Marine Fossils - Outline

Stern, C.W. & R.L. Carroll. 1989. *Paleontology: The study of life*. John Wiley & Sons, New York.

There are three types of rock:
Igneous rocks - rocks that have cooled from a molten condition. (lava)
* Sedimentary rocks - products of the mechanical breakup and dissolution of other rocks by weathering. The products are mud, sand, gravel, and materials in solution. They are carried by streams to sea or lakes where they are deposited as shale, sandstone, and conglomerate or precipitated as limestone or evaporites.
Metamorphic rocks - rocks that have been changed in structure, texture and composition by heat, pressure or chemicals, and stresses deep in the earth's crust.

* most sedimentary rocks (as opposed to the other two) have fossils. Sedimentary rocks are difficult to date - must use the dates found for igneous rocks above or below them.

What can the study of fossils tell us?
evolution
geochemistry
dating rocks
environmental reconstruction
paleogeography

How are fossils dated?
Lowest-oldest rule: lower layers of strata are older than those above them.
Magnetic reversals of the earth's field - particularly clear on sea floor.
(in the last 26 million years, the pole has reversed 48 times)
Radioactivity - based on known decay rates of minerals in rocks (elements used need to have long half-lives on the order of billions of years! E.g., uranium decays into lead and has a half-life of 4.5×10^9.

Radioactivity decay shows us that:
The earth is about 4500 MY old
Multicellular (metazoan, complex) animals arose 700 MYA
Animals with hard parts left their skeletons behind 570 MYA
Dinosaurs walked earth 200-66 MYA
Mammals have dominated land since 66 MYA

How are fossils created?
Soft parts and hard parts - soft parts don't remain more than a few days
Hard parts can remain
(esp. shells made of calcium carbonate, bones made of calcium phosphate)

Even hard parts must be protected from bioerosion and physical erosion to survive (e.g., by being covered rapidly by sediment)

Different types of preservation of fossils:

Unaltered remains- Hard parts can remain essentially unaltered in sedimentary rocks (eg, marine shells)

Permineralization - pores in shells and bones are filled in and reenforced by water and mineral seeping through them. (also petrified wood)

Recrystallization- Change in size and form of crystals that make up a shell (still calcium carbonate, but microstructure of shell destroyed.

Replacement - water seeping through hard parts sometimes dissolves the original matrix and replaces it with minerals in solution. Often the original is replaced by silica in limestone, by pyrite in shales,

Molds and casts - water passing through a fossil shell may dissolve it completely, leaving a mold (the negative or inside, the relief of a mold is the opposite of the original) or casts if molds are filled in (the positive or original shape).

Carbonization - black outline on a rock due to carbon residue of carbohydrates of soft parts. Usually takes place in anaerobic environments.

Tracks and Trails (or burrows) can be preserved when sediment hardens to rock.

Preservation bias

Major events on the time scale:

Oldest fossils were found in western Australia black chert (3300-3500 MYA): they are cellular filaments or beads on a string that look most like modern day cyanobacteria, also some methanogens and anaerobic bacteria.

First eukaryotic cells appeared 1500 million years ago (oxygen was at one third its present value) after 2 billion years of prokaryotic evolution. First eukaryotic cell was a product of symbiosis, sexual reproduction began. (Current 20% O2)

Ozone shield accumulated in the atmosphere after accumulation of enough O2 in the air from photosynthesis. The presence of life in shallow seas by the early archaen suggests that the shield was in place by then.

However, stromatolites were abundant by late archaen and early proterozoic so some say that that is when oxygen began to accumulate. Lethal oxygen before then taken up as it oxidized iron salts in the ocean.

First metazoans appeared around700 million years ago (at the close of the Proterozoic Era) hundreds of millions of years after first eukaryotic cell appeared.