2. CELL BIOLOGY

1. What are the ideas are in the cell theory?
   ➢ the cells are the building block of structures in living things
   ➢ the cell is derived from other cells by division
   ➢ the cell contains information that is used as instructions for growth, development and functioning
   ➢ the cell is the functioning unit of life; the chemical reactions of life take place within cells.

2. What is cell biology?
   The idea and concept of cell biology evolved during the 19th century as a result of gradual advancement in the field of microscopy and biochemistry.
   Today the study of the structure of cells (cytology) is part of a major branch of biology known as cell biology.

3. What are new branches related to cytology?
   Cytotaxonomy, Cytogenetics, Cell physiology, Cytochemistry, Molecular Biology, Cytopathology and Cytoecology.

4. Why we need microscope?
   The cells are very minute and complex organisations.
   The small dimensions and transparent nature of cell and its organelles pose problems to cell biologists trying to understand its organisation and functioning.
   Various instruments and techniques have been developed to study cell structure, molecular organization and function.

5. Write the SI units are used in the biology?
   1 metre (m) = 1000 millimetres (mm)  1 mm (10^-3 m) = 1000 micrometres (µm)  1 µm (10^-6 m) = 1000 nanometres (nm)  1 nm (10^-9 m) = 1000 picometres (pm)
   The Angstrom (Å) is 10^-10 m.

   The ability to reveal minute details is expressed in terms of limit of resolution. It is “the smallest distance that may separate two points on an object and still permit their observation as distinct separate points”.
   The resolving power of naked human eye is 0.1 mm or 100 µm. It means that we cannot differentiate any points that are closer than this. Hence we need instruments capable of high resolution to see smaller objects.

7. What is magnification?
   Power of magnification is different from resolving power. Magnification is ‘the increase in size of optical image over the size of the object being viewed’. Increased magnification without improved resolution results only in a large blurred image. The human eye has no power of magnification.

8. What is vital stain?
   Vital stains: - Vital dyes or stains are taken up by living cells without killing them. They selectively stain intracellular structures without affecting cellular metabolism and function. For example, Janus green B selectively stains mitochondria, Golgi apparatus, nuclear chromatin in a
dividing cell can be stained by **methylene blue; Neutral Red** dye or **Congo Red** dye can be used to stain yeast cells.

9. What are the stages in the cell preparation?

The stages of cell preparation on a glass slide involves killing, fixation, dehydration, embedding, sectioning, staining and mounting.

10. Define unit membrane hypothesis.

In 1960, **Robertson** using electronmicrographs proposed a **unit membrane hypothesis**. According to this hypothesis the two outer layers of **protein** are about 2 nm thick and appear densely granular. They enclose a clear central area of about 3.5 nm wide consisting of **lipids**. The lipids are mainly **phospholipid** molecules.

11. Explain fluid mosaic model

**Singer** and **Nicholson** (1972) have proposed a **fluid mosaic model** for the plasma membrane. The fluid mosaic membrane is a dynamic structure. In this structure much of the protein molecules float about. Some of them are anchored to the organelles within the cell. Lipid molecules also move about. ‘Fluid mosaic model’ is applied to all biological membranes in general.

12. What are the functions of plasma membrane?

The Plasma membrane controls the passage of materials both into and out of the cell. It regulates the passage of water and dissolved substances. Water passes through the membrane by **osmosis**. Water soluble substances cross the membrane by **diffusion** or by **active transport**. Many water soluble sol- utes are transported by carrier proteins. Lipid soluble compounds pass more quickly by dissolving in the phospholipid layer.

13. What are cristae?

Each mitochondrion is bound by two highly specialized membranes. The outer membrane is smooth. It is separated from the inner membrane by a 6-8 nm wide space. The **inner membrane** is highly convoluted, forming a series of in folding known as **cristae**.

14. Write important functions of mitochondria.

The mitochondria perform several important functions such as **oxidation, dehydrogenation, oxidative phosphorylation** and **respiratory chain** of the cell.

Since mitochondria play a key role in the oxidation of carbohydrates and fats, they are considered as the actual **respiratory organs** of the cells.

The energy is utilized by the mitochondria for synthesis of the energy rich com- pound known as **adenosine tri phosphate** or **ATP**.

Due to this function, the mitochondria are also known as “**power houses**” of the cell. In animal cells mitochondria produce 95 % of ATP molecules.

15. Write the faction of ribosome

The ribosomes are chemically composed of **RNA** and **proteins**. The **ribosomal RNA** (r**RNA**) play a central role in the process of **protein synthesis**. The ribosomal proteins enhance the catalytic function of the rRNA. The functioning of rRNA is under genetic control.

16. What is ER?

Electron microscopic study of sectioned cells has revealed the pres- ence of a three dimensional network of sae-like and tubular cavities called **cisternae** bounded by a unit membrane
inside the cell. Since these structures are concentrated in the endoplasmic portion of the cytoplasm, the entire organisation is called the **endoplasmic reticulum**. This name was coined by Porter in 1953.

17. What are types of ER?

   The ER is the site of specific enzyme controlled biochemical reactions. Its outer surface carries numerous ribosomes. The presence of ribosomes gives a granular appearance. In this condition ER is described as **rough endoplasmic reticulum** (RER). RER is the site of synthesis of proteins. Ribosomes are absent on **smooth endoplasmic reticulum** (SER). SER is concerned with lipid metabolism.

