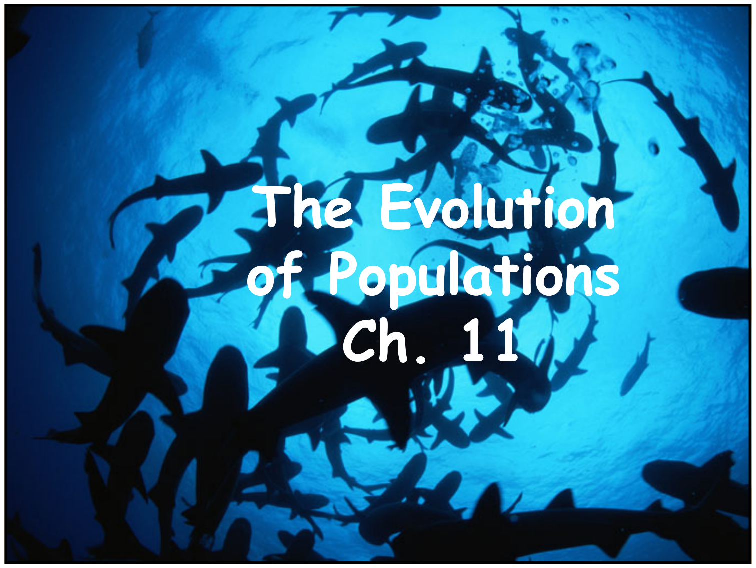
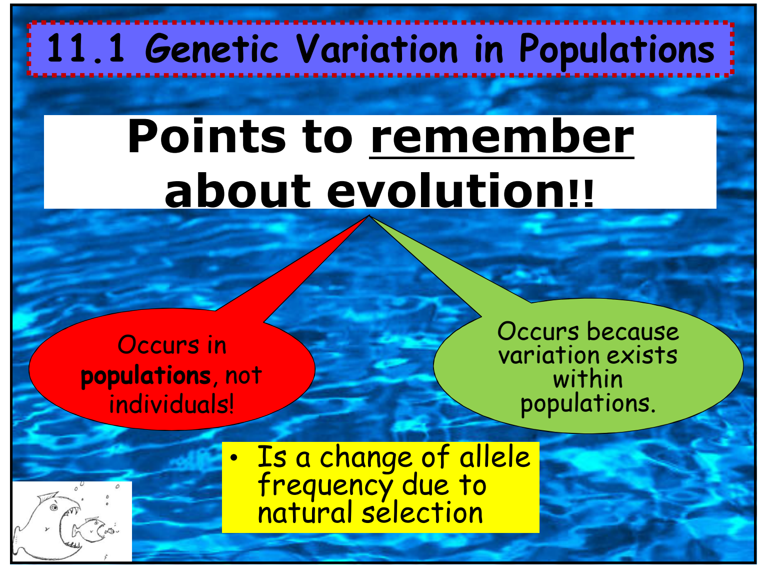
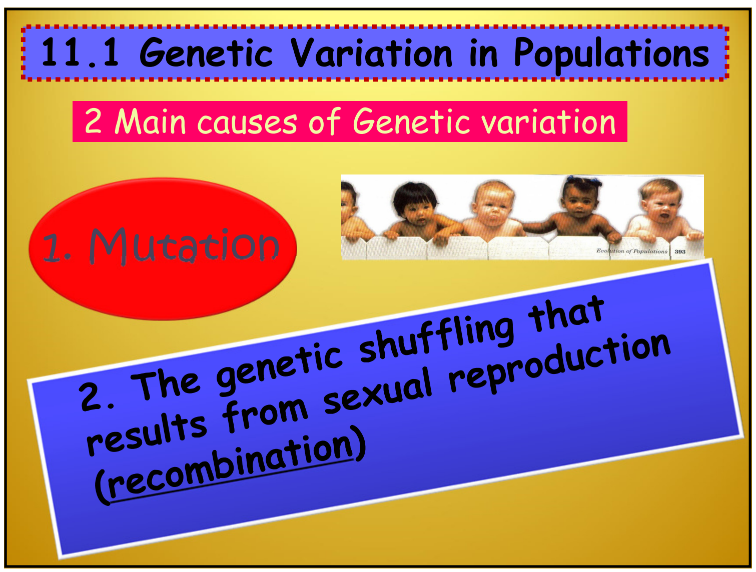
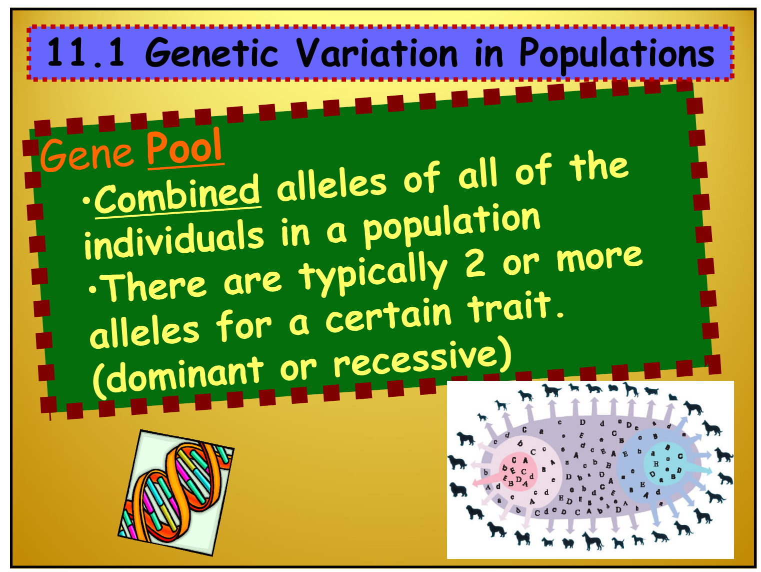

