Course: Biology-III (6453)
Semester: Autumn, 2021

ASSIGNMENT No. 1

Q.1 How animals could be classified into different levels? Explain with one example.

Biological scientists estimate that collectively the earth's 5 to 40 million species of organisms (depending on the estimate you choose to believe) make up a total of some two trillion tons of living matter, or biomass. The plants comprise well over 90 percent of the biomass. The animals, the focus of this article, comprise only a small percentage of the biomass, but they account for the majority of species. In accordance with the Linnaeus method, scientists classify the animals, as they do the plants, on the basis of shared physical characteristics. They place them in a hierarchy of groupings, beginning with the kingdom animalia and proceeding through phyla, classes, orders, families, genera and species. The animal kingdom, similar to the plant kingdom, comprises groups of phyla; a phylum (singular for phyla) includes groups of classes; a class, groups of orders; an order, groups of families; a family, groups of genera; and a genus (singular of genera), groups of species. As established by Linnaeus, the scientists call an animal species, as they do a plant species, by the name of the genus, capitalized, and the species, uncapitalized. So far, the scientists have classified and named something over a million animal species. Without doubt, they have millions more to go. Taxonomists, biological scientists who specialize in classifying and naming the living organisms, group the multicellular, independently mobile organisms that eat other organisms into the kingdom of animalia. The taxonomists recognize that the animals, unlike the plants, possess specialized tissues that may be organized into even more specialized organs, and they recognize that most animals, especially the more evolutionarily advanced species, have "bilateral symmetry," which means that the right and left sides are essentially mirror images of each other. Critically, especially in the desert, animals, unlike plants, often utilize their mobility to seek refuge from environmental stresses such as intense heat and prolonged drought.

Animal Populations

Worldwide, the animal population consists of species numbering somewhere in the millions. The largest, the blue whale, may exceed 100 feet in length and 150 tons in weight. The smallest known animals, for instance, a parasitic wasp that taxonomists have named Dicopomorpha echmepterygis, measure no more than a few thousands of an inch in length.

The most abundant and diverse animal communities occupy earth's most biologically productive regions, for example, the tropical rainforests, where the species of living organisms probably number in the millions. Conversely, the least abundant and diverse animal communities live in the least biologically productive regions, in particular, deserts like those of our Southwest, where the species of living organisms likely number in the tens to hundreds of thousands.

The biological richness of a tropical rainforest contrasts sharply with the biological impoverishment of our deserts. The net biological productivity of a typical area in a tropical rainforest may exceed that of a comparable area in our desert lands by a factor of 40 to 50 times, according to the Physical Geography.net Internet site. Moreover, according to the Tropical Rainforest Biome Internet site, "Scientists believe that the tropical

rainforests of the world might hold up to ninety percent of the plant and animal species on earth." In a paper called "Tropical Biomes," Professor Ralph E. Taggart, Michigan State University, said "The total biological diversity of only a few square kilometers of rich tropical rainforest can exceed that of entire regions in the temperate zone. Most of the plants and animals of the world are found in the complex mosaic of natural communities that make up this biome." Nevertheless, our deserts host a diverse and highly adapted community of animals.

The Animal Community

Taxonomists typically divide the animal kingdom into two "subkingdoms," which include the invertebrates (animals without backbones) and vertebrates (animals with backbones). As with the plants, taxonomists turn the subsequent animal groupings and classifications, from phyla through genera, into a churning landscape that is simply a part of the scientific process. Depending on their academic roots and research, they divide and re-divide the animal community in many different ways, frequently regrouping, reclassifying and even re-naming species as they go. Some, called "lumpers," identify species as belonging to the same group even though there may be small differences. Other scientists, called "splitters," identify the same species as belonging in distinct groups because of the same small differences. The lumpers produce a relatively simple taxonomy, the splitters, a far more complex taxonomy.

Classifying an Invertebrate

In our deserts, the invertebrate subkingdom includes phyla such as arthropods (insects, centipedes, spiders, scorpions, desert shrimp and many others), mollusks (snails) and annelids (earthworms). In the desert, as well as across the world, arthropods, measured in terms of abundance and diversity, rank at the top of all the animal phyla. An elegant insect, the monarch butterfly, serves as example of how the classification system works for the invertebrates.

