

EVOLUTION REVIEW

A. Top 10

1. Darwin's Principle of Natural Selection

- a. Variation - individuals within a population passes heritable variation within traits
 - Sexual recombination
 - Mutation
- b. Overproduction - organisms produce more offspring than can survive
- c. Competition - those individuals with advantageous adaptations will out-compete others
- d. Survival and Reproduction of the Fittest - individuals with favorable characteristics tend to have more offspring and pass on these traits to their offspring
 - Alleles for favorable traits increase in the population
 - Individuals are selected, but populations evolve

2. Selection

- a. Directional vs. Stabilizing vs. Disruptive
- b. Sexual selection
- c. Genetic drift = effect of chance events
 - Bottleneck effect (cheetahs)
 - Founder's effect (European settlers in America)
- d. Gene flow
- e. Coevolution: angiosperms and pollinators

3. Hardy Weinberg equilibrium

- a. $p + q = 1$ (allele frequency)
- b. $p^2 + 2pq + q^2 = 1$ (phenotype frequency)
- c. H-W conditions
 - Infinitely large population
 - Random mating
 - No mutation
 - No gene flow (migration in or out)
 - No selection

4. Phylogenies

- a. Comparative Biology
 - Clades
 - Homologous Structures
 - Ancestral trait and derived trait
 - Convergent evolution
- b. Parsimony Principle
- c. Sources of Data
 - Morphology
 - Development
 - Fossil record
 - Behavior
 - Molecular data

5. Speciation

- a. Biological species concept (Ernst Mayr) - population able to interbreed and produce viable, fertile offspring
- b. Allopatric - geographically isolated populations

- c. Sympatric - population in same environment adapt to fill different niches
 - Adaptive radiation (Galapagos finches)
 - Mechanisms
 - Prezygotic: habitat factors, temporal factors, behavioral factors, mechanical factors, gamete factors
 - Post-zygotic: reduced hybrid viability, reduced hybrid fertility
- d. Hybrid Zones
- e. Rate of speciation
 - Gradualism (Darwin)
 - Punctuated equilibrium (Stephen Jay Gould & Niles Eldridge)

6. Origin of Life

- a. Earth is 4.5 billion years old
- b. Abiotic origin
 - Atmosphere of CO_2 , methane (CH_4) and ammonia (NH_3) energized by lightning and UV rays
 - Formation organic compounds in seas (Miller-Urey experiment)
 - Formation of protobionts and then bacteria (3.5 bya)
- c. Continental drift
- d. Changes in oxygen concentration

7. Evidence

- a. Fossil record
- b. Biogeography
 - Convergent evolution (analogous structures)
- d. Comparative embryology
- e. Comparative genomics (molecular biology)
 - Universal genetic code
 - Conserved proteins (hemoglobin, cytochrome C)
- f. Artificial selection
 - Agriculture, dog breeding, pesticide resistance, antibiotic resistance

B. Sample Multiple Choice Questions

1. Which of the following is most often associated with the elaborate courtship rituals conducted by many birds?
 - a. species recognition
 - b. migration
 - c. feeding response
 - d. altruism
 - e. kin selection

2. The replacement of glutamic acid by valine at a specific position in the beta chains of hemoglobin leads to sickle cell anemia. This change represents which of the following mutational events?
 - a. DNA base-pair substitution
 - b. DNA base-pair deletion
 - c. DNA base-pair addition
 - d. chromosomal deletion
 - e. frameshift mutation

3. The difference in cricket calls among sympatric species of crickets are examples
 - a. habitat isolation
 - b. temporal isolation
 - c. physiological isolation

- d. behavioral isolation
- e. geographic isolation

4. Which of the following principles is NOT part of Darwin's theory of evolution by natural selection?

- a. Evolution is a gradual process that occurs over long periods of time.
- b. Variation occurs among individuals in a population.
- c. Mutations are the ultimate source of genetic variation.
- d. More individuals are born than will survive.
- e. Individuals that possess the most favorable variations have the best chance of reproducing.

