Section 15–1 The Puzzle of Life's Diversity

(pages 369–372)

Key Concepts

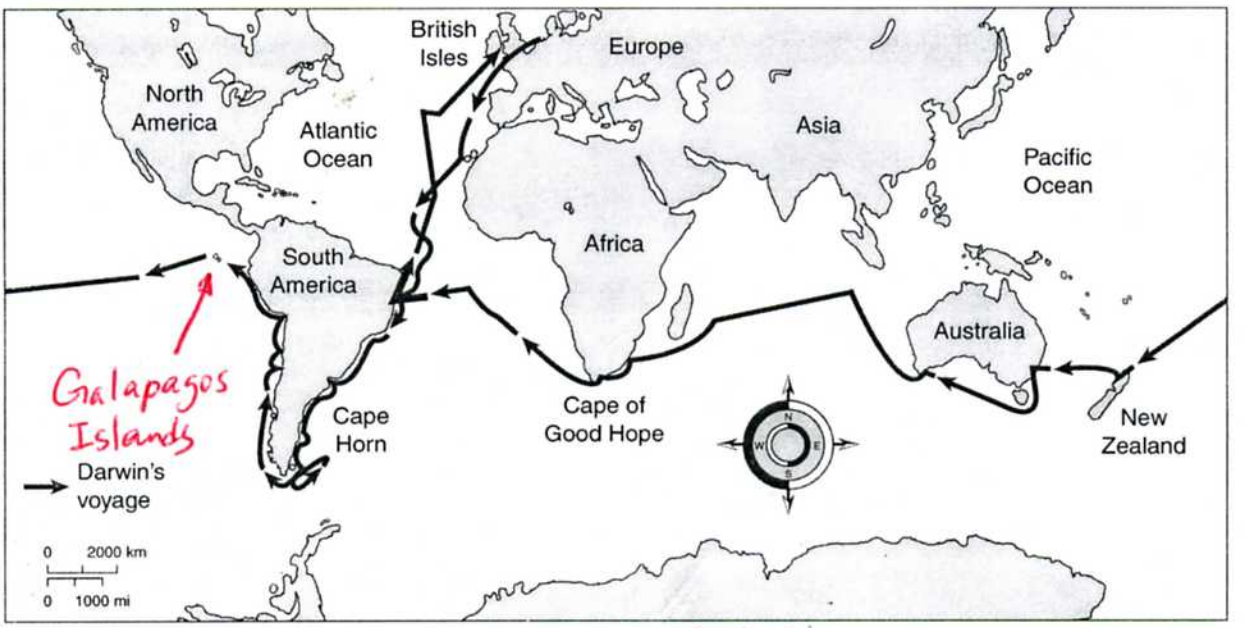
- What was Charles Darwin's contribution to science?
- What pattern did Darwin observe among organisms of the Galápagos Islands?

Introduction (page 369)

1. The process by which modern organisms have descended from ancient organisms is called evolution.
2. A well-supported explanation of phenomena that have occurred in the natural world is a(an) theory.

Voyage of the *Beagle* (pages 369–370)

3. Circle the letter of each sentence that is true about Charles Darwin.
   a. He was born in 1809.
   b. He was an English naturalist.
   c. He was ~~42~~ 32 when he began the voyage on the *Beagle*.
   d. The voyage lasted five years and took him around the world.
4. Label the Galápagos Islands on the map below.



5. Is the following sentence true or false? Darwin ~~was looking~~ looked for a scientific explanation for the diversity of life on Earth. sort of true

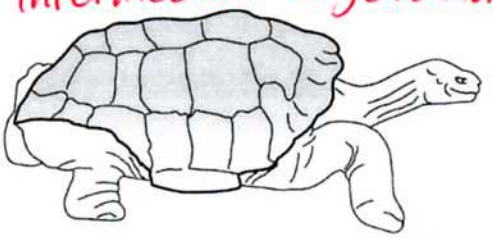
Page 1 left

Galápagos Tortoises

When Charles Darwin visited the Galápagos Islands, he discovered that similar animals that lived on separate islands had different features.

Look at the drawings of tortoises. Use the drawings to answer the questions.

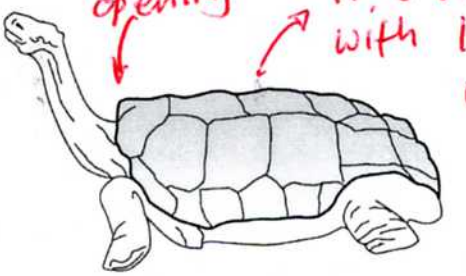
lived on island with intermediate vegetation



Pinta Island tortoise

high opening

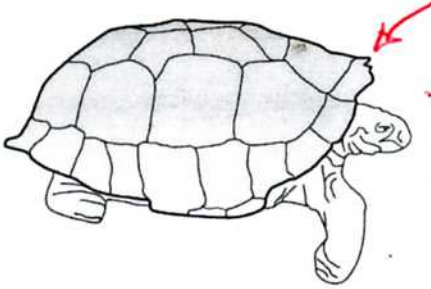
lived on island with little/sparse vegetation so have to reach all available vegetation inorder to survive



Hood Island tortoise

low opening

lived on island with lots/abundant vegetation



Isabela Island tortoise

1. The tortoises eat plants. On one island, plants grow very close to the ground. Which island is this most likely to be? Circle the correct answer.

Isabela Island Hood Island

2. Explain your answer to question 1. Why did you choose the island you did?

low opening shell = tortoises do not need to reach up to feed & survive

3. Which island most likely has sparse vegetation that is hard to reach? Circle the correct answer.

Pinta Island Hood Island

because there was abundant vegetation

Page 1 right

Darwin's Observations (pages 370–372)

6. Circle the letter of each observation that Darwin made.

   a. An enormous number of species inhabit Earth.

   b. Many organisms seem to be ~~poorly~~ very well suited to their environment.

   c. The ~~same~~ different sorts of animals are always found in the same ecosystems in different parts of the world.

   d. Some species that lived in the past no longer live on Earth.

7. The preserved remains of ancient organisms are called fossils.

8. As Darwin studied fossils, what new questions arose?
   (1) why did so many species disappear?
   (2) how were living species related to each other?

