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**AP Biology Exam Review : Microevolution and Macroevolution (Units 1 and 2)**

**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)
12. [Bozeman Biology: Classification of Life](http://www.youtube.com/watch?v=tYL_8gv7RiE&list=PL7A750281106CD067)
13. [Bozeman Biology: The Three Domains of Life](http://www.youtube.com/watch?v=wGVgIcTpZkk&list=PL7A750281106CD067&index=21)

**Topic Outline (Thank you to Megan Chirby and Amy Litz!)**

***Unit 1, Notes Packet #1: Evolution Basics and Unit 1, Notes Packet #2: Types of Natural Selection***

1. Natural Selection
2. Major mechanism of change over time – Darwin’s theory of evolution
3. There is variation among phenotypes – genetic mutations play a role in increasing variation
4. Competition for resources results in differential survival, with individuals with the most favorable traits surviving to reproduce offspring
5. 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.
6. Fitness is the ability to survive and reproduce
7. Stabilizing selection- selects for average ex. birth weight
8. disruptive selection- selects for extremes ex. Beak type
9. directional selection- towards one extreme ex. Pepper moth
10. sexual selection- competition for mates
11. Evidence for Evolution
12. 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.
13. 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.
14. Biochemical and genetic similarities, in particular DNA nucleotide and protein sequences, provide evidence for evolution and ancestry.

***Unit 1, Notes Packet #3: The Importance of Genetic Variation as Fuel for Natural Selection***

1. Genetic Variation
2. Be able to describe the basic structure of DNA and its organization in chromosomes in eukaryotic cells
3. Be able to describe how chromosomes are divided into gametes (sex cells) during meiosis and how these gametes come together during fertilization to create a zygote
4. Be able to describe the mechanisms of creating new genes and combining genes in different ways to increase genetic variation – mutation, crossing over, independent assortment, and random fertilization.
5. Be able to explain why genetic variation is important for the survival of a population (Hint: see cheetah example!)

***Unit 1, Notes Packet #4: Hardy-Weinberg Equilibirum***

1. Hardy-Weinberg Equilibrium
2. A mathematical model used to calculate changes in allele frequency, providing evidence for the occurrence of evolution in a population.
3. 5 conditions must be met for a population to be in HW equilibrium – conditions are seldom met
4. Large population / no genetic drift (must understand why genetic drift has a more significant effect on the gene pool of small populations and be able to describe both the bottleneck and founder effects)
5. No migration
6. No mutations
7. Random mating
8. No natural selection
9. Equations
10. p = the frequency of dominant alleles in a population
11. q = the frequency of recessive alleles in a population
12. p2 = the frequency of homozygous dominant individuals in a population
13. q2 = the frequency of homozygous recessive individuals in a population
14. 2pq=the frequency of heterozygous individuals in a population
15. p + q = 1
16. p2 + 2pq + q2 = 1

***Unit 2, Notes Packet #1: Macroevolution and Speciation***

1. Speciation
2. An evolutionary process by which 2 or more species arise from 1 species and 2 new species can no longer breed and reproduce successfully
3. Many mechanisms by which it can occur
4. Geographic isolation
* Species separated by physical barrier
1. Reproductive isolation
* Different behaviors limit mating
* Different habitats limit mating
* Different mating seasons limit mating
* Different anatomical structures limit mating
1. Can take place over millions of years or rapidly (after extinction events, for example)
2. Be able to describe the difference between divergent evolution / adaptive radiation, convergent evolution, and coevolution
3. Be able to describe the difference between the two theories regarding the rate of speciation: gradualism vs. punctuated equilibrium
4. Be able to describe the factors that could cause speciation between two populations: geographic isolation vs. reproductive isolation
5. Be able to explain the difference between prezygotic and postzygotic barriers to population interbreeding and provide examples of each

***Unit 2, Notes Packet #2: Classification and Biodiversity***

1. Phylogenetic Trees
2. Phylogenetic trees and cladograms illustrate the relatedness between two species, in that relatedness of any two groups on the tree is shown by how recently two groups had a common ancestor.
3. Phylogenetic trees and cladograms can be constructed from morphological similarities of living or fossil species, and from DNA and protein sequence similarities.
4. Phylogenetic trees and cladograms are dynamic, constantly changing due to current and emerging knowledge.
5. Be able to analyze an existing cladogram, and create a cladogram from a chart comparing organisms and their traits.
6. Be able to explain the development of the six kingdom and three domain classification systems and discuss major characteristics of organisms in each group.

***Unit 2, Notes Packet #3: Origin and History of Life***

1. Origin of Life
2. 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.
3. Chemical experiments have shown that it is possible to form complex organic molecules from inorganic molecules in the absence of life.
4. These complex reactions 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.

**Practice Multiple Choice Questions:**

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.

1. 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.
2. 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. 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.
2. 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
3. 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
4. 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. 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).

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.

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. 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. 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.

1. 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

Five new species of bacteria were discovered in Antarctic ice core samples. The nucleotide (base) sequences of rRNA subunits were determined for the new species. The table below shows the number of nucleotide differences between the species.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Species | 1 | 2 | 3 | 4 | 5 |
| 1 | - | 3 | 19 | 18 | 27 |
| 2 |  | - | 19 | 18 | 26 |
| 3 |  |  | - | 1 | 27 |
| 4 |  |  |  | - | 27 |

1. Which of the following phylogenetic trees is the most consistent with the data above?

2. Experimental evidence shows that the process of glycolysis is present and virtually identical in organisms from all three domains, Archaea, Bacteria, and Eukarya. Which of the following hypotheses could be best supported by this evidence?

(A) All organisms carry out glycolysis in mitochondria.
(B) Glycolysis is a universal energy-releasing process and therefore suggests a common ancestor for all forms of life.
(C) Across the three domains, all organisms depend solely on the process of anaerobic respiration for ATP production.
(D) The presence of glycolysis as an energy-releasing process in all organisms suggests that convergent evolution occurred.

THE NUMBER OF AMINO ACID DIFFERENCES IN CYTOCHROME *c* AMONG VARIOUS ORGANISMS

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Horse | Donkey | Chicken | Pengiun | Snake |
| Horse | 0 | 1 | 11 | 13 | 21 |
| Donkey |  | 0 | 10 | 12 | 20 |
| Chicken |  |  | 0 | 3 | 18 |
| Penguin |  |  |  | 0 | 17 |
| Snake |  |  |  |  | 0 |

1. Which of the following phylogenic tree can be made based on the data above:

(A)(B)

(D)
(C)



1. Centipedes and millipedes should NOT be placed in group *B* because they
	1. have an exoskeleton
	2. display segmentation
	3. have a coelom
	4. are heterotrophic
2. All organisms in this dichotomous key have which of the following present, and why?

(A) Prokaryotic cells – because they are the most primitive type of cells

(B) Cilia – because they all move

(C) Glycolysis – because it is conserved across all recognized domains

(D) Mitochondria – because that is where cellular respiration occurs