MICROBIAL GROUPS
CE 421/521

- Chapter 10 in Vaccari et.al.
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MICROBIAL GROUPS

Microorganisms are used routinely in engineered waste treatment systems such as sewage treatment plants. They are also of critical importance in the recovery process of natural environments degraded by human activities, such as in the self-purification of streams receiving sewage and runoff, and the natural attenuation of industrial contaminants leaked or spilled onto soil. On the other hand, microorganism have the potential to create substantial environmental problems. For example, they may deplete oxygen, generate unpleasant tastes and odors, clog equipment, and corrode pipes.

In this day we consider the prokaryotic groups, Bacteria and Archaea. We also examine the eukaryotic groups containing single- celled organism: protozoans, algea, fungi and slime molds, even though they also include many multicelluler, macroscopic species. There is a wide range of diversity within the world of microorganism in terms of survival strategy: where they find energy, how they grow, and what environments they prefer. Let's a brief overview of these alternatives.

- Energy sources: The two major sources of energy are chemical oxidation and photosynthesis (See Table 10.2).
- Carbon Sources: Since it is a major constituent of cell materials, all organisms need a source of carbon. *Heterotrophs* (including fungi, protozoans, and most bacteria) require organic carbon, whereas *autotrops* (algea and some bacteria) consume inorganic carbon (carbon dioxide and bicarbonate) (See Table 10.2).

Environmental Preferences

Microbial cells are also commonly classified on the basis of environments they prefer. Several factors are generally considered, including the presence of oxygen, temperature, salt tolerance, and pH.

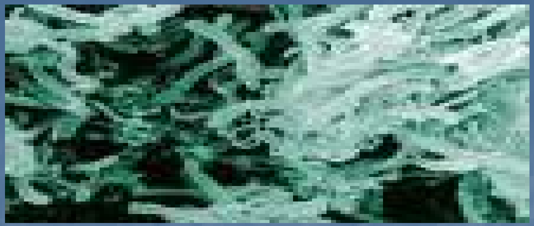
- Strict aerobes require oxygen; cells able to grow at very low oxygen levels may be referred to as microaerophilic. Facultative anaerobes, can grow with or without oxygen. Anaerobic metabolism may be respiratory (using a variety of inorganic terminal electron acceptors such as a nitrate, nitrite, ferric iron, sulfate, or carbon dioxide) or fermentative (using an organic terminal electron acceptor). Anoxic in the absence of oxygen , and thus is equivalent to anaerobic. The ability to utilize nitrate and/or nitrite as alternative terminal electron acceptors (denitrification).
- P microbes thrive under cold temperature condition, ranging from below $0^{o}C$ to the mid-teens. Organism that prefer moderate temperatures are referred to as m . Their temperature preferences range from the mid-teens to high-30s or low-$40^{o}C$. A relatively few organism, mainly bacteria, archaea, and fungi, prefer above 45 to $50^{o}C$ and are called t . Some prokaryotic extremophiles are h (temp. optimum above $80^{o}C$), a few even growing at above $100^{o}C$.

- Water tends to migrate across the cell membrane toward the higher salt zone by osmosis, thereby "attempting" to dilute it and eventually equilibrate the inner and outer salt levels. H

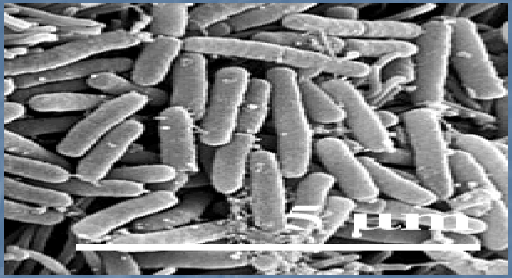
  (salt-loving) microbes require NaCl.
- Most microorganisms have a pH preference that falls within the range 5 to 9, and thus would be labeled

  n .There are many organisms that are able to tolerate, or that even prefer or require, pH levels outside the neutral range (acidic or alkaline).

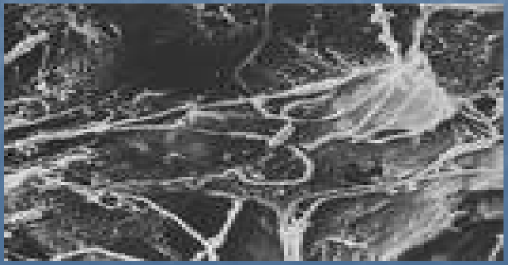
- *Fungi*, as a group, tend to favor acidic environments (often with optima at pH 4.5 to 5). *Ferrobacillus ferrooxidans* in acid-mine drainage waters and *Sulfolobus acidocaldarius* growing in acidic hot spring waters, for example, will readily proliferate at a pH of 1 to 2. Alkaliphiles prefer pH levels above 9. These microorganisms, such as *Natronabacterium* and *Natronocossus*, consequently tend to be both halophilic and alkaliphilic.