9. How did Darwin explain differences in shell shape of tortoises from Hood Island and Isabela Island? (1) shell shape was related to the amount of vegetations on different islands
   (2) amount of vegetation was related to climate & rain

10. Darwin observed that small brown birds on the Galápagos Islands differed in the shape of their beaks/bills.

The Journey Home (page 372)

11. What did Darwin think about on his journey home to England?
    the differences in characteristics of animals that lived in different places

12. After he returned to England, what hypothesis did Darwin develop to explain his findings? animals of different islands were once members of the same species.

Section 15–2 Ideas That Shaped Darwin's Thinking (pages 373–377)

Key Concepts

- How did Hutton and Lyell describe geological change?
- According to Lamarck, how did species evolve?
- What was Malthus's theory of population growth?

An Ancient, Changing Earth (pages 374–375)

1. Two scientists who helped Darwin and others recognize how old Earth is were Hutton and Lyell.

Page 2 left

2. Circle the letter of each idea that was proposed by James Hutton.

   a. Earth is a few ~~thousand~~ millions years old. (later it became billions of years)

   b. Layers of rock are moved by forces beneath Earth's surface.

   c. Most geological processes operate extremely slowly.

   d. The processes that changed Earth in the past are ~~different from~~ the same as the processes that operate in the present.

3. Circle the letter of each sentence that is true about Lyell's work.

   a. His book, *Principles of Geology*, was published ~~after~~ before Darwin returned from his voyage.

   b. His work explained how awesome geological features could be built up or torn down over long periods of time.

   c. His publications helped Darwin appreciate the significance of the geological phenomena that he had observed.

   d. He stressed that scientists must explain past events in terms of processes that they can actually observe.

4. In what two ways did an understanding of geology influence Darwin?

   (1) Earth can change, so life/living things can change

   (2) Earth was old enough for evolution to occur

Lamarck's Evolution Hyphotheses (page 376)

5. Is the following sentence true or false? Lamarck was among the first scientists to recognize that living things have changed over time. True

6. Is the following sentence true or false? Lamarck proposed that all organisms have an innate tendency toward complexity and perfection. True (But the idea was wrong)

7. How did Lamarck propose that species change over time?

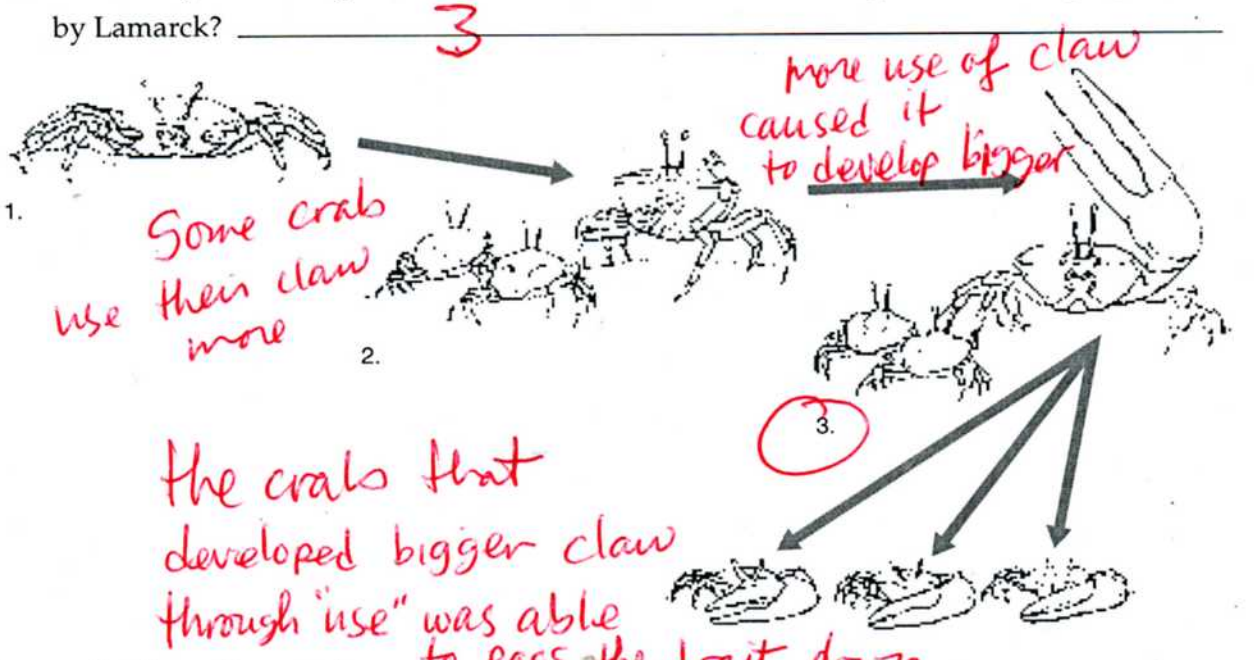
   Use & disuse of body caused genetic changes that were inherited by offspring

8. How did Lamarck pave the way for the work of later biologists?

   He proposed his ideas in a way that can be proven true or false by experiments

Page 2 right

9. Which step in the diagram below shows the inheritance of acquired traits as proposed by Lamarck? 3



Population Growth (page 377)

10. Circle the letter of each sentence that is true about Thomas Malthus.
   a. He was an important influence on Darwin.
   b. He was an English ~~naturalist~~ economist
   c. He believed that war, famine, and disease limit the growth of populations.
   d. His views were influenced by conditions in ~~twentieth-century~~ 18th century England.
11. Is the following sentence true or false? The overwhelming majority of a species' offspring survive. False / most offspring die

Section 15–3 Darwin Presents His Case

(pages 378–386)

Key Concepts

- How is natural variation used in artificial selection?
- How is natural selection related to a species' fitness?
- What evidence of evolution did Darwin present?

Publication of *On the Origin of Species* (pages 378–379)

1. Is the following sentence true or false? When Darwin returned to England, he rushed to publish his thoughts about evolution. F
2. The naturalist whose essay gave Darwin an incentive to publish his own work was Wallace.

Page 3 left

3. Circle the letter of each sentence that is true about Darwin's book *On the Origin of Species*.

a. It was published in ~~1869~~ 1859.

b. It was ignored when it was first published. it was a huge block buster

c. It contained evidence for evolution.

d. It described natural selection.

