

Evolution Workbook

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Evolution Interview and Paper

In addition to our regular assignments over Darwin and his idea of natural selection, each student will be responsible for a one-page paper on the topic of evolution. The goal of this unit is not to get each student to believe in the theory of evolution; rather, it is to get each student to *understand* the theory of evolution. This paper should reflect your understanding of the theory of evolution and include personal feelings on the validity of the theory.

The paper will not be graded on whether or not you accept evolution as a legitimate explanation for the variety of life on Earth. Your paper will be graded on coverage of the following issues:

- a) Explain, in your own words, the theory of natural selection.
- b) Interview a person (other than a fellow student) about their feelings on evolution. Include a paragraph with some quotes and a summary of their ideas.
- c) Include your personal opinion on the subject. If you agree with evolution, which "version" do you accept? Why or why not (don't bother writing this paragraph if you don't include a reason for opinion)?

Your paper should include at least one source other than the textbook. Sources can include books, journals, websites or interviews. Be sure to give credit to sources that provide you with information!!!

Section I Questions:

T/F...if false, change sentence to make it correct.

- ____ 1. Darwin is the only scientist responsible for our understanding of evolution.
- ____ 2. Traits that an individual acquires during their lifetime can be passed on to their offspring.
- ____ 3. Natural selection selects for favorable characteristics best suited for the environment.
- ____ 4. Artificial selection that is guided by humans is called natural selection.
- ____ 5. Variation must be heritable for natural selection to operate.
- ____ 6. Prior to Darwin and the development of evolutionary theory, most people believed the earth to be very old.
- ____ 7. Darwin's idea that individuals in a population compete for resources came from reading a book by Charles Lyell.
- ____ 8. Species produce more offspring than can survive in the environment
- ____ 9. Darwin used his observations of artificial selection, as he called it, to derive and promote his theory of evolution by natural selection.

____ 1. What type of fossil remains did Darwin discover in Argentina that turned out to be one of the largest land mammals that have ever lived?

- (a) Galapagos tortoise (b) Ground sloth
- (c) Giraffe (d) Elephant

____ 2. What is the process by which a certain trait becomes more common within a population?

- (a) Inheritance of Acquired Characteristics (b) Natural selection
- (c) Struggle for existence (d) Overproducing of offspring

____ 3. Who developed a theory of evolution similar to Darwin's?

- (a) Alfred Russel Wallace (b) Charles Lyell
- (c) John Baptiste Lamarck (d) Thomas Malthus

____ 4. A population of worms comes in two varieties: black worms and pink worms. A predator moves into the area that likes to eat only pink worms. What will happen to the worm population over time?

- (a) The population will eventually consist of more black worms than pink worms.
- (b) The population will eventually consist of more pink worms than black worms.
- (c) The predator will eat all the worms causing the worm population to go extinct.
- (d) The population will not change.

____ 5. Today, rose plants have thorns on their branches. These thorns help protect the plants from being eaten by animals. If there are no longer any animals that eat rose plants, what might be the result of evolution in the rose plant after a million years?

- a. they might become extinct b. they might no longer have thorns
- c. they might have many more thorns d. they might only grow in the wild, not in gardens

- _____6. What could be said about an organism that CANNOT meet its needs within an ecosystem?
- a. it may become extinct
 - b. it may change its coloring
 - c. it will become an herbivore
 - d. it will produce more offspring
- _____7. Natural selection depends on which of the following?
- a. variation within the population
 - b. geographic separation of two parts of the population
 - c. catastrophic destruction of most members of the population
 - d. migration of large numbers out of the population
- _____8. Which of the following would minimize variation in population?
- a. Crossing over of alleles
 - b. Lack of competition
 - c. Random fertilization
 - d. Independent assortment of alleles
- _____9. Which statement is true about evolution?
- a. It explains how mutations occur in animals and plants.
 - b. it is a theory that describes how and when the earth was formed
 - c. it explains why some animals live on land and others live in the water
 - d. it is a theory that describes the changes life on earth has undergone throughout time

Matching

- ___ 1. Natural Selection
- ___ 2. Charles Darwin
- ___ 3. John Baptiste Lamarck
- ___ 4. Charles Lyell
- ___ 5. Artificial Selection
- ___ 6. Thomas Malthus
- ___ 7. Alfred Russell Wallace

- a. The process by which a certain trait becomes more common within a population, including heritable variation, overproduction of offspring, and differential survival and reproduction.
- b. Concluded that the earth was very old and that many small changes over long periods of time led to present-day landscapes.
- c. Described competition among humans as a result of overpopulation and too little food which lead to the realization that all animals must compete to survive.
- d. Origin of Species author
- e. Animal or plant breeding where humans determine which individuals will reproduce.
- f. Developed independently the same theory of evolution as Darwin
- g. Although incorrect, his concept of inheritance of acquired characteristics provided more interest to the idea that life had evolved

Short Answer

1. Describe two observations Darwin made on his voyage on the Beagle that helped him develop his theory of evolution.

2. What is the inheritance of acquired characteristics? What scientist developed this mistaken idea?

3. What is artificial selection? How does it work?

4. How did Alfred Russel Wallace influence Darwin?

5. Why did Darwin's observations of Galápagos tortoises cause him to wonder how species originate?

6. Explain how the writings of Charles Lyell and Thomas Malthus helped Darwin develop his theory of evolution by natural selection.

