AP Biology Review Packet 5- Natural Selection and Evolution & Speciation and Phylogeny

1A1- Natural selection is a major mechanism of evolution.
1A2: Natural selection acts on phenotypic variations in populations.
1A3: Evolutionary change is also driven by random processes.
1A4- Biological evolution is supported by scientific evidence from many disciplines, including mathematics.
1B1- Organisms share many conserved core processes and features that evolved and are widely distributed today.
1B2- Phylogenetic trees and cladograms are graphical representations (models) of evolutionary history that can be tested.
1C1- Speciation and extinction have occurred throughout the earth's history
1C2- Speciation may occur when two populations become reproductively isolated from each other.
1C3- Populations of organisms continue to evolve.
1D1- There are several hypotheses about the natural origin of life on Earth, each with supporting evidence.
1D2- Scientific evidence from many different disciplines supports models of the origin of life.
4C2: Environmental factors influence the expression of the genotype in an organism.

EVOLUTION

A. Origin of Life

1. Earth is ~ 4.6 bya and life occurred about 3.9 bya
2. Early earth had no oxygen
3. All organisms share a common ancestral origin
4. Chemical evolution of organic molecules from free energy (u.v. light/lightning/volcanic); RNA could have been the earliest genetic material
5. Oparin/Haldane/Miller- Oparin/Haldane theorized about how organic compounds came to be; Miller tested it with set up
6. Protobionts/Microspheres/Coacervates were early precursors to cells
7. Heterotrophs first; then chemosynthesis; photosynthesis
8. Glycolysis is most primitive type of metabolism
9. Ozone layer/atmosphere
10. Endosymbiosis- blue-green bacteria took up residence in anaerobic bacteria to become chloroplasts, aerobic bacteria took up residence to become mitochondria

B. **Natural Selection**- premises for Darwin's(and Wallace's) theory

1. Went to Galapagos- looked at Finches; published *On Origin of Species*
2. Theory stated:

- Overproduction
- Size remains stable
- Limited Resources
- Competition
- Variation
- Inheritable
- Accumulation of change

C. Evidence for Evolution

1. Paleontology- fossil record (can be dated using C-14)
2. Artificial Selection- breeding
3. Embryology- Traits in embryos not seen in adults (i.e. gills, tails)
4. Comparative Anatomy- homologous/analogous structures; vestigial structures

5. Molecular Biology- DNA and protein similarities (DNA and RNA are shared by all modern living systems) Many metabolic pathways are conserved among all domains. Structures in eukaryotes show relatedness (mbo, chromosomes)
6. Biogeography- distribution of species result of environment
7. Ex. Chemical resistance, emergent diseases, phenotypic change, structural – such as heart chambers, brain or immune system

D. Hardy-Weinberg Equilibrium

1. Rules

- no mutation occurs
- no immigration or emigration
- large population
- random mating
- no natural selection- all offspring are equally able to survive

2. Equation= p2 (AA) + 2pq (Aa)+ q2 (aa)= 1 or p (freq. of A) + q (freq of a)= 1

E. Natural Selection

1. Differential reproduction of a certain genotype; ONLY the most fit survive to make babies- all about sex
2. Stabilizing selection- selects for average ex. birth weight
3. disruptive selection- selects for extremes ex. Beak type
4. directional selection- towards one extreme ex. Pepper moth
5. sexual selection- competition for mates

F. Mechanisms for Evolution

1. Genetic Drift- random chances affecting gene pool; Founder effect- certain individuals leave and start new population; bottleneck effect- only certain individuals survive catastrophic event
2. Natural Selection- environment determines which traits are favorable and therefore are passed on because they live to make babies
3. Mutations- raw material for natural selection; can be positive, negative, or neutral
4. Gene Flow- individuals entering or leaving population
5. Sexual Selection- mates choose for particular traits.

