Chapter 10

The Theory of Evolution Worksheets

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- **Lesson 10.1: Darwin and the Theory of Evolution**
- **Lesson 10.2: Evidence for Evolution**
- **Lesson 10.3: Microevolution and the Genetics of Populations**
- **Lesson 10.4: Macroevolution and the Origin of Species**

10.1 Darwin and the Theory of Evolution

Lesson 10.1: True or False

Name_____ **Class**_____ **Date**_____

Write true if the statement is true or false if the statement is false.

_____ 1. As recently as 200 years ago, many people believed that Earth was only 6,000 years old.

_____ 2. Artificial selection occurs when nature selects for beneficial traits.

_____ 3. The individual Galápagos Islands are all similar to each other.

_____ 4. Malthus argued that human populations grow faster than their resources.

_____ 5. Lamarck was one of the first scientists to propose that species evolve by natural selection.

_____ 6. Lyell was one of the first to say that Earth must be far older than most people believed.

_____ 7. Lamarck's inheritance of acquired characteristics is has become a widely accepted scientific theory.

_____ 8. Fossils proved to Darwin that species can evolve.

_____ 9. The term *fitness* to refer to an organism's ability to outrun its hunters.

_____ 10. Darwin published his findings soon after returning to England from the voyage of the *Beagle.*

_____ 11. According to Darwin, natural selection is what occurs, and evolution is how it happens.

_____ 12. During his journey aboard the *Beagle,* Darwin found fossils from the seas in the mountains.

_____ 13. Galápagos tortoises have differently shaped shells depending on where they live.

_____ 14. Darwin's book changed science forever.

_____ 15. Alfred Russel Wallace developed a theory of evolution at the same time as Darwin.

Lesson 10.1: Critical Reading

Name_____ **Class**_____ **Date**_____

Read these passages from the text and answer the questions that follow.

The Voyage of the *Beagle*

In 1831, when Darwin was just 22 years old, he set sail on a scientific expedition on a ship called the *HMS Beagle*. He was the naturalist on the voyage. As a naturalist, it was his job to observe and collect specimens of plants, animals, rocks, and fossils wherever the expedition went ashore.

Darwin was fascinated by nature, so he loved his job on the *Beagle*. He spent more than 3 years of the 5-year trip exploring nature on distant continents and islands. While he was away, a former teacher published Darwin's accounts of his observations. By the time Darwin finally returned to England, he had become famous as a naturalist.

Darwin's Observations

During the long voyage, Darwin made many observations that helped him form his theory of evolution. For example:

- He visited tropical rainforests and other new habitats where he saw many plants and animals he had never seen before. This impressed him with the great diversity of life.
- He experienced an earthquake that lifted the ocean floor 2.7 meters (9 feet) above sea level. He also found rocks containing fossil sea shells in mountains high above sea level. These observations suggested that continents and oceans had changed dramatically over time and continue to change in dramatic ways.
- He visited rock ledges that had clearly once been beaches that had gradually built up over time. This suggested that slow, steady processes also change Earth's surface.
- He dug up fossils of gigantic extinct mammals, such as the ground sloth. This was hard evidence that organisms looked very different in the past. It suggested that living things — like Earth's surface — change over time.

The Galápagos Islands

Darwin's most important observations were made on the **Galápagos Islands**. This is a group of 16 small volcanic islands 966 kilometers (600 miles) off the west coast of South America.

Individual Galápagos Islands differ from one another in important ways. Some are rocky and dry. Others have better soil and more rainfall. Darwin noticed that the plants and animals on the different islands also differed. For example, the giant tortoises on one island had saddle-shaped shells, while those on another island had dome-shaped shells. People who lived on the islands could even tell the island a turtle came from by its shell. This started Darwin thinking about the origin of species. He wondered how each island came to have its own type of tortoise.

Questions

1. What was Darwin's role on the *Beagle?*

2. What was significant about the new habitats Darwin visited?

3. What was significant about the rocks Darwin found in the mountains?

4. What was significant about the fossils Darwin found?

5. What did Darwin notice about life on the Galápagos Islands?

Lesson 10.1: Multiple Choice

Name_____ **Class**_____ **Date**_____

Circle the letter of the correct choice.

