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Prokaryote

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Keywords

Archaea; Bacteria; Microorganism

Synonyms

Bacteria

Definition

Prokaryote (from Greek *pro* [before] and *karyon* [nucleus]) denotes organisms that lack a membrane-enclosed nucleus, as well as other ▶ organelles.

Overview

Cellular life is represented by three lines of descent: the domains ▶ *Bacteria*, ▶ *Archaea*, and ▶ *Eukarya*. Two of them (*Bacteria* and *Archaea*) are embraced by the term "prokaryote," a term that has no standing in the taxonomic hierarchy. From the phylogenetic reconstructions based on the analysis of the ribosomal small subunit gene sequences, it seems that both domains differ dramatically in their evolutionary history (see Fig. 1). In this regard, *Archaea* and *Eukarya* seem to share a common ancestor, whereas *Bacteria* seem to be an independent line of descent. In contrast to eukaryotic cells, prokaryotes have a simpler internal structure, lacking membrane-enclosed organelles. Prokaryotes do not develop or differentiate into multicellular forms. Some grow in filaments, or masses of cells, but each cell in the colony is identical and capable of independent existence, they never form specialized tissues. It is generally accepted that the first living cells on the earth were prokaryotes that might have appeared about 3.5 billion years ago or before, and remained alone for about 1.5 billion years until the eukaryotes developed (2.0 billion years ago). Prokaryotes are considered to be the most abundant living cells in the biosphere, with numbers that range from 4×10^{30} to 6×10^{30}, and that produce a biomass equivalent to that of the vegetal material. They colonize almost every place on the earth where life is possible, and show the widest range of extreme life habitats. They colonize any available surface and cavity, and their abundance depends on the habitat. For example, 1 cm^3 may contain about 10^6 cells in seawater, 10^9 in sediments, 10^{12} in soils, 10^{10} in animal gut. Their metabolism is very diverse and can obtain energy from light (phototrophy), inorganic chemicals (chemolithotrophy), or organic chemicals (chemoorganotrophy). Some can fix inorganic carbon (autotrophy), but others depend on the assimilation of organic carbon (heterotrophy). Respiratory metabolism can occur aerobically (by reducing oxygen as a terminal electron acceptor), or anaerobically (by reducing a wide range of molecules such as sulfate, nitrate, iron, manganese, among others). On the

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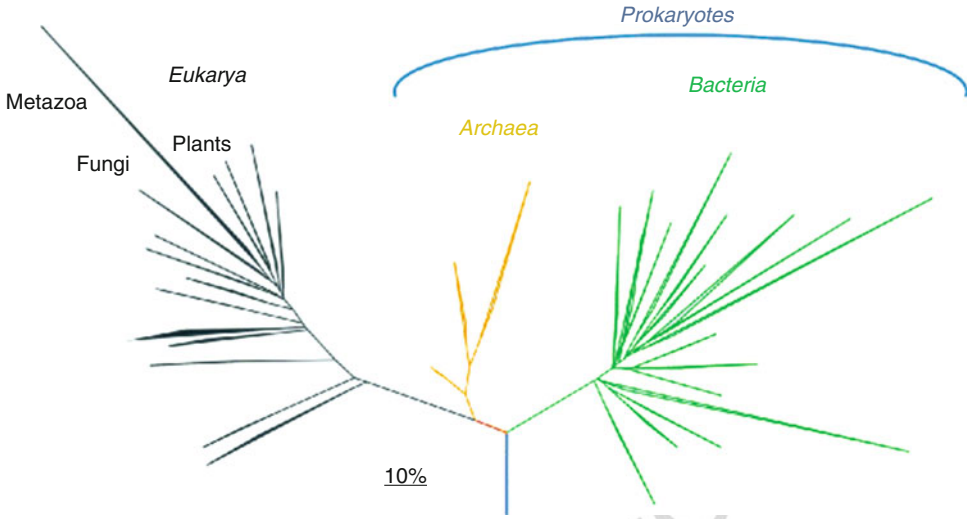

Fig. 1 Phylogenetic reconstruction based on 16S rRNA gene sequence analyzes of the three domains of life. The figure shows that the Prokaryotes appear to be a paraphyletic group embracing Archaea and Bacteria

other hand, some organisms ferment (reducing organic products of their own metabolism), or generate methane as a product of their anaerobic oxidative metabolism. In the prokaryotic world all these combinations are possible, and many of them can switch their metabolism depending on environmental conditions and the availability of different carbon and energy sources. The endosymbiosis of prokaryotes with eukaryotic cells had been essential for the development of the latter in the biosphere. Mitochondria seem to have originated from the symbiosis of an alphaproteobacterium, and gave eukaryotes the ability to respire oxygen. Chloroplasts seem to have their origin from a symbiosis with a cyanobacterium that gave algae and plants their photoautotrophic metabolism. Some animals show additional symbiosis with chemolithotrophs that provided them with an autotrophic metabolism. Prokaryotes are essential for the development of the biogeochemical cycles in the biosphere, and finally are responsible for recycling the basic elements that maintain life.

See Also

- Archaea
- Biogeochemical Cycles
- Cyanobacteria
- Electron Acceptor
- Endosymbiosis
- Eukarya
- Fermentation
- Microorganism
- Organelle
- Prokaryotes, Origin of

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