

EVOLUTION, LECTURE 9: DEEP TIME & THE FOSSIL RECORD (510–514, 515, 519–524)

Paleontology is the study of prehistoric life; it is the study of evolutionary and ecological history across deep time at any level of biological organization. Many of the paleontologists at Cal are **paleobiologists**, and they integrate the study of extant organisms into their studies of the past.

Fossils are the remains or traces of past organisms. There are many types of fossil: fossils may be *intact*, as in the case of fossil bones or fossil pollen grains; fossils may be *compressed*, as is the case for many macrofloral remains; fossils may be preserved in the form of *molds* and *casts* (negative and positive impressions); and some fossils may be **permineralized**, where original biological tissue is more or less completely replaced by exogenous elements (e.g., petrified wood).

The study of the fossilization process—the process by which a living organism enters the paleontological record, and including the chemical and physical alteration of its tissues—is called **taphonomy** (Gr., *taphos* [burial] and *nomos* [law]). In a broader context, taphonomy is the investigation of the entire sequence from living organism to study specimen.

A clear understanding of the **law of superposition** (Steno's Law)—in combination with the insights of investigators such as **William Smith**, who produced the first comprehensive geologic map of England, and who established in detail the practical role of fossils as index markers in sedimentary strata—led to the establishment of the geological time scale.

Radiometric (radioisotopic) dating techniques, as well as other methods, have helped to establish absolute age estimates for many geological deposits. Please understand the concept of the **half-life** in radioactive decay, and how it is used to determine absolute ages.

For present purposes, you need to know the three **eons** (**Archaen, Proterozoic, Phanerozoic**), the three **eras** of the Phanerozoic (**Paleozoic, Mesozoic, Cenozoic**), several important **periods** (**Ediacaran, Cambrian, Permian, and Cretaceous**), and three **epochs** (**Miocene, Pleistocene, Holocene**). If you prefer, just learn the whole time scale in Table 25.1 in your book, you would not regret that in future science classes.

Some dates to commit to memory include: the **age of the Earth** (4.55 Ga), the **oldest fossil prokaryotes** (3.5 Ga), the **Cambrian explosion** (c. 550 Ma), the **Permian mass extinction event** (251 Ma), the **K-T extinction event** (65 Ma), and the **end Pleistocene extinction events** (c. 65–13 ka).

Please be familiar with the major events of biological evolution across geological time, in so far as they are discussed in your text. The following should also be familiar: the **Urey-Miller experiments, stromatolites, prokaryotic cells, oxygenation of the atmosphere, serial endosymbiosis, eukaryotic cells, origins of multicellularity, Cambrian explosion, and theory of Continental Drift**.

The Permian mass extinction event (at the boundary between the Paleozoic and Mesozoic) claimed 96% of marine animal species in a short amount of time (maybe \ll 5 Ma). What role did supercontinent **Pangaea** play in the Permian mass extinction? For the K-T extinction, please know the **bolide impact hypothesis** and some of its supporting evidence (**iridium layer, Chicxulub crater**). What happened to the biota following the Permian and K-T extinctions?