

EEB 2245 & EEB 2245W  
**Final STUDY GUIDE for EXAM 1**  
 SPRING 2014

### Geological Time Scale and the Fossil Record

-distinction between the fossil record and the Geological Time Scale; age of earth (4.5) vs beginning of Geological Time Scale (3.5 bya) (How differ? Why differ?); understand that named intervals are not regularly spaced in time; events are concentrated in most recent ~500 million years; what determines boundaries of intervals? Precambrian-dates of beginning and end; Archean and Proterozoic Eons- dates of beginning and end; Phanerozoic Eon- date of beginning; **know the following Phanerozoic intervals in their relative sequence: Eras, Periods, and Epochs (Epochs of Cenozoic only); for each Era, Period, and Cenozoic Epoch know dates of beginning and end ( $\pm 10$  my for Eras and Periods;  $\pm 5$  my for Epochs), and major event (if discussed in class) marking temporal boundaries of each; 5 major mass extinction events and timing of each; examples of major taxa that went extinct as a result of each event; which is considered the greatest mass extinction and why?** What is a fossil? Distinguish biotic from abiotic types of evidence; 4 main types of fossils (i.e., molds, casts, trace, etc.); modes of fossilization (replacement, petrification, carbonization, etc.) which are organic and which are sources of DNA; example of each; ancient DNA- examples of ages and types of organisms from which ancient DNA has been extracted and sequenced; 3 major types of rocks and type most likely to harbor fossils (and why); limitations/biases of the fossil record: biased sample with respect to kinds of organisms (large, hard, numerous, more recent, etc.) most likely to be preserved and circumstances (wet periods, wet places, undisturbed areas, areas in which buried rapidly, etc) under which fossils are most likely to be preserved; complete/continuous sequences rare; difficulties with correlations between strata, sites, etc.; dating of the fossil record- relative dating methods (principle of superposition, index fossils & stratigraphy); absolute dating methods- major principle on which they rely (i.e., radioactive decay); understand how parent/daughter isotope ratios are used in radiometric dating; types of rock that can be dated with radiometric methods;  $C^{14}/N^{14}$  as a method of dating fossils themselves (Of what age? Why?);  $K^{40}/Ar^{40}$  as a method of dating rocks around fossils (Of what age? Why?)

### "Precambrian"

-3 Domains of life on earth (i.e. Bacteria, Archaea, Eukarya); major differences between prokaryotic and eukaryotic organisms (unicellular vs. multi-cellular, etc.); age of earth; formation of early atmosphere; is life considered to be monophyletic? (evidence? e.g., all organisms share nucleic acids as hereditary material, etc.); date of earliest life (3.5 by-why not before that?); Stromatolites- what were/are they? When did they first appear? First evidence of photosynthesis-when? What (e.g., 2.7 bya; chemical) What type of evidence? How does photosynthesis relate to  $O_2$  increases in atmosphere? Initial fate of  $O_2$  produced (iron oxide deposits); ultimate fate of  $O_2$  produced; 3 possible fates of anaerobic organisms alive at the time (extinction, retreat, adapt); serial endosymbiotic theory and the origin of eukaryotes- what is it? What does it explain? Evidence in support of the theory (organelles have their own DNA, etc.); primary vs. secondary plastic endosymbiosis); how does origin of mitochondria (i.e. from purple bacteria; once) differ from origin(s) of chloroplasts (i.e., originally from cyanobacteria; first unquestionable fossils of eukaryotes-what and when (i.e., acritarchs, 900 mya); what type of organisms were they? What and when was Rodinia? Evolution of metazoa- When? Features of metazoans (=animals) (e.g., multicellular, heterotrophic, embryos, etc.). What and when first evidence? Doushantuo embryos, etc.; Ediacaran fauna: why important? when? What types of fossils (trace fossils- tracks, burrows, etc.)- no hard parts; types of phyla? (extant e.g., cnidarians? sponges? Molluscs?; also some extinct, e.g., rangeomorphs exhibiting fractal morphology). Environment at end- break-up of Rodinia, snow-ball earth, etc.

### Phanerozoic Eon (=visible life)

#### Paleozoic Era

-**Cambrian Period:** when was it? Plant diversity (marine red, green, brown algae only). Cambrian expansion: what was it? When was it? In what sort of environment did it occur? (shallow coastal seas, etc.); disparity vs. diversity; Burgess shale and Chengjiang faunas: examples of taxa- extant (e.g., arthropods, annelids, priapulids- most modern phyla); examples of extinct taxa (e.g. *Marella*, *Opabinia*, *Anomalocaris*); evolutionary significance of *Pikaia*; conodonts, *Haikuchthyes*? Explanation(s) for increased diversity (i.e., evolution of predation, etc.). **Ordovician Period:** when was it? Habitat? Position of continents? Kinds of invertebrates present (echinoderms, trilobites, eurypterids, etc.); types of vertebrates present (i.e., diversity of fish: agnathans, ostracoderms, placoderms, elasmobranchs, bonyfish); examples of life on land- non-vascular plants (e.g., bryophytes, etc.); dessication a problem, remain small; first mass extinction. **Silurian Period-** when was it? What is happening with the continents? Kinds of organisms present in oceans (e.g. ostracoderms, placoderms). Life on land: animals (millipedes, spiders; NO vertebrates); plants- soil! bryophytes, and first vascular plants (*Cooksonia*) and their distinctive morphology. **Devonian Period:** when was it? Nature of the atmosphere? Position of continents? Plants (first vascular, first seeds- seed ferns), evolution of specialized body parts (roots, stem, leaves). Kinds of animals present in oceans (ammonites, fishes diversified; *Latimeria*- age of first fossils, distinctive features and

importance. Age of? Life on land: *Ichthyostega*- What was it? Why is it important? Challenges faced by first vertebrates emerging on to land (e.g. breathing, legs and wrap-around ribs to support body and organs respectively), environmental conditions that may have driven that change; second mass extinction.