5. In a small group of people living in a remote area, there is a high incidence of "blue skin", a condition that results from a variation on the structure of hemoglobin. All of the "blue-skinned" residents can trace their ancestry to one couple, who were among the original settlers of this region. The unusually high frequency of "blue skin" in the area is an example of

- a. mutation
- b. genetic drift
- c. natural selection
- d. sexual selection
- e. heterozygote advantage

6. Which of the following statements best expresses the concept of punctuated equilibrium?

- a. Small variations gradually accumulate in evolving lineages over periods of millions of years.
- b. Random mating ensures that the proportions of genotypes in a population remain unchanged from generation to generation.
- c. Stability is achieved when selection favors the heterozygote, while both types of homozygotes are at a relative disadvantage.
- d. Evolutionary changes consist of rapid bursts of speciation alternating with long periods in which species remain essentially unmodified.
- e. Under competition for identical resources, one of the two competing species will be eliminated or excluded.

7. In certain Native American groups, albinism due to homozygous recessive condition in the biochemical pathway for melanin is sometimes seen. If the frequency of the allele for this condition is 0.06, which of the following is closest to the frequency of the dominant allele in this population? (Assume Hardy-Weinberg equilibrium)

- a. 0.04
- b. 0.06
- c. 0.16
- d. 0.36
- e. 0.94

Question 8 - 9: In a certain flock of sheep, 4 percent of the population has black wool and 96 percent has white wool. Assume Hardy-Weinberg equilibrium.

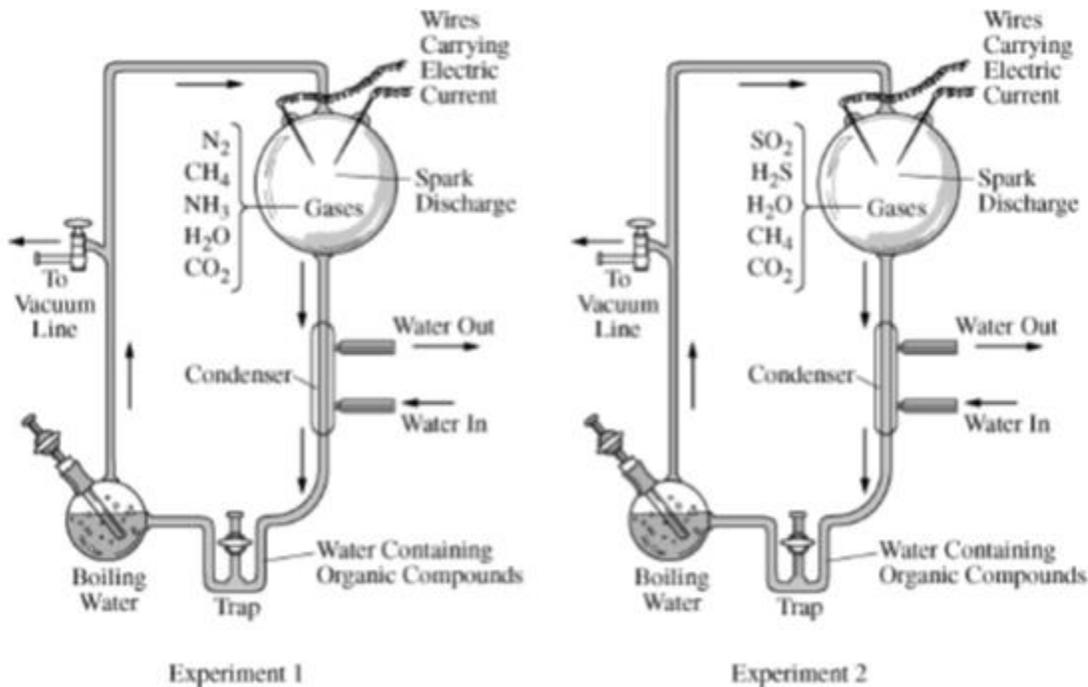
8. If black wool is a recessive trait, what percentage of the population is heterozygous for this trait?

