#### **Interactive Classroom**

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Glencoe Science

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Section 1: Darwin's Theory of Natural Selection
Section 2: Evidence of Evolution
Section 3: Shaping Evolutionary Theory

EXIT

**15.1 Darwin's Theory of Natural Selection** 

Darwin on the HMS Beagle

- Darwin's role on the ship was as naturalist and companion to the captain.
- His job was to collect biological and geological specimens during the ship's travel.



#### **15.1 Darwin's Theory of Natural Selection**

## The Galápagos Islands

- Darwin began to collect mockingbirds, finches, and other animals on the four islands.
- He noticed that the different islands seemed to have their own, slightly different varieties of animals.



#### **15.1 Darwin's Theory of Natural Selection**

 Almost every specimen that Darwin had collected on the islands was new to European scientists.



 Populations from the mainland changed after reaching the Galápagos.



#### **15.1 Darwin's Theory of Natural Selection**

**Darwin Continued His Studies** 

- Darwin hypothesized that new species could appear gradually through small changes in ancestral species.
- Darwin inferred that if humans could change species by artificial selection, then perhaps the same process could work in nature.



### **15.1 Darwin's Theory of Natural Selection**

## Natural Selection

- Individuals in a population show variations.
- Variations can be inherited.
- Organisms have more offspring than can survive on available resources.
- Variations that increase reproductive success will have a greater chance of being passed on.





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- **15.1 Darwin's Theory of Natural Selection** 
  - The Origin of Species
- Darwin published On the Origin of Species by Means of Natural Selection in 1859.
- Darwin's theory of natural selection is not synonymous with evolution.
- It is a means of explaining how evolution works.



**15.2 Evidence of Evolution** 

Support for Evolution

- The fossil record
  - Fossils provide a record of species that lived long ago.
  - Fossils show that ancient species share similarities with species that now live on Earth.





Armadillo





- **15.2 Evidence of Evolution**
- Derived traits are newly evolved features, such as feathers, that do not appear in the fossils of common ancestors.
- Ancestral traits are more primitive features, such as teeth and tails, that do appear in ancestral forms.
- Anatomically similar structures inherited from a common ancestor are called homologous structures.



### **15.2 Evidence of Evolution**

- Vestigial Structures
- Structures that are the reduced forms of functional structures in other organisms.
- Evolutionary theory predicts that features of ancestors that no longer have a function for that species will become smaller over time until they are lost.







#### **15.2 Evidence of Evolution**

- Analogous structures can be used for the same purpose and can be superficially similar in construction, but are not inherited from a common ancestor.
- Show that functionally similar features can evolve independently in similar environments





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**Comparative Embryology** 

 Vertebrate embryos exhibit homologous structures during certain phases of development but become totally different structures in the adult forms.



**Comparative Biochemistry** 

 Common ancestry can be seen in the complex metabolic molecules that many different organisms share.





#### **15.2 Evidence of Evolution**

- Comparisons of the similarities in these molecules across species reflect evolutionary patterns seen in comparative anatomy and in the fossil record.
- Organisms with closely related morphological features have more closely related molecular features.



## **Geographic Distribution**

The distribution of plants and animals that Darwin saw first suggested evolution to Darwin.









#### **15.2 Evidence of Evolution**

- Patterns of migration were critical to Darwin when he was developing his theory.
- Evolution is intimately linked with climate and geological forces.



## Types of Adaptation

- An adaptation is a trait shaped by natural selection that increases an organism's reproductive success.
- Fitness is a measure of the relative contribution an individual trait makes to the next generation.



# Camouflage 🕥



Leafy sea dragon

 Allows organisms to become almost invisible to predators





One species evolves to resemble another species.



Western coral snake



California kingsnake



- **15.2 Evidence of Evolution**
- **Consequences of Adaptations**
- Some features of an organism might be consequences of other evolved characteristics.
- They do not increase reproductive success.
- Features likely arose as an unavoidable consequence of prior evolutionary change.



#### **15.3 Shaping Evolutionary Theory**

Mechanisms of Evolution

- Population genetics
  - Hardy-Weinberg principle states that when allelic frequencies remain constant, a population is in genetic equilibrium.



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

- This equation allows us to determine the equilibrium frequency of each genotype in the population.
- Homozygous dominant (p<sup>2</sup>)
- Heterozygous (2pq)
- Homozygous recessive (q<sup>2</sup>)

#### **The Hardy-Weinberg Principle**

Condition	Violation	Consequence
The population is very large.	Many populations are small.	Chance events can lead to changes in population traits.
There is no immigration or emigration.	Organisms move in and out of the population.	The population can lose or gain traits with movement of organisms.
Mating is random.	Mating is not random.	New traits do not pass as quickly to the rest of the population.
Mutations do not occur.	Mutations occur.	New variations appear in the population with each new generation.
Natural selection does not occur.	Natural selection occurs.	Traits in a population change from one generation to the next.





