**CONCEPT 7 – EVOLUTION**

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. Hardy-Weinberg Equilibrium
8. A mathematical model used to calculate changes in allele frequency, providing evidence for the occurrence of evolution in a population.
9. 5 conditions must be met for a population to be in HW equilibrium – conditions are seldom met
10. Large population
11. No migration
12. No mutations
13. Random mating
14. No natural selection
15. Equations
16. p = the frequency of dominant alleles in a population
17. q = the frequency of recessive alleles in a population
18. p2 = the frequency of homozygous dominant individuals in a population
19. q2 = the frequency of homozygous recessive individuals in a population
20. 2pq=the frequency of heterozygous individuals in a population
21. p + q = 1
22. p2 + 2pq + q2 = 1
23. Speciation
24. An evolutionary process by which 2 or more species arise from 1 species and 2 new species can no longer breed and reproduce successfully
25. Many mechanisms by which it can occur
26. 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. Evidence for Evolution
3. 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.
4. 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.
5. Biochemical and genetic similarities, in particular DNA nucleotide and protein sequences, provide evidence for evolution and ancestry.
6. Origin of Life
7. 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.
8. Chemical experiments have shown that it is possible to form complex organic molecules from inorganic molecules in the absence of life.
9. These complex reaction sets could have occurred in solution (organic soup model) or as reactions on solid reactive surfaces.
10. The RNA World hypothesis proposes that RNA could have been the earliest genetic material.
11. Phylogenetic Trees
12. Phylogenetic trees and cladograms can represent traits that are either derived or lost due to evolution.
13. 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.
14. Phylogenetic trees and cladograms can be constructed from morphological similarities of living or fossil species, and from DNA and protein sequence similarities.
15. Phylogenetic trees and cladograms are dynamic, constantly changing due to current and emerging knowledge.

