GreatHearts®

9th Grade Biology:
Population Genetics and Speciation

April 20 – April 23

Time Allotment: 40 minutes per day

Student Name: _____

Period: _____

Teacher Name: *Ms. Carstens*

9th Biology – Population Genetics and Speciation
April 20 – April 23
Student Name: _____

Packet Overview

Date	Objective(s)	Page #
Monday, April 20	1. Distinguish between coevolution, convergent evolution, and divergent evolution. 2. Explain the significance of the gene pool in relation to evolution.	2
Tuesday, April 21	1. Explain the Hardy-Weinberg genetic equilibrium. 2. Identify disruptions in the Hardy-Weinberg genetic equilibrium that may result in evolution of a species.	7
Wednesday, April 22	1. Compare the effects of sexual selection, stabilizing selection, disruptive selection, and directional selection.	11
Thursday, April 23	1. Describe how isolation can lead to speciation. 2. Compare gradualism with punctuated equilibrium.	15
Friday, April 24	NO CLASS	

Additional Notes: Hi all! I hope you are doing well and adjusting to our new learning avenues! Remember, I am here for you—through email (kelly.carstens@greatheartsnorthernoaks.org) and also my Zoom office hours. Zoom sessions are intended for the purpose of asking questions, clarifying instructions, and seeking more information on the content topics for the week. If you need to attend, please join the session that corresponds with your class schedule. The times are listed below:

- 1st Period – Mondays, Wednesdays from 10:00-10:50 am
- 3rd Period – Mondays, Wednesdays from 1:00-1:50 pm
- 4th Period – Tuesdays, Thursdays from 10:00-10:50 am
- 6th Period – Tuesdays, Thursdays from 1:00-1:50 pm

Per usual, your weekly minor assessment is found on pgs. 17-18 of this packet. **At the end of your lesson on Friday, you will complete this minor assessment**. You **may use your notes** from the week. It should take approximately 10-15 minutes.

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Academic Honesty

I certify that I completed this assignment independently in accordance with the GHNO Academy Honor Code.

Student signature:

_____

I certify that my student completed this assignment independently in accordance with the GHNO Academy Honor Code.

Parent signature:

_____

9th Biology – Population Genetics and Speciation
April 20 – April 23
Student Name: _____

Unit Overview:

> *"Evolution is like walking on a rolling barrel. The walker isn't so much interested in where the barrel is going as he is in keeping on top of it."*—Robert Frost

Our next unit explores the occurrences of variation within populations and of speciation leading to the development of new organisms. Through the work of key scientists and observers, we can follow a tentative timeline through the history of life on Earth, and we will discover how certain environmental factors, along with genetic influences, have helped organisms adapt and change.

As we embark on this evolutionary journey, recall these things:

- **DNA makes up all living things**.
- **DNA sequencing allows for the diversity of species**.
- **Adaptations, variances, and mutations can allow for beneficial changes** to an organism's DNA.
- The **process of evolution can occur in more than one way**—*coevolution, convergent evolution, divergent evolution,* etc.
- **Natural selection proposes that organisms with advantageous traits are more likely to survive and that limiting factors in an organism's environment influence its survival.**
- An **allele** is **an alternative form of a gene that results in a characteristic** (example: an allele for brown hair)
- **Genotype refers to an organism's pairing of alleles for a specific trait**. (BB – homozygous dominant, Bb – heterozygous dominant, bb – homozygous recessive)
- An organism's **phenotype** is **an organism's appearance as a result of its genotype**.

I. Monday, April 20

Unit – Chapter 16: Population Genetics and Speciation
Lesson 1: Process of Evolution; Genetic Equilibrium

Lesson 1 Socratic Guiding Questions: Keep this in mind as you study!
What is the "gene pool?" How does it affect the process of evolution?

Objectives: Be able to do this by the end of this lesson.

