# **4. CELL BIOLOGY**

All organisms in the universe are made up of cells. CELL is basic unit of life. It was first descovered oy Robert Hooke.

All cells are basically alike in chemical compo- i s'or aro metabolic activities. The function of an a^ar sr. as a whole is the out come of the activities and interactions of the constituent-cells. As the cell is microscopic, it can be viewed with the help of instruments which magnify the object several times. Among those compound micro-scope can magnify the object 1,00,000 times. Instead of using ordinary light, electrons are passed through, the object. These electrons are condensed by EI§ctro-Magnets, and the image is made to fall on flourescent screen. The only defect is, one can not see living objects by this microscope.

To see the object under Microscope, jt must be very thin sometimes 1/100th m.m. 7b cut into minute thin slices, an instrument called Microtone is used and to measure the Microscope objects, an instrument called Micrometer is used.

Each cell acts as an autonomous unit. It inde-pendently carries out all fundamental biological processes. It oxidises food molecules to produce energy and utilises that energy and some nutrient molecules to synthesize complex molecule. The cells use these molecules to build up new struc-, lures and to replace those worn out. For example blood cells are continuously destroyed and re-placed by fresh one produced in the bone marrow.

In a multicellular organism, cells do not normally live a totally independent existence. They interact and co-operate with one another. Thus they develop a division of labour. The human body has trilions of cells. All divide from the fertilised ovum and carrying the same genetic material

The ultra structure of a cell, can be revealed with the help of an electron Microscope. A typical euncaryotic cell consists of a mass of jelly like translucent protoplasm, enclosed by a plasma membrane. In plants the plasma membrane is surrounded by a rigid and porus cellulose cell wall. It is absent in Animal cell.

The general fluid mass of the cell outside the nucleus makes cytoplasm. The cytoplasm contains several organella.

## Cell Wall:

Gives rigidity, shape and mechanical support to the cell. It is permeable to water, gases, and mineral salts. It is present in plant cells, bacteria, fungi. It is composed of cellulose material.

### PLASMA MEMBRANE:

It is selectively permeable that is, it regulates the movement of materials across it. This membrane consists of two outer layers of proteins and a middle layer of phospholipids. It is termed as "Unit membrane".

# **PROTOPLASM:**

It is the physical basis of life. It consists of 75 to 85% of water.

#### **NUCLEUS:**

It is the principal organelle of the cell. .It, is the dynamic centre of the cell. It is a dense, round or irregularly shaped body. It controls all. cellular metabolic activities. It intiates cell division. It is responsible for heridity.,

Nucleus is surrounded by a double membrane layer called the nucleuar envelope. It consists of two layers seperated by peri nuclear space. It is continous with lumen of the Rough Endo-plasmic reticulum. Nuclear envelope disappears during cell division and again reappears around two daughter nuclei.

There is a semifluid substance called nudoplasm or karyoplasm, one or more round bodies called nucleoli and a net work of dark staining fibres called the Chromatin reticulum is present in Nucleoplasm.

During cell division, this chromatic reticulum condenses to distinct threads called Chromo-somes.

Chromosomes are largely made of proteins. Every chromosome shows a constricted part called centromere. Chromosomes bear the genes. Each gene is composed of one,or more DNA (Deoxy Ribo Nucleic Acid).

### The nucleus has two major functions:

- 1. The contained genetic information is passed to the daughter cell.
- 2. Controling cellular activities.

It dictates what enzymes are to be formed through the formation of RNA. Nucleolus is the site of extensive RNA synthesis. It is also concerned with the synthesis of Ribosomes.

#### **Cytoplasm**:

The term cytoplasm is used for the jelly-like fluid general mass of protoplasm excluding the nu-cleus. It contains cell organells vitamins, enzymes, minerals, sugars, aminoacids etc.The various cell organelles are Endoplasmic reticulum, Ribosomes, Golgicomplex, Lysosomes, lentrioles (only in Animal cell) Mitochondria, plastids (Only in plant cells).

#### **Endoplasmic Reticulum (ER):**

It consists of an inter communicating system of channels made of membrane sacs (cisternae), tubules and vesicles. It extends from nuclear envelope to plasma



Add. 41-42A, Ashok Park Main, New Rohtak Road, New Delhi-110035 +91-9350679141 membrane thus giving me-chanical support to the colloidal cytoplasm; It -Acts as a circulatory system for intra cellular (with in the cell) transport of various substances.

