CELL – STRUCTURE AND FUNCTION

INTRODUCTION

All organisms are composed of structural and functional units of life called 'cells'. The body of some organisms like bacteria, protozoans and some algae is made up of a single cell while the body of fungi, plants and animals are composed of many cells. Human body is built of about one trillion cells. Cells vary in size and structure as they are specialized to perform different functions. But the basic components of the cell are common to all cells. This lesson deals with the structure common to all types of the cell.

OBJECTIVES

After completing this lesson, you will be able to :

_ justify that cell is the basic structural and functional unit of all organisms;
_ list the components of the cell and state cell theory;
_ differentiate between prokaryotic and eukaryotic cells;
_ differentiate between plant and animal cells;
_ illustrate the structure of plant and animal cells by drawing labelled diagrams;
_ describe the structure and functions of plasma membrane, cell wall, endoplasmic reticulum (ER), cilia, flagella, nucleus, ribosomes, mitochondria, chloroplasts, golgi body, peroxisome, glyoxysome and lysosome;
_ describe the general importance of the cell molecules-water, mineral ions, carbohydrates, lipids, amino acids, proteins, nucleotides, nucleic acids, enzymes, vitamins, hormones, steroids and alkaloids;

THE CELL AND CELL THEORY

Landmarks in cell study

Soon after Anton van Leewenhock invented the microscope, Robert Hooke in 1665 observed a piece of cork under the microscope and found it to be made of small compartments which he called "cells" (Latin cell = small room). In 1672, Leewenhock observed bacteria, sperm and red blood corpuscles, all of which were cells. In 1831, Robert Brown, an Englishman observed that all cells had a centrally positioned body which he termed the **nucleus**.

The cell theory

In 1838 M.J. Schleiden and Theodore Schwann formulated the "cell theory." The cell theory maintains that

_ all organisms are composed of cells.
_ cell is the structural and functional unit of life, and
_ cells arise from pre-existing cells.

The cells vary considerably, in shape and size. Nerve cells of animals have long extensions. They can be several feet in length. Muscle cells are elongated in shape. Egg of the ostrich is the largest cell (75 mm). Some plant cells have thick walls. There is also wide variation in the number of cells in different organisms.

The Cell

A cell may be defined as a unit of **protoplasm** bounded by a plasma or cell membrane and possessing a nucleus. Protoplasm is the life giving substance and includes the cytoplasm and the nucleus. The cytoplasm has in it **organelles** such as ribosomes, mitochondria, golgi bodies plastids, lysosomes and endoplasmic reticulum. Plant cells have in their cytoplasm

large vacuoles containing non-living inclusions like crystals, pigments etc. The bacteria have neither organelles nor a well formed nucleus. But every cell has three major components
_ plasma membrane
_ cytoplasm
_ DNA (naked in bacteria and covered by a membrane in all other organisms

Two basic types of cells
Cytologists recognize two basic types of cells. Organisms which do not possess a well formed nucleus are **prokaryotes** such as the bacteria. All others possess a well-defined nucleus, covered by a nuclear envelope. They are **eukaryotes**.

Differences between Eukaryotic and Prokaryotic cells

Prokaryotic cell (Pro = early/primitive)	**Eukaryotic cell** (eu = true, karyon = nucleus)
Nucleus not distinct, it is in the form nuclear membrane. of nuclear zone 'nucleoid'. Nuclear membrane absent. DNA is circular and lies free in the cytoplasm DNA is naked	Nucleus distinct, with well formed DNA is linear and contained in the nucleus DNA is associated with proteins
Single-membraned cell bodies like mesosomes present. Endoplasmic and Golgi body absent.	Double-membraned cell organelles (Chloroplasts, mitochondria nucleus). single membraned (Golgi apparatus, reticulum and lysosomes vacuole endoplasm reticulum) are present
Ribosomes - 70 S	Ribosomes - 80 S
No compartments.	Distinct compartments in the cell i.e. the cytoplasm and the nucleus
Mainly unicellular	Mainly multicellular except in Protista many of which are unicellular
Cell division mainly binary fission, no spindle formed	Mitosis, meiosis or both, spindle formed

Svedberg unit
When the cell is fractionated or broken down into its components by rotating in an ultracentrifuge at different speeds the ribosomes of eukaryotic and prokaryotic sediment (settle down) at different speeds. The coefficient of sedimentation is represented in Svedberg unit and depicted as S.

