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**AP Biology Exam Review : Evolution (Unit 7)**

Ms. Ottolini, 2012-2013

**Textbook Chapters:** 22 (Descent with Modification: A Darwinian View of Life), 23 (The Evolution of Populations), 24 (The Origin of Species)

**Helpful Videos and Animations:**

1. [Bozeman Biology: Natural Selection](https://www.youtube.com/watch?v=R6La6_kIr9g&list=PLFCE4D99C4124A27A&index=2) (an overview of natural selection and Hardy-Weinberg Equilibrium)
2. [Bozeman Biology: Examples of Natural Selection](https://www.youtube.com/watch?v=S7EhExhXOPQ&list=PLFCE4D99C4124A27A)
3. [Bozeman Biology: Genetic Drift](https://www.youtube.com/watch?v=mjQ_yN5znyk&list=PLFCE4D99C4124A27A)
4. [Bozeman Biology: Evidence of Evolution](https://www.youtube.com/watch?v=ooGKYediys8&list=PLFCE4D99C4124A27A)
5. [Bozeman Biology: Essential Characteristics of Life](https://www.youtube.com/watch?v=bILvTe2_FEE&list=PLFCE4D99C4124A27A) (preserved by natural selection)
6. [Bozeman Biology: Natural Selection Unit Review](https://www.youtube.com/watch?v=sBM9ZKTQ1PQ&list=PLFCE4D99C4124A27A) (a review from the previous five videos)
7. [Bozeman Biology: Solving Hardy Weinberg Problems](https://www.youtube.com/watch?v=xPkOAnK20kw&list=PL7A750281106CD067)
8. [Bozeman Biology: Speciation and Extinction](https://www.youtube.com/watch?v=yJLRl2G41nQ&list=PLFCE4D99C4124A27A)
9. [Bozeman Biology: Speciation](https://www.youtube.com/watch?v=rlfNvoyijmo&list=PLFCE4D99C4124A27A)
10. [Bozeman Biology: Evolution Continues](https://www.youtube.com/watch?v=yJLRl2G41nQ&list=PLFCE4D99C4124A27A)
11. [Bozeman Biology: Mechanisms of Genetic Variation in Prokaryotic vs. Eukaryotic Cells](http://www.youtube.com/watch?v=UjMn4oHfYL4)

**Topic Outline:**

1. Darwin’s Theory of Natural Selection

* Know the scientists who influenced Darwin and previous theories of the mechanism of evolution (ex: Lamarckian evolution)
* Be able to use and define the following terms: evolutionary fitness, mutation, gene pool, genetic variation, etc.
* Understand the conditions required for a population to be “non-evolving” / in Hardy Weinberg Equilibrium (see CC below)
* Know how to use the two equations proposed by Hardy Weinberg Equilibrium’
* Understand how humans have “driven” the evolution of various species (ex: bacteria, peppered moths)

