GRADE 12 BIOLOGY
UNIT C – EVOLUTION
REFERENCE READING REVIEW
EVOLUTION OF POPULATIONS

Name: _____
Date: _____

CHAPTER 17.1 GENES AND VARIATION

Define the terms gene pool and allele frequency.

Explain In genetic terms, what indicates that evolution is occurring in a population?

Predict. Suppose a dominant allele causes a plant disease that usually kills the plant before it can reproduce. Over time, what would probably happen to the frequency of that allele in the population?

2. a. **Review** List three sources of genetic variation.

b. **Explain** How does genetic recombination result in genetic variation?

c. **Relate Cause and Effect** Why does sexual reproduction provide more opportunities for genetic variation than asexual reproduction?

3. a. **Review** What is a single-gene trait? What is a polygenic trait?

b. **Explain** How does the range of phenotypes for single-gene traits differ from the range for polygenic traits?

c. **Infer** A black guinea pig and a white guinea pig mate and have offspring. All the offspring are black. Is the trait of coat colour probably a single-gene trait or a polygenic trait? Explain.

Explanation

4. Explain how mutations are important in the process of biological evolution. (Hint: How does mutation affect genetic variation?)

CHAPTER 17.2 EVOLUTION AS GENETIC CHANGE IN POPULATIONS

Allele Frequency

The Hardy-Weinberg principle can be used to predict the frequencies of certain genotypes if you know the frequency of other genotypes.

Imagine, for example, that you know of a genetic condition, controlled by two alleles **S** and ***s***, which follow the rule of simple dominance at a single locus. The condition affects only homozygous recessive individuals. (The heterozygous phenotype shows no symptoms.)

The population you are studying has a population size of 10,000 and there are 36 individuals affected by the condition. Based on this information, use the Hardy-Weinberg equations to answer the following questions:

1. Calculate What are the frequencies of the S and *s* alleles?
2. Calculate What are the frequencies of the SS, S*s*, and s*s* genotypes?
3. Calculate What percentage of people, in total, is likely to be carrying the s allele, whether or not they know it?

Which source of variation brings more diversity into a gene pool—mutation or sexual reproduction? Explain.

1. a. **Review** How does natural selection affect a single-gene trait?

b. **Compare and Contrast** Compare directional selection and disruptive selection.

2. a. **Review** Define genetic drift.

b. **Relate Cause and Effect** How can the founder effect lead to changes in a gene pool?

3. a. **Review** What five conditions are necessary to maintain genetic equilibrium?

b. **Infer** Why is genetic equilibrium uncommon in actual populations?

4. Do you think populations stay in genetic equilibrium after the environment has changed significantly? Explain your answer

CHAPTER 17.3 REVIEW
THE PROCESS OF SPECIATION

1. a. **Review** What is geographic isolation?

b. **Predict** A newly formed lake divides a population of a beetle species into two groups. What other factors besides isolation might lead to the two groups becoming separate species?

2. a. **Review** What types of reproductive isolation may have been important in Galápagos finch speciation? Explain.

b. **Apply Concepts** Explain how the vegetarian tree finch, which feeds on fruit, might have evolved.

CHAPTER 17.4 REVIEW

Molecular Evolution

1. a. Review What is a molecular clock?

b. Explain Why do molecular clocks use mutations that have no effect on phenotype?

2. a. **Review** How can crossing-over result in gene duplication?

b. **Explain** Describe how duplicate genes form.

c. **Relate Cause and Effect** Why is gene duplication important in evolution?

3. a. **Review** Use the evolution of the insect body plan to explain the significance of Hox genes in evolution.

b. **Infer** In evolution, why have small changes in Hox genes had a great impact?

STUDY GUIDE

Basic Idea: Evolution

A new species can form when a population splits into two groups that are isolated from one another. The gene pools of the two groups may become so different that the groups can no longer interbreed.

17.1 Genes and Variation

- Evolution is a change in the frequency of alleles in a population over time.
- Three sources of genetic variation are mutation, genetic recombination during sexual reproduction, and lateral gene transfer.
- The number of phenotypes produced for a trait depends on how many genes control the trait.