Table: Differences between plant cell and animal cell

Plant cell	**Animal cell**
1. Cellulose cell wall present around cell	1. No cell wall.

membrane.	
2. Vacuoles are usually large.	2. Generally vacuoles are absent and if present, are usually small..
3. Plastids present.	3. Plastids absent.
4. Golgi body present in the form of units	4. Golgi body well developed.
known as dictyosomes.	
5. Centriole absent.	5. Centriole present.

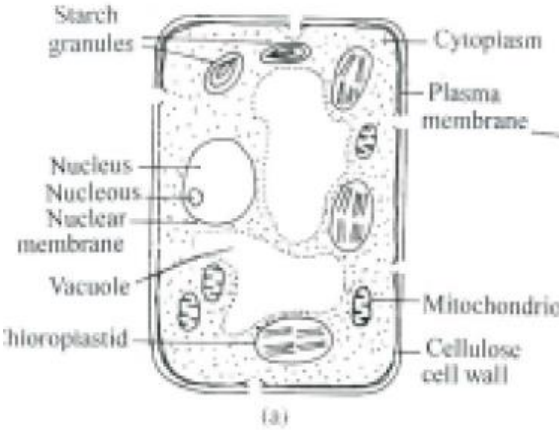


Fig. Generalised plant cell

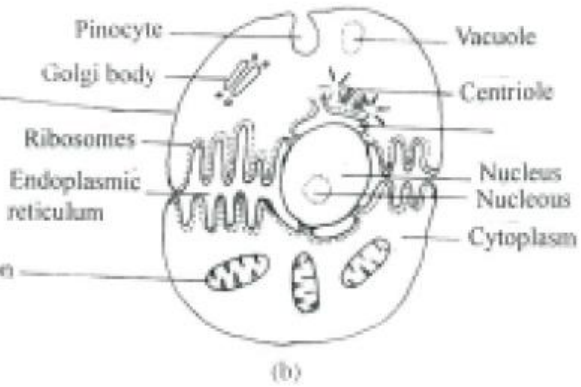


Fig. Generalised animal cell

QUESTIONS

1. From where do new cells arise?

.....

2. Name the scientists who proposed the cell theory.

.....

3. Name an organelle which a plant cell has but an animal cell does not.

.....

4. Give two points of difference between a prokaryotic cell and a eukaryotic cell

.....

COMPONENTS OF THE CELL

The major components of the cell are (1) cell membrane, (2) cytoplasm, and (3) nucleus / nucleoid(genetic material).

Cell membrane (Plasma membrane)

Each cell has a limiting boundary, the cell membrane, plasma membrane or plasmalemma. It is a living membrane, outermost in animal cells but next to cell wall in plant cells. It is flexible and can fold in (as in food vacuoles of *Amoeba*) or fold out (as in the formation of pseudopodia of *Amoeba*). The plasma membrane is made of proteins and lipids and several models were proposed regarding the arrangement of proteins and lipids. The **fluid mosaic model** proposed by Singer and Nicholson (1972) is widely accepted.

According to the fluid mosaic model,
(i) The plasma membrane is composed of a lipid bilayer of phospholipid molecules into which a variety of globular proteins are embedded.
(ii) Each phospholipid molecule has two ends, an outer head hydrophilic i.e. water attracting, and the inner tail pointing centrally hydrophobic, i.e. water repelling
(iii) The protein molecules are arranged in two different ways:
(a) Peripheral proteins or extrinsic proteins: these proteins are present on the outer and inner surfaces of lipid bilayer.
(b) Integral proteins or intrinsic proteins: These proteins penetrate lipid bilayer partially or wholly.

Functions
(i) The plasma membrane encloses the cell contents.
(ii) It provides cell shape (in animal cells) e.g. the characteristic shape of red blood cells, nerve cells, bone cells, etc
(iii) It allows transport of certain substances into and out of the cell but not all substance, so it is termed selectively permeable. Transport of small molecules (such as glucose, amino acids, water, mineral ions etc).

