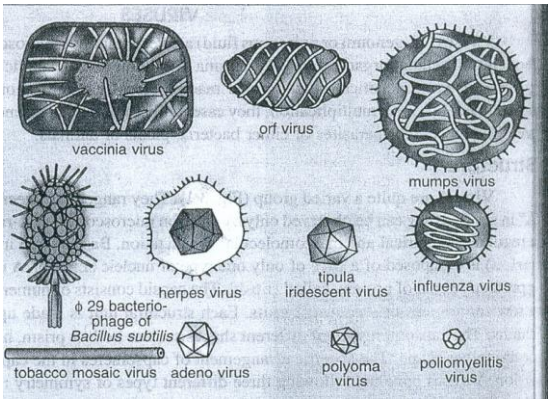
Objective Type Question

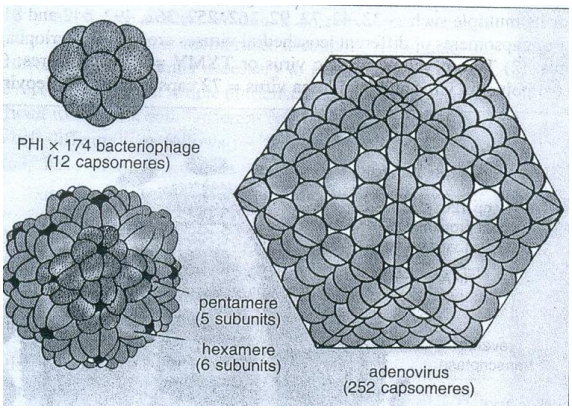
i-a; ii- c; iii-a; iv-a; v- a; vi- a; vii- b; viii- a; ix- a ; x- a

Answer for Descriptive question

Ans 2. Types of Virus: Viruses belong to quite varied group ranging between 30 or 300nm tp 3000 A^O in size and can only be observed by electron microscope and X ray crystallography. They possess a regular and macromolecular organization. A typical virus (infective) is known **as virion** and is composed of **core of only one type of nucleic acid (DNA or RNA).** It is wrapped with in a protective coat of protein called **Capsid.** Capsid consists of numerous capsomeres with their own structure **of few monomer or structural units.** Capsomeres are of different shapes such as hallow prism, hexagonal, pentagonal, and lobular or may be other more shapes. The specific arrangement of capsomeres in the Capsid determines the shape of any virion. Based on the specific symmetry viruses are classified under following three categories:

1. **Icosahedral symmetry (spherical, cubical or polygonal – 20 sided)**
   Example : i. Bateriophage ϕ (0phi) x 174 =12 pentomere;
   Tunip yellow mosaic viruses (TYMV) = 32 capsomeres
   Poliovirus = 32 capsomeres
   Polyoma and papilloma virus = 72 capsomere
   Retrovirus 92 capsomeres
   Herpes Virus = 162 capsomeres
   Adenovirus =252 capsomeres





2. **Helical or cylindrical symmetry:** The rod shaped helical capsid of viruses such as Tobacco Mosaic Virus (TMV); bacteriophage M 13; Influenza virus etc

3. **Complex symmetry: Viruses with complex shaped capsid are of two shapes**

   i. **Without identifiable Capsid (pox, cowpox etc)**
   ii. **With tadpole shaped structure (T-even phages of *E. coli*; T_2 phages**

Structural Detail of Tobacco Mosaic Virus

Tobacco mosaic virus (TMV). TMV is the most extensively studied plant virus. It was discovered by **Iwanowski** (1892) and obtained in a pure state (*i.e.,* in paracrystalline form) by **Stanley** (1935). **Bawden** and **Pirie** (1937) extensively purified TMV and showed it to be a nucleoprotein containing RNA. **H.Fraenkel-Conrat** experimentally demonstrated that RNA is the genetic substance of TMV.