G. Speciation- forming new species

1. Species- interbreeding organisms that can produce fertile offspring
2. Speciation rates can vary, especially when adaptive radiation occurs and new habitats become available.
3. Species extinction rates are rapid at times of ecological stress (five major extinctions; human impact)
4. Isolation of populations contribute to speciation (members cannot interbreed) which can be rapid or over millions of years
5. Types of isolation- prezygotic: habitat, behavioral, temporal; or mechanical
6. allopatric- geographical isolation
7. sympatric- no geological isolation- behavior or hybridization in plants
8. post zygotic- hybrid fertility or breakdown (makes it one or two generations)

H. Patterns of Evolution

1. gradualism- Elephant evolution
2. punctuated equilibrium- long periods of stasis with bursts of rapid speciation due to environmental pressure.

I. Phylogenetics and Math Models

1. Phylogenetic trees and cladograms can represent traits that are either derived or lost due to evolution.
2. Phylogenetic trees and cladograms illustrate speciation that has occurred, 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, by employing computer programs that have sophisticated ways of measuring and representing relatedness among organisms.
4. Phylogenetic trees and cladograms are dynamic (i.e., phylogenetic trees and cladograms are constantly being revised), based on the biological data used, new mathematical and computational ideas, and current and emerging knowledge.

AP Biology Investigation 2 Mathematical Modeling- Hardy Weinberg

Overview: Students created an excel spreadsheet to look at allele frequencies changed over generations. Students then were given different situations (i.e. selection, etc.) and asked to alter their spreadsheet to show how it changed the frequencies.

Equations: $p^2 + 2pq + q^2 = 1$ and $p + q = 1$

AP Biology Investigation 3- Comparing DNA Sequences to Understand Evolutionary Relationships Using BLAST

Overview: In Part I of this lab students were asked to draw a cladogram based on gene and protein similarities among four different species; they also completed an online tutorial on phylogenetic trees and cladistics. IN part II of this lab, students were asked to use BLAST two compare gene sequences from an "unknown" fossil to extant gene sequences. Then, the students used this data to place that organism on a cladogram with known living organisms.

Evolution:

adaptation
adaptive radiation
allele
allopatric
analogous structure
artificial selection
biogeography
biological species
coevolution
common ancestor
comparative anatomy
convergent evolution
Darwin
fossil
fossil record
founder effect
geologic time scale
geology
gene flow
gene pool
genetic bottleneck
genetic drift
genetic equilibrium
genetic variation
genotype
gradualism (aka anagenesis)
Hardy-Weinberg equation
natural selection
paleontology
parallel evolution
phenotype
phylogeny
polymorphism
polyploidy
population
postzygotic isolating mechanism
prezygotic isolating mechanism
primordial environment
radiometric dating
random mating
directional selection
disruptive selection
divergent evolution (aka cladogenesis
endosymbiosis
evo-devo
evolution
evolutionary fitness
extinction
fixation (of alleles)
homologous structures
homology
hybrid
Last Universal Common

Ancestor	mutation	species
mass extinction	reproductive isolation	stromatolite
migration	RNA world	sympatric
Miller-Urey experiments	rock strata	transitional fossil
molecular clock	speciation	vestigial organ

Questions and Practice:

1. What types of evidence support an evolutionary view of life?

2. What is the role of natural selection in the process of evolution?

3. How are heredity and natural selection involved in the process of evolution?

4. What mechanism account for speciation and macroevolution?

5. What different patterns of evolution have been identified and what mechanisms are responsible for each of these patterns?

6. Match each statement with an idea. In the blank to the left of each statement write "L" for Lamarckism, "D" for Darwinism, or "B" for both.
   a. _____Adaptive traits make an organism better suited for its environment.
   b. _____Traits accumulated over a single lifetime can be passed on to offspring.
   c. _____Populations are smaller than can be supported by the environment, traits are passed on genetically, and some organisms reproduce more than others.
   d. _____An organism can "will" a change to occur.
   e. _____If Vincent VanGogh had cut his ear off, then had a daughter, the daughter would be born without an ear.

