LESSION – 1

STRUCTURAL ORGANIZATION, STRUCTURE & FUNCTIONS OF HUMAN CELLS

Outline of the Lesson

1.0 OBJECTIVE

After study of this lesson you will know -

1. What is the organization of the body ?
2. What are the various systems of the body ?
3. Characteristics of living being.
4. Major structure of the body.
5. What are the major planes of the body ?
6. Cell, the smallest unit of the body.
7. DNA & RNA

2.0 INTRODUCTION

From structure point of view, body has different levels of organization and these levels are related to each other in an hierarchical way. Main organization levels are :

1. Chemical Level
2. Cellular Level
3. Tissue Level
4. Organ Level
5. System level
6. Organismic level

Primary level is chemical level. Human body is made of various chemicals which are made same elements as mentioned in periodic table of chemistry. Atoms of these elements form molecules and molecules of different elements react together and form chemical compounds. These chemicals constitute human body. For example hydrogen and oxygen react together and form water. Major part of our body is water.

Many chemicals get organized in a particular manner and form the cell. Cell is basic unit of a living - being and is complete from anatomy and physiology point of view. All characteristics of living being and physiological reaction happening in human body are present in a cell. There are different types of cells in our body, for example, nerve cells (neuron), blood cells, muscle cells. Though basic constituents of various cells are same but their structure differ from each other based on their function.

Cells of particular type combine together and form tissue. These cells are joined together by intercellular substance. These cells are of same embryological origin and together perform a particular function. For example – Epithelium tissue secrets mucus which moistens the food and make it smooth so that it can slide easily along oesophagus. Parietal cells in stomach secrets hydrochloric acid. Xymogenic cells produce enzymes which are useful for digesting proteins. Muscle tissue, connective tissue and nervous tissue are some other type of tissues.

Various types of tissues get together and form organ. An organ consists of two or more than two tissues. Every organ has a particular function. Examples of organs are – heart, lever, lungs.

Number of organs which contribute to a particular function, form a system e.g. digestive system. Food passes through oesophagus to stomach where it is digested. Nutrients are absorbed in small intestine from the digested food. Then it further passes to large intestine where water and other salts are absorbed. Left out material faeces gets collected in rectum and excreted from the body time to time. In addition to this bile is produced in the liver and pancreatic juices are produced in pancreas and all these juices help in digestion of the food. Thus we see so many organs together perform the activity of digestion and form digestive system.

3.0 VARIOUS SYSTEMS OF THE HUMAN BODY

Highest level of human body is organismic level. All the organs of the body perform the activities in co-ordinated manner and thus giving rise to a living being. Various systems of human body are mentioned below in brief.

3.1 Integumentary System :-

Organs : Skin and its associated organs – hair, nails, sweat, oil glands.

Function : Helping in control of body temperature, protection of inner organs, excretion of waste material through sweat, production of Vitamin – D, Sensing outside stimulus like touch, pressure, pain.

3.2 Skeleton System :

Organs : All bones, cartilage & joints.

Function : Skeleton of body, protection of the body, production of blood cells in bone marrow.

3.3 Muscular System :

Organs : Skeleton muscles & other muscles

Function : Regulation of body movements and postures. Production of heat.

3.4 Nervous System :

Organs : Brain, Spinal Cord & nerves

Function : Control of all activities of the body.

3.5 Endocrine System :

Organs : All the glands which secrete hormones

Function : Hormones controls the various activities of the body.

3.6 Cardiovascular System :

Organs : Heart, Blood, Blood Vessels (arteries & veins)

Function : To supply oxygen and other nutrients to all the cells of the body, removal of carbon dioxide from the cells, maintain balance of acid and alkali, maintain immune strength, control of body temperature, clotting of blood in case of injury.

3.7 Lymphatic System :

Organs : Lymph vessels, lymph fluid, lymph tissues.

Function : Filtration of body fluid, maintaining white cells and protection from diseases.

3.8 Respiratory System :

Organs : Lungs, Nose, Trachea, Larynx

Function : To supply oxygen & remove carbon dioxide from the body. Maintain acid alkali balance.

3.9 Digestive System :

Organs : Alimentary tract (mouth cavity, pharynx, oesophagus, stomach, small intestine, large intestine, rectum, anus) and accessory organs (saliva glands, liver, gall bladder, pancreas)

Function : Mechanical & Chemical digestion of food, absorption of nutrient and excretion of undigested food.

3.10 Excretory System :

Organs : Kidneys, urine bladder and urinary tract

Function : Remove waste from the blood, regulate chemical composition of the blood, maintain acid alkali balance.

3.11 Reproductive System :

Organs : In male - testes, Epididymis, prostrate, penis
In female – vulva, ovary, uterus, mamory glands

Function : Giving birth

4.0 CHARACTERISTICS OF LIVING BEING

Every living being has some characteristics which differentiate it from non – living being. In other words if beings have certain characteristics, then they are living being, otherwise they are non - living objects. Living being have following characteristics :- 1. Metabolism 2. Excitability3. Conductivity 4. Contractility 5. Growth 6. Differentiation, 7. Reproduction These are briefly described below :

4.1 Metabolism : Chemical reactions taking place in human body are referred as metabolism. These can be classified in two categories.

i) **Catabolism :-** All reactions which provide energy to the body for doing internal and external activities fall under this category.

ii) **Anabolism :-** All reactions which use energy (produced by catabolic reactions) to produce chemicals for building organs falls under this category.