TMV is a rod-shaped, helically symmetrical RNA virus Each virus particle is elongated, cigarette-like in shape having the length of 3000A^0 (300 nm) and diameter of 160 A^0 (16 nm; see **De Robertis** and **De Robertis, Jr.**, 1987). In each rod of TMV, there are about 2130 identical elliptical protein subunits or capsomeres. The capsomeres are closely packed and arranged in a helical manner around the RNA helix, forming a hollow cylinder. Thus, there is a hollow core (axial hole) of about 40A^0 (4nm) diameter which runs the entire length of the rod and contains the RNA molecule. The RNA molecule does not occupy the hole but is deeply embedded in the capsomeres. RNA of TMV is a single-stranded molecule consisting of 6500 nucleotides and is in the form of a long helix extending the whole length of viral particle. Lastly, there are about 16 capsomeres in each helical turn. Each capsomere contains about 158 amino acids and has a molecular weight of 18000 daltons. The whole TMV capsid has all amino acids found in other plant proteins.

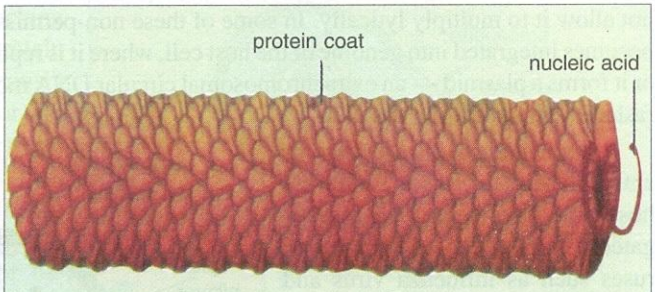


Fig. Molecular organization of the tobacco mosaic virus (TMV) (after De Robertis and De Robertis, Jr., 1987).

TMV infects the leaves of tobacco plant. It is transmitted and introduced into the host cell by some vector or by mechanical means such as rubbing, transplanting and handling. Once inside the host cell, the viral RNA directs the metabolic systems of host to synthesize its own proteins and to replicate (multiply) its RNA molecule. All the raw materials for RNA replication and capsomere biosynthesis are derived from the host cell. Ultimately when numerous viral particles are formed by self-assembly method inside the host cell, they are released after lysis of the cell. Recently, it was found that plant viruses exploit the route of plasmodesmata to pass from cell to cell. For example, TMV is found to produce a 30,000 dalton protein called P_{30} which tends to enlarge the plasmodesmata in order to use this route to pass or spread its infection from cell to cell

Ans 3. Describe three basic components of cell theory. Give a brief note about Prions.

Matthias Schleiden (1838) concluded that plants were made of cells and that the plant embryo arose from a single cell.

Theodor Schwann (1839) concluded that the cells of plants and animals are similar structures and proposed these two tenets of the **cell theory**:

- All organisms are composed of one or more cells.
- The cell is the structural unit of life.

Rudolf Virchow (1855) gave the third tenet of the cell theory:

- Cells can arise only by division from a preexisting cell.

Prions

Prion are proteinaceous infectious particle without any genetic material. They are known for causing neurodegenerative diseases such as scrapie in sheep and goat, Creutzfeld-Jakob Disease (CJD) in human beings and Mad Cow Disease in cow. Suffering animals lose coordination of their movements, tend to scrape or rub their skin, and eventually cannot walk. Prion seems to be a 33 to 35-kDa hydrophobic membrane protein, often called PrP (for **pr**ion **p**rotein). The *PrP* gene is present in many normal vertebrates and invertebrates, and the prion protein is bound to the surface of neurons.

Ans 4. Membranes are flexible, self-sealing, and selectively permeable to polar solutes.

E. Gorter and F. Grendel (1925) first proposal that cellular membranes might contain a lipid bilayer.

Hugh Davson and James Danielli (1935) proposed **lipoprotein model** of the plasma membrane. Plasma membrane was composed of a lipid bilayer that was lined on both its inner and outer surface by a layer of globular proteins. Later several modifications were done in this model.

