GRADE 12 BIOLOGY

UNIT C - EVOLUTION

WORKBOOK

A handy workbook of questions related to the

Unit C Evolution - Reference Reading

Most Test and Exams questions are extracted from this and some similar resources.

Not for Hand in

16 Study Guide

Big ideas Evolution

Natural selection is a natural process through which life evolves. It acts on populations whose individuals must struggle for existence and that have both heritable variation in traits and variable fitness among individuals.

16.1 Darwin's Voyage of Discovery

Darwin developed a scientific theory of biological evolution that explains how modern organisms evolved over long periods of time through descent from common ancestors.

Darwin noticed that (1) different, yet ecologically similar, animal species inhabited separated, but ecologically similar, habitats around the globe; (2) different, yet related, animal species often occupied different habitats within a local area; and (3) some fossils of extinct animals were similar to living species.

evolution (450) **fossil** (452)

16.2 Ideas That Shaped Darwin's Thinking

Hutton and Lyell concluded that Earth is extremely old and that the processes that changed Earth in the past are the same processes that operate in the present.

Lamarck suggested that organisms could change during their lifetimes by selectively using or not using various parts of their bodies. He also suggested that individuals could pass these acquired traits on to their offspring, enabling species to change over time.

Malthus reasoned that if the human population grew unchecked, there wouldn't be enough living space and food for everyone.

In artificial selection, nature provides the variations, and humans select those they find useful.

artificial selection (458)

16.3 Darwin Presents His Case

Natural selection occurs in any situation in which more individuals are born than can survive, there is natural heritable variation, and there is variable fitness among individuals.

According to the principle of common descent, all species—living and extinct—are descended from ancient common ancestors.

adaptation (461) **natural selection** (463)
fitness (461)

16.4 Evidence of Evolution

Patterns in the distribution of living and fossil species tell us how modern organisms evolved from their ancestors.

Many recently discovered fossils form series that trace the evolution of modern species from extinct ancestors.

Evolutionary theory explains the existence of homologous structures adapted to different purposes as the result of descent with modification from a common ancestor.

The universal genetic code and homologous molecules provide evidence of common descent.

The Grants have documented that natural selection takes place in wild Galápagos finch populations frequently, and sometimes rapidly, and that variation within a species increases the likelihood of the species adapting to and surviving environmental change.

biogeography (465) **analogous structure** (469)
homologous structure (468) **vestigial structure** (469)

Think Visually

Using the information in this chapter, create a concept map that links the following terms: *adaptation, artificial selection, biogeography, camouflage, Charles Darwin, Charles Lyell, evolution, fitness, fossil, homology, James Hutton, Jean-Baptiste Lamarck, mimicry, natural selection,* and *Thomas Malthus.*

16 Assessment

16.1 Darwin's Voyage of Discovery

Understand Key Concepts

1. Who observed variations in the characteristics of plants and animals on different islands of the Galápagos?
   a. James Hutton **c.** Charles Darwin
   b. Charles Lyell **d.** Thomas Malthus

2. In addition to observing living organisms, Darwin studied the preserved remains of ancient organisms called
   a. fossils. **c.** homologies.
   b. adaptations. **d.** vestigial structures.

3. What pattern of variation did Darwin observe among rheas, ostriches, and emus?

4. What connection did Darwin make between the Galápagos tortoises and their environments?

Think Critically

5. **Apply Concepts** Explain what the term *evolution* means, and give an example.

6. **Relate Cause and Effect** Why was Darwin's trip aboard the *Beagle* so important to his development of the theory of natural selection?

7. **Infer** Why was Darwin puzzled by the fact that there were no rabbits in Australia?

16.2 Ideas That Shaped Darwin's Thinking

Understand Key Concepts

8. Which of the following ideas proposed by Lamarck was later found to be incorrect?
   a. Acquired characteristics can be inherited.
   b. All species are descended from other species.
   c. Living things change over time.
   d. There is a relationship between an organism and its environment.