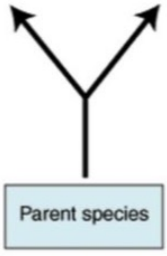
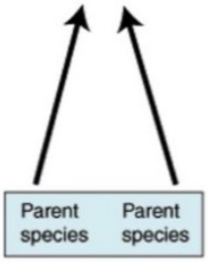
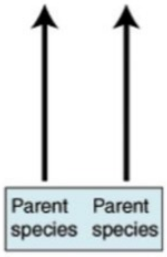
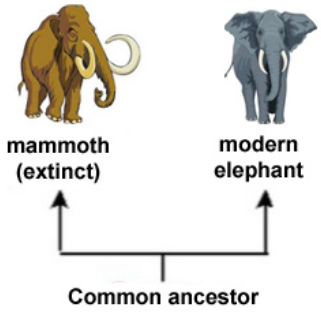
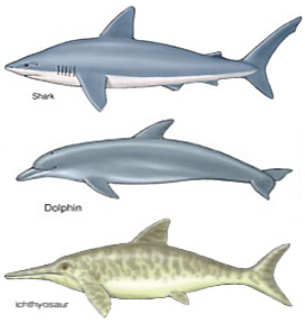
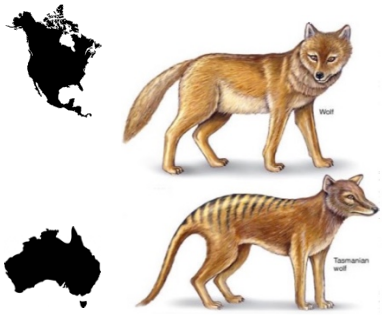
1. Distinguish between coevolution, convergent evolution, and divergent evolution.
2. Explain the significance of the gene pool in relation to evolution.

Introduction to Chapters 14-15: Lesson 5
Today's lesson will be two-part: 1) you will determine and identify certain situations as coevolution, convergent evolution, or divergent evolution, and 2) you will explore the significance that the gene pool holds in determining the evolution of an organism.

First, read through and complete the following activity found on pp. 3-4. This activity will focus on identifying examples of the three main patterns of evolution.

PATTERNS OF EVOLUTION

Types of Evolution	
Microevolution	**Macroevolution**
• Evolution that occurs within a species due to genetic variation, a struggle to survive and natural selection within that species. • *e.g. rabbits with better camouflage survive and reproduce more so that the entire species of rabbit becomes better camouflaged over time*	• Evolution that occurs between different species; focuses on how diverse groups of organisms change. • *e.g. dolphins and sharks both have a streamlined body shapes though dolphins are mammals and sharks are fish*

Patterns of Evolution		
Divergent Evolution	**Convergent Evolution**	**Coevolution**
When one species gradually develops into two species and those two species become increasingly different and better adapted to their own unique environment.	When two separate species begin to share analogous (comparable) traits because of shared environment pressures or shared demands.	When two separate species evolve independently, but in step with each other; sometimes occurs with species that coexist or are in a symbiotic relationship.
		
Example: *humans and apes are different but share a common ancestor*	Example: *whales and fish both have similar body shapes as they have both evolved to move through water*	Example: *there are similar marsupial animals in Australia as placental mammals elsewhere*
		

Review: *Read each description and choose the correct pattern of evolution it describes.*

1. In the ocean surrounding Antarctica, there are fish that survive the cold water by using a molecule made of glycoproteins that circulates the blood and keeps it from freezing. Certain kinds of worms that live in the Arctic ocean also make antifreeze proteins that help them live in icy water.

a. divergent evolution	b. convergent evolution	c. coevolution

2. Ants are the correct size and weight needed to open the flowers for the peony plant. The peony plant provides food for the ant and the ant fertilizes the peony's flowers.

a. divergent evolution	b. convergent evolution	c. coevolution

3. The kit fox lives in the desert and has large ears with greater surface area that keep the fox from getting overheated. The red fox lives in the forest and has a red coat that keeps it camouflaged.

a. divergent evolution	b. convergent evolution	c. coevolution

4. **A form of evolution where two separate populations of the same species accumulates enough differences over time to become two distinct species, becoming more and more dissimilar**.