***Vocabulary***

Adaptation

Bottleneck Effect

Common Ancestor

Cladogram

Evolution

Gene Flow

Gene Pool

Genetic Drift

Geographic Isolation

Fitness

Hardy-Weinberg Equilibrium

Natural Selection

Morphology

Phylogenetic Tree

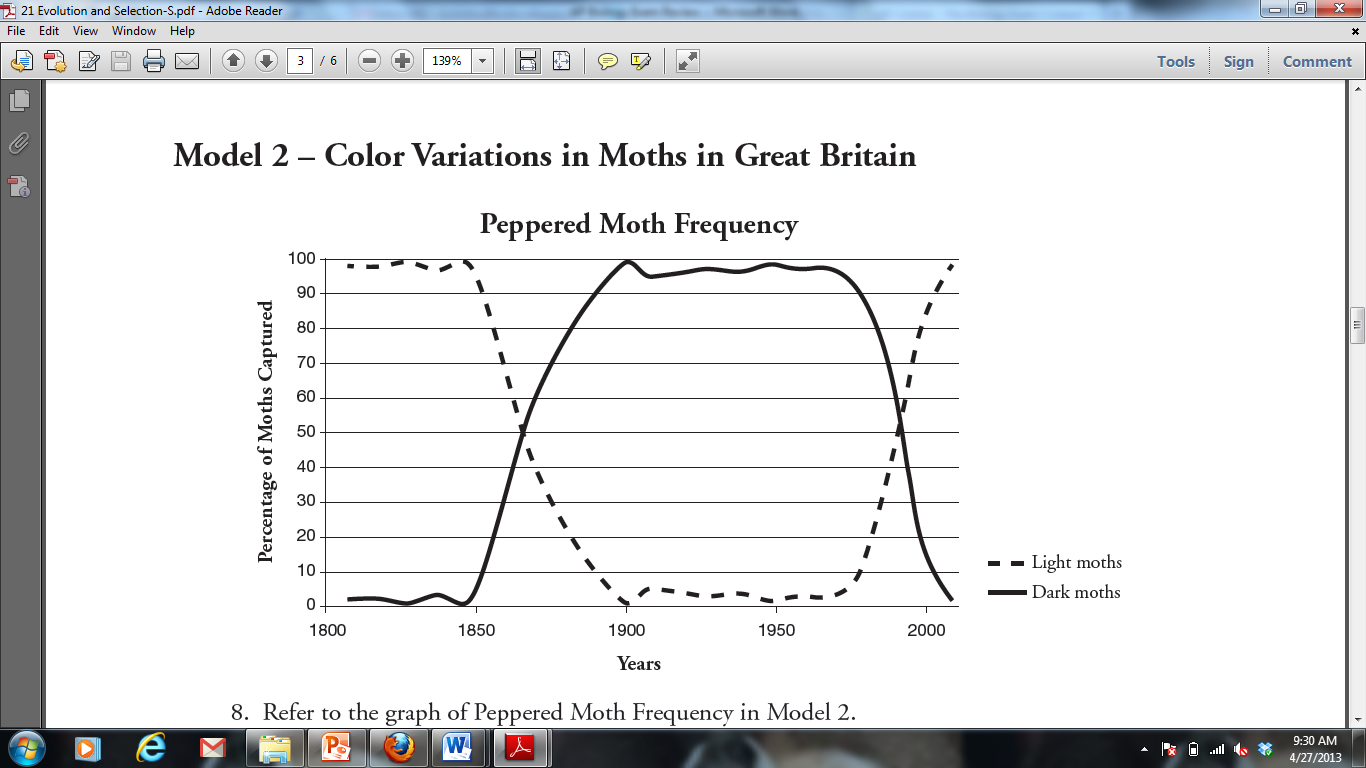
Reproductive Isolation

Speciation

Variation

***Thinking Questions***

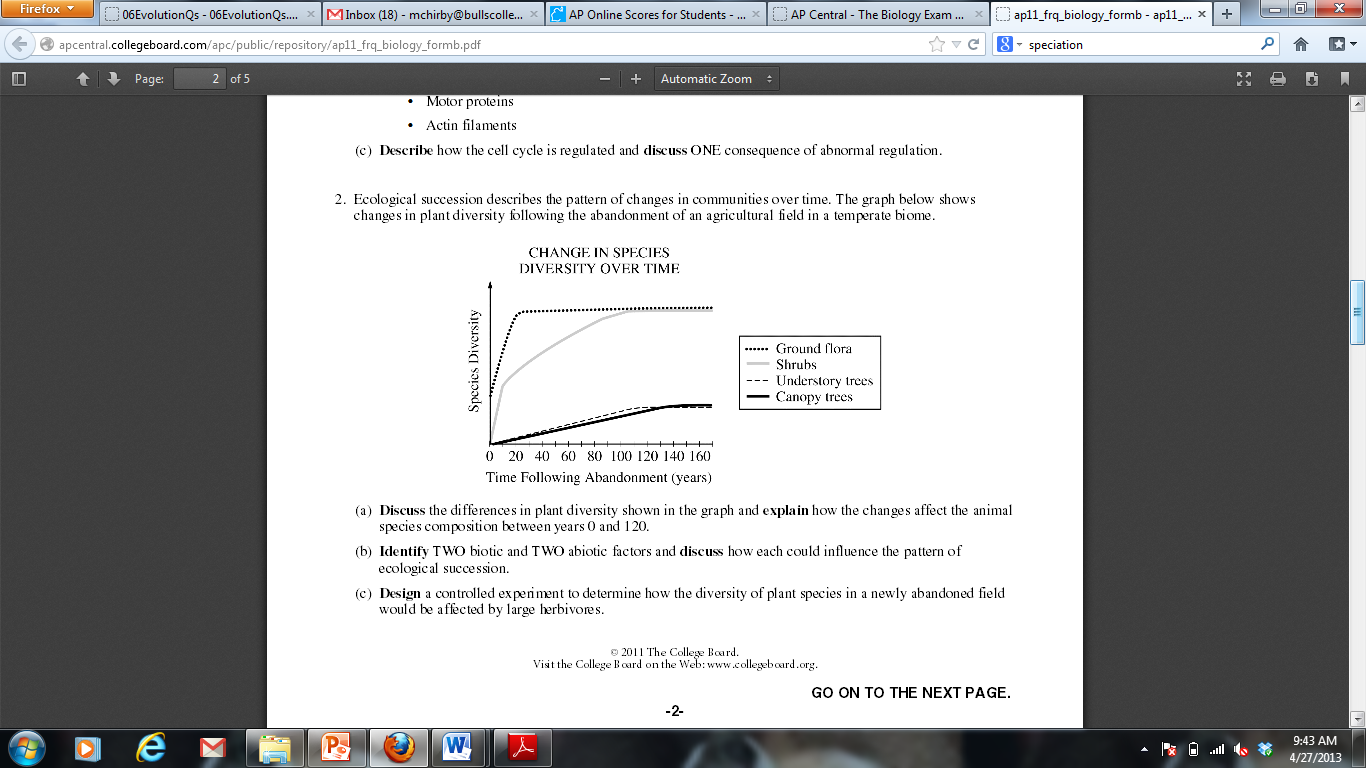
1. As a field researcher you are sent to the Arizona desert to study the prairie dog species C. ludivincianus to determine if the population is in Hardy-Weinberg equilibrium. Specifically, you are studying this population with respect to the gene that determines the coat color in C. ludivincianus. This 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. After sampling 170 of these prairie dogs, you find that 36% of the C. ludivincianus population is homozygous recessive for coat color. Assuming that the population is in Hardy-Weinberg equilibrium…
2. What is the allele frequency of the N allele?
3. What is the frequency of homozygous dominant prairie dogs?
4. What is the frequency of heterozygous prairie dogs?
5. What conditions must be being satisfied?
6. Sixty flowering plants are planted in a flowerbed. Forty of the plants are red-flowering homozygous dominant. Twenty of the plants are white-flowering homozygous recessive. The plants naturally pollinate and reseed themselves for several years. In a subsequent year, 178 red-flowered plants, 190 pink-flowered plants, and 52 white-flowered plants are found in the flowerbed. Use a chi-square analysis to determine if the population is in Hardy-Weinberg equilibrium.