7. In your own words, explain the theory of natural selection;

Darwin's Theory of Evolution

Darwin delighted in the great diversity of life, but also saw unity within that diversity. He saw striking patterns in the similarities and differences. Seeking an explanation for those patterns, he developed the concept of natural selection. Natural selection explains how today's organisms could be related – through “descent with modification” from common ancestors. Natural selection explains the story told by the fossil record – the long history of life on Earth.

In the light of natural selection, it is easy to see that variation – differences among individuals within a population – increases the chance that at least some individuals will survive if the environment changes. If we were all genetically identical – if variation (or genetic variation) did not exist – a virus which previously could kill just some of us would either kill all of us, or none of us.

Throughout the long history of life, variation has provided insurance that inevitable changes in the environment will not mean the extinction of a species. Similarly, the diversity of species ensures that environmental change will not mean the extinction of life. Life has evolved (or, the Earth's changing environment has selected) variation and diversity because they ensure survival.

Questions

1. “Darwin delighted in the great diversity of life, but also saw unity within that diversity.” Using any two organisms of your choosing, identify how they are unified and how they are diverse. What similarities do they have in common? Differences?

2. In your own words, explain the meaning of the phrase, “descent with modification.”

3. Why is variation so important to the continuation of life on earth?

Natural Selection

Another way to look at natural selection is in terms of fitness - the ability of an organism with a certain genotype to reproduce. Fitness can be measured as the proportion of that organism's genes in all of the next generation's genes. When differences in individual genotypes affect fitness; the genotypes with higher fitness become more common. This change in genotype frequencies is natural selection.

An intriguing corollary of genotype selection is kin selection. Behaviors which sacrifice reproductive success or even survival can actually increase fitness if they promote the survival and reproduction of close relatives who share a significant proportion of the same genes. Examples include subordinate male turkeys, who help their dominant brothers display to potential mates and honeybee workers, who spend their lives collecting pollen and raising young to ensure that their mother, the queen, reproduces successfully.

Why would a honeybee risk her life to defend a hive filled with another bee's offspring? Isn't this unselfish, altruistic behavior surprising in light of the theory of evolution?

Questions

1. What is fitness?

2. Organism A lives a long life and produces no offspring. Organism B lives a short life, but produces offspring. Which organism has the higher fitness?

3. How is fitness measured?

4. Why does an organism benefit from helping its kin survive and reproduce?

Section II Question

___ 1. The mutation that causes sickle cell anemia is what type of mutation?

- (a) single gene mutation (b) neutral
(c) chromosomal (d) non-heritable

___ 2. Mutations can be

- (a) neutral (b) harmful (c) helpful (d) all of the above

___ 3. If you saw a rabbit with brown fur color, what would you be able to determine about the rabbit?

- (a) Its phenotype for fur color. (b) Its genotype for fur color.
(c) The number of offspring it will be able to produce. (d) The age of the rabbit.

T/F...if false, change sentence to make it correct.

___ 1. Mutations in body cells do not affect the DNA in eggs and sperm.

___ 2. Sexual reproduction can create new alleles for a population.

___ 3. Individuals do not evolve.

___ 4. Mutations never improve an organism's fitness.

___ 5. The ability of an organism with a certain genotype to survive and reproduce is known as fitness.

Short Answer

1. Why are populations, rather than individuals, the units of evolution?

2. What is a gene pool?

3. Why is mutation needed for evolution to occur, even though it usually has little effect on allele frequencies?

4. What would you predicted would happen to the frequencies of alleles A and S if malaria were eliminated in Africa? Explain.

Evolution of Resistance

The evolution of resistance is a growing problem for many disease-causing bacteria and also for parasites, viruses, fungi, and cancer cells. The “miracle” of drug treatment which appeared to protect humans from disease may be short-lived. How does resistance happen? How can we prevent it?