a. divergent evolution	b. convergent evolution	c. coevolution

5. Ostriches (birds) and giraffes (mammals) are both native to the savannahs of Africa. They eat food that is high off the ground and share the same characteristic of an elongated neck.

a. divergent evolution	b. convergent evolution	c. coevolution

6. The Galapagos finches evolved through natural selection from a common mainland ancestor into a wide variety of different looking species.

a. divergent evolution	b. convergent evolution	c. coevolution

7. **A form of evolution where two species having a close ecological relationship evolve together such that one species adapts to changes in the other, thereby affecting each other's evolution**.

a. divergent evolution	b. convergent evolution	c. coevolution

8. The extinct pterosaurs (reptile) of the Jurassic period and the modern albatross (bird) both evolved wings as well as a distinct long beak but are not derived from a common ancestor.

a. divergent evolution	b. convergent evolution	c. coevolution

9. Hummingbirds have a beak just the right length to reach the nectar in the long cardinal flower. The cardinal flower's pollen tube is just the right length for the hummingbird to pick up pollen as it feeds.

a. divergent evolution	b. convergent evolution	c. coevolution

10. **A form of evolution where organisms with different ancestors become more alike as they adapt to similar environments or environmental pressures.**

a. divergent evolution	b. convergent evolution	c. coevolution

Next, read pp. 317 – 320 (up to "Hardy-Weinberg Genetic Equilibrium") in your text. Then, complete the tasks below.

Lesson Guide Tasks: *Genetic Equilibrium* (pp. 317–320)

1. **Write definitions** for the following terms:

a. population genetics –

b. gene pool –

c. allele frequency –

d. phenotype frequency –

2. What is the **bell curve** and what does it show?

3. Variations in genotype arise in three main ways, according to your text. What are they?

1)_____ 3)_____

2)_____

Closing: Check your understanding of the lesson by answering the following question in 4-6 sentences.

1. How does the gene pool affect the evolutionary process?

II. Tuesday, April 21

Unit – Chapters 16: Population Genetics and Speciation
Lesson 2: Population Equilibrium and Disruption (Part 1)

Lesson 2 Socratic Guiding Questions: Keep these questions in mind as you study!
What is equilibrium and how do disruptions result in change?

Objectives: Be able to do this by the end of this lesson.

1. Explain the Hardy-Weinberg genetic equilibrium.
2. Identify disruptions in the Hardy-Weinberg genetic equilibrium that may result in evolution of a species.

Introduction to Lesson 2
In Lesson 2, you will be introduced to the **Hardy-Weinberg Genetic Equilibrium principle**, which states that **genotype frequencies in a population tend to remain the same from generation to generation unless acted on by outside influences**. We will also explore three of the "outside influences" that could disrupt this equilibrium.

Read pp. 320 - 322 (STOP at "Nonrandom Mating") in your text. After reading, complete the tasks on the following pages.

Concept Review:

1. **Define** the Hardy-Weinberg genetic equilibrium principle and **list** the assumptions about an ideal, hypothetical population on which it is based.

Definition: _____

_____

Set of Assumptions:

A. _____

B. _____

C. _____

D. _____

E. _____

2. How might a mutation affect genetic equilibrium?

3. *Any* violation of the conditions necessary for Hardy-Weinberg equilibrium can result in

a. independent assortment.
c. evolution.
b. disorganizing selection.
d. extinction.

Vocabulary:

Distinguish between the terms in each of the following pair of terms.

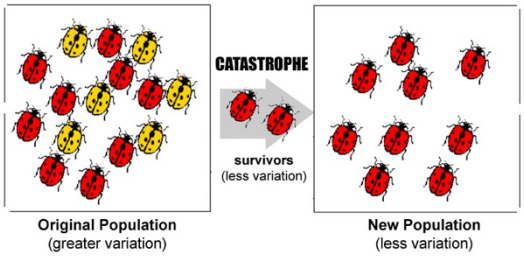
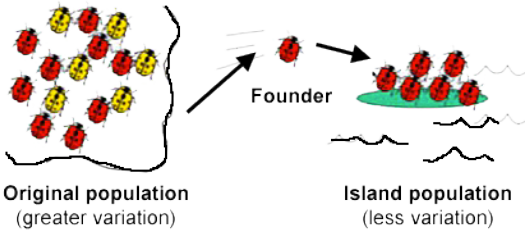
1. **immigration, emigration** – _____

_____

_____

Summary Activity: Read and complete the following.