***CC 1.A.1: Natural selection is a major mechanism of evolution.***

***a. According to Darwin’s theory of natural selection, competition for limited resources results in differential***

***survival. Individuals with more favorable phenotypes are more likely to survive and produce more offspring,***

***thus passing traits to subsequent generations.***

***b. Evolutionary fitness is measured by reproductive success.***

***c. Genetic variation and mutation play roles in natural selection. A diverse gene pool is important for the***

***survival of a species in a changing environment.***

***d. Environments can be more or less stable or fluctuating, and this affects evolutionary rate and direction;***

***different genetic variations can be selected in each generation***

***e. An adaptation is a genetic variation that is favored by selection and is manifested as a trait that provides an***

***advantage to an organism in a particular environment.***

***f. In addition to natural selection, chance and random events can influence the evolutionary process, especially***

***for small populations.***

***g. Conditions for a population or an allele to be in Hardy-Weinberg equilibrium are: (1) a large population size,***

***(2) absence of migration, (3) no net mutations, (4) random mating and (5) absence of selection. These conditions***

***are seldom met.***

***h. Mathematical approaches are used to calculate changes in allele frequency, providing evidence for the***

***occurrence of evolution in a population.***

***To demonstrate understanding of this concept, make sure you can utilize the following:***

***● Graphical analysis of allele frequencies in a population***

***● Application of the Hardy-Weinberg equilibrium equation***

***CC 1.A.2: Natural selection acts on phenotypic variations in populations.***

***a. Environments change and act as selective mechanism on populations.***

***b. Phenotypic variations are not directed by the environment but occur through random changes in the DNA***

***and through new gene combinations.***

***c. Some phenotypic variations significantly increase or decrease fitness of the organism and the population.***

***d. Humans impact variation in other species.***

***To demonstrate understanding, make sure you can explain examples like:***

***● Flowering time in relation to global climate change***

***● Peppered moth***

***● Sickle cell anemia***

***● DDT resistance in insects***

***● Artificial selection***

***● Loss of genetic diversity within a crop species***

***● Overuse of antibiotics***

1. Genetic Drift

* Understand why genetic drift has a more significant effect on the gene pool of small populations
* Be able to describe the changes that occur in a population due to genetic bottleneck
* Explain how the founder effect can cause speciation and a reduction in genetic diversity within the isolated population

***CC 1.A.3: Evolutionary change is also driven by random processes.***

***a. Genetic drift is a nonselective process occurring in small populations.***

***b. Reduction of genetic variation within a given population can increase the differences between populations of***

***the same species.***

1. Evidence for Evolution

* Be able to describe / provide examples of the following pieces of evidence for evolution

1. Biogeography
2. Comparative Morphology / Anatomy (homologous structures, analogous structures, vestigial structures)
3. Fossil Record (transitional forms, relative dating, absolute / radioactive dating)
4. Comparative Biochemistry (DNA, RNA, and amino acid sequences)
5. Comparative Embryology

* Be able to describe evidence that indicates one common ancestor for all living organisms (see CC 1.B.1 below)

***CC 1.A.4: Biological evolution is supported by scientific evidence from many disciplines, including mathematics.***

***a. Scientific evidence of biological evolution uses information from geographical, geological, physical, chemical***

***and mathematical applications.***

***b. Molecular, morphological and genetic information of existing and extinct organisms add to our***

***understanding of evolution.***

***Evidence of student learning is a demonstrated understanding of each of the following:***

***1. Fossils can be dated by a variety of methods that provide evidence for evolution. These include***

***the age of the rocks where a fossil is found, the rate of decay of isotopes including carbon-14, the***

***relationships within phylogenetic trees, and the mathematical calculations that take into account***

***information from chemical properties and/or geographical data.***

***2. Morphological homologies represent features shared by common ancestry. Vestigial structures are***

***remnants of functional structures, which can be compared to fossils and provide evidence for evolution.***

***3. Biochemical and genetic similarities, in particular DNA nucleotide and protein sequences, provide***

***evidence for evolution and ancestry.***

***4. Mathematical models and simulations can be used to illustrate and support evolutionary concepts.***

***To demonstrate understanding, make sure you can do the following:***

***● Graphical analyses of allele frequencies in a population***

***● Analysis of sequence data sets***

***● Analysis of phylogenetic trees***

***● Construction of phylogenetic trees based on sequence data***

***CC 1.B.1: Organisms share many conserved core processes and features that evolved and are***

***widely distributed among organisms today.***

***a. Structural and functional evidence supports the relatedness of all domains.***

***Evidence of student learning is a demonstrated understanding of each of the following:***

***1. DNA and RNA are carriers of genetic information through transcription, translation and replication.***

***2. Major features of the genetic code are shared by all modern living systems.***

***3. Metabolic pathways are conserved across all currently recognized domains.***

***b. Structural evidence supports the relatedness of all eukaryotes.***

***To foster student understanding of this concept, instructors can choose an illustrative example such as:***

* ***Cytoskeleton (a network of structural proteins that facilitate cell movement, morphological***
* ***integrity and organelle transport)***
* ***Membrane-bound organelles (mitochondria and/or chloroplasts)***
* ***Linear chromosomes***
* ***Endomembrane systems, including the nuclear envelope***

