Objectives for Unit Ten
Chapter 19 – 25 (19, 20.1, 20.3, 21 (not 21.3), 23.2, 23.4, 24.1, 24.4, 25.1-25.2):
Evolution, Evidence, Microevolution, Selection, Speciation, Phylogeny & Cladograms

You should be able to:

1. Identify the role of Linnaeus, Cuvier, Hutton & Lyell Jean Baptiste Lamarck, & Malthus, on the development of the theory of evolution.
2. Explain Lamarck's mechanism for evolution. What were his lasting contributions? How did his mechanism differ form Darwin's?
3. Describe each of the following as it relates to Darwin's theory of Natural Selection.
    a. HMS Beagle
    b. On Origin of Species
    c. Artificial Selection
    d. Galapagos Islands and finches
    e. A. R. Wallace
4. LAB: Finches' beak (with spoons, forks, knives, spoons, tape) (This was our introduction to natural selection). Apply the concepts of natural selection to beak selection and other populations
5. Explain the main points and arguments (observations & inferences) for Natural Selection as the mechanism for evolution. Explain how natural selection leads to adaptation in a population. Provide an example to illustrate.
6. Discuss "fitness" as it relates to evolution.
7. Explain why genetic variation and mutation are important for natural selection in a changing environment. Predict the effect decreased genetic diversity would have on the evolution of a species.
8. How does the environment affect the evolution of a species? Provide an example to illustrate.
9. Provide examples of changes to an environment and give examples of possible adaptations that such changes would select for in a population.
10. Explain the relationship between evolution and random events. The production of new variations is a random process. Is natural selection also a random process? Explain your reasoning.
11. Does the environment cause DNA to change in a specific direction? Explain.
12. How has human society affected the evolution of other species? Provide examples to illustrate.
13. Use any of the following examples to explain aspects of evolution:
    a. The peppered moth
    b. Sickle cell anemia
    c. DDT resistance in insects
    d. Artificial selection
    e. Overuse of antibiotics
    f. Flowertime in relation to global climate change (hypothesize!)
    g. Loss of genetic diversity within crop species
14. Associate examples with each of the lines of evidence for evolution:
    a. Artificial Selection
    b. Direct Observation (e.g. the development of drug resistance)
    c. Fossils, especially transitional fossils
    d. Biogeography, especially Pangea and islands
    e. Comparative Anatomy
        i. vestigial structures
        ii. homologous structures
    f. Comparative Embryology
    g. Molecular Biochemistry
15. List evidence that all living things can be traced back to a common ancestor.
    a. DNA and RNA carry genetic information
    b. The genetic code
    c. Metabolic pathways (like glycolysis) are conserved across all living things.
16. Using whales (or other organism like *Tiktaalik*) as an example, explain the importance of transitional fossils.
17. Distinguish between and give examples of homologous structures and analogous structures. Likewise distinguish between adaptive radiation and convergent evolution. Provide and recognize examples of each.
18. Discuss the molecular and genetic evidence from extant and extinct organisms, which indicates that all organisms on Earth share a common ancestral origin of life.