18. Write the functions of ER.

   1. It provides skeletal framework to the cell.
   2. It facilitates exchange of molecules by the process of osmosis, diffusion and active transport.
   3. Enzymes of ER control several metabolic activities.
   4. They serve as intracellular transporting system.
   5. It conducts intra-cellular impulses.
   6. It helps to form nuclear membrane after cell division.
   7. SER synthesises lipids.

19. What is dictyosome?

   Numerous such cisternae are associated with each other and appear in a lamellar arrangement. In the lamellar arrangement the space between each cisterna is 20-30 nm. A group of these cisternae is called the **dictyosome**. A group of dictyosomes constitute the Golgi apparatus.

20. What are the enzymes are in Lysozyme?

   Recent studies reveal that lysosomes may contain up to 40 types of hydrolytic enzymes. The enzymes are mostly proteases, nucleases, glycosidases, lipases, phospholipases, phosphatases and sulphatases.

21. What is autolysis?

   When a cell dies its own lysosomes release the enzymes that digest the remains of the cell in a process known as **autolysis**.

22. What is the fuction peroxisome?

   Peroxisomes contain catalase, an enzyme that catalyses the decomposition of hydrogen peroxide to the harmless products, water and oxygen. Hydrogen peroxide is a by-product of certain reactions of metabolism. It is potentially a very harmful oxidising agent.

23. What is basal body?

   Centriole supports a flagellum or cilium, it is called the **basal body**.

24. What is de novo?

   It was initially considered that new centrioles arise by the division of existing centrioles. This idea is no longer accepted. It appears that new centrioles are produced **de novo** or are synthesized using an existing centriole as a template.
25. Write the types of nucleolus based on number.

Usually the cells contain single nucleus (mononucleate). However certain cells may have more than one nuclei. Accordingly they may be called binucleate or polynucleate cells. The polynucleate cells of the animals are called syncytial cells (Osteoblast cells)

26. Types of chromosome based on shape.

The shape of the chromosome changes from phase to phase. Each chromosome has a clear zone, known as centromere or kinetocore along their length. The centromere divides the chromosome into two parts. Each part is called the chromosome arm. Thus according to the position of the cen- tromere and nature of the chromosome arm, the chromosomes may be Telo- centric, Acrocentric, Submetacentric and Metacentric.

27. What is cancer?

Cancer is a proliferation of cells which grow in an uncontrolled manner, invading local tissues and spreading widely through the blood or lym- phatics to produce secondary deposits, or metastases in distant parts of the body.
The word ‘cancer’ comes from Latin, meaning a crab.

28. What is tumor?

A tumor was called a cancer because of swollen veins around the area resembling a crab’s limbs.

29. Write notes on oncology?

The study of cancer is called Oncology. Oncology is a word derived from the Greek, onchos, a lump, or tumour. The abnormal tissue growth is called neoplasm. If a neoplasm can cause harm by spreading, it is said to be malignant.

30. List out the virus that cause cancer.

Later it was discovered that certain viruses can also cause cancer. One of the earliest virus, causing cancer, described was Rous sarcoma virus. Recently, human T-cell leukaemia has been found to be due to the virus HTLV-1.

31. How the normal cell converted into cancer cell?

The sequence of events that convert a normal cell into a cancer cell is called carcinogenesis. The process of carcinogenesis includes, initiation, growth, promotion, conversion, propagation and progression. Progression includes the processes of invasion and metastasis.

31. Write short notes on characteristic properties of cancer cell.

The cancer cells have characteristic properties. They can be differ- entiated from normal cells under microscopic observation. These cells have large nuclei. In each cancer cell, the ratio of nucleus to cytoplasm is high. They have prominent nucleoli. The cells can grow indefinitely in culture medium. As component cell of a tissue they remain less differentiated. Even after getting organised into tissues unlike other cells they do not lose their replicative capacity. Cancer cells have the ability to invade surrounding tissues.

32. What is proto-oncogene?

The parts of genome involved in cell growth become activated. These are called the ‘proto-oncogenes’. These strands of DNA induce malignant growth tranformation in the cells. The conversion of proto-oncogenes into oncogenes can happen due to ‘point mutations’ on DNA. Further such cancer cells dis play chromosomal abnormalities such as duplication, deletions and transloca- tions. Thus such alterations in gene arrangement can lead to generation of oncogenes.
33. Give the example Oncogene and Activation mechanism

<table>
<thead>
<tr>
<th>Oncogene</th>
<th>Type of cancer</th>
<th>Activation mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>hox11</td>
<td>Acute T-cell leukemia</td>
<td>Translocation</td>
</tr>
<tr>
<td>erbB-2</td>
<td>Breast and ovarian carcinomas</td>
<td>Amplification</td>
</tr>
<tr>
<td>L-myc</td>
<td>Lung carcinoma</td>
<td>Amplification</td>
</tr>
<tr>
<td>Ret</td>
<td>Thyroid carcinoma DNA</td>
<td>Rearrangement</td>
</tr>
</tbody>
</table>

34. What is gene amplification?
A distinct mechanism by which oncogenes are activated in human tumors is amplification. It results in elevated gene expression. Gene amplification is very common in cancer cells. It occurs a thousand times more frequently than in normal cells. Molecular biologists are now working on the products of oncogenes.

35. What is suppressor genes?
The growth of normal cells is controlled by suppressor genes. In cancer, parts of the genome functioning as the suppressor gene are either lost or inactivated. Hence, negative regulators of cell proliferation are removed. It contributes to the abnormal proliferation of cells.

