Topic: HUMAN PHYSIOLOGY

BA PART I,1ST PAPER, By: Dr. AMARJEET KUMAR, Home Science Department, Rohtas Mahila College, Sasaram. E-mail ID: amarjeetkumar011@gmail.com

CELL

The basic functional unit of the body is the cell. The cells are the building blocks of the organs and each of these organs performs its own specialized function.

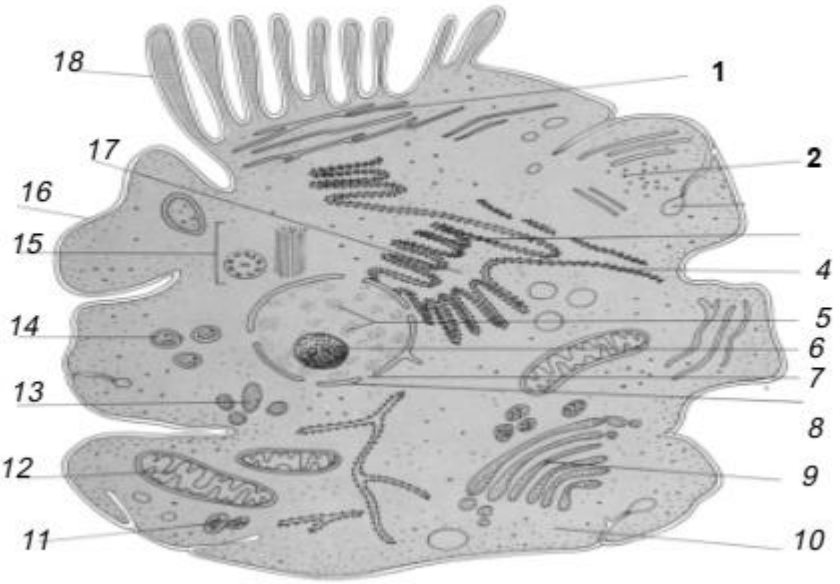

Fig. 1. Structure of Animal Cell

1. smooth endoplasmic reticulum
2. free ribosomes
3. ribosomes on rough endoplasmic reticulm
4. rough endoplasmic reticulum
5. chromatin
6. nucleolus
7. pore
8. membrane
9. golgi apparatus
10. cytoplasm
11. granules
12. mitochondrion
13. lysosome with digestive enzymes
14. vesicle
15. centrioles with microtubules
16. plasma membrane
17. cisterna of endoplasmic reticulum
18. microvilli

A typical cell is composed of nucleus and various organelles. The cell is filled with a colloid type of material called **protoplasm**. This is divided between 2 separate compartments. The nuclear compartment that contains **nucleoplasm** and the compartment outside the nucleus containing **cytoplasm**. The nucleoplasm is separated from the cytoplasm by the **nuclear membrane.** The cytoplasm is separated from the surrounding fluids by the **cell membrane.** The protoplasm is composed mainly of 5 basic substances

- Water
- Electrolytes such as potassium, magnesium, phosphate, bicarbonates and small amounts of sodium and chloride,
- Proteins
- Lipids and
- Carbohydrates.

The cell contains highly organized physical structures called **organelles** which are important for the functions of the cell. Some principal organelles of the cell are the cell membrane, nuclear membrane, endoplasmic reticulum, Golgi-complex, mitochondria and lysosomes.

Cell membrane

The cell membrane is thin and elastic, composed entirely of proteins and lipids. The structure shows a central layer of lipid covered by protein layers. The protein layer contributes to the structural strength of the membrane, also acts as carrier for transporting substances through the membrane.

Endoplasmic Reticulum (ER)

This is a network of tubular structures found in the cytoplasm. The endoplasmic reticulum is continuous with the nuclear membrane and with the inner chambers of the Golgi complex. It connects directly through small openings with the exterior of the cell. The main function is transporting substances formed in different parts of the cell which enter the endoplasmic reticulum and are conducted to other parts of the cell.