***CC 1.C.3: Populations of organisms continue to evolve.***

***a. Scientific evidence supports the idea that evolution has occurred in all species.***

***b. Scientific evidence supports the idea that evolution continues to occur.***

***To foster student understanding of this concept, make sure you can explain the following:***

***● Chemical resistance (mutations for resistance to antibiotics, pesticides, herbicides or***

***chemotherapy drugs occur in the absence of the chemical)***

***● Emergent diseases***

***● Observed directional phenotypic change in a population (Grants’ observations of Darwin’s***

***finches in the Galapagos)***

***● A eukaryotic example that describes evolution of a structure or process such as heart chambers,***

***limbs, the brain and the immune system***

1. Speciation and Extinction

* Be able to describe the difference between divergent evolution / adaptive radiation, convergent evolution, and coevolution
* Be able to describe the difference between the two theories regarding the rate of speciation: gradualism vs. punctuated equilibrium
* Be able to describe the factors that could cause speciation between two populations: geographic isolation vs. reproductive isolation
* Be able to explain the difference between prezygotic and postzygotic barriers to population interbreeding and provide examples of each

***CC 1.C.1: Speciation and extinction have occurred throughout the Earth’s history.***

***a. Speciation rates can vary, especially when adaptive radiation occurs when new habitats become available.***

***b. Species extinction rates are rapid at times of ecological stress. [See also 4.C.3]***

***To demonstrate understanding, make sure you can explain the following:***

***● Five major extinctions***

***● Human impact on ecosystems and species extinction rates***

***CC 1.C.2: Speciation may occur when two populations become reproductively isolated from***

***each other.***

***a. Speciation results in diversity of life forms. Species can be physically separated by a geographic barrier such***

***as an ocean or a mountain range, or various pre-and post-zygotic mechanisms can maintain reproductive***

***isolation and prevent gene flow.***

***b. New species arise from reproductive isolation over time, which can involve scales of hundreds of thousands***

***or even millions of years, or speciation can occur rapidly through mechanisms such as polyploidy in plants.***

1. The Origin and History of Life

* Be able to describe the conditions on early Earth that could enable the creation of the first organic molecules (amino acids)
* Be able to explain the main events in the history of life (see CC 1.D.1 below and your notes on the history of life)
* Be able to explain why RNA is considered the first genetic code molecule (RNA World Hypothesis)

***CC 1.D.1: There are several hypotheses about the natural origin of life on Earth, each with***

***supporting scientific evidence.***

***a. Scientific evidence supports the various models.***

***Evidence of student learning is a demonstrated understanding of each of the following:***

***1. Primitive Earth provided inorganic precursors from which organic molecules could have been***

***synthesized due to the presence of available free energy and the absence of a significant quantity of***

***oxygen.***

***2. In turn, these molecules served as monomers or building blocks for the formation of more complex***

***molecules, including amino acids and nucleotides.***

***3. The joining of these monomers produced polymers with the ability to replicate, store and transfer***

***information.***

***4. These complex reaction sets could have occurred in solution (organic soup model) or as reactions on solid reactive surfaces.***

