Bacteria

Author:
C Michael Hogan

Editor:
Sidney Draggan

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Introduction

Bacteria are any of a very large group of single-celled microorganisms that display a wide range of metabolic types, geometric shapes and environmental habitats—and niches—of occurrence. Normally only several micrometers in length, bacteria assume the form of spheres, rods, spirals and other shapes. Bacteria are found in a very broad gamut of habitats; for example, bacterial extremophiles that thrive in such places as hot springs, arctic environments, radioactive waste, deep sea oil seeps, deep Earth crustal environments, hypersaline ponds and within other living organisms. There are approximately 50 million bacterial organisms in a single gram of typical surface soil. The worldwide bacterial biomass exceeds that of all plants and animals on Earth. However, the majority of bacteria have not yet been characterised.

MycobacteriumtuberculosisLyngbya (ling-bee-a) is a filamentous cyanobacteria usually have many cells joined together

Taxonomy

Bacteria are members of the prokaryote group. In contrast to eukaryote cells, bacteria lack a cell nucleus and customarily have no organelles. The bacteria domain can be grouped into two major categories: (a)

Eubacteria and (b) Cyanobacteria. The latter group has historically been termed blue-green algae, but modern cladistics classifies these as bacteria. Presently the bacteria are considered composed of five discrete clades, or unique phylogenetic trees, each having a unique common ancestor. While there are a number of recognized phyla, the dominant ones are Proteobacteria, Firmicutes, Actinobacteria....

Proteobacteria

This major phylum incorporates a gamut of pathogens, such as *Escherichia, Salmonella, Vibrio, Helicobacter*, and numerous other genera. Some other proteobacteria are free-living, and include many of the species responsible for fixing nitrogen. Many move about using flagellae, but some are non-motile or rely on bacterial gliding. The latter include myxobacteria, a unique group of bacteria that can aggregate to form multicellular fruiting bodies.

Firmacutes

A wide variety of metabolic types reside within proteobacteria. Most species are facultatively or obligately anaerobic, chemoautotrophs, and heterotrophic, but there are many exceptions. Numerous genera, which are not closely related to each other, convert energy from light through photosynthesis. These are termed purple, in reference to their generally reddish pigmentation.

Actinobacteria

This gram positive phylum has widespread occurrence in soils, freshwater and marine ecosystems. Many of the species in the phylum are key decomposers of organic detritus, and thus have an important role in the carbon cycle. Some of the species of Actinobacteria are pathogens and inhabit plant or animal hosts. Most of the phylum are aerobic species, but some are capable of metabolizing in oxygen-deprived environments. This phylum often exhibits a filamentous branched structure as in the case of *Actinomyces israelii*. The organism believed to be the oldest living creature is a species within the Actinobacteria found in Siberia, that is thought to date to about 500,000 years before present.

Bacteroidetes

This widely occurring phylum is found in soils, sediment, animal guts and animal oral cavities. Bacteroidetes are known to inhabit the deserts of Antarctica. Some species are known for their robustness as decomposers notably of chitin and polymeric carbon, such as insoluble forms present in fungal cell walls; such strong decomposition capabilities make the Bacteroidetes instrumental in the carbon cycle and contribute to the ability to restore nutrient poor soils. The Bacteroidetes represent a phenotypically diverse set of organisms, whose geometric forms are frequently rod or curved shaped. In some cases the genera may be variously photosynthetic, non-motile or gliding, but they are generally gram-negative. Certain species are known to be invertebrate symbionts.

Cellular structure and metabolism

Bacterial cells, lacking a nucleus and organelles, are capable of rapid division; their cell division is by binary fission and may occur approximately every twenty minutes. As with the other prokaryotes, cell structures are markedly simpler than eukaryotes; correspondingly bacterial DNA is not associated with histones. Like other prokaryotes, the DNA is not enclosed in a nuclear membrane, but resides in a nuclear region of the cell. The chemistry of the bacterial cell wall is unique, and very often contains peptidoglycan.

Early life history

Ancestors of extant bacteria are thought to be unicellular organisms, possibly the first lifeforms of the planet Earth, appearing approximately 3.5 billion years before present. Some of the earliest evidence of bacteria is in Onverwact shales of South Africa. Scientists regard the emergence of bacteria is one of the most astounding events in Earth history, since there are no other proto-lifeforms of their complexity that previously were known to exist on Earth. How and where bacteria developed is one of the great mysteries of science. Bacterial micro-organisms likely diverged from archaea around about 3.2 to 2.5 billion years before present, with their common ancestor possibly a hyperthermophile, e.g. a creature capable of surviving unusually high thermal regimes.

One early bacterium, Kakabekia umbellata, has been determined to have existed in disparate locales including North Wales, Alaska and Iceland; the fact that this set of occurrences all share soils that are ammonia rich has prompted speculation that this bacterium derived from an era when the Earth's environment was rich in ammonia.

Until approximately one billion years before present, in fact, Earth's lifeforms were dominated by microscopic creatures such as bacteria, viruses and archaea.

Occurrence and function

Bacteria occur in almost any man-made or natural environment, including in soils, water and the atmosphere, as well as on and inside of living organisms. In fact, many bacteria species are extremophiles, which are adapted variously to extreme temperature, pressure, pH, salinity and other abiotic factors. The family Thermaceae is comprised by a number of thermophilic genera, including *Thermus, Meiothermus, Marinithermus, Vulcanithermus, Oceanithermus* and *Truepera.*

Bacterial members of genus *Deinococcus* are highly resistent to extreme doses of ionising radiation. In fact, some bacterial species within each phylum are some type of extremophile, and in some cases a given bacterium may be an extremophile with respect to two or more abiotic parameters.

Bacterial organisms are key in recycling nutrients, with many aspects of nutrient cycles depending on bacterial metabolism, such as nitrogen fixation from the Earth's atmosphere and putrefaction.

Anaerobic bacteria

Anaerobic bacteria are microorganisms that thrive in the absence of oxygen; in fact numerous anaerobes cannot survive in the presence of oxygen. Araerobic metabolism typically involves inorganic/organic redox reactions, including anaerobic respiration and fermentation reactions, producing volatile fatty acids and gaseous molecules, such as methane. Anaerobic bacteria are also involved in the digestion process of grazing animals.

History of bacterial research

Van Leeuwenhoek was the first scientist to observe a bacterium directly; in the year 1676 he employed a single lens microscope of his own development. It was not until the 1860s and 1870s that Louis Pateur, Robert Koch and Joseph Lister advanced the state of bacteriology by analyzing the phenomenology of bacterial action on food spoilage.

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