There are two types of ER:

a) Granular ER: This type of ER contains many small granular particles called ribosomes which are attached to the outer surface. The ribosomes contain ribonucleic acid (RNA) which is necessary for protein synthesis.

b) Agranular ER: This type of ER contains no ribosomes attached to it. This is otherwise known as smooth ER. This helps in synthesizing lipid substances.

Golgi complex

This is a specialized derivative of the endoplasmic reticulum. It is usually composed of 4 or more layers of thin vesicles. The Golgi complex is very prominent in secretory cells. Its function is believed to be temporary storage and condensation of secretory substances and preparation of these substances for final secretion. It also synthesizes carbohydrates and

combines it with protein to form **glycoproteins.** eg: mucopolysaccharide ground substance of both cartilage and bone. The golgi complex is also involved in formation of lysosomes which are important for digesting intracellular substances.

Mitochondria

The mitochondria are composed of a double - layered membrane, an outer membrane and an inner membrane. Many infoldings of the inner membrane form shelves onto which oxidative enzymes of the cell are attached. The inner cavity of the mitochondrion is filled with a gelatinous matrix containing enzymes. Mitochondria are the **'powerhouse'** of the cell. They provide most of the energy needed for performing cellular functions.

Lysosomes

These are spherical organelles surrounded by a membrane. The lysosomes provide an intracellular digestive system that allows the cell to digest and remove unwanted substances and structures, especially foreign bodies such as bacteria.

Nucleus

The nucleus is the control centre of the cell. The nucleus consists of a double walled **nuclear membrane** with pores, chromatin material throughout the nucleoplasm which becomes **the chromosomes** during cell division, and a protein structure called nucleolus. The nucleolus contains large amounts of RNA. The nucleus controls chemical reactions of the cell and cell reproduction. The nucleus contains large amounts of DNA which are important in cell division. The chromosomes consist of DNA and protein.

Cell division

Each human cell contains 46 chromosomes arranged in 23 pairs. In general, the genes in the two chromosomes of each pair are almost identical with each other, except for the sex chromosomes. Cell division or multiplication takes place by two processes – mitosis and meiosis.

Mitosis

The process by which the cell splits into two new cells is called **mitosis**. Mitosis begins once the DNA has been duplicated and each chromosome has split to form two new chromosomes. Mitosis takes place in a series of consecutive stages beginning from prophase, metaphase, anaphase and telophase.

Prophase: In this stage the chromatin material of nucleus gets condensed. Chromosomes can be seen each made up of 2 **chromatids** joined at the **centromere. Centrioles,** which are small cylindrical bodies, lie in the cytoplasm and move away from each other to the opposite poles of the cell. **Microtubules, which are thick protein filaments,** form a spindle between the two centrioles and radiate to form **astral rays**. The nucleoli and nuclear membrane disappear.

Metaphase: During this phase the chromosomes are pulled by the attached microtubules to the centre of the cell lining up in the equatorial plane.

Anaphase: The spindle grows further and each pair of chromosomes is now broken apart at the Centromere. All the chromosomes are grouped. Thus all 46 pairs of chromosomes are separated, forming 46 daughter chromosomes that are pulled toward one pole by mitotic spindle and 46 chromosomes pulled to the other end.

Telophase: The spindle fibers disappear. New nuclear membrane develops around each set of chromosomes. The cell pinches in two midways between the two nuclei, thus forming two daughter cells.