Inherited Variation and Artificial Selection (page 379)

4. Differences among individuals of a species are referred to as Variation.

5. Is the following sentence true or false? Genetic variation is found ~~only in wild~~ all organisms in nature. F

6. Circle the letter of each sentence that is true about artificial selection.

a. It is also called selective breeding.

b. It occurs when humans select natural variations they find useful.

c. It produces organisms that look very different from their ancestors.

d. It ~~is no~~ longer used today. is still used

Evolution by Natural Selection (pages 380–382)

7. What was Darwin's greatest contribution? Theory of evolution based on scientific method

Match each term with its definition.

	Terms	Definitions
C	8. fitness	a. Any inherited characteristic that increases an organism's chance of survival
A	9. adaptation	b. Survival of the fittest
B	10. natural selection	c. The ability of an individual to survive and reproduce in its specific environment

11. What does the phrase *struggle for existence* mean? Organisms compete with others to survive & reproduce

12. Is the following sentence true or false? Adaptations can be physical characteristics ~~but not more complex features such as~~ and behavior. F

13. Explain what Darwin meant by the phrase *survival of the fittest*. Only some organisms of a population will survive & reproduce, because they have the most adaptation.

14. Circle the letter of each sentence that is true about natural selection.

a. It selects traits that increase fitness.

b. It takes place without human control.

c. It can be observed directly in nature.

d. It leads to an increase in a species' fitness.

Page 3 right.

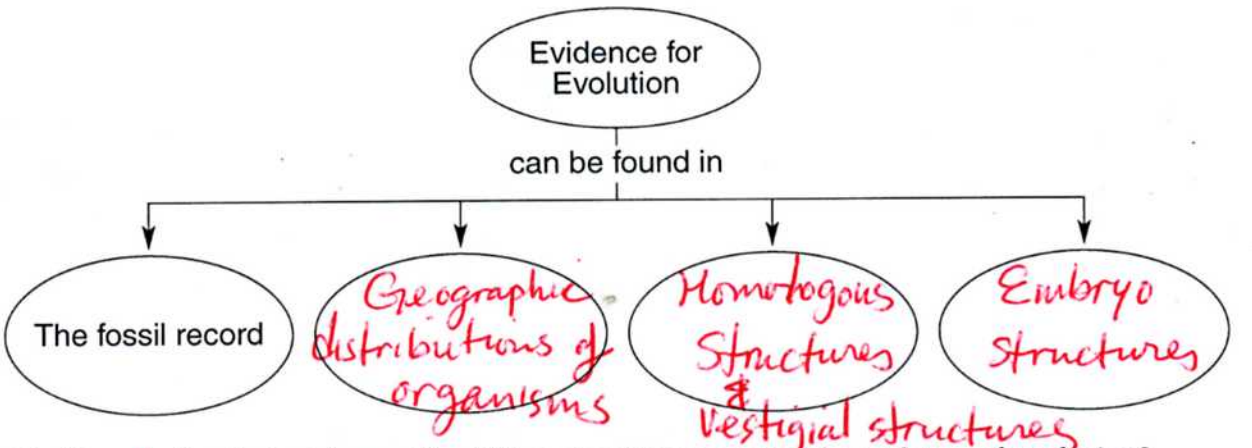
15. The principle that living species descend, with changes, from other species over time is referred to as descent with modification.

16. The principle that all species were derived from common ancestors is known as Common descent.

Evidence of Evolution (pages 382–385)

17. Is the following sentence true or false? Darwin argued that living things have been evolving on Earth for ~~thousands~~ millions of years. F

18. Complete the concept map.



19. How do fossils that formed in different rock layers provide evidence of evolution?
fossils of different layers show transitions as organisms evolve through intermediate stages

20. Circle the letter of the way Darwin explained the distribution of finch species on the Galápagos Islands.
   a. They had descended with modification from a common mainland ancestor. single ancestor species
   b. They had descended with modification from ~~several different mainland~~ ancestors.
   c. They had remained ~~un~~changed since arriving on the Galápagos from the mainland.
   d. They had become more ~~similar~~ different to one another after arriving on the Galápagos.

21. How did Darwin explain the existence of similar but unrelated species?
they lived in similar environment / under similar environmental conditions

22. Structures that have different mature forms but develop from the same embryonic tissues are called Homologous Structures.

23. Is the following sentence true or false? Homologous structures provide strong evidence that all four-limbed vertebrates have descended, with modifications, from common ancestors. T – same bone combination but with different shapes

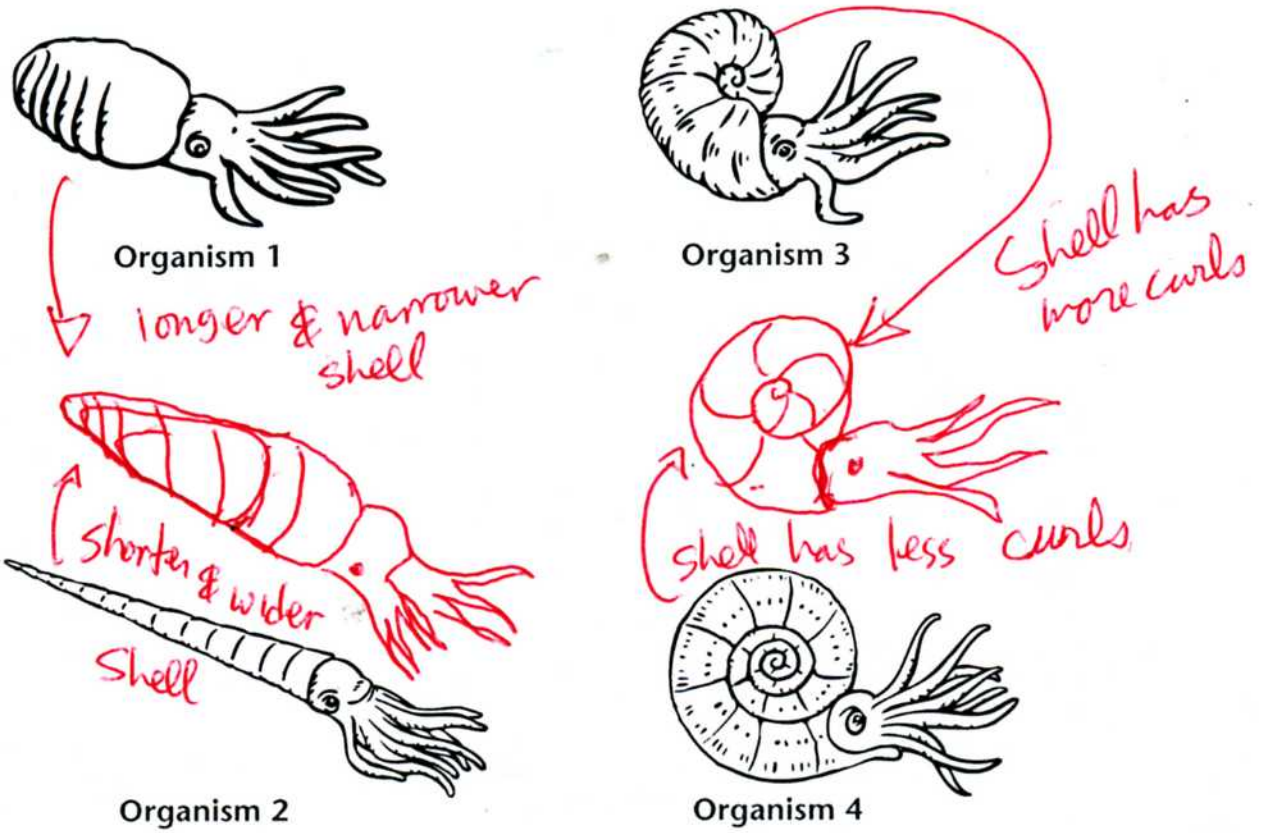
24. Organs that are so reduced in size that they are just vestiges, or traces, of homologous organs in other species are called Vestigial Structures

