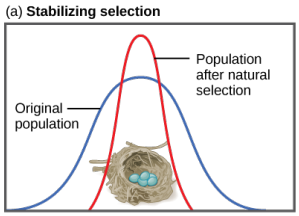
c. Lead to rise in **drug-resistant bacteria**



3. **Stabilizing Selection**- the intermediate phenotype is **favored** and becomes **more common.**

a. Decreases genetic diversity

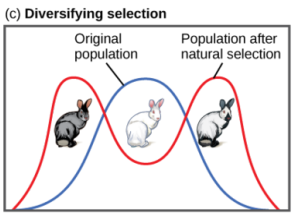
b. Extreme phenotypes may be lost



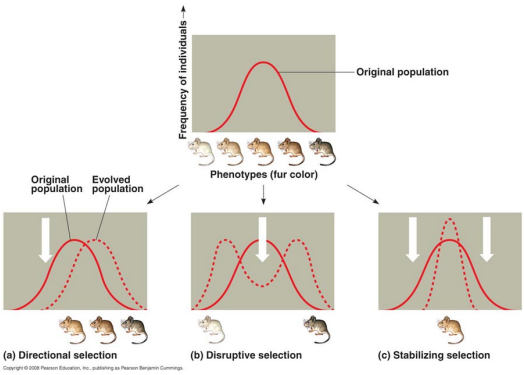
Robins typically lay four eggs, an example of stabilizing selection. Larger clutches may result in malnourished chicks, while smaller clutches may result in no viable offspring.

4. **Disruptive Selection (diversifying selection)**- occurs when both extremes are favored and intermediate are selected against

a. Intermediate forms selected against
b. Can lead to formation of new species



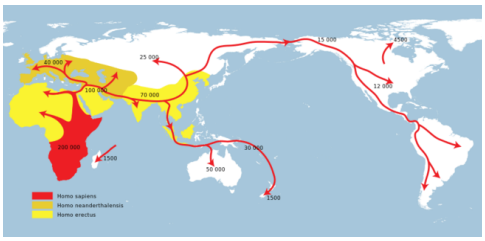
In a hyphothetical population, gray and Himalayan (gray and white) rabbits are better able to blend with a rocky environment than white rabbits, resulting in diversifying selection.



III. Other Mechanisms of Evolution (11.3)

A. Gene flow is the movement of alleles between populations

1. **Gene flow**- movement of alleles from one population to another

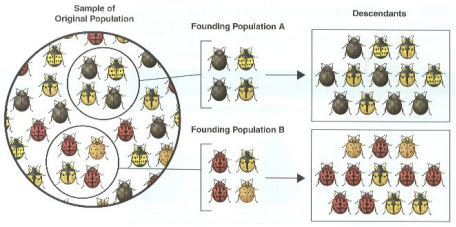


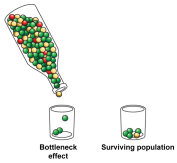
a. **Increases** genetic variation of **receiving** population
b. **Gene flow** between populations keeps gene pools **similar**
c. **Less** gene flow can create **genetically different** populations
d. **Lack of gene flow** increases chance that two populations will **evolve into different species**

B. Genetic drift is a change in allele frequencies due to chance

1. **Small populations** are <u>more likely</u> to be affected by **chance**

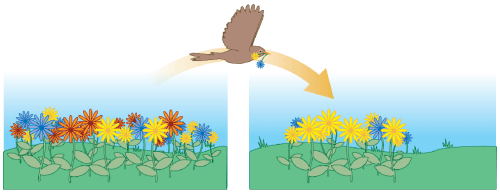
2. **Genetic Drift**- changes in allele frequencies due to chance (Two ways this occurs)





a. **Bottleneck Effect**- genetic drift that occurs after an event (e.g. overhunting)

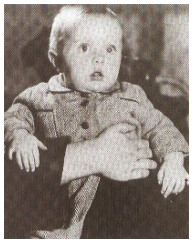
b. **Founder Effect**- genetic drift that occurs after a small number of individuals colonize a new area



3. Effects of Genetic Drift

a. **Lose of genetic variation**- ability of group to adapt to changing environment is lessened.

b. **Lethal alleles** may become **more common** in gene pool due to chance alone



Genetic drift has been observed in some small human populations that have become isolated due to reasons such as religious practices and belief systems. For example, in Lancaster County, Pennsylvania, there is an Amish population of about 12,000 people who have a unique lifestyle and marry other members of their community. By chance, **at least one of the original 30 Amish settlers in this community carried a recessive allele that results in short arms and legs and extra fingers and toes in offspring.** Because of small gene pool, many individuals inherited the recessive allele over time. **Today, the frequency of this allele among the Amish is high (1 in 14 rather than 1 in 1000 in the larger population of the U.S.)**