Digestion, absorption, respiration, production of hormones, excretion, all are metabolic reactions.

4.2 Excitability : Due to this characteristic, living beings are able to sense change in outer environment and in response to these changes, living beings cause necessary changes to the protect themselves.

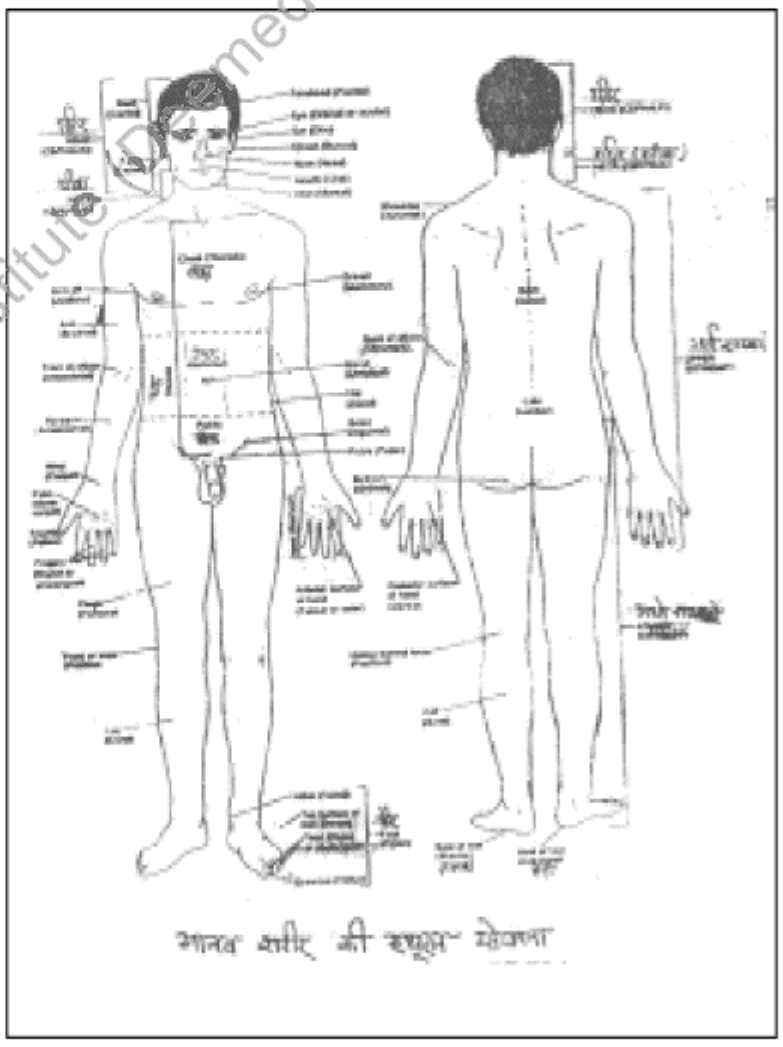
4.3 Conductivity : Information sensed in one part of the body is sent to other part (spinal cord, brain) through the nerves. This characteristic is called conductivity.

4.4 Contractility : In response to stimulus body or some parts of the body make necessary movements. This characteristic is prominently found in the muscles. This is due to the characteristics of contractility as in the case of movement some muscles contract and then relax.

4.5 Growth : Growth takes place in two ways – increase in number of cells, increase in the size of the cells. As a result of this characteristic, small body slowly grows to adult.

4.6 Differentiation : Due to this characteristic a normal cell divide into cells which are completely different in structure and function from the original cell. As a result of this property only a single fertilized egg (cell) result into formation of so many organs of the body having different types of cells.

4.7 Reproduction : Reproduction is one of the important characteristics of living being production of new cells to replace worn out cells, species similar to themselves only makes the clan to continue.



5.0 MAIN STRUCTURE OF THE BODY

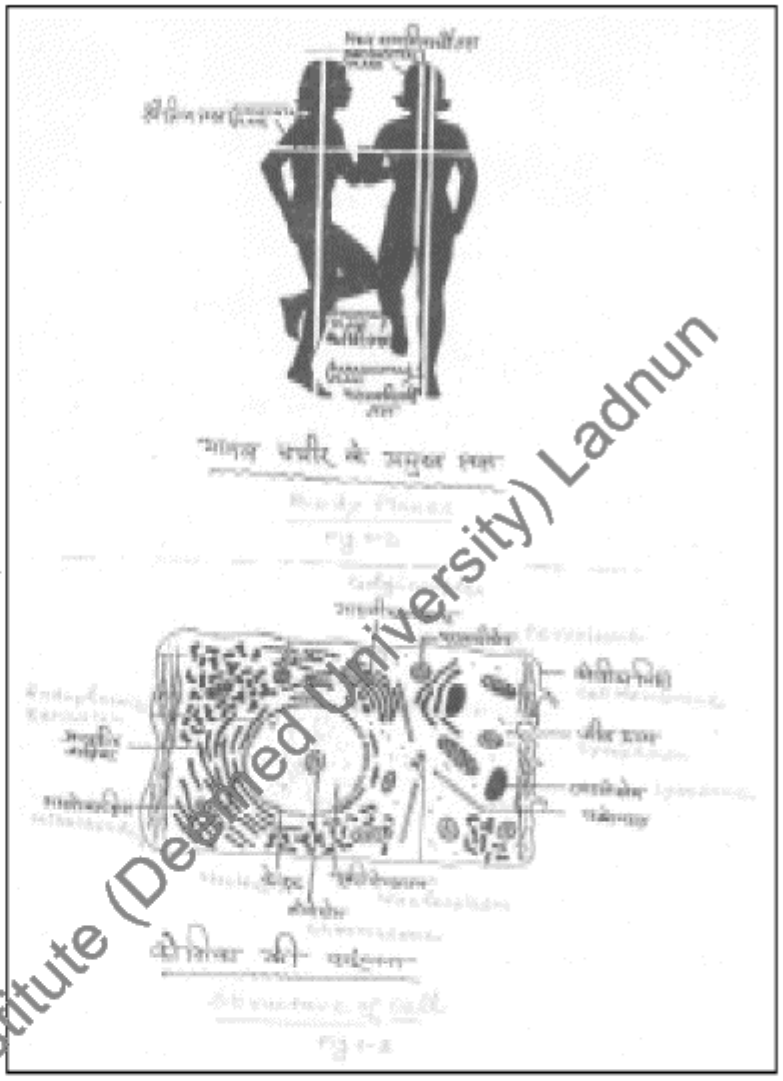
Human body consists of number of systems as described earlier. From physical structure point of view, human body can be divided into four parts : 1. Head, 2. Neck, 3. Trunk, 4. Upper Extremities, 5. Lower Extremities