At the phylum level, the monarch belongs to the arthropods, which share several physical characteristics. According to Barbara Terkanian, "A Vertebrate Looks At Arthropods," A Natural History of the Sonoran Desert, the arthropods have jointed legs, and they have external skeletons, or exoskeletal material, that includes "eyes, mouthparts, antennae, body, legs, the fore and hind sections of the digestive tract, and some respiratory surfaces. Regions of flexible, unhardened exoskeleton serve as joints between neighboring segments." The body cavity contains the digestive, circulatory, nervous and reproductive systems.

At the class level, the monarch has membership in the insect group, which comprises the overwhelming majority of the arthropods. The insects have several distinguishing physical characteristics, including three-part bodies, six legs (three pairs), compound eyes and two antennae. The class, called Insecta, includes three subclasses, according to Kendall Bioresearch Services Internet site. The first consists of insects that have never had wings throughout their evolutionary history. The young resemble the adults. The second subclass consists of insects that have wings at present or had them at some point during their evolutionary history. The nymphs resemble the adults. The third subclass consists of insects that have wings at present or had them at some point

during their evolutionary history. The young take the form of larvae that change into adults during a non-feeding metamorphosis. The first subclass consists of four orders, including, for example, bristletails and springs tails. The second subclass has 16 orders, including, for instance, dragonflies; crickets, grasshoppers and locusts; termites and sucking lice. The third subclass has nine orders, comprising insects such as beetles; fleas; bees, wasps and ants; and the butterflies and moths.

At the order level, the monarch belongs to butterflies and moths, called Lepidoptera, which rank high among the most intriguing and conspicuous insect orders in the Southwest. They have two pairs of membranous, scaled and often brightly colored wings. Typically they have large eyes, long antennae and a long sucking tube (which the insect coils beneath its head when not feeding). The larvae, or caterpillars, all have silk glands that they use for spinning their cocoons. Their order contains well over 100 families.

At the family level, the monarch is the star of the milkweed butterflies, called Danaidae, which are among the best known in our deserts (as well as across the country). The milkweed butterflies usually have goldish wings trimmed in black, according to Donald J. Borror and Richard E. White, A Field Guide to the Insects of America North of Mexico. Their caterpillars feed on milkweed leaves, which invest both larvae and adults with a bitter and toxic taste that discourages predators.

At the genera level, the monarch is one of a mere handful of closely related species collectively called Dannaus. These species show apparently common evolutionary origins in their caterpillars, which share similar spots and smooth skin texture on their abdomens, according to David Munro, "The Biogeography of the monarch Butterfly," San Francisco State University, Department of Geology, fall 1999.

At the species level, the monarch is called plexippus. It is, says Munro, "a medium sized butterfly, measuring about 3 inches from wingtip to wingtip. Its body is about one inch long. Its four wings are generally a field of yellow, orange or gold, with veins of black running through them. A band of black, thickest at the front, rings the wings, and the body is black as well. This black band is usually speckled with white spots, larger at the front and smaller at the back."

Q.2 Give a brief description on fractional account of carbohydrates.