C. **Sexual selection** occurs when certain traits increase mating success

1.**Mating** can have important effect on evolution of population

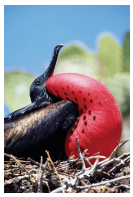
a. **Males** make many sperm continuously (value of each relatively small)

b. **Females** more limited in number of offspring can produce (each investment more valuable, and they want a good return)

2. **Sexual selection**- when certain **traits** <u>increase</u> **mating success**

a. Certain traits can become very exaggerated over time through sexual selection

b. These traits for mating success not always adaptive for survival of the individual



IV. Hardy-Weinberg Equilibrium (11.4)

A. **Hardy-Weinberg equilibrium** describes populations that are **not** evolving

1. Said genotype frequencies stay the same over time as long as certain conditions are met. (5 conditions)

a. **Very large populations** (no genetic drift can occur)

b. **No emigration or immigration** (no gene flow can occur)

c. **No mutations** (no new alleles can be added tothe gene pool)

d. **Random mating** (no sexual selection can occur)

e. **No natural selection** (all traits must equally aid in survival)

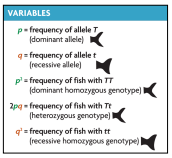
B. The Hardy-Weinberg equation is used to **predict** genotype **frequencies** in a population

1. Used in simple dominant-recessive systems

2. Shows values that would exist in population in equilibrium

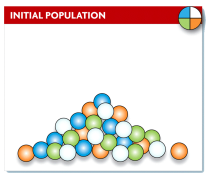
3. Use **equation** (if calculated frequencies match actual frequencies, then population in equilibrium)

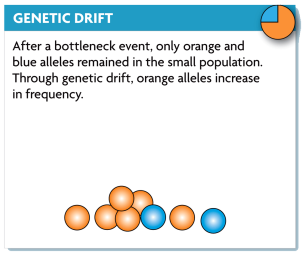
$$p^2 + 2pq = q^2 = 1$$



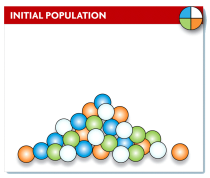
C. There are 5 factors that can lead to evolution (**populations not in Hardy-Weinberg equilibrium are evolving**)

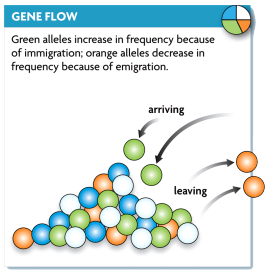
1. **Genetic drift** (allele frequencies change due to chance)



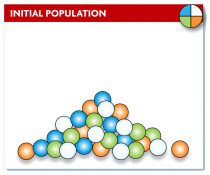


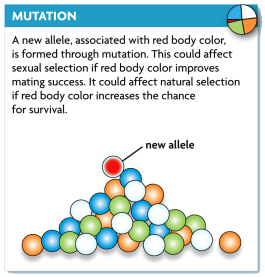
2. **Gene flow** (movement of alleles-emigration and immigration)



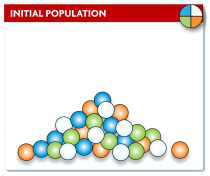


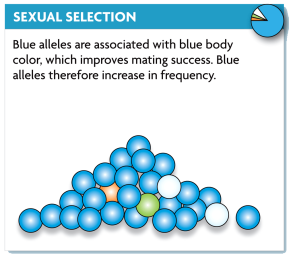
3 **Mutation** (New alleles form through mutation and create genetic variation)



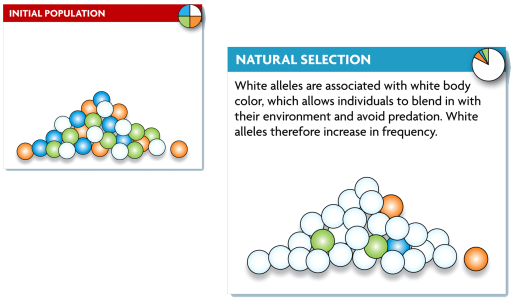


4. **Sexual selection** (certain traits improve mating success)



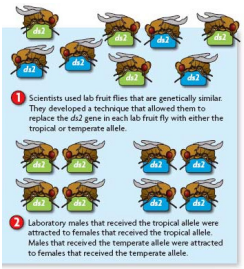


5. **Natural selection** (certain traits advantageous to survival. Alleles for these traits increase in frequency)



V. Speciation Through Isolation (11.5)

A. The isolation of populations can lead to speciation



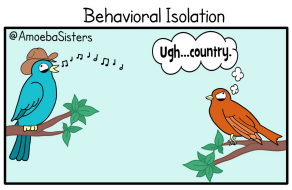
1. **Speciation**- the rise of two or more species from one existing species

