GCSE Geology 2.5: The origin and development of life on Earth

Life probably originated in oceans around hydrothermal vents/black smokers c. 3500 Ma (discovered on mid-ocean ridges in 1977). Super-heated water up to 350°C containing dissolved elements was emitted into cold, ocean-bottom waters, and around these vents there are now complex ecosystems that evolved by using the chemical elements as a source of energy/nourishment. Organisms there today include tubeworms, shrimps and crabs, but initially there would have just been bacteria.

The development of diversity in the evolution of life is identified from fossils found in sedimentary rocks. Below is the sequence of evolution as found in the fossil record:

- Single-celled organisms
- Multicellular organisms
- Animals with hard parts (Cambrian explosion including trilobites)
- Amphibians
- Reptiles
- Mammals
- Birds
- Humans

Note, the fossil record is very much incomplete and is hugely biased in favour of marine organisms that had hard parts (mainly shells). Soft-bodied organisms and those that lived on land are poorly represented in the fossil record.

The development of life on Earth was punctuated by major extinction events.
Cretaceous/Palaeogene (K/Pg) was a mass extinction event that involved an asteroid approximately 10 km in diameter colliding with the Earth in the Gulf of Mexico around 66 Ma. The collision resulted in 70% of all life on Earth becoming extinct including the dinosaurs and the ammonites.
The event separates the Cenozoic from the Mesozoic Eras in the geological column ('recent life' from 'middle life').
Evidence for the impact: 180 km-wide crater discovered in the Gulf of Mexico and a K/Pg boundary layer found worldwide containing iridium (radioactive material common in meteorites) with soot (carbon-rich layer due to global wildfires caused by the impact).
Causes of mass extinction: initial blast/shock wave killed everything within 1000 km radius plus possible 100 m high tsunami; wildfires generated due to debris fallout destroy Earth's vegetation; debris blocks out sunlight causing global winter for many years; impact shattered gypsum and limestone propelling sulphate particles into the atmosphere, reflecting sun's energy away from Earth = further cooling; sulphates dissolved in rainfall acidify rivers and oceans; sea water ejected into atmosphere caused global warming.
An alternative explanation for this mass extinction is related to flood basalts erupting in India to a depth of more than 2 km thick around 66 Ma.

Major fossil finds:
Burgess Shale fauna found in Canada in 1909 and dated at 520-512 Ma shows exceptional preservation of soft parts of organisms due to rapid burial of organisms in fine mud. Over 60,000 specimens extracted from a layer two metres thick, many of which were new to science at the time.
Archaeopteryx, a fossil that has both bird and reptilian features and proved conclusively that birds evolved from reptiles. Only 11 specimens found.
Complex fossil skeletons are reconstructed from incomplete and disarticulated remains; sometimes, just a few bones are used to reconstruct dinosaurs.
Lucy, a 40% complete skeleton of a female bipedal human dated at 3.2 Ma found in 1974 in Ethiopia. Lucy supports the view of human evolution that bipedalism preceded an increase in brain size.