**BSC2005 Exam #3 Study Guide**

In general, material from the book (and other readings), material from the lecture videos and other videos, and material from the assignments (especially those which reinforce a concept from the reading and/or lectures) is all fair game for the exam.

This is not an exhaustive list of everything you may need to know, and not every single thing from this list will necessarily be asked about on the exam, but this study guide is meant to help you focus in your studying effort on the most important concepts from the modules covered by this exam.

**Module 9: Evidence for Evolution**

* How can we tell the difference between a rock and a fossil? Why do we care about fossils in the first place?
  + Specialists learn to recognize the structures and patterns of anatomical features
  + Fossils give info about the kinds of organisms that lived, what they looked like and where and how they lived
* How do fossils form? How does this affect what organisms (or what parts of organisms) are more or less likely to become fossils?
  + Remains must avoid being trampled, scavenged, or decomposed
  + Remains must be buried rapidly in dry or anoxic (no oxygen) environment
  + Harder/larger parts are more likely to fossilize
  + Once remains are buried, minerals in the dirt around it soak into the bone/shell
  + Alternatively, soft tissues may leave an imprint
  + Fossil must be exposed to the surface and found before it erodes
* What are the three main types of rock? Which one is most likely to have fossils in it, and why?
  + Igneous: new rock, from lava
  + Sedimentary: hardened layers of sediment/dirt (sandstone)
  + Metamorphic: igneous or sedimentary rock with have been transformed by extreme pressure and/or heat
  + Fossils are found in sedimentary rock
* What is the principle of superposition? What is the principle of faunal succession? How can we use these to determine the age of a given fossil?
  + Superposition: in a sequence of sedimentary rocks, the oldest layer is at the bottom and the newest layers are at the top (layers are called strata)
  + Faunal succession: fossils appear in the same order in rock layers (older species appear first)
* What is radiometric dating? What kind of rocks does it work on? How can we use these to determine the age of a given fossil?
  + Absolute dating. Uses rate of decay of radioactive isotopes to determine age
* Relative dating:
  + Based on position. Older fossils are buried below younger fossils
* What is a half-life? Be able to go from # of half-lives to expected % of parent isotope remaining (or expected ratio of parent:daughter isotopes), and vice-versa.
  + Time it take for half of the original isotopes to decay
  + 1 / 2^num\_half\_lives = fraction remaining (1/16 after 4 half-lives)
  + Long time duration dating is done by dating surrounding layers of igneous rocks
* What are transitional fossils? What are some examples of transitional fossils (or transitional series) in the fossil record, and why are they considered transitional?
  + Fossils that show the evolution of a species
  + Horses, archaeopteryx (early bird), primitive whales, Tiktaalik
  + Horse ancestors got taller over time, and the number of toes dropped from 4 to 3 to 1
* Be able to define and recognize homologous traits.
  + Traits that were present in and inherited from a common ancestor
* What are vestigial structures and what do they tell us about the history of life?
  + Structures that have lost their use through evolution
  + They provide evidence for evolution because they suggest that an organism changed from using the structure to not using the structure, or using it for a different purpose
* How old is the Earth? How long has life existed on Earth? What was the earliest life on Earth like? When did eukaryotes evolve? Multicellular eukaryotes?
  + Earth is ~4.5 billion years old
  + Life has existed ~3.5 billion years
  + Earliest life was prokaryotes
  + Photosynthetic prokaryotes arose 2.5 billion years ago
  + Eukaryotes evolved around 1.5 billion years ago
  + Multicellular eukaryotes evolved around 1.2 billion years ago
  + Land plants appeared 400 MYA
  + Firs land vertebrates appeared 380 MYA
* What is the structure of the geologic time scale? (\_\_\_ subdivided into \_\_\_\_) How did we determine the boundaries between these divisions?
  + Eras are subdivided into periods
  + Each period is characterized by specific animals, plants, climates, and positions of the continents
  + Boundaries between periods are marked by extinction events
  + Really big extinctions mark the boundary between eras
* What event marked the beginning of the Paleozoic? The end of the Paleozoic and the start of the Mesozoic? The end of the Mesozoic and the start of the Cenozoic?
  + Paleozoic: start=Cambrian explosion, end=the great dying
  + End of Mesozoic=K/T boundary, dinosaur killing asteroid
* Approximately when were the two biggest mass extinction events in the history of life on Earth? Which one was bigger? What are believed to be the causes of each?
  + End-Ordovician: 444 MYA, 86% species lost, glacial activity
  + Late-Devonian: 360 MYA, 75% species lost, land plants created severe global cooling
  + End-Permian: 250 MYA, The great dying, the biggest, volcanic activity
  + End Triassic: 200 MYA, 80% lost, underwater volcanic activity
  + End-Cretaceous: 65 MYA, 76% lost, Yucatan asteroid