***5. The RNA World hypothesis proposes that RNA could have been the earliest genetic material.***

***CC 1.D.2: Scientific evidence from many different disciplines supports models of the origin of***

***life.***

***a. Geological evidence provides support for models of the origin of life on Earth.***

***Evidence of student learning is a demonstrated understanding of each of the following:***

***1. The Earth formed approximately 4.6 billion years ago (bya), and the environment was too hostile for***

***life until 3.9 bya, while the earliest fossil evidence for life dates to 3.5 bya. Taken together, this evidence***

***provides a plausible range of dates when the origin of life could have occurred.***

***2. Chemical experiments have shown that it is possible to form complex organic molecules from***

***inorganic molecules in the absence of life.***

***b. Molecular and genetic evidence from extant and extinct organisms indicates that all organisms on Earth***

***share a common ancestral origin of life.***

***Evidence of student learning is a demonstrated understanding of each of the following:***

***● Scientific evidence includes molecular building blocks that are common to all life forms.***

***● Scientific evidence includes a common genetic code.***

**Practice Multiple Choice Questions:**

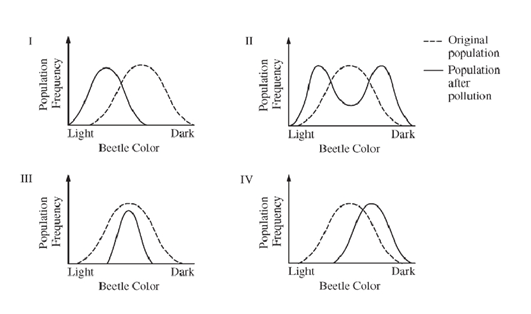
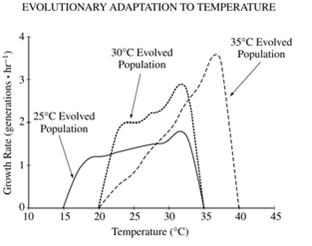
1. When Hurricane Katrina hit New Orleans the devastation to the biotic factors in the environment was widespread and catastrophic. While this event affected all populations, it will not have a long lasting effect on all the species in the area. This is due to the fact that genetic drift as an evolutionary factor is  
   (A) greater in a population with small numbers than a population with large numbers.  
   (B) greater in a population with much genetic variation than in a population with little genetic variation.  
   (C) responsible for the selection of mutations.  
   (D) connected to the movements of alleles between populations of a single species.
2. The deer mouse is the most widely distributed small mammal in North America. It varies widely according to its geographical location, especially in coat color, tail length, and foot length. Where would you expect deer mice to be relatively uniform?  
   (A) In mountainous areas, where environmental conditions change dramatically from place to place.  
   (B) On islands, where populations are isolated.  
   (C) Over large areas where there is little topographical or vegetational change.  
   (D) In regions between forests and deserts, where there is significant vegetational change.

A group of birds are flying at sea. A storm strikes and only a few birds survive due to their wing structure. They land on an island and are able to find enough resources to reproduce. A scientist studies what happened and determines that this is the founder effect.

1. Which of the following assumptions is the scientist basing his conclusion on?  
   (A) All birds had an equal chance of survival to colonize the island.  
   (B) The birds underwent natural selection during the colonizing of the island.  
   (C) The birds are able to adapt to their new environment.  
   (D) The scientist made no assumptions.
2. Why is this not TRULY an example of the founder effect?  
   (A) All birds had an equal chance of survival.  
   (B) The birds did not make the decision to colonize the island.  
   (C) Only birds with a certain wing structure were able to live through natural selection.  
   (D) This was a natural disaster, so should be considered a bottleneck effect.
3. A group of students summarized information on five great extinction events. The students are sampling a site in search of fossils from the Devonian period. Based on the chart, which of the following would be the most reasonable plan for the students to follow?

(A) Searching horizontal rock layers in any class of rock and trying to find those that contain the greatest number of fossils  
(B) Collecting fossils from rock layers deposited prior to the Permian period that contain some early vertebrate bones  
(C) Looking in sedimentary layers next to bodies of water in order to find marine fossils of bivalves and trilobites  
(D) Using relative dating techniques to determine the geological ages of the fossils found so they can calculate the rate of speciation of early organisms

In a hypothetical population of beetles, there is a wide variety of color, matching the range of coloration of the tree trunks on which the beetles hide from predators. The graphs below illustrate four possible changes to the beetle population as a result of a change in the environment due to pollution that darkened the tree trunks.