1. _____ developed the theory of evolution by natural selection.
   (a) Alfred Russel Wallace
   (b) Charles Darwin
   (c) Jean Baptiste Lamarck
   (d) Charles Lyell
2. The voyage of the *Beagle* circled the globe. This voyage lasted
   (a) 5 months.
   (b) 2 years.
   (c) 4 years.
   (d) 5 years.
3. Aboard the *Beagle*, Darwin served as
   (a) a naturalist.
   (b) the captain.
   (c) the captain's first officer.
   (d) the ship's doctor.
4. During the voyage of the *Beagle*, Darwin
   (a) experienced an earthquake that lifted the ocean floor 9 feet.
   (b) dug up fossils of gigantic extinct mammals.
   (c) saw many plants and animals he had never seen before.
   (d) all of the above
5. Where did Darwin make some of his most important observations that helped him develop his theory?
   (a) England
   (b) the Galápagos Islands
   (c) South Africa
   (d) South America
6. Who argued that human populations grow faster than the resources they depend on?
   (a) Thomas Malthus
   (b) Charles Lyell
   (c) Jean Baptiste Lamarck
   (d) Alfred Russel Wallace
7. One of the first scientists to propose that species change over time was
   (a) Charles Darwin.
   (b) Charles Lyell.
   (c) Jean Baptiste Lamarck.
   (d) Alfred Russel Wallace.
8. Natural selection states that
   (a) a change in a species occurs over time.
   (b) nature selects the variations within a species that are most useful for survival.
   (c) fitness is an organism's ability to survive and produce fertile offspring.
   (d) all of the above

Lesson 10.1: Vocabulary I

Name_____ **Class**_____ **Date**_____

Match the vocabulary word with the proper definition.

Definitions

_____ 1. change in species over time

_____ 2. one of the first scientists to propose that species change over time

_____ 3. ship on which Darwin served as naturalist

_____ 4. his theory of evolution unifies all of biology

_____ 5. the process by which evolution occurs

_____ 6. argued that human populations grow faster than the resources they depend on

_____ 7. small volcanic islands where Darwin made many important observations

_____ 8. selecting for plants and animals with useful traits

_____ 9. argued that gradual geological processes have gradually shaped Earth's surface

_____ 10. states that traits an organism develops during its own life time can be passed on to offspring

_____ 11. developed a theory of evolution at the same time as Darwin

_____ 12. an organism's relative ability to survive and produce fertile offspring

Terms

a. artificial selection

b. Darwin

c. evolution

d. fitness

e. Galápagos Islands

f. HMS Beagle

g. inheritance of acquired characteristics

h. Lamarck

i. Lyell

j. Malthus

k. natural selection

l. Wallace

Lesson 10.1: Vocabulary II

Name_____ **Class**_____ **Date**_____

Fill in the blank with the appropriate term.

1. In 1831, Darwin set sail on a scientific expedition on a ship called the *HMS* _____.
2. Darwin's most important observations were made on the _____ Islands.
3. Lamarck developed the idea known as the inheritance of _____ characteristics.
4. The _____ Darwin found helped convince him that species change over time.
5. The term _____ refers to an organism's ability to survive and produce fertile offspring.
6. _____ paper on evolution confirmed Darwin's ideas.
7. _____ said that Earth must be far older than most people believed.
8. Darwin was influenced by his knowledge of artificial _____.
9. Darwin proposed that _____ selects the variations in organisms that are most useful.
10. The Galápagos Islands are known for having giant _____ with differently shaped shells.
11. From Malthus, Darwin knew that populations could grow faster than their _____.
12. Darwin's theory of evolution unifies all of _____.

Lesson 10.1: Critical Writing

Name_____ **Class**_____ **Date**_____

Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.

Explain how a species can evolve through natural selection.

10.2 Evidence for Evolution

Lesson 10.2: True or False

Name_____ **Class**_____ **Date**_____

Write true if the statement is true or false if the statement is false.

_____ 1. Fossils provide clear evidence that evolution has occurred.

_____ 2. Embryos of many different vertebrates look much more similar than the adult organisms.

_____ 3. Early horses were about the size of a fox.

_____ 4. Darwin's comparison of DNA sequences provided strong evidence of evolution.

_____ 5. Today's scientists compare the anatomy, embryos, and DNA of modern organisms to understand how they evolved.

_____ 6. Homologous structures are structures that are different in related organisms because they were inherited from a common ancestor.