PROKARYOTES

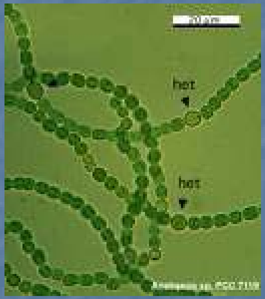


- Most common are cylindrical rods, also called bacilli and spherical cells ,called cocci.
- Typical rods may be 0.5 to 1.0 micrometer in diameter and 2 to 4 micrometer long.
- Many microorganisms grow as individual, single cells. However some grow in chains or filaments, composed of a single species.
- Most prokaryotes appear colorless under the microscope.
- Many microorganisms are able to use nitrogen (ammonium, and/or nitrate as their nitrogen source), sulfur (sulfate, or sulfide or organic sulfur).



BACTERIA

- As a group, the domain Bacteria is extremely diverse, including phototrops and chemotrops, organotrops and lithotrophs, heterotrophs and autotrophs, aerobes and anaerobs, psychrophiles and mesophiles and thermophiles, halopiles and nonhalopiles, acidophiles and neutrophiles and alkaliphiles, saprophytes and parasites. They are able to utilize a vast array of organic compounds as carbon and energy sources, many reduced inorganics as electron donors and many oxidized inorganic as electron acceptors.



- A is the most thermophilic known true bacteria.
- T is a thermophilic sulfate reducer using fermentation products such as lactate and pyruvate as its carbon and energy source.
- X contains two classes, Deinococci and Thermi. N

  is an autotroph that devices energy from the oxidation of nitrate to nitrate.

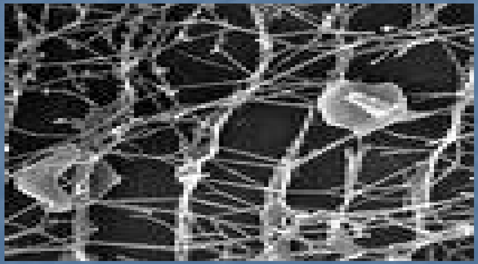
.. The C is a large, diverse, and environmentally important bacterial group. Many cyanobacteria have the unusual ability to be able to fix nitrogen (convert N_2 a combined form, usually as a ammonium or an amine compound). (Major groups of Cyanobacteria of Table 10.3).

- Another distinct group of phototrophs included (Table 10.4) is the green sulfur bacteria. The sulfide is oxidized first to elemental sulfur, which produces granules outside the cell, and then to sulfate.
- The P is a vast kingdom, including many of gram-negative species and many of the methabolic activities known among the bacteria.
- N bacteria are aerobic autotrophs that oxidize reduced nitrogen in two separate steps. Ammonium oxidizers such as N , n and n convert ammonium to nitrite. Nitrite oxidizers convert n to n .

- The P are a large group of aerobic, are common soil and water bacteria and because of their metabolic diversity, many are important in biodegradation of a very wide variety of natural and human made organic compounds.
- Escherichia coli is present in large numbers in the human intestines and is one of the c used as indicator organisms to monitor fecal pollution of water.
- Some strictly anaerobic proteobacteria, such as d , are able to utilize oxidized forms of sulfur, especially sulfate and elemental sulfur.
- G are chemoorganic heterotrophs, including both aerobes and anaerobes.

ARCHAEA

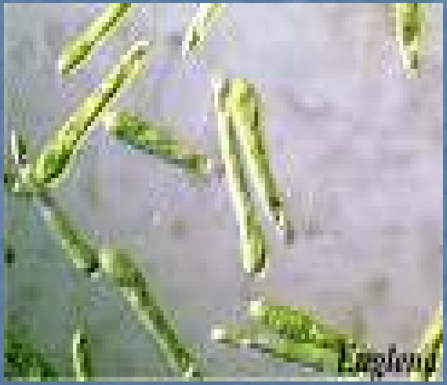
- **Three kingdoms of Archaea are now recognized, and with the exception of methane producers, most of the know species are extremophiles (high temperature, high or low pH, and/or high salinity). They include both aerobes and anaerobes, chemoorganotrops and cehmolithotrops and hetetrops and autotrops (Table 10.8). This pictures are belongs members of archaea, korarchaeota and crenarchaeota.**