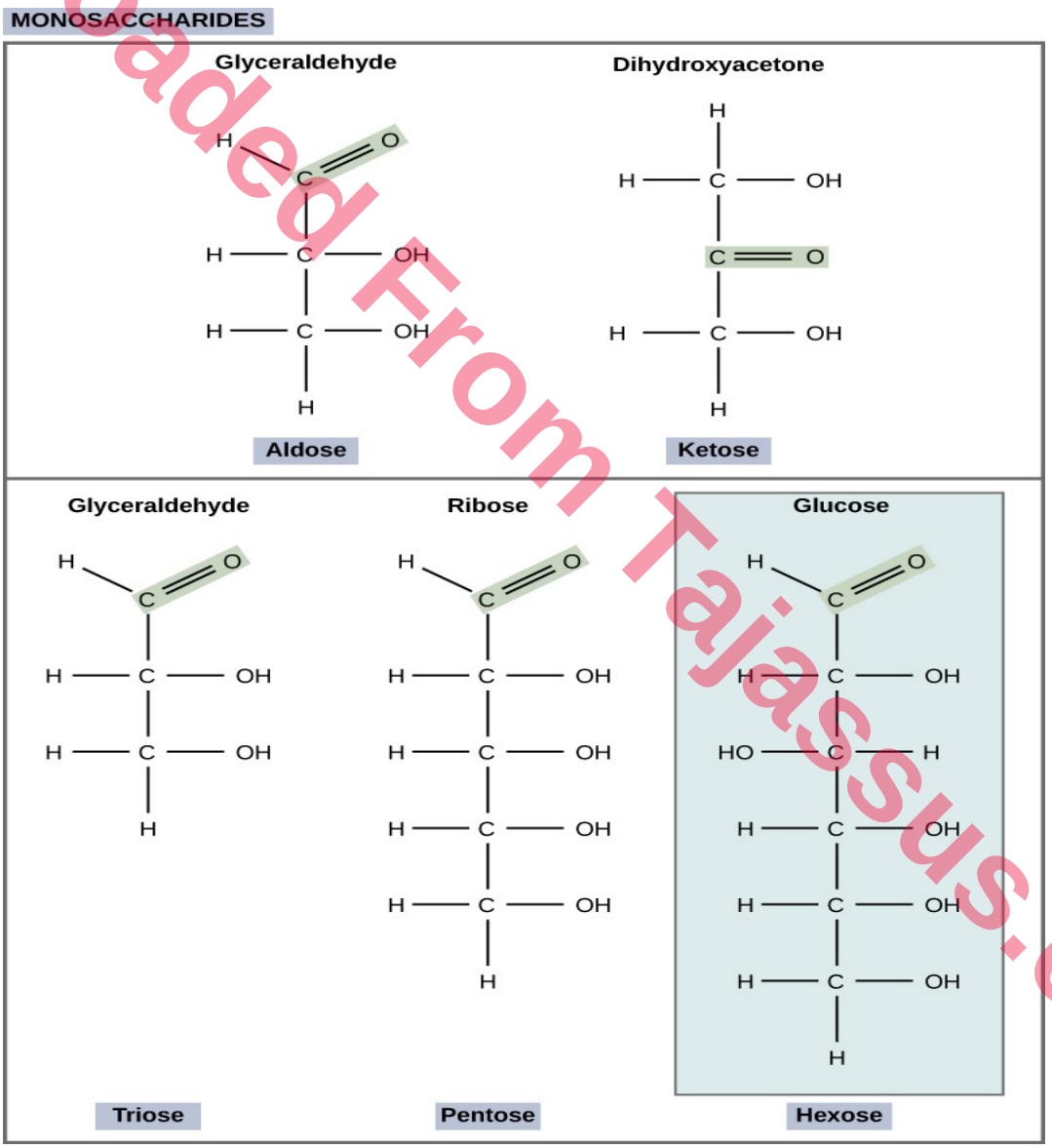
Most people are familiar with carbohydrates, one type of macromolecule, especially when it comes to what we eat. To lose weight, some individuals adhere to "low-carb" diets. Athletes, in contrast, often "carb-load" before important competitions to ensure that they have enough energy to compete at a high level. Carbohydrates are, in fact, an essential part of our diet; grains, fruits, and vegetables are all natural sources of carbohydrates. Carbohydrates provide energy to the body, particularly through glucose, a simple sugar that is a component of starch and an ingredient in many staple foods. Carbohydrates also have other important functions in humans, animals, and plants.

Carbohydrates can be represented by the stoichiometric formula $(CH_2O)n$, where n is the number of carbons in the molecule. In other words, the ratio of carbon to hydrogen to oxygen is 1:2:1 in carbohydrate molecules. This formula also explains the origin of the term "carbohydrate": the components are carbon ("carbo") and the

components of water (hence, "hydrate"). Carbohydrates are classified into three subtypes: monosaccharides, disaccharides, and polysaccharides.

