Part I
Fundamentals of Cellular and Molecular Biology

An Introduction to Molecular Biotechnology. Edited by M. Wink

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1
The Cell as the Basic Unit of Life

Learning Objectives ***This chapter offers a short introduction into the structure of prokaryotic and eukaryotic cells, as well as that of viruses.***

The base unit of life is the **cell**. Cells constitute the base element of all **prokaryotic cells** (cells without a cell nucleus, for example, bacteria) and **eukaryotic cells** (cells possessing a nucleus, for example, protozoa, fungi, plants, and animals).

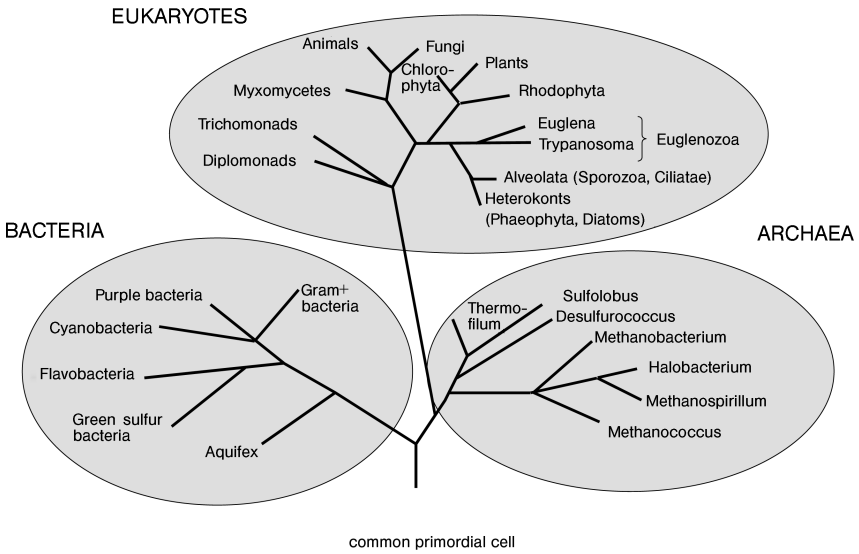

Fig. 1.1 Tree of life – phylogeny of life domains. Nucleotide sequences from 16S rRNA, amino acid sequences of cytoskeleton proteins and characteristics of cell structure were used to reconstruct this phylogenetic tree. Prokaryotes are divided into bacteria and archaea. Within the eukaryotes many monophyletic groups can be recognized (diplomonads/trichomonads, euglenozoa, alveolata, heterokonts, red algae and plants, myxomycetes and animals; see Tables 6.3, 6.4, and 6.5 for details). Whereas in this diagram archaea and eukaryota are presented as sister groups, there are also alternatives in which archaea and bacteria are not presented as sister groups.