9. Which of the following would an animal breeder use to increase the number of cows that give the most milk?
   a. overproduction **c.** acquired characteristics
   b. genetic isolation **d.** artificial selection

10. What accounts for the presence of marine fossils on mountaintops?

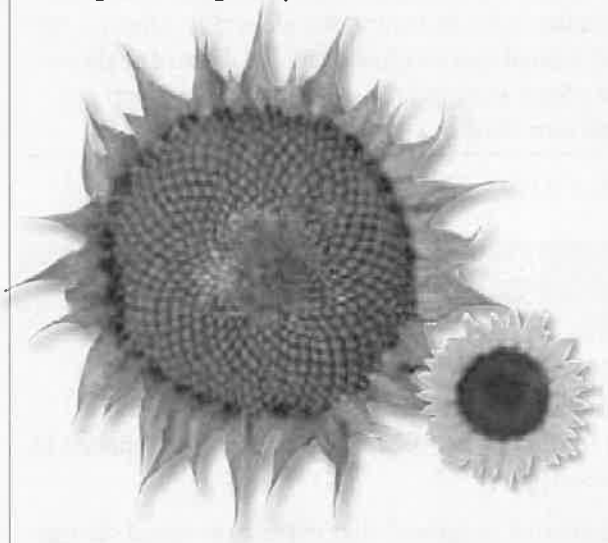
11. How did Lyell's *Principles of Geology* influence Darwin?

12. According to Malthus, what factors limit population growth? Why did Malthus's ideas apply to other organisms better than they did to humans?

13. What is artificial selection? How did this concept influence Darwin's thinking?

Think Critically

14. **Relate Cause and Effect** A sunflower produces many seeds. Will all the seeds grow into mature plants? Explain your answer.



15. **Evaluate** Explain why Lamarck made a significant contribution to science even though his explanation of evolution was wrong.

16.3 Darwin Presents His Case

Understand Key Concepts

16. An inherited characteristic that increases an organism's ability to survive and reproduce in its specific environment is called a(n)
   a. vestigial structure. **c.** speciation.
   b. adaptation. **d.** analogous structure.

17. How well an organism survives and reproduces in its environment can be described as its
   a. fitness. **c.** common descent.
   b. homologies. **d.** analogies.

18. How does natural variation affect evolution?
19. Explain the following statement: "Descent with modification explains the diversity of life we see today."
20. Describe the conditions necessary for natural selection to occur.

Think Critically

21. **Apply Concepts** How would Darwin explain the long legs of the water bird in **Figure 16–6**? How would Darwin's explanation differ from Lamarck's explanation?
22. **Compare and Contrast** Distinguish between fitness and adaptation. How are the two concepts related?
23. **Infer** How does the process of natural selection account for the diversity of organisms that Darwin observed on the Galápagos Islands?
24. **Infer** Many species of birds build nests in which they lay eggs and raise the newly hatched birds. How might nest-building behavior be an adaptation that ensures reproductive fitness?

16.4 Evidence of Evolution

Understand Key Concepts

25. Structures that have different mature forms but develop from the same embryonic tissue are called
    a. analogous. **c.** homologous.
    b. adaptations. **d.** fossils.
26. Intermediate fossil forms are important evidence of evolution because they show
    a. how organisms changed over time.
    b. how animals behaved in their environments.
    c. how the embryos of organisms develop.
    d. molecular homologies.
27. How does the geographic distribution of organisms support the theory of evolution?
28. How do vestigial structures indicate that present-day organisms are different from their ancient ancestors?
29. How do DNA and RNA provide evidence for common descent?

solve the CHAPTER MYSTERY

SUCH VARIED HONEYCREEPERS

The 'i'iwi and other Hawaiian honeycreepers resemble Galápagos finches in a number of ways. They are species of small birds found nowhere else on Earth. They live on islands that are separated from one another by stretches of open sea and that are hundreds of miles from the nearest continent. They are also related to finches!

There are more than 20 known species of Hawaiian honeycreeper. Like the species of Galápagos finches, the honeycreeper species are closely related to one another. This is an indication that they are all descended, with modification, from a relatively recent common ancestor. Experts think the ancestor colonized the islands between 3 million and 4 million years ago. Many honeycreepers have specialized diets, evolutionary adaptations to life on the particular islands they call home. Today, habitat loss is endangering most of the honeycreepers. In fact, many species of honeycreeper are thought to have become extinct since humans settled on the islands.