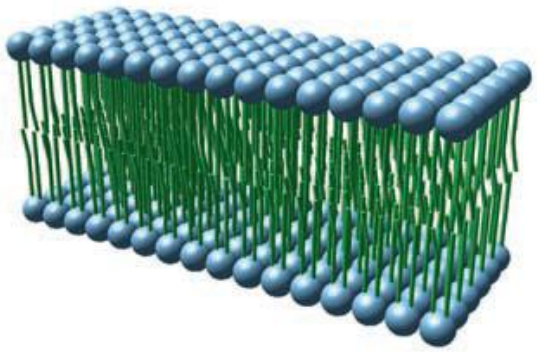


Figure 1 Gorter & Grendel Model

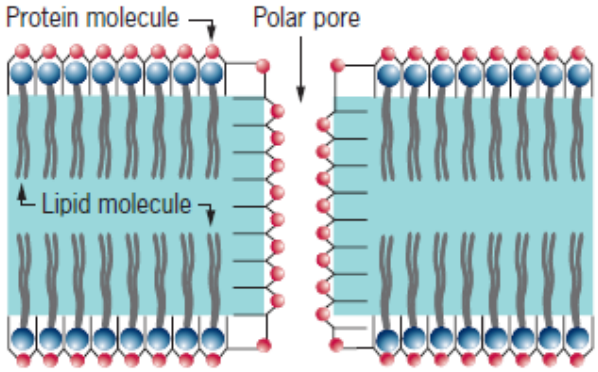


Figure 2 Davson-Danielli Model

Robertson (1953) gave **unit membrane model**. The unit membrane is considered to be trilaminar, with a bimolecular lipid layer between two protein layer. Later on, it was proved artifacts.

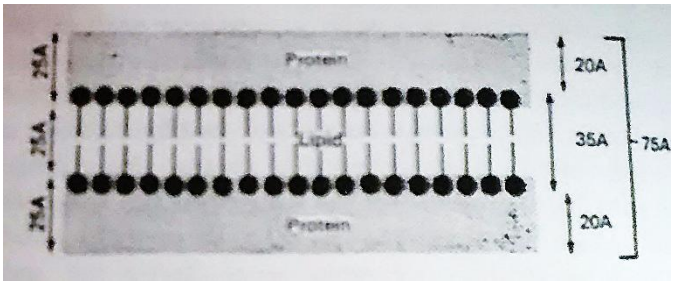


Figure 3 Unit Membrane Model

Fluid Mosaic Model

Fluid mosaic model was proposed in 1972 by S. Jonathan Singer and Garth Nicolson. This model is the "central dogma" of membrane biology. According to this modells, the lipid bilayer is present in a fluid

state, and individual lipid molecules can move laterally within the plane of the membrane. The model presents cellular membranes as dynamic structures in which the components are mobile and capable of coming together to engage in various types of transient or semipermanent interactions. The membrane mosaic is fluid because most of the interactions among its components are noncovalent, leaving individual lipid and protein molecules free to move laterally in the plane of the membrane.
Phospholipids form a bilayer in which the nonpolar regions of the lipid molecules in each layer face the core of the bilayer and their polar head groups face outward, interacting with the aqueous phase on either side. Proteins are embedded in this bilayer sheet.

