in the field of medicine because of the fact that it is forming a **major tool in explaining the development of disorders and diseases in the body;** that is why, one finds sophisticated latest update biochemical instruments like **PCR, gas liquid chromatography, atomic absorption spectrophotometer, autoanalysers, radioisotope laboratory, tissue culture laboratory, etc.** in the well established good departments/sections/units of biochemistry. The knowledge of biochemistry has been able to pinpoint the exact site of the disorder and to give a clue towards the line of treatment in most of the diseases. **The new offshoot of biochemistry i.e. genetic engineering is flourishing like anything in the Western advanced countries like U.S.A., U.K., Germany, France, Japan, etc. which may bring solution of several disorders like those of hereditary disorders and other incurable diseases, the treatment of which is not possible at the moment. Scientists and doctors are working day and night in these countries to synthesize genes responsible for various genetic defects but unfortunately in our own country, this science is still lagging behind. It is a cause of serious concern to the Government of India.**

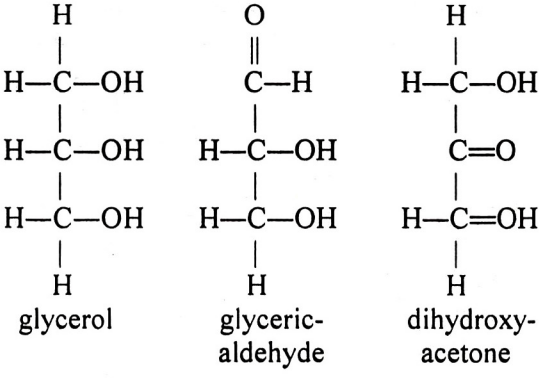
Hereditary diseases, which are considered to be incurable at present might be easily controlled or treated satisfactorily in the near future by simply changing the nature of the particular gene(s) responsible for the causation of such disease(s). **Attempts are being made to synthesize genes biochemically. Success in this field is bound to bring revolutionary, miraculous changes in the world of life-sciences.** Genes are the carriers of hereditary characters. After the synthesis of newer genes, it might be quite possible to produce off-springs of ones own choice. Suppose, then, if someone wishes a wrestler, or an athlete or a gymnast or a tall fellow, or a very intellectual one, it would be quite possible to have it. This also means that the usage of genes for the betterment of mankind may also be misused by someone, hence, care must be taken for its 'use' and not 'misuse'; therefore the Governments must enact some law(s) in future for the use of **'genes'** and the power of its usage should never be vested in a single hand (single doctor), rather in a board comprising of atleast 5-7 highly qualified specialists of that field.

Dr Har Gobind Khorana, India born Chemist, turned into a Biochemist, now-a-days settled in U.S.A. (a permanent citizen of U.S.A at present) is working for more than a quarter century on DNA and the synthesis of genes for which he was awarded the most prestigious award i.e. ***"Nobel Prize"*** **in the year 1968.**

The knowledge of biochemistry is also being extensively used in the field of diagnosis of diseases. Estimations of the levels of biogenic compounds and enzymes in the circulating blood/urine have been proved to be of valuable guidance to the Physicians/Surgeons in making the diagnosis of diseases, for instance, blood sugar level gets elevated in diabetes mellitus, blood urea and creatinine levels get raised in nephritis, serum calcium level gets elevated in hyperthyroidism and gets decreased in infantile tetany, serum inorganic phosphorus gets decreased in rickets, serum cholesterol level gets elevated in nephrosis, diabetes mellitus, obstructive jaundice, myxoedema and xanthomatosis and may be decreased in *hyperthyroidism,* level of enzyme acid phosphatase gets increased in the carcinoma of prostate glands, serum glutamic oxaloacetic transaminase (GOT) and creatine phosphokinase (CPK or CK) levels get elevated in myocardial infarction, and so on.

Certain qualitative tests in urine, e.g. for the detection of sugar, protein, bile pigments, bile salts,

it before oxidation in tissues.



(iii) Lipids

These are natural fats, oils and waxes and like carbohydrates are the compounds of carbon, hydrogen and oxygen. They occur in plant and animal tissues and are insoluble in water but are soluble in organic solvents like chloroform, benzene, ether, alcohol, etc.

(iv) Nucleic acids

These are the largest and most fascinating molecules found in living matter. These are the carriers and mediators of genetic information from one generation to another and exert primary control over the basic life processes in all organisms. **Like proteins, nucleic acids are also polymers.**

CELL STRUCTURE (Fig 3.1)

Shape and Size

Cells vary greatly in shape and size. Usually they are microscopic, but some of them are also visible to the naked eyes. They range from 0.2 to 0.5 micron in diameter (one micron is 1/1000 mm). Eggs are also single cells. Ostrich egg, single called plants such as Acetabularia and nerve cells may be 10 cm or more in length.

Cells can be of any conceivable shape. Their shape usually reflects the functions it carries out in an organism, e.g., nerve cells which have to transmit impulses to long distances are long; muscle cells are elongated. Cells may be flat, spindle shaped, cuboidal and of other shapes as well.

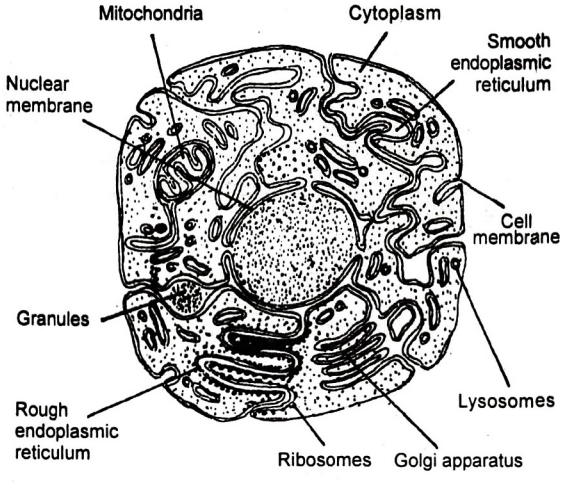


Fig. 3.1: Cellular components

All cells have certain common features. Presence of nucleus in cells is one such main feature (Brown, 1883). Nucleus in cells is the controlling centre. In Gloeocaspa (A blue-green algae), nucleus is not visible though it contains chromatin and chlorophyll and performs all the functions of a living cell. Bacteria and viruses are other variations. Both are devoid of a typical nucleus. Viruses have no recognisable structure of a generalised cell. They are so small that usually they are not visible without the help of an electron microscope. They do not have cytoplasm, however, they are crystals of nucleoprotein.

CELL PARTS

Meyer has divided the morphological structure of cells into the following three parts:

(i) the active living part **'protoplasm'**

(ii) partially active part **'alloplasm'**, and

(iii) All cells come from the division of pre-existing cells. A multicellular animal begins life as a single cell which undergoes repeated division to form its body.

Difficulties in Cell Theory

Today, there is an increasing opinion that 'all' living things are not **cellular** and that some organisms are **'acellular'**, i.e., without cell. A cell is defined as having a single distinct nucleus, but this description does not hold true to all cells. Some fungi, for example rhizopus are made up of an undivided mass of protoplasm, which has numerous nuclei scattered about in it. Distinct nucleus bounded by a membrane is also not found in the cells of **blue-green algae**, however regions containing DNA are present in them. Bacteria are also like blue-green algae and are devoid of nucleus. **Viruses** are also exceptions to cell theory. They are organisms having nucleic acids but exhibit none of the attributes of life, however, they cause drastic changes in the pattern of cell's living when introduced in other cells. These may be considered as exceptions and should not be treated as barriers in the study of cell structure and function.

Protoplasm

In the beginning, the cell theory emphasised the cell wall more and the contents less. **The cell contents were named as 'protoplasm' by the scientist Purkinje in the year 1840.** Dujardin made extensive studies of Protozoan protoplasm and named it **'Sarcode'** in 1835. Later on a German biologist, Max Schultz (1825-1874), in 1861 established the similarity between 'Sarcode' and 'Protoplasm' of animal and plant cells and declared- **'A cell is a lump of protoplasm inside which lies a nucleus'**. Thus, he offered a theory which was called **"Protoplasm Theory"** by the scientist O. Hertwig in the year 1892 which states-**"The cell is an accumulation of a living substance 'protoplasma' possessing a nucleus and a cell membrane.** Both the constituents are equally important and the disappearance of one or the other destroys the cell concept."

