Chapter # 4.

"Cells and tissues"

Understanding the concepts

~~ Question No 1 ~~

Explain the function of cell membrane?

Ans:

Function of cell membrane:-

All prokaryotic and eukaryotic cells have a thin and elastic cell membrane, covering the cytoplasm. The cell membrane functions as a semi-permeable barrier, allowing a very few molecules across it while fencing the majority of chemicals inside the cell. In this way the membrane maintains the internal composition of the cell to a constant or nearly constant level. In addition to this vital role, cell membrane can also sense chemical messages and can identify materials and other cells.

Question # 2

Describe the structure of cell wall?

Ans:

Cell wall:

The cell wall is a non-living and strong component of the cell, located outside the plasma membrane. It provides shape, strength, protection and support to the inner living matter (protoplasm) of the cell.

Structure of cell wall:

Plant cells have a variety of chemicals in their cell walls. The outer layer of the plant cell wall is known as primary wall and cellulose is the most common chemical in it. Some plant cells, for example, xylem cells, also have secondary walls on the inner side of the primary wall. It is much thicker and lignin and other chemicals are embedded in it. In the walls of neighbouring cells there are cytoplasmic connections called plasmodesmata. Through these connections, cells transfer chemicals among each other.

Presence of Chitin in the cell wall of fungi:

Fungi and protists have cell walls although they do not contain cellulose. Their cell walls are made of a variety of chemicals. For example, chitin is present in the cell wall of fungi. Prokaryotes have a cell wall composed of peptidoglycan that is a single large polymer of amino acid and sugar.

Question # 3

Discuss nucleus structure and function?

Ans:

Nucleus:

A prominent nucleus occurs in eukaryotic cells, In animal cells, it is present in the centre while in mature plant cells, due to the formation of large central vacuole, it is pushed to side.

Structure of nucleus:

The nucleus is bounded by a

double membrane known as nuclear envelope.

Nuclear Envelope:

The nuclear envelope contains many small poses that enable it to act as a differentially-permeable membrane.

Nucleoplasm:

Inside the nuclear envelope a granular matrix, the nucleoplasm, is present. The nucleoplasm contains one or two nucleoli (singular nucleolus) and chromosomes.

Visibility of Nucleolus:

The nucleus is usually visible as a dark spot and it is the site where ribosomal RNA are formed and assembles as ribosomes.

Chromosomes:

One of the rod-shaped bodies found in the nucleus of cells that contain genetic information (DNA)

Chromosomes are visible only during cell division while during interphase (non-dividing phase) of the

cell they are in the form of fine thread-like structures known as chromatin.

Structure of DNA:

Chromosomes are composed of Deoxyribonucleic acid (DNA) and histone proteins provide structural support to DNA for making the structure of chromosome.

messenger Ribonucleic Acid (mRNA):

DNA contains the message for the synthesis of specific proteins. According to this message, a molecule of messenger Ribonucleic Acid (mRNA) is synthesized. In this way, message is handed over to mRNA, which carries it to ribosomes. Ribosomes manufacture specific protein according to the message present on mRNA.

Function of DNA:

In this way DNA controls all the activities of the cell and is also responsible for the transmissi of characteristics to the next generation. That is why it is honoured as the hereditary material.

Main Function of Nucleus:

Nucleus is called brain of the cell. Nucleus controls all the activities of cell.

Note:

The prokaryotic cells do not contain prominent nucleus rather their chromosome is made of DNA only and is submerged in the cytoplasm.

Question # 4

Describe the structure and function of endoplasmic reticulum and Golgi apparatus?

Ans:

Endoplasmic Reticulum (ER):

Endoplasmic reticulum is a network of interconnected channels that extends from cell membrane to the nuclear envelope. This network exists in two forms:

Rough Endoplasmic Reticulum (RER):

Rough Endoplasmic Reticulum (RER) is so-named because of its rough appearance due to the numerous ribosomes that are attached to it.