Small molecules can be transported across the plasma membrane by any one of the following three methods:
(i) **Diffusion** : molecules of substances move from their region of higher concentration to their region of lower concentration. This does not require energy. Example : absorption of glucose in a cell.
(ii) **Osmosis** : movement of water molecules from the region of their higher concentration to the region of their lower concentration through a semipermeable membrane. There is no expenditure of energy in osmosis. This kind of movement is along concentration gradient.
(iii) **Active Transport** : When the direction of movement of a certain molecules is opposite that of diffusion i.e. from region of their lower concentration towards the region of their higher concentration, it would require an "active effort" by the cell for which energy is needed. This energy is provided by ATP (adenosine triphosphate). The active transport may also be through a carrier molecule.

Transport of large molecules (bulk transport)
During bulk transport the membrane changes its form and shape. It occurs in two ways:
(i) Endocytosis (taking the substance in)

Phagocytosis
a. intake of solid particles
b. membrane folds outgoing round the particle, forming a cavity and thus engulfing the particle

Pinocytosis
a. intake of fluid droplets

b. membrane folds in and forms a cup like structure sucks in the droplets
(ii) exocytosis (passing the substance out)

Cell membrane regulates movement of substance into and out of the cell. If the cell membrane fails to function normally the cell dies.

Cell wall
In bacteria and plant cells the outermost cell cover, present outside the plasma membrane is the **cell wall** . Bacterial cell wall is made of peptidoglycan.

(a) Structure of plant cell wall
– Outermost non-living, layer present in all plant cells.
– Secreted by the cell itself.
– In plant, made of cellulose but may also contain other chemical substance such as pectin and lignin.
– The substance constituting the cell is not simply homogenous but it consists of fine threads or fibres called microfibrils.
– It may be thin (1 micron) and transparent as in the cells of onion peel. In some cases it is very thick as in the cells of wood.

(b) Functions
– The cell wall protects the delicate inner parts of the cell.
– Being rigid, it gives shape to the cell.
– Being rigid, it does not allow distension of the cell, thus leading to turgidity of the cell that is useful in many ways
– It freely allows the passage of water and other chemicals into and out of the cells
– There are breaks in the primary wall of the adjacent cells through which cytoplasm of one cell remains connected with the other. These cytoplasmic strands which connect one cell to the other one are known as **plasmodesmata**.
– Walls of two adjacent cells are firmly joined by a cementing material called **middle lamella** made of calcium pectate.

QUESTIONS
1. Define diffusion and osmosis.
.....
2. What does active transport mean?
.....
3. Give one point of difference between phagocytosis and pinocytosis.
.....
4. Match the following:

(i) hydrophilic end	(a) cell wall
(ii) microfibrils	(b) inner ends of lipids
(iii) fluid-mosaic model	(c) fluid droplets
(iv) hydrophobic end	(d) outer ends of lipids
(v) pinocytosis	(e) Nicolson and Singer

5. Give two functions of the plant cell wall.
(i) ..... (ii) .....

THE CYTOPLASM AND THE CELL ORGANELLES

The cytoplasm contains many cell organelles of which we shall learn about:

1. those that trap and release energy e.g. mitochondria and chloroplasts;
2. those that are secretory or involved in synthesis and transport e.g. Golgi, ribosomes and endoplasmic reticulum
3. the organelles for motilily - cilia and flagella
4. the suicidal bags i.e. lysosomes
5. the nucleus which controls all activities of the cell, and carries the hereditary material

Mitochondria and chloroplast - the energy transformers

Mitochondria (found in plant and animal cells) are the energy releasers and the chloroplasts (found only in green plant cells) are the energy trappers.

Mitochondria (Singular = mitochondrion)

Appear as tiny thread like structure under light microscope. Approximately 0.5 - 1.00µm (micrometer). Number usually a few hundred to a few thousand per cell (smallest number is just one as in an alga (**Micromonas**)).

Structure: The general plan of the internal structure of a mitochondrion observed by means of electron microscope is shown.

Note:

– Wall made of double membrane

– The inner membrane is folded inside to form projections called cristae which project into the inner compartment called matrix.

Function : Oxidises pyruvic acid (breakdown product of glucose) to release energy which gets stored in the form of ATP for ready use. This process is also called **cellular respiration**.