# Genetic Drift 🗨

- A change in the allelic frequencies in a population that is due to chance
- In smaller populations, the effects of genetic drift become more pronounced, and the chance of losing an allele becomes greater.



## Founder Effect 🕥

- Occurs when a small sample of a population settles in a location separated from the rest of the population
- Alleles that were uncommon in the original population might be common in the new population.



# Bottleneck

 Occurs when a population declines to a very low number and then rebounds



## Gene Flow

 Increases genetic variation within a population and reduces differences between populations

## Nonrandom Mating

 Promotes inbreeding and could lead to a change in allelic proportions favoring individuals that are homozygous for particular traits



#### **15.3 Shaping Evolutionary Theory**

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## **Natural Selection**

 Acts to select the individuals that are best adapted for survival and reproduction



#### **15.3 Shaping Evolutionary Theory**

 Stabilizing selection operates to eliminate extreme expressions of a trait when the average expression leads to higher fitness.



#### **15.3 Shaping Evolutionary Theory**

# Directional selection makes an organism more fit.



#### **15.3 Shaping Evolutionary Theory**

Disruptive selection is a process that splits a population into two groups.



- Sexual selection operates in populations where males and females differ significantly in appearance.
- Qualities of sexual attractiveness appear to be the opposite of qualities that might enhance survival.


### **15.3 Shaping Evolutionary Theory**

- Prezygotic isolation prevents reproduction by making fertilization unlikely.
- Prevents genotypes from entering a population's gene pool through geographic, ecological, behavioral, or other differences



Eastern meadowlark and Western meadowlark



## **15.3 Shaping Evolutionary Theory**

- Postzygotic isolation occurs when fertilization has occurred but a hybrid offspring cannot develop or reproduce.
- Prevents offspring survival or reproduction



Liger



## **15.3 Shaping Evolutionary Theory**

## Allopatric Speciation

 A physical barrier divides one population into two or more populations.





## **15.3 Shaping Evolutionary Theory**

## Sympatric Speciation

- A species evolves into a new species without a physical barrier.
- The ancestor species and the new species live side by side during the speciation process.



## **15.3 Shaping Evolutionary Theory**

## Adaptive Radiation

- Can occur in a relatively short time when one species gives rise to many different species in
   Fish eater
   Cooplankton eater
  - response to the creation of new habitat or some other ecological opportunity



Follows large-scale extinction events

Snail eater

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## **15.3 Shaping Evolutionary Theory**

## Coevolution

- The relationship between two species might be so close that the evolution of one species affects the evolution of the other species.
- Mutualism
- Coevolutionary arms race



### **15.3 Shaping Evolutionary Theory**

## **Convergent Evolution**

 Unrelated species evolve similar traits even though they live in different parts of the world.







## **15.3 Shaping Evolutionary Theory**

## **Rate of Speciation**

- Evolution proceeds in small, gradual steps according to a theory called gradualism.
- Punctuated equilibrium explains rapid spurts of genetic change causing species to diverge quickly.



## **15.3 Shaping Evolutionary Theory**







## **COncepts In MOtion**





**Evolution Chapter 15** 

## **Chapter Resource Menu**



CheckPoint

**Chapter Diagnostic Questions** 

Formative Test Questions

CheckPoint

**Chapter Assessment Questions** 

CheckPoint

**Standardized Test Practice** Biology

biologygmh.com

**Glencoe Biology** Transparencies



Image Bank

<u>Vocabulary</u>



Animation

Click on a hyperlink to view the corresponding lesson.



Chapter Diagnostic Questions



Which is *not* a principle of Darwin's theory about the origin of species?

- A. Individuals show variations.
- B. Variations can be inherited.
- C. Organisms have more offspring than available resources will support.
- **D.**Offspring always inherit the best traits.



#### Chapter Diagnostic Questions



Identify the term that is used to describe anatomically similar structures inherited from a common ancestor.

A. ancestral traits
B. analogous structures
C. homologous structures
D. vestigial structures



Chapter Diagnostic Questions



Which is not a vestigial structure?

A. snake pelvis
B. Kiwi wings
C. porpoise flipper
D. human appendix



15.1 Formative Questions



Which was Charles Darwin's only qualification for his position as naturalist on the *Beagle*?

A. a degree in theology
B. an interest in science
C. a knowledge of biology
D. an understanding of geology



15.1 Formative Questions



What was Darwin's term for selective breeding?

A. evolution
B. speciation
C. artificial selection
D. natural selection



15.1 Formative Questions



What did Darwin infer from his observations of artificial selection?

A. Animal breeders could create new species.
B. A similar process could work in nature.
C. Reproductive success could be increased.
D. Variation in a species could be produced.



#### 15.1 Formative Questions



What is the relationship between the terms *natural selection* and *evolution*?