5.1 Head : Head has two parts :- 1. Skull 2. Face Skull is made of number of small bones. Its shape is like spherical container. Its hollow portion is called cranial cavity. Brain in contained in this hollow cavity and thus protected by skull bones from any outside injury. In the lower part of skull is face. Skull also has sockets in which sense organs like eyes and ears with the organs of balance are installed to maintain their fixed positions.

5.2 Neck : It is flexible structure made up of bones and muscles. It connects head with trunk. Vertebral column starts from the neck and

some vertebrae are located in the neck. Vertebra column gives strength to the neck. Spinal cord starting from the brain passes through the vertebral column. Air pipe (trachea) and food pipe (esophagus) pass through the neck.

5.3 Trunk : This is major central part of the body which houses all important organs. It is divided into two parts by diaphragm muscle – upper part in thoras and lower part is abdomen. Vertebral column at the back and ribs, sternum, pectoralgirgle all these bones form a cage like structure in which important organs like lungs, heart are situated. Abdomen does not have bones on front side and hence it is soft from the front. It houses liver, pancreas, intestines and kidneys. Lower most part of abdomen which is called pelvic region houses urethra, bladder and reproduction organs.



5.4 Upper Extremities : These are right hand and left hand connected to the upper part of the trunk. Joints where hands join the trunk are called shoulders. Every hand can be divided into :- arm, elbow, wrist and fingers. Every hand has five fingers and there is nail at extreme end of every finger. Shoulder, elbow, wrist and fingers all have special joints which facilitate various movements of these parts according to the need of the body.

5.5 Lower Extremities : From the lower parts of the trunk, two extremities branch out which are called right leg and left leg or lower limbs. These limbs are connected to the lower part of the trunk by hip joints. Each limb has thighs, Knee, ankle and sole. Each limb has five fingers which at their extreme end have nails.

6.0 BODY PLANES

In order to study the internal structure of the body and relative positions of the organs, help of planes is considered. Planes are immaginary surfaces dividing the body into two equal or unequal parts. Following major planes are considered in understanding the anatomy of the body.

6.1 Sagittal Plane : This is vertical plane (from top to bottom) which divides body or organs into two parts right and left. When two parts are equal, then this plane is called midsagittal plane. When two parts (right & left) are not equal, then this plane is called parasagittal plane.

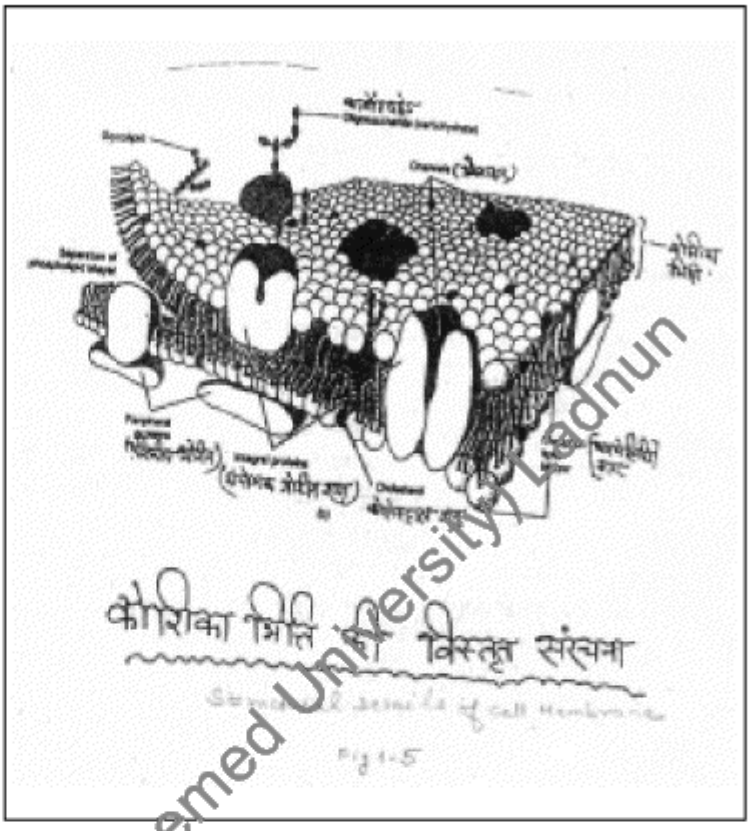
6.2 Frontal Plane : This is vertical plane which divides body in the front of back part.

