15.1 Natural Selection and the Evidence for Evolution

Charles Darwin and Natural Selection

- The modern theory of evolution is the fundamental concept in biology.
- Recall that evolution is the change in populations over time.

RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Fossils shape ideas about evolution

- Some evidence indicated that Earth was much older than many people had originally thought, biologists began to suspect that species change over time, or evolve.
- Many explanations about how species evolve have been proposed, but the ideas first published by Charles Darwin are the basis of modern evolutionary theory.

RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin on HMS *Beagle*

- It took Darwin years to develop his theory of evolution.
- He began in 1831 at age 22 when he took a job as a naturalist on the English ship HMS *Beagle*, which sailed around the world on a five-year scientific journey.

RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin on HMS *Beagle*

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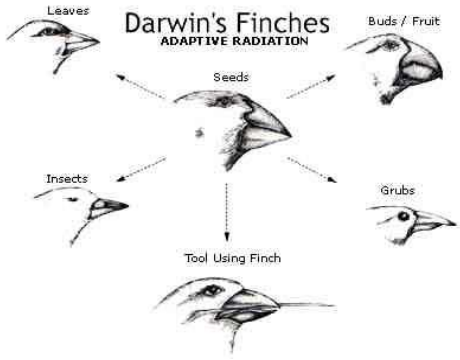


15.1 Natural Selection and the Evidence for Evolution

Darwin continues his studies

- For the next two decades, Darwin worked to refine his explanation for how species change over time.
- English economist Thomas Malthus had proposed an idea that Darwin modified and used in his explanation.
- Malthus's idea was that the human population grows faster than Earth's food supply.

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin continues his studies

How did this help Darwin?

- He knew that many species produce large numbers of offspring.
- He also knew that such species had not overrun Earth.

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin continues his studies

- He realized that individuals struggle to compete in changing environmental conditions.
- Only some individuals survive the competition and produce offspring.

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin continues his studies

- Darwin observed that the traits of individuals vary in populations. Variations are then inherited.
- Breeding organisms with specific traits in order to produce offspring with identical traits is called artificial selection.
- Darwin hypothesized that there was a force in nature that worked like artificial selection.

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin explains natural selection

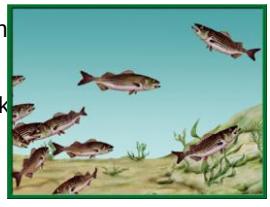
- Natural selection is a mechanism for change in populations.
- It occurs when organisms with favorable variations survive, reproduce, and pass their variations to the next generation.
- Organisms without these variations are less likely to survive and reproduce.

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Darwin explains natural selection

- Over time, offspring with certain variations make up most of the population and may look entirely different from their ancestors.



END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Interpreting evidence after Darwin

- Volumes of scientific data have been gathered as evidence for evolution since Darwin's time.
- Much of this evidence is subject to interpretation by different scientists.
- One of the issues is that evolutionary processes are difficult for humans to observe directly.

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Interpreting evidence after Darwin

- The short scale of human life spans makes it difficult to comprehend evolutionary processes that occur over millions of years.
- Almost all of today's biologists accept the theory of evolution by natural selection.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

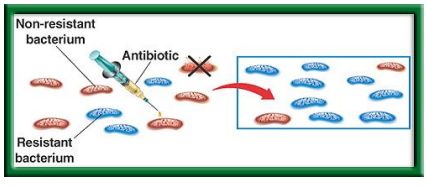
Chapter 15 Image Bank

Offspring and Ancestors

To return to the chapter summary click escape or close this document.
END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

Chapter 15 Image Bank

Resistant Bacteria



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END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

Chapter 15 Image Bank

Moth on Stucco Wall Mimicry

To return to the chapter summary click escape or close this document.
END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Structural adaptations arise over time

- Predators may learn quickly to avoid any organism with their general appearance.

END OF SLIDE

PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Structural adaptations arise over time

- Another subtle adaptation is camouflage, an adaptation that enables species to blend with their surroundings.

