Evolution Reading Guide (Chapters 22-26)

Chapter 22 Descent with Modification

Most of this chapter is a comfortable read. Read all of it with your attention to the following points.

22.1 The Darwinian Revolution

22.2 Descent with Modification

- be able to define evolutionary adaptation, recognize examples, and describe examples based on your personal knowledge
- be aware that our common usage of the term “adapt” includes meanings that are NOT related to evolution (ex: I may adapt to a poor night’s rest by increasing my caffeine consumption)
- what criteria must be met in order for a population to adapt, in the evolutionary sense

22.3 Evolution is supported by scientific evidence

Be prepared to recognize and/or describe examples that fall into each of the categories named here.

- direct observation (the HIV video described an additional example of this)
- molecular and anatomical homology--be sure to distinguish between homology and analogy (we will do a lab on molecular homology)
- the fossil record
- biogeography

I consider this topic fairly accessible and I do not plan to spend extensive class time on these topics. Be prepared to raise questions if needed.

Chapter 25 The History of Life on Earth

The due date for this chapter is farther ahead in the calendar, but I think it makes sense to read it after Chapter 22. We will spend very little class time on these topics. You are responsible for the following:

25.1 Conditions on early Earth

Get the gist of it.

25.2 The fossil record

Get the gist of it. Be able to explain why the fossil record is necessarily incomplete.

25.3 Key events in life’s history

- explain the term “oxygen revolution”
- review the “endosymbiont” theory and be able to explain how the first eukaryotic cells may have evolved

- be able to identify key adaptations that allowed plants to colonize land
- be able to identify key adaptations that allowed animals to colonize land
- recognize ways in which both modern plant and animal physiology give evidence of our shared ancestry with aquatic organisms

25.4 The rise and fall of groups of organisms
- We will use the term “adaptive radiation” in the context of speciation. Read this closely.

25.5 Major changes in body form
- This is an important application of what we studied on the topic of gene regulation. Be aware that a single mutation in a regulatory gene, particularly a gene that influences development of an organism, can have a dramatic impact on phenotype.
- We will connect this concept to macroevolution in chapter 24

25.6 Evolution is not goal-oriented
- This is a critical aspect of evolutionary theory. Read closely.

Chapter 23 Evolution of Populations--Microevolution

23.1 Genetic Variation
- be able to describe the role of genetic variation as raw material for the process of evolutionary change
- explain the *concept* of average heterozygosity: why would a population that has a low percentage of heterozygotes necessarily be less diverse for a particular trait versus a population that has a high percentage of heterozygotes?
- Distinguish between mutations that may result in new varieties of alleles and mutations that may result in new varieties of genes
- How does the life history of an organism (it’s life cycle, mechanism of reproduction, and reproductive strategy) impact the rate at which variation may accumulate in a population

23.2 The Hardy-Weinberg equation
- Define the terms population and gene pool
- Examine figure 23.8. Why is this Punnett square drawn with unequal dimensions for each square?
- You must memorize the conditions for Hardy-Weinberg equilibrium
- Recognize that HW equilibrium is the exception not the norm. Think of it as a baseline against which to measure evolutionary change--both adaptive and non-adaptive changes

23.3 Altering allele frequencies in a population
This section is a case by case description of how a population might evolve in response to violation of a different pre-condition of HW equilibrium
- distinguish between adaptive evolution and random evolution such as that demonstrated

by genetic drift and gene flow
- be prepared to recognize or offer examples of genetic drift
- why is genetic drift usually associated with small populations?
- why is genetic drift often deleterious to the long-term survival of a population?
- make a connection between the impact of genetic drift on species conservation efforts

23.4 Only natural selection causes adaptive evolution
- you are responsible for the terminology captured in figure 23.13
- distinguish between the term natural selection and sexual selection
- why is it important for species to preserve some variation rather than permit selection to eliminate “less fit” alleles? recognize and/or describe examples of
    - dipolidy
    - balancing selection
    - heterozygote advantage
    - frequency-dependent selection
- evolution should be thought of more like tinkering than engineering--what is the distinction?