19. Discuss the following as they relate to population genetics.
    a. Population
    b. Species
    c. Gene pool
    d. Genetic drift
    e. Gene flow
    f. Allele frequencies and genotype frequencies
    g. Heterozygous advantage
20. Be able to work any of the Hardy Weinberg problems in your handouts.
21. Explain how reduction of genetic variation within a given population affects the difference between populations of the same species.
22. LAB: Hardy-Weinberg Equilibrium (Modeling Hardy Weinberg Equilibrium, Genetic Drift, and the Heterozygous Advantage using cards)
23. LAB: AP Lab Manual #2: Mathematical Modeling: Hardy Weinberg. From both of these labs, you should be able to
    a. Using the equations and concepts of the Hardy-Weinberg equation, solve problems to estimate genotype and allele frequencies within populations.
    b. Calculate allele and geneotype frequencies given real data.
    c. Describe the assumptions that must be true in order for a population to be in Hardy Weinberg equilibrium (a non-evolving population). Are these conditions frequently met or not? Explain.
    d. Given selection, calculate the change in allele frequencies over multiple (2-3) generations.
    e. Construct a model to predict what with happen to allele and genotype frequencies in the future given certain assumptions (we did this in our spreadsheets and in our work with AlleleA1).
24. Discuss how each of the following leads to evolution. Indicate whether the change is adaptive (selective) or not.
    a. Genetic Drift
        i. Founder Effect
        ii. Bottleneck Effect
    b. Gene Flow
    c. Mutation
    d. Non-Random Mating
        i. Inbreeding
    e. Natural Selection
25. Given a starting value for p (frequency of A) and q (frequency of a), predict by making a graph of what would happen to p and q (or p^2, 2pq, and q^2) over time when:
    a. Population size change from very large to very small
    b. The recessive allele is lethal in the recessive phenotype
    c. The genotype Aa has an advantage, as in sickle cell trait and malaria
    d. The AA genotype interbreed and the aa genotype interbreeds
    e. The recessive allele is lethal in the recessive phenotype on an island population and this population receives migrants from the mainland who Aa.
26. Explain how the outcomes of following types of selection differ. For the first three, draw a graph illustrating the change in variation within the population over many generations
    a. stabilizing
    b. directional
    c. disruptive
    d. artificial selection
    e. sexual selection
        i. differences in reproductive contributions made by the male and female
        ii. Sexual dimorphism
27. Identify 4 sources of variation that serve as the raw material for evolution. (This is a review questions from our unit on meiosis and sexual reproduction.)
28. Explain the concept of fitness and how it relates to differential reproduction.
29. Define species, based on the Biological Species Concept. Identify situations when this definition is difficult to apply. Look at morphological species, phylogenetic species, ring species.
30. Describe and give examples of reproductive barriers that keep species separate by preventing gene flow. Identify whether these are pre- or post-zygotic barriers.
    a. Temporal isolation
    b. Habitat isolation
    c. Behavioral isolation
    d. Mechanical isolation
    e. Gametic isolation

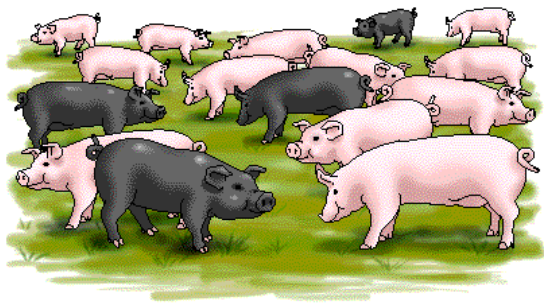
   f. Hybrid sterility
31. Speciation can happen in several difference ways. For each, explain how it occurs and what distinguishes it from the others
    a. Allopatric speciation
        i. Use experiments with fruit flies as evidence for allopatric speciation (see figure 24.9)
    b. Sympatric Speciation
        i. Polyploidy (We may discuss autoploidy and alloplody)
        ii. What is the rate of most speciation, and how does polyploidy change the rate of speciation?
    ~~c. Parapatric Speciation~~
32. Discuss the rate (tempo) of speciation, especially:
    a. Gradualism
    b. Punctuated equilibrium
33. Explain how adaptive radiation and new habitats becoming available affects the speciation rate.
34. Explain how species extinction rates are rapid at times of ecological stress by applying the concept to one of the five major extinctions and/or to human impacts on species extinction rates.
    - Using an example below, describe scientific evidence that supports the idea that evolution continues to occur.
    - 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
35. Identify the estimated age of the earth and its conditions in the beginning. When did prokarytotic cells arise? When did Eukaryotic cells arise?
36. How are fossils dated? (We did not discuss this question. (Bozeman's clip on Radiocarbon Dating might be useful to you here).
37. Explain how the Stanley Miller experiment models a hypothesis of early earth and the early steps toward the beginning of the first cells. Discuss what was required of Primitive Earth for the synthesis of organic molecules.
38. Describe the chemical experiments that show that it is possible to form complex organic molecules from inorganic molecules in the absence of life. (Same objective as above, just worded differently). (Bozeman's clip on the scientific evidence for the Origin of Life - http://www.youtube.com/watch?v=SWY3FKbtEz8 - might be helpful here as a review.
39. List a reasonable set of steps leading to the origin of the first prokaryotic and then eukaryotic cells.
40. Describe each of the following in relationship to the sequence: organic monomer --> organic polymer--> cell.
    a. sources of energy
    b. Deep-Sea Hydrothermal Vents
    c. Clay
    d. RNA World and ribozymes (why do research think RNA came before DNA?) - Why are polymers with the ability to replicate, store and transfer information important to the origin of life?
    e. Protobionts like Coacervates and Membrane formation
    f. Endosymbiosis
    g. Membrane infolding
41. Identify the organism alive today that is thought to be most similar to the first prokaryotic cells. (e.g. What are stromatolites?)
42. Explain why free molecular oxygen was an important development to early cells and where it came from.
43. List evidence that supports the idea that mitochondria and chloroplasts developed from prokaryotic cells. (What is the evidence for endosymbiosis?)
44. Why does the fossil record indicate rapid speciation following the five mass extinctions?
45. Describe the timeline of the formation of the earth, the formation of life, and the evidence used to support this timeline.
46. The official AP objectives ask students to distinguish between microevolution and macroevolution. These distinctions are a matter of scale. Micro – are small changes within a population; major changes, new species, extinctions, adaptive radiations are Macroevolutionary changes. They happen due to the same mechanism: Natural Selection, gene flow, genetic drift, and mutation. (See this brief description: http://wiki.answers.com/Q/What_is_the_difference_between_micro-evolution_and_macro-evolution)

