The protoplast is the living unit and or the physiological unit of a cell, while **protoplasm** is the essential living material that comprises the different parts of it (the protoplast). Protoplasm is the only substance that is endowed with life and, therefore, plants and animals containing this substance in their body are regarded as living. As the protoplasm dies, the cell ceases to perform any function for the plant or animal, which then becomes inert and dead as a whole. Protoplasm is thus, fittingly described as the *physical basis of life*. As the protoplast as a whole has to perform manifold functions of a cell, such as manufacture of food, nutrition, growth, respiration, reproduction, etc., it is differentiated into distinct living (protoplasmic) bodies:1-cytoplasm, 2-nucleus, and in special cells 3-plastid. It must however, be noted that these living bodies are never newly formed in the cells but always develop from pre-existing ones and that one kind of living body cannot give rise to another kind.

1.CYTOPLASM

The protoplasmic mass of a cell leaving out the nucleus and the plastids is otherwise called cell-protoplasm or **cytoplasm**. When the cell is young, the cytoplasm fills in the space between the cell-wall and the nucleus. The surface of the cytoplasm forms into an extremely thin delicate membrane known as the **plasma membrane** or **ectoplasm**. This plasma membrane is also hyaline but non-granular and somewhat firmer in consistency than the rest of the cytoplasm. It lies pressed against the cell-wall and is a very important layer, controlling the entrance and exit of substance into and out of the cell. The inner granular mass of the cytoplasm is often called **endoplasm.** Besides, the cytoplasm encloses numerous granules whose nature is obscure. These are known as the *microsomes.* They may represent pieces of endoplasmic reticulum. The fluid portion or matrix of the cytoplasm is known as the **hyaloplasm.** When the cell is very young it remains completely filled with the cytoplasm, but as it grows a large number of small non-protoplasmic but fluid- filled cavities of varying sizes, apparently like little bubbles, appear in the cytoplasm. These are called **vacuoles** (vacuus, empty). As the cell enlarges, these small vacuoles begin to fuse together and finally, in the mature cell, they form one large central vacuole which occupies the major part of the cell-cavity. The cytoplasm under this condition is pushed out-wards as a thin layer alongside the cell-wall, with the nucleus and the plastids lying embedded in this layer. Sometimes, instead of one, a number of comparatively small vacuoles persist in a mature cell, and then the cytoplasm occurs as delicate strands around those vacuoles and also as a very thin layer lining up with the cell-wall. These strands are seen to radiate from around the nucleus, often suspending it in the cavity of the cell. The vacuole is filled with a fluid called **cell-sap**. Dissolved in the cell-sap, or lying in a state of suspension in it , there occur various chemical compounds. The vacuole is thus, regarded as a storehouse of water, various salts, certain organic substances (mainly soluble food materials), anthocyanins, etc. It also maintains the requisite turgidity of the cell and the tissue as a whole. The layer of cytoplasm in

contact with the vacuole and surrounding it as a membrane as the vacuole **membrane** or **tenoplasm.** Like the ectoplasm, this membrane is also differentially permeable.

2.NUCLEUS.

Embedded in the cytoplasm, is a specialized protoplasmic body, usually spherical or oval and much denser than the cytoplasm itself. This is the **nucleus**. Its shape depends to some extent on the nature of the cell in which it occurs. In the young cell it occupies a median position and is almost always spherical or oval, but in the long cell it may become correspondingly elongated. In the mature cell due to the formation of vacuole it lies in the lining layer of cytoplasm and may become flattened against the cell-wall. Nuclei are universally present in all living cells. In higher plants, only a single nucleus is present in each cell. In the latex tissue and in many algae and fungi, many nuclei are often seen in a single cell. A nucleus can never be newly formed, but multiplies in number by the division of the pre-existing one.

Structure. Each nucleus is surrounded by a thin, transparent membrane known as 1-the **nuclear membrane** which separates the nucleus from the surrounding cytoplasm. There is a dense but clear mass of protoplasm known 2-the **nuclear sap** or **nucleoplasm** or **karyolymph**. Suspended in the nucleoplasm are numerous, fine, crooked threads loosely connected here and there, forming a sort of network, called 3-the **nuclear reticulum** or **chromatin network**. There is also 4-the **nucleoli** which remain attached to certain chromosomes their particular regions and are regarded as parts of those chromosomes.

Function: the principal function performed by the nucleus are as follows:

1-The nucleus takes a direct part in reproduction, asexual or sexual.

2-The nucleus takes the initiative in cell division.

3-The nucleus more particularly the chromosomes, are the *bearers* of hereditary material i.e. DNA.

Nucleic Acid: They are universally present in the nucleus and in the cytoplasm of all living cells, and are now known to form the chemical basis of life. They are very complex organic compounds made of phosphate, pentose sugar (ribose, as in RNA or deoxyribose, as in DNA) and nitrogen bases (purine and pyrimidine).

3. PLASTIDS

Besides the nucleus, the cytoplasm of a cell encloses many small specialized protoplasmic bodies, usually discoidal or spherical. These are called **plastid.** Their average size is 4-6*u*. Each plastid is bounded by a double membrane. The ground substance or matrix of the plastid is called the **stroma**, which is a

proteinaceous material. Lying embedded in the stroma is a large number of granules called **grana**. Each granum consists of a varying number of discs. The stroma is colourless whereas the granules contain the pigment or colouring matter. Plastids are living and multiply by division of the pre – existing ones. According to recent studies, plastids arise from pre – existing bodies, called **proplastids**, present in the embryonic cells. As the cells grow, the plastids also grow, multiply by division and assume their characteristic forms. Plastids occur in cells which have to perform specialized functions.

Plastids are of three types: 1. Chloroplasts, 2. Chromoplasts and leucoplasts. One form of plastids can change into another. For example, leucoplasts change into chloroplast when exposed to light for a prolong period. Similarly, chloroplast changes into leucoplasts in the continued absence of light. Similar change may take place in chromoplasts. In the young tomato fruit, the leucoplasts gradually change into chloroplasts and the latter into chromoplasts as the fruit ripens.

1 – Leucoplasts (leucos, white). These are colourless plastid. Leucoplasts occur most commonly in storage cells of roots and underground stems. They are also found in other parts not exposed to light. They vary in shape, often being spherical, discoidal or rod – like.

Leucoplasts convert sugar into starch in the form of minute grains for the purpose of storage. Larger Leucoplasts specially acting as starch – storing bodies, are known as **amyloplasts**. There is another colourless plastids called elaioplasts. They are concerned with the formation and storage of fats.

2. – Chloroplasts (chloros, green). These are green plastids, which owe their colour to the presence of pigment names chlorophyll. The green colour, which is present in green leaves and in green parts of the shoots, may sometimes be marked by other colours.

Functions: They work only in the presence of sunlight and perform some very important functions with the help of their chlorophyll, i.e. they carry out the process called **photosynthesis**. Chlorophyll is a mixture of four different pigments, viz. chlorophyll*a* (blue-block), chlorophyll *b* (green black), carotene (orange – red) and xanthophylls (yellow).

Chemical composition of chlorophyll

Chlorophyll a - $C_{55}H_{75}O_5N_{4Mg}$

Chlorophyll b - $C_{55}H_{70}O_6N_{4Mg}$

Carotene - $C_{40}H_{56}$

Xanthophylls - $C_{40}H_6O_2$