BIOLOGY

CELL BIOLOGY

Eukaryotic Cell vs. Prokaryotic Cell :

The distinction between **prokaryotes** and **eukaryotes** is considered to be the most important distinction among groups of organisms. Eukaryotic cells contain membrane-bound organelles, such as the nucleus, while prokaryotic cells do not. Differences in cellular structure of prokaryotes and eukaryotes include the presence of mitochondria and chloroplasts, the cell wall, and the structure of chromosomal DNA.

Prokaryotes were the only form of life on Earth for millions of years until more complicated eukaryotic cells came into being through the process of evolution.

Comparison chart

	Eukaryotic Cell	Prokaryotic Cell
Nucleus	Present	Absent
Number of chromosomes	More than one	One—but not true chromosome: Plasmids
Cell Type	Usually multicellular	Usually unicellular (some cyanobacteria may be multicellular)
True Membrane bound Nucleus	Present	Absent
Example	Animals and Plants	Bacteria and Archaea
Genetic Recombination	Meiosis and fusion of gametes	Partial, unidirectional transfers DNA
Lysosomes and peroxisomes	Present	Absent
Microtubules	Present	Absent or rare
Endoplasmic reticulum	Present	Absent
Mitochondria	Present	Absent
Cytoskeleton	Present	May be absent
DNA wrapping on proteins.	Eukaryotes wrap their DNA	Multiple proteins act together to fold and around proteins called histones condense prokaryotic DNA. Folded DNA is then organized into a variety of conformations that are supercoiled and wound around tetramers of the HU protein.
Ribosomes	Larger	Smaller
Vesicles	Present	Present
Golgi apparatus	Present	Absent
Chloroplasts	Present (in plants)	Absent; chlorophyll scattered in the cytoplasm
Flagella	Microscopic in size; membrane bound; usually arranged as nine doublets surrounding two singlets	Submicroscopic in size, composed of only one fiber

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Permeability of Nuclear Membrane	Selective	Not present
Plasma membrane with steroid	Yes	Usually no
Cell wall	Only in plant cells and fungi (chemically simpler)	Usually chemically complexed
Vacuoles	Present	Present
Cell size	10-100μm	1-10μm

Definition of eukaryotes and prokaryotes

Prokaryotes (pro-KAR-ee-ot-es) (from Old Greek *pro-* before + *karyon* nut or kernel, referring to the cell nucleus, + suffix *-otos*, pl. *-otes*; also spelled "procaryotes") are organisms without a cell nucleus (= karyon), or any other membrane-bound organelles. Most are unicellular, but some prokaryotes are multicellular.

Eukaryotes (IPA: are organisms whose cells are organized into complex structures by internal membranes and a cytoskeleton. The most characteristic membrane bound structure is the nucleus. This feature gives them their name, (also spelled "eucaryote,") which comes from the Greek ευ, meaning good/true, and κάρυον, meaning nut, referring to the nucleus. Animals, plants, fungi, and protists are eukaryotes.

- Life exhibits varying degrees of organization. Atoms are organized into molecules, molecules into organelles, and organelles into cells, and so on. According to the Cell Theory, all living things are composed of one or more cells, and the functions of a multicellular organism are a consequence of the types of cells it has. Cells fall into two broad groups: prokaryotes and eukaryotes. Prokaryotic cells are smaller (as a general rule) and lack much of the internal compartmentalization and complexity of eukaryotic cells. No matter which type of cell we are considering, all cells have certain features in common, such as a cell membrane, DNA and RNA, cytoplasm, and ribosomes. Eukaryotic cells have a great variety of organelles and structures.

Cell Size and Shape

- The shapes of cells are quite varied with some, such as neurons, being longer than they are wide and others, such as parenchyma (a common type of plant cell) and erythrocytes (red blood cells) being equidimensional. Some cells are encased in a rigid wall, which constrains their shape, while others have a flexible cell membrane (and no rigid cell wall).
- The size of cells is also related to their functions. Eggs (or to use the latin word, ova) are very large, often being the largest cells an organism produces. The large size of many eggs is related to the process of development that occurs after the egg is fertilized, when the contents of the egg (now termed a zygote) are used in a rapid series of cellular divisions, each requiring tremendous amounts of energy that is available in the zygote cells. Later in life the energy must be acquired, but at first a sort of inheritance/ trust fund of energy is used.
- Cells range in size from small bacteria to large, unfertilized eggs laid by birds and dinosaurs. The realtive size ranges of biological things is shown in Figure 1. In science we use the metric system for measuring. Here are some measurements and conversions that will aid our understanding of biology.

