STUDY GUIDE FOR EXAM I - Spring 2018

This guide is not a substitute for coming to class, taking notes and reading your text. It is merely a general checklist that should help guide you through your readings. Just because I may have missed a detail or two on this study guide doesn't mean it's unimportant. If we covered it in class or if it's in the assigned readings, it's fair game for the exam. The best study guide of all is the combination of your notes and text readings. The self-test questions at the end of each chapter are an excellent indicator of how well you're understanding the material.

Finally, be sure to read all the notes and your text completely. If a term or concept is on the study guide, it means you should be able to get all the information you need from the text and notes. If something isn't clear, I'll be happy to explain it.

For an excellent overview of misconceptions about natural selection and adaptation, go here: [https://evolution.berkeley.edu/evolibrary/misconceptions_faq.php](https://evolution.berkeley.edu/evolibrary/misconceptions_faq.php)

Links in the lecture notes are for your information, and to complement the lecture material for your better understanding. Remember: it's more important for you to understand how things work, than to memorize minute details of examples used to illustrate concepts! The stories and examples are there to help you understand HOW THINGS WORK, not for you to memorize.

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**Biodiversity**

**Know** the meaning/significance of: biodiversity, taxonomy, systematics, holotype, paratype, conspecific, species, population, nuclear genome, organelle genome,

What is the significance of inbreeding and outbreeding, with respect to genetic diversity and genetic "health" of a species?

**Understand** the nature of the anthropocentric, biocentric, and ecocentric points of view in conservation. Be able to recognize examples of each.

**Know** the meaning/significance/examples of: indicator species, keystone species, endangered species, threatened species, endemic species, exotic species, invasive exotic species

Finally, be sure you are familiar with the scientific method and the scientific definitions of hypothesis, theory, law, inductive vs. deductive reasoning, etc. The link at the end of Lecture 1 will help you review these, if you're a little rusty.

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**The History of Evolutionary Thought**

**Know** the general age of the universe, solar system, earth. How long as life been on earth (at least as far as current research tells us)? How long has Homo sapiens existed on earth?

**Know** the contributions of each of the following to modern evolutionary theory, and know a little bit about each person: Plato, Aristotle, (what is scala naturae?) Georges-Louis Leclerc, Jean Baptist Lamarck, Georges Cuvier, Charles Darwin, Mootoo Kimura.

**What is** epigenetic inheritance? (How is it somewhat related to the early ideas of Lamarck?)

**Know** the meaning/significance of spontaneous generation, abiogenesis. Is the origin of life the same as the evolution of life?

**Understand** the significance of neutral evolution, first proposed by Mootoo Kimura.

**Understand** what is meant by the molecular clock, and how it is applied. What type of gene would be the most appropriate index to use for a molecular clock study? One that is vital to an organisms function? A non-coding gene? An RNA gene? A pseudogene?

**Know** the meaning/significance of: evolution, microevolution, macroevolution, species, population, deme, gene, allele, gene pool, adaptation (physiological vs. evolutionary)

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**Systematics and Taxonomy (Workshop/Lecture AND your second laboratory session work)**

**Know** how to read a basic phylogenetic tree (the branching diagram representing evolutionary history of a particular lineage of organisms).

**Know** the reasons scientific classifications are useful. Know the (subtle) difference between taxonomy and systematics.

**Know** the significance of the work of Carl Linne (a.k.a., Linnaeus). What are the basic rules of Systema naturae? What are the *most basic* rules governing naming of species?

**Know** the meaning/significance of: taxon, as well as the meaning of the name, category, and rank of a taxon.

**Know what is meant by**: common ancestor, outgroup, ingroup, parsimony, sister taxa, clade, cladogenesis, analogous vs. homologous characters, homoplasy, primitive (plesiomorphic) vs. derived (apomorphic) characters; symplesiomorphy vs. synapomorphy, and what the significance/use of these are in constructing phylogenies

**Know** the classification hierarchy (Domain, Kingdom, Phylum, etc.), and what is meant by the "most inclusive" and "least inclusive" groups.

