SIMILARITIES AND DIFFERENCES BETWEEN PLANTS AND ANIMALS

In general, there are some basic similarities between plants and animals:

- Both plants and animals are made up of cells that are the smallest unit in the body in respect structure and function.

- Some metabolic events are the same in both groups, however tissues, organ systems, general structures and appearances of plants and animals are not similar.

- In general, complex plants and animals show distinct differences However these differences are far from being distinct in primitive plants and animals. Therefore some simple living beings are considered to be both plants and animals and are classified accordingly. However, living beings that contain chlorophyll are considered to be plants and living beings that do not contain chlorophyll are classified as animals.

Primary differences between plants and animals are summarized in the following table:

PLANTS	ANIMALS
Do not move actively (as in going somewhere)	Move actively
Contain chlorophyll, perform photosynthesis	Do not contain chlorophyll, therefore can not perform photosynthesis
Autotrophic	Heterotrophic
Basic source of energy is the sun.	Basic energy is provided from the potential energy that foods contain
Their cells have cellulosic cell walls	They lack cell wall, they only have cytoplasmic membranes
They are excitable, however they lack nervous system	They have nervous systems
They do not have systems for digestion, respiration, however these functions are somehow performed.	They have systems for digestion and respiration.
Their growth is unlimited (meristem tissue is present at the tips of the roots and the stems)	Their growth is limited.

Though they have many differences that we have specified above, plants and animals have a common and very important property:

Both plants and animals (in other words all living beings) are made up of cells and the primary material of a cell is a fluid called protoplasm (Protoplasm: The all living parts of the cell. Cytoplasm: The living parts outside the nucleus).

Differences between plant and animal cells are tabulated as follows:

Plant cell	Animal cell
Has a cellulosic cell wall	Only has a cell membrane
Plastids are found in the cytoplasm	Lacks plastids
Vacuole is present and is big	Vacuole is present and is small
Does not contain lysosome and centrosome	Lysosome and centrosome are present
Stores starch and cellulose	Stores glycogen
Cells are bound to each other with cell walls	Cells are independent
Cytoplasm division is via median lamella	Cytoplasm division is via articulation

Differences Between Cell Wall and Cell Membrane:

Cell wall	Cell membrane
Non-living	Living
Permeable	Semipermeable)
Durable	Indurable
Made up of cellulose	Made up of proteins and lipids

Comparison of plant and animals cells in respect to structure and function

Structure	Plant cells	Animal cell	Some functions
Cell membrane	Present	Present	Exchange of substances and separating the cytoplasm from the environment
Cell membrane	Present	Absent	Protection and support
Ribosome	Present	Present	Protein synthesis
Mitochondrion	Present	Present	Energy production center
Plastids	Present	Absent	Bearing various pigments, storing nutrients
Chlorophyll	Present (mostly)	Absent	Photosynthesis
Centrosome	Absent	Present	Cell division
Lysosome	A similar structure is present	Present	Digestion (within the cell)
Peroxisome	In some plant cells	Present	Carries enzymes similar to those of lysosomes and other enzymes that are related to hydrogen peroxide metabolism
Golgi device	Present	Present	Producing extracellular hormones etc.
Endoplasmic reticulum	Present	Present	Carrying some substances, lipid synthesis
Vacuole	Present (big)	Present (small)	Temporary storage unit
Nucleus	Present	Present	Genetics and management center of the cell
Nucleolus	Present	Present	RNA and ribosome synthesis

- **Endoplasmic Reticulum (ER):** It is found in all animal and plant cells except for erythrocytes and thrombocytes in mammals, and also except for bacteria. ER is the most extensive, versatile and adaptable organelle in eukaryotic cells. It consist of a three-dimensional network of continuous tubules and flattened sacs that underlie the plasma membrane, course through the cytoplasm and connect to the nuclear envelope but remain distinct from the plasma membrane. ER is a cytoplasma skeleton in which chemical reactions occur due to the enzymes and ribosomes that it contains and also a storage place for synthesized substances.

Smooth (Agranular) Endoplasmic Reticulum:

Smooth ER is found more in liver parenchyma cells, in sebaceous glands in which lipids are produced or in some endocrine glands that synthesize steroid hormones. Ribosomes are not found on Smooth ER, thus it does not participate in protein synthesis and the enzymes that are required to synthesize the other above mentioned substances are found within the ER membrane.

AER is found more in cells that have to have a certain shape, it surrounds the cytoplasm like a cage and helps to protect of the shape of the cell (especially the sensory cells in the retina). AER in general has a tubular structure, on the other hand GER consists of flat sacs associated with each other. AER functions in Ca balance during the contraction and relaxation of skeletal muscles. AER can be found in cells like liver, testicles, ovarium, suprarenal gland, mucosa epithelium of the intestines, skeletal muscles etc. all having different functions.