Page 4 left

The Fossil Record

In the fossil record, an intermediate form is a fossil that shows some characteristics of an earlier related organism and some characteristics of a later related organism. The illustrations below show organisms whose fossils make up part of the fossil record. The organisms are in order from oldest (organism 1) to most recent (organism 4).

Draw an animal that might have been an intermediate form between organism 1 and organism 2. Then, draw an animal that might have been an intermediate form between organism 3 and organism 4.



Use the illustrations to answer the questions.

1. Describe one change you see between organism 1 and organism 2.

shell becomes longer & more narrow & pointed

2. How might these fossils provide evidence for evolution?

transition of intermediate stages are visible

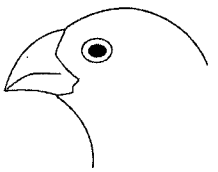
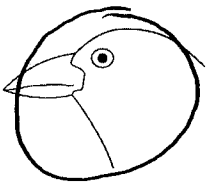
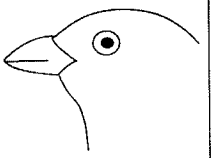
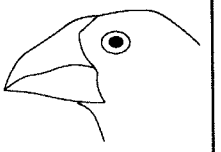
Page 4 right

Galápagos Island Finches

Finches in the Galápagos Islands have beaks adapted to eat the foods available in the birds' habitats.

Use the words below to match each finch with the food it is adapted to eat. The first one is done for you.

Insects that live inside dead wood Large, thick-shelled seeds Small seeds

Galápagos Islands Finches				
Shape of Head and Beak				
Main Food	Fruits	insects that live in dead branches	Small seeds	Large thick-shelled seeds
Feeding Adaptation	Parrotlike beak	Uses cactus spines	Pointed crushing beak	Large crushing beak
Habitat	Trees	Trees	Ground	Ground

Use the table to answer the questions.

1. How does the large crushing beak help the fourth finch survive?
   it can eat seeds the other finches cannot
2. Circle the finch that would be least likely to survive if the insect population decreased.

Page 5 left

Evidence for Evolution

Use the words below and your knowledge of the evidence for evolution to complete the table. The first one has been done for you.

fossil record geographic distribution of living species similarities in embryo development

Type of Evidence	What It Reveals
homologous body structures	Animals with different limb structures that develop from the same embryonic tissues evolved from a common ancestor.
similarities in embryo development	Vertebrates share a common ancestor, as shown by how these organisms develop.
fossil records	Intermediate forms show that organisms have evolved over time.
Geographic distribution of Living Species	Species have adapted over time to local conditions.

Summary of Darwin's Theory (page 386)

25. Circle the letter of each idea that is part of Darwin's theory of evolution.

(a) There is variation in nature.

b. ~~Fewer organisms~~ more offspring are produced than can survive.

(c) There is a struggle for existence.

(d) Species change over time.

26. According to Darwin's theory, what happens to individuals whose characteristics are not well suited to their environment? they do not survive
they do not reproduce

27. Darwin believed that all organisms on Earth are united into a single tree of life by descent with modification/evolution

Page 5 ought

Section 16–1 Genes and Variation (pages 393–396)

Key Concepts

- What are the main sources of heritable variation in a population?
- How is evolution defined in genetic terms?
- What determines the numbers of phenotypes for a given trait?

Introduction (page 393)

1. Is the following sentence true or false? Mendel's work on inheritance was published ~~after~~ during Darwin's lifetime. F
2. Which two important factors was Darwin unable to explain without an understanding of heredity? (1) how traits are passed down from parents to offspring (2) how variation was created

How Common Is Genetic Variation? (page 393)

3. All organisms have additional variations that is "invisible" because it involves small differences in biochemical processes.

Variation and Gene Pools (page 394)

4. A group of individuals of the same species that interbreed is a(an) species.
5. All of the genes in a population are called a(an) gene pool.
6. Is the following sentence true or false? A gene pool typically contains just ~~one~~ all alleles for each inheritable trait. F
7. The number of times that an allele occurs in a gene pool compared with the number of times other alleles for the same gene occur is called the relative frequency of the allele.