The Evolution
of Populations
Ch. 11


11.1 Genetic Variation in Populations
Points to remember about evolution!!
Occurs in populations, not individuals!
Occurs because variation exists within populations.
• Is a change of allele frequency due to natural selection


11.1 Genetic Variation in Populations
2 Main causes of Genetic variation
1. Mutation
2. The genetic shuffling that results from sexual reproduction (recombination)


11.1 Genetic Variation in Populations
Gene Pool
•Combined alleles of all of the individuals in a population
•There are typically 2 or more alleles for a certain trait. (dominant or recessive)

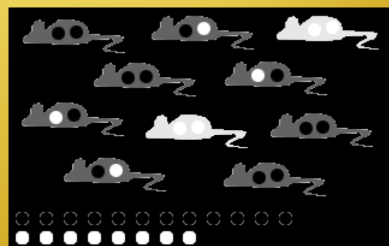
11.1 Genetic Variation in Populations

- **Allele frequency** —the measure of how common a certain allele is in a population.

Allele for black fur: 12

Total number of alleles: 20

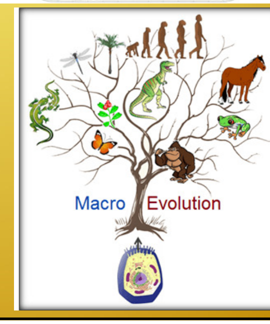
So 12/20= 60 %



11.2 Natural Selection in Populations

Macroevolution

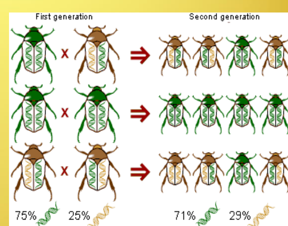
- Refers to changes between different species.
  - Patterns and changes among living things over long periods of time
  - Fossils and comparison between organisms

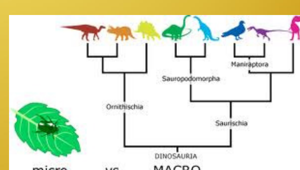


11.2 Natural Selection in Populations

Microevolution

- Change in the allele frequencies of a population over time.
  - Occurs on a small scale.
  - Looks at a single population.
  - Lead through natural selection





11.2 Natural Selection in Populations

Natural selection acts on the distribution of traits.

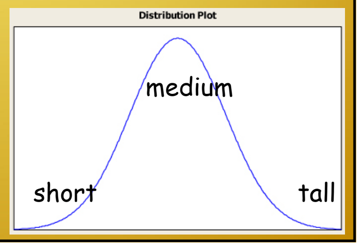
- Most phenotypes in a population result from polygenic traits rather than single-gene traits
- NS never acts directly on genes
- NS can only affect which individuals survive & reproduce

11.2 Natural Selection in Populations

Natural selection acts on the distribution of traits.