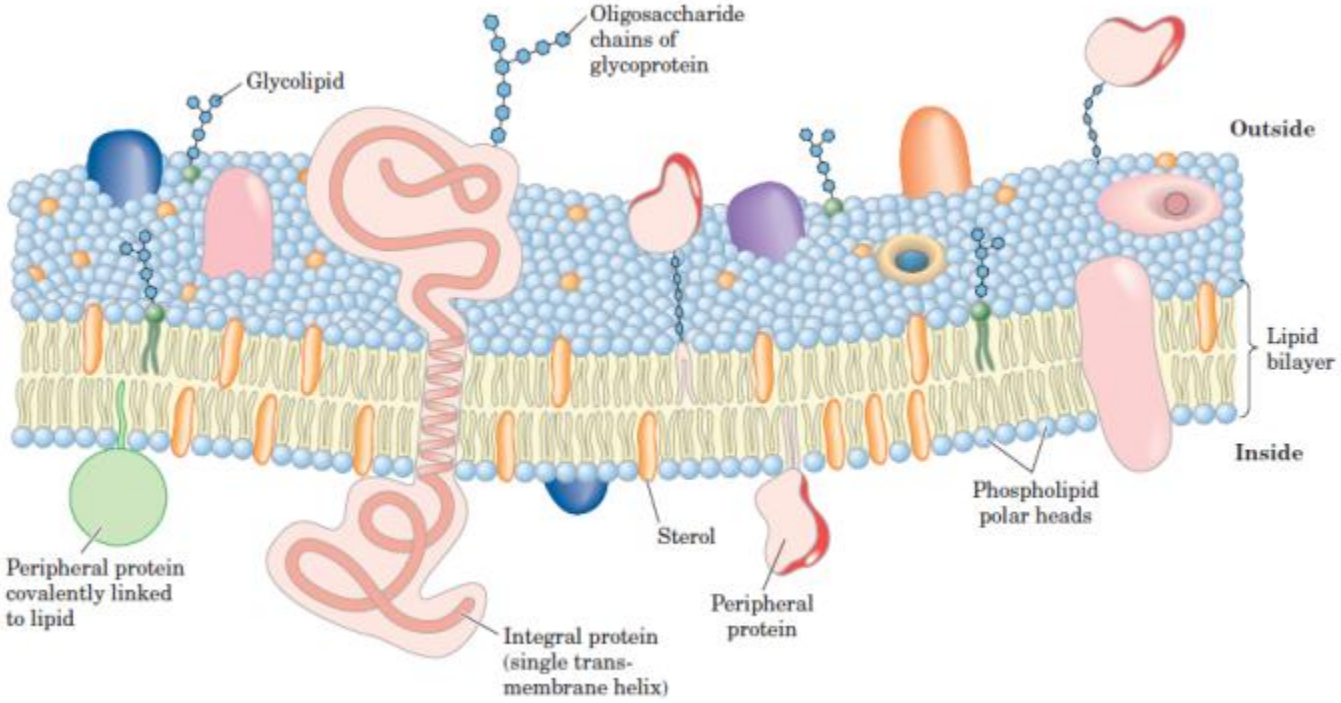


Figure 4Fluid Mosaic Model

Integral proteins penetrate the lipid bilayer. They are extractable with detergents, organic solvents, or denaturants. Integral proteins covalently attached to a membrane lipid can be released by treatment with phospholipase C. They are transmembrane proteins; that is, they pass entirely through the lipid bilayer and thus have domains that protrude from both the extracellular and cytoplasmic sides of the membrane.
Peripheral proteins that are located entirely outside of the lipid bilayer, on either the cytoplasmic or extracellular side, yet are associated with the surface of the membrane by noncovalent bonds; electrostatic interactions and hydrogen bonding with the hydrophilic domains of integral proteins and with the polar head groups of membrane lipids. For example, cytochrome *c*.
Lipid-anchored proteins that are located outside the lipid bilayer, on either the extracellular or cytoplasmic surface, but are covalently linked to a lipid molecule that is situated within the bilayer.

Ans 5. Active transport is the movement of biochemicals from the region of lower concentration to the region of higher concentration; hence, it requires energy. Passive transport is the movement of biochemicals from the region of high concentration to the region of low concentration; hence, it does not require energy.

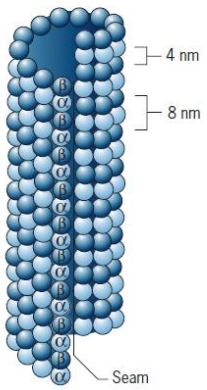
	Active Transport	Passive Transport
Definition	Movement of molecules AGAINST the concentration gradient. Transport occurs from a lower concentration of solute to higher concentration of solute. Requires cellular energy.	Movement of molecules DOWN the concentration gradient. It occurs from higher to lower concentration. Does not require cellular energy.
	Disrupts equilibrium established by diffusion.	Maintains dynamic equilibrium of water, gases, nutrients, wastes, etc. between cells and extracellular fluid.
Types of Particles Transported	proteins, ions, large cells, complex sugars.	Anything soluble (meaning able to dissolve) in lipids, small monosaccharides, water, oxygen, carbon dioxide, sex hormones, etc.
Examples	phagocytosis, pinocytosis, sodium/potassium pump, secretion of a substance into the bloodstream (process is opposite of phagocytosis & pinocytosis)	diffusion, osmosis, and facilitated diffusion.
Importance	Amino acids, sugars and lipids need to enter the cell by protein pumps, which require active transport.	Wastes (carbon dioxide, water, etc.) diffuse out and are excreted; nutrients and oxygen diffuse in to be used by the cell