2. **Reproductive isolation-** when members of **different populations** can **no longer mate successfully** with one another)

B. Populations can become isolated in several ways

1. **Behavioral barriers**

a. **Behavioral isolation**- isolation caused by differences in courtship or mating behavior)



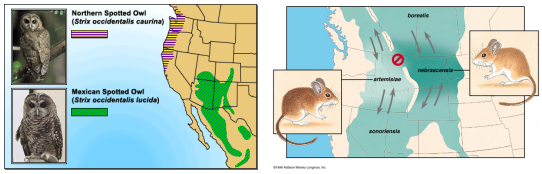
b. Chemical scents, courtship dances, courtship songs, sexual signals used to attract mates

2. **Geographic barriers**

a. **Geographic isolation**- involves physical barriers that divide populations

b. Include mountains, rivers, dried lakebeds, etc.

c. **Over time** isolated populations become **genetically different**

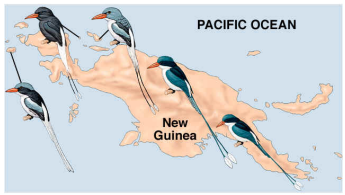


3. **Temporal Barriers**

a. **Temporal Isolation**- Timing prevents **reproduction** between populations

b. **Reproductive periods** may change and can lead to speciation

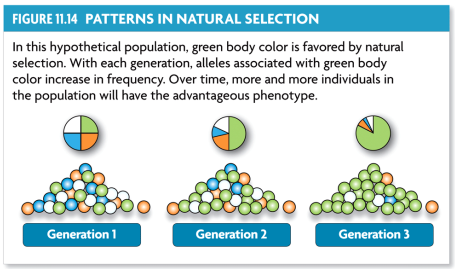
Phenotypic Differentiation—Papuan Kingfisher



VI. Patterns of Evolution (11.6)

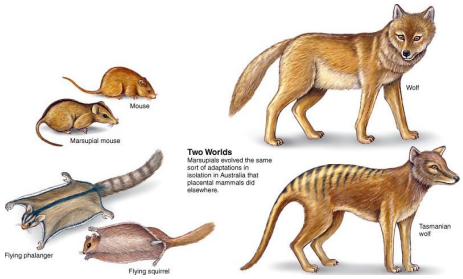
A. Evolution through natural selection is not random

1. **Environment** controls the direction taken by natural selection

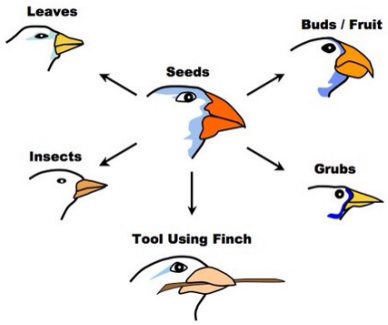


2. The **response of species to environmental challenges** and opportunities is **not random**

a. **Convergent Evolution**- evolution towards similar characteristics in unrelated species



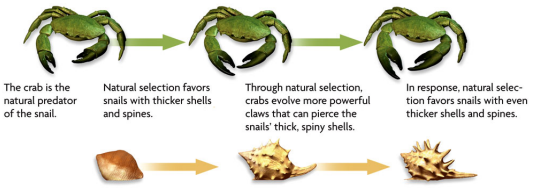
b. **Divergent Evolution**- related species evolve in different directions and become increasingly different



B. Species can shape each other over time

1. **Coevolution**- two or more species evolve in response to changes in each other

2. **Evolutionary arms race**- coevolution can occur in competitive relationships



C. Species can become extinct

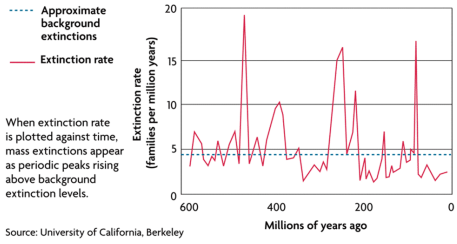
1. **extinction**- elimination of a species from Earth

2. **Background extinctions**- extinctions that occur continuously at very low rate

3. . **Mass extinction**- more rare, but more intense

a. Can occur on global level

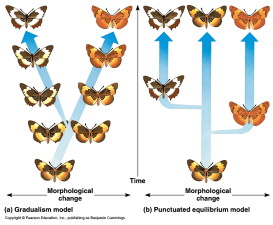
b. Thought to occur due to catastrophic events (e.g. ice age, asteroid impact)



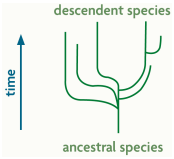
D. Speciation often occurs in patterns

1. **Punctuated equilibrium**- bursts of evolutionary activity

a. Episodes of speciation occur suddenly



b. Followed by periods of little change



2. **Adaptive radiation**- Diversification of one ancestral species into many descendent species