36. Give the example of suppressor genes

<table>
<thead>
<tr>
<th>Gene</th>
<th>Type of cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>Colon / rectum carcinoma</td>
</tr>
<tr>
<td>BRCA1</td>
<td>Breast and ovarian carcinoma</td>
</tr>
<tr>
<td>1NK4</td>
<td>Melanoma, lung carcinoma, brain tumors, leukemias, lymphoma</td>
</tr>
<tr>
<td>Rb</td>
<td>Retinoblastoma</td>
</tr>
<tr>
<td>PTEN</td>
<td>Brain tumors, kidney and lung carcinomas.</td>
</tr>
</tbody>
</table>

37. Write notes on types of cancer.
Cancers are named according to the tissues from which they arise.

- **Sarcoma** - Malignancy in structural tissues Ex: Osteosarcoma (bones), liposarcoma (fat).
- **Carcinoma** - Epithelial cancers. Ex: Lung carcinoma, breast carcinomas.
- **Lymphoma** - Lymphatic tissues
- **Leukemia** - White blood cells.

38. Any three causes of cancer.
- Exposure to ionising radiations such as x-rays, gamma rays, uv rays can produce cancer. These radiations rupture DNA strands, causing mutations. Solar radiations can cause skin cancers.
- Certain drugs if taken without medical advice can cause cancer.
- Viruses and parasitic organisms like schistosoma, liverfluke can also affect.
5. Mark

1. Write short notes on Discovery of microscope.

   The first useful compound microscope was invented by Francis Janssen and Zacharias Janssen in 1590. It had two lenses with magnification powers between 10x and 30x.

   Galileo Galilei (1564-1642) invented a simple microscope to study the compound eye of insects. His microscope had only one magnifying lens.

   Marcello Malpighi (1628-1694) an Italian microanatomist used a microscope to study organ tissues of animals.

   Robert Hooke an English microscopist in 1665 examined a slice of cork tissue under a compound microscope built by him.

   He coined the term “cells” to honey comb of cells in cork tissue. Anton van Leeuwenhoek (1632-1723) improved the quality of lenses used in microscopes.

   His microscopes achieved magnification upto 300x. He was the first to observe free living cells.

   Further advancements in cell biology were made by improving the quality of compound microscopes.

2. Write Short notes on any three microscope.

   **Compound light microscope**

   This microscope uses visible light for illuminating the object. It contains glass lenses that magnify the image of the object and focus the light on the retina of the observer’s eye.

   It has two lenses one at each end of a hollow tube. The lens closer to the object being viewed is called **objective lens**.

   The lens closer to the eye is called **ocular lens** or **eyepiece**. The object is illuminated by light beneath it.

   A third lens called **condenser lens** is located between the object and the light source and it serve to focus the light on the object.

   **Dark field microscope**

   This type of microscope is useful for viewing suspensions of bacteria. It has a special **condenser** that allows only rays of light scattered by structures within specimen.

   The result is an image that appears bright against a dark background, with a high degree of contrast. The process is similar to seeing dust particles floating in a sunbeam.

   **Phase contrast microscope**

   The phase contrast microscope has special fitments to the objective lens and sub stage condenser, the effect of which is to exaggerate the structural differences between the cell components.

   As a consequence, the structures within living, unstained cells become visible in high contrast and with good resolution.

   Phase contrast microscopy avoids the need to kill cells or to add dye to a specimen before it is observed microscopically.

   **Oil - immersion microscopy**

   In oil-immersion microscopy the light gathering properties of the objective lens are enhanced by placing oil in the space between the slide and objective lens.
Normally the technique is used to view permanently mounted specimens. The oil immersion lens gives higher magnification than the normal high power objective lens.

3. Explain about Electron microscopy.

The electron microscopy uses the much shorter wavelengths of electrons to achieve resolutions as low as 3Å.

**Electromagnetic coils** (ie., magnetic lenses) are used to control and focus a beam of electrons accelerated from a heated metal wire by high voltages, in the range of 20,000 to 100,000 volts.

The electrons are made to pass through the specimen. Electrons that do pass out of the object are focused by an **objective coil** (‘lens’).

Finally a magnified image is produced by a **projector coil** or ‘lens’. The final image is viewed on a screen or is recorded on photographic film to produce **electron micrograph**.

This type of electron microscope is called transmission electron microscope (TEM) In a compound light microscope, the image is formed due to differences in light absorption.

The electron microscope forms images as a result of differences in the way electrons are scattered by various regions of the object.

The degree to which electrons are scattered is determined by the thickness and atomic density of the object.

Hence the specimens used in electron microscopy must be extremely thin. Living cells which are wet cannot be viewed in electron microscope.

**Scanning electron microscopy (SEM)**

This microscope has less resolution power than the TEM (ie., about 200Å). However it is a very effective tool to study the surface topography of a specimen.

The whole specimen is scanned by a beam of electrons. An image is created by the electrons reflected from the surface of the specimen.

Scanning electron micrographs show depth of focus and a three dimensional image of the object.
4. Write short notes on cytological techniques.

Cells are transparent and optically homogeneous organisations. They can be observed either directly or after preservation. For direct observation, the specimen needs sufficient contrast. Direct observation is possible by using vital stains.

**Vital stains:**

Vital dyes or stains are taken up by living cells without killing them. They selectively stain intracellular structures without affecting cellular metabolism and function.

