2.4. SUMMARY

Microbes can grow over an immense range of conditions: temperatures above boiling and below freezing; high salt concentrations; high pressures (>1000 atm); and at low and high pH values (about 1 to 10). Cells that must use oxygen are known as *aerobic*. Cells that find oxygen toxic are *anaerobic*. Cells that can adapt to growth either with or without oxygen are *facultative*.

The two major groups of cells are *procaryotic* and *eucaryotic*. Eucaryotic cells are more complex. The essential demarcation between procaryotic and eucaryotic is the absence (procaryotes) or presence (eucaryotes) of a membrane around the chromosomal or genetic material.

The procaryotes can be divided into two major groups: the *eubacteria* and *archaebacteria*. The archaebacteria are a group of ancient organisms; subdivisions include methanogens (methane producing), halobacteria (live in high-salt environments), and thermoacidophiles (grow best under conditions of high temperature and high acidity). Most eubacteria can be separated into gram-positive and gram-negative cells. *Gram-positive* cells have an inner membrane and strong cell wall. *Gram-negative* cells have an inner membrane and an outer membrane. The outer membrane is supported by cell wall material but is less rigid than in gram-positive cells. The *cyanobacteria* (blue-green algae) are photosynthetic procaryotes classified as a subdivision of the eubacteria.

The eucaryotes contain both single-celled organisms and multicell systems. The fungi and yeasts, the algae, and the protozoa are all examples of single-celled eucaryotes. Plants and animals are multicellular eucaryotes.

Viruses are replicating particles that are obligate parasites. Some viruses use DNA to store genetic information, while others use RNA. Viruses specific for bacteria are called *bacteriophages* or phages.

All cells contain the macromolecules: *protein*, *RNA*, and *DNA*. Other essential components of these cells are constructed from lipids and carbohydrates. Proteins are polymers of amino acids; typically, 20 different amino acids are used. Each amino acid has a distinctive side group. The sequence of amino acids determines the *primary structure* of the protein. Interactions among the side groups of the amino acids (hydrogen bonding, disulfide bonds, regions of hydrophobicity or hydrophilicity) determine the *secondary* and *tertiary structure* of the molecule. If separate polypeptide chains associate to form the final structure, then we speak of *quaternary structure*. The three-dimensional shape of a protein is critical to its function.

DNA and RNA are polymers of nucleotides. DNA contains the cell's genetic information. RNA is involved in transcribing and translating that information into real proteins. Messenger RNA transcribes the code; transfer RNA is an adapter molecule that transports a specific amino acid to the reaction site for protein synthesis; and ribosomal RNAs are essential components of ribosomes, which are the structures responsible for protein synthesis.

In addition to their role as monomers for DNA and RNA synthesis, nucleotides play important roles in cellular energetics. The *high-energy phosphate bonds* in *ATP* can store energy. The hydrolysis of ATP when coupled to otherwise energetically unfavorable reactions can drive the reaction toward completion. *NAD* and *NAPH* are important carriers of *reducing power*.