Monosaccharides

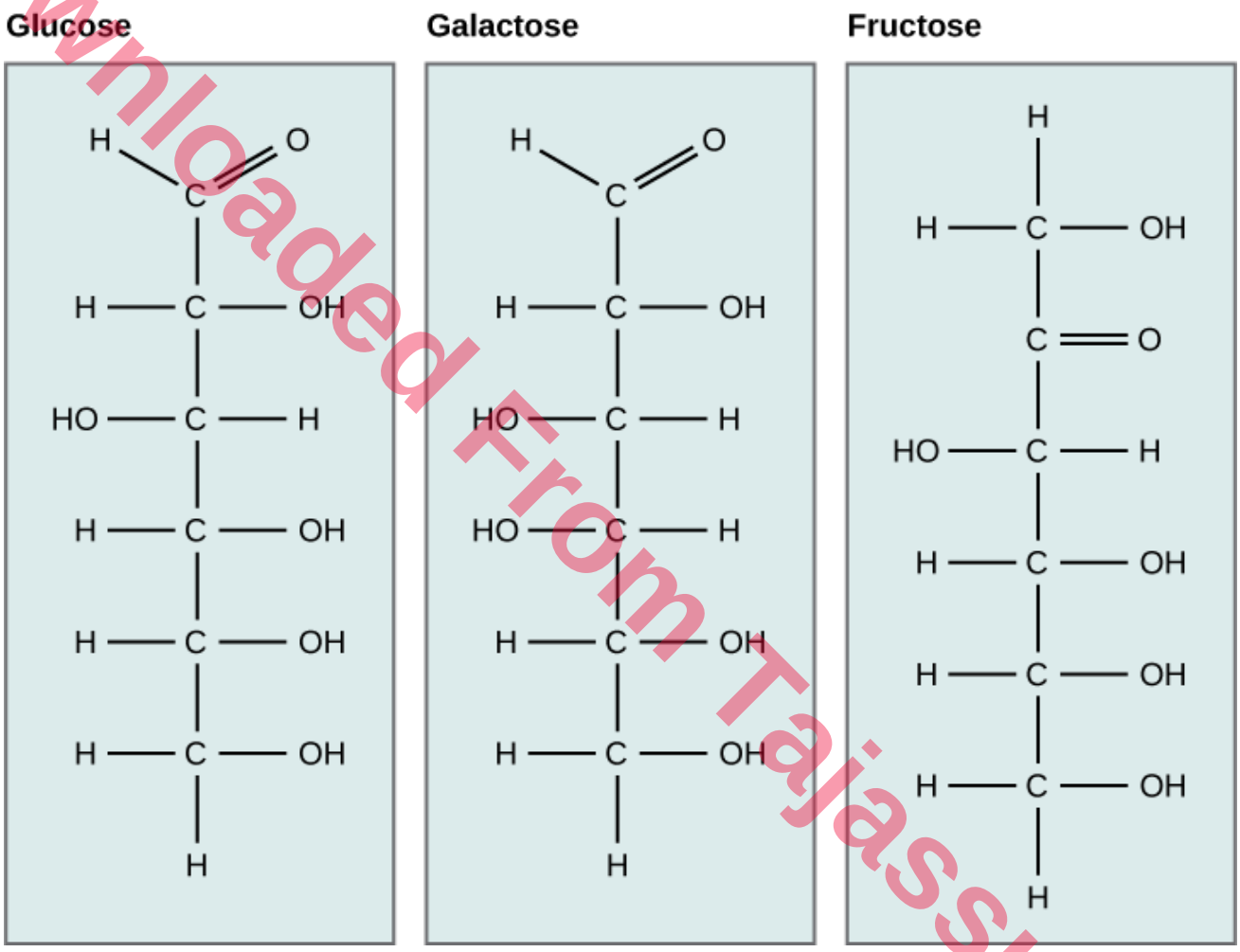
Monosaccharides (mono– = "one"; sacchar– = "sweet") are simple sugars, the most common of which is glucose. In monosaccharides, the number of carbons usually ranges from three to seven. Most monosaccharide names end with the suffix –ose. If the sugar has an aldehyde group (the functional group with the structure R-CHO), it is known as an aldose, and if it has a ketone group (the functional group with the structure RC(=O)R′), it is known as a ketose. Depending on the number of carbons in the sugar, they also may be known as trioses (three carbons), pentoses (five carbons), and or hexoses (six carbons). See Figure 1 for an illustration of the monosaccharides.