Sources of Genetic Variation (pages 394–395)

8. What is a mutation? (1) an change in DNA sequence
9. Why do mutations occur? (1) mistakes during DNA replication (2) radiation & certain chemicals (3) random forces
10. Circle the letter of each choice that is true about mutations.
    (a) They do not always change an amino acid. silent mutation
    b. They always affect lengthy segments of a chromosome. ← some (frame-shift)
    c. They always affect an organism's phenotype. ← some (harmful or beneficial)
    d. They always affect an organism's fitness.
11. Is the following sentence true or false? Most heritable differences are due to gene shuffling that occurs during the production of gametes. True

Page 6 left

gene shuffling = gene recombination due to meiosis and fertilization

12. Circle the letter of each choice that is true about sexual reproduction.
    a. It is a major source of variation in many populations.
    b. It can produce many different phenotypes.
    c. It can produce many different genetic combinations.
    d. It can change the relative frequency of alleles in a population. → Sexual selection will do this

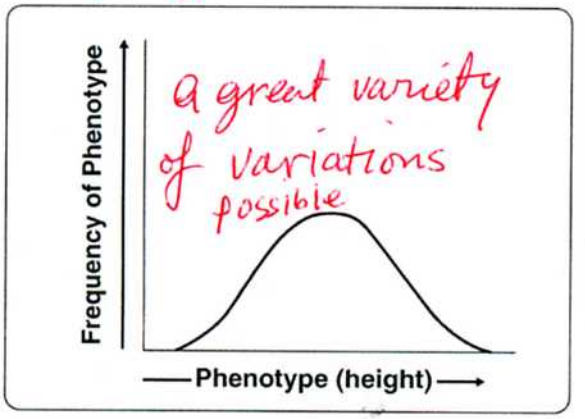
Single-Gene and Polygenic Traits (pages 395–396)

13. Is the following sentence true or false? The number of phenotypes produced for a given trait depends on how many genes control the trait. F / allele relationship

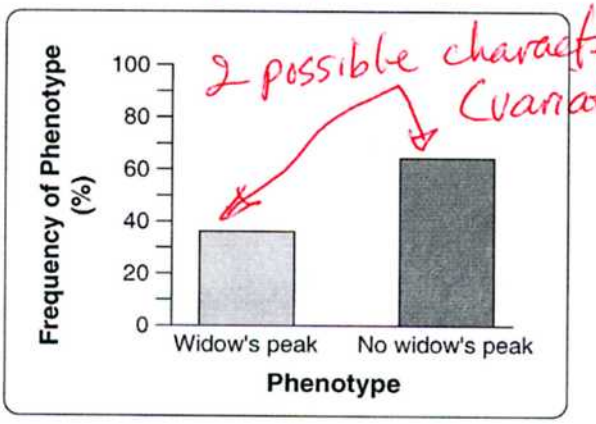
14. Is the following sentence true or false? Most traits are controlled ~~by a single gene.~~ F / polygenic

15. Label the two graphs to show which one represents a single-gene trait and which one represents a polygenic trait.

Polygenic trait



Single gene trait.



Section 16–2 Evolution as Genetic Change

(pages 397–402)

Key Concepts

- How does natural selection affect single-gene and polygenic traits?
- What is genetic drift?
- What is the Hardy-Weinberg principle?

Natural Selection on Single-Gene Traits (pages 397–398)

1. Is the following sentence true or false? Natural selection on single-gene traits ~~cannot~~ Can lead to changes in allele frequencies. F

2. If a trait made an organism less likely to survive and reproduce, what would happen to the allele for that trait? its relative frequency in the gene pool will decrease, then disappear

3. If a trait had no effect on an organism's fitness, what would happen to the allele for that trait? its relative frequency in the gene pool will remain constant

Page 6 right

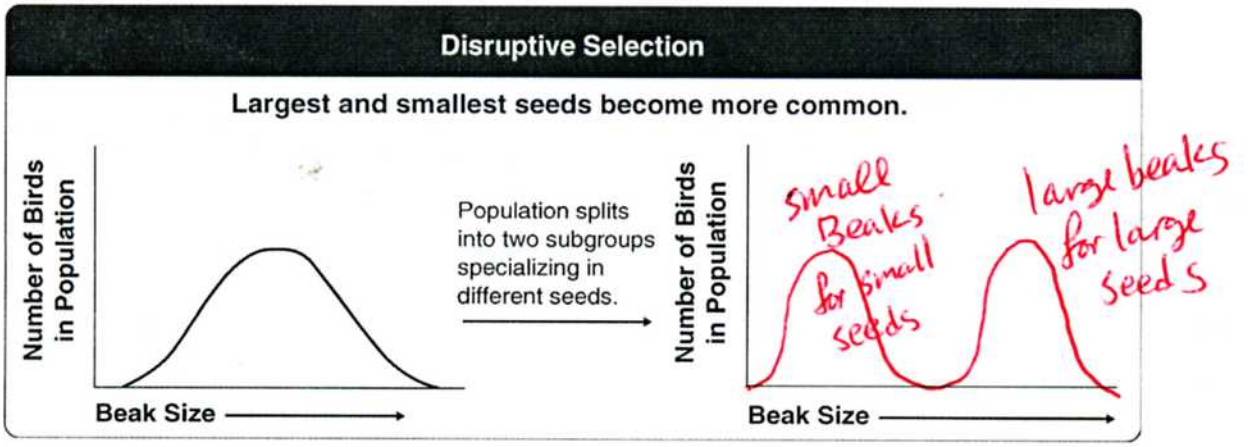
Natural Selection on Polygenic Traits (pages 398–399)

4. List the three ways that natural selection can affect the distributions of phenotypes.
   a. Stabilizing
   b. directional
   c. disruptive

Match the type of selection with the situation in which it occurs.

	Type of Selection	Situation
B	5. Directional	a. Individuals at the upper and lower ends of the curve have higher fitness than individuals near the middle.
C	6. Stabilizing	b. Individuals at one end of the curve have higher fitness than individuals in the middle or at the other end.
A	7. Disruptive	c. Individuals near the center of the curve have higher fitness than individuals at either end.

8. An increase in the average size of beaks in Galápagos finches is an example of directional selection.
9. Is the following sentence true or false? The weight of human infants at birth is under the influence of ~~disruptive~~ selection. F : stabilizing
10. Draw the missing graph to show how disruptive selection affects beak size.



Genetic Drift (page 400)

11. Is the following sentence true or false? Natural selection is the ~~only source~~ of evolutionary change. F : there's random change
12. Random change in allele frequencies in small populations is called Genetic drift.
13. A situation in which allele frequencies change as a result of the migration of a small subgroup of a population is known as the founder effect.
14. What is an example of the founder effect? fruit fly species on separate islands

page 7 left

Evolution Versus Genetic Equilibrium (page 401–402)

15. What does the Hardy-Weinberg principle state?
allele frequency will not change (remain constant) if mating is random and the trait does not increase or decrease fitness

16. The situation in which allele frequencies remain constant is called genetic equilibrium

17. List and describe the five conditions required to maintain genetic equilibrium.

a. mating is random

b. population is large

c. no immigration & no emigration

d. no mutation

e. no natural selection

Section 16–3 The Process of Speciation

(pages 404–410)

Key Concepts

- What factors are involved in the formation of new species?
- Describe the process of speciation in the Galápagos finches.