6.3 Horizontal or Transverse Plane : This plane divides body in upper and lower parts.

7.0 CELL

Cell is the basic unit of human body like brisk is the base unit of the building. Cell is complete from the structure and functional point of view. Cells have varied structures depending on their function (to which system the belong). But some basic characteristics are found in all the cells. The branch of science which deals with study of cells – their structure and function is called cytology.

Animals and plants both are in the category of living beings. Basic structural unit of both is cell. Tissues and organs are made up of cells in both cases. However cells of animals and plants differ in structure, animal cells are so small that they can not be seen by naked eyes and one has to use electronic microscope for studying their structure.



Animal cell can be divided into four parts for the purpose of the study of their structure.

1. **Cell Membrane :** It is outer cover of the cell and separates internal organelles of cell from outside. It also gives definite shape to the cell.
2. **Cytoplasm :** It is chemical liquid filled inside the membrane in which cell organelles are situated.
3. **Cell Organelles :** These have the same place in the cell structure as organs have in human body. All important functions of the cell are carried out by them.
4. **Cellular Inclusions :** These include chemical secretions which are produced and excreted from time to time.

7.1 Cell Membrane : Cell membrane is a thin, elastic and highly complex structure of lipids and proteins. It is semi permeable membrane (selective permeability – allowing certain substances to pass through while preventing others) membrane containing pores that allow the passage of water, oxygen, carbon dioxide and some solute in and out of the cell.

7.1.1 Cell membrane is 4.5 nanometer (10^{-9} meter) to 10 nanometer. It is made up of phospholipid and proteins cholesterol, glycolipid and carbohydrates are also present in small quantities. Phospholipid molecules are in two parallel layers interspersed by the protein molecules. Phospholipid molecules consist of two parts - head (protruding out) and tail (protruding inside). Protein molecules are of 2 types :-

1. Integral protein :- which can change their place based on the need and can adjust their positions to form entrances for chemicals into the cell.

2. Peripheral proteins :- These molecules are loosely connected to phospholipid layer and provide strength to the cell membrane. These molecules also help in chemical reactions taking place inside the cell.

Cell membrane is accepted as fluid mosaic model made up of small blocks of phospholipid and proteins. Cholesterol reduces flexibility and permeability of the membrane or in otherwords it provides rigidity. Glycolipid provides connectivity between the cells.

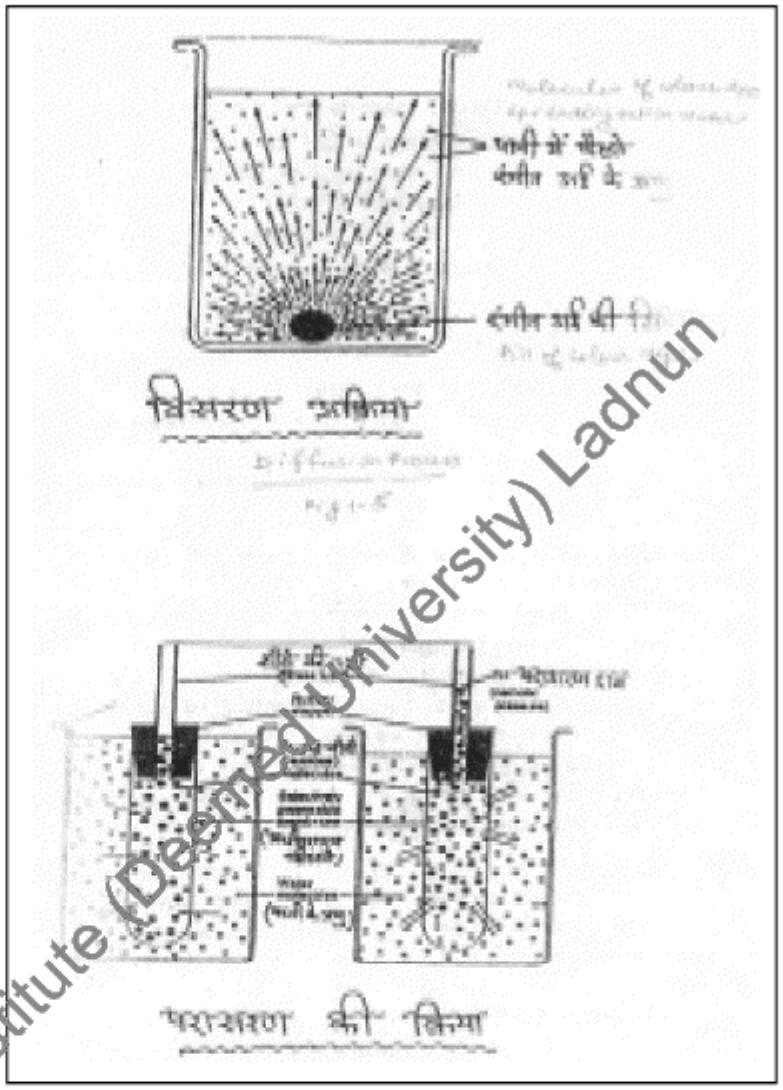
7.1.2 Functions of the Cell Membrane

1. Cell membrane is transparent. It can change its shape based on need.
2. It protects organallese.
3. Cells communicate through cell membrane to outside and with each other.
4. It regulates the movement of chemicals going in and out of the cell.
5. Cell membrane has various receptors which control the entry of chemicals based on their nature into the cell.
6. Through cell membrane, cell receives the nutrients and excretes the waste.
7. It responds to outside stimuli.