Genetic Drift	
• In **small populations**, individuals that carry a particular trait may leave more offspring than other individuals, just by chance. The environment is not "selecting" the more adapted individuals. • **Genetic drift** is a change in the genes of a population by **random chance**, making a particular allele more or less common in the population. • There are several ways that genetic drift can occur:	
Genetic Bottleneck	**The Founder Effect**
• Sometimes, a disaster, such as a disease, can kill many individuals in a population. • Just by chance, the smaller, leftover population's gene pool can be **different** from the original population's. • The bottleneck effect is a change in gene frequency following a **dramatic reduction of a population's size**. • The bottleneck effect usually results in a population with **reduced genetic diversity**.	• Genetic drift can also occur when only a few individuals colonize a **brand new habitat**. • These founding individuals may carry alleles that differ than those from the main population that they came from. • The new gene pool therefore stars out with different frequencies and grows in size. • When a small group of founding individuals colonize a new location, **reduced genetic diversity** usually occurs.

	
Example – Northern elephant seals have reduced genetic variation due to hunting in the 19th century, which left their population to as few as 20 total individuals. Their population has rebounded to 30,000, but the genes still are not as diverse as their southern elephant seal cousins, who were never hunted in the same way.	*Example – The Amish, a traditional sect of people that tend to live in isolated communities, have a higher frequency of polydactyly (extra fingers and toes) because the trait was brought over by one of its founders from Europe and then spread though the growing population due to intermarriage within the communities.*

Review: *Read each description and choose the correct pattern of genetic change it describes.*

1. When Christopher Columbus came to the Americas, he randomly chose 3 chickens from Spain to bring along. These 3 chickens were the only chickens to breed in the Americas for hundreds of years.

a. natural selection	b. genetic bottleneck	c. founder effect

2. **Organisms better adapted to their environment tend to survive and produce more offspring. Their genetic profile becomes more common in the population over time.**

a. natural selection	b. genetic bottleneck	c. founder effect

3. In 2013, Typhoon Haiyan is estimated to have killed over 500 water buffalo in the Philippines. Water buffalo are used in the Philippines to plow crops. Many of the water buffalo that perished were concentrated near farms. These animals are more muscular than buffalo allowed to roam free.

a. natural selection	b. genetic bottleneck	c. founder effect

4. The Afrikaner population of Dutch settlers in South Africa is descended from a few colonists. Today, the Afrikaner population has an unusually high frequency of the gene for Huntington's disease.

a. natural selection	b. genetic bottleneck	c. founder effect

5. **The reduced genetic diversity that results when a population is descended from a small number of colonizing ancestors that interbreed.**

a. natural selection	b. genetic bottleneck	c. founder effect

6. Camouflage allows many species to blend in to their environment. Those individuals with the best camouflage are not eaten by predators as often as those with poorer camouflage.

a. natural selection	b. genetic bottleneck	c. founder effect

7. **A catastrophe kills many individuals in a population, leaving a small number of individuals to interbreed. These individuals may have different genes than the original population.**

a. natural selection	b. genetic bottleneck	c. founder effect

8. More severe illnesses exist among certain Jewish groups. Ashkenazi Jews, for example, have a particularly high chance of suffering from Tay-Sachs disease, a fatal condition in young children.

a. natural selection	b. genetic bottleneck	c. founder effect

9. During a hike a man accidentally steps on a population of rare beetles that were in the path, leaving just four from the original twenty.

a. natural selection	b. genetic bottleneck	c. founder effect

10. Antibiotic resistance occurs when certain bacteria with a mutation that allows them to survive exposure to antibiotic chemicals live on and reproduce. Quickly, a fully resistant generation develops.

a. natural selection	b. genetic bottleneck	c. founder effect

III. Wednesday, April 22

Unit – Chapter 16: Population Genetics and Speciation
Lesson 3: Population Equilibrium and Disruption (Part 2)

Lesson 3 Socratic Guiding Question: Keep this question in mind as you study!
How does natural selection act as a disruption to a population's equilibrium?