_____ 7. Comparative anatomy is the study of the similarities and differences in the structures of different species.

_____ 8. Homologous embryology is the study of the similarities and differences in the embryos of different species.

_____ 9. Analogous structures are structures that are similar in related organisms.

_____ 10. Peter and Rosemary Grant were actually able to observe evolution by natural selection taking place.

_____ 11. The wings of bats and birds serve the same function and are homologous structures.

_____ 12. Adaptive radiation is when one species evolves into a new species to fill an available niche.

_____ 13. Biogeography is the study of how and why plants and animals live where they do.

_____ 14. The Galápagos finches have provided a tremendous amount of information about evolution.

_____ 15. DNA sequence similarities are the strongest evidence for evolution from a common ancestor.

Lesson 10.2: Critical Reading

Name_____ **Class**_____ **Date**_____

Read these passages from the text and answer the questions that follow.

Evidence from Biogeography

Biogeography is the study of how and why plants and animals live where they do. It provides more evidence for evolution. Let's consider the camel family as an example.

Biogeography of Camels: An Example

Today, the camel family includes different types of camels. All of today's camels are descended from the same camel ancestors. These ancestors lived in North America about a million years ago.

Early North American camels migrated to other places. Some went to East Asia. They crossed a land bridge during the last ice age. A few of them made it all the way to Africa. Others went to South America. They crossed the Isthmus of Panama. Once camels reached these different places, they evolved independently. They evolved adaptations that suited them for the particular environment where they lived. Through natural selection, descendants of the original camel ancestors evolved the diversity they have today.

Island Biogeography

The biogeography of islands yields some of the best evidence for evolution. Consider the birds called finches that Darwin studied on the Galápagos Islands. All of the finches probably descended from one bird that arrived on the islands from South America. Until the first bird arrived, there had never been birds on the islands. The first bird was a seed eater. It evolved into many finch species. Each species was adapted for a different type of food. This is an example of **adaptive radiation**. This is the process by which a single species evolves into many new species to fill available niches.

Eyewitness to Evolution

In the 1970s, biologists Peter and Rosemary Grant went to the Galápagos Islands. They wanted to re-study Darwin's finches. They spent more than 30 years on the project. Their efforts paid off. They were able to observe evolution by natural selection actually taking place. While the Grants were on the Galápagos, a drought occurred. As a result, fewer seeds were available for finches to eat. Birds with smaller beaks could crack open and eat only the smaller seeds. Birds with bigger beaks could crack and eat seeds of all sizes. As a result, many of the small-beaked birds died in the drought. Birds with bigger beaks survived and reproduced. Within 2 years, the average beak size in the finch population increased. Evolution by natural selection had occurred.

Questions

1. What is biogeography and what does it provide?

2. Where do all camels come from?

3. Why did camels evolve?

4. What is adaptative radiation? Give an example.

5. What did the Grants study? What did they observe?

Lesson 10.2: Multiple Choice

Name_____ **Class**_____ **Date**_____

Circle the letter of the correct choice.

1. Evidence of evolution includes
   (a) DNA sequence analysis.
   (b) the fossil record.
   (c) anatomical evidence.
   (d) all of the above
2. Which of the following is true about horse evolution? (1) Early horses were about the size of a fox. (2) Early horses had toes. (3) During evolution, their molars became covered with cement.
   (a) 1 only
   (b) 1 and 2
   (c) 2 and 3
   (d) 1, 2, and 3
3. Examples of analogous structures are
   (a) the tails of mice and rats.
   (b) the limbs of humans and apes.
   (c) the wings of bats and birds.
   (d) all of the above
4. An example of a vestigial structure is the
   (a) kangaroo pouch.
   (b) human tail bone.
   (c) cat forelimb.
   (d) all of the above
5. The strongest evidence for evolution from a common ancestor is
   (a) similar DNA sequences.
   (b) similar body structures.
   (c) similar embryological structures.
   (d) similar fossils.
6. Island biogeography
   (a) provides information on the migration and evolution of the camel.
   (b) provides information on the migration and evolution of the finch.
   (c) provides information on the migration and evolution of the ape.
   (d) none of the above
7. Biogeography shows that all camels
   (a) came from ancestors that lived in North Africa.
   (b) came from ancestors that lived in North America.
   (c) came from ancestors that lived in North Egypt.
   (d) evolved from the llama.
8. Peter and Rosemary Grant
   (a) spent more than 30 years studying Darwin's tortoises.
   (b) studied the migration of the camel.
   (c) actually observed evolution by natural selection taking place.

