Biology 211 **Fall 2013**
Biodiversity, Ecology, and Conservation Biology **Dr. Bob Podolsky**

EXAM 3 Study Guide

Exam 3 will include a mixture of questions like the first two exams (quick IDs, single choice, multiple choice, short answer, Jeopardy!, true-false, false statements, problem solving). This guide will help you to review concepts and skillscovered in lecture and readings, but is not an exhaustive list of questions that could be on the exam. The study guide will be most useful if you write down answers rather than just "thinking through" them and then check your understanding by quizzing and being quizzed by other students.

Unit 7. Macroevolution and phylogenies

1. Be able to define and use the following words and phrases: speciation, species, biological species concept, phylogenetic species concept, reproductive isolation, allopatric, sympatric, phylogeny, phylogenetic hypothesis, common ancestor, sister group, branch, node, clade, character, character state, parsimony, outgroup, ancestral, derived, informative character, synapomorphy, extant, homology, homoplasy, convergent evolution, monophyletic, paraphyletic, polyphyletic, taxonomy, adaptive radiation, homeotic (regulatory) genes.
2. Discuss the relative costs and benefits of each species concept: biological, morphological, and phylogenetic. How well does each help to identify "evolutionarily independent units"?
3. What are differences in how populations become genetically isolated during allopatric, sympatric, and stasipatric speciation?
4. How can microevolutionary processes (mutation, migration, genetic drift, natural selection, sexual selection, non-random mating) contribute to genetic divergence during speciation?
5. Why are shared, derived traits useful to identify monophyletic groups? Why are shared, ancestral traits not informative for identifying monophyletic groups? What type of group is often identified by shared, ancestral traits? by homoplasies?
6. Be able to use character states to infer the most parsimonious phylogeny for a small group of related organisms (e.g., m&m exercise).
7. From a phylogeny, identify the relative degrees of evolutionary relatedness among pairs of taxa.
8. Be able to determine when two phylogenetic hypotheses are the same or different and when two topologies are the same or different.
9. Compare and contrast homology and homoplasy. Which type of trait is more valuable for inferring phylogenies? Why?
10. "Birds should not be regarded as a separate class from reptiles." Use biological ideas to provide one argument in favor of and one argument against this statement. More generally, how many clades of vertebrates should be recognized as taxonomic classes?
11. Why is "prokaryote" not a useful term for understanding evolutionary relatedness among the domains of life?
12. What two basic types of events can trigger adaptive radiations? Use examples of adaptive radiations within the tree of life to support your answer.
13. How can relatively simple genetic changes result in dramatic morphological changes? Explain your answer using an example.
14. Explain how phylogenies can be used to study the frequency, order, and timing of evolutionary changes, using examples.

Unit 8. Prokaryotes and protists

1. Be able to use the following words and phrases: prokaryote, eukaryote, domain, pathogenic, bioremediation, decomposer, extremophile, halophile, thermophile, nitrogen fixation, anaerobe, autotroph, heterotroph, photosynthesis, chemosynthesis, conjugation, lateral gene transfer, ingestion, absorption, cilia, flagella, endomembrane system, malaria, amoebae, primary producers, plankton, phytoplankton, endosymbiosis, secondary endosymbiosis, multicellularity, colonial, chlorophyll, algae, meiosis, alternation of generations.
2. Be able to discuss the phylogenetic position, phylogenetic status (i.e., is it monophyletic, paraphyletic, polyphyletic), and defining characteristics of the following groups: Bacteria, Archaea, Eukarya, Prokaryote, green algae, red algae, brown algae, land plants, choanoflagellates, fungi, animals.
3. Be able to discuss the ecological roles and importance to humans of the following groups: Bacteria, Archaea, cyanobacteria.
4. Describe a major difference between Earth's early atmosphere and the atmosphere of today. Explain the timing and nature of events that were the source of this change.
5. Explain how metabolic diversity is related to ecological diversity in prokaryotes.
6. Describe the phylogenetic distribution of photosynthesis within the prokaryotes.
7. What is likely to be the source of energy for the production of ATP in pathogenic bacteria? Hydrothermal vent bacteria? Cyanobacteria? Explain.
8. Discuss the significance of cyanobacteria for the evolution of biodiversity. In what two different ways have cyanobacteria played an essential role in the diversification of life?
9. Discuss the evolutionary origin of the following traits: mitochondria, chloroplasts, cell walls, multicellularity. Which are thought to have evolved once and which more than once? How are these patterns of evolution reflected in the phylogeny of Eukarya?
10. Outline the steps in the endosymbiosis theory for the origin of mitochondria. What did each partner provide the other, and what did each receive in return? Answer the same questions for the origin of chloroplasts.
11. Describe the major sources of evidence in support of the endosymbiosis theory for the evolution of mitochondria and chloroplasts. In particular, be able to show phylogenetic hypotheses that would be in favor of as well as against the endosymbiosis theory.
12. Discuss the evolutionary history of photosynthetic eukaryotes. Why are "algae" so diverse?
13. "The tree of life as a metaphor for the evolutionary history of all organisms should be replaced with the web of life." Use biological concepts to give an argument in favor of this statement.
14. Discuss the functional and evolutionary significance of each of these evolutionary innovations: organelles, cytoskeleton, multicellularity, meiosis.
15. Where does meiosis fit in a life cycles that includes an alternation of generations?
16. What is found in an organism that is multicellular and which groups are multicellular?
17. What is found in life cycles that include an "alternation of generations"?