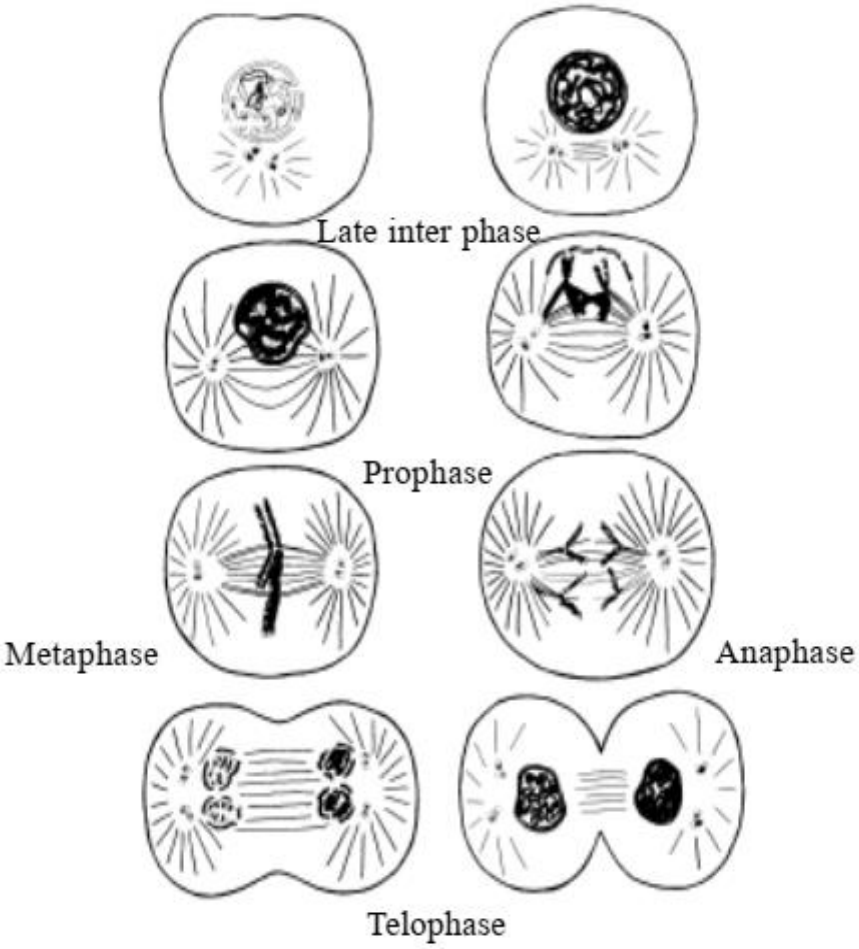

Fig. 2 - Stages of Mitosis

Meiosis

This is the process of cell division that occurs in the reproductive cells, i.e. ova and spermatozoa. In meiosis the chromosomes do not replicate as they do in mitosis. Instead, the pairs of chromosomes separate and one from each pair moves to the opposite poles of the parent cell. When it divides each of the daughter cells has only 23 chromosomes i.e. half the number of chromosomes or haploid number. During fertilization of the ovum with the spermatozoa, the resultant zygote will have the full complement of 46 chromosomes, half from the father and half from the mother.

Cancer

Cancer can occur in any tissue of the body. It results from a change in certain cells that do not follow normal growth limits and begin to multiply at an erratic rate. A **tumour** forms when the rate of cell multiplication is greater than that of cell death. The reasons for this uncontrolled cell multiplication are not known. Some factors are known to increase changes found in tumour cells. The process by which normal cell becomes cancerous in nature is called **carcinogenesis.** The agents that lead to this are called **carcinogens.** Examples of carcinogens: Environmental agents such as chemicals, irradiation and oncogenic viruses.

Chemical carcinogens

1. Aniline dyes 2. Arsenic compounds

3. Asbestos 4. Benzene derivatives

5. Cigarette smoke

6. Nickel compounds

7. Some fuel oils 8. Vinyl chloride.

Radiation carcinogens

X-rays, radioactive isotopes, environmental radiations and ultraviolet rays in sunlight.

Oncogenic viruses

Viruses, some consisting of DNA and some of RNA can cause mutation and thereby cancer.

Transport of substances through the cell membrane

Substances are transported through the cell membrane by 2 major processes.

1. Diffusion

2. Active transport.

Diffusion: This is the physical process involved in the ‘downhill’ movement of substances, i.e. from a higher concentration on one side to a lower concentration on the other, without the use of energy.

Active transport: This is the ‘uphill’ transport of substances across the membranes, i.e. from a lower concentration on one side to a region of higher concentration with the use of energy.