In cytoplasm, glucose (containing 6 atoms of carbon) enters cells, and it is broken into two Pyruvic acid molecules (containing 3atoms of carbon), which moves into the mitochondria where it is oxidised into CO_2, H_2O and ATP

Plastids

Plastids are found only in plant cell. They may be colourless or with colour. Based on this fact, there are three types of plastids.

(i) Leucoplast-white or colourless

(ii) Chromoplast – blue, red, yellow etc.

(iii) Chloroplast – green

Chloroplast

-Found in all green plant cells in the cytoplasm.

-Number 1 to 1008

-Shape: Usually disc-shaped or spherical as in most plants around you. In some ribbon - shaped as in an alga *spirogyra* or cup - shaped as in another alga Chlamydomonas.

Structure: the general plan of the structure of a single chloroplast is shown

Note the following parts :

-Wall made of double membrane i.e. outer membrane and inner membrane numerous stack-like (piles) groups or *grana* (singular = granum) are interconnected by *lamellae*.

-Sac like structures called thylakoids Placed one above the other constitute granum.
- Inside of the chloroplast is filled with a fluid medium calleds stoma.
- Function: chloroplasts are the seat of photosynthesis (production of sugar, from carbon-dioxide and water in the presence of sunlight).

Chloroplast versus mitochondria

Can you now visualize how these two organelles are opposite to each other, one traps the solar energy locking it in a complex molecule (by photosynthesis), the other releases the energy by breaking the complex molecule (by respiration).

Similarities between mitochondria and chloroplasts

Both contain their own DNA (the genetic material) as well as their own RNA (for protein synthesis). Thus, they can self-duplicate to produce more of their own kind without the help of nucleus.

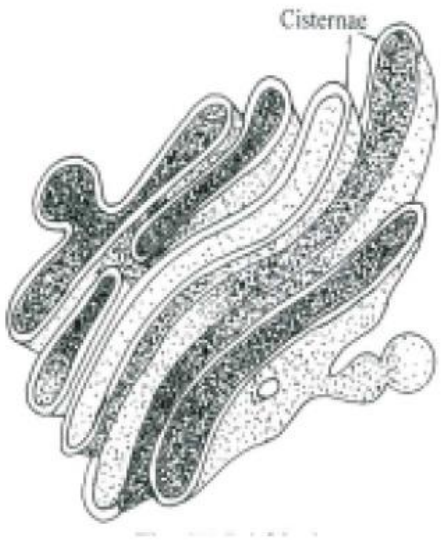
Since chloroplasts and mitochondria contain their own DNA the hereditary molecule and also their own ribosomes, they are termed semi-autonomous only because they are incapable of independent existence though they have ribosomes and DNA.

QUESTIONS

1. What is a cell organelle?
.....
2. Name the chemical which provides energy trapped in its bonds to the cell.
.....
3. Which part of the chloroplasts is the site of light reaction?
.....
4. Name the sac like structure which form the grana?
.....
5. Why is mitochondria called the “energy currency” of the cell?
.....
6. Which organelle contains enzymes for cellular respiration?
.....
7. State two similarities between mitochondria and chloroplast.
.....
8. Which plastids impart colour to flower petals?
.....
9. Which plastid is green in colour?
.....
10. Why are mitochondria and Chloroplast called semi-autonomous?
.....

Endoplasmic reticulum (ER), golgi body and ribosomes

Endoplasmic reticulum (ER) and Golgi body are single membrane bound structures. The membrane has the same structure (lipid-protein) as the plasma membrane but ribosomes do not have membranes Ribosomes are involved in synthesis of substances in the cell, Golgi bodies in secreting and the ER in transporting and storing the products. These three organelles operate together.



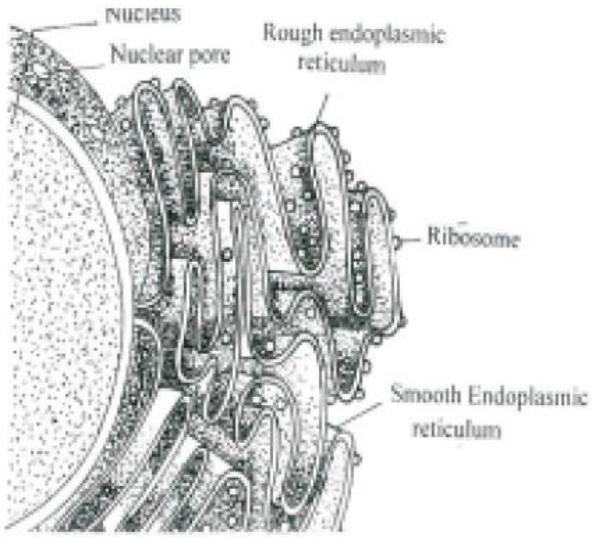


Fig. Golgi body under an electron
Note the ribosomes present in ER.