47. Correctly write a scientific name using binomial nomenclature. List the levels of biological classification in order (Domain, Kingdom, Phylum, etc.)
48. Identify the three domains of living things and the eukaryotic kingdoms.
49. What is phylogeny?
50. Use a phylogenetic tree to depict hypotheses about the evolutionary history of a species. Distinguish between derived and ancestral characteristics. Identify points of common ancestors.
51. LAB: AP Lab Manual #3: Comparing DNA Sequences to Understand Evolutionary Relationships with BLAST
    a. Describe how biochemical evidence (protein comparison) can aid in identifying evolutionary relationships among organisms.
    b. Describe how cladograms are used to show evolutionary relationships.
    c. Looking at a cladogram, circle organisms that would be members of a clade.
    d. Using sequences that have been aligned, identify a SNP (Single Nucleotide Polymorism), an insertion and a deletion. (See figure 26.8 and our labwork)
    e. Given information in a character table (like that in figure 26.11a and on AP Manual S43 and S44) draw a cladogram, placing characteristics and organisms in the correct locations.
    f. When comparing gene similarities and protein similarities among related organisms, explain why the gene percent similarity is always less than the protein percent similarity. (Hint: wobble)
    g. Explain in a general way what computer software like ClustalX, NJPlot, and BLAST are doing.
52. Distinguish between a phylogram and a cladogram. How does fossil evidence relate to a phylogenetic tree (phylogram)?
53. Each chapter has some multiple choice questions and a few other additional questions at its end. Give these a try. You might see them again!

Some Examples of Short Free Response Questions: (2-3 sentences): These might be the actual questions. Any of the above objectives could be turned into a short free response question.

1. In fruit flies (*Drosophila melanogaster*), straight wing shape is dominant to curly wing shape. A particular population of fruit flies is in Hardy-Weinberg equilibrium with respect to the alleles for wing shape.
   The Hardy-Weinberg equation, given below, is useful in understanding population genetics: $p^2+2pq+q^2=1$
   a. **Explain** what the terms (p^2, $2pq$, and q^2) represent in the population of fruit flies.
   b. **Describe** one condition that is necessary for the population to be in equilibrium.

2. 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.
   a. **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?
   b. **Explain** how the data you suggested in part (a) would provide a direct answer to the question.



3. Consider a population of pigs where B is tan and b is black. Below is a population of pigs. **Calculate** the percent of this pig population that is heterozygous for tan coat color.

4. In a certain population of 1000 fruit flies, 360 have red eye, with the remainder have sepia eyes, a recessive trait. How many individuals would you expect to be homozygous for red eye color?

5. Distinguish between genetic drift from gene flow in terms of (a) how they occur and (b) their implications for future genetic variation in a population.

ESSAYS:

I have listed many essays that correspond to this unit because any one part of these essays would make a good and reasonable short free response questions. You will write one essay during the test. Parts of these essays would make good short free response questions. You will not know which essay before the test.

Likely Essays: 216*, 211b,c, 209c*,206c, 203*, 195*, 192, 191*164Ab, 162, 160D, 150, 136*, 121, 116, 102, 91*