"About 3.8 billion years ago the last great flurry of asteroids subsided. From then until now the oceans have been a constant feature of this planet. From about the same time, too, there is evidence for life, preserved as the products of early microbial activity. So rapid was this appearance of life, after the period of heavy asteroid bombardment, that microbes might have evolved sometime in those perilous Hadean times, clinging on in rock fractures deep beneath the surface before emerging into a calmer Archaean oceanic realm.

From this beginning, all life in the oceans and on Earth has evolved in an unbroken chain of increasing diversity."

"For nearly the first half of Earth history the ocean was devoid of oxygen, although rich in dissolved iron. It teemed with microbes adapted to those conditions. The primitive life in those early seas was already changing (and being changed by) the chemistry of the oceans..."

"On Earth there are certain characteristics that apply to the smallest microbe and to the most complex human. Life is self-organized, and is composed of a complicated array of structures and chemicals, some of which are used to extract energy from the surrounding environment. Life is able to store information, reproduce, and pass on its information to future generations."

"...as early as 3.8 billion years ago and possibly somewhat earlier, life took off. This is evident in the rock record from black organic-rich shales with iron pyrite (fool's gold) that signal the activity of early sulphur-utilizing microbes. These earliest organisms might have been the Archaea, a group that resemble bacteria in small size and 'simplicity', but which have - possibly - yet more ancient origins."

"The first surface-dwelling organisms may, therefore, have had ancestors in the underworld: chemoautotrophs subsisting on chemical energy rather than photoautotrophs using the Sun's energy."

"This notion of a warm early Archaean is also supported by evidence from the 'tree of life', in which more ancient groups of organisms have proteins that are stable at higher temperatures, consistent with a thermophilic 'heat-loving' setting for their origins."

"We can glimpse the ancient environments of Earth through the lives of microbes whose ancestry stretches back some 4 billion years. The Archaea include forms with an ability to tolerate temperatures as warm as 120 degrees Celsius, acidity as low as pH 2, waters that are supersaturated with salt, and the complete lack of oxygen. They evolved on a warm Earth, where the surface temperatures may have reached 70 degrees Celsius and the atmosphere was made of methane, water vapour, carbon dioxide, and nitrogen. They lived in a world where the oceans were saturated in ferrous iron but bereft of oxygen."

"Surprisingly, for the Archaea were once thought to be specialists in colonizing oddball environments, they also live side-by-side with bacteria and eukaryotes in oxygenated waters with normal salinity. They are also widespread as microplankton in the oceans, where they may act as a primary food source."
"One group of Earth's early bacterial organisms, the cyanobacteria, started a revolution. They began to use water for photosynthesis, combining this with carbon dioxide to make sugars for energy, and as a by-product releasing free oxygen."

"...analysis of the rate at which genetic change has occurred in cyanobacteria, using their internal 'molecular clock', and a wider analysis of the fossil record suggests the rise of cyanobacteria occurred around the boundary between the Archaean and Proterozoic eons of the Precambrian, at a time referred to by geologists as the Great Oxygenation Event, or GOE. This is the point in time, 2.4 billion years ago, when oxygen began to accumulate in the atmosphere and surface of the oceans. It was a toxic poisonous gas for the organisms of the Archaean..

"Ocean life evolved only slowly during the almost unimaginably long interval of time of the early Proterozoic (the 'boring billion' some geologists have termed it), perhaps due to chronic nutrient starvation in the sulphidic seas. Then, something striking happened. About 1.7 billion years ago the first eukaryotic organisms appear in the fossil record. Life had engineered the nucleus to a cell."

Endosymbiosis is the posh word for it. A large cell engulfs a smaller cell - or, perhaps a smaller cell is trying to parasitize the larger...The two original organisms, one inside the other, both survive and begin to collaborate...The nucleus in a cell, the energy-providing mitochondria, and the chloroplasts - all are derived from originally independent organisms that went into partnership...a eukaryotic organism."

"...the first appearance of eukaryotes is seen in fossils from rocks in China and Australia from about 1.7 billion years ago."

"Despite their greater cellular complexity, evolution proceeded slowly without the possibility of complex multicellular structures. Then came the invention of sex."

"In the late Proterozoic the diversity of eukaryotic organisms, both unicellular and multicellular, increased dramatically. Sex, it seems, provided a rich source of evolutionary novelty that would lead to large, three-dimensional organisms populating the oceans."

"Among the first organisms to show cells taking cooperation further were sponges, which have a good fossil record that extends back to the Late Proterozoic. They lack specialized tissues for digestion, nerves, or circulation, but they can build shapes that enhance the water flow over their tissues. They also possess cells that can move within the body and change their function...sponges were present in marine ecosystems some 580 million years ago, but recent finds...may push this date back further to at least 650 million years ago."

"Sponges play a wider role. Before they appeared in Proterozoic oceans there were no suspension-feeding organisms, and so the seas would have been commonly turbid from clouds of suspended living and dead cells and microscopic organic debris...Sponges filter-feed particles from water down to cyanobacterial size, and as a result they remove turbidity from the water [which reduced the penetration of light into the oceans and therefore limited the development of larger eukaryotic and multicellular photosynthesizing organisms]."

"Then, another giant leap. This was to cnidarians, the other marine group considered to have very ancient (Precambrian) origins...biological innovations here were a definite gut, simple organs and...the beginnings of muscle. Cnidarians also possess nerve tissue..."

"How did life change so fast between 600 and 500 million years ago...life had been accumulating a series of steps towards complexity: the development of cells with organelles and nuclei, the acquisition of sex, the organization of many cells into multicellular organisms, and the division of labour between those cells to specialize in reproduction, feeding, and locomotion."
"...explosion of life at the beginning of the Phanerozoic Eon (our eon) transformed the oceans. It was the third pivotal biological event...as animals began to burrow into the seabed, new sources of food became available."

"Early Cambrian ecosystems were not only complex; they varied across the world...Among the Chengjiang fossils there is a little fish-like animal called Haikouichthys...does preserve gills, a notochord, a dorsal fin, and a distinctive head. Small and insignificant...it nonetheless shares a common ancestry with all of the fish living in the seas today, with the blue whale and also, of course, with us."