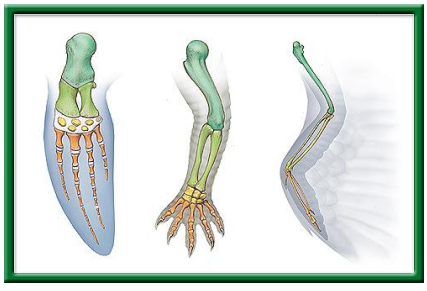
- Because well-camouflaged organisms are not easily found by predators, they survive to reproduce.

END OF SLIDE

PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE RESOURCES

Chapter 15 Image Bank

Homologous Structures



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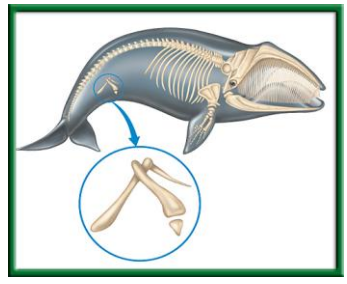
END OF SLIDE

PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE RESOURCES

Chapter 15 Image Bank

Vestigial Structures



To return to the chapter summary click escape or close this document.

END OF SLIDE

PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE RESOURCES

Anatomy

- For example, insect and bird wings probably evolved separately when their different ancestors adapted independently to similar ways of life.

END OF SLIDE
RESOURCES

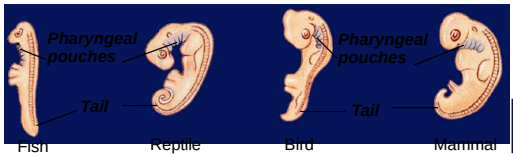
Fossils

- Fossils are an important source of evolutionary evidence because they provide a record of early life and evolutionary history.

END OF SLIDE
RESOURCES

Embryology

- An embryo is the earliest stage of growth and development of both plants and animals.
- The embryos of a fish, a reptile, a bird, and a mammal have a tail and pharyngeal pouches.



END OF SLIDE
RESOURCES

Biochemistry

- The data show the number of amino acid substitutions in the amino acid sequences for the different organisms.

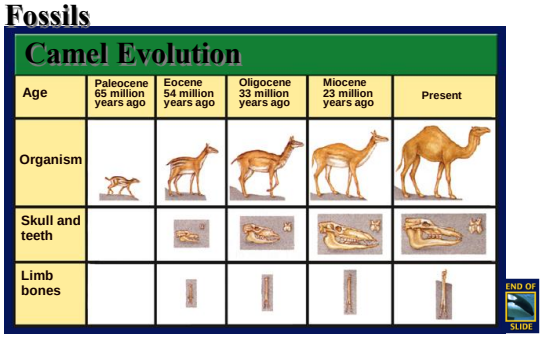
Biochemical Similarities of Organisms

Comparison of Organisms	Percent Substitutions of Amino Acids in Cytochrome c Residues
Two orders of mammals	5 and 10
Birds vs. mammals	8-12
Amphibians vs. birds	14-18
Fish vs. land vertebrates	18-22
Insects vs. vertebrates	27-34
Algae vs. animals	57

END OF SLIDE
RESOURCES

15.1 Natural Selection and the Evidence for Evolution

Fossils



15.2 Mechanisms of Evolution

Populations, not individuals, evolve

- Natural selection acts on the range of phenotypes in a population.
- Each member has the genes that characterize the traits of the species, and these genes exist as pairs of alleles.
- Evolution occurs as a population's genes and their frequencies change over time.

15.2 Mechanisms of Evolution

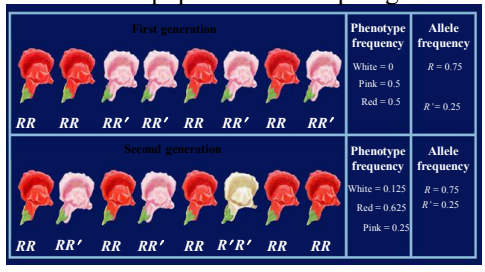
Populations, not individuals, evolve

- How can a population's genes change over time?
- Picture all of the alleles of the population's genes as being together in a large pool called a gene pool.
- The percentage of any specific allele in the gene pool is called the allelic frequency.

15.2 Mechanisms of Evolution

Populations, not individuals, evolve

- Look at the population of snapdragons.