17.2 Evolution as Genetic Change in Populations

- Natural selection on single-gene traits can lead to changes in allele frequencies and, thus, to changes in phenotype frequencies.
- Natural selection on polygenic traits can affect the relative fitness of phenotypes and thereby produce one of three types of selection: directional selection, stabilizing selection, or disruptive selection. *In small populations*, individuals that carry a particular allele may leave more descendants than other individuals leave, just by chance. Over time, a series of chance occurrences can cause an allele to become more or less common in a population.
- The Hardy-Weinberg principle predicts that five conditions can disturb genetic equilibrium and cause evolution to occur: (1) non-random mating; (2) small population size; and (3) immigration or emigration; (4) mutations; or (5) natural selection

17.3 The Process of Speciation

- When populations become reproductively isolated, they can evolve into two separate species.
- Reproductive isolation can develop in a variety of ways, including behavioural isolation, geographic isolation, and temporal isolation.
- Speciation in Galápagos finches most likely occurred by founding of a new population, geographic isolation, changes in the new population's gene pool, behavioural isolation, and ecological competition.
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17.4 Molecular Evolution

- A molecular clock uses mutation rates in DNA to estimate the time that two species have been evolving independently.
- One way in which new genes evolve is through the duplication, and then modification, of existing genes.
- Small changes in Hox gene activity during embryological development can produce large changes in adult animals.

VOCABULARY (page number where found in readings)

you should be familiar with this vocabulary:

gene pool (483) single-gene trait (485) allele frequency (483)
polygenic trait (486) directional selection (489) founder effect (490)
stabilizing selection (489) genetic equilibrium (491) disruptive selection (489)
genetic drift (490) Hardy-Weinberg principle (491) bottleneck effect (490)
sexual selection (492) species (494) behavioural isolation (495)
speciation (494) geographic isolation (495) reproductive isolation (494)
temporal isolation (495) molecular clock (498)

EXAMPLE ASSESSMENT QUESTIONS

17.1 Genes and Variation

1. The combined genetic information of all members of a particular population forms a(n):

a. gene pool b. niche. c. phenotype. d. population.

2. Mutations that improve an individual's ability to survive and reproduce are:

a. harmful. b. neutral. c. beneficial. d. chromosomal.

3. Traits, such as human height, that are controlled by more than one gene are known as:

a. single-gene traits. b. polygenic traits.
c. recessive traits. d. dominant traits.

4. Explain what the term allele frequency means. Include an example illustrating your answer.

5. Explain why sexual reproduction is a source of genetic variation.

6. Explain what determines the number (*frequency*) of phenotypes for a given trait.

7. What is lateral gene transfer?

8. Define evolution in genetic terms.

9. **Compare and Contrast** Which kind of mutation has the greater potential to affect the evolution of a population: a mutation to a body cell or a mutation in an egg cell? Explain.

10. **Apply Concepts** Explain how natural selection is related to phenotypes and genotypes.

11. **Apply Concepts** Explain how natural selection is related to individuals and populations.

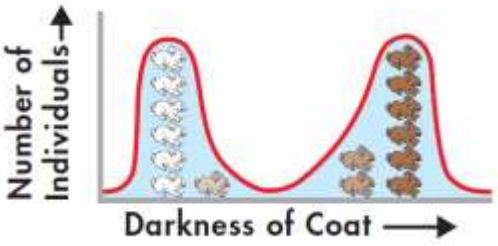
12. **Relate Cause and Effect** How does genetic recombination affect genetic variation?

17.2 Evolution as Genetic Change in Populations

13. The type of selection in which individuals of average size have greater fitness than small or large individuals have is called:

a. disruptive selection.
b. directional selection.
c. stabilizing selection.
d. neutral selection.

14. If coat colour in a rabbit population is a polygenic trait, which process might have produced the graph at the right.



a. disruptive selection
b. directional selection
c. stabilizing selection
d. genetic equilibrium

15. A random change in a small population's allele frequency is known as a.

a. gene pool b. variation c. genetic drift d. fitness

16. What is fitness in genetic terms?

17. How do stabilizing selection and disruptive selection differ?

18. What is genetic equilibrium? In what kinds of situations is it likely to occur?

Think Critically

19. **Compare and Contrast** Distinguish between the ways in which natural selection affects single-gene traits and the ways in which it affects polygenic traits. How are phenotype frequencies altered in each case?

20. **Infer** In a certain population of plants, flower size is a polygenic trait. What kind of selection is likely to occur if environmental conditions favour small flowers?

21. **Infer** A road built through a forest splits a population of frogs into two large groups. The allele frequencies of the two groups are identical. Has genetic drift occurred? Why or why not?

22. **Form a Hypothesis** DDT is an insecticide that was first used in the 1940s to kill mosquitoes and stop the spread of malaria. As time passed, people began to notice that DDT became less effective. Explain, in genetic terms, how the insects became resistant to the pesticide.