(d) all of the above

Lesson 10.2: Vocabulary I

Name_____ **Class**_____ **Date**_____

Match the vocabulary word with the proper definition.

Definitions

_____ 1. the strongest evidence for evolution from a common ancestor

_____ 2. shows how organisms are related by descent from common ancestors

_____ 3. structures that are similar in related organisms because they were inherited from a common ancestor

_____ 4. scientists who find and study fossils

_____ 5. structures that are similar in unrelated organisms

_____ 6. provide clear evidence that evolution has occurred

_____ 7. reduced structures that are no longer used

_____ 8. the process by which a single species evolves into many new species to fill available niches

_____ 9. the study of the similarities and differences in the embryos of different species

_____ 10. the study of how and why plants and animals live where they do

_____ 11. the study of the similarities and differences in the structures of different species

Terms

a. adaptive radiation

b. analogous structure

c. biogeography

d. cladogram

e. comparative anatomy

f. comparative embryology

g. DNA sequences

h. fossils

i. homologous structure

j. paleontologist

k. vestigial structure

Lesson 10.2: Vocabulary II

Name_____ **Class**_____ **Date**_____

Fill in the blank with the appropriate term.

1. Humans and apes are evolutionarily closely related, based on analysis of their _____-sequences.

2. Wings of bats and birds serve the same function and are _____ structures.

3. Comparative _____ is the study of the similarities and differences in the structures of different species.

4. _____ demonstrate that during the evolution of the whale, the whale moved from land into the sea.

5. The human tail bone and appendix are _____ structures.

6. _____ structures are structures that are similar in related organisms because they were inherited from a common ancestor.

7. Comparative _____ is the study of the similarities and differences in the embryos of different species.

8. Early North American camels migrated to other places, some crossing a land bridge during the last _____.

9. The forelimbs of all mammals have the same basic bone _____.

10. _____ who find and study fossils are called paleontologists.

11. Peter and Rosemary Grant studied Darwin's _____ in the Galápagos Islands.

12. The biogeography of _____ yields some of the best evidence for evolution.

Lesson 10.2: Critical Writing

Name_____ **Class**_____ **Date**_____

Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.

Describe how fossils help us understand the past. Provide an example.

10.3 Microevolution and the Genetics of Populations

Lesson 10.3: True or False

Name_____ **Class**_____ **Date**_____

Write true if the statement is true or false if the statement is false.

_____ 1. The fossil record reflects macroevolution.

_____ 2. Population genetics is a combination of evolutionary theory and Darwinian genetics.

_____ 3. For a gene with two alleles, if the frequency of one allele is 0.65, the frequency of the other allele is 0.30.

_____ 4. Hardy-Weinberg equilibrium can exist only in populations undergoing normal natural selection.

_____ 5. A forest fire can result in a bottleneck effect.

_____ 6. Individuals with sickle-cell anemia have a high fitness because they are resistant to malaria.

_____ 7. Natural selection causes allele frequencies to change.

_____ 8. Microevolution occurs over a very long period of time within a population or species.

_____ 9. Mutation creates new genetic variation in a gene pool.

_____ 10. Hardy-Weinberg equilibrium can only occur in a very small population.

_____ 11. Inbreeding in certain populations, together with the founder effect, can result in rare phenotypes within the population.

_____ 12. Directional selection occurs when one of two extreme phenotypes is selected for.

_____ 13. Hardy-Weinberg equilibrium conditions rarely occur in real populations.

_____ 14. Emigration results in gene flow.

_____ 15. Disruptive selection occurs when phenotypes at both extremes of the phenotypic distribution are selected against.

Lesson 10.3: Critical Reading

Name_____ **Class**_____ **Date**_____

Read these passages from the text and answer the questions that follow.

Forces of Evolution

The conditions for Hardy-Weinberg equilibrium are unlikely to be met in real populations. The Hardy-Weinberg theorem also describes populations in which allele frequencies are not changing. By definition, such populations are not evolving. How does the theorem help us understand evolution in the real world?

From the theorem, we can infer factors that cause allele frequencies to change. These factors are the forces of evolution. There are four such forces: mutation, gene flow, genetic drift, and natural selection.

