**DEFINITION OF CELL BIOLOGY**

* **The biological science which deals with the study of structure, function, molecular organization, growth, reproduction and genetics of the cells, is called cytology or cell biology**.
* **(Gr., *kytos* = hollow vessel or cell; *logous* = to discourse)**
* Study of structures and functions of specialized cells.
* The results of these studies are used to formulate the generalization applied to almost all cells as well as to provide the basic understanding of how a particular cell type carries out its specific functions.
* The cell biologist, without losing sight of the cell as a morphologic and functional

unit within the organism, has to study biological phenomena at all levels of organization and to use all the methods, techniques and concepts of other sciences.

* **Cell biology** interpreted the cell in terms of molecules (macromolecules

such as nucleic acids and proteins).

**HISTORY OF CELL BIOLOGY**

Ancient Greek philosophers

* **Aristotle** ( 384 —322 B.C.) and **Paracelsus :** concluded that “all animals and plants, however, complicated, are constituted of a few elements which are repeated in each of them.”

(macroscopic structures of an organism such as roots, leaves and flowers common to different plants, or segments and organs that are repeated in the animal kingdom).

* .**Da Vinci** (1485) recommended the uses of lenses in viewing small objects.
* In 1558, Swiss biologist,**Conrad Gesner** (1516—1565) published results of his studies on the structure of a group of protists called **foraminifera**.
* His sketches of these protozoa included so many details that they could only have been made if he had used some form of magnifying lenses. Perhaps this is earliest recorded use of a magnifying instrument in a biological study.
* Construction of the **compound microscopes** (Gr., *mikros* = samll; *skopein*= to see)
* **Growth of cell biology during 18th century:**
* The first useful compound microscope,
* invented in 1590 by **Francis Janssen** and **Zacharias Janssen**.

Their microscope had two lenses and total magnifying power between 10X and 30X. Such types of microscopes were called “**flea glasses**”, since they were primarily used to examine small whole organisms such as fleas and other insects.

* The term CELL coined by an English microscopist **Robert Hooke** (1635—1703) in 1665.
* (L., *Cella* = hollow space)
* Examined a thin slice cut from a piece of dried cork under the compound microscopes which were built by him.
* In 1665, **Hooke** published a collection of essays under the title *Micrographia*.
* One essay described cork as a honey comb of chambers or “cells”.
* The chambers or cells are now recognized to be empty spaces left behind after the living portions of the cell had disintegrated.
* **Hooke** thought of the cells, he observed as something similar to veins and arteries animals—they were filled with “juices” in living plants
* Dutch microscopist, **Anton van Leeuwenhoek** (1632—1723)
* first to observe living free-living cells
* **Growth of Cell Biology during 19th Century**
* Nineteenth century witnessed various cell biological inventions and formulations of various
* landmark theories such as cell theory and protoplasm theory.
* In 1807, **Mirbel** stated that all plant tissues were composed of cells.
* French biologist, **Rene Dutrochet** (1776—1827) correctly concluded in 1824, that all animal and plant tissues were “aggregates of globular cells.”
* In 1831, an English botanist **Robert Brown** ( 1773—1858) discovered and named the **nucleus** in the cells (*e.g.*, epidermis, stigmas and pollen grains) of the plant *Tradescantia*.
* He established that the nucleus was the fundamental and constant component of the cells.

**THE CELL THEORY**

* In 1838, a German botanist **Mathias Jacob Schleiden** (1804—1881) put forth the idea that cells
* were the units of structure in the plants
* In 1839, his coworker, a German zoologist , **Theodor Schwann** (1810—1882) applied Schleiden’s thesis to the animals.
* Postulated : cell isthe basic unit of structure and function in all life.
* This simple, basic and formal biological generalizationis known as **cell theory** or **cell doctrine**.
* In fact, both **Schleiden** and **Schwann** are incorrectly creditedfor the formulation of the cell theory; they merely made the generalizations which were based on the works of their predecesors such as **Oken** (1805), **Mirbel** (1807), **Lamarck** (1809), **Dutrochet** (1824),
* **Turpin** (1826), etc., (see **Sheeler** and **Bianchi**, 1987).
* However, **Schleiden** was the first to describe the **nucleoli** and to appreciate the fact that each cell leads a double life—one independent, pertaining to its own development, and another as integral part of a multicellular plant.
* **Schwann** studied both plant and animal tissues and his work with the connective tissues such as bone and cartilage led him to modify the evolving cell theory to include the idea that living things are composed of both cells and the products or secretions of the cells.
* **Schwann** also introduced the term **metabolism** to describe the activities of the cells.
* In the coming years, the cell theory was to be extended and refined further.
* **K. Nageli** (1817—1891) showed in 1846 that plant cells arise from the division of pre-existing cells. In 1855, a German pathologist **Rudolf Virchow** (1821—1902) confirmed the Nageli’s principle of the cellular basis of life’s continuity.
* He stated in Latin that the cells arise only from the pre-existing cells (*viz*., his actual
* aphorism was *“omnis cellula e cellula”* —every cell from a cell). **Virchow**, thus, established the significance of cell division in the reproduction of organisms.
* In 1858, **Virchow** published his classical textbook *Cellular Pathology* and in it he correctly asserted that as functional units of life, the cells were the primary sites of disease
* and cancer.
* Later , in 1865, **Louis Pasteur** (1822—1895) in France gave experimental evidence to support Virchow’s extension of the cell theory.
* The modern version of cell theory states that

