**Dr. Rima Kumari: Date: 10/08/2020**

Online class and e- content for MSc III semester students

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| Date and Time | Online class medium | E. content topic |
| 10/08/2020  12:30 p.m to 1.30 p.m | Via Google meet  Link: Meeting URL: https://meet.google.com/qem-qfxm-ssw | **Basic Introduction of Cell,**  **Cell History, Difference in Eukaryotic and Prokaryotic cell** |

**Cell Definition**

“A cell is defined as the smallest, basic unit of life that is responsible for all of life’s processes.” In other way it may be defined as” Cells are the structural, functional, and biological units of all living beings”. It is the smallest biological, structural, and functional unit of all plants and animals. A cell can replicate itself independently. Hence, they are known as the building blocks of life. Therefore, cells are the ‘Building Blocks of Life’ or the ‘Basic units of Life’. Organisms made up of a single cell are ‘unicellular’ whereas organisms made up of many cells are ‘multicellular’. Cells perform many different functions within a living organism such as digestion, respiration, reproduction, etc. They provide structure to the body and convert the nutrients taken from the food into energy.

Mycoplasmas are the smallest known cells. Cells are the building blocks of all living beings.

Each cell contains a fluid called the cytoplasm, which is enclosed by a membrane. Also present in the cytoplasm are several biomolecules like proteins, nucleic acids and lipids. Moreover, cellular structures called cell organelles are suspended in the cytoplasm.

Discovery of Cells

The study of cells from its basic structure to the functions of every cell organelle is called **Cell Biology**. Robert Hooke discovered the cell in 1665. **Robert Hooke** observed a piece of bottle cork under a compound microscope and noticed minuscule box like structures that reminded him of small rooms. Consequently, he named these “rooms” as cells. However, his compound microscope had limited magnification, and hence, he could not see any details in the structure. In a 1665 publication called Micrographia, experimental scientist Robert Hooke coined the term “cell” for the box-like structures he observed when viewing cork tissue through a lens. Owing to this limitation, Hooke concluded that these were non-living entities. Later **Anton Van Leeuwenhoek** observed cells under another compound microscope with higher magnification. This time, he had noted that the cells exhibited some form of movement (motility). As a result, Leeuwenhoek concluded that these microscopic entities were “alive.” Eventually, after a host of other observations, these entities were named as animalcules. In 1883, Robert Brown, a Scottish botanist, provided the very first insights into the cell structure. He was able to describe the nucleus present in the cells of orchids.

**Cell Theory**

Cell Theory is one of the basic principles of [biology](https://www.thoughtco.com/biology-meaning-373266). By the late 1830s, botanist Matthias Schleiden and zoologist Theodor Schwann were studying tissues and proposed the unified cell theory.

Rudolf Virchow famously stated “Omnis cellula e cellula”… “All cells only arise from pre-existing cells. “, This concept are widely agreed upon by the scientific community today. The generally accepted portions of the modern Cell Theory are as follows:

The Cell Theory states:

• All living organisms are composed of cells. They may be unicellular or multicellular.

• The cell is the basic unit of life.

• Cells arise from pre-existing cells. (They are not derived from spontaneous generation.)

The modern version of the Cell Theory includes the ideas that:

* Energy flow occurs within cells.
* Cells carry genetic Heredity information ([DNA](https://www.thoughtco.com/dna-models-373331))and is passed on from cell to cell.
* All cells have the same basic chemical composition.

Characteristics of Cells

Following are the various essential characteristics of cells:

Cells provide structure and support to the body of an organism.

The cell interior is organised into different individual organelles surrounded by a separate membrane.

The nucleus (major organelle) holds genetic information necessary for reproduction and cell growth.

Every cell has cytoplasm enclosed by membranous structure, nucleus and membrane-bound organelles in the cytoplasm.

Mitochondria, a double membrane-bound organelle is mainly responsible for the energy transactions vital for the survival of the cell.

Lysosomes digest unwanted materials in the cell.

Endoplasmic reticulum plays a significant role in the internal organisation of the cell by synthesising selective molecules and processing, directing and sorting them to their appropriate locations.

Types of Cells

Cells are similar to factories with different labourers and departments that work towards a common objective. Various types of cells perform different functions. Based on cellular structure, there are two types of cells: i) Prokaryotes ii) Eukaryotes

**Prokaryotic Cells**

Basic Structures of Prokaryotic Cells

Prokaryotes, found in both Domain Archaea and Bacteria, are unicellular organisms that lack membrane-bound organelles and a defined nucleus. Prokaryotic cells have no nucleus. Instead, some prokaryotes such as bacteria have a region within the cell where the genetic material is freely suspended. This region is called the nucleoid.

They all are single-celled microorganisms. Examples include archaea, bacteria, and cyanobacteria.

The cell size ranges from 0.1 to 0.5 µm in diameter.

The hereditary material can either be DNA or RNA.

Prokaryotes reproduce by binary fission, a form of sexual reproduction.

