

ANATOMY, PHYSIOLOGY AND HEALTH EDUCATION

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 **NIRALI**
PRAKASHAN
ADVANCEMENT IN KNOWLEDGE

TEXT BOOK OF

ANATOMY, PHYSIOLOGY AND HEALTH EDUCATION

For

First Year Bachelor of Pharmaceutical Sciences

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PREFACE

The thorough understanding and knowledge of Pharmacology makes the Pharmacist a vital member of the health care team. The knowledge of Anatomy and Physiology is the pre-requisite for initiating the study of Pharmacology. Keeping this requirement in mind; an attempt has been made here to provide the students with the necessary information on Human Anatomy, Physiology and Health Education.

Being a basic subject of Medical Sciences large number of books are available on this subject that give minute details in voluminous form. We felt it necessary to scan the voluminous information and gather the relevant information that may cater to the needs of students of first year Bachelor of Pharmaceutical Sciences.

Though in general, this book may prove useful to the students of Pharmacy, Nursing and other Paramedical Sciences; in particular it complies with the requirements of First Year B. Pharm. students. We shall highly appreciate constructive suggestions including criticism from the readers.

We sincerely thank Shri. V. S. Sandansive, AM, CTC, Kalayoga Arts, Asoda Jalgaon for drawing figures in this book and for preparing the cover design of this book. Our sincere thanks to Shri. D. K. Furia, Publisher and the staff members of Nirali Prakashan for timely publishing the book.

Dr. S. B. Bhise

Dr. A. V. Yadav

SYLLABUS

- 1. Structure and functions of skeleton :**
Classification of joints and their functions.
 - 2. Tissues :**
Properties and functions of epithelial, connective, muscular and nervous tissue.
 - 3. Lymphatic system :**
Structure and function of lymph gland and spleen.
 - 4. Heart :**
Structure of heart and its conducting system.
 - 5. Respiratory system :**
Parts of the respiratory system.
 - 6. Digestive system :**
Parts of the digestive system.
 - 7. Skeletal muscle :**
Structure of the skeletal muscle
 - 8. Nervous system :**
Structure of neuron. Parts of the CNS and peripheral nervous system.
 - 9. Sense organs :**
Structure of tongue, nose, eye, skin and ear.
 - 10. Urinary system :**
Structure of organs of the urinary system.
- Physiology :**
- 1. Cellular Physiology :**
Functional morphology, transport across cell membrane and membrane potential.
 - 2. Blood :**
Composition of blood, functions of blood elements. Coagulation of blood, blood groups.
 - 3. Lymphatic system :**
Function of lymph, lymph gland and spleen.
 - 4. Heart :**
Functions of the conducting system of heart. Blood pressure and factors regulating blood pressure; cardiac output and peripheral resistance. Cardiac cycle, normal ECG. Baroreceptors and cardiovascular reflexes.
 - 5. Respiratory system :**
Functions of the parts of respiratory system. Mechanism of breathing. Exchange of gases.
 - 6. Digestive system :**
Functions of the different parts of digestive system. Digestion and absorption of carbohydrates, proteins and fats. Structure and functions of liver.
 - 7. Skeletal Muscle :**
Mechanism of contraction, neuromuscular functions.
 - 8. Nervous system :**
Functions of CNS and peripheral nervous system.
 - 9. Sense Organs :** Functions of organs of taste, smell, vision, touch and hearing.
 - 10. Endocrine System :**
Location, hormones and functions of Pituitary, Thyroid, Adrenals, Pancreas, Testes and ovaries. Effects of hypo – & hyper–secretion.
 - 11. Reproductive system :**
Spermatogenesis, Menstrual cycle.
 - 12. Binary system :**
Functions of organs in urinary system. Formation of urine.
- Health Education :** Principles underlying the various family planning methods. Tropical diseases, Communicable diseases : Causative agents. Modes of transmission and prevention of:
- Respiratory infection; chicken pox, measles, influenza, diphtheria, whooping cough and tuberculosis.
 - Intestinal infections : Hepatitis, Cholera, Typhoid.
 - Insect borne diseases : Malaria, Filariasis, Kala Azar
 - Sexually Transmitted diseases : Syphilis, Gonorrhoea, AIDS.