1. **Infer** Suppose a small group of birds, not unlike the modern honeycreepers, landed on one of Hawaii's islands millions of years ago and then reproduced. Do you think all the descendants would have stayed on that one island? Explain your answer.
2. **Infer** Do you think that the climate and other environmental conditions are exactly the same everywhere on the Hawaiian Islands? How might environmental conditions have affected the evolution of honeycreeper species?
3. **Form a Hypothesis** Explain how the different species of honeycreepers in Hawaii today might have evolved from one ancestral species.
4. **Connect to the Big Idea** Why are islands often home to species that exist nowhere else on Earth?

Think Critically

30. **Infer** Which animal—a cricket or a cat—would you expect to have cytochrome c more similar to that of a dog? Explain your answer.

31. **Infer** In all animals with backbones, oxygen is carried in blood by a molecule called hemoglobin. What could this physiological similarity indicate about the evolutionary history of vertebrates (animals with backbones)?

32. **Apply Concepts** Do you think some species of snake might have vestigial hip and leg bones? Explain your answer.

Connecting Concepts

Use Science Graphics

Use the illustration below to answer questions 33 and 34.

33. **Infer** Based on what you can see, which mice—white or brown—are better adapted to their environment? Explain your answer.

34. **Apply Concepts** In what way is the coloring of the brown mice an adaptation? What other adaptations besides coloring might affect the mice's ability to survive and reproduce?

Write About Science

35. **Explanation** Write a paragraph that explains how the age of Earth supports the theory of evolution.

36. **Summary** Summarize the conditions under which natural selection occurs. Then, describe three lines of evidence that support the theory of evolution by natural selection.

37. **Assess the** Big idea Write a newspaper article about the meeting at which Darwin's and Wallace's hypotheses of evolution were first presented. Explain the theory of evolution by natural selection for an audience that knows nothing about the subject.

38. **Assess the** Big idea Look back at **Figure 16–10** on page 462. Explain how conditions could change so that yellow coloring becomes adaptive. What would happen to the relative numbers of green and yellow grasshoppers in the population?

Analyzing Data

Cytochrome c is a small protein involved in cellular respiration. The table compares the cytochrome c of various organisms to that of chimpanzees. The left column indicates the organism, and the right column indicates the number of amino acids that are different from those in chimpanzee cytochrome c.

Organism	Number of Amino Acids That Are Different From Chimpanzee Cytochrome c
Dog	10
Moth	24
Penguin	11
Yeast	38

39. **Interpret Data** Which of these organisms probably shares the most recent common ancestor with chimpanzees?

a. dog **c.** penguin
b. moth **d.** yeast

40. **Calculate** The primary structure of cytochrome c contains 104 amino acids. Approximately how many of these amino acids are the same in the chimpanzee and moth?

a. 10 **c.** 80
b. 24 **d.** 128

Standardized Test Prep

Multiple Choice

1. Which scientist formulated the theory of evolution through natural selection?
   A Charles Darwin C James Hutton
   B Thomas Malthus D Jean-Baptiste Lamarck

2. Lamarck's ideas about evolution were wrong because he proposed that
   A species change over time.
   B species descended from other species.
   C acquired characteristics can be inherited.
   D species are adapted to their environments.

3. Lyell's *Principles of Geology* influenced Darwin because it explained how
   A organisms change over time.
   B adaptations occur.
   C the surface of Earth changes over time.
   D the Galápagos Islands formed.

4. A farmer's use of the best livestock for breeding is an example of
   A natural selection. C extinction.
   B artificial selection. D adaptation.

5. The ability of an individual organism to survive and reproduce in its natural environment is called
   A natural selection.
   B evolution.
   C descent with modification.
   D fitness.

