

EEB 2245 & EEB 2245W  
(semi-final) STUDY GUIDE EXAM 1  
SPRING 2017

—Elucidation of patterns vs. elucidation of processes of evolution; general types of evidence for patterns (direct vs. indirect)

### Geological Time Scale and the Fossil Record

—distinction between the fossil record and the Geological Time Scale; age of earth (4.6) vs. beginning of Geological Time Scale (3.8 bya) (How differ? Why differ?); understand that named intervals are not regularly spaced in time; events are concentrated in most recent ~550 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 (Eras and Periods) in their relative sequence; know dates of beginning and end ( $\pm 10$  my for Eras and Periods), 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?** Distinguish biotic from abiotic types of evidence found in fossil record. What is a fossil? 4 main types of fossils (i.e., molds, casts, trace, etc.); modes of fossilization and how they occur (replacement, petrification, carbonization, etc.; example of each; which are organic; which are sources of DNA; ancient DNA—examples of ages and types of organisms from which ancient DNA has been extracted and sequenced (oldest?); 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, robust/hard, numerous, more recent, etc.); most likely to be preserved and circumstances under which fossils are most likely to be preserved (e.g., areas in which buried rapidly, wet periods, undisturbed areas, etc); complete/continuous sequences rare; difficulties with correlations between strata, sites, etc.; dating of the fossil record—relative dating methods (principle of superposition, index fossils); absolute dating methods—major principle on which they rely (i.e., radioactive decay); understand how parent/daughter isotope ratios are used in radiometric dating;  $C^{14}/N^{14}$  as a method of dating fossils themselves (of what age? Why age so limited?); types of older rock that can be dated with radiometric methods;  $K^{40}/Ar^{40}$  as a method of dating rocks around fossils (of what age? Why so old?); problems with this strategy.

—age of earth; formation of early atmosphere; type of environment through to 3.8 bya;

### "Precambrian"

—What events mark beginning of Archean and Proterozoic Eons (i.e., first fossil evidence of life and  $O_2$ -rich environment, respectively)? 3 Domains of life on earth (i.e. Bacteria, Archaea, Eukarya); major differences between prokaryotic and eukaryotic organisms (unicellular vs. multi-cellular, etc.); is life considered to be monophyletic? (evidence? e.g., all organisms share nucleic acids as hereditary material, etc.); date of earliest life? (first chemical vs. fossil evidence); why not before that? Stromatolites- what were/are they? When did they first appear? When first evidence of photosynthesis? 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, etc.); 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 plastid endosymbiosis; how does origin of mitochondria (i.e. from purple bacteria; once) differ from origin(s) of chloroplasts (i.e., originally from cyanobacteria); first fossils of eukaryotes-when? (2.5–1.4 bya? controversial); first unquestionable fossils of eukaryotes-what and when (i.e., acritarchs, 900 mya); what type of organisms were they (which came first plants or animals?) What and when was Rodinia? Features of metazoans (=animals) (e.g., multicellular, heterotrophic, develop from embryos, etc.); first evidence of metazoans-what? When? (i.e., Doushantuo embryos, 640 mya, etc.); Ediacaran fauna-when? why important? What types of fossils (trace fossils- tracks, burrows, etc.)- no hard parts; types of phyla? (extant e.g., Molluscs (chitons)?; also some extinct phyla (e.g., rangeomorphs exhibiting fractal morphology). Abiotic factors at end- break-up of Rodinia, "snow-ball" earth fully melted.

**Phanerozoic Eon** (=visible life) (what event marks beginning of this, the present, Eon?)

**Paleozoic Era** (=early animals)

—**Cambrian Period:** when was it? Plant diversity? (none; only marine red, green, brown algae). Cambrian explosion: what was it? When was it? How long did it take? (i.e., 20 my) In what sort of environment did it occur? (shallow coastal seas, etc.); different between disparity and diversity; Burgess shale (and Chengjiang) faunas: types of body plan innovations seen (e.g., bilateral symmetry, appendages, mouth, hard parts [skeletons]), examples of extant phyla (e.g., arthropods, annelids; most modern phyla); examples of extinct phyla (e.g. *Opabinia*, *Anomalocaris*, conodonts); evolutionary significance of conodonts, *Haikuiichthyes* (what phylum; is it extinct today)? Explanation(s) for increased diversity? (i.e., evolution of predation, etc.). **Ordovician Period:** when was it? Habitat? (i.e., animals marine; plants?); position of continents? Kinds of invertebrates present (echinoderms, trilobites, eurypterids [=arthropods], etc.); types of vertebrates present (i.e., diversity of fish: agnathans, ostracoderms, placoderms, early sharks and rays, bonyfish); life on land? (small, non-vascular plants [e.g., bryophytes, etc.]); dessication remains a problem; ends with first of 5 mass extinction events. **Silurian Period:** when was it? Position of continents? Kinds of organisms present in oceans? (e.g. ostracoderms, placoderms, etc.); life on land: animals (early insects; NO vertebrates); plants- bryophytes, soil!