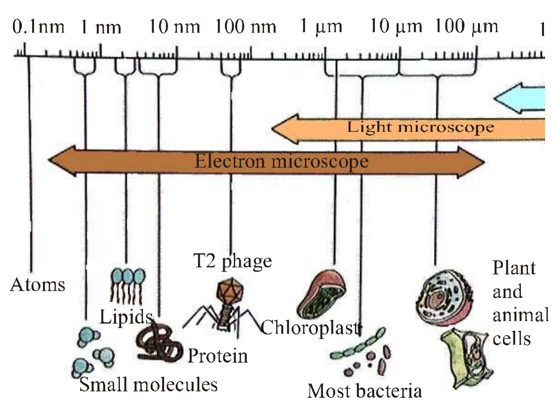
1 meter = 100 cm = 1,000 mm = 1,000,000 μm = 1,000,000,000 nm

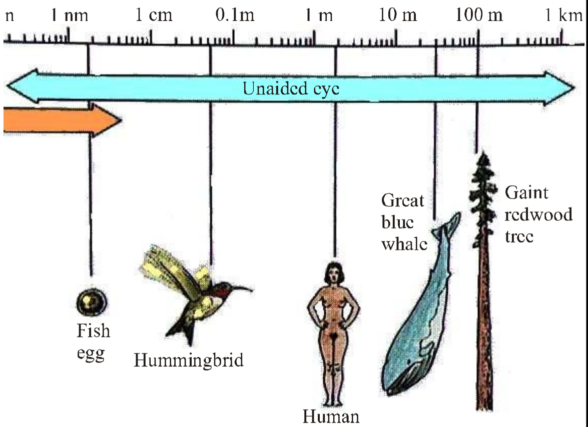
1 centimeter (cm) = 1/100 meter = 10 mm

1 millimeter (mm) = 1/1000 meter = 1/10 cm

1 micrometer (μm) = 1/1,000,000 meter = 1/10,000 cm

1 nanometer (nm) = 1/1,000,000,000 meter = 1/10,000,000 cm





CELLWALL

- The cell wall gives a definite shape and provides protection to the Protoplasm. It is non-living in nature and is permeable. Adjacent cells in the plant body remain interconnected by plasmodesmata. Cell wall composed chiefly of cellulose.

Points to Remember

- Cellulose is most abundant organic polymer. It is a polysaccharide, occurring as the major structural cell wall material in the plant kingdom. Some fungi have it as a component of their hyphal walls.
- A long-chain polysaccharide of repeating Cellobiose units, it may also be considered as a long chain of ß [1, 4] linked glucose units. Hydrogen bonding both within each molecule as well as between parallel molecules (producing crystalline microfibrils) gives cellulose its great tensile strength; but microfibrils can be loosened by lowered pH (an effect of Auxins on the cell) allowing for wall extension in cell growth, when more cellulose may be laid down between existing microfibrils. With Lignin, it forms lignocellulose.
- The fibrous texture of cellulose is responsible for its use in textile industries (Cotton, linen, artificial silk).

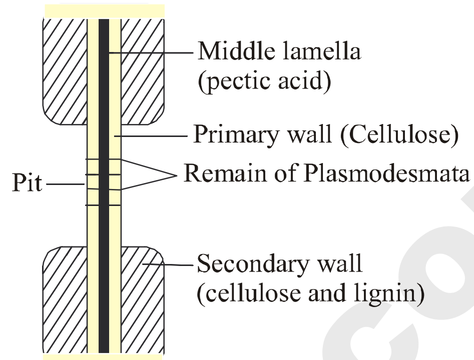


Fig. Sectional view of cell wall.

Cell wall consists of 3 parts

(i) Middle lamella—

- It chiefly consists of pectic acid in the form of Ca and Mg salts.
- Pectic acid is long polygalacturonic acid compound in which a-D-galacturonic acid units are joined together by glycosidic linkages in (1 : 4).
- It is hydrophilic in nature.