6. Which of the following is an important concept in Darwin's theory of evolution by natural selection?
   A descent with modification
   B homologous molecules
   C processes that change the surface of Earth
   D the tendency toward perfection

7. Which of the following does NOT provide evidence for evolution?
   A fossil record
   B natural variation within a species
   C geographical distribution of living things
   D homologous structures of living organisms

8. DNA and RNA provide evidence of evolution because
   A all organisms have nearly identical DNA and RNA.
   B no two organisms have exactly the same DNA.
   C each RNA codon specifies just one amino acid.
   D in most organisms, the same codons specify the same amino acids.

9. A bird's wings are homologous to a(n)
   A fish's tailfin. C dog's front legs.
   B alligator's claws. D mosquito's wings.

Questions 10 and 11

The birds shown below are 2 of the species of finches Darwin found on the Galápagos Islands.

Woodpecker Finch

Large Ground Finch

10. What process produced the two different types of beaks shown?
    A artificial selection
    B natural selection
    C geographical distribution
    D disuse of the beak

11. The large ground finch obtains food by cracking seeds. Its short, strong beak is an example of
    A the struggle for existence.
    B the tendency toward perfection.
    C an adaptation.
    D a vestigial organ.

Open-Ended Response

12. Compare and contrast the processes of artificial selection and natural selection.

If You Have Trouble With . . .

Question	1	2	3	4	5	6	7	8	9	10	11	12
See Lesson	16.1	16.2	16.2	16.2	16.3	16.3	16.4	16.4	16.4	16.3	16.3	16.3

GRADE 12 BIOLOGY
REFERENCE READINGS
WORKBOOK CHAPTER 17
EVOLUTION OF POPULATIONS

Name: _____
Date: _____

Genes and Variation

Darwin's original ideas can now be understood in genetic terms. Beginning with variation, we now know that traits are controlled by genes and that many genes have at least two forms, or alleles. We also know that individuals of all species are heterozygous for many genes

To understand evolution, genetic variation is studied in populations. A population is defined as a group of individuals of the same species that interbreed. Members of a population share a common group of genes, called a gene pool. A gene pool consists of all the genes, including all the different alleles, that are present in the population. In genetic terms, evolution is any change in the relative frequency of alleles in a population. The relative frequency of an allele is the number of times the allele occurs in a gene pool, compared with the number of times other alleles for the same gene occur.

The two main sources of genetic variation are mutations and gene shuffling. A mutation is any change in a sequence of DNA. Gene shuffling occurs during the production of gametes in sexual reproduction. It can result in millions of different combinations of genes. Mutation and gene shuffling do not change relative allele frequencies. However, they increase genetic variation by increasing the number of different genotypes.

The number of different phenotypes for a given trait depends on how many genes control the trait. A single-gene trait is controlled by one gene. If there are two alleles for the gene, two or three different genotypes are possible. An example in humans is the presence or absence of widow's peak. A polygenic trait is controlled by two or more genes, and each gene may have more than one allele. An example of a human polygenic trait is height.

Polygenic traits such as height produce many different phenotypes. Variation in a polygenic trait in a population often produces a bell-shaped curve, with most people falling near the middle of the curve.

Evolution as Genetic Change

Natural selection acts on individuals. Evolution acts on populations. Natural selection acting on individuals leads to the evolution of populations.

Natural selection on a trait controlled by a single gene with two alleles can cause one allele to increase and the other allele to decrease. Natural selection on polygenic traits is more complicated. Natural selection on polygenic traits can occur as directional selection, stabilizing selection, or disruptive selection. Directional selection takes place when individuals at one end of the bell shaped curve have higher fitness than individuals near the middle or at the other end of the curve. The result of directional selection is a shift in the curve toward the higher fitness end. Stabilizing selection takes place when individuals near the middle of the curve have higher fitness than individuals at either end. The result of stabilizing selection is a narrowing of the curve around the middle. Disruptive selection takes place when individuals at the upper and lower ends of the curve have higher fitness than individuals near the middle. As a result of disruptive selection, the curve develops a peak at each end and a low point in the middle.

Natural selection is not the only source of evolutionary change. In small populations, alleles can become more or less common simply by chance. This kind of change in allele frequency is called genetic drift. It occurs when individuals with a particular allele leave more descendants than other individuals, just by chance. Over time, this can cause an allele to become more or less common in a population.

