

Evolution

Part 1: Historical Perspective on the Theory of Natural Selection

1. In the 1860's, what types of evidence were available to indicate that evolution had occurred on Earth?

2. How did knowledge of mechanisms of artificial selection (used in developing various strains of domesticated animals and plants) help Darwin understand how evolution could occur?

3. Based on his studies, Darwin made a number of observations; they are listed in the chart. Complete the chart by answering how Darwin made the observations.

Observation	How did Darwin make this observation? That is, what did he read or observe that gave him this understanding?
a. All species populations have the reproductive potential to increase exponentially.	
b. The number of individuals in natural populations tends to remain stable over time.	
c. Environmental resources are limited.	

Observation	How did Darwin make this observation? That is, what did he read or observe that gave him this understanding?
d. Individuals in a population vary in their characteristics.	
e. Much of this variation in characteristics is heritable.	

4. Based on these observations, Darwin made a number of inferences. Which of the observations in question 3 allowed Darwin to make each inference?

Inference	Observations that led to the inference
a. Production of more individuals than the environment can support leads to a struggle for existence such that only a fraction of the offspring survive each generation.	
b. Survival for existence is not random. Those individuals whose inherited traits best fit them to their environment are likely to leave more offspring than less fit individuals.	
c. The unequal ability of individuals to survive and reproduce leads to a gradual change in population, with favorable characteristics accumulating over the generations.	

5. Based on these observations, what was Darwin's definition of fitness?

6. How did Darwin define evolution?

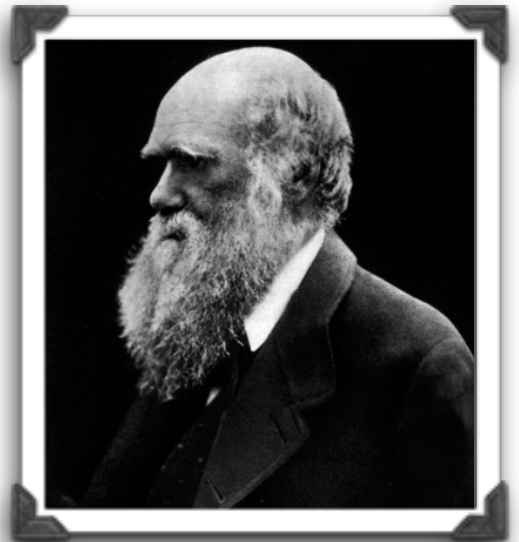
7. What is the unit of natural selection? What is selected? What evolves?

8. In a population of mice, some individuals have brown fur and some have black fur. At present, both phenotypes are equally fit. What could happen to change the relative fitness of the two phenotypes in the population?

9. Why is it incorrect to say: Vertebrates evolved eyes in order to see?

Part 2: Darwin vs. Lamarck

Read the following statements. For each one, decide if it is more Lamarckian or more Darwinian. If the statement is Lamarckian, change it to make it Darwinian.

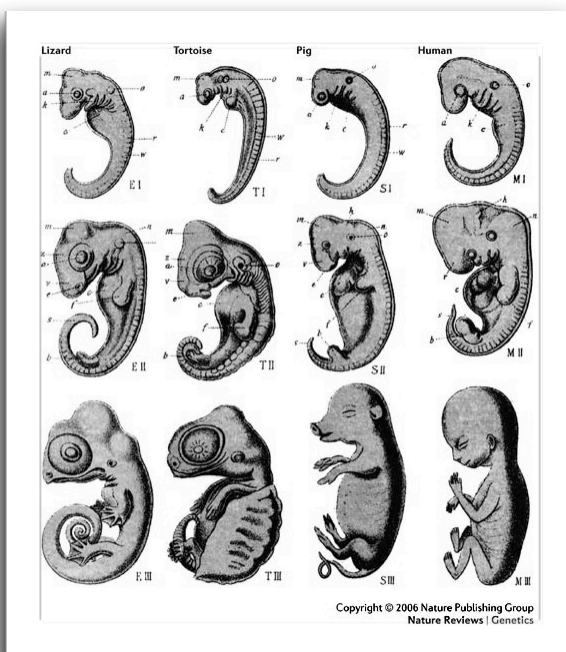


1. Many of the bacterial strains that infect humans today are resistant to a wide range of antibiotics. These resistant strains were not so numerous or common prior to the use of antibiotics. These strains must have evolved in response to the use of antibiotics.
2. Life arose in the aquatic environment and later invaded land. Once animals came onto land, they had to evolve effective methods of support against gravity and locomotion in order to survive.
3. A given phenotypic trait--for example height, speed, tooth structure--(and therefore the genes that determine it) may have positive survival or selective value, negative survival or selective value or neutral survival or selective value. Which of these it has depends on the environmental conditions the organism encounters.
4. According to one theory, the dinosaurs became extinct because they couldn't evolve fast enough to deal with climactic changes that affected their food and water supplies.

5. The children of body builders tend to be much more athletic, on average, than other children because the characteristics and abilities gained by their parents have been passed on to the children.

6. The widespread use of DDT in the middle of the last century put pressure on insect populations to evolve resistance to DDT. As a result, large populations of insects today are resistant to DDT.