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INTRODUCTION

The human being is a very complex multicellular organism. The study of human body is divided under two major headings, i.e. Anatomy and Physiology.

(1) Anatomy: It is the study of the structure of the body as a whole, as also the study of its individual parts and their relations to one another.

(2) Physiology: It is concerned with the way in which the various organs function and how they are integrated to produce a coordinated action of the whole body.

A cell is the smallest functional unit of an organism. Groups of cells having the same physical characteristics and performing similar specialized function, are described as tissues. Various types of tissues join to form an organ, and a system consists of a number of such organs and tissues. Although each system carries out one or more of the vital functions of the body, none of the systems can exist in isolation because of specialization of cells.

Different body organs have different structures. The variation in structures is due to the variations in the functions they perform. For example, the bony skeleton provides support to various organs; therefore, bones are rigid in structure. The heart has to pump blood through the blood vessels; hence walls of the heart are highly muscular. In the alveoli of lungs, transfer of gases across the wall is continuous; therefore the alveolar membrane is very thin. The small intestine is responsible mainly for digestion and absorption of food; hence it contains many secretions and villi which assist in effective absorption.

Before discussing these specialities in structures, the various systems are briefly described below:

The human body consists of the following systems:

- (1) Skeletal system:** It consists of the bony framework. It acts as the supporting structure and offers protection to the internal organs.
- (2) Muscular system:** The muscles and tendons are attached to the bones. They help to give the body its shape and power to move at will.
- (3) Nervous system:** It serves to control and to coordinate the functions of various parts of the body. It also makes an individual keenly aware of the environments in which he lives.

- (4) **Circulatory system:** It distributes the essential supply of oxygen and nutrient materials to all the parts of the body and removes the waste products, from the body.
- (5) **Respiratory system:** It supplies the body with oxygen from the atmosphere and even as it disposes of carbon dioxide and water vapours from the body. It comprises of lungs and bronchi.
- (6) **Digestive system:** It is concerned with the intake of food, its digestion and absorption. It comprises of the digestive tract from the mouth to the anus.
- (7) **Excretory system:** It removes waste products from the body. It comprises organs like kidneys, large intestine, skin, and lungs.
- (8) **Endocrine system:** It produces certain chemical substances through endocrine glands, which are termed as hormones. The hormones regulate the body processes.
- (9) **Reproductive system:** It is a system of organs concerned with reproduction, especially sexual reproduction.

All these systems work as an integrated whole producing the coordinate effort necessary for the maintenance of health and well-being.

The human body is built round the bony framework or skeleton which consists of the following parts:

- (a) The head and neck
- (b) The trunk divided into thorax, abdomen, and pelvis;
- (c) The limbs, both upper and lower.

For the simplicity of description, the body is divided into four cavities, i.e.

- | | |
|-------------------|--------------|
| (1) Cranial | (2) Thoracic |
| (3) Abdominal and | (4) Pelvic. |

The *cranial cavity* encloses the brain. Its boundaries are formed by the bones of the skull. The *thoracic cavity* contains lungs, heart, trachea; bronchi, esophagus, aorta; superior and inferior vena cava. The boundaries of thoracic cavity are formed by ribs, sternum and supporting muscles. The *abdominal cavity* is home to stomach, small intestine, most of the large intestine, liver; gall bladder, pancreas, spleen; kidneys, upper part of the uterus and suprarenal glands. The *abdominal cavity* is lined by a dome-shaped muscle called diaphragm on the superior side and lumbar vertebrae and muscles on the posterior side. On the inferior side, it is continuous with the *pelvic cavity*. The pelvic cavity contains lower part of the large intestine, few loops of small intestine, urinary bladder, and lower part of the ureter: urethra and reproductive organs. The pelvic cavity is lined by pelvis, sacrum and coccyx and muscles of the pelvic floor.

Following are some of the terms used for the anatomical description of the various parts of the skeletal system.

Anatomical position: This is the upright position of the human body with the head facing forward, the arms at the sides with palms of the hands facing forward and the feet together.

Median plane: When the body in the anatomical position is divided longitudinally in two equal parts, it is divided in the median plane. Any structure towards the midline is termed 'medial' and the structure away from the midline is called as 'lateral'.

Proximal and distal: These terms are used for describing bones of the limbs. The proximal end is nearest to the point of attachment of the limb and the distal end is the farthest.

Anterior or ventral: It indicates that the part being described is nearer to the front of the body.

Posterior or dorsal: It indicates that the part being described is nearer to the back of the body.

Superior: It indicates a structure near the head.

Inferior: It indicates a structure away from the head.

Border: It is a ridge of bone which separates two surfaces.

Spine, spinous Process or crest: It comprises series of vertebrae extending from skull to the small of the back.

Tubercle: These are small, rough bony projections for attachment of muscles or ligaments.

Fosse: It is a depression or a hollow.

Foramen: It is a hole in a structure.

Sinus: It is a cavity within a bone.

Meatus: It is a tube-shaped cavity within a bone.

Articulation: It is a joint between two or more bones.

Suture: It is an immovable joint between two or more bones.

Articulating surface: It is that part of a bone which enters into the formation of a joint.

Facet: It is a small, flat, articulating surface.

Condyle: It is a smooth rounded projection of a bone which takes part in a joint.

Septum: It is a partition separating two cavities.

Fissure or Cleft: It indicates a narrow slit.

THE CELL

The cell is a basic and the smallest functional, living unit of the body tissue. The cells are grouped together to form the tissues. Cytology is the branch of science which is concerned with the study of the cell. In an unicellular organism, a single cell performs

all the functions while in multicellular organisms cells get specialized to form different tissues; each tissue performs a specific function.

Plasma or cell membrane

The membrane which separates the internal components of a cell from extracellular material is known as plasma membrane or cell membrane. The plasma membrane regulates passage of the substances in and out of the cell. The plasma membrane consists of equal proportion of proteins and lipids. Lipids are made up of 75 per cent of phospholipids. Lipids normally consist of phosphorus and small amount of cholesterol and glycolipids. The phospholipids are arranged in parallel layers forming a phospholipids bilayer which forms the basic framework of the plasma membrane. Phospholipids are amphipathic in nature.

Such types of amphipathic molecules have a dual nature. That is they contain both polar and non-polar regions. The head of the polar part contains phosphate which is hydrophilic. The non-polar part is the tail which contains two fatty acids which are hydrophobic in nature.

Glycolipids

These are also amphipathic in nature, and comprise 05 per cent of membrane lipids. They are present only in the layer that faces the extracellular fluid. Glycolipids contribute to the regulation of cellular growth and development.

Cholesterol

About 20 per cent of the membrane lipids are cholesterol molecules, which are found in animal cells. Cholesterol strengthens the membrane of an animal cell but decreases its flexibility.

Membrane protein

They are of two types: integral and peripheral. The integral proteins are glycoproteins which extend across the phospholipids bilayer between the fatty acids tails. Normally, sugar portion of glycoproteins faces the extracellular fluid. The peripheral proteins are loosely attached to the inner and outer surfaces of membrane. Some integral proteins have a pore through which certain substances can pass in or out of the cell while some act as a carrier to move a substance from one side of the membrane to other side. Integral proteins work as receptors which attach the specific molecule such as nutrients, hormones, neurotransmitter and these are essential for cellular functions. The molecule which is attached to the receptor is known as ligand.

Physiological properties of membrane

The membrane serves as a cellular communication. It interacts with other body cells, foreign body cells and Ligands. It encloses the cellular contents and keeps it away from extracellular fluid. The plasma membrane maintains an electrical and chemical gradient known as 'electrochemical gradient' between the inside and outside of the cell. The plasma membrane controls entry and exit of materials. It allows passage for certain substances and restricts the passage for others; such a property of the membrane is known as selective permeability. The selective permeability depends on several factors such as lipid solubility, size, charge and presence of channels and transporters.

Transport of material across the membrane

There are two main transport processes: the passive process wherein the cellular energy is not used and an active process, in which the cell uses some of its own energy by splitting ATP to move the substance across the membrane. Passive process includes simple diffusion, osmosis, bulk flow and facilitated diffusion. In these, the transport of molecules depends on the pressure or concentration differences.

Simple diffusion

Molecules and ions move under kinetic energy (energy of motion) and collide with one another. The random mixing of ions and molecules in the solution due to their kinetic energy is known as simple diffusion. In simple diffusion, high concentration of molecules or ions is present in one area and low concentration of molecules or ions is present in an other area. This difference in concentration between the two areas forms concentration gradient. When two such areas are connected, then substances will move from higher concentration to lower concentration till the concentration on both sides becomes equal.

Osmosis

In a living system, water diffuses through the permeable membrane. Water moves under osmosis across a cell membrane from the area of higher water concentration to an area of lower water concentration. For movement of water between various body compartments, osmotic pressure is important, which is creating a force for movement of water. In an isotonic solution, the cells such as RBC, maintain their shape. The concentration of water and solute in the fluid outside RBC must be same as the concentration of fluid inside the cell.

Bulk flow

The large number of molecules, ions or particles which are dissolved in a fluid medium or air, moving in one direction, is known as bulk flow. Such type of movement occurs from higher pressure to lower pressure. Examples of bulk flow in the body are flow of blood within the vessels and movement of air into and out of lungs.

Facilitated diffusion

In this the substances move under the concentration gradient from an area of higher concentration to a area of lower concentration with the help of specific integral proteins in the membrane which work as carriers for each type of substances, such as ions, urea, glucose, fructose, galactose, vitamins. These substances are also lipid soluble and can diffuse through phospholipids bilayer and cross plasma membrane by facilitated diffusion.

Active transport

Some substances which enter or leave the body cells do not move passively across the cell membrane because they are supposed to move against the concentration gradient. These substances move across membrane by active processes. For active transport ATP is required, and particular integral membrane proteins act as ATP driven pumps to push certain ions and smaller molecules across cell membrane. In vesicular transport, there is formation of vesicles. These vesicles either detach from plasma membrane during material transport into cell or merge with the plasma membrane to

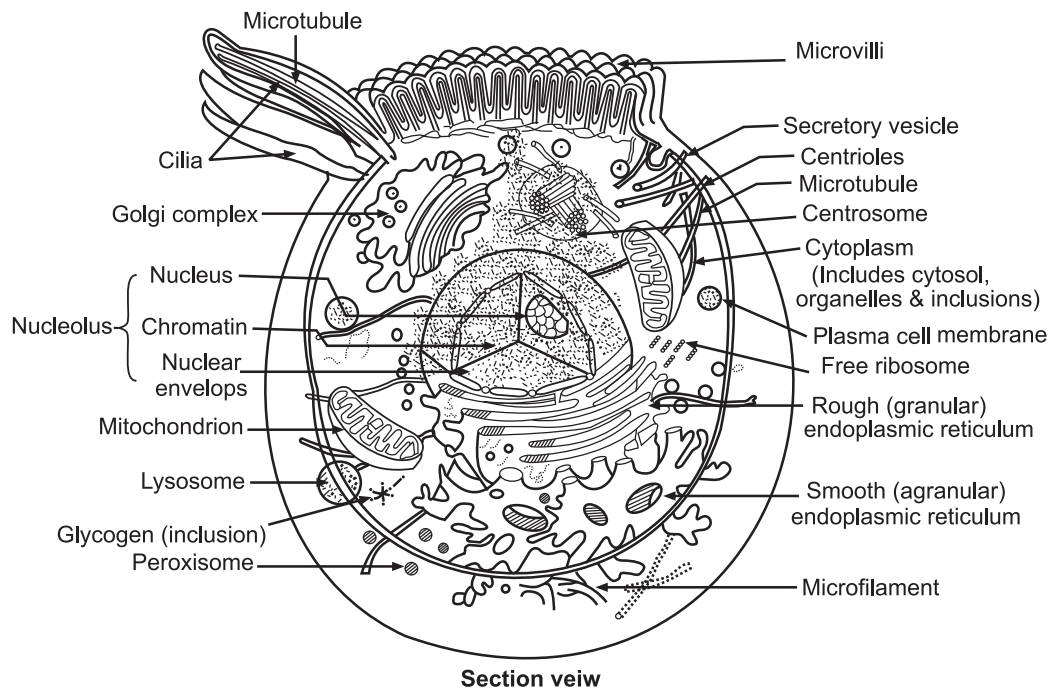
release material from the cell. Particles such as bacteria, RBC and large molecules such as polysaccharides, and proteins, may enter or leave the cell by vesicular transport. There are several types of vesicular transport methods. These are phagocytosis, Pinocytosis, receptor-mediated endocytosis and exocytosis.