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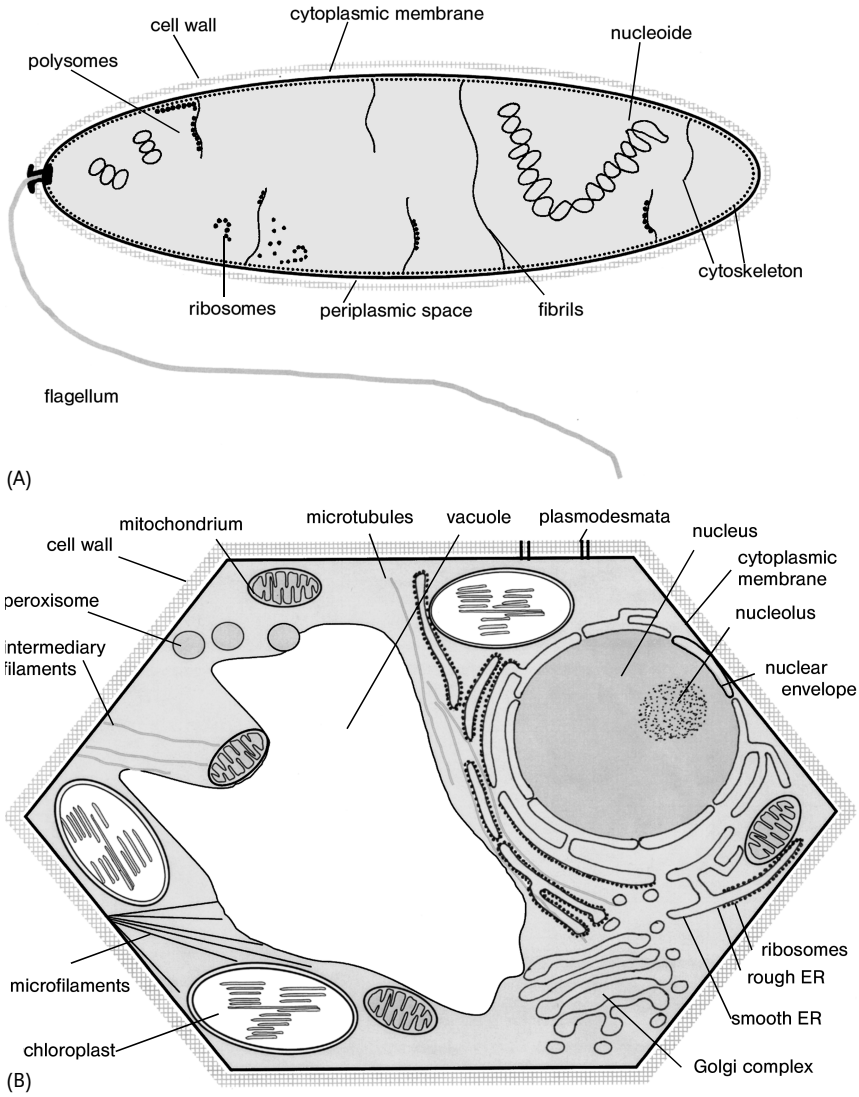
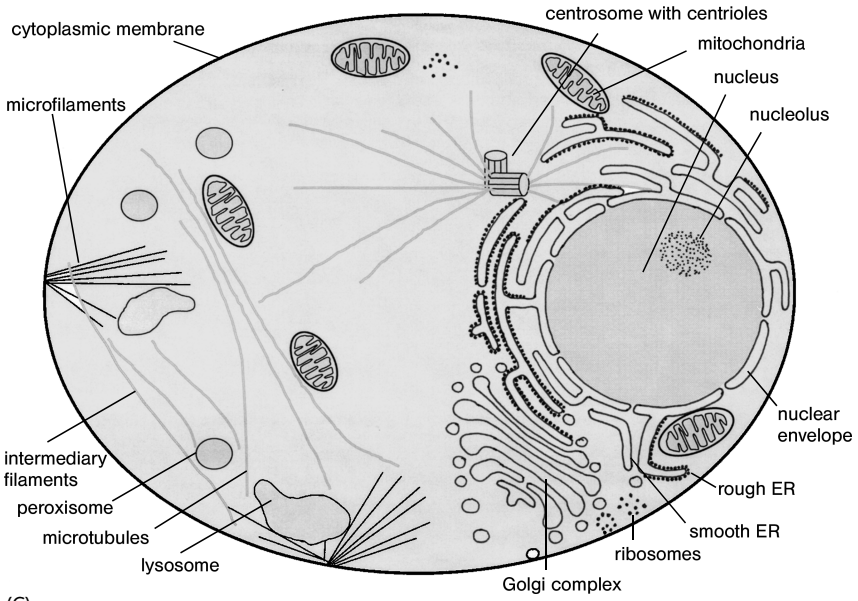


Fig. 1.2 Schematic structure of prokaryotic and eukaryotic cells. (A) Bacterial cell, (B) Plant mesophyll cell



(C)

Fig. 1.2 (C) Animal cell.

Cells are small membrane bound units with a diameter of 1–20 μm and are filled with concentrated aqueous solutions. Cells are not created *de novo*, but possess the ability to copy themselves, meaning that they emerge from the division of a previous cell. This means that all cells, since the beginning of life (around four billion years ago), are connected with each other in a continuous line. In 1885, famous cell biologist Virchow founded the law of *omnis cellula e cellulae* (all cells arise from cells), which is still valid today.

The structure and composition of all cells are very similar due to their shared evolution and phylogeny (Fig. 1.1). Because of this, it is possible to limit the discussion of the general characteristics of a cell to a few basic types (Fig. 1.2):

- bacterial cell
- plant cell
- animal cell.

As **viruses** and **bacteriophages** (Fig. 1.3) do not have their own metabolism they therefore do not count as an organism in the true sense of the word. However, they are dependent on the host cells for reproduction and therefore their physiology and structure are closely linked to that of the host cell.

In the following discussion on the shared characteristics of all cells, the diverse differences which appear in multicellular organisms should not be forgotten. These differences must be understood in detail if cell-specific disorders, such as cancer, are to be understood and consequently treated.

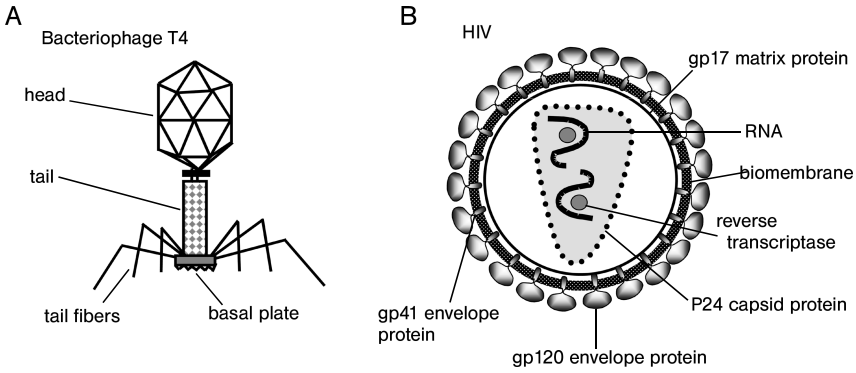


Fig. 1.3 Schematic structure of bacteriophages and viruses. (A) Bacteriophage T4, (B) Structure of the human immunodeficiency virus.

Before the detailed discussion of cellular structures and their functions (see Chapter 3), a short summary of the biochemical basics of cellular and molecular biology will be given in the following chapter.