Objective: Be able to do this by the end of this lesson.

1. Compare the effects of sexual selection, stabilizing selection, disruptive selection, and directional selection.

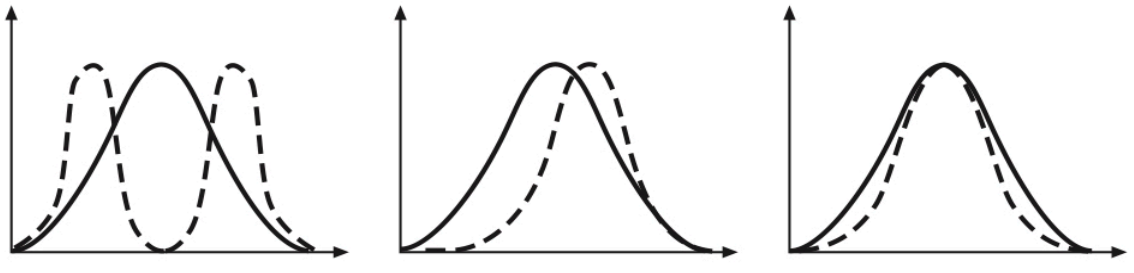
Introduction to Lesson 3:
Today's topic addresses **two additional conditions that may cause evolution** to occur within a population—***nonrandom mating*** and ***natural selection***. By understanding these concepts, we begin to see how nature, both the environment AND an organism's actions and behaviors) can force change upon a population. We'll discuss different forms of selection which leads organisms on varying pathways of the evolutionary process.

Read pp. 323-325 in your text. Then, complete the tasks below.

1. Contrast random and nonrandom mating. Which is more common within populations? Explain your answer.

2. How might being brightly colored increase the fitness of the males of some bird species?

STRUCTURES AND FUNCTIONS Label the three types of selection illustrated by the graphs below.



a _____ b _____ c _____

TYPES OF SELECTION

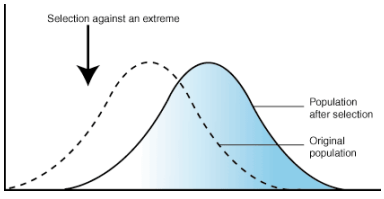
Introduction:

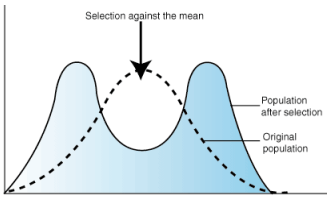
Types of Evolution	
Microevolution	**Macroevolution**
• Evolution that occurs within a species due to genetic variation, a struggle to survive and natural selection within that species. • e.g. rabbits with better camouflage survive and reproduce more so that the entire species of rabbit becomes better camouflaged over time	• Evolution that occurs between different species; focuses on how diverse groups of organisms change. • e.g. dolphins and sharks both have a streamlined body shapes though dolphins are mammals and sharks are fish

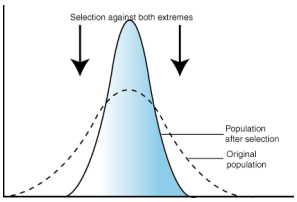
Types of Natural Selection	
1. stabilizing selection	When extreme phenotypes are selected against in favor of the average. *(e.g. average male height of 5'9" is not too short and not too tall)*
2. directional selection	Involves the selection of extreme forms of a particular trait. *(i.e. dark pepper moths in area where air pollution has made tree bark darker)*
3. disruptive selection	When both extreme phenotypes are selected. *(i.e. mountain rabbits that are gray or gray-white vs. pure white)*
4. sexual selection	A special case that involves females (mainly) selecting males based on traits that have value during courtship and mating. *(i.e. large feathers in peacocks)*
Types of Artificial Selection	
5. selective breeding	The selective breeding of species by humans to increase desirable traits. *(i.e. other dogs are bred with poodles to obtain hypoallergenic fur – labradoodle)*

Review:

1. Label the type of natural selection that is shown by each of the graphs below.







a.	b.	c.