Fig. ER under an electron microscope.

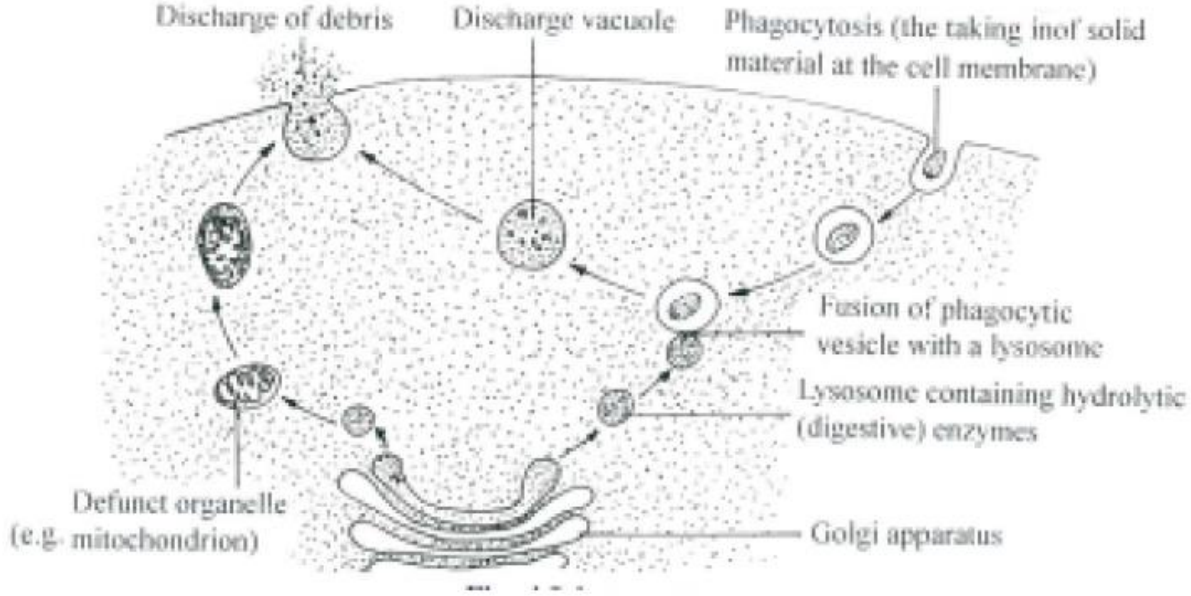
Endoplasmic reticulum (ER)	**Ribosomes**	**Golgi body**
Structure A network of membranes with thickness between 50 - 60A°. It is of two types– rough endoplasmic reticulum (RER) i.e. when ribosomes are attached to it and Smooth-endo-plasmic reticulum (SER) when no ribosomes are present.	Spherical about 150 - 250Å in diameter, made up of large molecules of RNA and proteins (ribonucleo proteins).	Is a stack of membranous sacs of the same thickness as ER. Exhibit great diversity in size and shape.
Throughout the cytoplasm and is in contact with the cell membrane as well as the nuclear membrane.	Present either as free particles in cytoplasm or attached to ER. Also found stored in nucleolus inside the nucleus. 80S types found in eukaryotes and 70S in prokaryotes (Ssvedberg unit of measuring ribosomes).	In animal cells present around the nucleus, 3 to 7 in number. In plant cells, many and present scattered throughout the cell called dictyosomes.
Function Provides internal framework, compartment and reaction surfaces, transports enzymes and other materials throughout the cell. RER is the site for protein synthesis and SER for steroid synthesis, stores carbohydrates.	Site for protein synthesis.	Synthesis and secretion as enzymes, participates in transformation of membranes to give rise to other membrane structure such as lysosome, acrosome, and dictyosomes, synthesize wall element like pectin, mucilage.