The chemical formula for glucose is $C_6H_{12}O_6$. In humans, glucose is an important source of energy. During cellular respiration, energy is released from glucose, and that energy is used to help make adenosine triphosphate (ATP). Plants synthesize glucose using carbon dioxide and water, and glucose in turn is used for

energy requirements for the plant. Excess glucose is often stored as starch that is catabolized (the breakdown of larger molecules by cells) by humans and other animals that feed on plants.

Galactose and fructose are other common monosaccharides — galactose is found in milk sugars and fructose is found in fruit sugars. Although glucose, galactose, and fructose all have the same chemical formula ($C_6H_{12}O_6$), they differ structurally and chemically (and are known as isomers) because of the different arrangement of functional groups around the asymmetric carbon; all of these monosaccharides have more than one asymmetric carbon.



Monosaccharides can exist as a linear chain or as ring-shaped molecules; in aqueous solutions they are usually found in ring forms. Glucose in a ring form can have two different arrangements of the hydroxyl group (−OH) around the anomeric carbon (carbon 1 that becomes asymmetric in the process of ring formation). If the hydroxyl group is below carbon number 1 in the sugar, it is said to be in the alpha (α) position, and if it is above the plane, it is said to be in the beta (β) position.

Q.3 Draw labeled diagram of mitochondria and Golgi apparatus.

A cell is the structural and functional unit of life. Every living organism existing on this planet is composed of either one or many cells. The living cells are composed of minute organelles which are collectively called as

cell organelles. They are the membrane-bound structure, bounded in a double layer of phospholipids found within a cell.

Mitochondria are known as the powerhouses of the cell. It is involved in different cellular activities like respiration, differentiation, cell signalling, cell senescence, controlling the cell cycle, cell growth and other metabolic activities of the cell. They are rod-shaped, a double membraned organelle found both in the plant as well as animal cells.

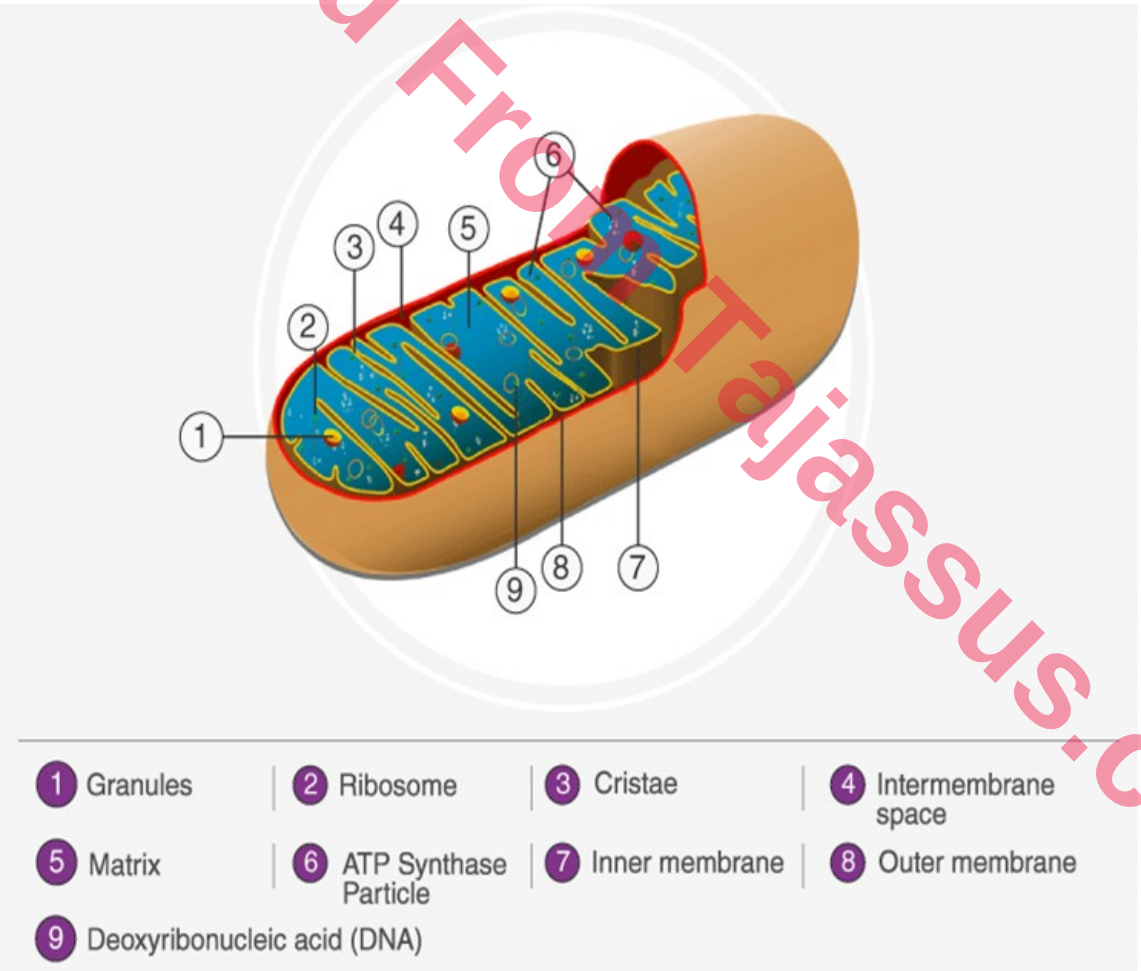
The term 'mitochondrion' is derived from a Greek word which refers to threadlike granules and it was first described by German pathologist -Richard Altmann in the year 1890.