Mutation

Mutation creates new genetic variation in a gene pool. It is how all new alleles first arise. In sexually reproducing species, the mutations that matter for evolution are those that occur in gametes. Only these mutations can be passed to offspring. For any given gene, the chance of a mutation occurring in a given gamete is very low. Thus, mutations alone do not have much effect on allele frequencies. However, mutations provide the genetic variation needed for other forces of evolution to act.

Gene Flow

Gene flow occurs when people move into or out of a population. If the rate of migration is high, this can have a significant effect on allele frequencies. Both the population they leave and the population they enter may change.

During the Vietnam War in the 1960s and 1970s, many American servicemen had children with Vietnamese women. Most of the servicemen returned to the United States after the war. However, they left copies of their genes behind in their offspring. In this way, they changed the allele frequencies in the Vietnamese gene pool. Was the gene pool of the American population also affected? Why or why not?

Genetic Drift

Genetic drift is a random change in allele frequencies that occurs in a small population. When a small number of parents produce just a few offspring, allele frequencies in the offspring may differ, by chance, from allele frequencies in the parents. This is like tossing a coin. If you toss a coin just a few times, you may by chance get more or less than the expected 50 percent heads or tails. In a small population, you may also by chance get different allele frequencies than expected in the next generation. In this way, allele frequencies may drift over time. Genetic drift occurs under two special conditions. They are called bottleneck effect and founder effect.

1. Bottleneck effect occurs when a population suddenly gets much smaller. This might happen because of a natural disaster, such as a forest fire. By chance, allele frequencies of the survivors may be different from those of the original population.
2. Founder effect occurs when a few individuals start, or found, a new population. By chance, allele frequencies of the founders may be different from allele frequencies of the population they left.

Questions

1. What are the forces of evolution?

2. Describe the type of mutations that affect evolution. Why?

3. Was the gene pool of the American population also affected by the gene flow described above? Why or why not?

4. What is genetic drift?

5. Describe one special condition under which genetic drift occurs.

Lesson 10.3: Multiple Choice

Name_____ **Class**_____ **Date**_____

Circle the letter of the correct choice.

1. The main difference between macroevolution and microevolution is
   (a) the time frame of the evolutionary process.
   (b) the species that evolve during each.
   (c) that microevolution is only for small organisms, and macroevolution is for large organisms.
   (d) all of the above
2. Which of the following statements is correct?
   (a) Individuals do not evolve, genes do evolve.
   (b) Individuals do not evolve, populations do evolve.
   (c) Populations do not evolve, individuals do evolve.
   (d) Populations do not evolve, species do evolve.
3. Which of the following statements is true concerning mutations? (1) Mutations are how all new alleles first arise. (2) Mutations create new genetic variation in a gene pool. (3) Only mutations that occur in gametes influence evolution. (4) Mutations really do not have much influence on allele frequencies.
   (a) 1 and 2
   (b) 2 and 4
   (c) 1, 2, and 3
   (d) 1, 2, 3, and 4
4. In a population with 100 members, the total number of copies of each gene in the population is
   (a) 50.
   (b) 100.
   (c) 200.
   (d) 400.
5. In a population with 100 members, if there are 120 dominant alleles, how many recessive alleles are there?
   (a) 60
   (b) 80
   (c) 120
   (d) 240
6. In a population with 100 members, if 9 individuals have the recessive phenotype, how many individuals are heterozygous?
   (a) 9
   (b) 21
   (c) 42
   (d) 70
7. The forces of evolution include
   (a) natural selection.
   (b) gene drift.
   (c) genetic flow.
   (d) all of the above

8. Which of the following describes disruptive selection?
   (a) Selection that occurs when one of two extreme phenotypes is selected for.
   (b) Selection that occurs when phenotypes at both extremes of the phenotypic distribution are selected against.
   (c) Selection that occurs when phenotypes in the middle of the range are selected against.
   (d) Selection that occurs when one phenotype is disrupted and goes extinct.

Lesson 10.3: Vocabulary I

Name_____ **Class**_____ **Date**_____

Match the vocabulary word with the proper definition.