- a. 4%
- b. 20%
- c. 32%
- d. 64%
- e. 80%

9. What percentage of the population is homozygous for white wool?

- a. 20%
- b. 40%
- c. 64%
- d. 80%
- e. 96%

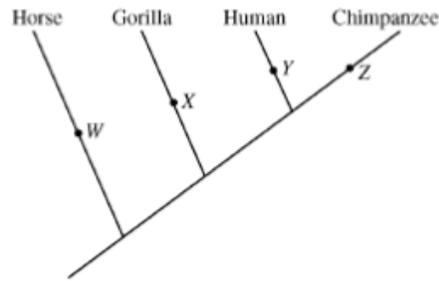
10. Two groups of students attempted to re-create the primitive atmospheric conditions of early Earth using the apparatus represented below. Each group ran the experiment with different gas mixtures in the apparatus.



Which of the following statements justifies the claim that the conditions in at least one of the experiments could generate the molecular building blocks essential for life?

- A. The carbon dioxide gas and water vapor in experiment 1 could react spontaneously to produce phospholipids required by the first life forms.
- B. The nitrogen gas and ammonia gas in experiment 1 could provide the elemental nitrogen required for the formation of amino acids.
- C. The sulfur dioxide gas in experiment 2 could donate the excited electrons required to drive the process of photosynthesis.
- D. The methane gas in experiment 2 could act as the electron acceptor required to complete the process of cellular respiration.

11. The cladogram below depicts an accepted model of the evolutionary relationships among selected species.



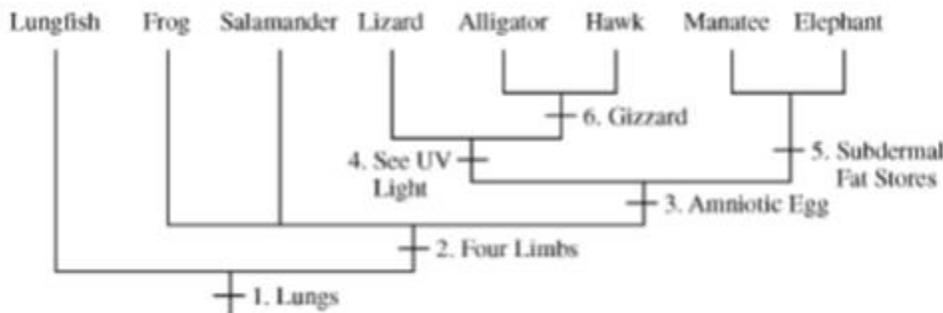
The amino acid at position 104 in the beta-hemoglobin protein for each of these four organisms is listed below.

Species	Amino Acid 104
Horse	Arginine
Gorilla	Leucine
Human	Arginine
Chimpanzee	Arginine

The validity of the cladogram is best supported by molecular evidence for which of the following changes in the amino acid composition of the beta-hemoglobin protein during the evolution of these species.

- A. Arginine to leucine at position X on the cladogram.
- B. Arginine to leucine at position Y on the cladogram.
- C. Leucine to arginine at position W on the cladogram.
- D. Leucine to arginine at position Z on the cladogram.

12. **Completion question**



The cladogram above shows proposed phylogenetic relationships for several vertebrates. Selected derived traits are indicated on the cladogram by numbered labels. Based on the information presented, which of the derived traits is shared by alligators and manatees but not salamanders? Give your answer as the number label of a character indicated on the cladogram.

C. Sample Free Response Questions

1. Darwin is considered the "father of evolutionary biology." Four of his contributions to the field of evolutionary biology are listed below.