First, recognize that resistance describes the bacterium (or other microorganism) – not the human. Bacteria multiply much more rapidly than humans, and therefore can evolve much more rapidly. Consider a population of bacteria infecting an individual with tuberculosis. Like all populations, individuals within that population show variation. Mutations add more variation. By chance, mutation may change the chemistry of one or a few bacteria so that they are not affected by a particular antibiotic. If the infected human begins to take antibiotics, they change the environment for the bacteria, killing most of them. However, the few bacteria which by chance have genes for resistance will survive this change in environment - and reproduce offspring which also carry the genes. More and more of the bacterial population will be resistant to antibiotics, because the antibiotics select for resistance. The bacteria are merely evolving in response to changes in their habitats! If the resistant bacteria are transmitted to another human “habitat”, their population continues to expand, and if the new “habitat” takes different drugs, natural selection may result in multi-drug resistance.

Questions

1. Compare the rate of reproduction in humans to the rate of reproduction in bacteria.
2. How does the difference in rates of reproduction between humans and bacteria relate to the amount of time it takes each organism to evolve?
3. Are all individual bacterium in a population of bacteria the same? What may be one difference?
4. What role does chance play in the development of antibiotic resistance?
5. Explain in your own words how a population of bacteria evolves resistance to an antibiotic over time.

Populations and Gene Pools

Individuals do not evolve. Natural selection may affect an individual's chance to survive and reproduce, but it cannot change the individual's genes. However, a **population** – a group of organisms of a single species in a certain area – evolves when natural selection imposes differential survival on individuals within it. **Population genetics** studies populations at the level of genes and alleles in order to discover how evolution works.

If we consider all the alleles of all the genes of all the individuals within a population, we have defined the **gene pool** for that population. Gene pools contain all the genetic variation – that raw material for natural selection – within a population. The gene pool for a rabbit population, for example, includes alleles which determine coat color, ear size, whisker length, tail shape, and more. If a population geneticist wants to focus on the variation in an individual gene, s/he may look at the gene pool of all the alleles for that gene alone.

Questions

1. Why can't an individual evolve?
2. Name three populations of organisms that live in your neighborhood.
3. What are some alleles present in the gene pool of a rabbit population?
4. What are some alleles present in the gene pool of a human population?

Section III Questions

_____1. Reproductive isolation

- (a) increases speciation (b) decreases speciation
(c) stabilizes speciation (d) has no effect on speciation

_____2. The idea that the rate of evolution is slow and constant, with small changes accumulating to form big changes, is called

- (a) punctuated equilibrium (b) Biological species concept
(c) ecological niche (d) gradualism

_____3. Large changes in a species (speciation) over geologic time would be considered

- (a) microevolution (b) macroevolution
(c) Hardy-Weinberg model (d) genetic equilibrium

_____4. In order for a mutation to be passed from parent to offspring it must appear in

- (a) gametes (b) any of the parents' cells
(c) all of the body cells (d) none of the above

T/F...if false, change sentence to make it correct.

_____ 1. All humans are members of the same species.

_____ 2. Long periods of environmental stability may slow the rate of speciation.

_____ 3. Gradualism describes the rate of evolution as relatively stable with brief periods of rapid speciation.

_____ 4. Rivers, mountains, and glaciers are examples of geographic barriers that result in Sympatric speciation.

Short Answer

1. Define speciation.

2. Describe how allopatric speciation occurs.

3. What is gradualism? When is it most likely to apply?

4. Describe the timing of evolutionary change according to the punctuated equilibrium model.

5. You read in this chapter about adaptive radiation on the Galápagos Islands. A single finch species evolved into many new species to fill all available niches. For example, the species evolved adaptations for a variety of food sources.

What is a species' niche? What do you think it might include besides the food a species eats?

Section IV Questions

T/F. *If false, change sentence to make it correct.*

- ___ 1. The liver is a vestigial structure found in humans.
- ___ 2. Analogous structures are structures which evolved from the same structure within a common ancestor.
- ___ 3. The fossil record for horses shows gradual changes which correspond to changes in the environment.
- ___ 4. Evolution is like a progressing ladder, where species become more and more perfect as time goes on.
- ___ 5. The wing of a bat and the wing of a bird are considered to be analogous structures.
- ___ 6. The fossil record for horse evolution has large gaps where huge amounts of information are missing.
- ___ 7. Paleontologists are scientists who study fossils.
- ___ 8. Radioactive decay is a random process that occurs at a fixed rate.
- ___ 9. The rate of evolution is always the same.
- ___ 10. Geographic changes can affect patterns of evolution.