Cytoskeleton:

Microfilaments are approximately 8 nm in diameter and composed of globular subunits of the protein, **actin**. In the presence of ATP, actin monomers polymerize to form a flexible, helical filament. As a result of its subunit organization, an actin filament is essentially a two-stranded structure with two helical grooves running along its length. The terms *actin filament*, *F-actin*, and *microfilament* are basically synonyms for this type of filament. Because each actin subunit has polarity and all the subunits of an actin filament are pointed in the same direction, the entire microfilament has polarity. Consequently, the two ends of an actin filament have different structures and dynamic properties.

Intermediate filament (IF) is solid, unbranched filaments with a diameter of 10–12 nm. Intermediate filaments have only been identified in animal cells (absent in plant cell). Intermediate filaments are strong, flexible ropelike fibers that provide mechanical strength to cells that are subjected to physical stress, including neurons, muscle cells, and the epithelial cells that line the body's cavities. IFs are a chemically heterogeneous group of structures that, in humans, are encoded by approximately 70 different genes.

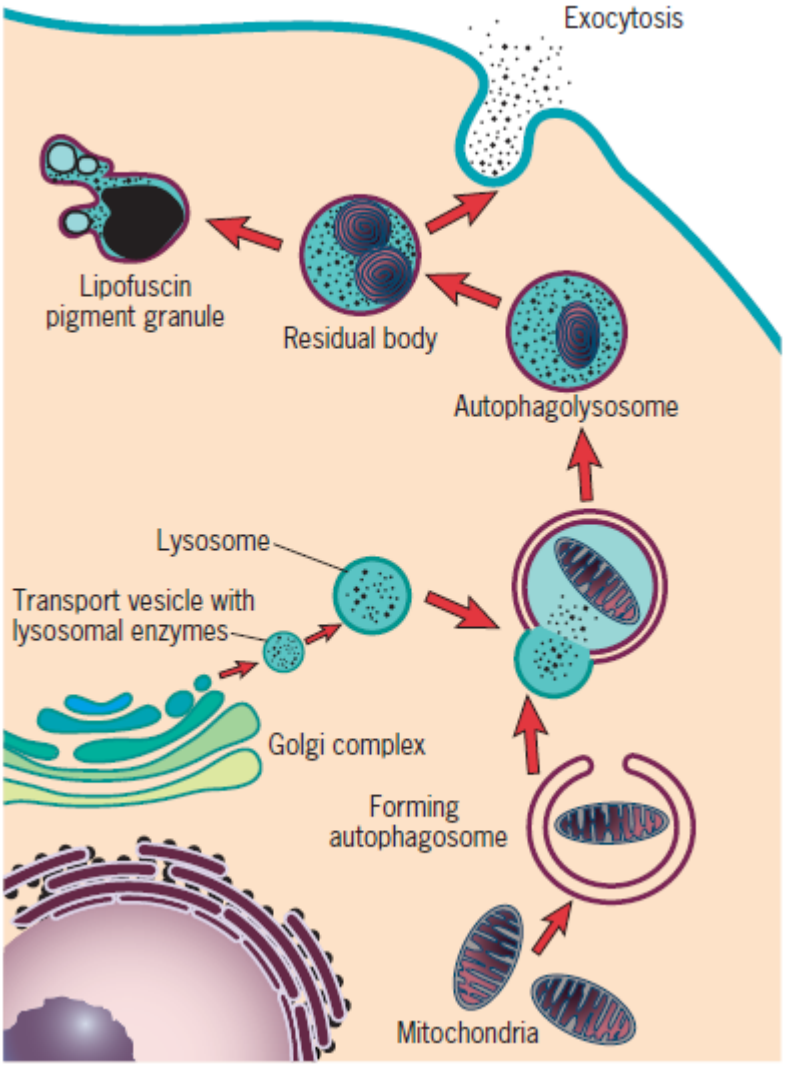
Microtubules are components of many types of structures such as mitotic spindle of dividing cells and the core of cilia and flagella. Microtubules have an outer diameter of 25 nm and a wall thickness of approximately 5 nm, and may extend across the length or breadth of a cell. The wall of a microtubule is composed of globular proteins arranged in longitudinal rows, termed **protofilaments** that are aligned parallel to the long axis of the tubule. In cross section, microtubules are seen to consist of 13 protofilaments aligned side by side in a circular pattern within the wall. Non-covalent interactions between adjacent protofilaments are thought to play an important role in maintaining microtubule



