Domain bacteria

Introduction Bacteria are microorganisms, which usually consist of a single cell that lack chlorophyll. They are prokaryotes; that is their DNA (the cell genome) is not enclosed in a nucleus. Their basic structure is a capsule cosseted by a lipid membrane. Mostly, they reproduce by fission, which involves a single cell dividing to produce two new cells. Under favorable conditions, they multiply very rapidly, forming colonies of millions of organisms within a limited space. Steyn states that bacterial characteristics are among the most diverse in any life domain.

Scientists characterize bacteria in a number of different ways. The relatedness between any two given metazoans such as a human and a slug is often much more than the relation between two bacteria species. They appear in a variety of shapes (rods, spirals, spheres, blogs and helical among others) and sizes ranging between 0. 5 and 5. 0 microns. Most bacteria are of one of three typical shapes, which include round/ball-shaped (coccus), rod-shaped (bacillus) and spiral-shaped (spirillum), with an additional group, vibrios, that appear as incomplete spirals.

Scientists also characterize bacteria by their growth patterns such as the chains formed by streptococci. While some bacteria, mainly the spirillum and bacillus forms, are motile or swim about by whip-like movements of flagella, others have pili, rigid rod-like protuberances, which serve as tethers. Pili join pairs of bacteria together facilitating transfer of DNA between them. Some bacteria have short, hair-like, proteinaceous projections called fimbriae at the cell ends or over the entire surface, which enable the bacteria to adhere to surfaces. Depending on the bacteria species, flagella may be set in any of four ways, which includes the monotrichous form with a single flagellum at one end, the amphitrichous with a single flagellum at each bacterium end, the lophotrichous with two or more flagella at either or both bacterium ends and the peritrichous form with flagella distributed over the entire cell.

Bacterial cells can exist as discrete individual cells or may group together in chains as in the case of rods and cocci. Cocci forms can also aggregate in clusters. They contain a cell envelope comprising of a capsule, the cell wall and a plasma lemma or plasma membrane and a cytoplasmic region, which contains the cell genome, ribosomes and various cell inclusions. Most bacteria have a rigid cell wall, which consists of a polymer of disaccharides that are cross-linked by peptides (short amino acid chains) forming a peptidoglycan called mucin. The cell wall protects the cell protoplast from osmotic lysis. It allows characterizing of bacteria into Gram-positive (those that have a cell wall with a thick layer of murein) and Gram-negative, which have a comparatively thin cell wall composed of murein surrounded by an outer membrane. Murein is unique to bacterial cell walls.

Bacteria thrive in a variety of environments. Most thrive at temperatures close to that of the human body (37°C) but some prefer cold temperatures as low as freezing and others prefer very hot temperatures like those found in hot springs. Mostly, bacteria achieve optimum growth within a narrow range of pH of 6. 7-7. 5. However, some prefer acidic while others prefer basic conditions. Some bacteria are aerobic forms and thus can function metabolically only in the presence of atmospheric or free oxygen. Others are anaerobic forms and thus cannot grow in the presence of atmospheric oxygen but acquire oxygen from compounds. Some of these anaerobic forms are facultative, growing with or without free oxygen while others are obligate anaerobes thus poisoned by oxygen.

As a group, bacteria have different nutritional needs and carry out a wide range of activities. They obtain most of their nutrients from their aqueous environment and therefore require moisture to grow. For their growth and reproduction, bacteria require carbon. Most are heterotrophs and derive carbon from organic nutrients such as sugar, with some surviving as parasites. Autotrophs however get their carbon from CO2 with some such as cyanobacteria using sunlight to produce sugars from CO2. Others break down inorganic chemical compounds such as nitrates and sulfur forms for energy. Bacteria internal plasmids, which are short DNA loops exchanged between bacteria giving them unique abilities, and their entire cell genome are other key elements that accounts for their characteristics.

Archaea are terrestrial or aquatic microorganisms that exhibit a variety of shapes, including rod-shaped, spherical and spiral forms. They are in a Kingdom of their own because biochemically, they are nearly as different from bacteria as they are from eukaryotes. They lack ester-linked lipids and murein in the cell walls, which is characteristic of bacteria and instead have ether lipids and a number of diverse cell-wall constituents. They also differ in the structure of their ribosomal RNAs. Unlike bacteria, they reproduce via a broad variety of mechanisms, including budding, fragmentation and binary and multiple-fission. Their ribosomes are sensitive to diphtheria toxin while those in bacteria are not. They also differ in their composition of lipids in the cell membrane and in their behavior towards toxins and antibiotics. Whereas most bacteria are sensitive to streptomycin, kanamycin and chloramphenicol, archaea are insensitive to them. Although some archaea are capable of nitrogen fixation and denitrification, unlike bacteria, none of them is capable of nitrification. They also differ from both bacteria and eukaryotes in that they are capable of methanogenesis and their membrane lipids are not ester-linked but ether-linked.

The United States' centers for disease control and prevention explains that Cyanobacteria are bacteria that grow in water and are photosynthetic. They live in terrestrial, brackish, fresh or marine water. Although they are microscopic, they sometimes can form visible colonies. They get their name from phycocyanin, the bluish pigment they use to capture light for photosynthesis. Like plants, they also contain chlorophyll a, and whatever their color they are photosynthetic. Some can fix nitrogen. They can thrive with just air, light, water and a bit of salt.

Cyanobacteria may be single-celled or may undertake colonial living. Colonies may form filaments, sheets or even hollow balls depending upon the species and environmental conditions. Some filamentous colonies exhibit the ability to differentiate into three diverse cell types. Under favorable growing conditions, they form vegetative cells as the normal photosynthetic cells but when environmental conditions become harsh, they may form climate-resistant spores.

During nitrogen starvation, some filamentous cyanobacteria, such as Nostoc punctiforme form specialized nitrogen-fixing cells, the third type of cell, known as Heterocyst. It is a thick-walled cell containing the enzyme nitrogenase vital for nitrogen fixation. They are therefore sites for nitrogen fixation. Heterocyst-forming species fix nitrogen gas, which plants cannot absorb, into ammonia, nitrates or nitrites, which plants can absorb and convert to nucleic acids and protein. It is important to note that once a regular cyanobacteria cell turns into a heterocyst, it cannot turn back.

Works cited

Steyn, L. M. Bacterial Taxonomy and Nomenclature, (1998). Retrieved 16th

April, 2009 from: http://web. uct. ac. za/depts/mmi/lectures/bactax/index. html

United States’ Centers for Disease Control and Prevention. Cyanobacteria (blue-green algae). Retrieved 16th April, 2009 from: http://www. cdc. gov/hab/cyanobacteria/facts. htm