THE ORIGIN OF CELLS

With the establishment of the fact that all animals and plants were made up of minute units called **'cells'**, the next question that immediately arose was "where do cells come from"? Schwann believed that new cells were formed spontaneously out of the living substance, but other biologists noticed that one cell seemed to divide into two. The German scientist, Rudolf Virchow (1821-1902), agreed with this view and wrote 'Omnis', **'cellulae cellula'**, which means **'all cells from cells'.**

There were, of course, other scientists who believed in spontaneous generation, but today all biologists accept the cell theory of Schleiden and Schwann and Virchow's hypothesis that all cells come from pre-existing cells. It is true that some animals and plants are unicellular or single-celled where cell and organism are one, but the ones with which we are most familiar (multi-cellular animals) are made up of many kinds of cells which perform a variety of functions. The cells are integrated for proper functioning.

Ultimately, in the twentieth century great advancement has been made in this field and the development of **'electron microscope'** has recently added more information about the structure of the cell. **Now, the cell is defined as a highly organised unit.**

Nucleus is not only the control-centre of the physiological activities, it is also very important for cell- division. A denucleated cell can neither grow nor reproduce. It has been reliably established that the **'gene'**, which are the actual determiners of hereditary characters lie is nuclear chromosome.

Inulin

It is a polysaccharide which exclusively contains **D-fructose units.** It occurs as the reserve carbohydrate in the tubers of chicory, Jerusalem artichoke, dahlia and in the bulbs of onion and garlic. It is a white, more or less crystalline powder. It is very easily hydrolyzed by acids. It is not hydrolyzed by amylase **but is split by inulinase.**

Inulin is used as a source of commercial fructose. It is also administered to animals in the studies of glomerular membrane filtration rates. It is not hydrolyzed by any of the enzymes of the gastrointestinal tract and is not utilized as food.

HETEROPOLYSACCHARIDES (HETEROGLYCANS)

Agar

Agar is a vegetable mucilage obtained from seaweeds. It is a sulfuric acid ester of a complex galactose polysaccharide. It is odourless and tasteless. It swells strongly in cold water but does not dissolve. It gets dissolved in hot water to form a sol which upon cooling sets into a gel. A 1 percent agar gel is fairly rigid, and a 2 percent gel is very rigid. Agar is non-digestible and at times is given to provide bulk to the faeces in the treatment of constipation.

Gum Acacia or Gum Arabic

The vegetable gums are carbohydrate materials containing hexoses or pentoses or both in glycosidic union and a carbohydrate acid group. It is one of the most important and best- known gums. Gum arabic appears to be the salt of a high polymer of arabic acid which upon complete hydrolysis yields galactose, arabinose, rhamnose and glucuronic acid.

Gum arabic is used in the preparation of pharmaceuticals, in confections, and as an adhesive.

Pectins

"Pectin" is the term used to represent the substance or substances which in the presence of sugar and the proper acid concentration causes the formation of jellies. **It occurs in abundance in nature and is found especially in the pulp of citrus fruits, apples, carrots, beets, etc.** Commercial pectin is generally prepared from lemons or apples. When soluble, pectin is boiled with dilute acid, it is slowly hydrolyzed to pectic acid and methyl alcohol.

Large amounts of pectin are used in the fruit conserving industry and for other purposes.

"Pectin" is a group term and a number of different pectins are known today, some of which are insoluble and useless for gelation.

Alginic Acids

Alginic acids consist chiefly of linear polymers of D-mannuronic acid units. Its molecular weights range from 50,000 to 1,85,000. These are found in many marine algae and in giant kelp, which is a commercial source. Large amounts are used as emulsifier and smoothening agents in food industries.

Mucopolysaccharides (Glycosaminoglycans)

These are referred to as the substances which are composed of amino sugar and uronic acid units as the principal components, though some are chiefly made up of amino sugar and monosaccharide unit without the presence of uronic acid. The hexosamine present is generally acetylated.

Mucopolysaccharides are essential components of tissues. **They may be combined with proteins as mucoproteins or mucoids.** Important examples of mucopolysaccharides include hyaluronic acid, heparin and the chondroitin sulphates.