QUESTIONS. Given below is a list of functions, relate them to their respective organelles:
(a) synthesis of some enzymes .....

(b) synthesis of steroids .....
(c) storage of carbohydrates .....
(d) Intracellular transport .....
(e) Synthesis of proteins .....
2. Name the equivalent structure of Golgi body in plants. Mention two differences between their structures.
(i) ……..…. (ii) …….....……
3. Mention any two advantages of the extensive network of endoplasmic reticulum?
(i) …….. (ii) ……...……
4. What are the three places where ribosomes occur in a cell?
.....
5. Name the membrane system that connects the nuclear membrane with the cell membrane?
.....

The microbodies (tiny but important)
These are small sac-like structures bounded by their membranes. These are of different kinds of which we will take up three like lysosomes, peroxisomes and glyoxysomes.

Lysosomes (lysis = breaking down; soma = body)
Lysosomes are present in almost all animal cells and some non - green plant cells. They perform intracellular digestion.



Some main features of lysosomes are as follows :
(i) Membranous sacs budded off from golgi body.
(ii) May be in hundreds in single cell.
(iii) Contain several enzymes (about 40 in number)
(iv) Materials to be acted upon by enzymes enter the lysosomes.
(v) Lysosomes are called “suicidal bags” as enzymes contained in them can digest the cell’s own material when damaged or dead.

Importance of intracellular digestion by the lysosomes
(i) help in nutrition of the cell by digesting food, as they are rich in various

enzymes which enable them to digest almost all major chemical constituents of the living cell.
(ii) Help in defence by digesting germs, as in white blood cells.
(iii) Help in cleaning up the cell by digesting damaged material of the cell.
(iv) Provide energy during cell starvation by digestion of the cells own parts (autophagic, auto : self; phagos: eat up).
(v) Help sperm cells in entering the egg by breaking through (digesting) the egg membrane.
(vi) In plant cells, mature xylem cells lose all cellular contents by lysosome activity.
(vii) When cells are old, diseased or injured, lysosomes attack their cell organelles and digest them. In other words lysosomes are autophagic, i.e. self-devouring.

Peroxisomes
Found both in plant and animal cells. Found in the green leaves of higher plants.

- They participate in oxidation of substrates resulting in the formation of hydrogen peroxide.
- They often contain a central core of crystalline material called nucleoid composed of urate oxidase crystals.
- These bodies are mostly spherical or ovoid and about the size of mitochondria and lysosomes.
- They are usually closely associated with E.R.
- They are involved in photorespiration in plant cells.
- They bring about fat metabolism in cells.

Glyoxysomes
The microbodies present in plant cells and morphologically similar to peroxisomes.
Found in the cell of yeast and certain fungi and oil rich seeds in plants.
Functionally they contain enzyme of fatty acid metabolism involved in the conversion of lipids to carbohydrates during germination.

QUESTIONS
1. Why are lysosomes called suicidal bags?
.....
2. List the usefulness of intracellular digestion by lysosomes
.....
3. What is the function of peroxisomes in plant cells
.....

Cilia and flagella (the organelles for mobility)
(i) Some unicellular organisms like *Paramecium* and *Euglena* swim in water with the help of cilia and flagella respectively.
(ii) In multicellular organism some living tissues (epithelial tissues) have cilia. They beat and create a current in the fluid in order to move in a given direction e.g. in the wind pipe (trachea) to push out the mucus and dust particles.
(iii) Cilia beat like tiny oars or pedals (as in a boat) and flagella bring about whip-like lashing movement.
(iv) Both are made up of contractile protein tubulin in the form of microtubules.
(v) The arrangement of the microtubules in termed 9 + 2, that is, two central microtubules and nine set surrounding them.

Cilia	Flagella
shorter (5 to 10µm)	longer (15µm)
several 100 per cell structure : protoplasmic projection and membrane bound	usually 1 or 2 in most cells
consist of 9 sets of peripheral microtubules and 1 set of tubules in the centre	same as in cilia

Centriole
It is present in all animal cells (but not in *Amoeba*), located just outside the nucleus.
It is cylindrical, 0.5µm in length and without a membrane. It has 9 sets of peripheral tubules but none in the centre. Each set has three tubules arranged at definite angles. It has its own DNA and RNA and therefore it is self-duplicating.