For example, **Janus green B** selectively stains mitochondria, Golgi apparatus, nuclear chromatin in a dividing cell can be stained by **methylene blue; Neutral Red** dye or **Congo Red** dye can be used to stain yeast cells.

**Preserved and stained tissues:**

For detailed microscopic study, tissues containing cells are passed through various stages.

The stages of cell preparation on a glass slide involves killing, fixation, dehydration, embedding, sectioning, staining and mounting.

**Killing and fixation:**

This process causes sudden death of cells or tissues and preserves freshly killed tissues in as lifelike a condition as possible.

A good fixative prevents bacterial decay and autolysis. It will also different cell components more visible and prepare the cell for staining.

The commonly used fixatives are Acetic acid, Formaldehyde, Bouin’s solution and Carnoy’s fluid.

1. **Dehydration:** In this process water vapour are removed from cells or tissues using chemical agents. It is done by using ethanol and benzene.

2. **Embedding:** The tissues are infiltrated with molten paraffin wax. It hardens up on cooling and provides enough support to allow thin sections. Very thin sections need to be taken for electron microscopy. Hence plastics are used for embedding.

3. **Sectioning:** The embedding material is cut into thin sections of needed thickness. It is done by using an instrument called **microtome**.

4. **Staining:** The sections are immersed in dyes that stain some structures better than others. For example, cytoplasm stains pink with eosin. Nucleus stains blue with haematoxylin or red with safranin.

5. **Dehydration:** Stained sections are immersed in ethanol to remove water. The tissue becomes more transparent. Dehydration is done gradually by using a series of increasing concentrations of ethanol in water. Finally the section is placed in ‘absolute’ alcohol.

6. **Mounting:** Cleaned sections are mounted on a slide using a suitable medium like canada balsam. A cover slip is added and the medium is allowed to dry.
5. Draw structure of a typical animal cell

![Ultra structure of a typical animal cell](image)

6. Write notes on Plasma Membrane

It is the outer limiting membrane of both prokaryotic and eukaryotic cells. It is an ultra thin, elastic, living membrane.

Plasma membrane is a dynamic and selective transport barrier. Since the plasma membrane is ultra thin, it could be observed only under electron microscope.

Structure of the membrane is studied by isolating the same from the cell and conducting biochemical investigations.

In 1895 Overton suggested that the membrane is made of fatty substances. Other workers later concluded that two layers of lipid were present in the cell membrane.

According to a model proposed by Danielli and Davson in 1935, the lipid bilayer of the membrane was coated on either side with protein.

In 1960, Robertson using electronmicrographs proposed a unit membrane hypothesis.

According to this hypothesis the two outer layers of protein are about 2 nm thick and appear densely granular.
They enclose a clear central area of about 3.5 nm wide consisting of lipids. The lipids are mainly phospholipid molecules.

Singer and Nicholson (1972) have proposed a fluid mosaic model for the plasma membrane. The fluid mosaic membrane is a dynamic structure.

In this structure much of the protein molecules float about. Some of them are anchored to the organelles within the cell.

Lipid molecules also move about. ‘Fluid mosaic model’ is applied to all biological membranes in general.

The fluid mosaic membrane is a dynamic structure. In this structure much of the protein molecules float about. Some of them are anchored to the organelles within the cell.

The cell membrane controls the passage of materials both into and out of the cell. It regulates the passage of water and dissolved substances.

Water passes through the membrane by Osmosis. Water soluble substances cross the membrane by diffusion or by active transport.

Many water soluble sol- utes are transported by carrier proteins. Lipid soluble compounds pass more quickly by dissolving in the phospholipid layer.

7. Write notes on mitochondria.

The mitochondria are filamentous or granular cytoplasmic organelles of all aerobic cells of higher animals and plants.

They are also found in micro organisms including Algae, Protozoa and Fungi. They were first observed by Kolliker in 1850 as granular structures in the striated muscles.

The name ‘mitochondria’ was given to them by Benda (1897-98). Various steps of glycolysis in mitochondria was discovered by two German biochemists Embden and Meyerhof.

Embden got the Nobel Prize in 1922. Sir Hans Adolph Krebs, in 1937 found out various reactions of citric acid cycle.

Kennedy and Lehninger (1948-50) showed that Citric acid cycle, oxidative phosphorylation and fatty acid oxidation took place in the mitochondria.

The number of mitochondria in a cell depends on the type and functional state of the cell. Certain cells contain large number of mitochondria e.g., eggs of sea urchin contain 140,000-150,000 mitochondria.

Oocytes of amphibians contain 300,000 mitochondria. Liver cells of rat contain only 500-1600 mitochondria. Some algal cells may contain only one mitochondrion.

The mitochondria may be filamentous or granular in shape. They vary in size from 0.5 µm to 2.0 µm.

Due to their minute nature they cannot be seen under light microscope. Each mitochondrion is bound by two highly specialized membranes.

The outer membrane is smooth. It is separated from the inner membrane by a 6-8 nm wide space.

The inner membrane is highly convoluted, forming a series of infoldings known as cristae.

Thus mitochondria are double membrane envelopes. The inner membrane divides the mitochondrial space into two distinct chambers.

The outer compartment is the peri-mitochondrial space. It is found between outer and inner membranes. The inner compartment is the matrix space.

It is filled with a dense gel like substance called mitochondrial matrix. The matrix contains lipids, proteins and circular DNA molecules.
The outer and inner membranes, intermembrane space and mitochondrial matrix contain several enzymes.