7. For the past 10 to 25 years, farmers have planted crop seeds that have been genetically modified to withstand treatment with a common weed killer called Roundup®. This allows the farmers to spray their fields to get rid of weeds without harming their crops. Recently, more and more farmers have discovered that their fields have Roundup-resistant pigweed growing along with their crop. Describe what has most likely happened over time to lead to this.
8. Peppered moths have wings that vary in color, ranging from white to dark gray. During the Industrial Revolution through the mid-20th century, factories and power plants, which burned coal, produced large quantities of soot and smog. Near industrialized areas, black powder covered surfaces, including the moth habitat.
9. Use this information to explain the changes seen in light and dark peppered moths from 1800-1950, as shown in the graph below.



1. Propose an explanation for the return of the peppered moth population to more light than dark moths by the year 2000.
2. 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. Draw a phylogenetic tree indicating the relatedness of these 5 species.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Species | 1 | 2 | 3 | 4 | 5 |
| 1 | - | 2 | 23 | 19 | 17 |
| 2 |  | - | 24 | 19 | 18 |
| 3 |  |  | - | 23 | 23 |
| 4 |  |  |  | - | 1 |
| 5 |  |  |  |  | - |





1. Discuss the differences in diversity among the plants shown in the graph.
2. If a scientist wanted to determine if two understory trees in the field were the same species, what pieces of evidence would she gather and how would these inform her conclusion?

**Evolution Long Free Response (10 points)**