**(1) All living organisms (animals, plants and microbes) are made up of one or more cells and cell products.**

**(2) All metabolic reactions in unicellular and multicellular organisms take place in cells.**

**(3) Cells originate only from other cells, *i.e.*, no cell can originate spontaneously or *de novo*, but comes into being only by division and duplication of already existing cells.**

**(4) The smallest clearly defined unit of life is the cell.**

* The cell theory had its wide biological applications.
* With the progress of biochemistry, it was shown that there were fundamental similarities in the chemical composition and metabolic activitiesof all cells.
* **Kolliker** applied the cell theory to embryology—after it was demonstrated that the organisms developed from the fusion of two cells—the spermatozoon and the ovum.
* However, in the recent years, large number of sub-cellular structures such as ribosomes, lysosomes, mitochondria, chloroplasts, etc., have been discovered and studied in detail. Consequently, it may appear that cell is no longer a basic unit of life, because life may exist without cells also.
* Even then, the cell theory remains a useful concept.

**Exception to cell theory.**

Cell theory does not have universal application, *i.e.*, there are certain living organisms which do not have true cells.

All kinds of true cells share the following three basic characteristics:

1. A **set of genes** which constitute the blueprints for regulating cellular activities and

making new cells.

2. A limiting **plasma membrane** that permits controlled exchange of matter and

energy with the external world.

3.A **metabolic machinery** for sustaining life activities such as growth,

reproduction and repair of parts.

**Viruses** do not easily fit in these parameters of a true cell. Thus, they

lack a plasma membrane and a metabolic machinery for energy production and for the synthesis of proteins.

However, like any other cellular organism, viruses have

(1) A definite genetically determined macromolecular organization;

(2) A genetic or hereditary material in the form of either DNA or RNA;

(3) A capacity of auto-reproduction; and

(4) A capacity of mutation in their genetic substance.

* In consequence, viruses can only reproduce inside the host cells which may belong to animals, plants or bacteria.
* They use their own genetic programme for reproduction but rely on the raw materials (*i.e*., amino acids, nucleotides) and biosynthetic machinery of the host cells ( *i.e.*, ribosomes, tRNA,
* enzymes) for their multiplication.
* Thus, a virus may be defined as an infectious, subcellular and ultramicroscopic particle representing an obligate cellular parasite and a potential pathogen whose reproduction (replication) in the host cell and transmission by infection cause characteristic reaction
* in the host cells. Outside the host cells, viruses are just like non-living inert particles and like the salt or sugar, they can be purified, crystallized and placed into jars on a shelf for years.
* Due to this fact, viruses have been variously described such as “*naked genes that had somehow acquired the ability to* *move from one cell to another* (**Alberts** *et al.*, 1989), or as “*cellular forms that have degenerated* *through parasitism*”, or as *“primitive organisms that have not reached a cellular state.*”

**Protoplasm Theory**

* Up to middle of the 19th century, greater emphasis was given to the cell wall and less to the cellular content.
* Protoplasm theory holds that all living matter, out of which animals and plants are formed, is the protoplasm.
* The cell is an accumulation of living substance or protoplasm which is limited in space by an outer membrane and possesses a nucleus.
* The protoplasm which is filled in the nucleus is called **nucleoplasm** and that exists between the nucleus and the plasma membrane is called **cytoplasm**.

**Growth of Cell Biology in 20th Century**

Presently, both of these theories have been replaced by another new theory called **organismal theory**.

**Organismal Theory**

* The organismal theory holds that the body of all multicellular organisms is a continuous mass of

protoplasm which remains divided incompletely into small centres, the cells, for the various biological

activities.

* Thus, a multicellular organism is a highly differentiated protoplasmic individual, differing

with a unicellular Protozoa only in size and degree of differentiation of the protoplasm.