**Know** the three aspects of a taxon (name, rank, content) and be able to recognize which is which.

**Know** how to read and understand a cladogram (a phylogenetic tree constructed using cladistic techniques)
Know what is meant by parsimony, and be able to recognize a most parsimonious phylogenetic tree from among a selection of several different phylogenies.
Understand the role of horizontal gene transfer in evolution
Know what is meant by monophyletic, polyphyletic, and paraphyletic taxonomic groups. Which one should a systematist always seek to construct when classifying organisms?

The Darwinian Revolution
What was Darwin doing when he devised his famous theory of evolution by natural selection?
Know the contributions of the following historical persons to Darwin’s ideas: James Hutton, Charles Lyell, Robert Malthus, Alfred Russell Wallace
Know the meaning/significance of: HMS Beagle, Captain John Fitzroy, the Galapagos Islands, uniformitarianism, catastrophism, artificial selection
Know Darwin’s four tenets of evolution by natural selection, how to apply them, and how to recognize examples in nature of the “tenets in action.”  Don’t just memorize them. Understand what they mean. What is the meaning of Darwin’s term “descent with modification”?
Understand what is meant by adaptive, maladaptive, and neutral traits?
Understand the meaning of the phrase “survival of the fittest” in the context of Darwinian evolution. You may think you already know. But just be sure to read the section on this topic in the notes from the lecture on the Darwinian Revolution so you really do know. You have been forewarned.
Know the meaning of the word “tautology”. Is the term “survival of the fittest” a tautology? Is the term meaningful in terms of Darwinian evolution?
Be able to address the common misconceptions about evolution and explain why they are incorrect.
Understand what is meant by the concept of the “selfish gene” (perhaps better termed the immortal gene) and how Richard Dawkins popularized the idea.
What is a “survival machine”, as described in the short video interview with Richard Dawkins?

Evidence for Evolution: Fossil Record
Know the four basic lines of evidence of evolution. (Watch the videos at the beginning of lecture 4)
Understand: What types of fossils are there?
Know the meaning/significance of: trace fossils; be able to recognize examples of both altered and unaltered fossils (what’s the difference?). What is permineralization?
Understand: What types of organisms fossilize best? What conditions promote fossilization?
Is the fossil record the best line of evidence for evolution? Why or why not?
Understand the difference between relative and absolute dating of fossils, and the basic way each is done. (The Geologic Principles will help with understanding of relative dating.)
What is meant by “half life”? Which isotopes are best for dating relatively recent fossils? Which are most commonly used to date extremely ancient ones?

Evidence for Evolution: Biogeography
When did the continents begin to drift apart? By what time were they fully separated? Of what significance is this in terms of organic evolution? Understand the connection between continental drift and climate/climate change.
Know the meaning/significance of: biogeography, Pangaea, Laurasia, Gondwanaland, Old World vs. New World, subduction zone, seafloor spreading zone, continental plate, oceanic ridge,
Understand how congruence of phylogenetic trees of organisms and geographical change can indicate evolutionary history shared by the organisms and the continents (and smaller land masses) on which they live.
Also understand that—as represented on a phylogenetic tree—once an ancestral population has been split by continental drift (or any other mechanism, for that matter), that ancestral population is no longer, technically, the same as it originally was (it has split into two genetically different units), and that it is thus considered to be “extinct” in the cladistics sense. The parent population (hypothetical ancestors) have given rise to two different populations (descendants), even if one or the other doesn’t evolve into anything that appears significantly different from the original ancestor.