Mitochondria are a double-membrane-bound cell organelle found in most eukaryotic organisms. In all living cells, these **cell organelles** are found freely floating within the cytoplasm of the cell.

The diagram of Mitochondria is useful for both Class 10 and 12. It is one among the few topics having the highest weightage of marks and is majorly asked in the examinations.

Diagram Of Mitochondria

The diagram below shows the structure and functions of the mitochondria.



Matrix

It is a viscous or a gel-like fluid containing a mixture of enzymes, ribosomes, inorganic ions, mitochondrial DNA, nucleotide cofactors, and organic molecules. It is involved in the cellular respiration and production of ATP molecules.

Cristae

The inner layer, surrounded by the folds of the mitochondrial matrix are collectively referred to Cristae. These inner membranes increase the surface area of the inner membrane and have different roles in cellular respiration, generation of ATP molecules- the energy currency of the cell and other chemical reactions.

Ribosomes

The ribosomes found within the mitochondria are called as the mitochondrial ribosome or mitoribosome. It is a protein complex, which functions by translating mitochondrial mRNAs encoded in mtDNA.

Inner membrane

The inner mitochondrial membrane holds proteins and functions by permitting the entry of only the selected molecules. Therefore they are also called the special membrane transporters.

Outer membrane

The outermost layer of the Mitochondria that hold proteins called porins and form channels that allow the movement of proteins across the inner and outer membrane of mitochondria. It also holds a number of enzymes with a wide variety of functions.

Intermembrane Space

This is the area between the inner and outer membranes. It is subdivided into two distinct subcompartments: the intra cristae space and the lumen. Both are separated by the tubular structures measuring 10 to -40nm in diameter called the cristae junctions. The Intermembrane space is mainly involved with the transportation, modification of proteins coordinates, apoptosis and also in the regulation of the respiratory chain complexes.

Golgi apparatus, also called **Golgi complex** or **Golgi body**, membrane-bound organelle of eukaryotic cells (cells with clearly defined nuclei) that is made up of a series of flattened, stacked pouches called cisternae. The Golgi apparatus is responsible for transporting, modifying, and packaging proteins and lipids into vesicles for delivery to targeted destinations. It is located in the cytoplasm next to the endoplasmic reticulum and near the cell nucleus. While many types of cells contain only one or several Golgi apparatus, plant cells can contain hundreds.

Secretory proteins and glycoproteins, cell membrane proteins, lysosomal proteins, and some glycolipids all pass through the Golgi apparatus at some point in their maturation. In plant cells, much of the cell wall material passes through the Golgi as well.

The Golgi apparatus itself is structurally polarized, with three primary compartments lying between the “cis” face and the “trans” face. These faces are biochemically distinct, and the enzymatic content of each segment is markedly different. The cis face membranes are generally thinner than the others.