Term

- ___ 1. homologous structures
 - ___ 2. embryology
 - ___ 3. biogeography
 - ___ 4. vestigial structures
 - ___ 5. analogous structures
 - ___ 6. fossils
 - ___ 7. comparative anatomy
 - ___ 8. relative dating
 - ___ 9. paleontology
- a. The study of patterns of distribution of species on continents and islands.
 - b. Similar structures with identical functions shared by distantly related species that are a result from natural selection in similar environments, but that evolved independently.
 - c. The study of the similarities and differences in organisms' structures.
 - d. Structures which evolved from the same structure within a common ancestor; may or may not serve the same function.
 - e. The study of fossils to explore the history of life.
 - f. A tree-like diagram showing evolutionary relationships according to a given set of data, such as molecular data.
 - g. Structures which are reduced and perhaps even nonfunctional in one species but homologous to functional structures in a closely related species.
 - h. A technique for aging fossils based on comparing their positions within rock layers; fossils in lower layers are usually older than fossils in upper layers.
 - i. A branch of comparative anatomy which studies the development of vertebrate animals before birth or hatching.
 - j. The mineralized remains of an animal, plant, or other organism.

____1. A scientist who studies fossils to explore the history of life is called a
(a) geologist. (b) botanist. (c) archeologist. (d) paleontologist.

____2. Structures that evolved independently in two different species are referred to as
(a) homologous. (b) vestigial. (c) analogous. (d) comparative.

____3. The study of the development of vertebrate animals before birth or hatching is called
(a) anatomy. (b) embryology. (c) homology. (d) biogeography.

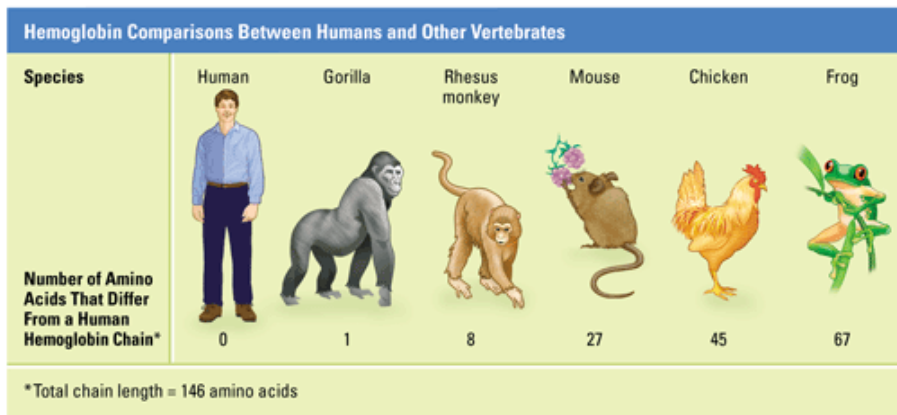
____4. What two structures appear in the early development of all vertebrate embryos?
(a) fur and nails (b) feathers and lungs (c) fingers and toes (d) gill slits and a tail

____5. Which of the following types of evidence for evolution did Darwin not know about?
(a) Molecular data (b) Biogeography (c) Comparative anatomy (d) Fossils

____6. The study of the distribution of plants and animals and the processes that influence their distribution is called
(a) biogeography. (b) comparative anatomy. (c) comparative embryology. (d) molecular data.

Short Answer

1. Use the diagram below to answer the following question: Are frogs and chickens more closely related to each other than they are to humans? Explain.



2. Give an example of 2 species that show divergent evolution. (Become different over time.)

3. Give an example of 2 species that show convergent evolution. (Become similar because they are subject to similar environments.)

4. Describe what fossils reveal about the evolution of the horse.

5. What are vestigial structures? Give an example.

6. Define biogeography.

7. Describe an example of island biogeography that provides evidence of evolution.

8. Compare and contrast homologous and analogous structures. What do they reveal about evolution?

9. Why might comparative embryology show similarities between organisms that do not appear to be similar as adults?

Homologous Structures Lab

1. Draw the bones of the human arm, chicken wing and bat wing below. Label the following bones (humerus, radius, ulna, carpels, metacarpels).

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2. What is a homologous structure?
3. What is a vestigial structure?
4. Give an example of a vestigial structure and explain what makes it a vestigial structure:

Study Guide for Evolution Test – Lovrien biology

Define Evolution:

Darwin didn't invent evolution, he proposed Natural Selection in his book *On the Origin of Species*. Be able to list and explain the three steps of natural selection:

Be able to complete halflife problems. If you start with 1000 units of U-238 and only 250 units remain, how old is the object (halflife 710 million years).

Be able to explain why evolutionists find the following lines of evidence as supporting Theory of Evolution:

- Comparative Anatomy (Homologous Structures, Vestigial Structures):
- Comparative Embryology:
- Comparative BioChemistry (amino acids and DNA):
- How do workers in social insects, such as honeybees, pass on genes without ever having children?
- Be able to define the following terms: population, niche, altruism, speciation, homologous structure, vestigial structure, natural selection, artificial selection.
- Explain how Darwin's theory differed from the theory proposed by Lamarck.