**Carboniferous Period:** when was it? Sharks and rays diversify; land dominated by rich forests consisting of what types of plants? (club mosses, lycopsids, tree ferns and gymnosperms); period is source of much of today's richest coal and oil deposits; also on land which insect groups? (dragonflies, etc.); critical event: evolution of first amniotes; amniotic egg- 4 main components and their functions; what advantage did amniotes have over other vertebrates? **Permian Period:** when was it? plant groups found on land? Which insects (most of modern insect orders)? Amphibians diversify. Three major types of amniote skulls (anapsid, synapsid, diapsid); how do they differ from one another? Synapsids: modern representatives (mammals), dominated Permian (e.g., pelycosaur such as *Dimetrodon*; therapsids i.e., mammal-like "reptiles"); diapsids: modern representatives (all living amniotes other than mammals). Why are they not considered to be dinosaurs? End of Era marked by greatest extinction in history of earth; examples of groups that went extinct; distinguish taxonomic diversity from taxonomic disparity; environmental perturbations (volcanism).

**Mesozoic Era** (= Age of what type of organisms?)

-**Triassic Period:** when was it? Configuration of continents at beginning (i.e., Pangaea). On land: synapsids persisted (as therapsids), but didn't diversify; diapsids diversified: 1<sup>st</sup> dinosaurs: distinguishing features (e.g. open acetabulum in hip, bipedal, warm-blooded? etc.); 2 lineages of dinosaurs (Ornithischia vs. Saurischia) and diagnostic features of each (lizard-hipped vs. bird-hipped, carnivores vs. herbivores, etc.); know one example one saurischian and one ornithischian from the Triassic Period (i.e., *Euparkeria* and *Lesothosaurus*, respectively); both monophyletic (assuming Saurischia also include all extinct and extant birds); first pterosaurs (no head crest, long tail) =sister taxon to dinosaurs (not dinosaurs); also crocs and lineage that led to modern lizards, etc.; mass extinction at end. **Jurassic Period:** when was it? Land in configuration of 2 major continents (Laurasia and Gondwana). Plants: gymnosperms dominate land; key plant innovation-evolution and diversification of first flowering plants (on land); synapsids persist in the form of therapsids, possibly also first mammals (small and likely nocturnal); dinosaurs diversify; know one example of a saurischian and one example of an ornithischian dinosaur that characterizes this period; Connecticut state fossil-(*Eubrontes*- what was it?); pterosaurs diversity; feathered dinosaurs present; *Archaeopteryx*- What is it? Why is it important? Features it shares with birds; features unlike birds. To which dinosaur lineage does it belong? Pterosaurs diversify; why? **Cretaceous Period:** when was it? All 4 plant lineages present; example of saurischian and ornithischian dinosaurs that characterize this Period; diversification of birds; how did Cretaceous pterosaurs differ from earlier pterosaurs? Last fossils of *Latimeria*. Mass extinction at end of Era; major groups that went extinct; cause of extinction?

**Cenozoic Era** (= Age of what type of plants? Of what type of animals?) (**reminder: know sequence and approx. dates + 5 my of Epochs**)

-all 3 major mammal groups present (i.e., monotremes, marsupials, placentals); general features shared by all 3 groups (e.g., hair, mammary glands, perfectly occluded teeth, heterodonty). Possible explanation for mammal diversification (i.e., heterodonty). **Tertiary Period:** climate begins to cool and becomes drier; continents continuing to separate- reach modern positions when? know examples of key organisms that appeared in each Epoch (e.g. evolution of horses, proboscidiens, primates, etc.). "Great American Interchange"-What was it? When was it? What were some of the results? **Quaternary Period:** was punctuated by 4 major glacial events separated by interglacial periods; our current status with respect to glacial and interglacial events.

### Primate Evolution

-primate features (nails, grasping hands, etc.); understand where humans fit in primate classification (i.e., Anthrooidea, Hominoidea, Hominoidea, *Homo sapiens*); anthropoid features (postorbital closure, no grooming claws, etc.); early hominoid features (no tail, gap between canines and incisors, etc.), early hominoids (*Proconsul*, *Gigantopithecus*), age and distinctive characteristics of each; hominid features (bipedal, loss of opposable toe, etc.), relationship between locomotion and leg and arm length, early fossil hominids (i.e., *Australopithecus afarensis*, *Australopithecus africanus*)- age, location and distinguishing characteristics of both species; *Homo* features and species (i.e., *Homo habilis*, *Homo erectus*, *Homo neanderthalensis*, *Homo sapiens*, and *Homo floresiensis*)- age? geographic distribution? Distinctive morphological (including cranial capacity) and societal features of each; temporal overlap among species? (Note: **Hominoidea** includes orangutans, gorillas and chimps and humans; **Hominidae** includes several fossil lineages, but today only *Homo sapiens* remains).

Understand and be able to provide an example of Cope's Rule.

Understand and be able to explain the key innovations such as evolution of the seed, amniotic egg, feathers, etc.

NOTE: you are not responsible for the information presented by our Prominent Evolutionary Biologist visitors but a bonus question is not beyond possibility.