**Key Points**

* Prokaryotes lack an organized nucleus Prokaryotic DNA is found in a central part of the cell called the nucleoid.
* Prokaryotic cells lack a defined nucleus, and other membrane-bound organelles. but have a region in the cell, termed the nucleoid, in which a single chromosomal, circular, double-stranded DNA molecule is located.
* The cell wall of a prokaryote acts as an extra layer of protection, helps maintain cell shape, and prevents dehydration.
* Prokaryotic cell size ranges from 0.1 to 5.0 μm in diameter.
* **nucleoid**: the irregularly-shaped region within a prokaryote cell where the genetic material is localized
* **plasmid**: a circle of double-stranded DNA that is separate from the chromosomes, which is found in bacteria and protozoa
* **osmotic pressure**: the hydrostatic pressure exerted by a solution across a semipermeable membrane from a pure solvent

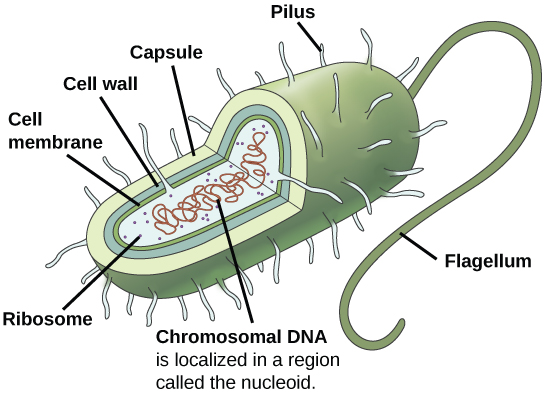
## Components of Prokaryotic Cells

All cells share four common components:

1. cell wall and plasma membrane: an outer covering that separates the cell’s interior from its surrounding environment.
2. cytoplasm: a jelly-like cytosol within the cell in which other cellular components are found
3. DNA: the genetic material of the cell
4. ribosomes: where protein synthesis occurs

### The Prokaryotic Cell

Prokaryotes are unicellular organisms that lack organelles or other internal membrane-bound structures. Therefore, they do not have a nucleus, but, instead, generally have a single chromosome: a piece of circular, double-stranded DNA located in an area of the cell called the nucleoid. Most prokaryotes have a cell wall outside the plasma membrane.



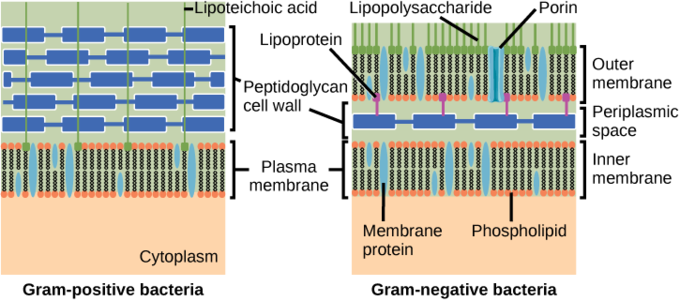
The composition of the cell wall differs significantly between the domains Bacteria and Archaea, the two domains of life into which prokaryotes are divided. The composition of their cell walls also differs from the eukaryotic cell walls found in plants (cellulose) or fungi and insects (chitin). The cell wall functions as a protective layer and is responsible for the organism’s shape. Some bacteria have a capsule outside the cell wall. Other structures are present in some prokaryotic species, but not in others. For example, the capsule found in some species enables the organism to attach to surfaces, protects it from dehydration and attack by phagocytic cells, and increases its resistance to our immune responses. Some species also have flagella used for locomotion and pili used for attachment to surfaces. Plasmids, which consist of extra-chromosomal DNA, are also present in many species of bacteria and archaea.

### The Cell Wall

The cytoplasm of prokaryotic cells has a high concentration of dissolved solutes. Therefore, the osmotic pressure within the cell is relatively high. The cell wall is a protective layer that surrounds some cells and gives them shape and rigidity. It is located outside the cell membrane and prevents osmotic lysis (bursting due to increasing volume). The chemical composition of the cell walls varies between archaea and bacteria. It also varies between bacterial species.

Bacterial cell walls contain peptidoglycan composed of polysaccharide chains that are cross-linked by unusual peptides containing both L- and D-amino acids, including D-glutamic acid and D-alanine. Proteins normally have only L-amino acids; as a consequence, many of our antibiotics work by mimicking D-amino acids and, therefore, have specific effects on bacterial cell wall development. There are more than 100 different forms of peptidoglycan. S-layer (surface layer) proteins are also present on the outside of cell walls of both archaea and bacteria.