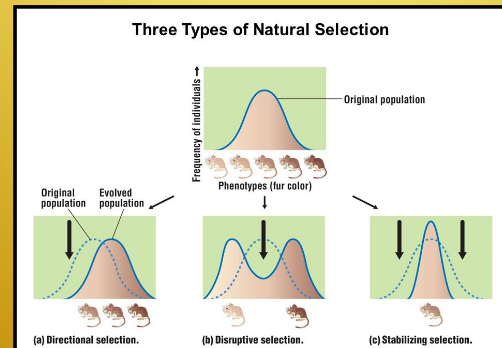
- Normal distribution: phenotypes near the middle of the range tend to be most common, while extremes are less common

•Ex: height→ tall/short height less common
→ medium height more common



11.2 Natural Selection in Populations

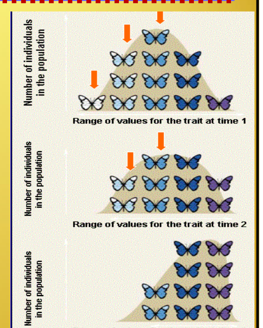
Natural selection can change the distribution of a trait in three ways:

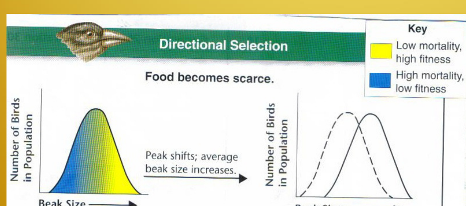


11.2 Natural Selection in Populations

1. Directional Selection

- Favors phenotypes at **one extreme** of a trait's range
- Individuals at one end of the curve have higher fitness

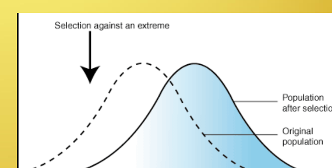




11.2 Natural Selection in Populations

1. Directional Selection

Occur in response to:
- directional change in the environment
- one or more new environmental conditions
- a mutation



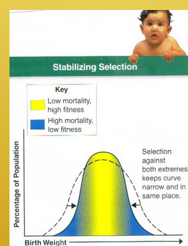
Examples include: peppered moths, pesticide resistance, and antibiotic resistance

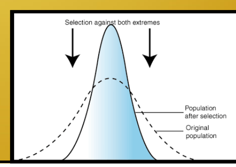
11.2 Natural Selection in Populations

2. Stabilizing selection

- Favors individuals near the **middle** of a curve have higher fitness than individuals at either end
  - Favors intermediate phenotypes in a population

Ex: Human birth weight stays between 6-8 lbs. Lower or higher birth weights have a higher mortality

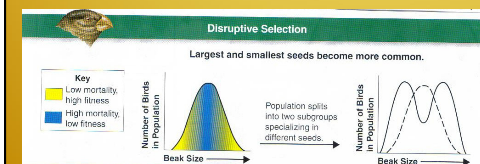




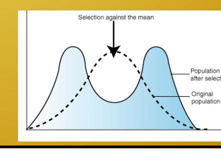
11.2 Natural Selection in Populations

3. Disruptive selection

- Favors extreme traits
- The **upper & lower ends** of the curve have higher fitness
- **One population divided into two**

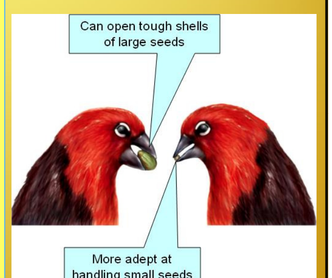


Favors short and longer beaks



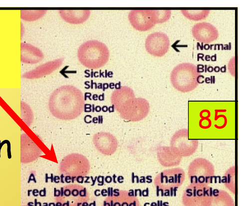
11.2 Natural Selection in Populations

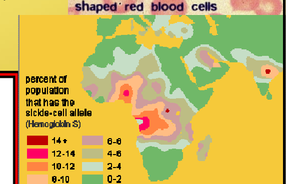
- Discruptive selection
  For example, two distinct bill types are present in black-bellied seedcrackers in which larger-billed birds are more efficient when feeding on hard seeds and smaller-billed birds are more efficient when feeding on soft seeds.

