

Introduction to Cell Biology Prokaryotes and Eukaryotes

A Timeline

- 1595 – Jansen credited with 1st compound microscope
- 1665 – Hooke described ‘cells’ in cork.
- 1674 – Leeuwenhoek discovered protozoa. He saw bacteria some 9 years later.
- 1833 – Brown described the cell nucleus in cells of the orchid.
- 1838 – Schleiden and Schwann proposed cell theory, stating that the nucleated cell is the universal building block of plant and animal tissues.
- 1840 – Albrecht von Roelliker realized that sperm cells and egg cells are also cells.
- 1856 – N. Pringsheim observed how a sperm cell penetrated an egg cell.
- 1858 – Rudolf Virchow (physician, pathologist and anthropologist) expounds his famous conclusion: *omnis cellula e cellula*, that is cells develop only from existing cells [cells come from preexisting cells]
- 1857 – Kolliker described mitochondria.
- 1879 – Flemming described chromosome behavior during mitosis.
- 1883 – Germ cells are haploid, chromosome theory of heredity.
- 1898 – Golgi described the golgi apparatus.
- 1938 – Behrens used differential centrifugation to separate nuclei from cytoplasm.
- 1939 – Siemens produced the first commercial transmission electron microscope.
- 1952 – Gey and co workers established a continuous human cell line.
- 1955 – Eagle systematically defined the nutritional needs of animal cells in culture.
- 1957 – Meselson, Stahl and Vinograd developed density gradient centrifugation in cesium chloride solutions for separating nucleic acids.
- 1965 – Ham introduced a defined serum-free medium. Cambridge Instruments produced the first commercial scanning electron microscope.
- 1976 – Sato and colleagues publish papers showing that different cell lines require different mixtures of hormones and growth factors in serum-free media.
- 1981 – Transgenic mice and fruit flies are produced. Mouse embryonic stem cell line established.
- 1994- Chalfie and collaborators introduce green fluorescent protein (gfp) as a marker to follow the behavior of proteins in living cells.
- 1995 – Tsien identifies mutant of GFP with enhanced spectral properties
- 1998 – Mice are cloned from somatic cells.
- 1999 – Hamilton and Baulcombe discover siRNA as part of post-transcriptional gene silencing (PTGS) in plants.

1665	Cell first observed Robert Hooke, an English scientist, discovered a honeycomb-like structure in a cork slice using a primitive compound microscope. He only saw cell walls as this was dead tissue. He coined the term "cell" for these individual compartments he saw.
1670	First living cells seen Anton van Leeuwenhoek, a Dutch biologist, looks at pond water with a microscope he made lenses for.
1683	Miniature animals Anton van Leeuwenhoek made several more discoveries on a microscopic

	level, eventually publishing a letter to the Royal Society in which he included detailed drawings of what he saw. Among these was the first protozoa and bacteria discovered.
1833	The center of the cell seen Robert Brown, an English botanist, discovered the nucleus in plant cells.
1838	Basic building blocks Matthias Jakob Schleiden, a German botanist, proposes that all plant tissues are composed of cells, and that cells are the basic building blocks of all plants. This statement was the first generalized statement about cells.
1839	Cell theory Theodor Schwann, a German botanist reached the conclusion that not only plants, but animal tissue as well is composed of cells. This ended debates that plants and animals were fundamentally different in structure. He also pulled together and organized previous statement on cells into one theory, which states: 1 - Cells are organisms and all organisms consist of one or more cells 2 - The cell is the basic unit of structure for all organisms
1840	Where does life come from Albrecht von Roelliker discovers that sperm and eggs are also cells.
1845	Basic unit of life Carl Heinrich Braun reworks the cell theory, calling cells the basic unit of life.
1855	3rd part to the cell theory added Rudolf Virchow, a German physiologist/physician/pathologist added the 3rd part to the cell theory. The original is Greek, and states Omnis cellula e cellula. This translates as all cells develop only from existing cells. Virchow was also the first to propose that diseased cells come from healthy cells.

CELL CONCEPT

One of the most important concept in biology is that a cell is a basic structural and functional unit of living organism. This is known as a cell theory and was proposed jointly by two scientists. A Belgian Botanist called Schleiden and the German zoologist called Schwan. They studied the plant cell and animal cell respectively and come up with the idea that plants and animals are made up by small individuals which perform different functions of the whole organism. They finally come up with what they say cell theory.

The cell theory embraces four ideas, these are:

1. Living organisms are made up of smallest sufficient unit of living matter called cell.
2. The new cell is derived from pre-existing ones by cell division.
3. Each cell is independent with others but function as integral part of the whole organism.
4. The cell contains the hereditary material which is passed from generation to generation.