first vascular plants (i.e., *Cooksonia*—distinctive morphology?) (with roots? leaves? stems? flowers?) **Devonian Period** (= Age of what type of organisms?): when was it? Nature of the atmosphere? Position of continents? Plants: diversify— evolution of specialized body parts (roots, stem, leaves), seedless vascular plants large (e.g., lycopsids), first seeds (protogymnosperms); why seen=key innovation? Kinds of animals present in oceans: ammonites, fishes diversified, *Latimeria*—age of first fossils, distinctive features and importance. 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? (But were they truly terrestrial?); period ends with second of 5 mass extinctions. **Carboniferous Period**: when was it? Position of continents? Climate? In oceans: sharks and rays diversify; land dominated by rich forests consisting of what types of plants? (e.g., large club mosses, lycopsids, tree ferns; gymnosperms appear); why is period source of rich coal and oil deposits today? Animals on land? (dragonflies, etc.); key innovation: evolution of first amniotes; amniotic egg— main components and their functions; what advantage did amniotes have over other vertebrates? First "reptiles" by end of Period. **Permian Period**: When was it? Environment? Plant groups found on land? (i.e. still just 3 major groups); animals on land: most of modern insect orders, amphibians and "reptiles" 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), not diverse in Permian. 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; loss of taxonomic disparity high; cause? (environmental perturbations—volcanism).

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

—**Triassic Period**: when was it? Position of continents at beginning (i.e., Pangaea). On land: plants—still 3 major groups; animals—synapsids persisted (as therapsids), not very diverse; diapsids diversified substantially: 1<sup>st</sup> true dinosaurs—distinguishing features? (e.g. open acetabulum in hip, bipedal, warm-blooded? etc.); 2 (monophyletic?) lineages of dinosaurs (Ornithischia vs. Saurischia) and diagnostic features of each (lizard-hipped, mostly carnivorous vs. bird-hipped, mostly herbivorous, etc.); know 1 example 1 saurischian and 1 ornithischian from the Triassic Period (i.e., *Euparkeria* and *Lesothosaurus*, respectively); how related to birds? First pterosaurs— no head crest, long tail, =sister taxon to dinosaurs (not dinosaurs), key innovation?; also crocs and lineage that led to modern lizards, etc.; 3<sup>rd</sup> of 5 mass extinctions at end of Period. **Jurassic Period**: when was it? Position of continents? (i.e., Laurasia and Gondwana). Plants: gymnosperms dominate land; key plant innovation—evolution and diversification of first flowering plants (why adaptive advantage?) Animals: synapsids persist in the form of therapsids, possibly also first mammals (small and likely nocturnal); diapsids diversify (both dinosaurs and pterosaurs); know one example of a saurischian and one ornithischian dinosaur that characterizes this period; Connecticut state fossil—(*Eubrontes*— which lineage?); feathered dinosaurs appear; *Archaeopteryx*— What is it? Why is it important? Features it shares with birds; features unlike birds. To which dinosaur lineage does it belong? Pterosaur features (no head crest, tail reduced); why did pterosaurs diversify? **Cretaceous Period**: when was it? Position of continents? All 4 plant lineages present. Mammals small (all 3 lineages present?); diapsids diverse: example of saurischian and ornithischian that characterizes this Period; diversification of birds; how did Cretaceous pterosaurs differ from earlier pterosaurs? End of Era and Period marked by 4<sup>th</sup> mass extinction. Key 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 dates of Periods; sequence and dates of Epochs as relate to Primate evolution**)

—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, etc.). Possible explanation for mammal diversification? (key innovation?). **Tertiary Period**: Climate? Position of continents? Major trends (e.g., evolution of horses, proboscideans, Cope's Rule?) **Quaternary Period**: Position of continents? Punctuated by 4 major glacial events separated by interglacial periods; our current status with respect to glacial and interglacial events; current Period? Current Epoch?

**Primate Evolution** (beings when? i.e., Eocene, 45 mya)

—Order Primata: primate features (nails, grasping hands, etc.); understand where humans fit in primate classification (i.e., SO Anthrozoidea, IO Hominoidea, F Hominidae, G&S *Homo sapiens*); extinct diversity high (concentrate on hominids); 3 modes of locomotion (bipedal, etc.); anthropoids, first one? When (incl. Epoch?); early hominoid features (no tail, gap between canines and incisors, etc.), early hominoids (*Proconsul*, *Gigantopithecus*), when (incl. Epoch) and distinctive characteristics of each, modern members?; 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*), when (incl. Epoch), distribution, and distinguishing characteristics of both species; *Homo* features and species (i.e., *Homo habilis*, *Homo erectus*, *Homo neanderthalensis*, and *Homo sapiens*, when (incl. Epoch)? 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).

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