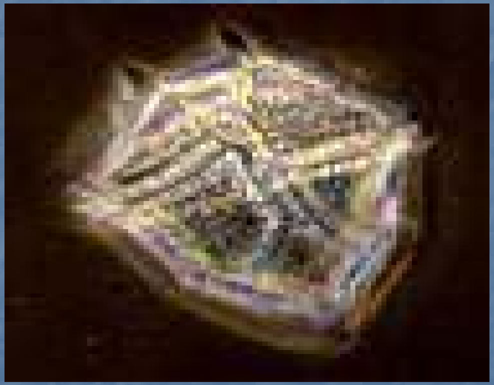


EUKARYA

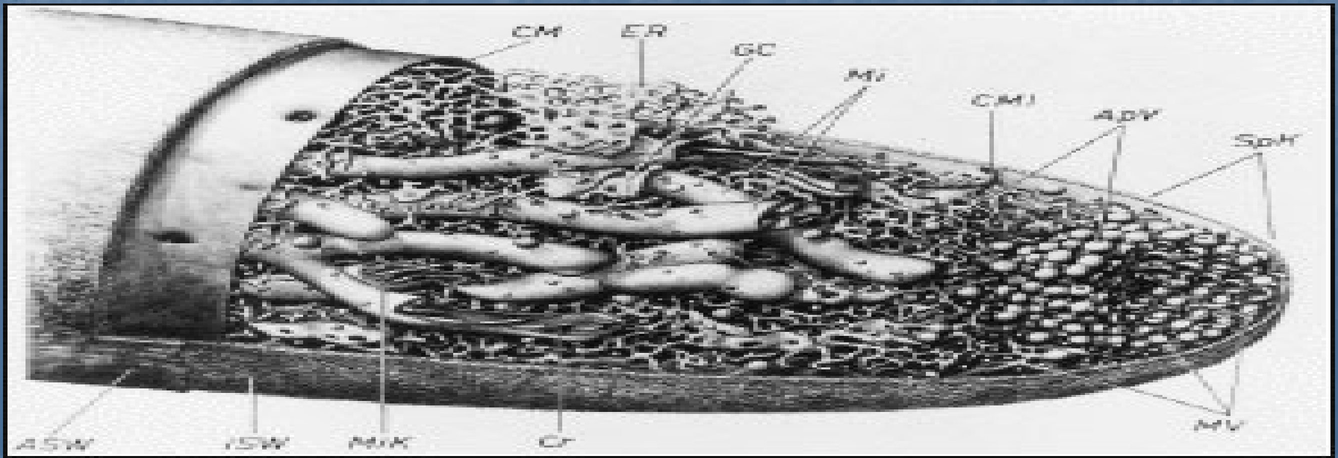
- They are including several each animals, plants, fungi and protista, which included protozoans, algae, and slime molds.
- Protozoans are chemoorganotrophic unicellular heterotrophic eukaryotes. They may absorb dissolved nutrients, but most feed mainly by ingestion of small particles (such as bacteria, algae, bits of organic matter, or macromolecules) through one of three methods. They are usually motile by one of four means, at least   in one part of their life cycle, and this has led to their being broken into the four major groups described Table 10.9. Picture shown “sarcodina”, which is exceed 1mm (although most are much smaller).

- A are photosynthetic, oxygenic autotrops. They most are unicellular, floating, phytoplankton. They are utilized some wastewater treatment process to produce oxygen or remove nutrients. Table 10.10 shown different phylum of algae. They found in oxidation ponds, aerobic lagoons.





- Fungi (Table 10.11) are chemoorganotrophic hetetrops. Most are saprobic, but some are parasites or symbionts. They use organic compounds for carbon and energy. They ability of many to degrade cellulose and of some to attack lignin. Fungi store energy either as gylcogen or lipids. Fungi also can tolerate lower pH than many common organotrophic bacteria. If the pH drops below 5.5 to 6, fungi may grow excessively and interfere with the settling process (fungal balking).



- **Structure of a fungal cell wall:**

VIRUSES, VIROIDS AND PRIONS

- Viruses, viroids and prions are submicrocopic particles that are not composed of cells. Viruses are too small-typically 20 to 30 nm. The nucleic acid in a virus genome is either DNA and RNA (but not both) and is either single or double stranded.