2. In seed cracking birds, there is an occurrence of large or small beak sizes, with medium sized beaks being absent. This is an example of what type of selection?

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

3. Larger squirrels can carry larger acorns to their burrows, and they outcompete smaller squirrels when acorn supplies are limited. What type of selection will most likely occur?

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

4. Male peacocks have large showy feathers. The feathers make them more noticeable to predators and prevent the peacock from quickly escaping. However, large showy feathers attract peahens (female peacocks); peacocks with the showier feathers attract more mates and reproduce more.

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

5. Spotted brown-and-white butterflies blend into the splotchy bark of tree trunks, making it difficult for predators to see them, while solid brown and solid white butterflies are easier to see and get eaten. What type of selection will most likely occur?

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

6. Panthers with teeth that are too short have difficulty capturing prey, while panthers with teeth that are too long have difficulty chewing their food. What type of selection will most likely occur?

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

7. The rocks at the bottom of a stream are either black or white. Snails that live on these rocks are a range of color from solid black to gray to solid white. A local fish loves to munch on these snails, but it can't see the solid black or solid white snails when the snails are on matching rocks. Gray does not blend into either rock color and is much easier to see. What type of selection will most likely occur?

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

8. Dogs are bred for temperament and other traits (fur type, color, body size). Some of this has to do with breeding dogs for certain jobs (hunters, herders, etc.) but a lot of it just personal preference.

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

9. Human babies usually do not survive if they are born under 4 pounds because their organs are too small to work properly; they cannot be born if they are too big because the mother would not be able to give birth without dying.

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

10. Many plants have flowers that are pretty and brightly colored. This is because the brightest colors attract bees, butterflies, and other pollinators, which enable the plant to reproduce. If a flower is dully colored, it does not reproduce.

a. stabilizing selection	b. directional selection	c. disruptive selection
d. sexual selection	e. selective breeding	f. none of the above

Closing: Check your understanding of the lesson by completing the following.

1. Identify **<u>at least two</u>** ways natural selection acts as a disruption to a population's equilibrium.

_____

_____

_____

_____

_____

_____

_____

_____

IV. Thursday, April 23

Unit – Chapter 16: Population Genetics and Speciation
Lesson 4: Formation of Species

Lesson 4 Socratic Guiding Question: Keep these questions in mind as you study!
What is speciation? How does it occur?

Objectives: Be able to do this by the end of this lesson.

1. Describe how isolation can lead to speciation.
2. Compare gradualism with punctuated equilibrium.

Introduction to Lesson 4
In this lesson, we will **explore the process of how organisms branch off to become individual species**. There are several pathways to speciation as will be discussed in your text and concept review. **All of these pathways revolve around a central concept – isolation**. Within isolation, we see the greatest chance for evolutionary change among species.

Read pp. 326–330. After reading, complete the tasks below.

1. *Define* the following two concepts of species.
   A. Morphological Concept of Species:_____