EUKARYOTES AND PROKARYOTES

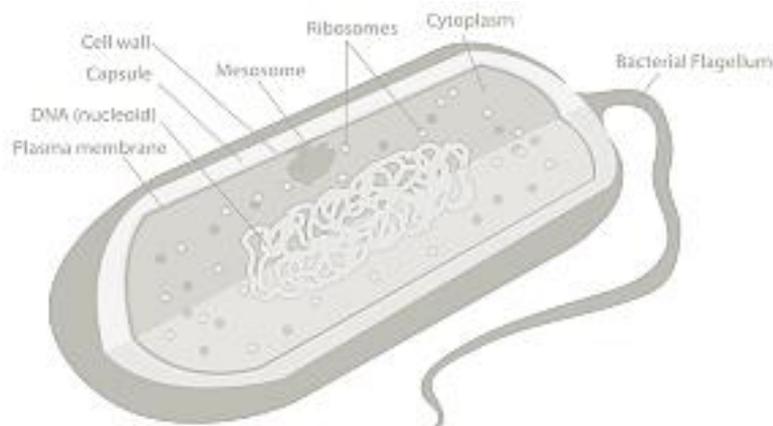
There are two fundamentally different types of cells. These are:

- The prokaryotic cell
- The eukaryotic cell

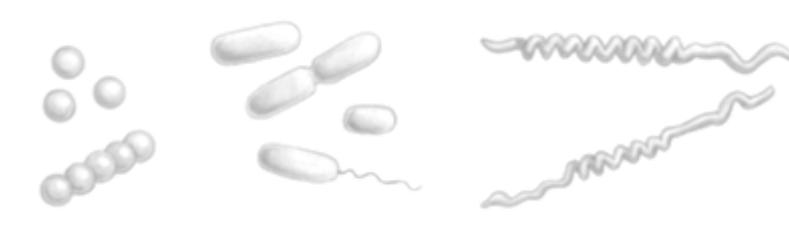
Organisms whose cells have a nucleus are called eucaryotes (from the Greek words *eu*, meaning “well” or “truly,” and *karyon*, a “kernel” or “nucleus”). Organisms whose cells do not have a nucleus are called procaryotes (from *pro*, meaning “before”).

Prokaryotes

Prokaryotes are organisms made up of cells that lack a cell nucleus or any membrane-encased organelles. This means the genetic material DNA in prokaryotes is not bound within a nucleus. Additionally, the DNA is less structured in prokaryotes than in eukaryotes. In prokaryotes, DNA is a single loop. In Eukaryotes, DNA is organized into chromosomes. Most prokaryotes are made up of just a single cell (unicellular) but there are a few that are made of collections of cells (multicellular). Scientists have divided the prokaryotes into two groups, the Bacteria and the Archaea.



Prokaryotes are typically spherical, rod like, or corkscrew-shaped, and small—just a few micrometers long, although there are some giant species as much as 100 times longer than this. They often have a tough protective coat, called a cell wall, surrounding the plasma membrane, which encloses a single compartment containing the cytoplasm and the DNA.



Spherical cells,
e.g., *Streptococcus*

Rod-shaped cells,
e.g., *Escherichia coli*,
Salmonella

Spiral cells,
e.g., *Treponema pallidum*

Eukaryotes

Eukaryotes are organisms made up of cells that possess a membrane-bound nucleus as well as membrane-bound organelles. Genetic material in eukaryotes is contained within a nucleus within the cell and DNA is organized into chromosomes. Eukaryotic organisms may be multicellular or single-celled organisms. Eukaryotic cell membrane contains sterols,

whereas no prokaryotes except the wall of *Mycoplasma*, has sterol in its membrane. All animals are eukaryotes. Other eukaryotes include plants, fungi, and protists.

Eukaryotic cells, in general, are bigger and more elaborate than bacteria and archaea. Some live independent lives as single-celled organisms, such as amoebae and yeasts; others live in multicellular assemblies. All of the more complex multicellular organisms—including plants, animals, and fungi—are formed from eukaryotic cells.

	Eukaryotic cell	Prokaryotic cell
Nucleus	Present	Absent
Number of chromosomes	More than One	One but not true chromosomes: plasmids
Cell type	Multicellular	Unicellular
True membrane bound molecules	Present	Absent
Examples:	Animals and plants	Bacteria and archaea
Lysosomes and Peroxisomes	Present	Absent
Microtubules	Present	Absent or rare
Endoplasmic reticulum	Present	Absent
Mitochondria	Present	Absent
Ribosomes	Larger 80S	Smaller 70S
Vesicles	Present	Present
Golgi Apparatus	Present	Absent
Chloroplasts	Present (in plants)	Absent
Plasma membrane with steroid	Yes	Usually no
Permeability of nuclear membrane	Selective	Not present
Vacuoles	Present	Absent
Cell Size	1-1000Um	1-10um
Flagella	Microscopic in size; membrane bound; usually arranged as nine doublets surrounding two singlets	Submicroscopic in size, composed of only one fiber