Chapter 24 The Origin of Species
24.1 The biological species concept
- be able to state and apply the biological definition of *species*
- describe *reproductive isolation* as a potential mechanism for the formation of new species
- Fig 24.3: Reproductive barriers
    - distinguish between pre-zygotic and post-zygotic reproductive barriers
    - For each barrier, focus on the concept illustrated by each example. It is more important to be able to use the concepts than to memorize the all of the names
- recognize the limitations of the biological species concept
- describe instances in which morphology, ecology, or phylogeny may be more useful frames of reference to define species

24.1 Speciation can occur with or without geographic isolation
- distinguish between allopatric and sympatric isolation--read *A Review* on p. 497 <u>before</u> you read the detailed description of each type
- make a connection to *adaptive radiation* discussed in Chapter 25 (see Fig 25.20)
- recognize and/or provide examples of both allopatric and sympatric isolation
- recognize that some of the same factors may be at play in both allopatric and sympatric isolation--the key difference is whether or not the isolation is occurring within the same established geographic boundary
- Speciation by polyploidy is rare, but not to be ignored. Think about *why* this mechanism is limited almost exclusively to plants and even among plants has occurred very infrequently
- divergence between isolated populations may or may not be adaptive--the gene pools of

the two populations may accumulate differences due to either natural selection or due to random events

24.3 Hybrid Zones

- Fig 24.14 summarizes the text well
- Get the big picture: reproductive isolation is a process and it is subject to change.
    - If the hybrid zone reinforces reproductive isolation, then two new species are likely to emerge
    - If the hybrid zone weakens reproductive isolation, then it is likely for one species to emerge from two
    - If the hybrid zone is stabilized, two species persist with imperfect reproductive isolation

24.4 Speciation can occur rapidly or slowly

- recognize patterns of divergence that represent either a punctuated pattern or a gradual pattern
- punctuated change and gradual change are not competing theories. Both mechanisms operate in different evolutionary lineages

Chapter 26 Phylogeny

26.1 Phylogenies show evolutionary relationships

- Distinguish between classification and systematics
- The most important vocabulary that you must know with respect to phylogenetic trees (also called cladograms) is that branch points indicate a common ancestor
- It is likely that you will also encounter the terms *monophyletic, polyphyletic, and paraphyletic*. You can memorize them...or think about the words. Phylogeny has to do with common ancestry. If all of the species named in a group are recent descendents of *one* common ancestor, the group is *mono*phyletic. If *more than one* ancestor defines the recent ancestry of the group, it is *poly*phyletic. If the group does not contain all descendents of a recent ancestor, the group is *para*phyletic.

26.2 Phylogenies are inferred from morphological and molecular data

- Explain why morphological comparisons alone do not always yield correct phylogenetic relationships

26.3 Shared characters are used to construct phylogenetic trees

- all of the vocab used in cladistics are less important than the concepts
- Be able to identify the common branch point between any two species and thereby infer the relative relatedness (close or distant) between pairs of species
- For fig 26.11, cover up the figure (b) and practice using the character table to draw a phylogenetic tree
- note that, unless otherwise stated, a time variable is implicit along the axis of the phylogenetic tree, but you cannot assume it is drawn to scale unless that information is

explicitly stated
- fig 26.12 shows a phylogenetic tree that displays a variable other than time along the axis
- Study fig 26.14 and 26.15 to acquaint yourself with the methods to evaluate the competing phylogenies based on the same data set

26.4 An organism's evolutionary history is documented in its genome
- This section takes an abrupt side-track from phylogeny. Read for the gist of it, not the details.

26.5 Molecular clocks help track evolutionary time
- A molecular clock is an estimation of the timescale of evolutionary change among living species
- The concept of a molecular clock is simple, but it relies on two unreliable assumptions
    - concept: the more differences there are between the molecular structure found in two living species (base pairs in a gene or amino acids in a protein), the more time has elapsed since the two lineages branched from their common ancestor
    - assumption: the mutation rate is the same in different lineages
    - assumption: the fossil record comprehensively documents transitional species (radiocarbon dating of fossil specimens is necessary to establish the timescale for mutation rate)
- The reliability of molecular clocks are improved by basing them on more than one gene or more than one protein at a time

26.6 New information
- be able to state the defining characteristics of each of the three domains
- it is not surprising that lively debate and controversy characterize the depiction of the history of the very earliest evolutionary events on earth; read this section for the general idea