It contains many enzymes and other proteins. Two kinds of endoplasmic reticulums are ob-served in cells. One is Smooth Endoplasmic Reticulum (SER) and other Rough Endoplasmic Reticulum (RER)). RER has membranes with ribosomes attached to the cytoplasmic surface. The function of S'ER is to synthesize lipids and sterols and RER is concerned with synthesis of proteins as it posseses Ribosomes.

## **Golgi Complex or Dictyosomes:**

It consists of one or more stacks af flat inter communicating, cisternae. A cisterna is a fluid <sup>r</sup> ed lumen enclosed by a single smooth mem- Drane. Cisternae are curved, shallow Lovwls. It is abundant in glandular cells. Endoplasmic reticu- um is the seat of origin of Golgicomplex.

Secretion is the main function of- golgibodies. It synthesizes cell wall materials, glycoprotein, -: .cc pds, gums etc. Golgi vesicles also form the ce p ates after cell division in plants.

# LYSOSOMES:

Lysosomes are Enzyme filled small spherical bodies originate from golgi complex. Lysomoes are concemed with intracellular digestion. It c not orry food materials and foreign particles but also various useless cells organelles.

## **Plastids** :

These are concerned with synthesis and storage cr feod materials. It is of 3 types.

- (a) Luecoplasts colourless plastids which store food materials.
- (b) Chromoplasts Coloured plastids meant for attraction, present in petals and ripe fruits.
- (c) Chloroplasts Green plastids which syn-thesize food materials by photosynthesis.

Chloroplast contains the- green .pigment chlorophyll. Chloroplasfs are covered by double membrane, containing a. space filled with a col-ourless proteineceous matrix called stroma. The stroma contains a small circular double helical DNA, Ribosomes and several enzymes. Many flat, membranous structures, called Thylakoids occur.in stroma. They are .placed'one above.the other like a stack of coins to form a granum. The main fuction of the chloro'plast is to trap solar energy and convert it into chemical bond energy in photosynthesis.

## Mitochondria:

Also called as power houses of the cell or cellular furnaces, since energy, is generated in it. It is mainly concerned with transduction of energy from food materials to energy rich ATP (Adeno- cine tri phosphate) which stores it and it releases energy whenever, the cell requires.

Mitochondria is enclosed by a double membrane envelope. The two membranes of the envelope are separated by a narrow fluid filled space called outer compartment which contains some en-zymes. The inner membrane surrounds a central cavity or matrix filled with fluid.

Inner membrane projects into finger like appear-ances called CRISTAE which bear numerous particles called F<sub>1</sub> particles.

Mitochondria serve as compartments -for aerobic respiration.

### **Ribosomes:**

Cell organell concerned with protein synthesis Ribosomes are synthesized in the nucleolus and enter into the cytoplasm where they remain freely in the cytoplasm or attached to the Endoplasmic Reticulum. About 6 to 8 ribosomes become attached to an mRNA (messenger Ribo Nucliec acid) molecule to form beaded string called polysome or polyribosome.

### Micro bodies:

These are spherical or oval vesicles enclosed by a membrane and are filled with a fluid matrix.Peroxisomes are microbodies in liver ceils. They prevent peroxides from acting on the cellular contents. Glyoxisomes are microbod es in the cells of germinating fatty seeds. **Centrjoies :** 

These are non-membrane organelles found in animal-and in flagellated plant cells. These occur in pairs, at right angles to one another near one pole of the nucleus. Each centriole is made of nine triplets of microtubules. The - centrioles separate and migrate to opposite poles during cell division from where they function as centres for the organisation of the spindle.

Centrioles are involved in the organisation and development of cilia and. flegella.

## Vacuoles :

These are sap filled vesicles in the cytoplasm, covered by a membrane called "TONOPLAST". This sap contains .minerals, sugars, aminoacids, protein, esters water soluble pigments and waste products in solution. In mature plant cells, vacuoles fuse to form one large central vacuole. Some protozoan cells contain contractile vacuoles which are meant for excretion and Osmoregulation.

## **Ergastic Substances:**

The non-protoplasmic inclusions of a cell which are non-living are called ' ergastic substances. They are



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#### Mote :

- 1. The reserved food materials like carbohy-drates, nitrogenous matters, fats and oils are stored in the cells for futureuse.
- 2. Secretory materials include pigments, nectar and enzymes.
- 3. Excretory materials produced as a by product during metabolic activities of the cell.