7.2 Movement through Cell Membrane : As already mentioned, cell membrane has selective permeability. This selective permeability of molecules through cell membrane depends on the size of molecules, their solubility in lipids, charge on ions and availability of carrier molecules of integral protein.

Movement of chemicals through cell membrane is of two types : 1. Passive Transport, 2. Active Transport

7.2.1 Passive Transport Processes : In these processes of movement of matter through cell membrane, no external energy is required. Movement of molecules uses their own kinetic energy. Following are various types of passive transport processes :-



a) Diffusion :- Molecules of liquid and gas are in constant motion, and tend to spread from lower concentration until a uniform concentration is achieved. Water, gases and some solutes diffuse easily through a permeable membrane, when concentration of molecules is higher on one side than the other molecules will move through the permeable membrane until both concentrations are equal. Large molecules diffuse more slowly than small ones. For example, if we put a piece of coloured chalk in water contained in a beaker. Slowly whole water becomes coloured. It is due to diffusion of molecules of chalk in whole water. Movement of oxygen from lungs to blood and movement of carbon dioxide from blood to the lungs are examples of diffusion process.

b) Facilitated Diffusion :- In this process, molecules bind to the carrier (integral protein on one side of the membrane and then carrier molecules cross the membrane and then release the attached molecule. In this process, even some molecules are bigger in size as compared to the size of pores in the membrane can pass through the carrier. Molecules of various types of sugars are recognized by integral protein molecules and are transported through the cell membrane to the cell.

c) Osmosis :- Osmosis is the movement of water through semi permeable membrane from a solution of low concentration to one of higher concentration (i.e. the reverse of diffusion). Molecules in solution tend to hold or attract water this drawing power is known as osmotic pressure. Osmotic pressure is determined by the number of molecules dissolved in a solution, thus greater the number of molecules in solution the greater its drawing power for water i.e. higher the osmotic pressure.

d) Dialysis :- In this process, smaller molecules can be separated from larger molecules by diffusion through a selective (semi) permeable membrane. If we take a solution which has small and large molecules of solutes and fill in a bag of semi permeable membrane and put in a breaker of water. After sometime, all smaller molecules would come to water in the beaker and large molecules would remain in the bag. This principle is utilized in dialysis machine (artificial kidney) to remove waste products like urea from the blood and send purified blood to the arteries.

7.2.2 Active Transport : In this process, matter is moved from low concentration to higher concentration (movement against the concentration gradient) and this requires energy. This energy comes from stored ATP in the cell. A typical body cell expends 40 percent of ATP it generates in active transport. Active transport takes place through two mechanisms namely pinocytosis and phagocytosis.

a) Pinocytosis :- This is mechanism in which the cell membrane indents and sucks the liquid substance to be absorbed into the cell. This process is also called cell drinking.

b) Phagocytosis :- This process is similar to pinocytosis, the major difference being that the cell extends pseudopodia to surround and engulf larger particles such as bacteria and foreign material. Chemicals that stop ATP generation for example, poison cyanide are Lethal because they shut down active transport in the cells through the body.

7.3 Cytoplasm

7.3.1 Structure : It is semi liquid substance between cell membrane and nucleus. It occupies nearly 55 percent of the total volume of the cell it is colourless, semitransparent and some what watery, chemical composition varies from place to place inside the cell. It has 75 to 90 percent water and balance are various dissolved and suspended components. Among these are different types of ions, glucose, amino acids, fatty acids, proteins, lipids, ATP and waste products. It is said that cytoplasm changes its structure, sometime clear, homogenous, sometime net structure, sometime bubble like structure appears.

7.3.2 Function : Cytoplasm is site of many chemical reactions required for cell's existence. For example enzymes in cytoplasm catalyze glycolysis, a series of 10 chemical reactions that produces two molecules of ATP from one molecule of glucose. Other type cytoplasmic reactions provide the building blocks for maintenance of cell structure and for cell growth. Also transport of substances inside the cell and from one cell to other cell takes place through cytoplasm. Excretion of waste products also done through cytoplasm.

7.4 Cell Organelles : Organelles are specialized structures within the cell which have characteristic shapes. They perform specific functions in cellular growth, maintenance and reproduction. Despite the many chemical reactions going in a cell at a given time, there is little interference among reactions because they are confined to different organelles. Each type of organelles has its own set of enzymes that carryout specific reactions and serves as functional compartment for specific biochemical process. Number and types of organelles vary in different cells, depending on the cell's function. Although they have different functions, organelles often co-operate to maintain homeostasis.

Following are major organelles :

1. Nucleus	2. Ribosome	3. Endoplasmic Reticulum
4. Golgi Complex	5. Lysosome	6. Mitochondria
7. Peroxysomes	8. Cytoskeleton	9. Centrosome

7.4.1 Nucleus : The nucleus is a spherical or oval shaped structure that usually is the most prominent feature of a cell. The nucleus is the control centre of the cell and contains a special type of protein, called nucleoprotein. It controls both the chemical reactions that occur in the cell and the reproduction of the cell.