      _____

   B. Biological Species Concept: _____

      _____
2. The idea that speciation occurs at a gradual rate is called _____.

   Some scientists think speciation happens in bursts; this is called *punctuated*

   _____. Punctuated refers to _____ change, and
3. _____ refers to periods of little change.

SPECIATION

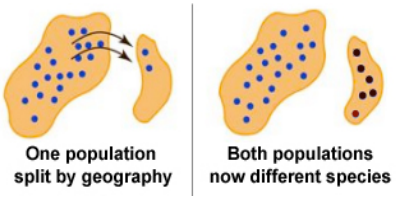
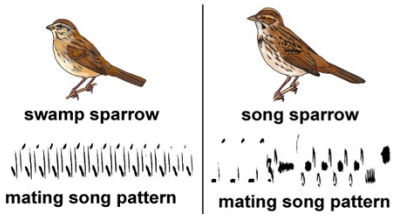
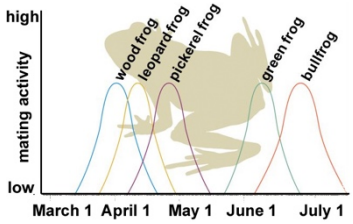
Introduction: How does one species become two species? **Natural selection** and **genetic drift** can change the frequency of certain genes, causing a population to evolve within itself, but these processes do **not** lead to brand new species by themselves.

Speciation
• The process of **forming new species** from a species already in existence. • Speciation requires that a population of that species **becomes isolated** from the original population.

- The original population splits into two isolated groups, which begin to breed among themselves, and genetic changes accumulate over time.
- Because the two populations no longer breed with each other, **reproductive isolation** has occurred.

Reproductive Isolation

- Reproductive isolation occurs when to populations **no longer interbreed**.
- When reproductive isolation occurs, 2 separate species can arise since the gene pools are different.
- Over time, the two populations become so different that they can no longer mate with each other to produce fertile offspring, even if the isolation was removed. Thus, two new species are created.
- There are **3 ways** that reproductive isolation can occur:

Geographic Isolation	Behavioral Isolation	Temporal Isolation
• When two populations become separated by a **physical barrier**, such as rivers, mountains, or lake. • Does not guarantee isolation for good, as the barrier may disappear, such as lakes being connected by flooding.	• When two populations become isolated by **differences in courtship rituals** or other behaviors. • The populations may live in the same area, but do not breed with each other.	• When two populations become isolated because they reproduce **at different times** or patterns. • For example, certain plants could theoretically breed with each other, but they flower at different times of the year.
		
Example – Darwin's finches arose from a common mainland ancestor but became isolated on different islands and evolved into 15 separate species based on the different environmental conditions on each island.	*Example – The eastern meadowlark (Sturnella magna) and the western meadowlark (Sturnella neglecta) have different mating calls. Therefore, females of each species do not respond to the different mating calls.*	*Example – The red-legged frog's (Rana aurora) breeding season lasts from January - March. The closely related yellow-legged frog's (Rana boylii) mating season lasts from March – May.*

Review: *Read each description and choose the correct type of reproductive isolation it describes.*

1. In the Great Lakes region of North America, gray wolves and coyotes are similar species but do not mate because their breeding periods occur at different times of the year.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

2. The females of two species of fruit fly, *Drosophila melanogaster* and *Drosophila simulans* release slightly different mating hormones called pheromones, which are used to attract male mates.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

3. **A type of isolation in which two populations become separated by a physical barrier such as a canyon, river, lake, preventing the two populations from interbreeding.**

a. geographic isolation	b. behavioral isolation	c. temporal isolation

4. *Tradescantia ohiensis*, a plant also known as bluejacket and its relative, T. subaspera have similar reproductive mechanisms but do not mate, as one species lives in sun while the other lives in shade.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

5. **A type of isolation in which two populations with complex courtship displays or rituals become different enough that they no longer respond to the other's actions.**

a. geographic isolation	b. behavioral isolation	c. temporal isolation

6. The American toad *(Anaxyrus americanus)* and Fowler's toad *(Bufo fowleri)* live in the same area. However, The American toad mates in early summer while Fowler's mates in late summer.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

7. The flashing pattern of the firefly (Lampyridae) is used to attract the opposite sex. Female fireflies only flash back and attract male fireflies who first signal them with a species-specific pattern of light.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

8. **A type of isolation where two species whose ranges overlap have different periods of sexual activity or breeding seasons.**

a. geographic isolation	b. behavioral isolation	c. temporal isolation

9. Albert's squirrel and the Kaibab squirrel are distinct subspecies that live on opposite sides of the Grand Canyon. They were once one species, but now differ significantly, including fur coloring.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