Hence the mitochondria perform several important functions such as oxidation, dehydrogenation, oxidative phosphorylation and respiratory chain of the cell.

8. Write notes on Ribosomes

The ribosomes are small dense, rounded and granular particles. They contain ribonucleoprotein.

They occur either freely in the matrix of the mitochondria, chloroplast and cytoplasm or remain attached with the membrane of the endoplasmic reticulum and nucleus.

The ribosomes were described by G.E.Palade in 1952. The name ‘ribosome’ was coined by R. B. Roberts in 1958.

The ribosomes occur in both prokaryotic and eukaryotic cells. In the cells in which active protein synthesis takes place, the ribosomes remain attached with the membranes of the endoplasmic reticulum.

The cells where such active synthesis happens are pancreatic cells, hepatic cells, osteoblasts, serous cells of submaxillary gland, chief cells of the glandular stomach, thyroid cells and mammary gland cells.

The ribosomes are spheroid structures with a diameter of 150 to 250 Å. Each ribosome is composed of two subunits.

One subunit is large in size and has a dome like shape. The other ribosomal subunit is smaller in size and it occurs above the larger subunit forming a cap-like structure.

The ribosomes are chemically composed of RNA and proteins. The ribosomal RNA (rRNA) play a central role in the process of protein synthesis.

The ribosomal proteins enhance the catalytic function of the rRNA. The functioning of rRNA is under genetic control.

9. Write notes on Endoplasmic Reticulum. (ER)

Electron microscopic study of sectioned cells has revealed the presence of a three dimensional network of sac-like and tubular cavities called cisternae bounded by a unit membrane
inside the cell.

Since these structures are concentrated in the endoplasmic portion of the cytoplasm, the entire organisation is called the **endoplasmic reticulum**.

This name was coined by Porter in 1953. The occurrence of ER varies from cell to cell. They are absent in erythrocytes, egg cells and embryonic cells.

The ER is the site of specific enzyme controlled biochemical reactions. Its outer surface carries numerous ribosomes.

The presence of ribosomes gives a granular appearance. In this condition ER is described as **rough endoplasmic reticulum** (RER). RER is the site of synthesis of proteins.

Ribosomes are absent on **smooth endoplasmic reticulum** (SER). SER is concerned with lipid metabolism.

Morphologically ER may occur in three forms namely 1. Lamellar form 2. Vesicular form and 3. Tubular form.

**Lamellar form or Cisternae** :- These are long, flat, sac like tubules. Their diameter is about 40-50 µm. The RER has a **synthetic** role. It is mostly seen in cells of pancreas, notochord and brain.

**Vesicles** :- These are oval, vacuolar structures. Their diameter is about 25-500 µm. They occur in most of the cells.

**Tubules** :- These are branched structures forming the reticular system along with the cisternae and vesicles. They have a diameter of 50-190 µm. They occur in almost all cells.

**Functions** :-

- It provides skeletal framework to the cell.
- It facilitates exchange of molecules by the process of osmosis, diffusion and active transport.
- Enzymes of ER control several metabolic activities.
- They serve as intracellular transporting system.
- It conducts intra-cellular impulses.
- It helps to form nuclear membrane after cell division.
- SER synthesises lipids.
10. Write notes on Golgi apparatus

The Golgi apparatus was discovered by an Italian neurologist, Camillo Golgi in 1873. The Golgi apparatus occurs in almost all animal cells except red blood cells.

Animal cells usually have a single Golgi apparatus. Some cells have more of Golgi apparatus. In most of the ectodermal and endodermal cells it occurs in between the nucleus and the periphery.

In nerve cells it occupies a circum-nuclear position. The simplest unit of the Golgi apparatus is the cisterna. A cisterna is about 1 µm in diameter.

It has a membrane bound space. This space accumulates secretions. Numerous such cisternae are associated with each other and appear in a lamellar arrangement.

In the lamellar arrangement the space between each cisterna is 20-30 nm.

A group of these cisternae is called the dictyosome. A group of dictyosomes constitute the Golgi apparatus. Typically a Golgi apparatus appears as a complex arrangement of interconnecting tubules, vesicles and cisternae.

The Golgi apparatus is the site of synthesis of biochemicals. They also collect proteins and lipids made in the ER and add additional substances.

11. Write notes on Lysosomes

These are tiny vesicles surrounded by a membrane. Lysosomes are involved in intracellular digestion and are primarily meant for destroying unwanted and aged organelles inside the cells.

Lysosomes were initially named as ‘perinuclear dense bodies’. The name ‘lysosome’ was coined by C.de Duve in 1955.

Lysosomes occur in all animal cells. However they are not found in mature mammalian erythrocytes. Muscle cells contain very few lysosomes.
They are numerous in epithelial cells of secretory and excretory organs. Each lysosome is a round structure. It is filled with a dense material.

Their shapes and densities vary. Their size ranges from 0.2 to 5 µm. Recent studies reveal that lysosomes may contain up to 40 types of hydrolytic enzymes.

The enzymes are mostly proteases, nucleases, glycosidases, lipases, phospholipases, phosphatases and sulphatases.

Lysosomes originate either from the Golgi apparatus or directly from the endoplasmic reticulum.

The enzymes they contain are used in the dissolution and digestion of redundant structures or damaged macromolecules from within or outside the cell.

For example, when an animal cell ingests food into a food vacuole, lysomes fuse with the vacuole and break down the contents.