Most cells have single nucleus, although some, such as mature red blood cells, have none. In contrast, skeletal muscle cells and few other types of cells have multiple nuclei. A double membrane called the nuclear envelope separates the nucleus from the cytoplasm. Both layers of nuclear envelop are lipid bi layers similar to the cell membrane (Plasma Membrane). Nuclear envelope has number of pores through which nucleus is in contact with cytoplasm. Inside nucleus is thick liquid called nucleoplasm. Inside the nucleus are one or more spherical bodies called nucleoli (singular is nucleolus) which function in producing ribosomes. Each nucleolus is simply a cluster of protein, DNA (De-oxy Ribonucleic Acid) and RNA (Ribo Nucleic Acid). It is not enclosed by membrane. Nucleoli are the sites of synthesis of proteins. Nucleoli are quite prominent in cells that synthesize large amounts of protein, such as muscle and liver cells.

Nucleoli disperse and disappear during cell division and reorganize when new cells are formed.

Within the nucleus are most of the cells hereditary units, called genes, which control cellular structure and direct cellular activities. Genes are arranged along chromosomes. Human body cells have 46 chromosomes 23 inherited from each parent. Each chromosome is long molecule of DNA that is coiled together with several proteins. This complex of DNA, Proteins and some RNA is called chromatin.

Genes are made of a complex protein compound, DNA and carry hereditary information of the cell. It is the genes which pass on the characteristics of the parent to the organism. Not only are most obvious features such as colour of hair and eyes, height and body shape so transmitted but also the factors which influence an individuals blood group, and in some instances, certain congenital defects and hereditary diseases.

7.4.2 Ribosome : Ribosomes are small granules which are found in cytoplasm in single units or groups. Their maximum size is 25 nanometer (10^{-9} meter). These are made of ribosomal RNA (rRNA) and ribosomal protein. Structurally; a ribosome consists of two sub units, one about half the size of other. The large and small sub units are made separately in nucleolus, a spherical body inside nucleolus. Once produced the large and small sub units exit the nucleus separately, then come together in cytoplasm.

Some ribosomes are attached to the outer surface of the nuclear membrane and to an extensively folded membrane called endoplasmic reticulum (R). These ribosomes synthesize proteins destine for specific organelles, for insertion in plasma membrane or for export from the cell. Some ribosomes are not attached to other cytoplasmic structure and are called 'free robosome'. They also synthesize proteins used in cytoplasm. Ribosomes are also located in mitochondria where they synthesize mitochondrial proteins.

7.4.3 Endoplasmic Reticulum : It is network of membranes in the form of flattened. Sacs or tubules connected with the nucleus and cell membrane. Endoplasmic reticulum are of two types.

a) Grannular or Rough Endoplasmic reticulum – Ribosomes are attached to its outer surface.

b) Agrannular or smooth endoplasmic reticulum.

Here ribosomes are not attached to its outer surface. Endoplasmic Reticulum is site for many chemical reactions. Rough Endoplasmic Reticulum synthesizes glycoproteins and phospholipids that are transferred to cellular organelles, insert into plasma membrane.

Smooth endoplasmic reticulum synthesizes fatty acids and steroids such as estrogens and testosterone. In liver cells, enzymes of smooth endoplasmic reticulum help release glucose into blood stream and inactivate or detoxify, lipid soluble drugs or potentially harmful substances, such as alcohol, pesticides, and carcinogens (cancer – causing agents.

It transfers substances from one part of the cell to another and along with Golgi Complex it helps in synthesizing and packing proteins.

7.4.4 Golgi Complex : It is near to nucleus. It consists of 4 to 8 small flattened membranous sacs with bulging edges flattened sacs are called cisternae (singular is cisterna). Cisterna is of three types :- cis, medial and trans. Medical cisterna is in the centre and cis and trans are above and below respectively. Main function of Golgi Complex is modification, sorting, packing and transport of proteins produced by Rough Endoplasmic Reticulum to various parts of the cell where these are required. Like proteins, Golgi Complex also sorts and packs and transports lipids (fatty acids) produced by smooth Endoplasmic Reticulum near to the cell membrane for exporting out of the cell.

7.4.5 Lysosome : These are membrane enclosed vesicles that form from Golgi Complex. Inside these have special powerful chemicals which can be called enzymes. These enzymes can breakdown wide variety of complex molecules. These enzymes digest and remove particles which are useless or harmful like bacterias, viruses. Lysosome helps in intercellular digestion and also in extra cellular digestion.

7.4.6 Mitochondria : Mitochondria (singular is mitochondrion) are called power houses of the cell. These generate most of the ATP (Adenosive Triphosphate) through combustion of carbon compounds (e.g. glucose) recovered the cell in presence of oxygen. A cell may have as few as a hundred or as many as several thousand mitochondrias depending on how active the cell is, Active Cells such as those found in the muscles, liver and kidneys, which use ATP at high rate, have large number of mitochondria.