Function of Rough Endoplasmic Reticulum (RER):

It connects to the nuclear envelope through which the messenger RNA (mRNA) travels to the ribosomes. Due to the presence of ribosomes, RER serves a function in protein synthesis.

Smooth Endoplasmic Reticulum (SER):

Smooth Endoplasmic Reticulum (SER) lacks ribosomes and is involved in lipid metabolism and in the transport of materials from one part of the cell to the other. It also detoxifies the harmful chemicals that have entered the cell.

Golgi Apparatus:

An Italian physician named Camillo Golgi discovered a set of flattened sacs (cisternae) that are stacked over each other. Golgi named this set of cisternae as Golgi apparatus. It is also called Gogli body or Golgi complex and found in both plants and animal cells.

Function of Golgi Apparatus:

It modifies molecules arriving from rough ER and packs them into small membrane bound sacs called Golgi vesicles. These sacs can be transported to various locations in the cell or to its exterior in the form of secretions.

Question # 5

Describe the formation and function of lysosomes?

Ans:

Lysosomes:

In the mid-twentieth century, the Belgian scientist Christian Rene de Duve discovered lysosomes.

Formation of lysosomes:

These are single-membrane bound organelles. Lysosomes contain strong digestive enzymes and work for the breakdown (digestion) of food and waste materials within the cell.

Function of lysosomes:

During its function, a lysosomes

fuses with the vacuole that contains the targeted material and its enzymes breakdown the material.

Question # 6

Explain what happen when a plant and an animal cell is placed in a hypertonic solution?

Ans:

Animal cell in hypotonic environment:

i: When an animal cell, such as the red blood cell, is placed in an isotonic solution, the cells volume remains constant because the rate at which water is entering cell is equal to the rate at which it is moving out.

ii: When a cell is placed in a hypotonic solution (which has lower salt concentration than the cell) water enters and the cell swells and may rupture like an overfilled balloon.

iii: An animal cell placed in a hypertonic solution (which has higher salt concentration than the cell will lose water and will shrink in size.

i: So in hypotonic environments (freshwater) animal cell must have ways to prevent excessive intry of water and hypertonic environments (seawater) they must have ways to prevent excessive loss of water.

Plants cell in hypotonic environment:

i: Most plant cells live in hypotonic environment because there is low concentration of solutes in extracellular fluids than in their cells. As a result water tends to move first inside the cell and then inside the vacuole.

ii: When vacuole increases in size the cytoplasm presses firmly against the interior of the cell wall, which expands a little.

iii: Due to strong cell wall, plant cell does not rupture but instead becomes rigid. The internal pressure of such a rigid cell is known as turgor pressure and this phenomenon is known as turgor.

iv: In isotonic environment the plant cell is flaccid, because the net uptake of water is not enough to make it turgid.

v. In a hypertonic environment a plant cell loses water, causing the cytoplasm to shrink within the cell wall. The shrinking of cytoplasm is called plasmolysis.

Question # 7

Describe the internal structure of chloroplast and compare it with that of mitochondrion?

Ans:

Like mitochondria, chloroplast is also bound by a double membrane. The outer membrane is smooth while the inner one gives rise to membranous sacs called thylakoids (the stack of thylakoids is known as a granum floating in a fluid termed the stroma.

Function of chloroplast:

Chloroplasts are the sites of photosynthesis in eukaryotes. They contain chlorophyll, the green pigment necessary for photosynthesis, and associated accessory pigments. These pigments are present in thylakoids of the grana of chloroplasts.

Question # 8

Explain the phenomenon involved in the passage of matter across cell membrane.

Ans:

Chemical analysis reveals that cell membrane is mainly composed of proteins and lipids with small quantities of carbohydrates. Electron microscope examination of cell membranes have led to the development of the fluid-mosaic model of cell membrane.

i: Lipids are aligned in such a way that they make a bilayer. It gives fluidity and elasticity to the cell membrane.

ii: Proteins may be fully submerged in the lipid bilayer or some of them may "stick out" into the interior and outside of the cell. These proteins function as gateways that allow certain molecules to cross into and out of the cell.

iii. Small amounts of carbohydrates are also found in cells membrane. These are joined with proteins

(in the form of glycoproteins) or with lipids (in the form of glycolipids). Both these forms act as fingerprint of the cell.