Genetic drift also may occur when a small group of individuals colonizes a new habitat. By chance, the small group may have different relative allele frequencies than the original population. When this happens, it is called the founder effect.

To understand how evolution occurs, scientists first had to answer the question: Under what conditions does evolution not occur? The answer to this question is called the Hardy-Weinberg principle. The principle states that allele frequencies in a population will remain constant unless one or more factors cause those frequencies to change. The situation in which allele frequencies remain constant is called genetic equilibrium. For a population to be in genetic equilibrium, five conditions are required: random mating, very large population size, no migrations, no mutations, and no natural selection. Random mating assures that each individual has an equal chance of reproducing. Very large population size prevents genetic drift from occurring. If all five conditions are met, relative allele frequencies will not change and evolution will not occur.

The Process of Speciation

Speciation means the formation of new species. For one species to evolve into two new species, the gene pools of two populations must become separated, or reproductively isolated. Reproductive isolation has occurred when the members of two populations cannot interbreed and produce fertile offspring. Reproductive isolation can involve behavioural, geographic, or temporal isolation.

Behavioural isolation occurs when populations have different courtship rituals or other behaviours involved in reproduction. Geographic isolation occurs when populations are separated by geographic barriers, such as mountains or rivers. Temporal isolation occurs when populations reproduce at different times.

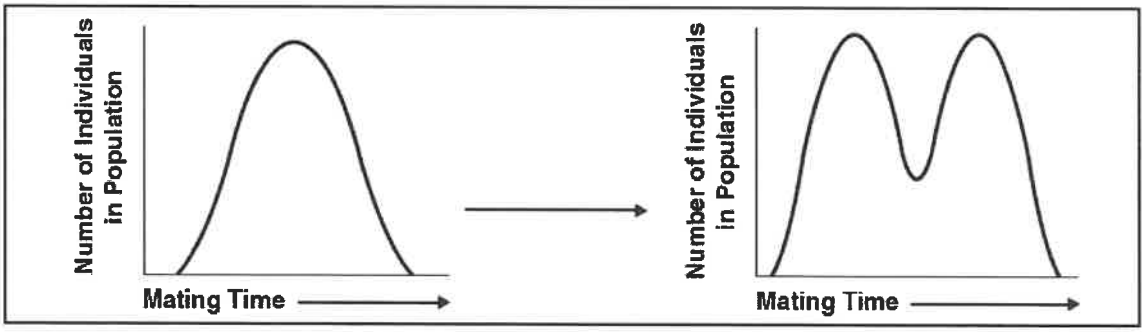
Recently, Peter and Rosemary Grant proved that natural selection is still causing evolution of finches on the Galápagos Islands. The Grants showed that there was enough heritable variation in finch beaks to provide raw material for natural selection. They also showed that differences in beaks produced differences in fitness. These differences in fitness caused directional selection to occur.

Darwin thought that different finch species evolved on the Galápagos Islands from a single species of founding birds. We now know how this could have happened. A few finches may have traveled from mainland South America to one of the islands to found a new population. There, they survived and reproduced. Some birds crossed to a second island, and the two populations became geographically isolated. They no longer shared a gene pool. Seed sizes on the second island favoured birds with larger beaks. The population on the second island evolved into a population with larger beaks. Eventually, the large beaked birds on the second island became reproductively isolated and evolved into a new species.

Evolution continues today. For example, bacteria are evolving to have resistance to drugs. Evolutionary theory can help us understand these changes.

Vocabulary Review

Interpreting Diagrams The diagrams show the distribution curves for time of mating in a population of insects. The diagram on the left represents the starting population. The diagram on the right represents the population several generations later. **Study the diagrams and answer the questions below**.



1. What type of natural selection has occurred?

2. Which phenotypes are selected against?

3. Which phenotypes have higher fitness?

4. If natural selection continues in this way, what may eventually happen to the population?

Completion Fill in the blanks with terms from Chapter 17.