Mitochondria are like cylindrical rod in construction and located in cytoplasm all around. A mitochondrion consists of an outer mitochondrial membrane and an inner mitochondrial membrane with a small fluid – filled space between them. Both membranes are similar in structure to the plasma membranes. The inner mitochondrial membrane contains a series of folds called cristae (ridges). The large central fluid – filled cavity of a mitochondrion, enclosed by the inner membrane is the matrix. The elaborate folds of the cristae provide an enormous surface area for the chemical reactions that are part of the cellular respiration which produce ATP. Mitochondrion has speciality that it can divide into two or more identical mitochondria. When more energy is needed, mitochondria divide into large number of mitochondria and then all of them produce energy in the form of ATP to meet the demand. This replication of mitochondrion is controlled by DNA which is present inside mitochondrion.

7.4.7 Peroxisome : Another group of organelles similar in structure to Lysosomes but smaller, are peroxisomes. Peroxisomes contain several enzymes that can oxidize (remove hydrogen atoms from) various organic substances. For instance, amino acids and fatty acids are oxidized in peroxisomes as part of normal metabolism. In addition, enzymes in peroxisomes oxidize toxic substances, such as alcohol. Thus peroxisomes are very abundant in the liver where detoxification of alcohol and other toxic substances occur.

7.4.8 Cytoskeleton : The cytoskeleton is network of protein filaments that extends throughout the cytoplasm. In the order of increasing diameter, these filaments are microfilaments, intermediate filaments, and microtubules. Microfilaments are about 6 nanometer in diameter and are made of 'actin' protein. These give strength and movement to the cells. Intermediate filaments have about 10 nanometer diameter and are relatively straight. These help in extension and contraction of cells. Microtubules are long hollow tubes composed mainly of protein tubelin. These give strength and shape to the cell and also help in the movement of substances inside the cells.

7.4.9 Centrosome : This lies close to the nucleus and is made up of two centrioles which are cylindrical structures, each composed of nine clusters of three microtubules arranged in a circular pattern. Like a bundle of thin woods wound together. Centrisome plays major role in cell division. Like mitochondria, centrosomes also have capacity to replicate themselves. During cell division, centrosomes replicate themselves so that succeeding generation of cells have the capacity for cell division.

7.5 Cellular Inclusions : These include chemical secretions which are produced and excreted from time to time. These include many chemicals which dissolve other substances, transport substances and helps in chemical reactions. These include, Amorphous, Hyaluromic Acid, Condroitin, Sulfate, Collagenous, Reticular and Elastic fibres. Apart from these there are vacuoles and nissil bodies found in cytoplasm.

8.0 EXERCISES

Descriptive Types

1) Describe in detail structure and function of animal cell.
2) Describe human body organization in detail.

Short Notes

3) Describe various structural levels of human body.
4) What are passive and active transport processes of cells ?

Objective Types

5) Endocrine glands secrete :
   a) Sweat b) Digestive Juices c) Enzymes d) Harmones
6) Mitochondria is called _____ of cell
7) Following are found in nucleus of cell.
   a) Mitochondria b) Cytoplasm c) Chromosomes d) Water

9.0 REFERNECES

Principles of Anantomy & Physiology by Gerard J. Tortora & Bryan Derrikson

LESSON-2 :

TISSUE – TYPES STRUCTURE & FUNCTION

&

LESSON-3 :

MUSCLE TISSUE, NERVOUS TISSUE – TYPES STRUCTURE & FUNCTION

Outline Of The Lesson

1.0 Objectives

After study of this lesson one will know –

1. How many types of tissues are ?
2. What is the function of tissues in the body ?
3. Whether blood is also a tissue ?
4. How many types of muscles are ?
5. One will understand the Neuro - Endocrine Control of muscles

2.0 Introduction

Identical cells form tissue. There are mainly four types of tissues in the human body :

1. Epithelial Tissue 2. Connective Tissue 3. Muscular Tissue 4. Nervous Tissue

3.0 Epithelial Tissue

Epithelial tissue provides covering and lining membranes for free surfaces inside and outside the body. Outer skin, trachea, digestive glands, arteries and veins, all are lined with epithelial tissue. Epithelial tissues donot have blood vessels. Epithelial tissue can be classified into two categories : 1. Simple Epithelial Tissue, 2. Stratified (combined) Epithelial Tissue