Their enzymes digest carbohydrates, fat and proteins. The glands in some digestive organs package their digestive enzymes in lysosomes before releasing them outside the membrane.

When a cell dies its own lysosomes release the enzymes that digest the remains of the cell in a process known as autolysis.

12. Write notes on Centrioles

The centrioles are two cylindrical, microtubular structures found near the nucleus. When a centriole supports a flagellum or cilium, it is called the basal body.

The centrioles occur in most of the animal cells, algal cells and some fern cells. They are absent in prokaryotes, red algae, yeast cells and flowering plants and some non-flagellated or non-ciliated protozoans.

The centrioles range in size from 0.15-0.25 µm in diameter. They are usually 0.3-0.7 µm in length.

Each centriole and basal body is formed of nine triplet microtubules equally spaced around a perimeter. Each microtubule has a diameter of 200-260 Å in diameter.

The microtubules are made up of a structural protein, tubulin, along with lipid molecules.

It was initially considered that new centrioles arise by the division of existing centrioles. This idea is no longer accepted. It appears that new centrioles are produced de novo or are synthesized using an existing centriole as a template.

In most of the animal cells the centrioles are the focal point for the centrosome. The centrosome organizes cytoplasmic microtubules during interphase in mitosis. It provides the two poles of the mitotic spindle.

The centrioles form the basal body and the cilia. In spermatozoon one centriole gives rise to the tail fibre or flagellum. The centrioles are also involved in ciliary and flagellar activity.

13. Write notes on Nucleus

The nucleus is the most important organelle of cell. It controls all metabolic processes and hereditary activities of the cell.

The nucleus was first discovered and named by Robert Brown in 1833. The occurrence of a nuclear membrane was first revealed by O. Hertwig in 1893.

The nucleus is found in all the eukaryotic cells of plants and animals. However some eukaryotic cells such as the sieve tubes of higher plants and mammalian erythrocytes have no nucleus.
Usually the cells contain single nucleus (mononucleate). However certain cells may have more than one nuclei. Accordingly they may be called binucleate or polynucleate cells.

The polynucleate cells of the animals are called syncytial cells (Osteoblast cells). The shape of the nucleus may be spherical, elliptical or discoidal.

In certain cells the nucleus is irregular in shape. The size of the nucleus may vary from 3 µm to 25 µm in diameter.

The size is directly propotional to that of the cytoplasm. Nuclear size may also be determined by the number of chromosomes or ploidy.

The nucleus of the haploid cells are smaller than that of the diploid cells. The nucleus is surrounded by a nuclear envelope.

This envelope is comprised of two membranes of 5-10 nm thickness. The inner nuclear membrane supports a fibrous sheath called the nuclear lamina.

The inner nuclear membrane is surrounded by the outer nuclear membrane. The space between the inner and outer membranes is known as perinuclear space.

It is a 10 to 50 nm wide fluid filled compartment. The nuclear lamina is a protein meshwork. It is a very dynamic structure.

The nuclear envelope is perforated by nuclear pores. Each pore has a diameter between 10 nm to 100 nm. It has been calculated that the nuclear pores account for 5 to 15 percent of the surface area of the nuclear membrane.

There is continuous movement of molecules across the nuclear envelope through the pores. The nucleus is filled with a transparent semisolid matrix known as nucleoplasm or nuclear sap.

The chromatin threads and the nucleolus remain suspended in the nucleoplasm. The nucleoplasm is composed of nucleoproteins, proteins, enzymes and minerals.

The nucleoplasm contains several thread like coiled structures. These are the chromatin fibres. During the cell division they become thick ribbon like structures known as chromosomes.

The chromatin is made up of Deoxy - ribose nucleic acid (DNA) and proteins. The nucleus contains one or more spherical colloidal structures called nucleoli.

The size of nucleolus is related to the synthetic activity of the cell. The number of nucleoli in the cells may be one, two or four.

Chemically, nucleolus contains DNA of nucleolar origin, four types rRNA, 70 types of ribosomal proteins, RNA binding proteins and RNA splicing nucleoproteins.

Ribosomal subunits are synthesized in the nucleolus. Initiation, production and maturation stages of ribosomal formation happen in three distinct regions of the nucleolus.
14. Write notes on Chromosomes

The chromatin fibres get condensed into chromosomes during cell divisions. They are capable of self-reproduction and they play an important role in heredity.

The nucleus was first observed and described by Karl Nagli (1842) in the nuclei of plant cells.

Chromosomes and their role in cell division was first explained by A. Schneider (1873). In 1887 Benden and Bovery reported that the number of chromosomes for each species is constant.


In 1924, Robert Feulgen showed that chromosomes contain DNA. The number of chromosomes is constant for a particular species.

The reproductive cells such as sperm or ovum has one set of chromosomes and it is known as the haploid set (n). It is also known as the genome. The somatic or body cells contain two haploid set or genomes and are known as the diploid cells (2n).

The diploid condition is arrived at by the union of the haploid male and female gametes in the sexual reproduction.

Number of chromosome

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Chromosome Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramoecium</td>
<td>P. aurelia</td>
<td>30-40</td>
</tr>
<tr>
<td>Hydra</td>
<td>H. vulgaris</td>
<td>32</td>
</tr>
<tr>
<td>Housefly</td>
<td>Musca domestica</td>
<td>12</td>
</tr>
<tr>
<td>Fruit fly</td>
<td>Drosophila sps</td>
<td>8</td>
</tr>
<tr>
<td>Pigeon</td>
<td>Columba livia</td>
<td>80</td>
</tr>
<tr>
<td>Gorilla</td>
<td>Gorilla gorilla</td>
<td>48</td>
</tr>
<tr>
<td>Man</td>
<td>Homo sapiens</td>
<td>46</td>
</tr>
</tbody>
</table>

The size of a chromosome can be measured during mitotic metaphase. It may range from 0.25 µm to 30 µm.