Part 3: How would you evaluate these explanations of Darwin's ideas?



Here is a question from a test on evolution:

4 points:

In two or three sentences describe Darwin's theory of descent with modification and the mechanism of natural selection that he proposed to explain how this comes about.

Read the following responses and provide a grade. For any grade less than full credit, please explain why points were lost:

Student 1: Darwin saw that populations increased faster than the ability of the land to support them could increase, so that individuals must struggle for limited resources. He proposed that individuals with some inborn advantage over others would have a better chance of surviving and

reproducing offspring and so be naturally selected. As time passes, these advantageous characteristics accumulate and change the species into a new species.

Grade:

Student 2: Darwin's theory of evolution explains how new species arise from already existing ones. In his mechanism of natural selection, organisms with favorable traits tend to survive and reproduce more successfully, while those that lack the traits do not. Beneficial traits are passed on to future generations in this manner, and a new species will be created in the end.

Grade:

Student 3: Descent with modification using natural selection was Darwin's attempt at explaining evolution. An organism is modified by its surrounding, activities, and lifestyle. These modifications, by natural selection, make the organism better suited to its life.

Grade:

Student 4: Darwin's theory states that organisms can become modified by environmental conditions or use or disuse features and that the modifications can be passed down to succeeding generations. He proposes that nature selects for a characteristic trait that is beneficial to the survival of the organisms and that organisms would pass on this trait.

Grade:

Part 4: Hardy-Weinberg Practice

Use your understanding of the Hardy-Weinberg theorem to answer the questions.

Remember: $p^2 + 2pq + q^2 = 1$; $p + q = 1$

1. Assume a population is in Hardy-Weinberg equilibrium for a given genetic autosomal trait. What proportion of individuals in the population are heterozygous for the gene if the frequency of the recessive allele in the gene pool is 1%?

2. About one child in 2,500 is born with phenylketonuria or PKU (an inability to metabolize the amino acid phenylalanine). This is known to be a recessive trait.
 - a. If the population is in Hardy-Weinberg equilibrium for this trait, what is the frequency of the PKU allele?

 - b. What proportion of the population are carriers of the PKU allele (that is, what proportion are heterozygous)?

3. In purebred Holstein cattle, about one calf in 100 is spotted red rather than black. The trait is autosomal and red is a recessive to black.
 - a. What is the frequency of the red alleles in the population?

 - b. What is the frequency of black homozygous cattle in the population?

 - c. What is the frequency of black heterozygous cattle in the population?

Part 5: What effects can selection have on populations?

1. What effects can natural selection have on populations? For example, what types of selection can occur in a population, and how are these defined?



2. Examine the scenarios on the following pages. For each scenario:
 - a. Decide whether or not natural selection is operating. In doing this, indicate whether there is variability in the population(s). If no, what does this imply about evolution? If yes, what is the nature of the variation? For example, what characteristics must the variation have for selection to operate on it?
 - b. Is there any indication that members of the population(s) differ in fitness? If no, what does this imply about the operation of natural selection? If yes, describe the difference in fitness.
 - c. Given our answers to parts a and b, what trend's should characterize the future behavior or composition of the population(s)?

Be sure to indicate any assumptions that you make in answering the questions.

Scenario I: A particular species of mouse feeds on the seeds of a single species of cherry tree. When the mice eat a seed, they digest it completely. The mice choose seeds of intermediate and large sizes, leaving the small seeds of the cherry tree uneaten.

- a.
- b.
- c.

Scenario II: After a severe spring ice storm, about half of the finches (small birds) in a population are found dead. Examination of the dead birds indicates that they vary in age from young to old. About 60% of the dead are new fledglings (just left the nest); about 20% are over 3 years of age (old for this species).

a.

b.

c.

Part 6: What factors affect speciation?

1. How does the existence of an archipelago (a small chain of islands) promote speciation? Explain or provide an example?
2. Are speciation events that occurred on these islands more likely to have been allopatric or sympatric? Explain.
3. Is the type of speciation seen on islands more likely to be the result of anagenesis or cladogenesis? Explain.
4. Hybrids formed by mating two different species are often incapable of reproducing successfully with each other or with the members of their parent populations. Explain why this is the case (Hint: Think chromosomes).

5. Because most hybrids can't reproduce, their genes (and the genes of their parents) are removed from the population. Only the genes of individuals who breed with members of their own species remain in the population. This implies that there is a strong selective advantage for genes that enable individual organisms to recognize members of their own species. Today a wide range of reproductive isolating mechanisms has been identified. Each of the following scenarios describes a reproductive isolating mechanism. Indicate whether each is a pre-zygotic or post-zygotic isolating mechanism. Explain your answers.

a. Crickets use species-specific chirp patterns to identify a mate of their own species.

b. Two species of butterfly mate where their ranges overlap and produce fertile offspring, but the hybrids are less viable than the parental forms.

c. Two species of a plant cannot interbreed because their flowers differ in size and shape and require pollination by different species of bee.

d. Two species of firefly occupy the same prairie and have similar flash patterns, but one is active for a half-hour around sunset while the other doesn't become active until an hour after sunset.