1. Which of the following includes the most likely change in the coloration of the beetle population after pollution and a correct rationale for the change?  
   (A) The coloration range shifted toward more light-colored beetles, as in diagram I. The pollution helped the predators find the darkened tree trunks.  
   (B) The coloration in the population split into two extremes, as in diagram II. Both the lighter-colored and the darker-colored beetles were able to hide on the darker tree trunks.  
   (C) The coloration range became narrower, as in diagram III. The predators selected beetles at the color extremes.  
   (D) The coloration in the population shifted toward more darker-colored beetles, as in diagram IV. The lighter-colored beetles were found more easily by the predators than were the darker- colored beetles.
2. By discharging electric sparks into a laboratory chamber atmosphere that consisted of water vapor, hydrogen gas, methane, and ammonia, Stanley Miller obtained data that showed that a number of organic molecules, including many amino acids, could be synthesized. Miller was attempting to model early Earth conditions as understood in the 1950s. The results of Miller's experiments best support which of the following hypotheses?  
   (A) The molecules essential to life today did not exist at the time Earth was first formed.  
   (B) The molecules essential to life today could not have been carried to the primordial Earth by a comet or meteorite.  
   (C) The molecules essential to life today could have formed under early Earth conditions.  
   (D) The molecules essential to life today were initially self-replicating proteins that were synthesized approximately four billion years ago.   
     
   The graph to the right shows the growth rates of populations of bacteria that have evolved for many generations at different culture temperatures (25°C, 30°C, and 35°C). Each population grows over only a limited range of temperatures (its thermal niche), which are bounded by its critical thermal limits. Within this range, growth rate increases with temperature up to a maximal value and then declines rapidly with increasing temperature. Growth rates are known to be the major determinant of fitness for these bacteria.
3. Which of the following is true concerning the thermal dependence of growth rate between 25°C and 30°C in these populations  
   (A) Thermal dependence is greatest in the population evolved at 25°C.  
   (B) Thermal dependence is greatest in the population evolved at 30°C.  
   (C) Thermal dependence is greatest in the population evolved at 35°C.  
   (D) Growth rates of all populations are equally thermally dependent over this temperature range.
4. Which of the following is evidence based on the data that supports which has the highest fitness at 25°C?

(A) The population evolved at 25°C, because this population evolved at 25°C

(B) The population evolved at 30°C, because at this population has the highest reproductive rate at 25°C  
(C) The population evolved at 35°C, because at this population has the highest reproductive rate at 25°C  
(D) All populations are equally fit at this temperature.

1. Which of the following can be correctly concluded from this experiment?   
   (A) The temperature range of the thermal niche remains constant at different evolutionary temperatures, even though critical thermal limits may change.  
   (B) Critical thermal limits remain constant during evolution at different temperatures.  
   (C) The same maximal growth rate is attained in all three populations, but it is attained at different temperatures.  
   (D) Maximal growth rate is not always attained at the temperature at which a population evolved.
2. If all three populations were mixed together and placed at 37°C, which of the following would be most likely to happen?   
   (A) Only the population evolved at 25°C would die and become extinct.  
   (B) Only the population evolved at 35°C would survive and reproduce.  
   (C) All the bacteria would die and the populations would become extinct.  
   (D) All populations would grow, and transfer of genes would create one common population.  
     
   These questions refer to the following model as an example of adaptive radiation and species diversification.  
   One of the classical examples of evolution occurs on the Galápagos Islands with Darwin’s finches. The islands have always been separate from the South American mainland and vary in size and elevation. The lowlands are covered with thorn scrub, while higher elevations (found only on the larger islands) are covered with moist, dense forests. All the organisms living on these islands are descendants of species that have emigrated there, primarily from South America. In studying the finch populations, researchers have identified fourteen species, none of which are found on the mainland.
3. The initial colonizing population of finches most likely exhibited which of the following?   
   (A) Hybridization with bird species already existing on the islands  
   (B) High rates of interbreeding with mainland populations  
   (C) Increased rates of mutation to fill habitats   
   (D) A smaller gene pool than that of the mainland populations
4. As opposed to the mainland, on the islands the initial colonists (finches) had the opportunity to evolve in new directions primarily because there  
   (A) was an absence of interspecific competition  
   (B) was mixing of the gene pool  
   (C) was a higher mutation rate  
   (D) was higher predation pressure
5. Initially, one species of finch may have settled on two different islands, maintained this separation over hundreds of years, and eventually followed divergent adaptive pathways. If these now two separate species should migrate onto a new island, they could maintain their individual species identities on this island in all the following ways EXCEPT if one species