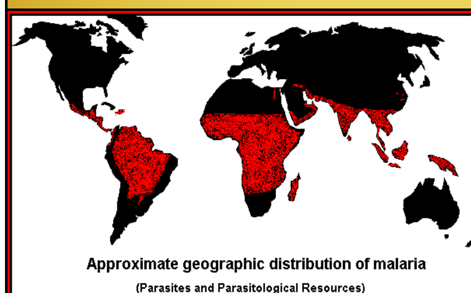


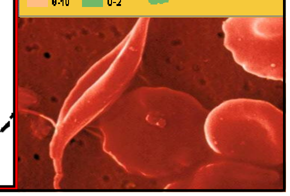
Heterozygote Advantage

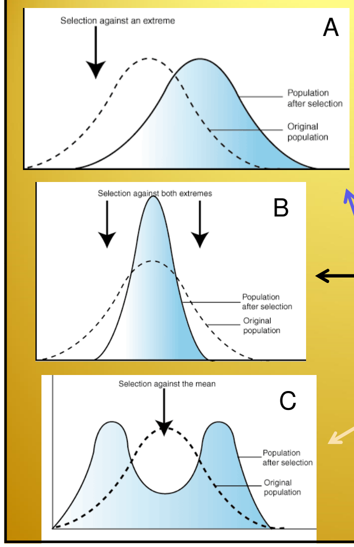
- Exists when a **heterozygote (Aa) has a higher fitness** than either homozygote (AA, aa).
- **ex: Sickle Cell**











What type of distribution is each graph showing?

Stabilizing Selection

Disruptive Selection

Directional Selection

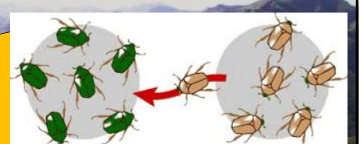
11.3 Other Mechanisms of Evolution

Other Mechanisms of Evolution

- Other factors besides natural selection may lead to evolution
- Other mechanisms of evolution include:

1.) gene flow
2.) genetic drift
3.) sexual selection

Gene Flow



The movement of alleles from one population to another

- Gene flow between neighboring species keeps their gene pools similar
- A lack of gene flow in a population leads to different species

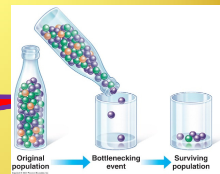
GENE FLOW – immigration & emigration of genes

Genetic Drift

Changes in allele frequency due to chance alone
- Affects small populations more
- Causes gene pools of 2 isolated populations to become different as alleles are lost or fixed
- loss of genetic diversity

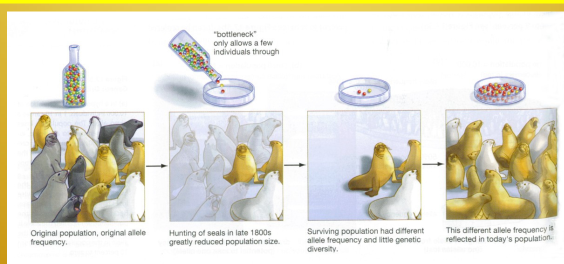
Caused by 2 things:
1.) population bottleneck
2.) the founding of a small population

Cause of Genetic Drift

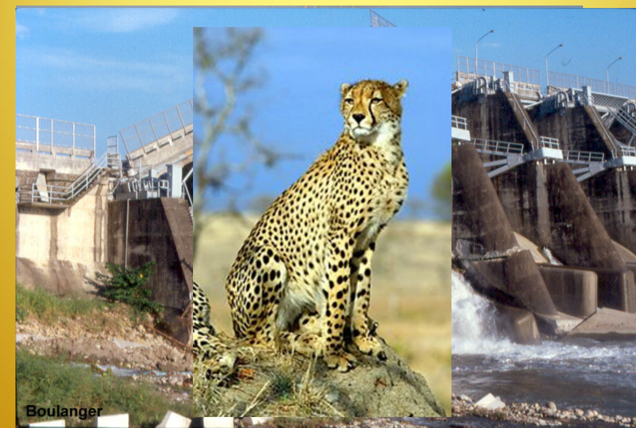


1. Bottleneck effect

Occurs after a destructive event reduces the size of a population



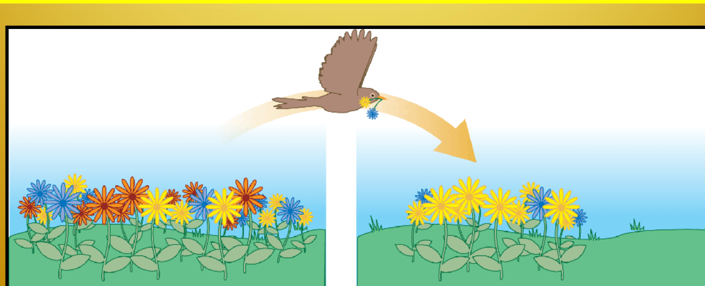
1. Bottleneck effect:



Cause of Genetic Drift

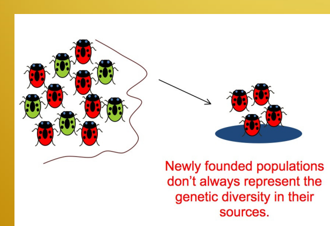
2. Founder effect:

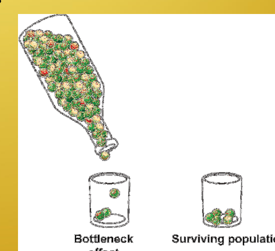
Occurs after a small number of individuals colonize a new area



Genetic drift has negative effects on a population.

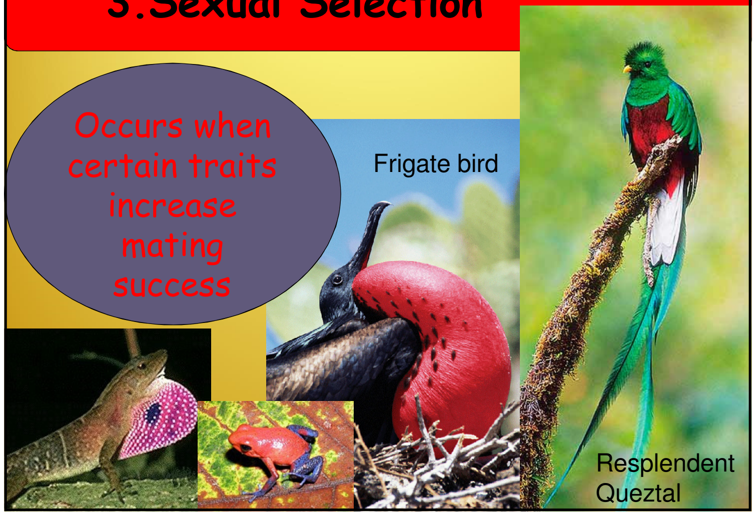
- less likely to have some individuals that can adapt
- harmful alleles can become more common due to chance





3.Sexual Selection

Occurs when certain traits increase mating success



11.4 Evolution vs.Genetic Equilibrium

Genetic equilibrium - when allele frequencies remain constant, the population will not evolve

Hardy-Weinberg equilibrium

- Showed genotypes frequencies in pop stay the same if certain condition are met.
- Can predict the frequencies.
  - $p^2 + 2pq + q^2 = 1$

p= freq of dominant allele
q= freq of recessive allele

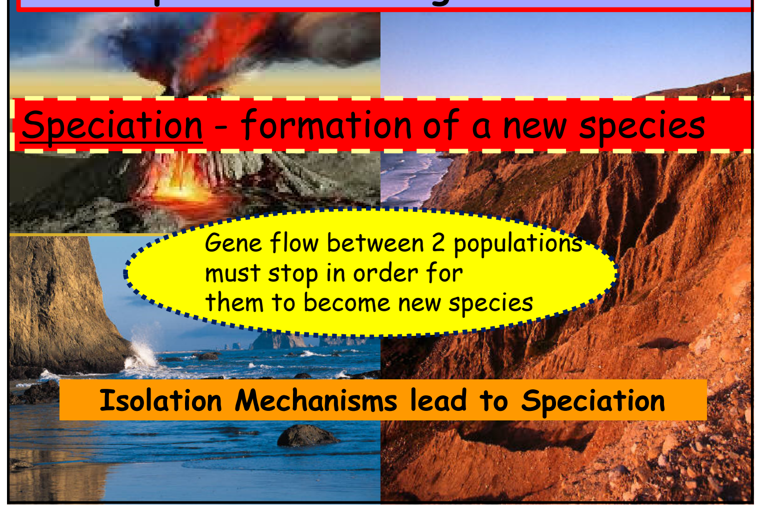
11.4 Evolution vs.Genetic Equilibrium

Five conditions are required to maintain genetic equilibrium and prevent evolution:

1. Very Large population
2. No emigration or immigration
3. No Mutation
4. Random Mating
5. No Natural Selection

Rarely do any population meet all five conditions

11.5 Speciation Through Isolation



Speciation - formation of a new species

Gene flow between 2 populations must stop in order for them to become new species

Isolation Mechanisms lead to Speciation

11.5 Speciation Through Isolation

As new species evolve, populations become reproductively isolated from each other

1. Reproductive isolation
2. Behavioral Isolation
3. Geographic Isolation
4. Temporal Isolation

•Overtime they can change so much that they become unable to breed as they adapt to their environment.

Isolating Mechanisms

1.) Reproductive isolation - when members of 2 populations can't interbreed & produce fertile offspring

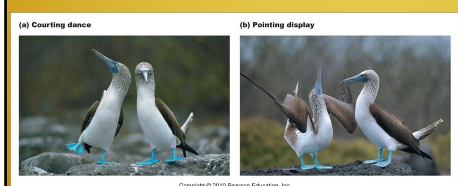
Satin bowerbird

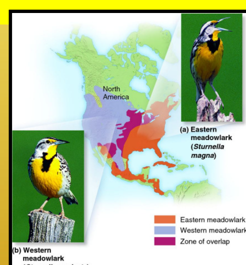
MacGregor's Bowerbird

Isolating Mechanisms

2.) Behavioral isolation - when 2 populations are capable of interbreeding but have differences in courtship rituals or other reproductive strategies that involve behavior

Ex.) Birds with different mating songs or behavior

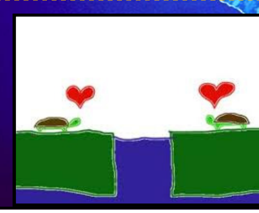


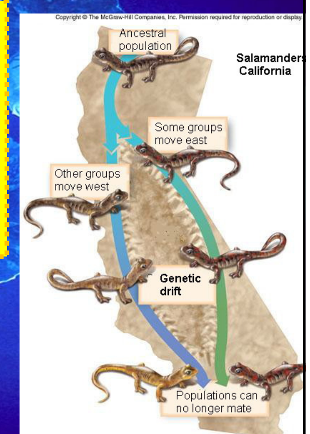


Isolating Mechanisms

3.) Geographic isolation - 2 populations are separated by geographic barriers like rivers, mountains, or bodies of water

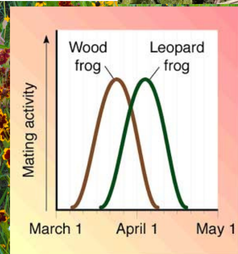
- Ex.) Salamenders split by mountain range





Isolating Mechanisms

4.) Temporal isolation
- when 2 or more species reproduce at different times

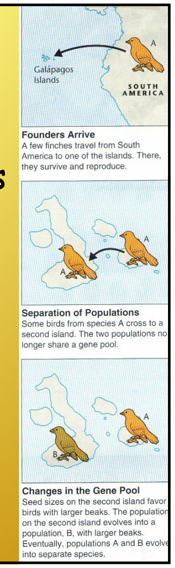


Ex.) Orchids releasing pollen on different days

•Different mating seasons

Speciation in Darwin's Finches

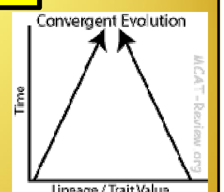
- Speciation in the Galapagos finches occurred by:
  - founding a new population
  - geographic isolation
  - changes in the new population's gene pool
  - reproductive isolation
  - ecological competition

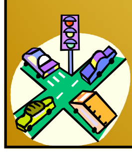


11.6 Patterns in Evolution

Convergent Evolution

•Evolution toward similar characteristics in unrelated species
•Structurally similar function and appearance but evolved through different evolutionary pathways.

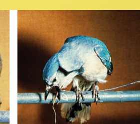


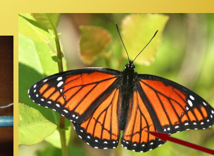


Ex: Dolphins (mammals) and sharks (fish) have evolved similar tail fins as each has adapted to similar environmental conditions

Convergent evolution led to mimicry

Why do these pairs look so similar?

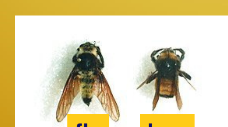




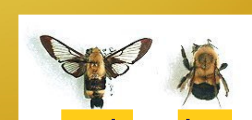
Monarch male poisonous

Viceroy male edible

Which is the moth vs. the bee?



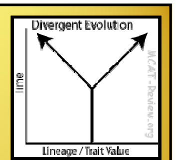
fly bee

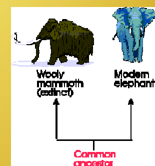


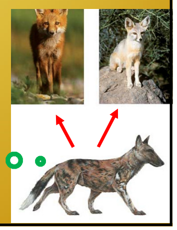
moth bee

11.6 Patterns in Evolution

Divergent Evolution

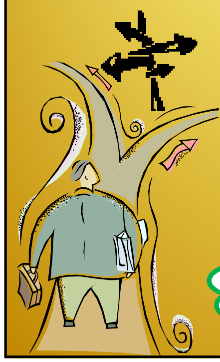






- The process of two or more related species becoming more and more dissimilar.

The red fox and the kit fox evolved from a common ancestor.



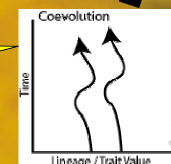
11.6 Patterns in Evolution

Coevolution

Two or more species evolve in response to changes in each other

Acacia Ant & Acacia Tree

Plants and the animals that pollinate them.



11.6 Patterns in Evolution

Extinction The elimination of a species from Earth

2 Types

1.) Background extinctions: Occurs continuously but at a low rate. One or few species

Iberian Lynx

2.) Mass extinctions: Occur suddenly & can destroys many species or families.

- 5 have occurred
- Ex: ice age or asteroid impact

passenger pigeon

What causes a species to go extinct?

Unable to adapt to its environment

99.9% of all species that have ever existed are now extinct

11.6 Patterns in Evolution

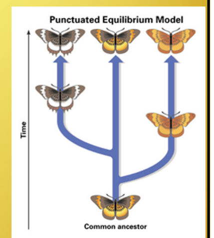
Punctuated equilibrium

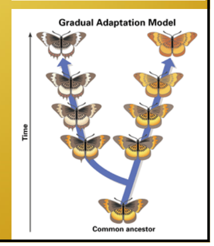
Speciation occur suddenly followed by long periods of little evolutionary activity

2 ways in which the evolution of a species can occur

Species with a shorter evolution evolved mostly by punctuated equilibrium

Those with a longer evolution evolved mostly by gradualism



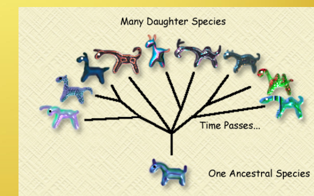


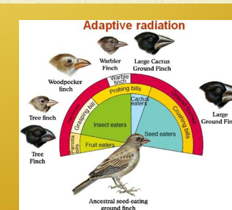
11.6 Patterns in Evolution

Adaptive radiation

- Many species evolve from one species
- Descendent species usually adapt to a wide range of environments

Usually occurs when a population colonizes an area of diverse geographic or ecological conditions
- New niches
- Happens rapidly





What do we know?

- Organisms have more offspring than the environment can support
- Not everybody survives
- How do we know this?

OBSERVATION

Over-production

Competition

How does that work?

Variation

Over-Production & Competition

Adaptation

Nature selects the ones that "fit" the environment better … survive & reproduce

Natural Selection

Survival & Reproduction of the fittest

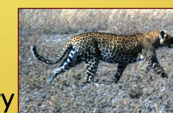
…the fittest!

Adaptations

the traits that help an organism fit the environment better to survive & reproduce

What determines survival?

- Natural Selection
  - traits that help individuals survive
    - survive predators
    - survive disease
    - compete for food
    - compete for territory
  - traits that help individuals reproduce
    - attracting a mate
    - compete for nesting sites
    - successfully raise young



Evolution explains Unity & Diversity

- Only evolution explains both
  - unity of life
    - similarities between all living things
  - diversity of life
    - wide variety of different creatures on Earth