The general reaction for cholesterol, fatty acids, steroid hormon biosynthesis and detoxification reactions generally take place in the AER as a hydroxilation reaction. These reactions are catalyzed by various enzymes found in the cytochrome p450 system. This reaction provides the elimination of foreign exogenous substances and also potentially harmful indogenous chemicals and takes place within ER. It is especially related to the detoxification of harmful like pesticides and herbicides and also related to lipid biosynthesis.

- It also provides secretion of stomach acids and provides H^+ and Cl^- iyons. Provides the removal of Cl^- fom stomach cells.

- It is well developed in testis and ovarium cells and also in cells secreting steroid hormones in the suprarenal gland.

In summary, functions of ER:

- Allows secretion and reuptake of Ca^{2+} ions to the sarcomere in skeletal muscle cells, that is, plays role in the contraction and relaxation.

- Takes place in the destruction and modification of toxic substances in the liver; participate in the making of cholesterol and bile acid and in the transformation of glucose due to the glucose-6-phosphatase enzyme that it contains.

- The vast number of enzymes that it carries changes according to the race, populations and even accordig to individuals. Therefore, plays role in phenomena like resistance/tolerance to drugs and the side effects of drugs among individuals (intolerance to penicillin etc.).

- Newborn babies can not tolerate some drugs during the first 3 months of their lives, and the reason for this is underdeveloped smooth ER enzymes that they have.
- Provides breaking down of some drugs especially in the liver cells.
- Plays role in lipid transport and lipid metabolism seen in epithelium cells of the intestines.
- Helps in the excitation of cells of the retina

Some granules (ribosomes) are present on his type of ER which is seen as canaliculus (small channels) and vesicles. Since thay carry ribosomes, they are closely related to protein synthesis. The intensity of ribosomes vary according to the tissue. For example, though Rough ER is found in less amounts in the epithelium cells of the retina or in the meristem cells of plants, they are found to be more in liver cells. They are aslso well developed in gland cells which are rich in proteins. Proteins that are synthesized in ribosomes attached to ER passes through the small chanelles and vesicles and go to the Golgi apparatus to mature.

Ribosomes

Free or bound ribosomes are not considered to be real organs since they lack membranes. They consist of a big and small subunit.

Ribosomes in prokaryotes are **70 S** and the bigger subunit is 50S, and the smaller subunit is 30S. Eukaryote ribosomes are **80 S;** the bigger subunit is 60S, and the smaller subunit is 40S.

S= Svedberg unit is the rate of precipitation with an ultracentrifuge according to the size of the molecule.

These two subunits are produced in the nuclelus and then transported to the cytosol through the pores found in the nucleolus membrane. When protein synthesis is halted, these two subunits separate from each other.

During the protein synthesi the smaller subunt is attached to the mRNA. Then the bigger subunit come soposite and the ribosome is formed. **Mg^{2+}** ions also play role in this. And ribosomes are attached to ER with their bigger subunits.

Ribosomes can be found in all cells and can be seen as abundantly or scarce according to the condition of the cell. Ribosomes can be found in vast amounts in pancreatic enzyme secreting pancreas cells; antibody producing cells; liver cells; rapidly growing plant and animal cells. Proteins synthesized with the help of ribosomes pass to the cisterns (vesicled structures) of the ER, passed to the Golgi and after being processed and whether used within the cell or sent outside the cells where they are needed.

Golgi apparatus

Takes the name after Camillo Golgi (1898) who had discovered it. It is formed of straight, thin channels and or complex vesicles resembling smooth ER. Has a structure like cell membrane and contains various enzymes, well-developed in cells producing secretions. The proteins synthesized in the ribosomes are transferred to the ER vesicles (cisterns) first and the to Golgi, and they are processed here.

- Golgi is functionally divided into three regions: **cis Golgi, medial Golgi)** and **trans Golgi)**. Cis Golgi receives the proteins, proteins start to mature here. They continue to mature along the medial Golgi, and then released from the trans Golgi in vesicles (released to the cytoplasm or sent outside the cell).

In summary, functions of Golgi are:

At first, Golgi complex was thought to be an organelle where materials were stored and condensed before being sent outside. But today it is considered that Golgi complex has many biochemical activities:

- Golgi assists in the formation of intercellular secretions.
- Lipoproteins, connective tissue components and cartilage tissue components are produced in the Golgi.
- With the help of various enzymes like glycosyl and galactosyl transferases complex carbohydrates are synthesized and these are bound to proteins to form glycoproteins. Glycolipids also form here.

- Takes part in intracellular digestion. For example, assists in the digestion of lipids in the epithelial cells of the small intestine after meals.
- Lipids are synthesized in Golgi and stored in small vesicles.
- Golgi apparatus has a role in the transformation of spermatids into spermatozoa and also in the production of lysosomes.
- Various essential oils and secretions are produced in Golgi according to the type of plant and the animal cell.

Lysosome

Lysosomes are small vesicles with a diameter of 0.2-0.6 microns, surrounded with a thin membrane. They control the intracellular digestion of macromolecules. Proteins facing the lumen are glycoproteins to a high extent and form the glycocalyx.