Evidence for Evolution: Homology of Form, Embryos, Genes
Recall the meaning/significance of: homology, analogy (analog=homoplasy), primitive vs. derived character, (plesiomorphy vs. apomorphy, and symplesiomorphy vs. synapomorphy), convergent evolution.
Know how the study of symplesiomorphies and synapomorphies among species is applied to the study of their evolutionary relationships. (Your Systematics and Taxonomy workshop and the lab will help with this.)
Know what is meant by "Just So Stories", genotype, phenotype, ontogeny, heterochrony, neoteny, progenesis, paedomorphy, isometric vs. allometric growth, DNA (and the four “letters” of the DNA alphabet)
Be able to recognize examples of morphological, ontogenetic, and molecular homology among species.
Know the meaning/significance of vestigial and atavistic characters.
What is an exaptation?
What is a gastrea? What is its significance to animal evolution?
What is “Evo Devo”?
Understand what Ernst Haeckel meant by the phrase “ontogeny recapitulates phylogeny”? Was he correct? Understand why or why not.
Know the meaning/significance (in terms of ontogenetic homology) of: zygote, blastula, gastrula, gastrulation, blastopore, protostome, deuterostome, homeotic (Hox) genes (what is their job? Check your text if you don’t remember this from lecture, or Google it!), radial vs. bilateral symmetry
Know the meaning of heterochrony. How can this result in changes in species? What is the link between heterochrony, allometric growth, and paedomorphy? (See http://www.bio.miami.edu/dana/dox/heterochrony.html)
Understand and be able to recognize examples of molecular and chromosomal homology.
What is synteny?

Evidence for Evolution: Evolution Observed
Understand how recently observed incidences of microevolutionary change provide evidence that such processes have been occurring since life on earth began.
Don’t memorize the examples in the lecture notes, but do understand them and how they represent observable instances of evolution.
Know the meaning/significance of: Bergmann’s Rule, evolution as compromise
Know the different levels of reproductive isolation and be able to recognize examples of each.
Know the different types and levels of reproductive isolating mechanisms (review them here: http://www.bio.miami.edu/dana/dox/reproductive_isolation.html) and how they work.
Know the difference between microevolution and macroevolution, and be able to recognize examples of each.
Understand what is meant by “selfish” genes and how natural selection can be said to occur at the level of the gene. Who were/are the scientists that developed this idea? (Refer to the links at the beginning of Lecture 6)

Quantifying Evolution: Hardy-Weinberg
Know the meaning/significance of: gene, allele, population, deme, gene pool, polymorphism, homozygous, heterozygous, the tenets of evolution by natural selection
Know the meaning/significance of: microevolution, macroevolution, speciation
Understand the various types of polymorphisms one might find in a population.
Know the difference between physiological and evolutionary adaptation, and how they are related.
Know the five factors that can cause a population to evolve.
Remember that while natural selection (and the other five HW factors) may occur at the level the individual organism, individual organisms do not evolve. Only populations evolve from one generation to the next.
Know how to use the Hardy-Weinberg equation to address a question about a population that might be evolving. Use the questions embedded in Lecture 6 (near the end) to practice and help you understand this model.
Know how to do a Chi square test and devise a null and alternative hypothesis regarding a population you might be studying.
Understand the significance of heterozygosity to populations and organismal health.

TIPS FOR EFFECTIVE STUDYING:
1. The Workshops will help you understand the exam material, and they should be considered part of your study material for the exam. Don’t memorize the details or names of specific examples in the notes or text or workshops. Instead, try to understand the concept those examples are illustrating, and be able to recognize new examples of the same concepts. Memorization is fine for things like vocabulary and names. But the MOST important thing you can do is UNDERSTAND HOW THINGS WORK and apply this to new situations.

2. Read the textbook chapters and USE THE PRACTICE PROBLEMS AT THE END OF EACH CHAPTER TO TEST YOURSELF. They are an excellent gauge of how well you are actually understanding the material.

3. If you don’t remember the definition or significance of something in the notes or this study guide... GOOGLE IT.

Seriously! This is sometimes the BEST way to find multiple sources that will really help you understand these sometimes-tough concepts. And you’ll learn other interesting things along the way!