The shape of the chromosome changes from phase to phase. Each chromosome has a clear zone, known as centromere or kinetocore along their length.

The centromere divides the chromosome into two parts. Each part is called the chromosome...
arm. Thus according to the position of the centromere and nature of the chromosome arm, the chromosomes may be Telo-centric, Acrocentric, Submetacentric and Metacentric.

15. Write notes on cancer

Cancer is a proliferation of cells which grow in an uncontrolled manner, invading local tissues and spreading widely through the blood or lymphatics to produce secondary deposits, or metastases in distant parts of the body.

The word ‘cancer’ comes from Latin, meaning a crab. A tumour was called a cancer because of swollen veins around the area resembling a crab’s limbs.

The study of cancer is called Oncology. Oncology is a word derived from the Greek, onchos, a lump, or tumour. The abnormal tissue growth is called neoplasm.

If a neoplasm can cause harm by spreading, it is said to be malignant. Cancer was known to ancient civilizations.

However the disease as it would be defined today was established as an entity by German pathologists of 19th century.

They described cellular nature of cancer and classified cancer. At the beginning of the 20th century, most major forms of cancer had been described.

Further, attention was focused on finding the cause and introducing treatment. In 1775 Pott recognised cancer in chimney sweeps. He associated soot with cancer.

From this time onwards environmental and occupational hazards were recognised as follows:
- shale oil skin cancer in workers
- radio active ores lung cancer in miners
- beta-naphthylamine bladder cancer in rubber industry workers
- cigarettes lung cancer

Later it was discovered that certain viruses can also cause cancer. One of the earliest virus, causing cancer, described was Rous sarcoma virus.

Recently, human T-cell leukaemia has been found to be due to the virus HTLV-1. Some forms of cancer can also be inherited.

A rare eye tumour, retinoblastoma is inherited. It is a dominant character showing Mendelian inheritance.

16. Write notes on Cancer biology

The knowledge of cancer biology is growing rapidly. Researchers are being conducted to fully understand the development of cancer at the cellular or molecular level.

The available information is not sufficient for satisfactory treatment of cancer.

During normal development and growth the cells in our body divide mitotically and get differentiated to specialized cells of the tissues.

The processes of cell mitosis, growth and differentiation are controlled by cellular genes. Cancer is caused due to mutation or abnormal activation of such genes.

such a mutation can happen in a single cell. Thus it may be monoclonal in origin.

With further growth of cancer, additional mutations may occur in the daughter cells giving rise to subclones.

The mutated cells may remain as heterogeneous cancer cells. Among these subclones some
may have greater capacity and metastasize to distant tissues.

They may also remain more resistant to damage from various anticancer treatments. The cancer cells have characteristic properties.

They can be differentiated from normal cells under microscopic observation. These cells have large nuclei. In each cancer cell, the ratio of nucleus to cytoplasm is high.

They have prominent nucleoli. The cells can grow indefinitely in culture medium. As component cell of a tissue they remain less differentiated.

Even after getting organised into tissues unlike other cells they do not lose their replicative capacity. Cancer cells have the ability to invade surrounding tissues.

The sequence of events that convert a normal cell into a cancer cell is called carcinogenesis. The process of carcinogenesis includes, intiation, growth, promotion, conversion, propagation and progression.

Progression includes the processes of invasion and metastasis. Mature cancers have relatively uncontrolled growth, behaviour.

As other normal cells they do not show any of the normal intracellular and extracellular growth control mechanisms.

Initially the cancer cells have an exponential growth. Gradually their growth surpasses blood vascular supply. This results in slowing down of growth.

17. Write notes on Molecular biology of cancer

Techniques in molecular biology have helped in understanding the most intimate structure of the cancer cell. It has been found that at molecular level two mechanisms operate.

The parts of genome involved in cell growth become activated. These are called the ‘protooncogenes’.

These strands of DNA induce malignant growth transformation in the cells. The conversion of protooncogenes into oncogenes can happen due to ‘point mutations’ on DNA.

Further such cancer cells display chromosomal abnormalities such as duplication, deletions and translocations. Thus such alterations in gene arrangement can lead to generation of oncogenes.

Oncogenes of human tumours

<table>
<thead>
<tr>
<th>Oncogene</th>
<th>Type of cancer</th>
<th>Activation mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>hox11</td>
<td>Acute T-cell leukemia</td>
<td>Translocation</td>
</tr>
<tr>
<td>erbB-2</td>
<td>Breast and ovarian carcinomas</td>
<td>Amplification</td>
</tr>
<tr>
<td>L-myc</td>
<td>Lung carcinoma</td>
<td>Amplification</td>
</tr>
<tr>
<td>ret</td>
<td>Thyroid carcinoma DNA</td>
<td>Rearrangement</td>
</tr>
</tbody>
</table>

A distinct mechanism by which oncogenes are activated in human tumors is amplification. It results in elevated gene expression. Gene amplification is very common in cancer cells.

It occurs a thousand times more frequently than in normal cells. Molecular biologists are now working on the products of oncogenes.

