THE CELL AND ITS STRUCTURAL ORGANIZATION

The living world comprises of around four million different species of various living forms. These include bacteria, protozoa, plants and animals that differ in morphology, function as well as behavior. The cells and molecules constitute the building blocks of all the forms of life. Cell is referred to as the basic unit of life which is a microscopic structure. It remains almost same in all except for in few specialized forms and comprises of almost similar functions. It is also confirmed that a single cell can perform all the activities as a multicellular organism in which the cells are grouped and differentiated into tissues and organs. A cell comprises of few basic structures which include- nuclei, cytoplasmic matrix, plastids, mitochondria, endoplasmic reticulum, golgi apparatus, plasma membrane etc, all with regulated functions at molecular level. Biochemists have found that cells comprise of all the elements of inorganic world organized into more complex molecules such as proteins, fats, polysaccharides and nucleic acids.

With the advent of Electron microscope, the sub cellular organization of a cell upto molecular level was made possible. Apart from these methods of cell fractionation has paved the way for separating cell organelleles and these have led to the branches of Biochemistry and Molecular Biology. Various levels of organization of biological structures are mentioned in the following table:

	Dimensions	Biological field	Structure	Method of study
1	0.1mm or 100μm or larger	Anatomy	Organs	Eyes and simple lenses
2	100μm to 10μm	Histology	Tissues	Various types of light microscopes, x-ray microscope
3	10μm to 0.2μm (200nm)	Cell Biology	Cell, Bacteria	
4	200nm to1nm	Submicroscopic morphology	Cell components, Viruses	Polarization microscopy, Electron microscopy
5	Smaller than 1nm ($10A^{o}$)	Ultra structure molecular and atomic structure	Arrangements of atoms	x-ray diffraction

History of Cell Biology: It dates back to 384-322 B.C, during which the Greek Philosophers such as Aristotle and Paracelsus have concluded that “all animals and plants, however, complicated, are constituted of a few elements which are repeated in each of them”. Many

centuries later, magnifying lenses were discovered which allowed viewing microscopic structures of plant parts. Da Vinci (1485) recommended use of lenses for viewing small objects. With the developments in optical lenses and construction of compound microscopes, development of the field of cell Biology took place.

Francis Janssen and Zacharias Janssen invented the first useful microscope in 1590 that had a magnifying power of around 10X to 30X. In 1610 Galilio Galilei (1564-1642) invented simple microscope with a single lense that could be used to view the compound eye of insects. Later, Italian Micro anatomist Marcello Malphighi (1628-1694) was the first to use simple microscope to observe slices of animal tissues. He also studied plant cells and referred to the structural units as 'Utricles'. Robert Hooke (1635 -1703), the English Microscopist has coined the term, "Cell" in 1655, (L., Cella= Hollow space), after this observation of slices of dried cork (Figure1). The cells in the fork are the empty spaces left after disintegration of living matter of the cells. Dutch Microscopist, Anton Van Leeuwen Hoek (1632 – 1723), had succeeded in improving the art of polishing lenses and the magnification could be improved to 300X (figure 2). He was the first to observe free living cells. He collected rain water into tubes that were inserted in soil, and this was used for his microscopic studies. His sketches of microorganisms include many bacteria, protozoan's, rotifers, hydra etc. He also extended his studies and described sperm cells of human, dogs, rabbits, fish etc., and he also observed movement of blood cells of mammals, birds, amphibians and fish. He observed the central body of a cell (nucleus) in various shapes which was revealed in his writings to the royal Society of London during 1675-1683. Nehamiah Grew (1641- 1721) studied sections of plants, flowers, roots, stems etc. in 1831, English Botanist Robert Brown (1771- 1858), discovered nucleus and named it so. 19^{th} century has witnessed various inventions in Cell Biology that led to the formulation of theories such as cell theory and protoplasm theory.

Figure 1. Image of hollow spaces in dried cork

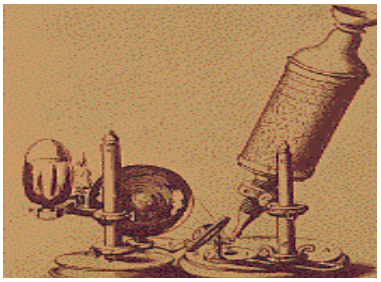

Figure 2. Compound microscope used by Anton Van Leeuwen Hoek

Theories of cell formation:

1. Cell theory: Mathias Jacob Schleiden and Theodor Schwan, 1839 postulated that the cell is the basic unit of structure and function in all forms of life. Schleiden was the first to describe the nucleoli, and stated that each cell leads a double life, one which involved its own development and the other as an integral part of multicellular plant. Schwann studied both plant and animal tissues that led to modification of cell theory to include the idea that living things are composed of both cells and the products or secretions of the cells. He introduced the term metabolism to describe the activities of the cells.

K.Nageli (1817-1891) showed in 1846, that plant cells arise from the division of pre-existing cells. German Pathologist Rudolf Virchow (1821- 1902) confirmed Nageli's proposal of cell life's continuity. Virchow established the significance of cell division in the reproduction of organisms. He also established that cells were the primary sites of disease and cancer. In 1865, Louis Pasteur (1822- 1895) gave practical evidence in support of Virchow's extension of cell theory.

Modern version of Cell Theory:

1) All living organisms are made up of one or more cells and cell products.
2) All metabolic reactions in unicellular and multi cellular organisms take place in cells.
3) No cell can originate spontaneously de novo, but only from previously existing cells.
4) The smallest defined unit of life is the cell.

With further advancements in techniques, sub-cellular structures such as ribosomes, lysosomes, mitochondria, chloroplasts etc., indicated that cell is not the only basic unit of cell.

Exception to cell theory:

All kinds of cells share the three characteristics mentioned below:

1) Cell activities and replication are regulated by a set of genes.
2) Plasma membrane regulates exchange of materials of cells with outside environment.
3) Metabolic machinery is involved in sustaining all activities of life like growth, reproduction and repair of parts.

These do not apply for viruses which reproduce inside the host cells. But they definitely carry all the genetic material required for their organization and reproduction. Even organisms such as the Protozoans Paramecium, the fungus Rhizopus and the algae Vaucheria, do not fit the above hypothesis as they lack cell sort of definite organization.

Protoplasm theory:

With the increase in knowledge about subcellular components, emphasis was given to contents of protoplasm. Felix Dujardin (1835) coined the term "Sarcode" to refer jelly like substance in Protozoans. Czech Biologist J. E. Purkinje coined the term protoplasm and Von Mohl (1846) used the above term to describe contents of animal embryonic cells. In 1892, O.Hertiwig came up with Protoplasm theory. The theory states that all living matter, out of which animals and plants are formed, is the protoplasm. The cell accumulates it and is limited by an outer membrane and has a nucleus inside. The protoplasm in nucleus is called as the Nucleoplasm while that which exists between nucleus and outer membrane is called the Cytoplasm. With the advent of techniques like Electromicroscopy, X-ray diffraction, Immunochemical and cytochemistry, Ultra centrifuge etc., and even freeze fractionation, micro manipulation, chromatography, electrophoretic and spectrophotometric techniques, the world of cell was explored. This has resulted in another new theory called **Organismal theory.**

Organismal theory:

This theory states that multicellular organisms have a continuous mass of protoplasm which remains divided incompletely into cells for performing biological activities. This theory fails to answer the phenomenon of viral replication.