Definitions

_____ 1. consists of all the genes of all the members of the population

_____ 2. creates new genetic variation in a gene pool

_____ 3. occurs over geologic time above the level of the species

_____ 4. occurs when one of two extreme phenotypes is selected for

_____ 5. refers to differences between the phenotypes of males and females of the same species

_____ 6. occurs when phenotypes in the middle of the range are selected against

_____ 7. occurs when people move into or out of a population

_____ 8. occurs over a relatively short period of time within a population or species

_____ 9. occurs when phenotypes at both extremes of the phenotypic distribution are selected against

_____ 10. how often an allele occurs in a gene pool relative to the other alleles for that gene

_____ 11. the science that focuses on evolution within populations

_____ 12. shows that allele frequencies do not change in a population if certain conditions are met

Terms

a. allele frequency

b. directional selection

c. disruptive selection

d. gene flow

e. gene pool

f. Hardy-Weinberg theorem

g. macroevolution

h. microevolution

i. mutation

j. population genetics

k. sexual dimorphism

l. stabilizing selection

Lesson 10.3: Vocabulary II

Name_____ **Class**_____ **Date**_____

Fill in the blank with the appropriate term.

1. _____ occurs over a relatively short period of time within a population or species.
2. _____ occurs over geologic time above the level of the species.
3. The _____ theorem shows that allele frequencies do not change in a population if certain conditions are met.
4. Natural selection occurs when there are differences in _____ among members of a population.
5. Genetic _____ is a random change in allele frequencies that occurs in a small population.
6. The gene _____ consists of all the genes of all the members of the population.
7. Mutation creates new _____ variation in a gene pool.
8. Gene _____ occurs when people move into or out of a population.
9. Allele _____ is how often an allele occurs in a gene pool.
10. _____ selection occurs when one of two extreme phenotypes is selected for.
11. _____ selection occurs when phenotypes in the middle of the range are selected against.
12. Population _____ focuses on evolution within populations.

Lesson 10.3: Critical Writing

Name_____ **Class**_____ **Date**_____

Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.

Distinguish between microevolution and macroevolution.

10.4 Macroevolution and the Origin of Species

Lesson 10.4: True or False

Name_____ **Class**_____ **Date**_____

Write true if the statement is true or false if the statement is false.

_____ 1. The process by which a new species evolves is called speciation.

_____ 2. For a new species to arise, members of a species must no longer be able to breed with each other.

_____ 3. Coevolution occurs when members of one species evolve independently of a symbiotic species.

_____ 4. Darwin believed evolution occurred both through gradualism and punctuated equilibrium.

_____ 5. Geographic separation usually leads to sympatric speciation.

_____ 6. A new river separating a population can result in allopatric speciation.

_____ 7. When geologic and climatic conditions are stable, punctuated equilibrium occurs.

_____ 8. The hummingbird and the flower it pollinates have coevolved.

_____ 9. When geologic and climatic conditions are changing, evolution may occur more quickly. This is known as gradualism.

_____ 10. Hawthorn flies are undergoing geographic separation.

_____ 11. During coevolution, as one species changes, the other species goes extinct.

_____ 12. The Kaibab squirrel is in the process of allopatric speciation.

_____ 13. A new mountain range or canyon separating a population can result in sympatric speciation.

_____ 14. A species is a group of organisms that can breed and produce fertile offspring.

_____ 15. Punctuated equilibrium is a relatively slow process.

Lesson 10.4: Critical Reading

Name_____ **Class**_____ **Date**_____

Read these passages from the text and answer the questions that follow.

Introduction

Macroevolution is evolution over geologic time above the level of the species. One of the main topics in macroevolution is how new species arise. The process by which a new species evolves is called **speciation**. How does speciation occur? How does one species evolve into two or more new species?

Origin of Species

To understand how a new species forms, it's important to review what a species is. A species is a group of organisms that can breed and produce fertile offspring together in nature. For a new species to arise, some members of a species must become reproductively isolated from the rest of the species. This means they can no longer interbreed with other members of the species. How does this happen? Usually they become geographically isolated first.

Allopatric Speciation

Assume that some members of a species become geographically separated from the rest of the species. If they remain separated long enough, they may evolve genetic differences. If the differences prevent them from interbreeding with members of the original species, they have evolved into a new species. Speciation that occurs in this way is called **allopatric speciation**.

Sympatric Speciation

Less often, a new species arises without geographic separation. This is called **sympatric speciation**. The following example shows one way this can occur.