Question # 9

Describe how turgor pressure develops in a plant cell?

Ans:

Most plant cells live in hypotonic enviroment because there is low concentration of solutes in extracellular fluids than in their cells. As a result water tends to move first inside the cell and then inside the vacuole. When vacuole increases in size the cytoplasm presses firmly against the interior of the cell wall, which expends a little. Due to strong cell wall, plant cell does not rupture but instead becomes rigid. The internal pressure of such a rigid cell is known as turgor pressure and this phenomenon is known as turgor.

Question # 10

State the relationship between cell function and cell structure?

Ans:

(a) Size and shape

Function of nerve cells:

Nerve cells are long for the transmission of nerve impulse.

Function of xylem cells:

Xylem cell are tube-like and have thick walls for conduction of water and support.

Function of red blood cells:

Red blood cells are round to accomodate globular haemoglobin

Surface area to the volume ratio:

Function of root hair cell:

Root hair cells have large surface area for the volume ratio maximum absorption of water and salts.

Presence or absence of organelles:

Cells involved in making secretions have more complex ER and Golgi apparatus.

ii: Cells involved in photosynthesis have chloroplast.

Question # 11

Describe the differences in prokaryotic and eukaryotic cell?

Ans:

Differences between prokaryotic and eukaryotic cell:

i: The significant differences between prokaryotic and eukaryotic cell is that eukaryotic cell has a prominent nucleus and many membrane-bound organelles, which are not present in prokaryotic cell.

ii: The DNA of a prokaryotic cell floats in cytoplasm near the centre (this region is called nucleoid); the DNA of eukaryotic cell is held within the nucleus.

iii: There is much higher level of intracellular division of labour in eukaryotic cells than in prokaryotic.

Some more differences between prokaryotic and eukaryotic cell:

- Size: Eukaryotic cells are, on average, ten times the size of prokaryotic cells.
- Genomic composition and length: The DNA of eukaryotes is much more complex and extensive than the DNA of prokaryotes.
- Cell wall: Prokaryotes have a cell wall composed of peptidoglycan that is a single large polymer of amino acids and sugar. The cell walls of eukaryotic cells is made of cellulose (in plants) or chitin (in fungi).

Question # 12

Explain how surface area to volume ratio limits cell size?

Ans:

Cell size and surface area to volume ratio:

Cells very greatly in size.

Mycoplasmas:

The smallest cells are bacteria called mycoplasmas, with diameter between 0.1 μm 1.0 μm.

Bulkiest cells:

The bulkiest cells are bird eggs, and the longest cells are some muscle cells and nerve cells. Most cells lie between these extemes.

Note:

Most cells are small in size. Large cells have less surface area in relation to their volume while small cells of the same shape have more surface area.

The surface-to-volume relationship of cube-shaped cell:

The figure shows 1 large cells and 27 small cells. In both cases the total volume is the same.

Volume = $30\ \mu m \times 30\ \mu m \times 30\ \mu m = 27{,}000\ \mu m^3$

Total surface areas:

In contrast to the tolal volume, the total surface areas are very different. Because the cubical shape has 6 sides, its surface area is 6 times the area of 1 side. The surface areas of the cubes are as follows:

Surface area of 1 large cube = $6 \times (30\mu m \times 30\mu m)$
$= 5400\mu m^2$

Surface area of 1 small cube = $6 \times (10\mu m \times 10\mu m)$
$= 600\mu m^2$ and

Surface area of 27 small cubes = $27 \times 600\mu m$
$= 16,200\mu m^2$

The relationship between cell size and surface area to volume ratio works to limit cell size. As the size of a cell increases, cell volume increases more rapidly than its surface area.

Effect of cell size on surface area.

Question # 13

Describe the major animal tissues (epithelial, connective, muscular and nervous) in terms of their cell specifities, locations and functions?