In general, the Golgi apparatus is made up of approximately four to eight cisternae, although in some single-celled organisms it may consist of as many as 60 cisternae. The cisternae are held together by matrix proteins, and the whole of the Golgi apparatus is supported by cytoplasmic microtubules. The three primary compartments of the apparatus are known generally as "cis" (cisternae nearest the endoplasmic reticulum), "medial" (central layers of cisternae), and "trans" (cisternae farthest from the endoplasmic reticulum). Two networks, the cis Golgi network and the trans Golgi network, which are made up of the outermost cisternae at the cis and trans faces, are responsible for the essential task of sorting proteins and lipids that are received (at the cis face) or released (at the trans face) by the organelle. The proteins and lipids received at the cis face arrive in clusters of fused vesicles. These fused vesicles migrate along microtubules through a special trafficking compartment, called the vesicular-tubular cluster, that lies between the endoplasmic reticulum and the Golgi apparatus. When a vesicle cluster fuses with the cis membrane, the contents are delivered into the lumen of the cis face cisterna. As proteins and lipids progress from the cis face to the trans face, they are modified into functional molecules and are marked for delivery to specific intracellular or extracellular locations. Some modifications involve cleavage of oligosaccharide side chains followed by attachment of different sugar moieties in place of the side chain. Other modifications may involve the addition of fatty acids or phosphate groups (phosphorylation) or the removal of monosaccharide's.

Q.4 What is importance and role of nervous tissues in animals?

The muscular tissue of the body constitutes from one-third to one-half of the body mass of the average vertebrate. Muscular tissue is a specialized tissue in animals which applies forces to different parts of the body by contraction. It is made up of thin and elongated cells called muscle fibers. It controls the movement of an organism. The cytoplasm in the muscle fibers is called sarcoplasm. It contains a network of membrane called the sarcoplasmic reticulum. The membrane surrounding the muscle fibers is called sarcolemma.

Properties of Muscular Tissue

1. **Contractibility**– It is the ability of muscle cells to shorten forcefully.
2. **Extensibility**– A muscle has the ability to be stretched.
3. **Elasticity**– The muscles have the ability to recoil back to its original length after being stretched.
4. **Excitability**– The muscle tissue responds to a stimulus delivered from a motor neuron or hormone.

Structure of Muscular Tissue

1. The muscular tissues are bundled together and surrounded by a tough connective tissue similar to cartilage known as perimysium.
2. The bundle of nerve cells that run in long fibers called fascicles are surrounded by the epimysium.
3. The fascicles are surrounded by a protective layer known as perimysium. It allows the flow of nerves and blood to the individual fibers.
4. Another protective layer, the endomysium surrounds the fibers.

5. These layers and muscles help in the contraction of different parts of the muscles. The different bundles slide past one another as they contract.
6. The epimysium connects to the tendons attached to the periosteum connective tissue that surrounds the bones. This helps in the movement of the skeleton when the muscles contract.
7. The epimysium connects to other connective tissues to produce a force on the organs and control everything from circulation to food processing.

Types of Muscular Tissue

The muscular tissue is of three types:

- Skeletal Muscle Tissue
- Smooth Muscle Tissue
- Cardiac Muscle Tissue

Skeletal Muscle Tissue

- These muscles are attached to the skeleton and help in its movement.
- These muscles are also known as striated muscles because of the presence of alternate patterns of light and dark bands.
- These light and dark bands are sarcomeres which are highly organized structures of actin, myosin, and proteins. These add to the contractility and extensibility of the muscles.
- Skeletal muscles are voluntary muscles composed of muscle fibers.
- 40% of our body mass comprises skeletal muscles.
- Each skeletal tissue contains myofibrils.
- The cells of these tissues are multinucleated.
- These are provided with blood vessels and many elongated mitochondria and glycogen granules.
- They bring about the movement of the organs of the body.

Smooth Muscle Tissue

- These are non-striated, involuntary muscles controlled by the Autonomous Nervous System.
- It stimulates the contractility of the digestive, urinary, reproductive systems, blood vessels, and airways.
- The actin and myosin filaments are very thin and arranged randomly, hence no striations.
- The cells are spindle-shaped with a single nucleus.