Introduction (page 404)

1. What is speciation? forming new species from existing species

Isolating Mechanisms (pages 404–405)

2. Is the following sentence true or false? Individuals in different species can have the same gene pool. F / never / gene pool differences = species

3. What does it mean for two species to be reproductively isolated from each other?
individuals from the two species cannot mate with each other & produce fertile offspring

4. What must happen in order for new species to evolve? Reproductive isolation

5. List three ways that reproductive isolation occurs.

a. Behavioral

b. Geographic

c. Temporal

Page 7 right

6. When does behavioral isolation occur? mating/courtship behaviors are different

7. Is the following sentence true or false? Eastern and Western meadowlarks are an example of behavioral isolation. T - different songs are used

8. When does geographic isolation occur? rivers, mountains, physical barriers are present

9. Abert and Kaibab squirrels in the Southwest are an example of Geographic isolation.

10. Is the following sentence true or false? Geographic barriers guarantee the formation of new species. F some individuals might overcome the barriers

11. What is an example of temporal isolation? mating/courtship seasons are different

Testing Natural Selection in Nature (pages 406–407)

12. Is the following sentence true or false? The basic mechanisms of evolutionary change ~~cannot~~ can be observed in nature. T

13. Circle the letter of each hypothesis about the evolution of Galápagos finches that was ~~tested~~ by the Grants.

   a. The finches' beak size and shape has enough inheritable variation to provide raw material for natural selection.

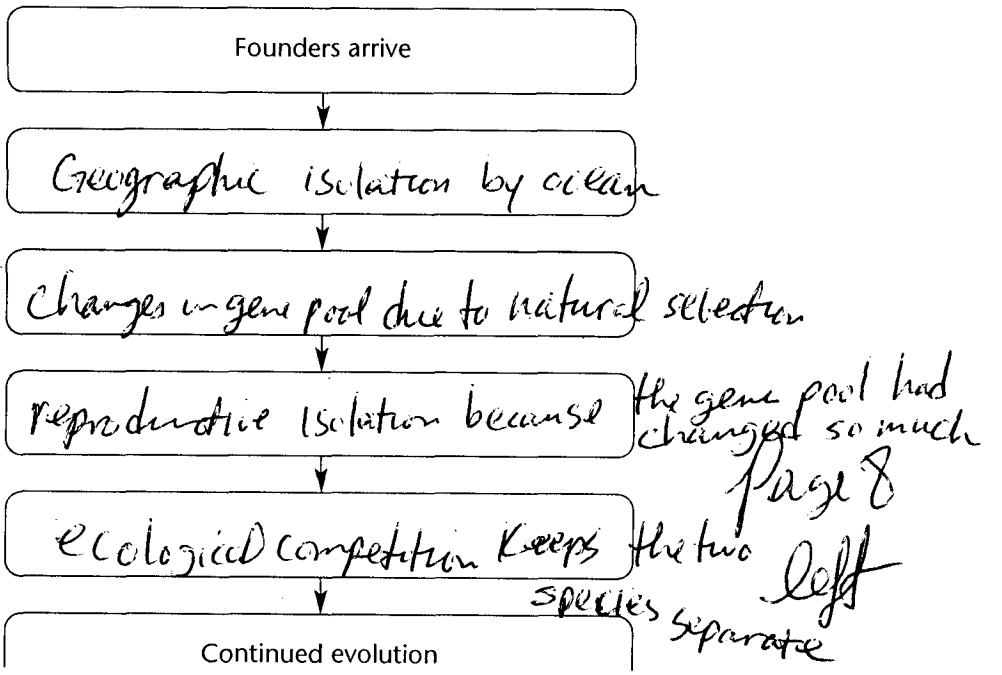
   b. The different finch species are the descendants of a common mainland ancestor. Grants studied speciation

   c. Differences in the finches' beak size and shape produce differences in fitness that cause natural selection to occur.

   d. The evolution of the finches is proceeding ~~slowly and gradually~~ rapidly.

Speciation in Darwin's Finches (pages 408–409)

14. Complete the flowchart to show how speciation probably occurred in the Galápagos finches.



Page 8 left

15. How could differences in beak size lead to reproductive isolation?

Birds mate with other birds with similar beaks
Birds move to/live where suitable food is plentiful

Studying Evolution Since Darwin (page 410)

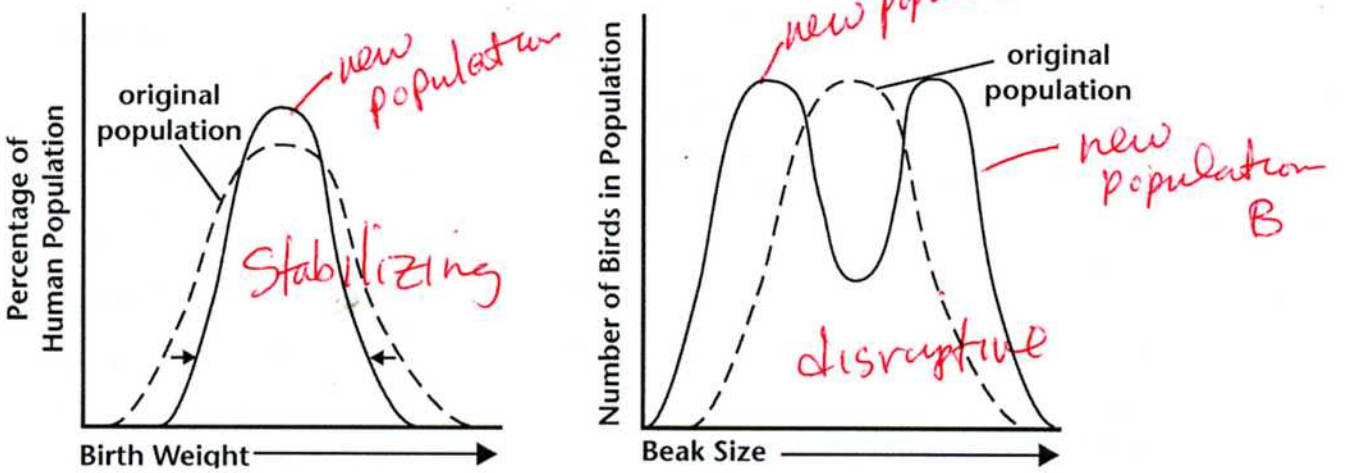
16. Why is the study of evolution important?