3.1 Simple Epithelial Tissue

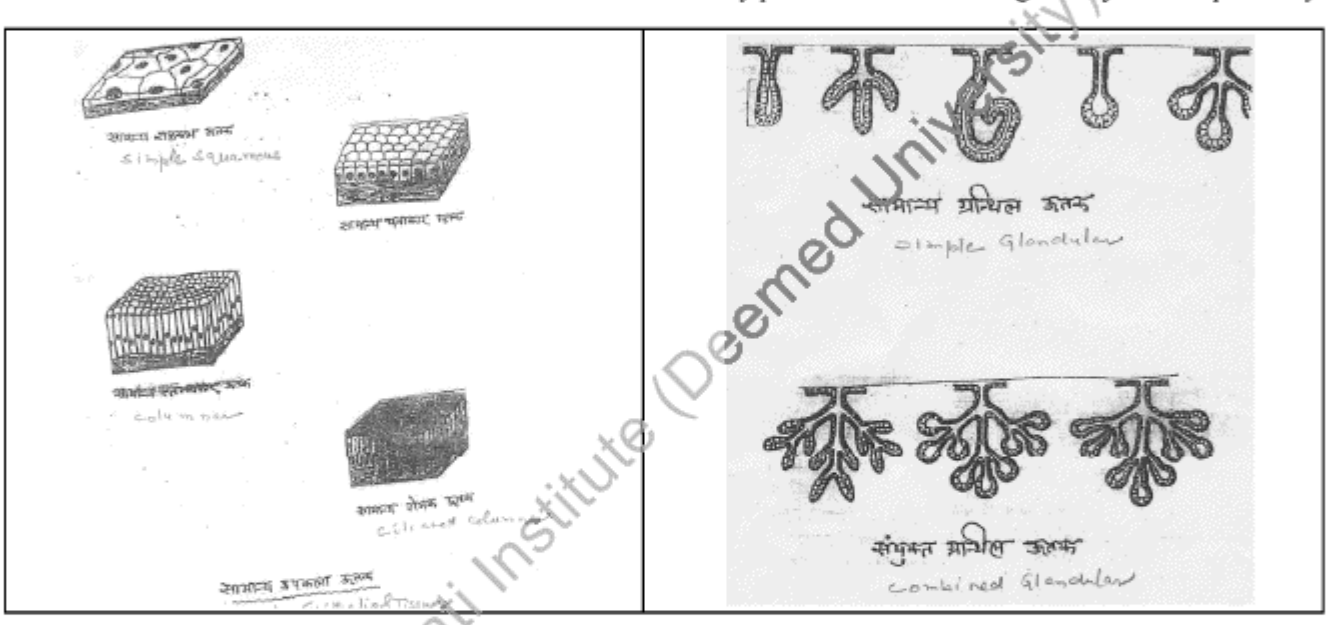
Epithelial Tissue has only single layer of cells. Epithelial tissue is of five types:

1. Simple Squamous Epithelium (Pavement Epithelium Tissue)
2. Columnar Epithelium Tissue
3. Glandular Epithelium Tissue
4. Ciliated Columnar Epithelium Tissue
5. Sensory Epithelium Tissue

3.1.1 Simple Squamous Epithelium Tissue : It is made of hexagonal or octagonal shape cells and have arrangement of cells similar to that of floor tiles. It forms a smooth, flat membrane. It is found in the alveoli of lungs, lining of the interior of the heart and blood vessels.

3.1.2 Columnar Epithelium Tissue : It consists of cylindrical shaped cells, one layer thick forming shape of column. These tissues are found in inner lining of stomach.

3.1.3 Glandular Epithelium Tissue : Some cells in human body join together and form shape link 'surahi' long necked pot (jug) and inside these cells secret mucus. These tissues are called glandular epithelium tissue. These are found in mucus membrane of mouth and stomach where they produce mucus and digestive juices respectively.



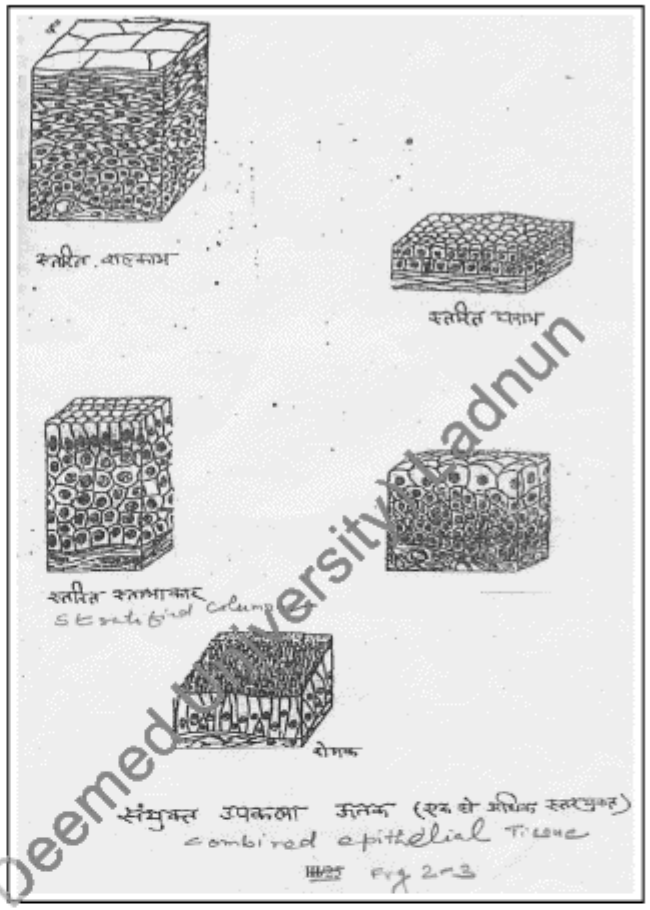
3.1.4 Ciliated Columnar Epithelium Tissue : These are columnar epithelium tissue having hair like process or cilia on free surface of cells. The cilia bend rapidly to one side and then straighten again, this whipping movement sweeps onwards any substance or fluid in contact with the surface of the cell. Ciliated epithelium is found in respiratory system and lines the nasal cavities, trachea and bronchi. The movement of the cilia conveys mucus, dust, etc. from the deeper parts of the lungs towards exterior.

3.1.5 Sensory Epithelium Tissue : This covers inside of nasal cavity and inner ends of cells are in contract with sensory nerves and free end covered with cilia.

3.2 Combined Epithelial Tissue : These tissues are made of multiple layer of cells (as against simple layer of cells in simple epithelium tissue). These are of two types : 1. Stratified Epithelium Tissue, 2. Transitional Epithelium Tissue

3.2.1 Stratified Epithelium Tissue : