Vacuole

It is an organelle full of fluid and is the place where substances found within the cell fluid are gathered (crystals, tannins, tartaric acid, malic acid, minerals, pigments, proteins, lipidic substances). The liquid part of the vacuole is called **tonoplasm**, and the vacuole membrane is called **tonoplast**. Vacuole also regulates the water equilibrium of the cell. Vacuole takes water from the outside or release water to the outside according to osmotic pressure.

Peroxisome

They are small, round objects with a size of 0.5-0.6 microns. They develop from rough ER and their life span is 3-4 days, they are continuously renewed. Their number is less than lysosomes and found to be abundant in liver, kidney and cardiac cells. They are a very important source for intracellular H_2O_2. Oxidase enzymes found within peroxisomes play role in the formation of H_2O_2. this substance is actually very harmful for the cell and it is broken down by the enzyme catalase which is also found in the peroxisome.

Mitochondria

They are present in all cells except for the erythrocytes of mammals, bacteria and blue-green algae. Mitochondrion means filamentous particle, the plural is called mitochondria. They are generally rod-shaped structures with a width of 0.5 microns and length of 2-4 microns and sometimes they can be round.

Since they are the energy production and storage centers of the cell, they are found abundantly in cells that require more energy. For example, 25 mitochondria are present in the sperm and 500-1000 mitochondria are present in cardiac cells and secretory cells. They are also abundant in the muscles cells that perform contraction, and at the intersections of nerves. They consist of a membrane and a liquid (matrix) phase:

- Outer membrane: 70 A° thick. Has a similar structure to the cell membrane and has a transport protein called porin and forming large channels.
- Inner membrane: 50-60 A° thick. Contains projections towards matrix to increase the surface area. Though the structure of the inner membrane resembles cell membrane, it is somehow different in respect to its lipid and protein composition.

Matrix is of moderate density, it contains protein molecules and hundreds of enzymes that are required for citric acid cycle (Krebs cycle) and the oxidation of fatty acids and pyruvates.

95% of the energy required for the cell is produced in mitochondria.

Centrosome

They are usually found in animal cells and in mushrooms and algae (a primitive form of plant). However they are also absent in the mature oocytes and skeletal muscle cells of animals. In a centrosome, a centroplasm and orthogonally attached two centrioles (mother and daughter centrioles) are found. Though they are not considered to be a real organelle, they have an important role in cell division.

In the early stages of cell division a perpendicular bud is formed at the side of each centriole. When prophase of the mitosis initiate, each centriole goes to the poles with its bud and forms a pair of centrioles (centrosome). The microtubules extending to the chromosomes from the centrosome during metaphase capture the chromosomes and pull them to the poles.

Nucleus

The nucleus contains most of the cells genetic information and serves as the center of regulatory activity. The nucleus provides a site for genetic transcription that is segregated from the location of translation in the cytoplasm, allowing levels of gene regulation. The main function of the cell nucleus is to control gene expression and mediate the replication of DNA during the cell cycle.

- Its size various according to the type of the cell. In humans, the biggest nucleus has a diameter of 25-40 microns and is found in the mature oocytes. In a cell usually one nucleus if found, however liver cells and Leydig cells of the testicles contain two nuclei.

Nucleolus:

One or more can be present in a nucleus. It is more viscous then nucleus and does not contain a membrane. It is bigger and found in more numbers in rapidly growing embryonic cells, cancer cells, brain cells, main cells of the blood tissue and active cells like those performing protein synthesis. Human cells usually have one nucleus, however cells with 2-3 nucleolus are also present. Its main task is helping in the formation of ribosomal subunits, i.e. formation of ribosomes.

CELL METABOLISM

Metabolism: All chemical reactions that take place in a cell for the growth, development and reproduction of living beings is called "**metabolism**".

In order to perform metabolic reactions, the living being has to be provided food that would yield energy and also be the starting material in new syntheses.

What is a foodstuff? **Foodstuff** is considered to be all substances that provide energy to living beings, and work as a nutrient or used in the regular performance of vital phenomenon.

They can be divided into 2 groups:

1) Both nutrients and energy source:
   - Carbohydrates
   - Lipids
   - Proteins
2) Vital substances required to survive:
   - Water
   - Salts
   - Vitamins

Primary source of energy for a living being the sun. The first energy is passed to all foodstuff via photonic reactions and stored in foodstuffs. This energy is turned into chemical energy with photosynthesis. During cellular respiration this energy is released and used for different purposes in various places.

E nergy transformation takes place via:

a) **Anabolism**

b) **Catabolism**

a) Anabolism, or biosynthesis, is the process by which living organisms synthesize complex molecules of life from simpler ones. Anabolism, together with **catabolism**, are the two series of chemical processes in cells that are, together, called **metabolism**. Anabolic reactions are divergent processes. That is, relatively few types of raw materials are used to synthesize a wide variety of end products. Anabolic processes produce peptides, **proteins**, polysaccharides, lipids, and nucleic acids. These molecules comprise all the materials of living cells, such as membranes and chromosomes, as well as the specialized products of specific types of cells, such as enzymes, antibodies, **hormones**, and neurotransmitters.

Metabolic reactions are basically similar in plants and animals, though these two groups of living beings have different morphologies. Enzymes, the biological catalyzers are required in every stage of metabolic events .

Respiration (Cellular respiration): Transformation of chemical energy of the organic molecules into another form of energy that is used in metabolic reactions is called **respiration**.