Glycocalyx or the cell coat is usually used to define the carbohydrate layer found on the cell surface. It is synthesized by the Golgi apparatus. It is found in outer surfaces of all cells. Glycocalyx may have different thickness according to the cell or the different part of a cell. This coat is mostly well observed in the cells covering the small intestines, stomach, gallbladder, proximal tubules of the kidneys and the epididymis. It is usually 5-10 nm thick, however can reach to 50-200 nm thickness in the above mentioned organs.

Glycocalyx found in the lysosomes is considered to protect the lysosome from the effect of acidic hydrolase enzymes that it contains. Lysosomes are found in all animal cells except for erythrocytes and are abundant in macrophages, leucocytes, liver cells and in tubule cells of the kidneys. It is not present in plant cells, however, similar structures are present in the meristematic cells of the root tips. Hydrolase enzymes break down molecules like proteins, carbohydrates and lipids with the help pf water. Approximately 50 different types of hydrolase enzymes are known to be present in lysosomes. Among these enzyme, acid phosphatase enzymes function in acidic environment (pH 3-5).

With the help of lysosomes, substances that are harmful for the cell are digested and thus the cells is protected. In addition, substances with high molecular weights are broke down and made ready to be used by the cells.

Lysosomes also take part in the regeneration of cell organelles. Aging cells or organelles are digested via autophagia and new ones are produced. In addition, the tails of tadpoles, the membranes found between the fingers of humans are also removed by this way.

- They phagocyte excessive secretion granules and regulate the production of secretions by secretory glands. By this way excessive secretion accumulation in the cell is prevented. Secretion of breast milk and the secretions of endocrine glands are regulated this way.

Some diseases are encountered in the absence of some lysosome enzymes. For example:

- Pompe disease: Pompe disease is an inherited disorder caused by the buildup of a complex sugar called glycogen in the body's cells in he absence of α-1,4-glucosidase. The accumulation of glycogen in certain organs and tissues (the heart, tongue, liver), especially muscles, impairs their ability to function normally.

- Researchers have described three types of Pompe disease, which differ in severity and the age at which they appear. These types are known as classic infantile-onset, non-classic infantile-onset, and late-onset.

- The classic form of infantile-onset Pompe disease begins within a few months of birth. Infants with this disorder typically experience muscle weakness (myopathy), poor muscle tone (hypotonia), an enlarged liver (hepatomegaly), and heart defects. Affected infants may also fail to gain weight and grow at the expected rate (failure to thrive) and have breathing problems. If untreated, this form of Pompe disease leads to death from heart failure in the first year of life.

- The non-classic form of infantile-onset Pompe disease usually appears by age 1. It is characterized by delayed motor skills (such as rolling over and sitting) and progressive muscle weakness. The heart may be abnormally large (cardiomegaly), but affected individuals usually do not experience heart failure. The muscle weakness in this disorder leads to serious breathing problems, and most children with non-classic infantile-onset Pompe disease live only into early childhood.

- The late-onset type of Pompe disease may not become apparent until later in childhood, adolescence, or adulthood. Late-onset Pompe disease is usually milder than the infantile-onset forms of this disorder and is less likely to involve the heart. Most individuals with late-onset Pompe disease experience progressive muscle weakness, especially in the legs and the trunk, including the muscles that control breathing. As the disorder progresses, breathing problems can lead to respiratory failure

Gaucher disease: Gaucher disease is a rare genetic disorder characterized by the deposition of glucocerebroside in cells of the macrophage-monocyte system. The disorder results from the deficiency of the enzyme glucocerebrosidase. The body can not break down glucocerebroside and the fatty material can collect in the spleen, liver, kidneys, lungs, brain and bone marrow.

While Gaucher disease manifests with vast clinical heterogeneity, it has traditionally been differentiated into the following three clinical subtypes, delineated by the absence or presence of neurologic involvement and its progression:

- Type 1 – Non-neuronopathic Gaucher disease
- Type 2 - Acute neuronopathic Gaucher disease
- Type 3 - Chronic neuronopathic Gaucher disease

- Patients with type 1 disease commonly present with painless splenomegaly, anemia, or thrombocytopenia. They may also have chronic fatigue, hepatomegaly (with or without abnormal liver function test findings), bone pain, or pathologic fractures and may bruise easily because of thrombocytopenia. Bleeding secondary to thrombocytopenia may manifest as nosebleeds, bruising, or both.

- Patients with type 2 disease may present at birth or during infancy with increased tone, seizures, strabismus, and organomegaly. Failure to thrive, swallowing abnormalities, oculomotor apraxia, hepatosplenomegaly, and stridor due to laryngospasm are typical in infants with type 2 disease.
- In addition to organomegaly and bony involvement, individuals with type 3 disease have neurologic involvement

Lysosome membrane is normally resistant to the effect of hydrolase enzymes, however this resistant membrane can be torn dissolves due to bacterial and viral infections and other pathological conditions, lysosomal enzymes pass to the cytosol and result in the digestion of the cells and then the tissues. E.g.: In chronic rheumatoid arthritis, lysosome enzymes that are discharged into the joint spacing destroys the cartilage.