5. Any change in the relative frequency of alleles in a population is called: _____

6. A gene pool consists of all the genes in a(an): _____-

7. The two main sources of genetic variation are gene shuffling and _____

8. A random change in allele frequency is called: _____

9. When birds cannot interbreed because they have different mating songs, they are characterized by _____ isolation.

10. A situation in which allele frequencies change as a result of the migration of a small subgroup of a population is known as the _____

11. Research on Galápagos finches by Peter and Rosemary Grant showed that a type of natural selection called _____ selection was occurring.

12. Two related species that live in the same area but mate during different seasons are separated by _____ isolation.

1. Is the following sentence true or false? Mendel's work on inheritance was published after Darwin's lifetime. _____

2. Which two important factors was Darwin unable to explain without an understanding of heredity?

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

4. A group of individuals of the same species that interbreed is a(an) _____

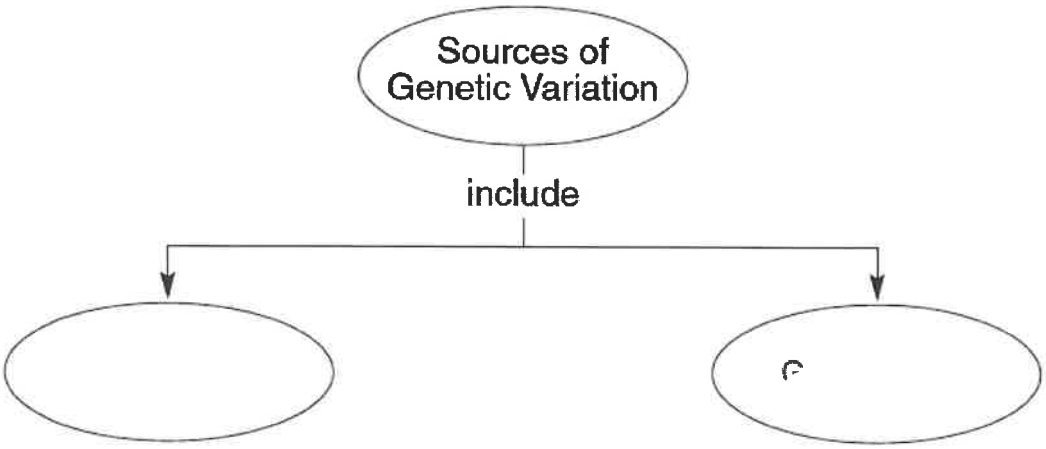
5. All of the genes in a population are called a(an) _____

6. Is the following sentence true or false? A gene pool typically contains just one allele for each inheritable trait. _____

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 _____ _____ of the allele.

Sources of Genetic Variation

8. Complete the concept map.



9. What is a mutation?

10. Why do mutations occur?

11. Circle the letter of **each** choice that is true about mutations.

a. They do not always change an amino acid.

b. They always affect lengthy segments of a chromosome.

c. They always affect an organism's phenotype.

d. They always affect an organism's fitness.

12. Is the following sentence true or false? Most heritable differences are due to gene shuffling that occurs during the production of gametes. _____

13. 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.

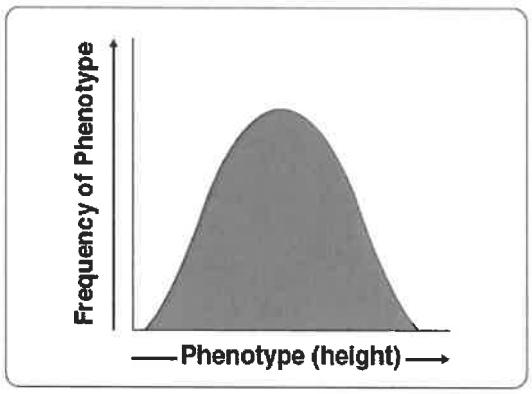
d. It can change the relative frequency of alleles in a population.