10. Of the seven species of cicada, *(Cicadae),* three follow a 17-year mating cycle, while four follow a 13-year cycle. In regions where their geographic range overlaps, their emergence coincides once in every 221 years. This last happened in North America in 2015 and will not occur again until the year 2236.

a. geographic isolation	b. behavioral isolation	c. temporal isolation

The following pages contain your minor assessment for the week and <u>should be completed on Thursday</u> only <u>AFTER</u> you have completed all previous work in this packet. You may use your notes and text in this packet to support your answers. It should take you approximately 10-15 minutes.

Quiz: Chapter 16

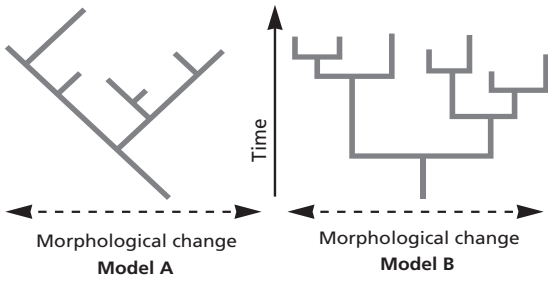
Directions: Complete the Standardized Test Preparation below. Write Short Response and Extended Response answers on the next page.

Standardized Test Preparation

DIRECTIONS: Choose the letter of the answer choice that best answers the question.

1. What is the term for the total genetic information in a population?
   A. gene pool
   B. allele frequency
   C. distribution of traits
   D. phenotype frequency
2. Saint Bernards and Chihuahuas (two breeds of domestic dogs) cannot normally mate because they differ so much in size. Thus, they are reproductively isolated to some extent. What type of isolating mechanism is operating in this case?
   F. artificial
   G. prezygotic
   H. postzygotic
   J. geographic
3. How do mutations affect genetic equilibrium?
   A. Mutations cause emigration.
   B. Mutations cause immigration.
   C. Mutations introduce new alleles.
   D. Mutations maintain genotype frequency.

INTERPRETING GRAPHICS: The illustration below shows two contrasting models for rates of speciation. Use the illustration to answer the questions that follow.

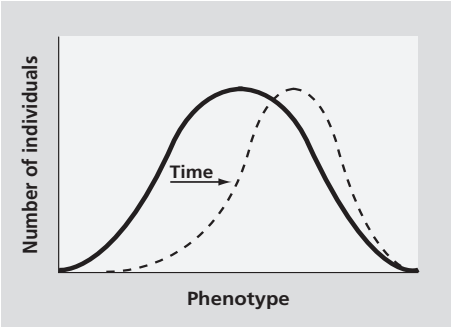


4. Which model of speciation rates is illustrated by model A in the graph?
   F. gradualism
   G. sexual selection
   H. disruptive selection
   J. punctuated equilibrium
5. Which model of speciation rates is illustrated by model B in the graph?
   A. gradualism
   B. sexual selection
   C. disruptive selection
   D. punctuated equilibrium

DIRECTIONS: Complete the following analogy:

6. genotype : allele :: phenotype :
   F. trait
   G. mutation
   H. gene pool
   J. population

INTERPRETING GRAPHICS: The illustration below shows the occurrence of variations in a particular characteristic within a population. The dark line represents an earlier point in time than the dashed line. Use the illustration to answer the question that follows.



7. Which type of selection is modeled in the illustration above?
   A. sexual selection
   B. disruptive selection
   C. stabilizing selection
   D. directional selection

SHORT RESPONSE

Explain the difference between reproductive isolation and geographic isolation.

EXTENDED RESPONSE

The phrase *Hardy-Weinberg genetic equilibrium* refers to the frequency of genotypes in populations from generation to generation.

Part A Briefly describe what this model predicts about genotype frequencies.

Part B What are the set of assumptions that must be met for the Hardy-Weinberg genetic equilibrium to be valid?

Test TIP For multiple-choice questions,

Short Response:

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Extended Response:

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