## CHROMOSOME

The rod like bodies found in nuclear region during cell divi-sion are called chromosomes. Man has 23 pairs of Chromo-somes or 2 sets of genomes or 46 chromosomes.

In Eucaryotic cells 2 types of chromosomes are present. Sex chromosomes which de-termine sex of the organism and second one is autosomes or somatic chromosomes.

Each chromosome consists of 2 Chromatids which remain attached to a point called centro-mere. Each chromosome basically consists of DNA and basic proteins called histones.

# DNA (Deoxy Ribonucleic Acid) :

DNA is mainly found in nucleus' and it. also occurs in chloroplast and mitochondria. It is the genetic material and contains all the information needed for the development and existence of an organism.

It is located by means of Feulgen staining tech-nique which Is specific for DNA.. "Watson, and Crick" were able to corordinate all the known facts of DNA into a model and proposed a right handed double helix model.

DNA consists of two poly nucleotide strands which are coiled helically in clock-wise direction. DNA is a linear polymer of "PURINE" and "PYRAMiDINE" nucleotides. A . nucleotide is nothing but a nucleoside attached to a nitrogen base. A nucleoside is inturn a linkage of sugar and phosphate radical. In DNA, the sugar molecule is deoxy ribose sugar. It is different from RNA in not having an oxygen molecule (in RNA, the sugar molecule is ribose sugar).

Sugar molecule + Phosphate radical  $\rightarrow$ 

Nucleoside

Nucleoside + Nitrogen base Nucleotide.

Such nucleosides in large numbers form a poly nucleotide strand.. Such two strands which are anti parallel coil together to form DNA.

There are 4 nitrogen- bases in. DNA.

- (a) Adenine. (A) (b) Thymine (T)
- (c) Guanine (G) (d) Cytosine (C)

Adenine and guanine- are purines ehd Thymine and cytosine are pyramidines. A purine is always paired with pyramidine. That is Adenine always pairs, with Thymineand Guanine is always pairs with Cytosine. This complementary is known as Base - pairing rule.

A polynucleotide strand of sugar and phosphate radicals are linked alternately to form external back bones. In between the sugar molecules of two back bones, nitrogen bases are arranged in the form of steps. The nitrogen bases are inter connected by week hydrogen bonds.

The DNA molecule is the most unique molecule in the living world. It is the only molecule that can replicate itself.

# **RNA (Ribo Nucleic Acid) :**

It is found in all living cells. RNA, is synthesized mostly in nucleus but moves out into the cyto-plasm. RNA is responsible for transmitting the information from the nucleus to the ribosomes where protein - synthesis occurs. RNA is single stranded, consists of only one polynucleotide strand.

There are 3 types of RNA

- (a) Ribosomal RNA or Y RNA found in the Ribosomes where protein synthesis occurs-
- (b) Messenger RNA or'm' RNA which is produced in the nucleus and carries the information,for the synthesis of proteins. For each protein there is specific 'm' RNA.
- (c) Transfer RNA is RNA. Its role is to collect aminoacids from the cytoplasm for protein synthesis.

**The Golgi Apparatus :** It is a membranous cell organelle composed of flattened sac-like cisternae stacked on one another. These cisternae resemble the smooth endoplasmic reticulum. While most of the eukaryotic cells posses Golgi apparatus, many fungi and some protozoans L-tck well-formed golgi bodies. The important function of the Golgi apparatus is to prepare for secretions. The material to be secreted moves from the ER to the Golgi apparatus during which vesicles arc budded off from the endoplasmic reticulum. Most proteins iliat are syntnesised at the endoplasmic reticulum 'are glycoproteins. These glycoproteins are transported to the Golgi apparatus and are modified there. The Golgi apparatus then sends the modified proteins to different locations by enclosing these proteins in vesicles that bud off from the Golgi apparatus.

**Lysosomes:** These are small vesicles that bud off from the Golgi apparatus. They contain some digestive enzymes. The Lysosomes are bound by a single membrane. These digestive enzymes are synthesised on the rough endoplasmic reticulum (RER) and packed into the Lysosomes. Sometimes, the cell may also digest a part of its own cytoplasm in a type of secondary lysosome called autophagic lysosome. Since the autophagic lysosomes sometimes digest a part of their own cell and its cytoplasm, they are called the suicide bags of the cell.



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