Cardiac Muscle Tissue

- These are found only in the heart.
- These are involuntary muscles and the heart pumps the blood through cardiac contractions.
- The cells of the cardiac muscles known as the cardiomyocytes are striated.
- They are single-celled and uninucleated.
- The ends of the cells are joined and the junctions are called intercalated discs. The cells are attached to each other by desmosomes.

Muscular Tissue Function

1. The muscular tissues are connected to the same nerve bundles.
2. The nerve impulse from the brain tells the muscles to contract.
3. Each muscle cell contains the proteins actin and myosin. These proteins slide past one another when the signal is received for contraction.
4. A single cell contracts up to 70% in length. The entire muscle shortens during contraction.
5. Muscular tissues help in the movement of bones, squeeze different organs, or compress chambers.

Q.5 Write notes on the following:

i. Activation energy

The minimum amount of free energy to start a chemical reaction is called activation energy. Most chemical reactions require an input energy to start. For example a match is lit. Its heat energy is used to start wood burning in a fin place. Input energy must break existing chemical bonds in a chemical reaction. Then this energy form new bonds. This input energy is called activation energy in thermodynamics. There are two types of reactions•

(a) **Exergonic reaction:** The reactions in which net release of energy take place is called exergonic reaction. The reactants contain more energy than the products. The amount of this excess energy is called free energy. This energy is greater than the activation energy required to initiate a reaction. It is released into the environment. These reactions occur spontaneously and are called exergonic.

(b) **Endergonic reactions:** The reactions which absorb energy are called endergonic reactions. The product contains more energy than the reactants. So they require a greater input of energy from the environment than is released. These reactions do not occur spontaneously. So they are called endergonic.

Reaction rate and catalysis

The amount of reactant substance converted to product substance in a given period of time is called reaction rate. The reaction rate of an exergonic reaction does not depend on the released energy. Its reaction rate depends on the amount of activation energy required for the starting of reaction. A few molecules succeed in overcoming the initial energy hurdle. Therefore, larger the activation energy of a chemical reaction, the more slowly the reaction occurs bonds are stressed, they may break more easily. The lowering of the activation of energy of a reaction is called catalysis.

Catalysts

Any substance that performs catalysis is called a catalyst. A catalyst is a substance that accelerates the rate of a chemical reaction. The reaction proceeds at a lower environmental temperature by decreasing the activation energy. But catalyst itself is not used up in the reaction. The catalysts are always enzymes in cells.

ii. Endocytosis and exocytosis

Exocytosis is the process by which cells move materials from within the cell into the extracellular fluid. Exocytosis occurs when a vesicle fuses with the plasma membrane, allowing its contents to be released outside the cell.

Exocytosis serves the following purposes:

- **Removing toxins or waste products from the cell's interior:** Cells create waste or toxins that must be removed from the cell to maintain homeostasis. For instance, in aerobic respiration, cells produce the waste products carbon dioxide and water during ATP formation. Carbon dioxide and water are removed from these cells via exocytosis.
- **Facilitating cellular communication:** Cells create signaling molecules like hormones and neurotransmitters. They are delivered to other cells following their release from the cell through exocytosis.
- **Facilitating cellular membrane growth, repair, signaling and migration:** When cells absorb materials from outside the cell during endocytosis, they use lipids and proteins from the plasma membrane to create vesicles. When certain exocytotic vesicles fuse with the cellular membrane, they replenish the cell membrane with these materials.

Endocytosis is the process by which cells take in substances from outside of the cell by engulfing them in a vesicle. These can include things like nutrients to support the cell or pathogens that immune cells engulf and destroy. Endocytosis occurs when a portion of the cell membrane folds in on itself, encircling extracellular fluid and various molecules or microorganisms. The resulting vesicle breaks off and is transported within the cell. Endocytosis serves many purposes, including:

- **Taking in nutrients for cellular growth, function and repair:** Cells need materials like proteins and lipids to function.
- **Capturing pathogens or other unknown substances that may endanger the organism:** When pathogens like bacteria are identified by the immune system, they are engulfed by immune cells to be destroyed.
- **Disposing of old or damaged cells:** Cells must be safely disposed of when they stop functioning properly to prevent damage to other cells. These cells are eliminated through endocytosis.