(ii) Primary wall

- Growing plant cells are surrounded by a polysaccharide rich primary wall.
- Chiefly consists of cellulose, a long straight chain polysaccharide in which ß-D-glucose units are jointed together by glycosidic linkages in (1 : 4).
- An association of about 100 cellulose chains is termed as a micelle, 20 micelles constitute a microfibril while an aggregation of 250 microfibrils is called fibril.
- Cellulose is strongly hydrophilic in nature.
- Besides cellulose, the primary wall also contains lignin, hemicellulose, some pectic substances and proteins which form the amorphous matrix.
- Primary wall is part of the apoplast which itself is largely self-contiguous and contains everything that is located between the plasma membrane and the cuticle. The primary wall and middle lamella account for most of the apoplast in growing tissue. The symplast is another unique feature of plant tissues. This self-contiguous

phase exists because tube-like structures known as plasmodesmata connect the cytoplasm of different cells.

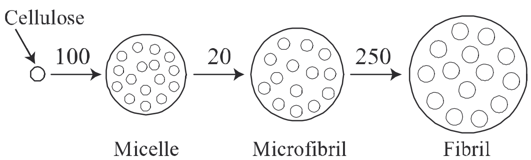


Fig. : Diagrammatic representation of composition of fibril.

Functions of the primary wall:

- Structural and mechanical support.
- maintain and determine cell shape.
- resist internal turgor pressure of cell.
- control rate and direction of growth.
- ultimately responsible for plant architecture and form.
- regulate diffusion of material through the apoplast.
- carbohydrate storage - walls of seeds may be metabolized.
- protect against pathogens, dehydration, and other environmental factors.
- source of biologically active signalling molecules.
- cell-cell interactions.

(iii) Secondary wall

- Plants form two types of cell wall that differ in function and in composition. Primary walls surround growing and dividing plant cells. These walls provide mechanical strength but must also expand to allow the cell to grow and divide. The much thicker and stronger secondary wall (see figure on right), which accounts for most of the carbohydrate in biomass, is deposited once the cell has ceased to grow. The secondary walls of xylem fibers, tracheids, and sclereids are further strengthened by the incorporation of lignin.
- It is more pronounced in dead cells such as tracheids and sclerenchyma.
- Primary and secondary walls contain cellulose, hemicellulose and pectin, albeit in different proportions. Approximately equal amounts of pectin and hemicellulose are present in dicot primary walls whereas hemicellulose is more abundant in grasses (e.g., switchgrass). The secondary walls of woody tissue and grasses are composed predominantly of cellulose, lignin, and hemicellulose (xylan, glucuronoxylan, arabinoxylan, or glucomannan). The cellulose fibrils are embedded in a network of hemicellulose and lignin. Cross-linking of this network is believed to result in the elimination of water from the wall and the formation of a hydrophobic composite that limits accessibility of hydrolytic enzymes and is a major contributor to the structural characteristics of secondary walls.

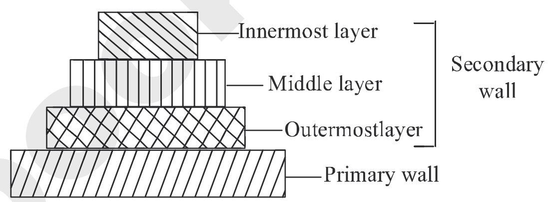


Fig. : Telescopic view of the wall layers of tracheid showing orientation of microfibrils.

Comparison of some characteristics of Primary and Secondary Wall

S. No.	Primary Wall	Secondary Wall
1.	Extensible layer	Non-extensible layer
2.	Dispersed texture of microfibril	microfibrils (to long axis)
3.	Smallest cellulosic unit micelle or microfibril	Smallest cellulose unit microfibril or fibril
4.	Cellulose 5·2%	Cellulose 50-94%
5.	Lipid content 5-10%	Normally no lipid
6.	Proteins 5%	Proteins very low
7.	Hemicellulose 50%	Hemicellulose 25%

Functions of cell walls

- Provide tensile strength and limited plasticity which are important for: