The Cell

The cell is a structural and functional unit of life. All animals and plants are made up of a large number of such units, in a manner to the utilization of bricks in the construction of a building Living cells are divided into two groups, Le, the prokaryotic cells and the eukaryotic cells. As their name suggests (proprior to: karyot nucleus; cu= true), the fundamental difference between them is the absence or presence of a true nucleus.

PROKARYOTIC CELLS

The simplest form of the cell is a prokaryotic cell. Prokaryotes, e.g. bacteria are unicellular and have one of the three basic shapes, viz, spheroidal (Cocci), rodlike (Bacilli) and helically-colled (Spirella).

A prokaryotic cell is small in size (1 to 10 nm), relatively simple in structure and has only a single membrane, called cell membrane, which is usually surrounded by a rigid cell wall of characteristic structure.

There may or may not be a surrounding capsule.

Besides, there is a single chromosome comprised of a molecule of double helical DNA which is densely coiled to form a nuclear zone.

Reproduction is by asexual division. The best characterized prokaryotic cell is Escherichia coli. Some prokaryotes possess pili and flagella for adhesion and movement, respectively .

Organelles of Prokaryotic Cell

Cell Wall

Found only in prokaryotic cells Surrounds the plasma membrane Gives the cell its shape

Prevents bursting when turgid pressure is high Helps anchor appendages like pili and flagella Composed of cellulose microfibers which form a thick wall

. Grows with the cell

Helps the cell maintain osmotic balance.

Plasma Membrane

Found in both prokaryotic and eukaryotic cells.

. Encloses the interior of the cell Regulates the flow of material in and out of the cell.

Ribosomes

70S ribosome is made up of 50S and 305 components

Translates the genetic code from the DNA to make proteins: They can be either free or attached to endoplasmic reticulum.

Nucleoid

There is no clear nuclear cytoplasmic difference

Not a membrane bound nucleus.

An area of the cytoplasm where the strands of DNA are found.

Pili

Small hairlike projections emerging from the outside cell surface Assists in the cell attaching to other cells and surfaces. Thus helps in pathogenic organisms to stic surface.

Flagella

⚫ Flagella are hairlike structures that allow the cell to move by beating in a propeller-like motion

⚫They help bacterium move toward nutrients, away from toxic chemicals, etc.

EUKARYOTIC CELLS

Animals, plant, fungi and protozoa are called eukaryotes which may be unicellular or multicellular.

Eukaryotic cells are one to ten thousand times large in size and are more complex in structure than th prokaryotic cells.

They may vary from one tissue to another with respect to their functions, e.g. the liver parenchymal cell adipose cell, nerve cell renal tubular cell, white blood cells.

⚫ Generally, a eukaryotic cell has a well-defined membrane-bound nucleus containing several chromosome Their chromosomes undergo replication of DNA during mitosis and get separated into daughter chromosomei.e. these cells reproduce by cell division. A typical eukaryotic cell contains various organelles such as nucleus, endoplasmic reticulum, Golgiapparatus, ,

mitochondria.tc.

Major differences between prokaryotic and eukaryotic cell structures are

Parameters	Prokaryotic	Eukaryotic

STRUCTURE AND FUNCTIONS OF INTRACELLULAR COMPONENTS

THE NUCLEUS

The lugest component of the cell, containing DNA organized into separate chromosome

by a membrane called nuclear membrane.

The nuclear membrane consists of two layers which are separated by an intermembrane space termed as perinuclear space. The outer membrane though is continuous with the endoplasmic reticulum but the two of the nuclear membrane are fused together at several places producing nuclear pores for the exchange of material between the nucleus and the cytoplasm.

The nucleus is filled with the nucleoplasm which has a discrete body called nucleolus and a thread-like structures called chromatin.

The nucleolus

The number of mucleoli may vary from one cell type to another. The genes for three of the mal &NA molecules are located in the nucleolus. Nucleoli are rich in RNA and disappear

• Chromatin à contains most of the cellular DNA in association with basic proteins, termed histones At the timeof celldivision, the chromatin is organized into small thread-like structures called chromosomes

Humans somatic cell 23 pairs of chromosomes.

Important Functions of the Nucleus

Control of cell division (DNA replication)

• Protein synthesis by controlling the synthesis of RNA) The region of DNA synthesis and other functions of the nucleus are severely disturbed in some pathological conditions such as cancer

DNA and DNA polymerase are the markers of the nucleus.

THE ENDOPLASMIC RETICULUM

Endoplasmic reticulum is a system of membranes (lipid bilayer structures) with a network of vesicular spaces This network is present throughout the cytoplasmic matrix and grows by its own synthesis. These membranes run parallel to each other creating channels which are called cisternae. The interior of the endoplasmic reticulum thus is well connected with perinuclear spaces and through pores on the cell surface, with the extracellular space. Cisternae have a role in the exchange of materials between the cell and the extracellular fluid. The surface of the endoplasmic reticulum may or may not bear ribosomes. Accordingly, endoplasmic reticulum is of two types:

⚫ Rough endoplasmic reticulum (RER): It is also called the granular type of endoplasmic reticulum since it has small granules attached to it. These granules are termed as ribosomes. Smooth endoplasmic reticulum (SER): It is also called the agranular type of endoplasmic reticulum since it consists of the membranous structure only and does not contain ribosomes on its outer surface The SER has enzymes for the biosynthesis of lipids and glycoproteins. Further, SER are very important in hepatocytes where these are primarily concerned with oxidative metabolism and for the detoxification of many drugs and other toxic organic molecules.

Glucose-6-phosphatase is a marker enzyme for the endoplasmic reticulum.

THE RIBOSOMES

Ribosomes consist of ribonucleoprotein particles of two sizes, Le: 505 and 305 in prokaryotes or 605 and 405 in eukaryotes. Because of their high RNA content, ribosomes are the site of protein synthesis. Ribosomes on the RER are associated with the synthesis of proteins for export from the cell.

Free ribosomes, on the other hand, are present in the cytoplasm and synthesize proteins for use within the cell.

⚫ RNA is used as a marker for the ribosomes.

THE GOLGI APPARATUS

The Golgi apparatus is a smooth membrane system with vacuoles. It is rich in lipids and is

considered to be the site where secretions from other organelles are brought and assembled.
⚫The newly synthesized proteins are also transferred from RER and stored in the Golgi apparatus. temporarily.

Some of the synthesized proteins also undergo post-translational modifications within the Golgi apparatus and thereafter, are transported to different destinations. The Golgi apparatus is thus especially active in cells which produce proteins for export. They form secretory granules for the proteins after their synthesis on the ribosomes.

Galactosyl transferase is a marker enzyme for the Golgi apparatus.

THE MITOCHONDRIA

The mitochondria are the major organelle of a eukaryotic cell lacking any direct structural relationship with other organelles and contain its own DNA .

A mochondrion produces energy in the Form of ATP (adenosine triphosphate) for the cellular functions and is thus called ava power house of the cell. This depending upon energy requirement of the cell, mito Chodria may vary in stre, shape and number from cell to cell

Besides producing energy, mitochondria also help to control the level of calcium in the cytoplasm.

Mitochondrial Membrane

Its a double-layered structure where the two layers are separated from each other by 50-100 A intermembrane space Several enzymes especially those involved in the nucleotide metabolism are located here. The outer membrane of the mitochondria has a smooth structure. It is composed of both lipids and proteins and is freely permeable to most of the small molecules. Several enzymes involved in lipid metabolism, such as the enzymes for fatty acid elongation, glycerol phosphate acyltransferase and phospholipase A, are associated with the outer membrane of the mitochondria. The inner membrane of the mitochondria has a denser structure. It has more proteins than lipids. The inner membrane has extensive irregular foldings, called cristae. Cytochromes, the enzymes of electron transport chain and flavoproteins are localized within the inner membrane of the mitochondria..

Matrix

The intra-mitochondrial space (enclosed within the inner membrane) is called mitochondrial

matrix. This chamber contains enzymes for B-oxidation of fatty acids, citric acid cycle and glutamate dehydrogenase. In addition to, mitochondria also have DNA, referred to as mtDNA (mitochondrial DNA).

Mitochondrial DNA: Mitochondria are the only cellular organelles that contain their own chromosomal DNA (mtDNA), which is maternally inherited. Human mtDNA is a small double stranded circular molecule (about 16,000 base pairs), encoding 13 polypeptides that are integrated into the inner mitochondrial membrane along with other polypeptides encoded by nuclear genes. In addition, it encodes 2 rRNAs and 22 tRNAs that are used in protein synthesis within the organelle, mtDNA differs from nuclear DNA in several aspects.