structure. Each protofilament is assembled from dimeric building blocks consisting of one α-tubulin and one β-tubulin subunit.

The two types of globular tubulin subunits have a similar three-dimensional structure and fit tightly together. The tubulin dimers are organized in a linear array along the length of each protofilament. Because each assembly unit contains two nonidentical components (a heterodimer), the protofilament is asymmetric, with an α-tubulin at one end and a β-tubulin at the other end. All of the protofilaments of a microtubule have the same polarity. Consequently, the entire polymer has polarity. One end of a microtubule is known as the *plus end* and is terminated by a row of β-tubulin subunits. The opposite end is the *minus end* and is terminated by a row of α- tubulin subunits.

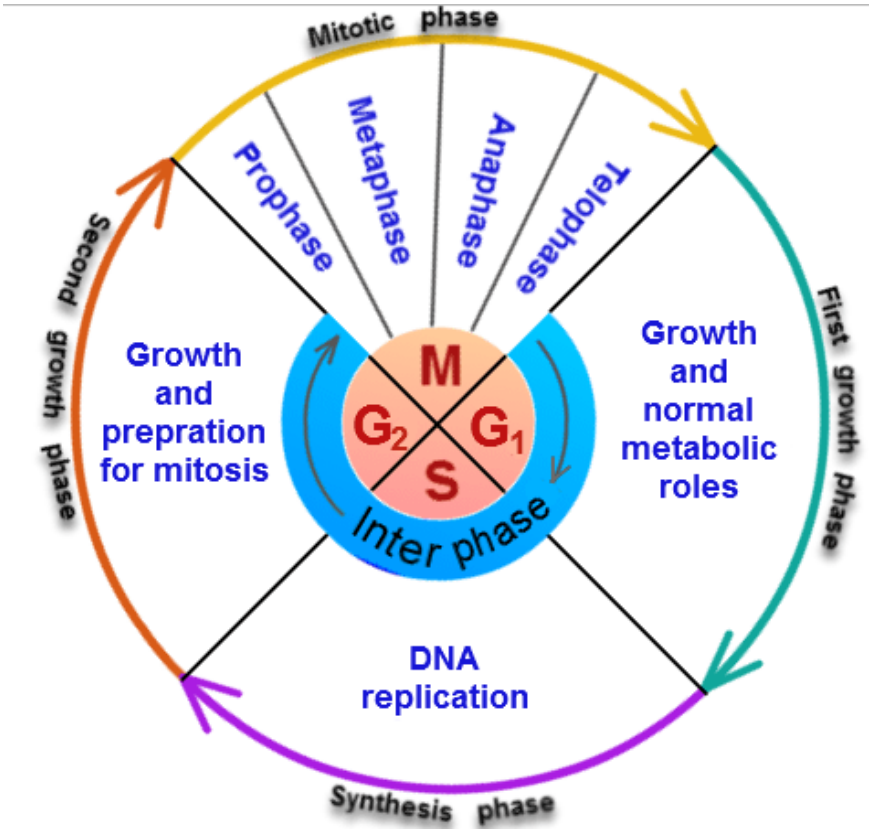
Lysosomes are an animal cell's digestive organelles. A typical lysosome contains at least 50 different hydrolytic enzymes produced in the rough ER and targeted to these organelles. Lysosomal enzymes can hydrolyze virtually every type of biological macromolecule. The enzymes have their optimal activity at an acid pH and thus are **acid hydrolases**. The pH optimum of these enzymes is approximately 4.6. The high internal proton concentration is maintained by a proton pump (an H^+_-ATPase) present in the organelle's boundary membrane. Lysosomal membranes contain a variety of highly glycosylated integral proteins whose carbohydrate chains are thought to form a protective lining that shields the membrane from attack by the enclosed enzymes. Lysosomes also play a key role in organelle **turnover**, that is, the regulated destruction of the cell's own organelles and their replacement. During this process, which is called **autophagy**, an organelle, such as the mitochondrion to produce a structure called an *autophagosome*. The outer membrane then fuses with a lysosome to produce an *autophagolysosome* in which the enclosed organelle is degraded and the breakdown products are made available to the cell.