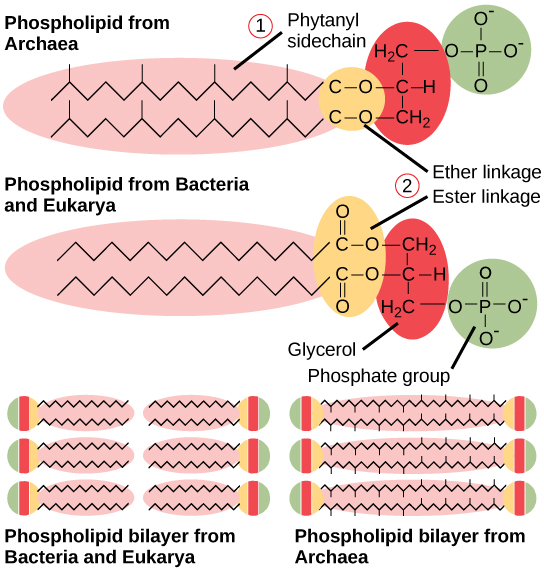
Bacteria are divided into two major groups: gram-positive and gram-negative, based on their reaction to gram staining. Note that all gram-positive bacteria belong to one phylum; bacteria in the other phyla (Proteobacteria, Chlamydias, Spirochetes, Cyanobacteria, and others) are gram-negative. The gram-staining method is named after its inventor, Danish scientist Hans Christian Gram (1853–1938). The different bacterial responses to the staining procedure are ultimately due to cell wall structure. Gram-positive organisms typically lack the outer membrane found in gram-negative organisms. Up to 90 percent of the cell wall in gram-positive bacteria is composed of peptidoglycan, with most of the rest composed of acidic substances called teichoic acids. Teichoic acids may be covalently linked to lipids in the plasma membrane to form lipoteichoic acids. Lipoteichoic acids anchor the cell wall to the cell membrane. Gram-negative bacteria have a relatively thin cell wall composed of a few layers of peptidoglycan (only 10 percent of the total cell wall), surrounded by an outer envelope containing lipopolysaccharides (LPS) and lipoproteins. This outer envelope is sometimes referred to as a second lipid bilayer. The chemistry of this outer envelope is very different, however, from that of the typical lipid bilayer that forms plasma membranes.



**Gram-positive and gram-negative bacteria**: Bacteria are divided into two major groups: gram-positive and gram-negative. Both groups have a cell wall composed of peptidoglycan: in gram-positive bacteria, the wall is thick, whereas in gram-negative bacteria, the wall is thin. In gram-negative bacteria, the cell wall is surrounded by an outer membrane that contains lipopolysaccharides and lipoproteins. Porins, proteins in this cell membrane, allow substances to pass through the outer membrane of gram-negative bacteria. In gram-positive bacteria, lipoteichoic acid anchors the cell wall to the cell membrane.

### The Plasma Membrane

The plasma membrane is a thin lipid bilayer (6 to 8 nanometers) that completely surrounds the cell and separates the inside from the outside. Its selectively-permeable nature keeps ions, proteins, and other molecules within the cell, preventing them from diffusing into the extracellular environment, while other molecules may move through the membrane. The general structure of a cell membrane is a phospholipid bilayer composed of two layers of lipid molecules. In archaeal cell membranes, isoprene (phytanyl) chains linked to glycerol replace the fatty acids linked to glycerol in bacterial membranes. Some archaeal membranes are lipid monolayers instead of bilayers.



**Plasma membrane structure**: Archaeal phospholipids differ from those found in Bacteria and Eukarya in two ways. First, they have branched phytanyl sidechains instead of linear ones. Second, an ether bond instead of an ester bond connects the lipid to the glycerol.

## Nucleid:

The nucleoid (meaning nucleus-like) is an irregularly-shaped region within the cell of a prokaryote that contains all or most of the genetic material. In contrast to the nucleus of a eukaryotic cell, it is not surrounded by a nuclear membrane. The genome of prokaryotic organisms generally is a circular, double-stranded piece of DNA, of which multiple copies may exist at any time. The length of a genome varies widely, but is generally at least a few million base pairs.

The nucleoid can be clearly visualized on an electron micrograph at high magnification, where it is clearly visible against the cytosol. Sometimes even strands of what is thought to be DNA are visible. The nucleoid can also be seen under a light microscope.by staining it with the Feulgen stain, which specifically stains DNA. The DNA-intercalating stains DAPI and ethidium bromide are widely used for fluorescence microscopy of nucleoids.

Experimental evidence suggests that the nucleoid is largely composed of about 60% DNA, plus a small amount of RNA and protein. The latter two constituents are likely to be mainly messenger RNA and the transcription factor proteins found regulating the bacterial genome. Proteins helping to maintain the supercoiled structure of the nucleic acid are known as nucleoid proteins or nucleoid-associated proteins, and are distinct from histones of eukaryotic nuclei. In contrast to histones, the DNA-binding proteins of the nucleoid do not form nucleosomes, in which DNA is wrapped around a protein core. Instead, these proteins often use other mechanisms, such as DNA looping, to promote compaction.

**The Genophore**

A genophore is the DNA of a prokaryote. It is commonly referred to as a prokaryotic chromosome. The term “chromosome” is misleading, because the genophore lacks chromatin. The genophore is compacted through a mechanism known as supercoiling, but a chromosome is additionally compacted through the use of chromatin. The genophore is circular in most prokaryotes, and linear in very few. The circular nature of the genophore allows replication to occur without telomeres. Genophores are generally of a much smaller size than Eukaryotic chromosomes. A genophore can be as small as 580,073 base pairs (Mycoplasma genitalium). Many eukaryotes (such as plants and animals) carry genophores in organelles such as mitochondria and chloroplasts. These organelles are very similar to true prokaryotes.