15.2 Mechanisms of Evolution

Populations, not individuals, evolve

- They refer to a population in which the frequency of alleles remains the same over generations as being in genetic equilibrium.

15.2 Mechanisms of Evolution

Populations, not individuals, evolve

- A pattern of heredity called incomplete dominance governs flower color in snapdragons.
- The population of snapdragons is in genetic equilibrium when the frequency of its alleles for flower color is the same in all its generations.

15.2 Mechanisms of Evolution

Changes in genetic equilibrium

- One mechanism for genetic change is mutation.
- Environmental factors, such as radiation or chemicals, cause many mutations, but other mutations occur by chance.

15.2 Mechanisms of Evolution

Changes in genetic equilibrium

- Many are lethal.
- However, occasionally, a mutation results in a useful variation, and the new gene becomes part of the population's gene pool by the process of natural selection.

15.2 Mechanisms of Evolution

Changes in genetic equilibrium

- Another mechanism that disrupts a population's genetic equilibrium is genetic drift—the alteration of allelic frequencies by chance events.
- Genetic drift can greatly affect small populations that include the descendants of a small number of organisms.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

Changes in genetic equilibrium

- Genetic drift has been observed in some small human populations that have become isolated due to reasons such as religious practices and belief systems.
- Genetic equilibrium is also disrupted by the movement of individuals in and out of a population.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

Changes in genetic equilibrium

- The transport of genes by migrating individuals is called gene flow.
- When an individual leaves a population, its genes are lost from the gene pool.
- When individuals enter a population, their genes are added to the pool.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

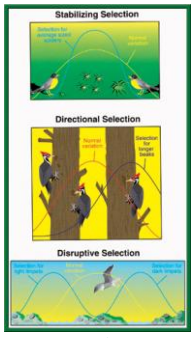
Natural selection acts on variations

- Some variations increase or decrease an organism's chance of survival in an environment.
- There are three different types of natural selection that act on variation: stabilizing, directional, and disruptive.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2

Transparencies



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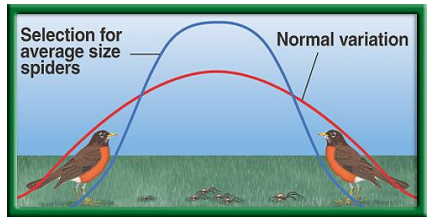
RESOURCES

Chapter 15

Image Bank

Stabilizing Selection



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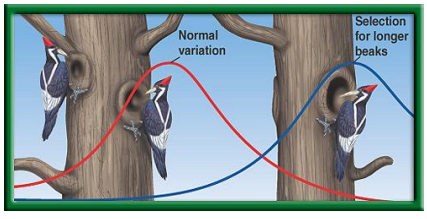
RESOURCES

Chapter 15

Image Bank

Directional Selection



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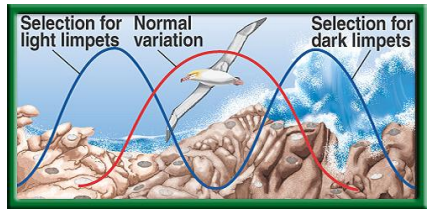
RESOURCES

Chapter 15

Image Bank

Disruptive Selection



To return to the chapter summary click escape or close this document.

RESOURCES

15.2 Mechanisms of Evolution

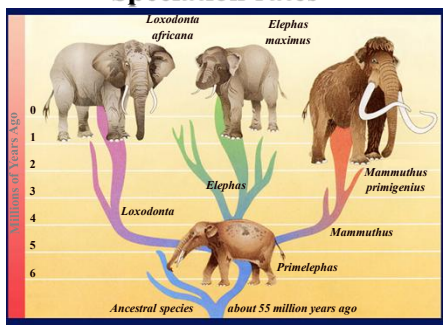
The Evolution of Species

- Recall that a species is defined as a group of organisms that look alike and can interbreed to produce fertile offspring in nature.
- The evolution of new species, a process called speciation (spee shee AY shun), occurs when members of similar populations no longer interbreed to produce fertile offspring within their natural environment.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

Speciation rates



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PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

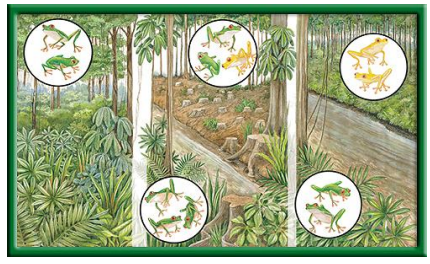
Physical barriers can prevent interbreeding

- In nature, physical barriers can break large populations into smaller ones.
- Geographic isolation occurs whenever a physical barrier divides a population.
- A new species can evolve when a population has been geographically isolated.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

Chapter 15 Image Bank

Geographic Isolation

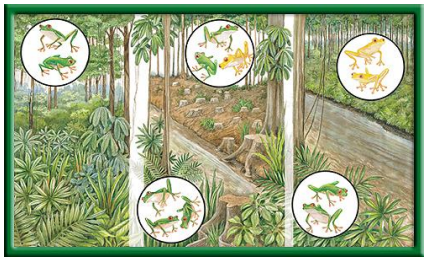


To return to the chapter summary click escape or close this document.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

Chapter 15 Image Bank

Geographic Isolation



To return to the chapter summary click escape or close this document.

15.2 Mechanisms of Evolution

Speciation rates

- Scientists once argued that evolution occurs at a slow, steady rate, with small, adaptive changes gradually accumulating over time in populations.
- Gradualism is the idea that species originate through a gradual change of adaptations.
- Some evidence from the fossil record supports gradualism.

15.2 Mechanisms of Evolution

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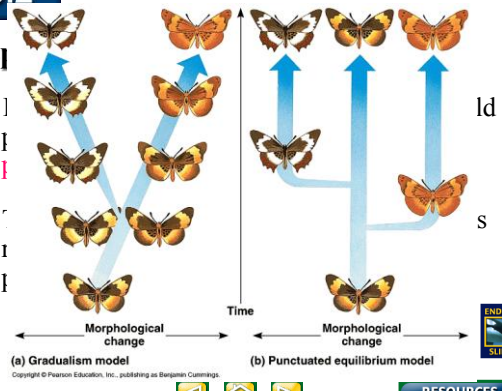


15.2 Mechanisms of Evolution

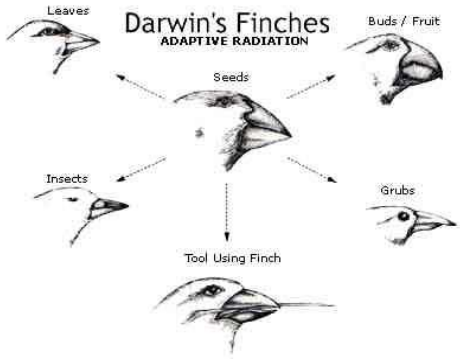
Speciation rates

- Biologists generally agree that both gradualism and punctuated equilibrium can result in speciation, depending on the circumstances.

15.2 Mechanisms of Evolution

Diversity in new environments

- When an ancestral species evolves into an array of species to fit a number of diverse habitats, the result is called adaptive radiation.



END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

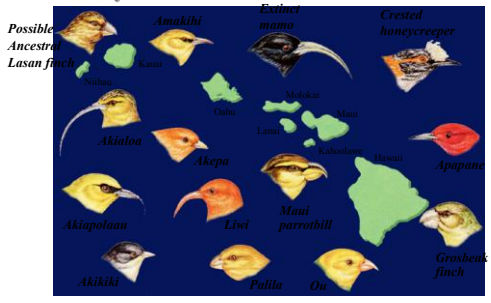
Diversity in new environments

- Adaptive radiation in both plants and animals has occurred and continues to occur throughout the world and is common on islands.
- Adaptive radiation is a type of divergent evolution, the pattern of evolution in which species that were once similar to an ancestral species diverge, or become increasingly distinct.

END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

Diversity in new environments



END OF SLIDE
PREVIOUS SLIDE TABLE OF CONTENTS NEXT SLIDE
RESOURCES

15.2 Mechanisms of Evolution

Different species can look alike

- A pattern of evolution in which distantly related organisms evolve similar traits is called convergent evolution.
- Convergent evolution occurs when unrelated species occupy similar environments in different parts of the world.