Unit 9. Plants and fungi

1. Be able to use the following words and phrases: deforestation, desertification, bioprospecting, embryo, moss, pores, vascular tissue, lignin, fern, pollination, seed, cone, gametophyte, sporophyte, spore, zygote, mycorrhizae, saprophyte, yeast, hyphae, mycelium, heterokaryotic, basidium, ascus, ascocarp, chitin, endophyte, extracellular digestion, lignin peroxidase, cellulase, spore, plasmogamy, karyogamy, sporangium, opisthokont.

2. Be able to discuss the phylogenetic position, phylogenetic status (i.e., is it monophyletic, paraphyletic, polyphyletic), and defining characteristics of the following groups: green algae, land plants, non-vascular plants, vascular plants, seedless vascular plants, seed plants, gymnosperms, angiosperms.
3. Draw a simplified phylogeny of land plants and map the origin of the following traits: spores, seeds, tracheids, vessels, cuticle, stomata, pollen, flowers, fruits.
4. What challenges are associated with living on land for plants? Discuss evolutionary innovations that are important for living and reproducing on land. Be able to map these traits onto a phylogeny of the green plants.
5. Discuss the evolutionary radiation of angiosperms. Why are angiosperms likely so much more diverse than gymnosperms?
6. Be able to discuss the ecological roles and importance to humans of the following groups: ectomycorrhizal fungi, arbuscular mycorrhizal fungi, lichens, yeasts, chytrids.
7. Describe two different ways that fungi play essential roles in increasing the productivity of terrestrial ecosystems.
8. Discuss why the fungus body form is especially advantageous for making a living as a decomposer.
9. Compare and contrast reproduction in ascomycetes and basidiomycetes.
10. Which of the following groups include species with alternation of generations: protists, land plants, animals, fungi? Draw a generalized life cycle with alternation of generations and label the following events or structures: sporophyte, gametophyte, meiosis, mitosis, zygote, fertilization, syngamy, spores, gametes. How is this basic plan altered to result in the life cycles of the following organisms: bryophytes, angiosperms, basidiomycetes, animals?
11. Compare and contrast the typical fungal life cycle (for example, as seen in basidiomycetes) with the typical animal life cycle (for example, as seen in vertebrates) and with the typical angiosperm life cycle.
12. Compare and contrast the roles of plants and fungi in the carbon cycle with the roles of bacteria in the nitrogen cycle.
13. Discuss two distinct ways that life has solved the surface area-to-volume problem.

Unit 10. Animals

1. Be able to use the following words and phrases: Cambrian explosion, body plan, body axis, diploblast, triploblast, tissue, epithelium, ectoderm, endoderm, mesoderm, asymmetry, radial symmetry, bilateral symmetry, cephalization, pentaradial symmetry, coelom, pseudocoelom, hydrostatic skeleton, protostome, deuterostome, gastrulation, sessile, exoskeleton, endoskeleton, internal fertilization, external fertilization, metamorphosis, water vascular system, pharyngeal gill slits, notochord, dorsal hollow nerve cord.
2. Be able to discuss the phylogenetic position, phylogenetic status (i.e., is it monophyletic, paraphyletic, polyphyletic), and defining characteristics of the following groups: Porifera, Cnidaria, protostomes, deuterostomes, Annelida, Nematoda, Arthropoda, Platyhelminthes, Mollusca, Echinodermata, Chordata, vertebrates, invertebrates, fishes, amphibians, reptiles, birds, mammals.
3. Draw a simplified phylogeny of animals (including at least six major phyla) in order to map the origin of the following traits: radial symmetry, bilateral symmetry, diploblasty, triploblasty, coelom, pseudocoelom, segmentation, protostome development, deuterostome development, radula, exoskeleton, jointed appendages, notochord, pharyngeal gill slits.

4. Draw a simplified phylogeny of deuterostomes (including echinoderms, amphibians, lampreys, lungfish, ray-finned fishes, sharks reptiles, mammals) and map the origin of the following traits: cranium, radial symmetry, pharyngeal slits, cartilaginous skeleton, bony skeleton, vertebrae, jaw, lungs, limbs, amnion, endothermy, notochord.
5. Discuss the importance of the following evolutionary innovations: collagen, mesoderm, bilateral symmetry, metamorphosis, desiccation-resistant eggs, jointed appendages.
6. What challenges for animals are associated with the transition to terrestrial habitats? Discuss the important evolutionary innovations associated with this transition in the vertebrates. Compare and contrast the adaptations for life on land within the vertebrates with similar adaptations in the arthropods, molluscs, and plants.
7. Compare and contrast the role of metamorphosis in the life cycle of animals with a sessile adult stage and in the life cycle of animals with a mobile adult stage.
8. Discuss the evolutionary radiation of arthropods. Why are arthropods so diverse?
9. Use the evolution of vertebrate limbs and jaws to discuss the evolution of novel adaptations that allowed for adaptive radiations.
10. Compare and contrast adaptations involved in the diversification of the three most species-rich animal lineages: arthropods, molluscs, and vertebrates.
11. Compare and contrast adaptations for life on land seen within the plants vs. the vertebrates.
12. Discuss at least three examples of major adaptive radiations within the evolution of animals. Describe the key events that appear to have triggered these radiations.