(A) hybridizes successfully with the other species  
(B) lives in the forests and the other in the scrubland  
(C) carries out different stages of its life cycle at different times than the other species  
(D) fails to produce viable young after mating with the other species

1. Although the initial finch species on the islands may have all been seed eaters, which of the following processes minimized competition as the population expanded?   
   (A) Selection for niche diversification  
   (B) Development of more efficient attack behavior  
   (C) Further emigration when carrying capacity was reached  
   (D) Genetic drift
2. Trout in stream A and trout in stream B look similar, but not quite identical. Scientists were unsure if they were two populations of one fish species, or two separate species. To figure this out, they studied the life cycle, habitat, and reproduction of the trout. In a year with a typical amount of rainfall, the trout stay within their own stream and mate with individuals that live nearby. However, in years that include excessive rainfall and flooding, the fish are washed downstream to a larger river, and must swim back up into either stream A or stream B. They choose which stream to swim up randomly, often ending up in a different location than where they themselves were born. When a trout that originated from stream A does breed with a trout from stream B, their offspring are healthy and show no decrease in fertility. Scientists think that flooding in this watershed is happening more and more frequently, due to global climate change. Given this information, predict what is the most likely result for trout A and trout B.  
   (A) they will become reproductive isolated from each other  
   (B) they will become more similar in their gene pools  
   (C) they will go through random changes due to genetic drift  
   (D) they will adapt to different conditions and look more and more different
3. As many as 60% of people in malaria-infected regions of Africa have the sickle-cell allele, but only about 10% of the U.S. population of African ancestry carries the allele. Malaria remains a major disease in central Africa but has not been a serious problem in the U.S. for many generations. What are the reason for the difference in the percentages and what is a reasonable statement about future percentages?  
   (A) The presence of malaria in Africa maintains the advantage of the heterozygous sickle-cell trait, and the prevalence of malaria will likely continue to preserve the 60% rate in Africa. However, we would predict that the prevalence of the sickle-cell trait will continue to decline in the African-American population.  
   (B) The difference is due to lack of interbreeding between the African and African-American populations. We would expect travel and gene flow to increase in human populations, until native Africans and African-Americans both level off at about a 35% rate.  
   (C) African-Americans have a lower rate of sickle cell because not all of their ancestors migrated from the regions of Africa infected by malaria. However, now that new therapies are treating sickle-cell anemia among African-Americans, we expect the prevalence of sickle-cell anemia to rise in the African-American population until it reaches the 60% mark.  
   (D) Natural selection is affecting the African-American population, reducing the prevalence of a harmful allele, but natural selection is not affecting the African population. We expect the African-American population to continue decreasing the prevalence of the sickle-cell trait, but the African population to remain unchanged until affected by genetic drift.
4. We have seen how natural selection and the use of pesticides can lead to the development of resistant varieties of insects, but there are other techniques that can reduce insect numbers. One of these has been used against an insect, the screwworm fly, which is a parasite of animals like cattle, and can cause great economic harm. Scientists grow screwworm flies in the laboratory, and then blast them with radioactivity to make them sterile (but not kill them). The sterile flies are continuously released in a local habitat, and the screwworm population in the area is greatly reduced, even going locally extinct. One critical factor is that the female screwworm fly only mates once. But which of the following is also necessary for sterile release to work?  
   (A) The female screwworm flies must not sense that the sterile male flies are behaving abnormally during courtship.  
   (B) The female screwworm flies can, if impregnated successfully, lay up to 400 eggs.  
   (C) The screwworm flies will suffer postzygotic reproductive isolation.  
   (D) The screwworm flies will emigrate, bringing both healthy and sterile flies to new habitats.
5. The “RNA world hypothesis” poses that RNA may have functioned as the first genetic material in early protobionts. Scientists point to three characteristics of RNA that support the “RNA world hypothesis” with evidence. Which of the following is NOT one of these characteristics of RNA?   
   (A) RNA in modern cells can sometimes act as ribozymes and show catalytic activity, increasing the rate of certain chemical reactions.  
   (B) Modern cells use an RNA template when synthesizing proteins.  
   (C) A single strand of RNA can temporarily bind to complementary RNA monomers, and produce a second strand, with a predictable sequence of nucleotide bases.  
   (D) In modern cells, RNA provides the template on which DNA nucleotides are assembled.
6. Guppies are small fish found in streams in Venezuela. Male guppies are brightly colored, with black, red, blue and iridescent (reflective) spots. Males cannot be too brightly colored or they will be seen and consumed by predators, but if they are too plain, females will choose other males. Natural selection and sexual selection push in opposite directions. When a guppy population lives in a stream in the absence of predators, the proportion of males that are bright and flashy increases in the population. If a few aggressive predators are added to the same stream, the proportion of brightly-colored males decreases with about 5 months (3-4 generations). The effects of predators on guppy coloration have been studied in artificial ponds with mild, aggressive, and no predators, and by similar manipulations of predators in natural stream environments (Endler, 1980). For each of the following questions, choose the one answer that best reflects how an evolutionary biologist would answer.

