CLASS XI BIOLOGY

CHAPTER - 8

CELL: THE UNIT OF LIFE

Introduction

- All organisms are composed of cells. Some are composed of a single cell and are called unicellular organisms while others, like us, composed of many cells, are called multicellular organisms.

WHAT IS A CELL?

- Unicellular organisms are capable of (i) independent existence and (ii) performing the essential functions of life. Anything less than a complete structure of a cell does not ensure independent living. Hence, cell is the fundamental structural and functional unit of all living organisms. Anton Von Leeuwenhoek first saw and described a live cell. Robert Brown later discovered the nucleus. The invention of the microscope and its improvement leading to the electron microscope revealed all the structural details of the cell.

CELL THEORY

- In 1838, Matthias Schleiden, a German botanist, examined a large number of plants and observed that all plants are composed of different kinds of cells which form the tissues of the plant. At about the same time, Theodore Schwann (1839), a British Zoologist, studied different types of animal cells and reported that cells had a thin outer layer which is today known as the 'plasma membrane'. He also concluded, based on his studies on plant tissues, that the presence of cell wall is a unique character of the plant cells. On the basis of this, Schwann proposed the hypothesis that the bodies of animals and plants are composed of cells and products of cells. Schleiden and Schwann together formulated the cell theory. This theory however, did not explain as to how new cells were formed. Rudolf Virchow (1855) first explained that cells divided and new cells are formed from pre-existing cells (Omnis cellula-e cellula). He modified the hypothesis of Schleiden and Schwann to give the cell theory a final shape. Cell theory as understood today is: (i) all living organisms are composed of cells and products of cells. (ii) all cells arise from pre-existing cells.

Property	Prokaryotes	Eukaryotes
Size	Most of them are very small. Some are larger than 50 µm.	Most are large cells (10-100µm). Some are larger than 1 mm.
General Characteristics	All are microbes. Unicellular or colonial. The nucleoid is not membrane bound.	Some are microbes; most are large organisms. All possess a membrane-bound nucleus.
Cell Division	No mitosis or meiosis. Mainly by binary fission or budding.	Mitosis and meiosis types of cell division occur.
Sexual system	Absent in most forms, when present unidirectional transfer of genetic material from donor to recipient.	Present in most forms, equal male and female participation in fertilization.
Development	No multi-cellular development from diploid zygotes. No extensive tissue differentiation.	Haploid forms are produced by meiosis and diploid from zygotes. Multi-cellular organisms show extensive tissue differentiation.
Flagella Type	Some have simple bacterial flagella composed of only one fibril.	Flagella are of 9 + 2 type
Cell Wall	Made up of peptidoglycan (mucopeptide). Cellulose is absent.	Cell wall is made up of cellulose in plants and chitin in fungi.
Organelles	Membrane bound organelles such as endoplasmic reticulum, golgi complex, mitochondria, chloroplasts and vacuoles are absent.	Membrane bound organelles such as endoplasmic reticulum, golgi complex, mitochondria, chloroplasts and vacuoles are present.
Ribosomes	Ribosomes are smaller made of 70s units (s refers to Svedberg unit, the sedimentation coefficient of a particle in the ultra centrifuge).	Ribosomes are larger and made of 80s units.
DNA	Genetic material (DNA) is not found in well-organized chromosomes.	Genetic material is found in well organized chromosomes.

Cell Envelope

- Most prokaryotic cells, particularly the bacterial cells, have a chemically complex cell envelope. The cell envelope consists of a tightly bound three layered structure i.e., the outermost glycocalyx followed by the cell wall and then the plasma membrane.
- Although each layer of the envelope performs distinct function, they act together as a single protective unit.
- Bacteria can be classified into two groups on the basis of the differences in the cell envelopes and the manner in which they respond to the staining procedure developed by Gram viz., those that take up the gram stain are **Gram positive** and the others that do not are called **Gram negative bacteria**

GRAM POSITIVE BACTERIA
VERSUS
GRAM NEGATIVE BACTERIA

Gram positive bacteria retain the crystal violet stain during gram staining	Gram negative bacteria do not retain the crystal violet stain during gram staining
Appear in purple color under the microscope	Appear in pink color under the microscope
Outer membrane is present	Outer membrane is absent
Peptidoglycan layer is thick and multilayered	Peptidoglycan layer is thin and single-layered
Periplasmic space is absent	Periplasmic space is present
Cell wall is around 20-80 nm	Cell wall is around 5-10 nm

Cell wall is smooth	Cell wall is wavy
Cell wall contains virtually non lipopolysaccharide content	Cell wall high lipopolysaccharide content
Lipid and lipoprotein content is low in the cell wall	Lipid and lipoprotein content is high in the cell wall
More susceptible to anionic detergents	Less susceptible to anionic detergents

Examples of **Gram positive Gram negative bacteria**

Gram negative bacteria	Gram positive bacteria
Salmonella typhi	*Staphylococcus aureus*
Salmonella typhimurum	*Staphylococcus epidermidis*
Pseudomonas aeroginosa	*Staphylococcus saprophyticus*
Proteus merabilis	*Steptococcus pyogenes*
Proteus vuligaris	*Streptococcus pneumoniae*
Klebsiella pneumoniae	*Streptococcus mutanus*
Acinetobacter	*Streptococcus fecalis*
Escherichia coli	*Streptococcus agalagtia*

Cell Envelope and its Modifications

- Glycocalyx differs in composition and thickness among different bacteria. It could be a loose sheath called the slime layer in some, while in others it may be thick and tough, called the capsule.
- The cell wall determines the shape of the cell and provides a strong structural support to prevent the bacterium from bursting or collapsing. The plasma membrane is semi-permeable in nature and interacts with the outside world. This membrane is similar structurally to that of the eukaryotes.
- A special membranous structure is the mesosome which is formed by the extensions of plasma membrane into the cell. These extensions are in the form of vesicles, tubules and lamellae. They help in cell wall formation, DNA replication and distribution to daughter cells. They also help in respiration, secretion processes, to increase the surface area of the plasma membrane and enzymatic content. In some prokaryotes like cyanobacteria, there are other membranous extensions into the cytoplasm called chromatophores which contain pigments.

Cell Envelope and its Modifications

- Bacterial cells may be motile or non-motile. If motile, they have thin filamentous extensions from their cell wall called flagella. Bacteria show a range in the number and arrangement of flagella. Bacterial flagellum is composed of three parts – **filament, hook and basal body**. The filament is the longest portion and extends from the cell surface to the outside. Besides flagella, Pili and Fimbriae are also surface structures of the bacteria but do not play a role in motility. The pili are elongated tubular structures made of a special protein. The fimbriae are small bristle like fibres sprouting out of the cell. In some bacteria, they are known to help attach the bacteria to rocks in streams and also to the host tissues.

Ribosomes

- In prokaryotes, ribosomes are associated with the plasma membrane of the cell. They are about 15 nm by 20 nm in size and are made of two subunits - 50S and 30S units which when present together form 70S prokaryotic ribosomes. Ribosomes are the site of protein synthesis. Several ribosomes may attach to a single mRNA and form a chain called polyribosomes or polysome. The ribosomes of a polysome translate the mRNA into proteins.

Inclusion Bodies

- Reserve material in prokaryotic cells are stored in the cytoplasm in the form of inclusion bodies. These are not bound by any membrane system and lie free in the cytoplasm, e.g., phosphate granules, cyanophycean granules and glycogen granules. Gas vacuoles are found in blue green and purple and green photosynthetic bacteria.