B.Pharm: 2nd Sem; Subject: APHE-I; Topic: Cell and its component

Cells are the body's smallest functional units. They are grouped together to form *tissues*, each of which has a specialised function, e.g. blood, muscle, bone. Different tissues are grouped together to form *organs*, e.g. the heart, stomach and brain. Organs are grouped together to form *systems*, each of which performs a particular function that maintains homeostasis and contributes to the health of the individual. For example, the digestive system is responsible for taking in, digesting and absorbing food, which involves a number of organs, including the stomach and intestines. The structure and functions of cells and types of tissue are explored in this chapter. The terminology used to describe the anatomical relationships between body parts, the skeleton and the cavities within the body are then considered. The final section considers features of benign and malignant tumours, their causes and how they grow and may spread.

The cell: structure and functions

The human body develops from a single cell called the *zygote*, which results from the fusion of the ovum (female egg cell) and the spermatozoon (male sex cell). Cell division follows and, as the fetus grows, cells with different structural and functional specialisations develop, all with the same genetic make-up as the zygote. Individual cells are too small to be seen with the naked eye. However, they can be seen when thin slices of tissue are stained in the laboratory and magnified using a microscope. A cell consists of a *plasma membrane* enclosing a number of *organelles* suspended in a watery fluid called *cytosol* . Organelles, literally 'small organs', have individual and highly specialised functions, and are often enclosed in their own membrane within the cytosol. They include: the nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes and the cytoskeleton. The cell contents, excluding the nucleus, is the *cytoplasm*, i.e. the cytosol and other organelles.

Plasma membrane

The plasma membrane consists of two layers of *phospholipids* with proteins and sugars embedded in them. In addition to phospholipids, the lipid *cholesterol* is also present. The phospholipid molecules have a head, which is electrically charged and *hydrophilic* (meaning 'water loving'), and a tail which has no charge and is

hydrophobic (meaning ‘water hating’). The phospholipid bilayer is arranged like a sandwich with the hydrophilic heads aligned on the outer surfaces of the membrane and the hydrophobic tails forming a central water-repelling layer. These differences influence the transfer of substances across the membrane.

Membrane proteins

Those proteins that extend all the way through the membrane provide channels that allow the passage of, for example, electrolytes and non-lipid soluble substances. Protein molecules on the surface of the plasma membrane. The membrane proteins perform several functions:

- branched carbohydrate molecules attached to the outside of some membrane protein molecules give the cell its immunological identity
- they can act as receptors (specific recognition sites) for hormones and other chemical messengers
- some are enzymes
- transmembrane proteins form channels that are filled with water and allow very small, water-soluble ions to cross the membrane
- some are involved in pumps that transport substances across the membrane.

Organelles

Nucleus

All body cells have a nucleus, with the exception of mature erythrocytes (red blood cells). Skeletal muscle fibres and some other cells contain several nuclei. The nucleus is the largest organelle and is contained within the nuclear envelope, a membrane similar to the plasma membrane but with tiny pores through which some substances can pass between it and the cytoplasm. The nucleus contains the body’s genetic material, in the form of deoxyribonucleic acid (DNA); this directs all its metabolic activities. In a non-dividing cell DNA is present as a fine network of threads called *chromatin*, but when the cell prepares to divide the chromatin forms distinct structures called *chromosomes* . A related substance, ribonucleic acid (RNA) is also found in the nucleus. There are different types of RNA, not all found in the nucleus, but which are in general involved in protein synthesis. Within the nucleus is a roughly spherical structure called the *nucleolus,* which is involved in synthesis (manufacture) and assembly of the components of ribosomes.

Mitochondria

Mitochondria are membranous, sausage-shaped structures in the cytoplasm, sometimes described as the ‘power house’ of the cell. They are central to aerobic respiration, the processes by which chemical energy is made available in the cell. This is in the form of ATP, which releases energy when the cell breaks it down. Synthesis of ATP is most efficient in the final stages of aerobic respiration, a process which requires oxygen. The most active cell types have the greatest number of mitochondria, e.g. liver, muscle and spermatozoa.

Ribosomes

These are tiny granules composed of RNA and protein. They synthesise proteins from amino acids, using RNA as the template. When present in free units or in small clusters in the cytoplasm, the ribosomes make proteins for use within the cell. These include the enzymes required for metabolism. Metabolic pathways consist of a series of steps, each driven by a specific enzyme. Ribosomes are also found on the outer surface of the nuclear envelope and rough endoplasmic reticulum where they manufacture proteins for export from the cell.

Endoplasmic reticulum (ER)

Endoplasmic reticulum is an extensive series of interconnecting membranous canals in the cytoplasm. There are two types: smooth and rough. Smooth ER synthesizes lipids and steroid hormones, and is also associated with the detoxification of some drugs. Some of the lipids are used to replace and repair the plasma membrane and membranes of organelles. Rough ER is studded with ribosomes. These are the site of synthesis of proteins, some of which are ‘exported’ from cells, i.e. enzymes and hormones that leave the parent cell by exocytosis to be used by cells elsewhere.

Golgi apparatus

The Golgi apparatus consists of stacks of closely folded flattened membranous sacs. It is present in all cells but is larger in those that synthesise and export proteins. The proteins move from the endoplasmic reticulum to the Golgi apparatus where they are ‘packaged’ into membrane-bound *vesicles*. The vesicles are stored and, when needed, they move to the plasma membrane and fuse with it. The contents are expelled (secreted) from the cell. This process is called *exocytosis* .

Lysosomes

Lysosomes are small membranous vesicles pinched off from the Golgi apparatus. They contain a variety of enzymes involved in breaking down fragments of organelles and large molecules (e.g. RNA, DNA, carbohydrates, proteins) inside the cell into smaller particles that are either recycled, or extruded from the cell as waste material. Lysosomes in white blood cells contain enzymes that digest foreign material such as microbes.

Cytoskeleton

This consists of an extensive network of tiny protein fibres.

Microfilaments : These are the smallest fibres. They provide structural support, maintain the characteristic shape of the cell and permit contraction, e.g. actin in muscle cells.

Microtubules: These are larger contractile protein fibres that are involved in movement of:

• organelles within the cell
• chromosomes during cell division
• cell extensions (see below).

Centrosome: This directs organisation of microtubules within the cell. It consists of a pair of *centrioles* (small
clusters of microtubules) and plays an important role in cell division.

Cell extensions: These project from the plasma membrane in some types of cell and their main components
are microtubules, which allow movement. They include:

• microvilli – tiny projections that contain microfilaments. They cover the exposed surface of certain types of cell, e.g. absorptive cells that line the small intestine. By greatly increasing the surface area, microvilli make the structure of these cells ideal for their function – maximising absorption of nutrients from the small intestine.
• cilia – microscopic hair-like projections containing microtubules that lie along the free borders of some cells. They beat in unison, moving substances along the surface, e.g. mucus upwards in the respiratory tract.
• flagella – single, long whip-like projections, containing microtubules, which form the ‘tails’ of spermatozoa that propel them through the female reproductive tract.

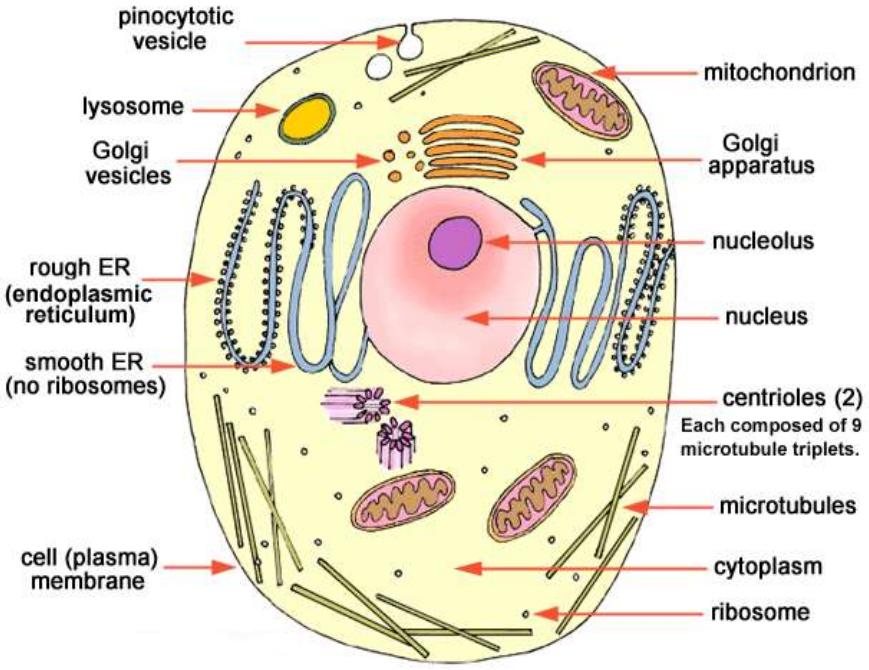


Figure: The Cell

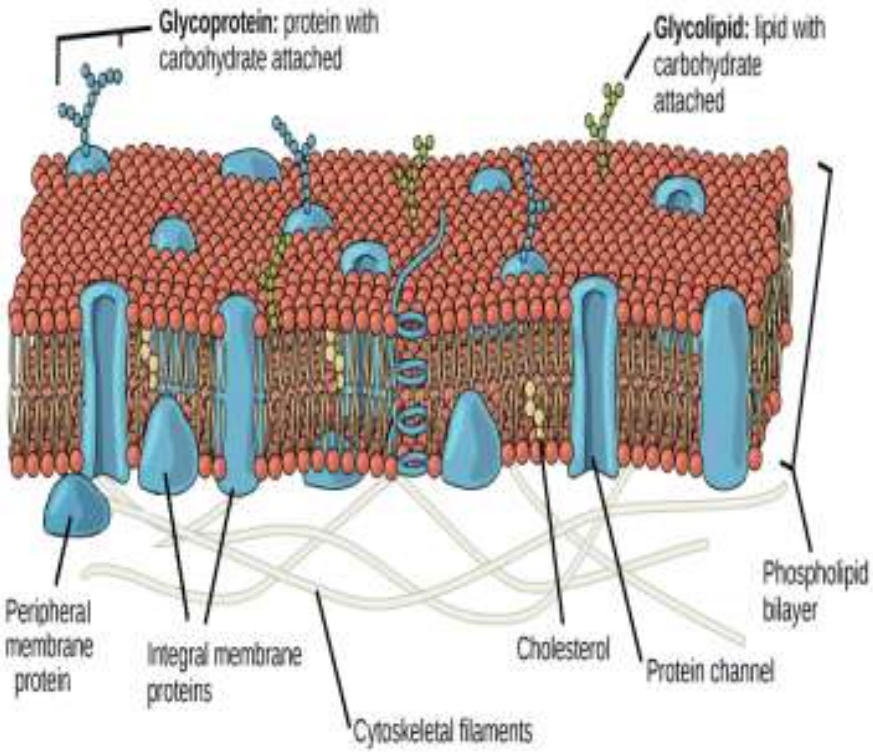
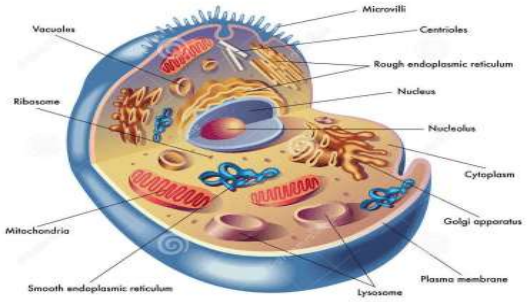


Figure: Plasma membrane

Cells be like

Cell Processes



The Mitochondria is the powerhouse of the cell

Figure: mitochondria & RER