Fitness is a term often used by biologists to explain the evolutionary success of certain organisms. Which feature would a biologist consider to be most important in determining which guppies re “most fit?”  
(A) Large body size and ability to swim quickly away from predators.  
(B) Excellent ability to compete for food.  
(C) High number of offspring that survive to reproductive age.  
(D) High number of matings with many different females.

1. Assuming ideal conditions, abundant food, space, and no predators, what would happen if a guppy pair was put in a large pond?  
   (A) The guppy population would grow slowly, as guppies would have only the number of babies that are needed to replenish the population.  
   (B) The guppy population would grow slowly at first, then would grow rapidly, and thousands of guppies would fill the pond.  
   (C) The guppy population would never become very large, because only organisms such as insects and bacteria reproduce in that manner.  
   (D) The guppy population would continue to grow slowly over time.
2. Once a population of guppies has been established for a number of years in a real (not ideal) pond with other organisms including predators, what will likely happen to the population?  
   (A) The guppy population would stay about the same size.  
   (B) The guppy population will continue to rapidly grow in size.  
   (C) The guppy population will gradually decrease until no more guppies are left.  
   (D) It is impossible to tell because populations do not follow patterns.
3. In guppy populations, what are the primary changes that occur gradually over time?  
   (A) The traits of each individual guppy within a population gradually change.  
   (B) The proportions of guppies having different traits within a population changes.  
   (C) Successful behaviours learned by certain guppies are passed to offspring.  
   (D) Mutations occur to meet the needs of the guppies as the environment changes.

Populations of a plant species have been found growing in the mountains at altitudes above 2,500 meters. Populations of a plant that appears similar, with slight differences, have been found in the same mountains at altitudes below 2,300 meters.

1. Which of the following describe TWO kinds of data that could be collected to provide a direct answer to the question, do the populations growing above 2,500 meters and the populations growing below 2,300 meters represent a single species?

(A) Rate of hybrid death, rate of hybrid success

(B) Number of differences between the species and the rate of reproductive success

(C) Rate of successful interbreeding between the populations, occurrence of hybrid fertility

(D) Ability of upper plant species to grow in the altitudes below 2,300 meters, and length of life of hybrids

1. Before and during Darwin’s time, many theories of evolution had been proposed. With which of the following theories would Darwin most agree?
   1. Malthus suggested that species and populations were limited by the available resources and lack of resource

created competition. That competition drove evolution.

(B) Cuvier’s theory of catastrophism supported the theory that there were abrupt changes and that survivors of the catastrophes were not new species at all.

(C) Lyell’s theory of uniformity stated that there was a steady, gradual, and lengthy molding of Earth and its species.

(D) Lamarck suggested that single simple forms could become more complex in an individual and that change in characteristics could be inherited in the next generation.

1. The Hardy-Weinberg formula is used to estimate the frequency of carriers of alleles that cause genetic disorders and traits. In considering the Hardy-Weinberg equilibrium equation

(A) p represents the number of dominant individuals

(B) q represents the number of recessive individuals

(C) p² + 2pq represents the percent of individuals expressing the dominant phenotype.