It explains how living species have come to be

Stabilizing and Disruptive Selection

In most populations, a trait that has higher fitness leads to greater numbers of organisms with that trait. On the graphs, dotted lines represent the original population. The solid lines represent the population after selection has taken place.

Identify whether each graph shows stabilizing selection *or* disruptive selection. *Write the type of selection shown below each graph.*



Use the graphs to answer the questions.

1. Under which type of selection do organisms in the middle of the curve have the highest fitness? Circle the correct answer.

disruptive stabilizing

2. In disruptive selection, organisms represented by which part of the curve have the lowest fitness? Circle the correct answer.

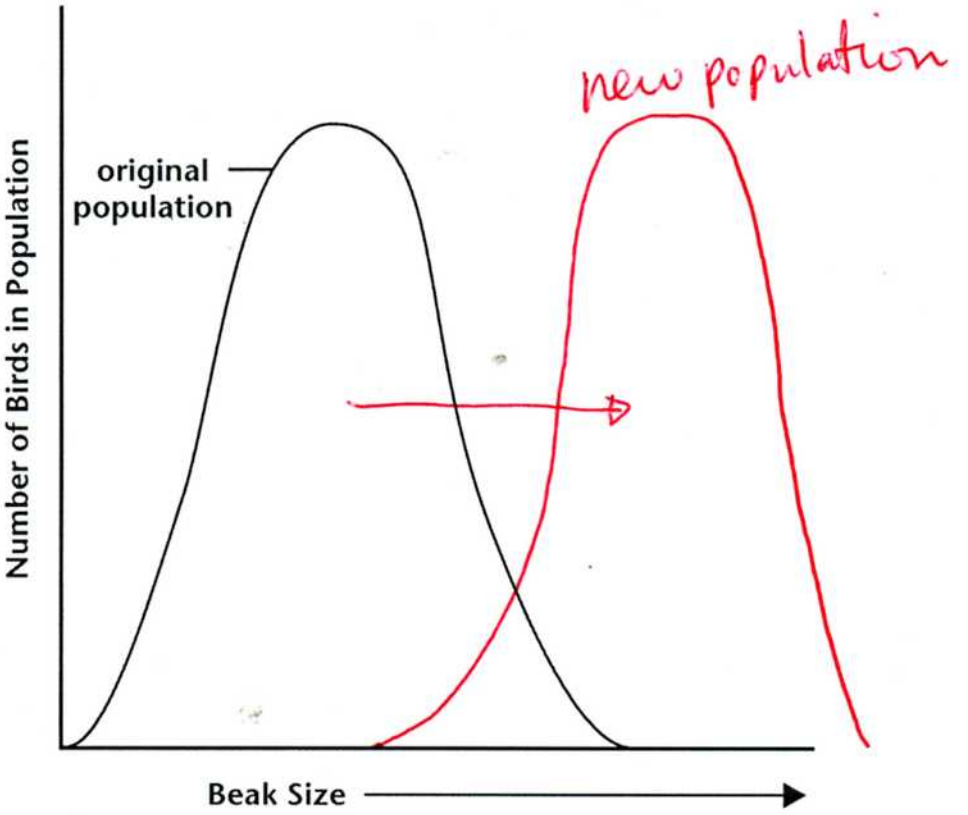
middle of the curve ends of the curve

Page 8 right.

Directional Selection

A population of birds eats seeds. Small seeds can be eaten by birds with small beaks. Larger, thicker seeds can be eaten only by birds with larger, thicker beaks. Suppose there is a shortage of small seeds but that there are still many large seeds.

Draw a new curve on the graph to show how the distribution of beak sizes might change as a result of selection in this environment.



Use the graph to answer the questions.

1. Which birds in this population have the highest fitness? Circle the best answer.

small-beaked birds large-beaked birds

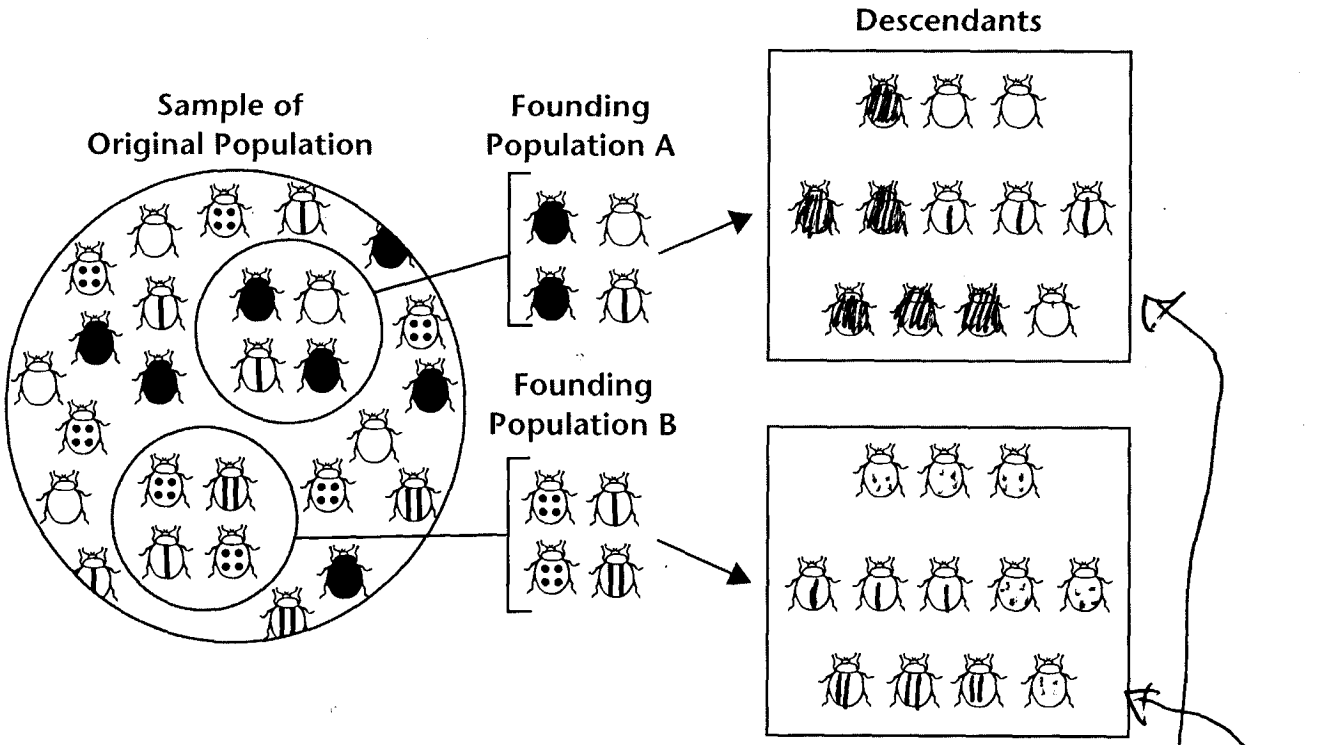
2. Explain how natural selection could lead to the change you predicted.