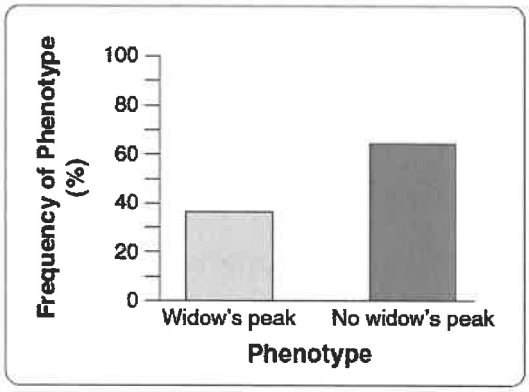
Single-Gene and Polygenic Traits

14. Is the following sentence true or false? The number of phenotypes produced for a given trait depends on how many genes control the trait _____

15. Is the following sentence true or false? Most traits are controlled by a single gene. _____

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





17 – 2. Evolution as Genetic Change

Natural Selection on Single-Gene Traits

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

2. If a trait made an organism less likely to survive and reproduce, what would happen to the allele for that trait?

3. If a trait had no effect on an organism's fitness, what would happen to the allele for that trait?

Natural Selection on Polygenic Traits

4. List the three ways that natural selection can affect the distributions of phenotypes.

a. _____

b. _____

c. _____

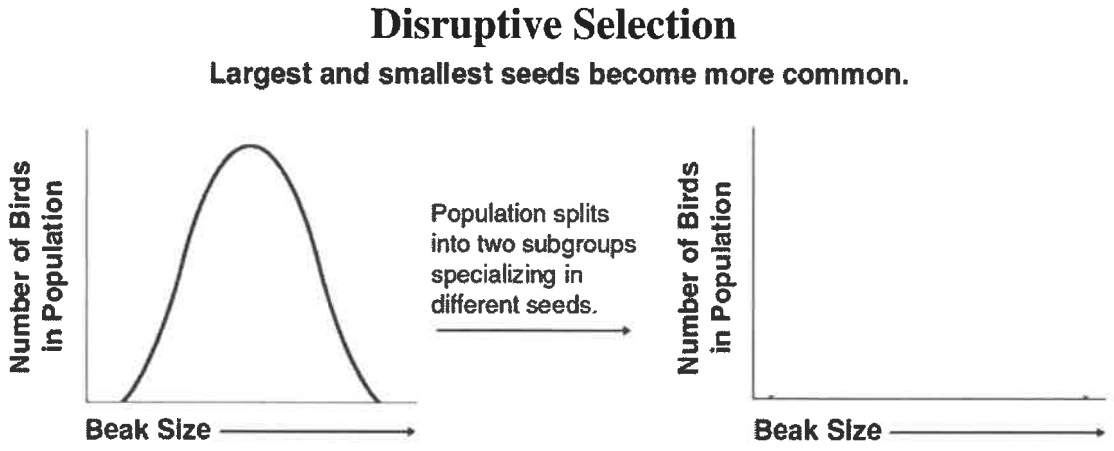
Match the type of selection with the situation in which it occurs.

Type of Selection	**Situation**
_____ 5. Directional	a. Individuals at the upper and lower ends of the curve have higher fitness than individuals near the middle.
_____ 6. Stabilizing	
_____ 7. Disruptive	b. Individuals at one end of the curve have higher fitness than individuals in the middle or at the other end.
	c. Individuals near the centre 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 _____ selection.

9. Is the following sentence true or false? The weight of human infants at birth is under the influence of disruptive selection. _____-

10. Draw the missing graph to show how disruptive selection affects beak size.



Genetic Drift

11. Is the following sentence true or false? Natural selection is the only source of evolutionary change. _____

12. Random change in allele frequencies in small populations is called: _____

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 _____

14. What is an example of the founder effect?

Evolution Versus Genetic Equilibrium

15. What does the Hardy-Weinberg principle state?

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

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

a.

b.

c.

d.

e.

18. Why is large population size important in maintaining genetic equilibrium?

Section 17–3 The Process of Speciation

1. What is speciation?

Isolating Mechanisms

2. Is the following sentence true or false? Individuals in different species can have the same gene pool. _____

3. What does it mean for two species to be reproductively isolated from each other?

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

5. List three ways that reproductive isolation occurs.

a.

b.

c.

6. When does behavioural isolation occur? It occurs when populations are capable of interbreeding but have differences in courtship rituals or other types of behaviour.