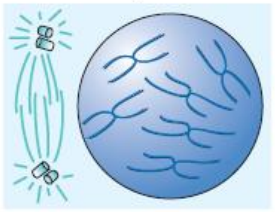
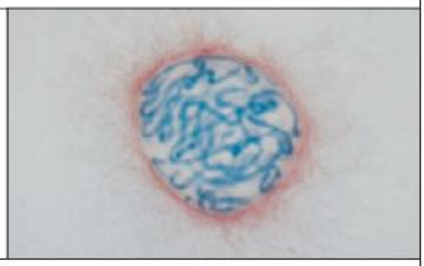
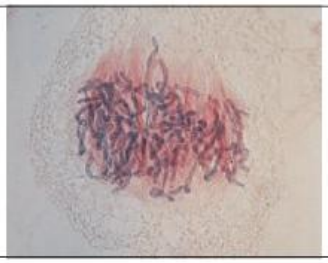
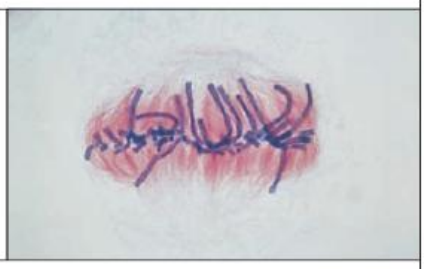
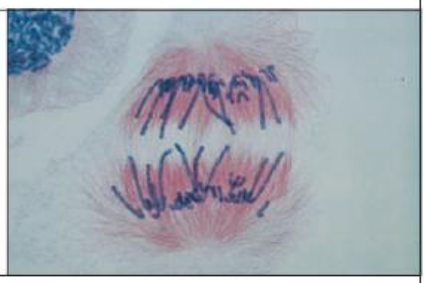
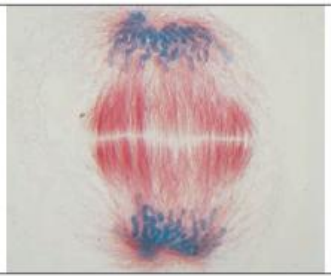


Ans 6.

Cell cycle is an ordered set of events, which terminate in cell growth and division into two daughter cells. Non-dividing cells are not considered to be in the cell cycle. The stages of cell cycle are G1-S-G2-M. The G1 stage stands for "GAP 1". The S stage stands for "Synthesis". This is the stage when DNA replication occurs. The G2 stage stands for "GAP 2". The M stage stands for "mitosis", and is when nuclear (chromosomes separate) and cytoplasmic (cytokinesis) division occur.

Cell cycle is regulated by a small number of heterodimeric protein kinases. The concentration of the regulatory subunits of these kinases, called cyclins increase or decrease in phase with cell cycle. Their catalytic subunits are called cyclin dependent kinases (cdks).



Prophase		
1. Chromosomal material condenses to form compact mitotic chromosomes. Chromosomes are seen to be composed of two chromatids attached together at the centromere. 2. Cytoskeleton is disassembled, and mitotic spindle is assembled. 3. Golgi complex and ER fragment. Nuclear envelope disperses.		
Prometaphase		
1. Chromosomal microtubules attach to kinetochores of chromosomes. 2. Chromosomes are moved to spindle equator.		
Metaphase		
1. Chromosomes are aligned along metaphase plate, attached by chromosomal microtubules to both poles.		
Anaphase		
1. Centromeres split, and chromatids separate. 2. Chromosomes move to opposite spindle poles. 3. Spindle poles move farther apart.		
Telophase		
1. Chromosomes cluster at opposite spindle poles. 2. Chromosomes become dispersed. 3. Nuclear envelope assembles around chromosome clusters. 4. Golgi complex and ER reforms. 5. Daughter cells formed by cytokinesis.		