- The nonconstancy of species
- Branching evolution, which implies the common descent of all species

- Occurrence of gradual changes in species
- Natural selection as the mechanism for evolution
- a. For EACH of the four contributions listed above, **discuss** one example of supporting evidence.
- b. Darwin's ideas have been enhanced and modified as new knowledge and technologies have become available. **Discuss** how TWO of the following have modified biologists' interpretation of Darwin's original contributions.
 - Hardy-Weinberg equilibrium
 - Punctuated equilibrium
 - Genetic engineering

2. Charles Darwin proposed that evolution by natural selection was the basis for the differences that he saw in similar organisms as he traveled and collected specimens in South America and on the Galapagos Islands.

- Explain** the theory of evolution by natural selection as presented by Darwin. Each of the following relates to an aspect of evolution by natural selection.
- Explain** three of the following.
 - Convergent evolution and the similarities among species (ecological equivalents) in a particular biome (e.g., tundra, taiga, etc.)
 - Natural selection and the formation of insecticide-resistant insects or antibiotic-resistant bacteria
 - Speciation and isolation § Natural selection and behavior such as kinesis, fixed-action-pattern, dominance hierarchy, etc. (Old curriculum)
 - Natural selection and heterozygote advantage

Principles of Life: Chapter Breakdown (Essential Exam Content)

Chapter 15: Processes of Evolution

15.2 Mutation, Selection, Gene Flow, Genetic Drift and Nonrandom Mating Result in Evolution

- Mutation generates genetic variation
- Selection on genetic variation leads to new phenotypes
- Natural selection increases the frequency of beneficial mutations in populations
- Gene flow may change allele frequencies
- Genetic drift may cause large changes in small populations
- Nonrandom mating can change genotype or allele frequencies

15.3 Evolution Can Be Measured by Changes in Allele Frequencies

- Evolution will occur unless certain restrictive conditions exist
- Deviations from Hardy-Weinberg equilibrium show that evolution is occurring

15.4 Selection Can Be Stabilizing, Directional or Disruptive

- Stabilizing selection reduces variation in populations
- Directional selection favors on extreme
- Disruptive selection favors extremes over the mean

15.6 Recombination, Lateral Gene Transfer and Gene Duplication Can Result in New Features

- Sexual recombination amplifies the number of possible genotypes

Chapter 16: Reconstructing and Using Phylogenies

16.1 All of Life is Connected through Its Evolutionary History

- Phylogenetic trees are the basis of comparative biology
- Derived traits provide evidence of evolutionary relationships

16.2 Phylogeny Can Be Reconstructed from Traits of Organisms

- Parsimony provides the simplest explanation for phylogenetic data
- Phylogenies are constructed from many sources of data
- Mathematical models expand the power of phylogenetic reconstruction
- The accuracy of phylogenetic methods can be tested

16.3 Phylogeny Makes Biology Comparative and Predictive

- Phylogenies are important for reconstructing past events
- Phylogenies allow us to understand the evolution of complex traits
- Ancestral states can be reconstructed
- Molecular clocks help date evolutionary events

16.4 Phylogeny is the Basis of Biological Classification

- Evolutionary history is the basis for modern biological classification
- Several codes of biological nomenclature govern the use of scientific names

Chapter 17: Speciation

17.1 Species Are Reproductively Isolated Lineages on the Tree of Life

- We can recognize many species by their appearance
- Reproductive isolation is key

17.3 Speciation Is a Natural Consequence of Population Subdivision

- Physical barriers give rise to allopatric speciation
- Sympatric speciation occurs without physical barriers

17.4 Reproductive Isolation is Reinforced When Diverging Species Come into Contact

- Prezygotic isolating mechanisms prevent hybridization between species
- Postzygotic isolating mechanisms result in selection against hybridization
- Hybrid zones may form if reproductive isolation is incomplete

Chapter 18: The History of Life on Earth

18.2 Changes in Earth's Physical Environment Have Affected the Evolution of Life

- The continents have not always been where they are today
- Earth's climate has shifted between hot and cold conditions
- Volcanoes have occasionally changed the history of life
- Extraterrestrial events have triggered changes on Earth
- Oxygen concentration in Earth's atmosphere have changed over time