

The Cell and Its Components

Cells are the smallest organized structural units able to maintain an individual, albeit limited, life span while carrying out a wide variety of functions. Cells have evolved on earth during the past 3.5 billion years, presumably originating from suitable early molecular aggregations. Each cell originates from another living cell as postulated by R. Virchow in 1855 (“omnis cellula e cellula”). The living world consists of two basic types of cells: prokaryotic cells, which carry their functional information in a circular genome without a nucleus, and eukaryotic cells, which contain their genome in individual chromosomes in a nucleus and have a well-organized internal structure. Cells communicate with each other by means of a broad repertoire of molecular signals. Great progress has been made since 1839, when cells were first recognized as the “elementary particles of organisms” by M. Schleiden and T. Schwann. Today we understand most of the biological processes of cells at the molecular level.

Eukaryotic cells

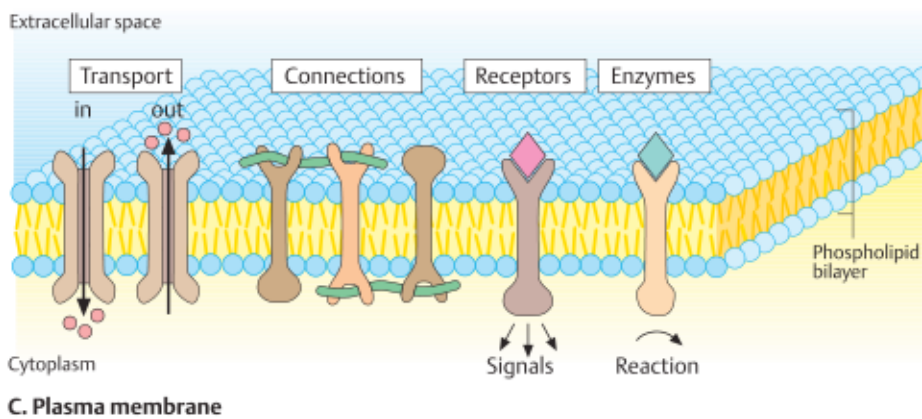
A eukaryotic cell consists of cytoplasm and a nucleus. It is enclosed by a plasma membrane. The cytoplasm contains a complex system of inner membranes that form cellular structures (organelles). The main organelles are the mitochondria (in which important energy-delivering chemical reactions take place), the endoplasmic reticulum (consisting of a series of membranes in which glycoproteins and lipids are formed), the Golgi apparatus (for certain transport functions), and peroxisomes (for the formation or degradation of certain substances). Eukaryotic cells contain lysosomes, in which numerous proteins, nucleic acids, and lipids are broken down. Centrioles, small cylindrical particles made up of microtubules, play an essential role in cell division.

Ribosomes are the sites of protein synthesis.

Nucleus

The eukaryotic cell nucleus contains the genetic information. It is enclosed by an inner and an outer membrane, which contain pores for the transport of substances between the nucleus and the cytoplasm. The nucleus contains a nucleolus and a fibrous matrix with different DNA-protein complexes.

Plasma membrane of the cell

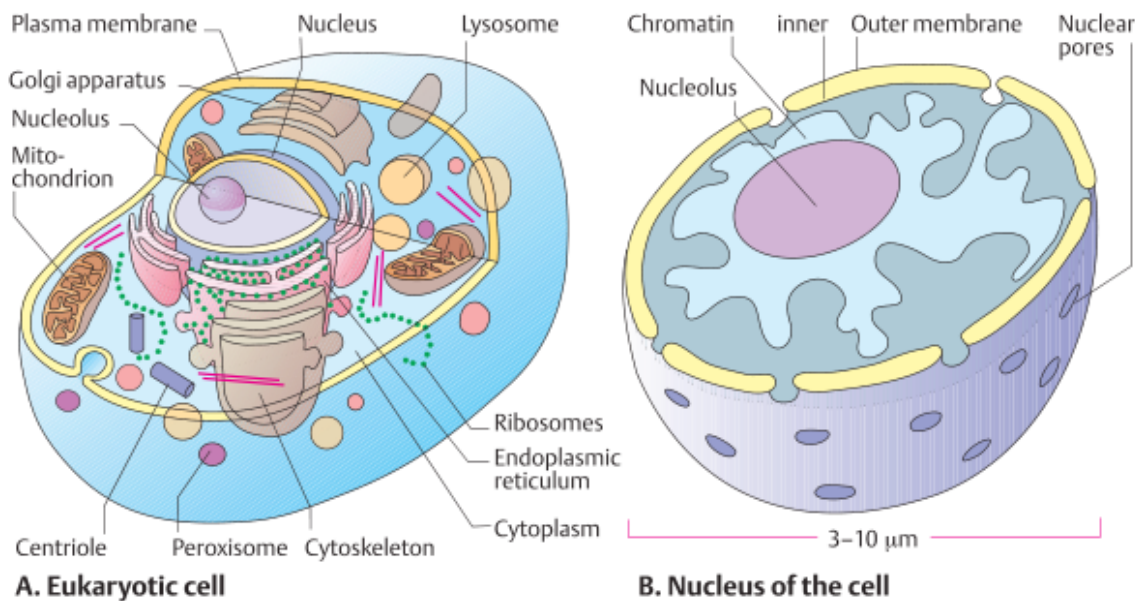


Plasma membrane of the cell

The environment of cells, whether blood or other body fluids, is water-based, and the chemical processes inside a cell involve water soluble molecules. In order to maintain their integrity, cells must prevent water and other molecules from flowing in or out uncontrolled. This is accomplished by a water-resistant membrane composed of bipartite molecules of fatty acids, the plasma membrane. These molecules are phospholipids arranged in a double layer (bilayer) with a fatty interior. The plasma membrane itself contains numerous molecules that traverse the lipid bilayer once or many times to perform special functions. Different types of membrane proteins can be distinguished: (i) transmembrane proteins used as channels for transport of molecules into or out of the cell, (ii) proteins connected with each other to provide stability, (iii) receptor molecules involved in signal

transduction, and (iv) molecules with enzyme function to catalyze internal chemical reactions in response to an external signal. (Figure redrawn from Alberts et al., 1998.)

Comparison of animal and plant cells



Eukaryotic cell and nucleus

Plant and animal cells have many similar characteristics. One fundamental difference is that plant cells contain chloroplasts for photosynthesis. In addition, plant cells are surrounded by a rigid wall of cellulose and other polymeric molecules and contain vacuoles for water, ions, sugar, nitrogen-containing compounds, or waste products. Vacuoles are permeable to water but not to the other substances enclosed in the vacuoles. (Figures in A, B and D adapted from de Duve, 1984.)

Alberts, B. et al.: Essential Cell Biology. An Introduction to the Molecular Biology of the Cell. Garland Publishing Co., New York, 1998.

de Duve, C.: A Guided Tour of the Living Cell. Vol. I and II. Scientific American Books, Inc., New York, 1984.

Lodish, H. et al.: Molecular Cell Biology (with an animated CD-ROM). 4th ed. W.H. Freeman & Co., New York, 2000.