small-beaked birds starve to death
allele for small beaks decrease in gene pool.
allele for small beaks disappear from gene pool
only alleles for large beaks remain in gene pool

Genetic Drift

In a small population, an individual with particular alleles may have more descendants than another individual, by chance. This kind of chance can, over time, lead to an allele's becoming more common in a population.

Draw what the descendants of these populations might look like. Draw 12 descendants for each population.



Use the diagrams to answer the questions.

1. Draw a beetle that could be found in both descendant populations.

2. Why are the beetles in the two descendant populations different?

no alleles for spots present in gene pool
no alleles for solid color present in gene pool

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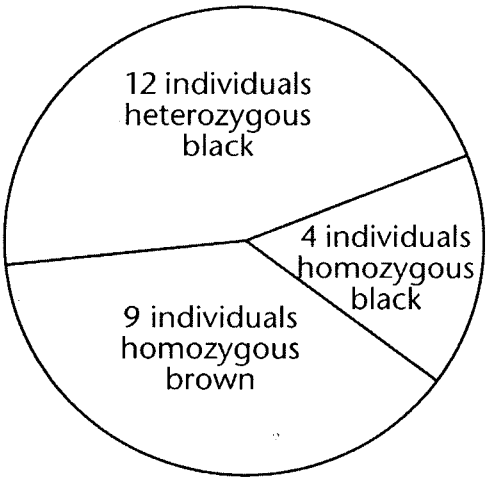
Gene Pools

A homozygous black mouse has two alleles for black fur. A heterozygous black mouse has one allele for black fur and one allele for brown fur. A homozygous brown mouse has two alleles for brown fur.

Sample Population



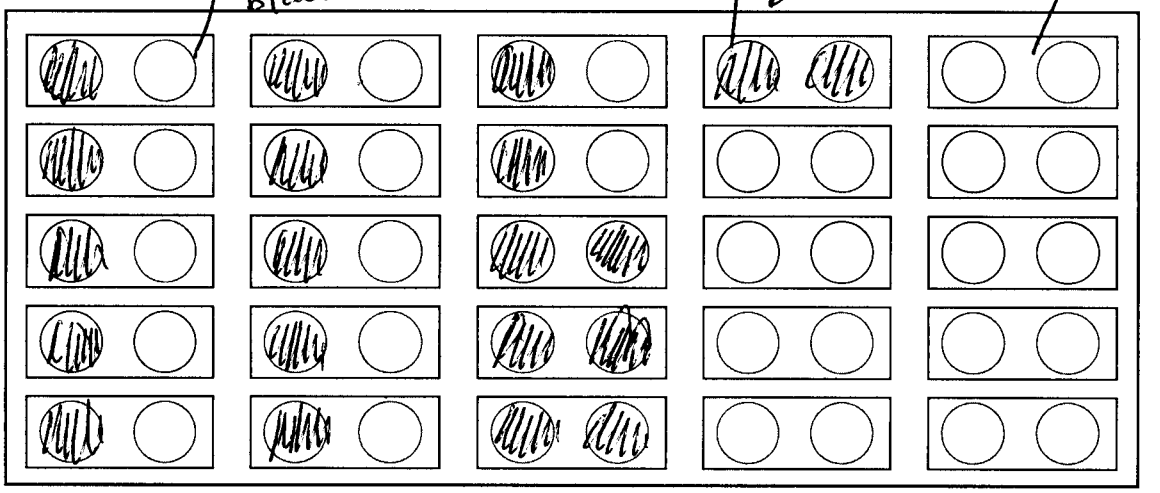
Each rectangle represents one mouse. Each mouse has two alleles, represented by circles, for fur color. Use the graph to color the gene pool of the sample population. Color alleles for black fur black and alleles for brown fur brown.

heterozygous black mouse

homozygous black mouse

homozygous brown mouse

Gene Pool



Use the diagram to answer the questions.

1. How many black alleles are in the gene pool? 70 out of 50
2. How many brown alleles are in the gene pool? 30 out of 50

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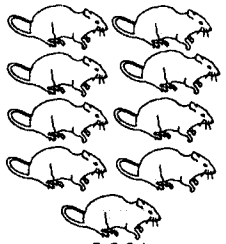
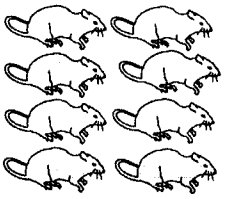
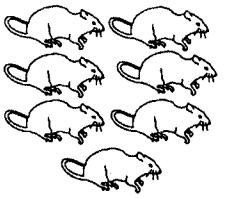
Natural Selection on a Single-Gene Trait

A color mutation occurred in a brown mouse population, causing darker fur. The table below shows how the population changed over the next 30 generations.

Initial Population	Generation 10	Generation 20	Generation 30
 90%	 80%	 70%	 40%
 10%	 20%	 30%	 60%

Use the table to answer the questions.

1. What is happening to the relative frequency of the lighter fur color allele?

   decreasing

2. What is happening to the relative frequency of the darker fur color allele?

   increasing

3. Is the darker color mutation favorable or unfavorable?

   favorable

4. What might cause the change shown in the table?

   the environment grows more trees so it becomes darker, darker mice are more camouflaged

5. How do you predict the mouse population will look after 40 generations?

   almost 0% brown mice

   almost 100% black mice

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