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**

1. **Origin of Life**
2. Earth is ~ 4.6 bya and life occurred about 3.9 bya
3. Early earth had no oxygen
4. All organisms share a common ancestral origin
5. Chemical evolution of organic molecules from free energy (u.v. light/lightning/volcanic); RNA could have been the earliest genetic material
6. Oparin/Haldane/Miller- Oparin/Haldane theorized about how organic compounds came to be; Miller tested it with set up
7. Protobionts/Microspheres/Coacervates were early precursors to cells
8. Heterotrophs first; then chemosynthesis; photosynthesis
9. Glycolysis is most primitive type of metabolism
10. Ozone layer/atmosphere
11. Endosymbiosis- blue-green bacteria took up residence in anaerobic bacteria to become chloroplasts, aerobic bacteria took up residence to become mitochondria
12. **Natural Selection**- premises for Darwin’s( and Wallace’s) theory
13. Went to Galapagos- looked at Finches; published *On Origin of Species*
14. Theory stated:
* Overproduction
* Size remains stable
* Limited Resources
* Competition
* Variation
* Inheritable
* Accumulation of change
1. **Evidence for Evolution**
2. Paleontology- fossil record (can be dated using C-14)
3. Artificial Selection- breeding
4. Embryology- Traits in embryos not seen in adults (i.e. gills, tails)
5. Comparative Anatomy- homologous/analogous structures; vestigial structures
6. 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)
7. Biogeography- distribution of species result of environment
8. Ex. Chemical resistance, emergent diseases, phenotypic change, structural – such as heart chambers, brain or immune system
9. **Hardy-Weinberg Equilibrium**
10. Rules
* no mutation occurs
* no immigration or emigration
* large population
* random mating
* no natural selection- all offspring are equally able to survive
1. Equation= p2 (AA) + 2pq (Aa)+ q2 (aa)= 1 or p (freq. of A) + q (freq of a)= 1
2. **Natural Selection**
3. Differential reproduction of a certain genotype; ONLY the most fit survive to make babies- all about sex
4. Stabilizing selection- selects for average ex. birth weight
5. disruptive selection- selects for extremes ex. Beak type
6. directional selection- towards one extreme ex. Pepper moth
7. sexual selection- competition for mates
8. **Mechanisms for Evolution**
9. Genetic Drift- random chances affecting gene pool; Founder effect- certain individuals leave and start new population; bottleneck effect- only certain individuals survive catastrophic event
10. Natural Selection- environment determines which traits are favorable and therefore are passed on because they live to make babies
11. Mutations- raw material for natural selection; can be positive, negative, or neutral
12. Gene Flow- individuals entering or leaving population
13. Sexual Selection- mates choose for particular traits.
14. **Speciation- forming new species**
15. Species- interbreeding organisms that can produce fertile offspring
16. Speciation rates can vary, especially when adaptive radiation occurs and new habitats become available.
17. Species extinction rates are rapid at times of ecological stress (five major extinctions; human impact)
18. Isolation of populations contribute to speciation (members cannot interbreed) which can be rapid or over millions of years
19. Types of isolation- prezygotic: habitat, behavioral, temporal; or mechanical
20. allopatric- geographical isolation
21. sympatric- no geological isolation- behavior or hybridization in plants
22. post zygotic- hybrid fertility or breakdown (makes it one or two generations)
23. **Patterns of Evolution**
24. gradualism- Elephant evolution
25. punctuated equilibrium- long periods of stasis with bursts of rapid speciation due to environmental pressure.
26. **Phylogenetics and Math Models**
27. Phylogenetic trees and cladograms can represent traits that are either derived or lost due to evolution.
28. 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.
29. 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.
30. 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.

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***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: p2 + 2pq + q2= 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.

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**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

mass extinction

migration

Miller-Urey experiments

molecular clock

mutation

reproductive isolation

RNA world

rock strata

speciation

species

stromatolite

sympatric

transitional fossil

vestigial organ

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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.

7. 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

8. 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.