Function : Centrioles are involved in cell division. They give orientation to the 'mitotic spindle' which forms during cell division

Basal bodies
These are structures similar to centrioles. They have the same nine sets of triplet organization, as in the centrioles. The cilia and flagella appear to arise from the basal bodies.

NUCLEUS (THE HEREDITARY ORGANELLE)
General structure of nucleus :
(i) It is the largest organelle seen clearly when the cell is not dividing.
(ii) It stains deeply, is mostly spherical, WBC have lobed nuclei.
(iii) It is mostly one in each cell (uninucleate, some cells have many nuclei; (multinucleate).
(v) Double layered nuclear membrane enclosing nucleoplasm which contains chromatin network and a nucleolus.
Functions
Maintains the cell in a working order.
Co-ordinates the activities of organelles.
Takes care of repair work.
Participates directly in cell division to produce genetically identical daughter cells, this division is called mitosis.
Participates in production of gametes through another type of cell division called meiosis.

The part of a nucleus includes:

1. Nuclear membrane
- Double layered membrane is interrupted by large number of pores.
- Membrane is made up of lipids and proteins (like plasma membrane) and has ribosomes attached on the outer membrane which make the outer membrane rough.
- The pores allow the transport of large molecules in and out of nucleus, and the membranes keep the hereditary material in contact with the rest of the cell.

2. Chromatin

- Within the nuclear membrane there is jelly like substance (karyolymph or nucleoplasm) rich in proteins.
- In the karyolymph, fibrillar structures form a network called *chromatin fibrils*, which gets condensed to form distinct bodies called **chromosomes** during cell division. On staining the chromosomes, two regions can be identified in the chromatin material heterochromatin dark and autromaticn (light). Heterochromatin has less DNA and genetically less active than euchromatin which has more DNA and genetically more active.

- Number of chromosomes is fixed in an organism. During cell division chromosomes divide in a manner that the daughter cells receive identical amounts of hereditary matter.

3. Nucleolus

- Membraneless, spheroidal bodies present in all eukaryotic cells except in sperms and in some algae.
- Their number varies from one to few, they stain uniformly and deeply.
- It has DNA, RNA and proteins.
- Store house for RNA and proteins; it disappears during cell division and reappears in daughter cells.
- Regulates the synthetic activity of the nucleus.
- Thus nucleus and cytoplasm are interdependent, and this process is equal to nucleo-cytopalsmic interaction.

QUESTIONS

1. Why cannot the cell survive without the nucleus?

.....

2. Explain the following terms:

(a) chromatin network..... .....

(b) chromosomes .....

3. What is the function of the nucleolus in the cell?

.....

MOLECULES OF THE CELL

The cell and its organelles are made of organic chemicals such as proteins, carbohydrates, nucleic acid and fats. These are aptly termed biomolecules. Inorganic molecules such as water and minerals are also present in the cell.

A. Water

- Water with unique physical and chemical properties has made life possible on earth.
- It is a major constituent of protoplasm.
- It is a medium in which many metabolic reactions occur.
- It is universal solvent in which most substances remain dissolved.
- It is responsible for turgidity of cells.

B. Elements necessary for life

Elements	Functions
Hydrogen, Carbon, Oxygen, Nitrogen, Calcium, Potassium, Sodium,	1. Required for organic compounds of the cell and present as major constituents.

Magnesium, Phosphorous, Sulphur, Chlorine, Iron, Boron, Silicon, Manganese, Copper, Zinc, Cobalt, Molybdenum, Silicon	(C, H, O, N as organic compounds in plant cell wall) 2. Act as major cations (Na, K) and anions (Cl) in most physiological process. 3. As cofactor of enzymes participate in most of the biochemical reaction of a cell (Fe, Cu, Mo, Zn, B) 4. Involved in energy transfer reactions (P in ATP). 5. Green pigment chlorophyll in plants have magnesium in the centre.