1. Hawthorn flies lay eggs in hawthorn trees. The eggs hatch into larvae that feed on hawthorn fruits. Both the flies and trees are native to the U.S.
2. Apple trees were introduced to the U.S. and often grow near hawthorn trees. Some hawthorn flies started to lay eggs in nearby apple trees. When the eggs hatched, the larvae fed on apples.
3. Over time, the two fly populations — those that fed on hawthorn trees and those that preferred apple trees — evolved reproductive isolation. Now they are reproductively isolated because they breed at different times. Their breeding season matches the season when the apple or hawthorn fruits mature.
4. Because they rarely interbreed, the two populations of flies are evolving other genetic differences. They appear to be in the process of becoming separate species.

Questions

1. What is a species?

2. What is speciation?

3. How do new species arise?

4. Describe allopatric speciation.

5. Describe sympatric speciation. Provide an example.

Lesson 10.4: Multiple Choice

Name_____ **Class**_____ **Date**_____

Circle the letter of the correct choice.

1. Which statement best describes allopatric speciation?
   (a) Speciation that occurs without reproductive separation.
   (b) Speciation that occurs without geographic separation.
   (c) Speciation that occurs when some members of a species become geographically separated from the rest of the species.
   (d) Speciation that occurs when some members of a species become reproductively separated from the rest of the species.
2. Which statement best describes sympatric speciation?
   (a) Speciation that occurs without reproductive separation.
   (b) Speciation that occurs without geographic separation.
   (c) Speciation that occurs when some members of a species become geographically separated from the rest of the species.
   (d) Speciation that occurs when some members of a species become reproductively separated from the rest of the species.
3. Which is the best definition of a "species"?
   (a) A group of organisms that can breed and produce fertile offspring together.
   (b) A group of organisms that can breed and produce infertile offspring together.
   (c) A group of organisms that can breed together.
   (d) A group of organisms that look and act similar.
4. An example of coevolution would be
   (a) the evolution of wings in bats and birds.
   (b) the toad and the flies they eat.
   (c) the hummingbird and the tubular flower it pollinates.
   (d) all of the above
5. Which statement is true concerning gradualism? (1) Gradualism occurs when geologic and climatic conditions are stable. (2) Darwin thought evolution occurred this way. (3) This type of evolution may result in long periods of little change.
   (a) 1 only
   (b) 1 and 2
   (c) 1 and 3
   (d) 1, 2, and 3
6. Punctuated equilibrium is
   (a) well supported by the fossil record.
   (b) a slow form of evolution.
   (c) how Darwin proposed evolution occurs.
   (d) none of the above
7. The hawthorn fly
   (a) is undergoing allopatric speciation.
   (b) can live on either hawthorn trees or apple trees.
   (c) has been geographically separated by the planting of new tree species.

(d) all of the above

8. The Kaibab squirrel

(a) is undergoing allopatric speciation.
(b) is undergoing sympatric speciation.
(c) were geographically separated from Abert's squirrels by the formation of the Grand Canyon.
(d) both a and c

Lesson 10.4: Vocabulary I

Name_____ **Class**_____ **Date**_____

Match the vocabulary word with the proper definition.

Definitions

_____ 1. a group of organisms that can breed and produce fertile offspring

_____ 2. when a new species arises without geographic separation

_____ 3. the process by which a new species evolves

_____ 4. when some members of a species become geographically separated from the rest of the species

_____ 5. evolution over geologic time above the level of the species

_____ 6. when species in symbiotic relationships evolve together

_____ 7. evolution that occurs gradually

_____ 8. evolution that occurs quickly

Terms

a. allopatric speciation

b. coevolution

c. gradualism

d. macroevolution

e. punctuated equilibrium

f. speciation

g. species

h. sympatric speciation

Lesson 10.4: Vocabulary II

Name_____ **Class**_____ **Date**_____

Fill in the blank with the appropriate term.

1. _____ is slow, gradual evolution.

2. _____ equilibrium is illustrated by bursts of rapid change.

3. The very long mouth part of the hummingbird has _____ with the tubular flower it pollinates.

4. _____ speciation is speciation without geographic separation.

5. _____ speciation may occur when some members of a species become geographically separated from the rest of the species.

6. Evolution occurs in response to a change in the _____.

7. A _____ is a group of organisms that can breed and produce fertile offspring.

8. New species arise in the process of _____.

9. In coevolution, as one species changes, the other species must also change in order to _____.

10. Macroevolution is evolution over _____ time.

Lesson 10.4: Critical Writing

Name_____ **Class**_____ **Date**_____

Thoroughly answer the question below. Use appropriate academic vocabulary and clear and complete sentences.

Describe two ways that new species may evolve.