ORGANELLES

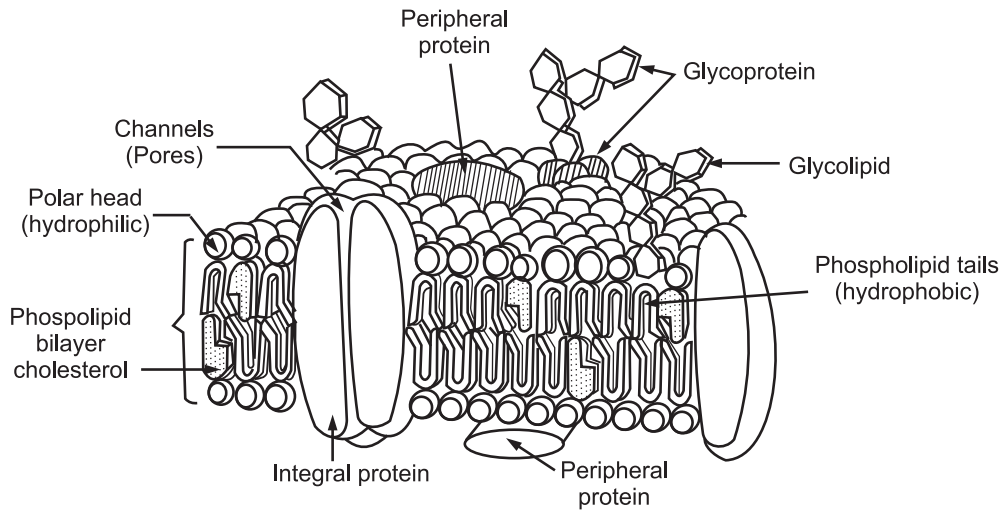
Inside the cell, there are specialized structures which have a specific role in growth, maintenance, repair and control. These specialized structures provide compartments inside the cells and are called Organelles.

Nucleus

It is the largest structure in the cell, and is usually spherical or oval in shape. Nucleus contains hereditary units called genes. These genes control the cellular activities and the structure. Genes are arranged in a single file along structures known as chromosomes. Human body contains 46 chromosomes. Nucleus has a double membrane known as nuclear envelope which separates the nucleus from the cytoplasm. Envelope also consists of a phospholipids bilayer which has nuclear pores. It allows ions and water soluble molecules to pass between nucleus and cytoplasm. Inside the nucleus, there are spherical bodies called nucleoli, which are the sites for ribosomes. The chromosomes are clusters of DNA molecules. DNA molecule is a sequence of nucleotides and each nucleotide has three components, a sugar molecule, phosphate group and nitrogen containing base. Also there are four bases in DNA: adenine (A), thiamine (T), guanine (G) and cytosine (C). Ribosomes are essential for protein synthesis.