C. Biomolecules

	Structure	Functions
CARBOHYDRATE	1. Composed of C, H and O 2. Simple six carbon sugar (glucose) is called a Monosaccharide. 3. Two molecules or units join together to form disaccharide (sucrose). 4. More than ten units of monosaccharides join in a chain to form a polysaccharide e.g. starch and cellulose.	1. Most abundant organic substance present in nature in the form of cellulose in plant cell wall. 2. In both plants and animals it is used as a source of energy (sugar). 3. An important storage form in plants is starch and in animals it is glycogen. 4. Present in nucleic acids as five carbon surgar (Ribose).
Amino acid	1. Basic amino acid structure shows that the central carbon atom is attached with an amino group (–NH2), a carboxylic acid group (–COOH), one hydrogen and one side group (R). 2. There are 20 different side groups which give 20 different amino acids.	1. Plants have the ability to utilize inorganic nitrogen and synthesize amino acid. 2. In animals principal source of amino acid is the plant or animals that it consumes in its diet (pulses are rich in protein).

Proteins	1. Composed of C, H, O and N. 2. Amino acids join together by "peptide" bonds to form protein molecules. 3.Twenty different amino acids make numerous simple and complex protein. 4. Based on the complexity of structure they can have primary, secondary, tertiary and quaternary structures. 5. When proteins exist with other molecules they are known as conjugated proteins e.g. glycoprotein, lipoprotein, chromoprotein etc.	1. Structurally proteins form integral part of the membranes 2. Functionally in the form of enzymes they play a vital role in metabolic reactions. 3. Synthesis of DNA is regulated by proteins. 4. Proteins are so important that nucleic acids directly regulates protein synthesis
Nucleic Acids	1. They are of two types: Deoxyribose nucleic acid (DNA) and Ribosose nucleic acid (RNA) 2. They are long chain polymers composed of units called **nucleotides**. 3. Each nucleotide has pentose sugar, nitrogen base and phosphate group. 4. DNA has one oxygen less in its sugar molecule.	1. DNA is the main genetic material for almost all organisms except certain viruses. 2. RNA molecules are involved in information transfer and protein synthesis.
Lipids	1. Composed of C, H, O. Amount of oxygen is very less. 2. They are synthesized from fatty acids and glycerol. Simple lipids are called glycerides. 3. Fats can be saturated or unsaturated. 4. Fats are solid at room temperature, those that remain liquid at room temperature are called oils.	1. Due to their low oxygen content, they store and release more energy during oxidation 2. A molecule of fat can yield twice as much energy as from carbohydrate. 3. Phospholipids are important component of cell membranes.
Vitamins	1. Vitamins are organic compounds required in the diet of animals for their healthy growth. 2. Vitamins are classified according to their solubility into two groups : Water soluble vitamin B and ascorbic acid and fat soluble vitamins (viz. A, D, E, K) 3. Plants have the ability to synthesize vitamines from CO2, NH3 and H2S.	1. Vitamins (from plant) are essential nutrients in animals diet as animals cannot synthesise such compounds. 2. Their deficiency cause various diseases in animal, like deficiency of vitamin B causes"beri-beri" and that of vitamin C causes scurvy. 3. Vitamin A present in carotene pigment of carrot. Vitamin D can be produced by man with the help of sunlight. Vitamin K produced by bacteria in human intestine.

Hormone	1.Hormones are specific organic substances effective in low concentrations, synthesized by cells in one part of the organism and then transported to another part of the organism, where it produces characteristic physiological responses.	1. In animals hormones are produced in glands called endocrine glands which control all biochemical activities of the organism 2. In animals hormones may be proteins, peptides or steroids. 3.In plants hormones (growth regulators) are generally produced in metabolically active cells and control the vegetitive and reproductive growth of the entire plant.
Alkaloids	1. Alkaloids are complex organic compounds made of C, H, O and N. alkaloids e.g. Quinine from cinehona plant. Ephedrine from Ephedra Morphine from poppy plants 2. Alkaloid in plants are produced from amino acids.	1. The active principles of drugs from medicinal plants are generally
Steroids	1. These are fat soluble lipid compounds synthesized from cholesterol. 2. They are produced by the reproductive organs like ovaries, testes and placenta and also by adrenal glands. 3. They include testosterone, estrogen, cortisol etc.	

QUESTIONS

1. What is the importance of water in a living cell.
.....
2. What is the basic molecule in starch?
.....
3. What is a peptide bond and where do you find it?
.....
4. Which is the most energy containing biomolecule in living organisms?
.....
5. What are nucleotides?
.....