(D) q² represents the number of recessive alleles.

1. The South American rhea, the Australian emu, and the African ostrich are all species of birds that share similar features, but each is native to distant geographic locations. The study of these birds is an example of
   1. biogeography
   2. comparative morphology
   3. natural evolution
   4. geologic dispersion
2. Humans impact variation in other species which results in changes in allelic frequencies. These changes can lead to a shift in phenotypes to one extreme, as in the pepper moth population, they are an example of
   1. directional selection
   2. stabilizing selection
   3. disruptive selection
   4. sexual selection
3. All of the following are prezygotic isolating mechanisms EXCEPT
   1. temporal isolation.
   2. hybrid sterility.
   3. gamete incompatibility.
   4. behavioral isolation.
4. In a certain prairie community, a dominant prairie grass species has an allele frequency of P = .7 and q = .3. Ten years ago there was a wild fire on the prairie, which resulted in the death of 80% of the prairie grass. Over the past ten years the population has rebounded and currently the allele frequencies are P = .1, q = .9 Which of the following justifies this data based on the effects of genetic drift and or selection.

(a) The new allele frequencies are due to selective pressure placed on the dominant allele.

(b) The reduction in the dominant allele frequencies is due to a less favorable trait, which resulted in selection against the allele

(c) The increase in the recessive allele frequency is due to the combined effects of a bottleneck and genetic drift.

(d) The change in the allele frequencies is due to the migration of new species in the area once the competition was reduced.

31. A species of malaria-carrying mosquito lives in a forest in which two species of monkeys, A and B, coexist. Species A is immune to malaria but species B is not. The malaria-carrying mosquito is the chief food for a particular kind of bird in the forest. If all of these birds are eliminated suddenly by hunters, which of the following would be the immediate observable consequence?

a) Increased mortality in monkey species A

b) Increased mortality in monkey species B

c) Increased mortality in the malaria-carrying mosquitoes

d) Emergence of malaria-resistant strains in monkey species B

36. 32. The introduction of antibiotics such as penicillin several years ago was immediately effective in combating infections caused by Staphylococcus. In 1958, however, there were several outbreaks of staphylococcal infections. People with the infections did not respond to treatment with any of the antibiotics and there was a large number of deaths. The best explanation for this situation is that

(a) the bacteria from other hosts such as birds, cats, and dogs migrated into human hosts

(b) the bacteria exposed to nonlethal doses of antibiotics quickly learned to avoid them

(c) each generation of bacteria acquired the ability to use antibiotics as nutrients

(d) antibiotic-resistant bacteria survived and multiplied, and these were the forms causing the infections

33. According to the scientific theory of the origin of life on earth, life arose spontaneously from inanimate chemicals. Do scientists think this process is still occurring on our planet today?

(a) yes, it probably is

(b) no, because conditions on earth have changed and are no longer conducive to spontaneous evolution of life

(c) Yes, they have proven it in lab conditions

(d) no, because we no longer have the inanimate chemicals present

34. Once a protocell was capable of reproduction, it became a true cell and \_\_\_\_\_\_\_\_\_\_ would have begun.

(A) photosynthesis and the buildup of an atmosphere

#### (B) biological evolution

(C) aerobic respiration

(D )the geological time scale

**Practice Long Response Questions:**

1. 2004:2

Darwin is considered the "father of evolutionary biology." Four of his contributions to the field of

evolutionary biology are listed below.

* The non-constancy 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. 2003B:4

Biologists are interested in preserving the diversity of living organisms on the planet.

a. **Explain THREE** of the following processes of phenomena, using an appropriate

example for each.

* mutation
* adaptive radiation
* polyploidy
* population bottlenecks
* growth of the human population

b. For each process or phenomena you selected in (a), **discuss** its impact on the diversity

of life on Earth.

3. 2001:2

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.

a. Explain the theory of evolution by natural selection as presented by Darwin.

b. 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.
* Natural selection and heterozygote advantage