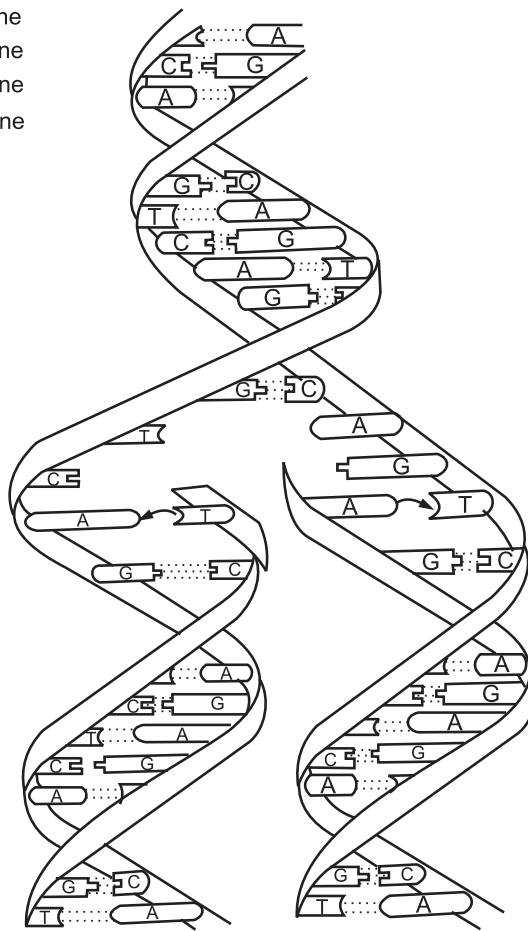


(a) Generalized Animal Cell-based on Electron



(b) CYTOSOL - Details of Plasma Membrane Structure

- = Adenine
- = Guanine
- = Thymine
- = Cytosine



(c) Nucleic Acid

Fig. 1.1

Ribosome

Ribosomes are fine granules which contain ribosomal RNA, synthesized by DNA in the nucleolus. They synthesize proteins from amino acids. When these ribosomes are present in free units or in small clusters in the cytoplasm, the ribosomes make proteins for use within the cell. Ribosomes are also present on the outer surface of rough endoplasmic reticulum.

Endoplasmic reticulum

Some of the inward projections penetrate into the centre of the cell in the form of channels which widen out into vesicles. This complex within the cell is called endoplasmic reticulum. At many places, the endoplasmic reticulum carries granules called ribosomes which synthesize proteins. The endoplasmic reticulum without ribosomes helps in the synthesis of lipid substance.

Golgi apparatus

Golgi apparatus is present near the nucleus. The Golgi apparatus stores secretory substances and prepare the substances for final secretion. It consists of flattened sacs called cisterns, which are situated upon each other like a pile of plates. Small Golgi vesicles are associated with cisterns. Golgi complex has a number of functions, such as sorting, packaging and delivery of proteins and lipids to the plasma membrane and formation of Lysosomes and secretory vesicles.

Lysosomes

Lysosomes are another intracellular structures surrounded by a lipoprotein unit membrane. It is filled with large number of small granules which are aggregates of digestive enzymes. These enzymes digest proteins, nucleic acids, mucopolysaccharides and glycogen. Normally, the membrane surrounding Lysosomes prevents the enclosed digestive enzymes from coming in contact with other substances in the cell. Lysosomal enzymes work best in an acidic pH. Interior of the Lysosomes has a pH of 05. Lysosomal enzymes digest bacteria and other substances which enter the cell in phagocytic vesicles and pinocytic vesicles.

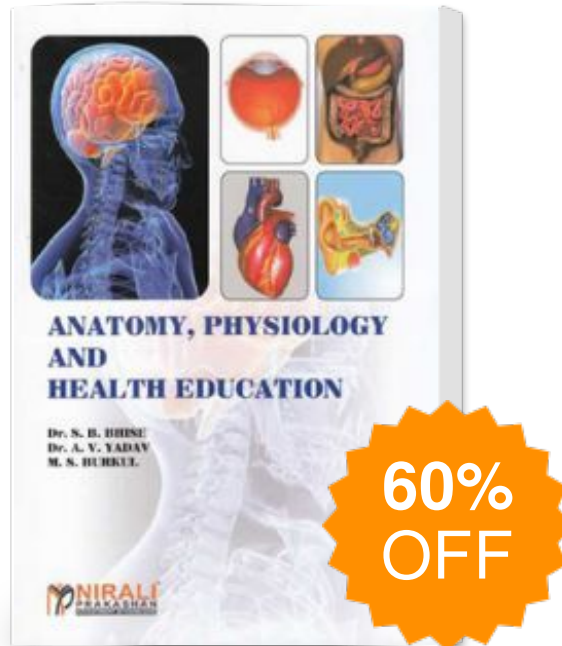
Peroxisome

Peroxisomes have a similar structure to Lysosomes, but they are smaller and contain one or two enzymes which use oxygen to oxidize various organic substances and to form hydrogen peroxide. The enzyme known as catalase uses H_2O_2 , formed by other enzyme to oxidize various substances, such as phenol, formic acid, formaldehyde and alcohol. These substances are toxic in nature.

Mitochondria

Mitochondria are small intracellular organelles which are surrounded by double unit membrane. Enfolding of the inner unit membrane form shelves on which oxidative enzymes of cell are absorbed. When nutrient and oxygen come in contact with these

Anatomy, Physiology And Health Education



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