In **anabolic events** animals take their food from outside and plants make their own food. Therefore,

- animals are named as "**heterotrophic living beings**" and
- plants are named as "**autotrophic living beings**". According to this, the concept of feeding is examined in two groups.

1) **Autotrophic nutrition**: The cells produce the foodstuff that they require themselves. If solar energy is used during this process, then it is called **PHOTOSYNTHESIS** and if chemical energy is used, then it is called **CHEMOSYNTHESIS**.

2) Heterotrophic nutrition: Some plants lacking chlorophyll and animals can not make their own food. This type of feeding also has different types:

i) **Saprophytic** nutrition.

ii) **Parasitic** nutrition

- Total parasite nutrition
- Semi-parasite nutrition

iii) **Symbiosis**

- Mutualism (two living beings benefit from each other).
- Commensalism (two living beings live together but do not benefit from each other or do not harm each other)

iv) **Insectivorous** plants.

i) Saprophytic nutrition: (sapro: rotten)

In **saprophytic nutrition** the organisms obtain their food from dead and decaying organic matter of dead plants and animals and other decomposing organic matter and they are called **saprophytes**. Fungi, bread mould, some protists and many bacteria are saprophytic in nutrition. In this type, the saprophytic organisms like fungi release digestive enzymes in their surrounding medium to convert the complex organic molecules such as sugars in simple forms such as glucose. This simple food is then absorbed through the body surface, and utilized for various activities by fungus.

ii) Parasitic nutrition: In this type of nutrition, the organisms (called parasites) depend on the body of other living organisms (called their host) for getting their food. Many viruses, bacteria, fungi and animals have this mode of nutrition.

It is divided into two as **total parasites** and **semi-parasites**.

a) **Total parasites**: Parasitic plants have special suckers (haustorium) that may invade the host plant's food channels and draw off sugars and minerals. Many parasitic plants are totally dependent on their host for food and no longer need green leaves. Pathogen bacteria, some fungi, plants like *Orobanche* sp. and *Cuscuta* sp. and intestinal parasites and examples.

b) Semi-parasites: These plants have chlorophyll, therefore they only obtain water and minerals from the hot and make photosynthesis. E.g..: *Viscum album* (misletoe).

iii) Symbiosis: This is any type of a close and long-term biological interaction between two different species, be it mutualistic, commensalistic, or parasitic. Symbiosis can be obligatory, which means that one or both of the symbionts entirely depend on each other for survival , or facultative (optional) when they can generally live independently. It can be seen between plants and animals etc. as:

a) **Mutualism:** A mutualistic relationship is when two organisms of different species "work together," each benefiting from the relationship. One example of a mutualistic relationship is that of the oxpecker (a kind of bird) and the rhinoceros or zebra. Oxpeckers land on rhinos or zebras and eat ticks and other parasites that live on their skin. The oxpeckers get food and the beasts get pest control. Also, when there is danger, the oxpeckers fly upward and scream a warning, which helps the **symbiont** (a name for the other partner in a relationship).

b) **Commensalism: Commensalism**, in biology, a relationship between individuals of two species in which one species obtains food or other benefits from the other without either harming or benefiting the latter. The commensal—the species that benefits from the association—may obtain nutrients, shelter, support, or locomotion from the host species, which is unaffected. The commensal relation is often between a larger host and a smaller commensal. The host organism is essentially unchanged by the interaction, whereas the commensal species may show great morphological adaptation.

This relationship can be contrasted with mutualism, in which both species benefit. One of the best-known examples of a commensal is the remora (family Echineidae) that rides attached to sharks and other fishes. Remoras have evolved on the top of their heads a flat oval sucking disk structure that adheres to the bodies of their hosts. Both remoras and pilot fishes feed on the leftovers of their hosts' meals

c) Symbiosis between plants: The most well-known example of mutualism is Lichens (**Algae+Fungus**) The non-fungal partner contains chlorophyll and is called the **photobiont**. The fungal partner may be referred to as the **mycobiont**. While most lichen partnerships consist of one mycobiont and one photobiont, that's not universal for there are lichens with more than one photobiont partner. When looked at microscopically, the fungal partner is seen to be composed of filamentous cells and each such filament is called a **hypha**. These hyphae grow by extension and may branch but keep a constant diameter. Amongst the photobionts there are those that are also filamentous in structure while others are composed of chains or clusters of more-or-less globose cells.

Given that they contain chlorophyll, algae and cyanobacteria can manufacture carbohydrates with the help of light via the process of photosynthesis. By contrast, fungi do not make their own carbohydrates. Every fungus needs existing organic matter from which to obtain carbon. In a lichen some of the carbohydrate produced by the photobiont is of course used by the photobiont but some is 'harvested' by the mycobiont.

In addition, nitrogen bacteria (*Bacterium radicicola*, *Bacillus radicicola*) living in the nodosides found in the roots of Fabaceae plants capture the free nitrogen from the air and the plant benefits from this. In return, bacterium finds a place (habitat) to live.

d) Symbiosis between animals and plants: Bacteria living in the intestines of animals is an example for this kind of. These bacteria assist digestion in the intestines and by this way obtain a habitat for themselves. E.g. probiotics.

iv) Insectivorous plants (insectivores): These plants can make photosynthesis, however they need nitrogen and obtain it from the insects. E.g.: Some insectivore plants like *Nepenthes, Drosera, Dionea* grow in swamps etc. That are poor in nitrogen, so they catch insects, digest them and benefit from their nitrogenous compounds.