- A. They mean the same thing.
- B. Evolution works against natural selection.
- C. Evolution explains how natural selection works.
- D.Natural selection explains how evolution works.





The Archaeopteryx seems to have evolved from reptiles and is a direct ancestor of modern birds.



**15.2 Formative Questions** 



Which is an example of a derived trait?

A. a tail B. bones C. feathers D. teeth



#### 15.2 Formative Questions



Which features are similar in use and evolve in similar environments, but do not evolve from a common ancestor?

A. analogous structures
B. embryological structures
C. homologous structures
D. vestigial structures



15.2 Formative Questions





# Organisms with similar anatomy share similar DNA sequences.



15.2 Formative Questions



At the heart of the theory of evolution by natural selection lies the concept of \_\_\_\_\_.

A. adaptation
B. biogeography
C. gradualism
D. speciation



#### 15.3 Formative Questions



The development of the evolutionary theory has led to the understanding that the raw material for evolution is \_\_\_\_\_.

A.genes B. traits C. adaptation

D. competition



#### 15.3 Formative Questions



## Why does the ratio of gray to red owls remain the same after the population has doubled?







A. They each have different predators.

B. They compete with one another for resources.

C. Both are equally adapted to survive in their environment.

D. New individuals have emigrated into the population.



#### 15.3 Formative Questions



Which of these conditions can act on phenotypes to provide adaptive advantages to a population?

A. mutations
B. natural selection
C. nonrandom mating
D. small population size



#### 15.3 Formative Questions



# Which description is evidence that a speciation has taken place?



#### 15.3 Formative Questions



- A. A physical barrier has caused two groups from a population to adapt to different environments.
- B. Some members can no longer produce fertile offspring with members of the original population.
- C. A small group has developed mating behaviors that are different than those of the rest of the population.
- D. Some members from a population have developed physical characteristics that are different than the original population.



#### 15.3 Formative Questions



Which evolutionary pattern is represented by the similarities between these two organisms that live on separate continents?

Resources

A. coevolution
B. convergent evolution
C. directional evolution
D. divergent evolution

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Chapter Assessment Questions



Determine which morphological adaptation the monarch butterfly exhibits.

A. camouflage
B. mimicry
C. embryological adaptation
D. vestigial structure



Chapter Assessment Questions



## The divergent evolution of these cichlid fish is an example of what type of speciation?



Chapter Assessment Questions



## What tempo of evolution does this model represent?

A. gradual
B. elevated
C. sequential
D. punctuated





### Standardized Test Practice



Which explains why the tortoises on the different islands of the Galápagos had slightly different variations in their shells?

A. The different tortoises were different species. B. The environment on each island was different.

- C. Each type of tortoise could survive only on its own island.
- D. They arrived on the islands from different continents.



### Standardized Test Practice



Which is the best explanation for the similarities in the construction of these forelimbs?



- A. Each forelimb is a similar modification derived from a different ancestor.
- B. Natural selection has produced similar modifications in the forelimb.


#### Standardized Test Practice



Which is the best explanation for the similarities in the construction of these forelimbs?



C. They are functionally similar features that have evolved independently.

D. They are modifications of the forelimbs of a common ancestor.



### Standardized Test Practice



Predators learn to avoid monarch butterflies because they contain a poison that is distasteful and can cause the predator to get sick. The viceroy butterfly finds protection by closely resembling the monarch. What is this adaptation in the viceroy called?

A. camouflage B. fitness C. mimicry D. resemblance

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### Standardized Test Practice



Why are cheetahs so genetically similar that they appear inbred?

- A. Individuals in the population had mated randomly.
- B. Their population had declined to a very low number.
- C. A large sample of the population settled in a separate location.
- D. A mutation appeared and became common in subsequent generations.



Standardized Test Practice



Within a population of squirrels, those that live higher in the mountains where it is cooler have long fur. Squirrels that live in the foothills where it is warmer have short fur. The original population is believed to have had intermediate fur length. Which graph represents this type of natural selection?





### Standardized Test Practice



These cichlid fish are believed to have diverged from a single ancestor. What type of speciation is represented by this divergence?

Resources

A. adaptive radiation
 B. allopatric speciation
 C. convergent evolution
 D. disruptive coevolution

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# Section 1

- artificial selection
- A natural selection
- evolution



# Section 2

- derived trait E 8
  - ancestral trait
  - homologous
    - structure
- vestigial structure **(**=)
  - analogous structure
  - embryo







- mimicry
- camouflage

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# Section 3

- Hardy-Weinberg principle
- genetic drift
- founder effect
- bottleneck
- stabilizing selection
- directional selection

- disruptive selection
  sexual selection
  prezygotic
  - isolating mechanism



# Section 3 (cont.)

- allopatric speciation
- postzygotic isolation mechanism
- sympatric speciation
- adaptive radiation
- gradualism
- punctuated equilibrium