The growth of normal cells is controlled by suppressor genes. In cancer, parts of the genome functioning as the suppressor gene are either lost or inactivated.

Hence, negative regulators of cell proliferation are removed. It contributes to the abnormal proliferation of cells.
<table>
<thead>
<tr>
<th>Gene</th>
<th>Type of cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>Colon / rectum carcinoma</td>
</tr>
<tr>
<td>BRCA 1</td>
<td>Breast and ovarian carcinoma</td>
</tr>
<tr>
<td>1 NK 4</td>
<td>Melanoma, lung carcinoma, brain tumors, leukemias, lymphoma</td>
</tr>
<tr>
<td>Rb</td>
<td>Retinoblastoma</td>
</tr>
<tr>
<td>PTEN</td>
<td>Brain tumors, kidney and lung carcinomas.</td>
</tr>
</tbody>
</table>

The protein products of the tumor suppressor genes normally inhibit cell proliferation. Inactivation of such genes therefore leads to tumor development.

The complete sequence of events required for the development of any human cancer is not yet known.

But it is clear that both the activation of oncogenes and the inactivation of tumor suppressor genes are critical steps in tumor initiation and progression.

Simultaneous effect on both the genes will result in multiple genetic defect. It results in the increased proliferation, invasiveness and metastatic potential of cancer cells.

18. Write notes on causes of cancer.

Causes for Cancer (Etiology)

Majority of the cancers are caused by living habits and environmental factors.

- **Tobacco**: Nearly 35% of all cancer deaths are due to usage of tobacco in some form. Atleast 90% of lung cancer deaths are due to smoking. Smoking can also affect gastrointestinal tract, pancreas, genito-urinary tract and upper respiratory passage. Snuff and chewing tobacco can affect mouth and respiratory tracts. Smoke inhaled by non-smokers (passive smoke) can also cause lung cancer and blood cancer.

- Exposure to ionising radiations such as x-rays, gamma rays, UV rays can produce cancer. These radiations rupture DNA strands, causing mutations. Solar radiations can cause skin cancers.

- Physical irritants, such as continued abrasion of the linings of the intestinal tract by some types of food can also lead to cancer. Dietary substances such as fat, high calorie intake of animal proteins, salted or smoked food can cause cancer in Breast, Colon, Stomach and Oesophagus.

- Certain drugs if taken without medical advice can cause cancer.

- Viruses and parasitic organisms like schistosoma, liverfluke can also affect.

19. How to cancer cause death?

A severe onset of cancer ends in the death of a person. It is because of the unique characteristics of the cancer cells.

The growth of normal cells is controlled by certain factors. However the cancer cells do not require the growth factors.

Hence these cells do not respect usual cellular growth limits. Normal cells have a nature of remaining together in tissues.

But the cancer cells are less adhesive to each other. Hence they wander through the tissues and enter the blood.
They can be transported to all parts of the body and cause new cancer growths. The cancer cells rapidly multiply.

Some cancers also produce angiogenic factors that cause many new blood vessels to grow into the cancer.

Thus these cells will drain all the nutrients and normal cells get deprived of food. Ultimately the normal cells and tissues suffer nutritive death.

20. List out the treatment of cancer.

The treatment or management of cancer depends on an accurate diagnosis. Diagnosis is made through microscopic observations (tissue biopsy), study of markers on the surface of cells, cytochemical methods, cytogenetics and various scanning and ‘x’ ray diagnostic methods.

In order to compare results and for communicating treatment programme among medical personnel staging systems are essential (Ex: stage1, stage2) staging defines tumours as either confined to the tissue of origin or having spread to local tissues and organs and finally as having metastasized.

After diagnosis, treatment of cancer involves surgery, chemotherapy, radiotherapy and hormonal treatments.

Till last century, surgery was the only effective method of treatment. Even today through surgery biopsy can be effected for diagnosis.

If the tumour is restricted to the primary site, through surgery it can be removed. In latest treatment procedures surgery is restricted to affected region, rather than amputation or removal of the entire organ.

Radiotherapy: Discovery of x-rays by Roentgen (1895) and of radioactivity by Curie in 1899 opened new ways of treating cancer.

In Radiotherapy high energy ionising radiations are used. The radiations used are x-rays and gamma rays or subatomic particles such as beta particles, high energy electrons and neutrons or charged particles like helium ions. Ionising radiations can penetrate tissues.

They can damage DNA leading to cell death and mutagenesis. The basis of radiation therapy depends on the differential sensitivity of the tumour tissue and the normal tissue.

Hence the aim of radiotherapy is to prescribe sufficient radiation dose to the tumour, sparing as much of the normal tissue as possible.

Chemotherapy: The purpose of chemotherapy is to prevent cancer cells from multiplying, invading and metastasizing.

The chemicals used in treatment affect cell multiplication and tumour growth. Several drugs are now available for usage.

They can used singly or in combination. Some cancers like breast cancer are hormone dependent. Hence hormones are used in their management.

Inspite of all advances in diagnostics and treatment, the death rate due to cancer is greater. Primary prevention of cancer will be a better alternative to diagnosis and treatment.

70% to 80% of cancers result from environmental causes. Hence public awareness towards environmental issues is a need.

33% of cancers in India are tobacco related. Hence smoking cessation and other measures to reduce tobacco usage are to be insisted upon.

Consumption of fibrous food and avoidance of fatty food will avoid tumours related to alimentary canal.

Thus it is apparent that fight against cancer will be successful with early detection and appropriate education for avoidance.