7. Is the following sentence true or false? Eastern and Western meadowlarks are an example of behavioural isolation. _____

8. When does geographic isolation occur?

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

10. Is the following sentence true or false? Geographic barriers guarantee the formation of new species. _____

11. What is an example of temporal isolation?

Testing Natural Selection in Nature

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

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.

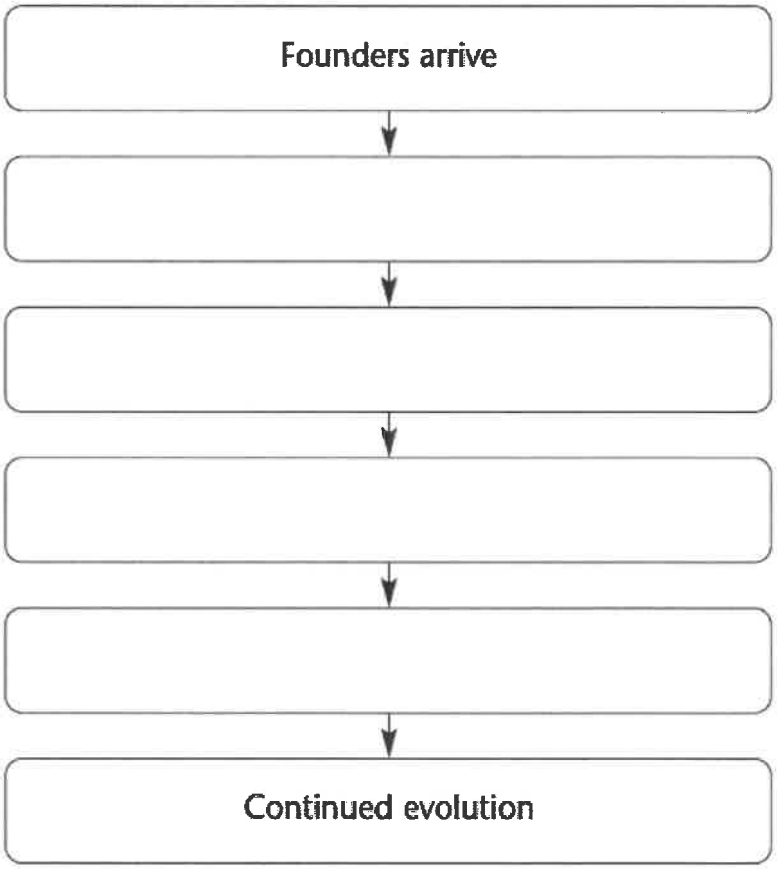
b. The different finch species are the descendants of a common mainland ancestor.

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.

Speciation in Darwin's Finches

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



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

Studying Evolution Since Darwin

16. Why is the study of evolution important?

WordWise

Test your knowledge of vocabulary terms from Chapter 17 by solving the clues. Then, copy the numbered letters in order to reveal the hidden message.

Clues	Vocabulary Terms
Type of isolation that prevents Eastern and Western meadowlarks from interbreeding	_ _ _ _ _ _ _ _ _ _ (1, 2, 3, 4)
Type of selection that acts against individuals of an intermediate type	_ _ _ _ _ _ _ _ _ _ (5, 6, 7)
Term that means the formation of new species	_ _ _ _ _ _ _ _ _ _ (8, 9)
Type of selection that causes an increase in individuals at one end of the curve	_ _ _ _ _ _ _ _ _ _ (10)
Type of selection that keeps the center of the curve at its current position	_ _ _ _ _ _ _ _ _ _ (11, 12)
Kind of pool that contains all the genetic information in a population	_ _ _ _ (13, 14, 15)
Type of isolation that prevents species from interbreeding	_ _ _ _ _ _ _ _ _ _ (16, 17)
Type of isolation that led to the evolution of the Kaibab squirrel	_ _ _ _ _ _ _ _ _ (18)
Type of equilibrium that occurs when allele frequencies do not change	_ _ _ _ _ _ (19)
Name of the principle stating that allele frequencies will remain constant unless factors cause them to change	_ _ _ _ _ _ _ _ _ _ _ _ _ (20, 21, 22, 23)
Type of trait produced by more than one gene	_ _ _ _ _ _ _ _ _

Hidden Message:

_ .

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24