5. If a population IS in Hardy-Weinberg Equilibrium, which of the following IS assumed to be true? CHECK ALL THAT APPLY.
   a. _____The population is large b._____Organisms do not select their mates
   c. _____Mutations occur rarely d. _____Natrual selection occurs
   e. _____There is no migration

6. Match the following mechanisms of evolution to its correct example.

_____Bottleneck Effect	A. Organisms move into a population changing the allele freq.
_____Founder Effect	B. Certain traits offer a selective advantage over others
_____Mutations	C. Changes in DNA seq. result from mistakes in DNA replication
_____Fitness	D. Carriers of the sickle cell gene have resistance to malaria
_____Heterzygote Advantage	
_____Gene Flow	E. A small # of individuals inhabit an island and begin reproducing.
	F. A hurricane wipes out a large portion of the population and a few individuals are left to reproduce.

As a field researcher you are sent to the Arizona desert to study the prairie dog species C. ludivincianus to determine if the population is in Hardy-Weinberg equilibrium. Specifically, you are studying this population with respect to the gene that determines the coat color in C. ludivincianus. This trait is coded for by a single gene (the NDY6 gene) with two alleles (N, n) and is passed down from one generation to the next.

a. After sampling 170 of these prairie dogs, you find that the C. ludivincianus population IS basically in Hardy-Weinberg equilibrium for this trait. Your result are as follows: Genotype frequency of n/n = 0.36

   What is the allele frequency of the N allele?
   What is the genotype frequency of N/N?
   What is the genotype frequency of N/n?

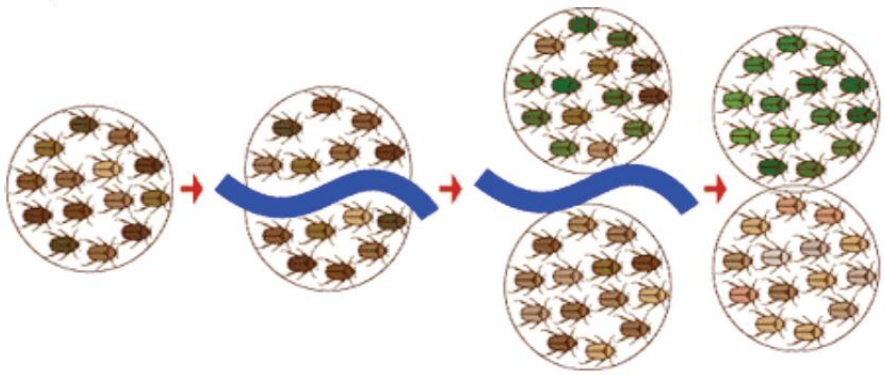
   What conditions must be being satisfied?

9. A population of Daphnia (diploid water fleas) is divided as follows into genotypes for albinism (a recessvie trait). A = dominant allele for dark color a = recessive allele for albinism

Genotype	Number of Daphnia
AA	846
Aa	148
Aa	6

a. How many total alleles are in the population?
b. What is the allele frequency of A?
c. What is the genotype frequency of aa?
d. Using the Hardy-Weinberg equation, calculate the EXPECTED genotype frequency of homozygous recessives.
e. Is this Daphnia population in Hardy-Weinberg equilibrium? Explain your answer.

10. What type of speciation is shown in the picture below? Describe how it leads to the formation of two species. Name and describe at least 4 reproductive barriers that might maintain the gene pool differences.



11. You are a botantist from UC Berkeley who is studying evolution in plants. You have recently begun a project categorizing and analyzing the plant species on the Aragon campus. You are particularly interested in the plants C. donis and C. asterum (two plants commonly found in center court). C. donis has a diploid number of 12 and C. asterum has a diploid number of 16. As you comb through center court you discover a 3rd plant that you call C. plantus growing right in the middle of your C. donis and C. asterum. You wonder…is this a new species?
    a. If this IS a new species of plant, what mechanism was likely responsible for its development? How might this have happened?
    b. If you were to analyze this new plant's cells—what would the diploid number be?

12. The following two charts demonstrate two theories on the rates of evolution.
    a. Underneath each chart write which one represents "Gradualism" and which one represents "Punctuated equilibrium."
    b. Label the correct terms for the y and x axes.