**Module 10: Life on Earth**

* Approximately how many species are there on Earth right now? Approximately what percent are animals vs. plants vs. fungi vs. unicellular organisms? How would that change if we looked at estimated species vs. described species?
* Define biodiversity. Why is it important?
* Define biogeography. What can the movement of the continents tell us about the evolution of life? Explain some examples.
* What is an adaptive radiation? Why/how does it occur?
* What’s the difference between gradualism vs. punctuated equilibrium?
* What is binomial nomenclature, and why is it important?
* What are the levels of Linnean taxonomy, from most inclusive to least inclusive?
* What is a phylogenetic tree, and how is it similar to / different from Linnean taxonomy?
* Given a phylogenetic tree (drawn in a variety of ways), be able to identify:
  + the common ancestor/root and the tips of the tree. What does this imply about how time is depicted using a tree?
  + the most recent common ancestor of any two organisms on that tree.
  + the closest relative of any organism on a tree.
  + the clades that that tree contains
  + identical trees with rotated branches
* What are nodes on phylogenetic trees? What event in the evolutionary history of a group of organisms do they represent?
* What types of traits can be used to reconstruct phylogenetic trees? What are some of their pros/cons? Which types of organisms can they be used for vs. not used for?
* What is the principle of parsimony, and how does it apply to phylogenies? Given a simple set of traits, be able to identify the most parsimonious phylogeny.
* Be able to identify synapomorphies, symplesiomorphies, and analogous/convergent traits. Which one is the same as homologous traits?

**Module 11: Prokaryotes**

* Review from Exam 1: What are the differences between prokaryotes and eukaryotes?
* What are the three domains of life? Be able to draw/interpret their phylogeny (how are the three related to each other?).
* Where do we find prokaryotes? What is the microbiome?
* Differentiate between obligate anaerobes, obligate aerobes, and facultative anaerobes. Can you relate this back to what you learned about cell respiration & metabolism back in Module 4?
* Differentiate between autotrophic and heterotrophic prokaryotes. What are some of the ways each type can get their nutrients?
* What are the three main shapes of bacteria? How does shape affect their lifestyle?
* What’s unique about the bacterial cell wall? What’s the difference between gram positive and gram negative bacteria?
* How do bacteria move around vs. stay in one place?
* How do bacteria reproduce? How does this differ from the process of mitosis that you learned about in Module 5?
* What is conjugation? How is this similar to sexual reproduction? How does it differ?
* What are endospores? In what conditions might they be formed?
* What are biofilms? Where are they found?
* How do Archaea differ from Bacteria?
* What does it mean to be an extremophile? Which domain has the most diverse extremophiles? What kind of environments can they be found in?
* Are most prokaryotes beneficial, harmful, or neutral in their effect on humans?
* Why are cyanobacteria so important to the history of life on Earth?
* What are some of the main jobs that prokaryotes do that benefit humans (directly or indirectly)?
* What is nitrogen fixation and why is it so important? What role to prokaryotes play?
* What is symbiosis? What does it mean if a symbiotic relationship is parasitic? Mutualistic? Commensalistic? Be able to give examples of each.

**Module 12: Eukaryotes**

* Review from Exam 1: What are eukaryotes? What features do they all share that distinguish them from prokaryotes?
* What is endosymbiont theory? What does it suggest about how eukaryotes evolved? Which organelles are involved? What is the evidence that supports this theory?
* What are the four main groups/types of Eukaryotes? Which of these are clades (Module 10) and which is not?
* What are protists? How do they get their food? Where can we find them? Are they always unicellular? Give some examples.
* What features distinguish plants from other eukaryotes?
* When did land plants first evolve? What major challenges of living on land did they have to face?
* Also, what is the importance of the following traits? In the evolution of land plants, which groups have which traits? Which of these traits evolved earliest vs. latest?
  + Vascular tissue (xylem & phloem)
  + True leaves
  + Seeds
  + Flowers & Fruits
  + Cones
* Who are the members of each of the following groups? What unique features do they have?
  + Bryophytes
  + Lycophytes
  + Ferns
  + Gymnosperms
  + Angiosperms
* What features distinguish animals from other eukaryotes?
* Define asymmetrical, radially symmetrical, and bilaterally symmetrical body plans. Give examples of animals that have each type.
* Who are the members of each of the following groups? What unique features do they have?
  + Cnidarians
  + Mollusks
  + Annelids
  + Arthropods
* What’s the difference between each of these comparisons, and who belongs to each group? For each, which one are you?
  + Invertebrates and vertebrates?
  + Protostomes and deuterostomes?
  + Fish vs. Tetrapods?
  + Amphibians vs. Amniotes?
  + Monotremes, Marsupials, and Placental Mammals?
  + Endotherms vs. Ectotherms?
* How are fungi similar to plants? How are they similar to animals? Which one are they more closely related to, phylogenetically?
* What are hyphae? Mycelium?
* What are some other types of fungi in addition to mushrooms?
* How do fungi get their nutrients?