Table 13.1 Differences between prokaryotic and eukaryotic organisms

Structure	Prokaryotes	Eukaryotes
Cell wall structure	Usually contains peptidoglycan	Peptidoglycan absent
Nuclear membrane	Absent	Present. Possess a true nucleus
Nucleolus	Absent	Present
Number of chromosomes	One	More than one
Mitochondria	Absent	Present
Mesosomes	Present	Absent
Ribosomes	70S	80S

organic materials in the environment. Pharmaceutical microbiology, however, is concerned with the relatively small group of biological agents that cause human disease, spoil prepared medicines or can be used to produce compounds of medical interest.

In order to understand microorganisms more fully, living organisms of similar characteristics have been grouped together into taxonomic units. The most fundamental division is between prokaryotic and eukaryotic cells, which differ in a number of respects (Table 13.1) but particularly in the arrangement of their nuclear material. Eukaryotic cells contain chromosomes, which are separate from the cytoplasm and contained within a limiting nuclear membrane, i.e. they possess a true nucleus. Prokaryotic cells do not possess a true nucleus and their nuclear material is free within the cytoplasm, although it may be aggregated into discrete areas called nuclear bodies. Prokaryotic organisms make up the lower forms of life and include Eubacteria and Archaeobacteria. Eukaryotic cell types embrace all the higher forms of life, of which only the fungi will be dealt with in this chapter.

One characteristic shared by all microorganisms is the fact that they are small; however, it is a philosophical argument whether all infectious agents can be regarded as living. Some are little more than simple chemical entities incapable of any free-living existence. Viroids, for example, are small circular, single-stranded RNA molecules not complexed with protein. One particularly well-studied viroid has only 359 nucleotides (one-10th the size of the smallest known virus) and yet causes a disease in potatoes. Prions are small, self-replicating proteins devoid of any nucleic acid. The prion associated with Creutzfeld–Jakob disease in humans, scrapie in sheep and bovine spongiform encephalitis in cattle has only 250 amino acids and is highly resistant to inactivation by normal sterilization procedures.

Viruses are more complex than viroids or prions, possessing both protein and nucleic acid. Despite being among the most dangerous infectious agents known, they are still not regarded as living. Table 13.2 shows the major groups of viruses infecting humans.

Viruses

Viruses are obligate intracellular parasites with no intrinsic metabolic activity, being devoid of ribosomes and energy-producing enzyme systems. They are thus incapable of leading an independent existence and cannot be cultivated on cell-free media, no matter how nutritious. The size of human viruses ranges from the largest poxviruses, measuring about 300 nm, to the picornaviruses, such as the poliovirus which is approximately 20 nm. When one considers that a bacterial coccus measures 1000 nm in diameter, it can be appreciated that only the very largest virus particles may be seen under the light microscope, and electron microscopy is required for visualizing the majority. It will also be apparent that few of these viruses are large enough to be retained on the 200 nm (0.2 μm) membrane filters used to sterilize thermolabile liquids.

Viruses consist of a core of nucleic acid (either DNA as in vaccinia virus or RNA as in poliovirus) surrounded by a protein shell or capsid. Most DNA viruses have linear, double-stranded DNA but in the case of the parvovirus it is single stranded. The majority of RNA-containing viruses contain one molecule of single-stranded RNA, although in reoviruses it is double stranded. The protein capsid comprises 50–90% of the weight of the virus and, as nucleic acid can only synthesize approximately 10% its own weight of protein, the capsid must be made up of a number of identical protein molecules. These individual protein units are called capsomeres and are not in themselves symmetrical but are arranged around the nucleic acid core in characteristic symmetrical patterns. Additionally, many of the larger viruses possess a lipoprotein envelope surrounding the capsid arising from the membranes