Ans:

Animal Tissues:

In the bodies of animals, there are four major categories of tissues:
epithelial tissue, connective tissue, muscular tissue and nervous tissue.

1. **Epithelial tissue:**

Epithelial tissue covers the outside of the body and the lines organ and cavities. The cells in this types of tissue are very closely packed together and joined with little space between them

Function of Epithelial tissue:

Epithelial tissue helps to protect organisms from microorganisms, injury and fluid loss. These tissues are commonly classified on the base of the shape of the cells as well as the number of cell layer.

Types of epithelial tissue and their function:

Some types include:

Simple Squamous Epithelium	• A single layer of tightly packed, flattened cell. • Found in living of air sacs of the lungs, heart and blood vessels etc. • Allows diffusion and filtration.
Simple Cubodial Epithelium	• Consist of single layer of elongated cells. • Found in the lining of digestive tract and gallbladder etc. • Makes enzymes secretion.
Ciliated Columnas Epithelium	• A tuft of cilia is present at the top of each columnar cell. • Found in the lining of trachea and bronchi. • Propels mucous by ciliary action.
Stratified Squamous Epithelium	• Consist of many layers of flattened cells • Found in the inner lining of esophagus mouth at the surface of the skin. • Protects underlining tissues from abrasion

2. Connective Tissue:

As the name implies, connective tissue serves a "connecting" function. It supports and binds other tissues. Unlike epithelial tissue, connective tissue

typically, has cells scattered throughout an extracellular matrix.

Types of connective tissue:

There are many types of this tissue.

Loose Connective Tissue	• Most common type, matrix contains loosely arranged collagens (a protein) fibres. • Widely distributed under the epithelial tissue. • Holds organ in place and attaches epithelial tissue to other underlying tissues.
Fibrous connective Tissue	• Matrix contain tightly packed collagen fibres. • Found in tendons, which attach muscles and bones, and ligaments, which join two bones. • Provide structural strength.
Adipose Tissue	• Swollen cells due to the presence of large number of fat droplets. • Found around kidneys, under skin, in abdomen. • Provides energy when fat is oxidized, insulates against heat loose, protect and supports organs.
Cartilage	• Matrix contains bundles of collagens fibres embedded in a rubbery substance.

	• Found around the bones of knees in external ears, in nose, trachea, in discs between vertebrate (bones of vertebral column) as skeleton in many fishes. • Provide support while allowing flexibility.
Bone	• Matrix contain collagen fibres embedded in calcium salts. • Found in skeleton. • Support, protects, provides lever system for movements, stores calcium and forms blood cell.
Blood	• Matrix is not solid but in the form of fluid (plasma), Red and White blood cells are suspended in plasma. • Found in blood vessels. • Transport substances from one part of the body to the other, and responsible for immunity.

3. **Muscular Tissue:**

Muscle tissue consists of bundles of long cells called muscle fibers. It is the most abundant tissue in a typical animal. The cells of this tissue have ability to contract.

Voluntary action muscle tissue:

The skeletal muscles are voluntary in action i.e. their contraction is under the control of our will.

Involuntary action muscle tissue:

The smooth and cardiac muscles are involuntary in action i.e. their contraction is not under the control of our will.

Skeletal Muscle	• Composed of striated (striped) cells that are long and cylindrical and contain many nuclei. • Found attached to bones e.g bicep muscle. • Responsible for voluntary movements and locomotion.
Smooth Muscle	• Composed of non-striated (smooth) cells that are spindle shaped and each

co contains a single nucleus.

- Found in the walls of digestive tract, urinary bladder, blood vessels.
- Moves substances (foodstuff, usine) along internal passageways.

Cardiac Muscle

- Composed of striated cells that are branched and each contains a single nucleus.
- Found in the walls of the heart.
- Produce heartbeat that propies blood into the circulation.

1- Nervous Tissue:

Animal's survival depends on its ability to responed appropriately to stimuli from its enviroment This ability requires the transmission of information from one part of the body to another. Nervous tissue forms a communication system and performs this task.