17.3 The Process of Speciation

Understand Key Concepts

23. Temporal isolation occurs when two different populations:

a. develop different mating behaviours.
b. become geographically separated.
c. reproduce at different times.
d. interbreed.

24. When two populations no longer interbreed, what is the result?

a. genetic equilibrium b. stabilizing selection
c. reproductive isolation d. artificial selection

25. Explain how the different species of Galápagos finches may have evolved.

Think Critically

26. **Relate Cause and Effect** Explain why reproductive isolation usually must occur before a population splits into two distinct species.

27. **Form a Hypothesis** A botanist identifies two distinct species of violets growing in a field, as shown in the left of the illustration below. Also in the field are several other types of violets that, although somewhat similar to the two known species, appear to be new species. Develop a hypothesis explaining how the new species may have originated.

17.4 Molecular Evolution

Understand Key Concepts

28. A group of related genes that resulted from the duplication and modification of a single gene is called a(n)
:

a. gene pool. b. lateral gene transfer.
c. molecular clock. d. gene family.

29. Each “tick” of a molecular clock is an occurrence of:

a. genetic drift. b. DNA mutation.
c. crossing-over. d. mitosis.

30. How do chromosomes gain an extra copy of a gene during meiosis?

31. What are neutral mutations?

32. What is the study of “evo-devo,” and how is it related to evolution?

Think Critically

33. **Pose Questions** What kinds of questions would scientists who are studying the evolution of Hox genes most likely be asking?

34. **Apply Concepts** Describe the relationship between evolutionary time and the similarity of genes in two species.

Test Prep

Multiple Choice

1. Which of the following conditions is MOST likely to result in changes in allele frequencies in a population?

A. random mating
B. small population size
C. no migrations into or out of a population
D. absence of natural selection

2. Mutations and the genetic recombination that occurs during sexual reproduction are both sources of:

A. genetic variation.
B. stabilizing selection.
C. genetic equilibrium.
D. genetic drift.

3. In a population of lizards, the smallest and largest lizards are more easily preyed upon than medium size lizards. What kind of natural selection is MOST likely to occur in this situation?

A. genetic drift B. stabilizing selection
C. sexual selection D. directional selection

4. Populations of antibiotic-resistant bacteria are the result of the process of

A. natural selection. B. genetic drift.
C. temporal isolation. D. artificial selection.

5. If species A and B have very similar genes and proteins, what is probably true?

A. Species A and B share a relatively recent common ancestor.
B. Species A evolved independently of species B for a long period.
C. Species A is younger than species B.
D. Species A is older than species B.

6. When two species reproduce at different times, the situation is called:

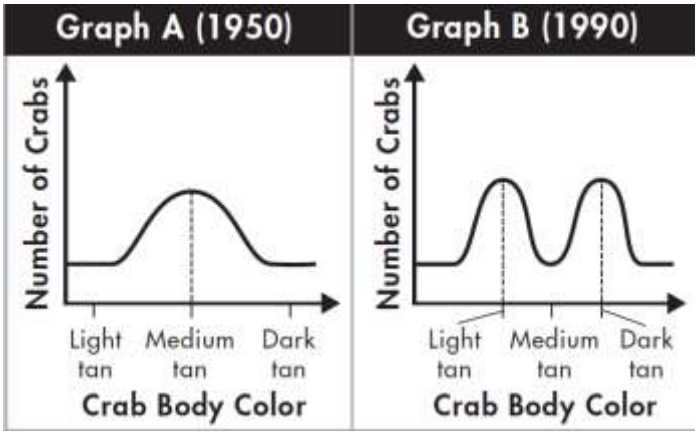
A. genetic drift.
B. temporal selection.
C. temporal isolation.
D. lateral gene transfer.

7. The length of time that two taxa have been evolving separately can be estimated using:

A genetic drift. B a molecular clock.
C gene duplication. D Hox genes.

Questions 8–9

The graphs below show the changes in crab colour at one beach.



8. What process occurred over the 40-year period?

A. artificial selection B. stabilizing selection
C. directional selection D. disruptive selection

9. Which of the following is MOST likely to have caused the change in the distribution?

A. A new predator arrived that preferred dark-tan crabs.
B. A new predator arrived that preferred light-tan crabs.
C. A change in beach colour made medium-tan crabs the least visible to predators.
D. A change in beach colour made medium-tan crabs the most visible to predators.

Open-Ended Response

10. How does evolution change the relative frequency of alleles in a gene pool? Why does this happen?