Ans. 7.

Necrosis	Apoptosis
Morphological features	
Loss of membrane integrity	Membrane blebbing, but no loss of integrity
	Aggregation of chromatin at the nuclear membrane
Begins with swelling of cytoplasm and mitochondria	Begins with shrinking of cytoplasm and condensation of nucleus
Ends with total cell lysis	Ends with fragmentation of cell into smaller bodies
No vesicle formation, complete lysis	Formation of membrane bound vesicles (apoptotic bodies)
Disintegration (swelling) of organelles	Mitochondria become leaky due to pore formation Involving proteins of the bcl-2 family.
Biochemical features	
Loss of regulation of ion homeostasis	Tightly regulated process involving activation and enzymatic steps
No energy requirement (passive process, also occurs at 4^{o} C	Energy (ATP)-dependent (active process, does not occur at 4°C)
Random digestion of DNA (smear of DNA after agarose gel electrophoresis)	Non-random mono- and oligonucleosomal length fragmentation Of DNA (Ladder pattern after agarose gel electrophoresis)
Postlytic DNA fragmentation (= late event of death)	Prelytic DNA fragmentation
	Release of various factors (cytochrome C, etc.) into cytoplasm by mitochondria
	Activation of caspase cascade
	Alterations in membrane asymmetry (i.e., translocation of phosphatidylserine from the cytoplasmic to the extracellular side of the membrane)

Normal cell ↓		**Cancer cell** ↓
Normal cells are uniform and orderly.	Cell size and shape ↔	Cancer cells have large variations in cell size and shape. Often, they have a large irregularly shaped nucleus and a relatively small cytoplasm.
Normal cells grow, divide and die in a controlled way and with a predictable lifespan. Normal cells destroy themselves if they become damaged (through a process called apoptosis).	Cell division and death ↔	Cancer cells exhibit uncontrolled growth as they have lost their normal control mechanisms. They grow and divide at a rapid rate and they outlive their normal lifespan (i.e. become immortal). They may also be able to prevent self-destruction when damaged.
Normal cells become specialised or 'mature'. They start out as immature cells (stem cells) and acquire specific functions when they mature.	Specialisation of cells ↔	Cancer cells do not carry on maturing once they have become cancerous. In fact, the cancer cells can become less mature over time. Cancer cells can lose specialised functions and become more and more primitive.
Normal cell growth and healing is very orderly and precise. The cells know when there are enough new cells to mend the body. They send chemical messages to each other so that they stop growing and reproducing.	Obeying signals ↔	Something in the cancer cells overrides the normal signalling system. This may be because the genes that tell the cell to reproduce keep on and on sending signals or because the genes that normally tell the cell to stop reproducing have been damaged or lost.
Cells have a natural ability to stick together in the right place (cell adhesion). Molecules on the surface of the cell match those on its neighbours. Normal cells maintain their diploid chromosomal complement as they grow and divide, both in vivo and in vitro.	Cells sticking together ↔	Cancer cells can lose the molecules on their surface that keep normal cells in the right place so they can become detached from their neighbours. Cancer cells are genetically unstable and often have highly aberrant chromosome complements, a condition termed *aneuploidy*.

Conclusion

The key difference between normal and cancerous cells is that cancer cells have lost the restraints on growth that characterise normal cells.

Cancers are classified according to the tissue and cell type from which they arise.

Carcinomas: Cancers arising from epithelial cells are termed carcinomas. They are ecrodermal or endodermal in origin. For example, cervical, breaset, skin, and brain carcinoma.

Sarcomas: Cancers arising from connective tissue or muscle cells are termed sarcomas. They are of mesodermal origin. For example, tumors form connective tissue, cartilage, bone, and muscles.

Leukemia: they are neoplastic growth of leucocytes; characterized by excessive production of the cells. Tthey constitute 4% of human cancers.

Lymphomas: they are excessive production of lymphocytes by spleen and lymph nodes. For example, Hodgkin's disease.