Location of nervous tissue:

Nervous tissue is found in brain, spinal cord and nerves.

Specification of nervous tissue:

The tissue is mainly composed of nerve cells or neurons, which are specialized to conduct messages in the form of nerve impulses.

Types of nervous tissue and their function:

Nervous Tissue	• Composed of elongated cells. • Found in nerves, spinal cord and brain. • Responsible for communication among body parts.

Question # 14

Describe the major plant tissues i.e. simple tissue (meristematic tissues, permanent tissue) and compound tissue (xylem tissue and phloem tissue) in terms of their cells specifities, locations and functions?

Ans:

Cell specifities, locations and functions of plant tissues

Simple Tissue	Meristematic	1-Apical Meristem Found in tips of roots and shoots

a. Responsible for increase in length (primary growth).

2. Lateral Meristem (Vascular cambium and Cork cambium)

a. Found on the lateral sides of roots and shoots.

b. Responsible for increase in width (secondary growth).

- Cells with thick cytoplasm, large nucleus and thin walls
- Have ability to divide
- Responsible for growth and repair

Permanent

Different shapes and sizes.

- Cannot divide

1. Epidermal Tissue

a. Single layer of epidermal cells

b. Cover the plant body.

c. Responsible for protection and absorption

• Responsible for different functions.

2. Ground Tissue
a. Made a parenchyma cells with large vacuoles.
b. Found in all parts of plant body.
c. Responsible for photosynthesis (in leaves) and respiration and synthesis (in other parts).

3. Support Tissue Collenchyma
a. Made of long cells with unevenly thickened primary walls.
b. Found beneath epidermis and midribs.
c. Responsible for support in plant parts.

Sclerechyma
a. Made of rigid cells with thick secondary walls.
b. Fiber cells found in xylem and phloem.

		Sclerids: cells found in seed coats. c. Responsible for support, strength and transport.
Compound Tissue	Xylem and phloem tissue	**Xylem Tissue** a. Responsible for the transport of water and support b. Vessel Elements c. Short, hollow and dead cells with thick walls, join to form long tube. **Tracheids** a Long, slender cells, with thick walls. **2. Phloem Tissue** a. Responsible for the conduction of food. **Seive Tube cells** a. Long cells with sieve plates at the end walls, join to form long pipe li **Companion cells** Make proteins for sieve tube ce

Short Questions:

Question # 1

State the cell theory?

Ans:

Cell theory:

The cell theory, in its modern form includes the following principles:

i. All organisms are composed of one or more cells, within which all life processes occur.

ii. Cells are the smallest living things, the basic unit of organization of all organisms

Cells arise only by divisions in previously existing cells.

Question # 2

What are the function of leucoplasts and chromoplasts?

Ans:

Function of leucoplasts:

Leucoplasts are the third type of plastids. They are colourless and store strach, proteins

and lipids. They are present in the cells of those parts where food is stored.

Function of chromoplast:

The second type of plastids in plants cells are chromoplasts. They contain pigments associated with the bright colours and are present in the cells of flower petals and fruits. Their function is to give colours to these parts and thus help in pollination and dispersal of fruit.

Question # 3

Differentiate between difusion and facilitated difussion?

Ans:

Diffusion:

Diffusion is the net movement of a substance from a higher concentration to the area of lower concentration i.e. along concentration gradient.

Facilitated diffusion:

Many molecules do not diffuse freely acrosss cell membranes because of their size or charge. Such

molecules are taken into or out of the cells with the help of transport-proteins present in the cell membranes. When one of these transport proteins makes it possible for a substance to move it down its concentration gradient (from higher to lower concentration), the process is called facilitated diffusion. The rate of facilitated diffusion is higher than simple diffusion.

Facilitated diffusion is a type of passive transport:

Facilitated diffusion is also a type of passive transport because there in no extenditure of energy in this process.

Question # 4

What is meant by hypertonic and hypotonic solution?

Ans:

Hypertonic Solution:

A hypertonic solution has relatively more solute.

Hypotonic Solution:

A hypotonic solution has respectively less solute.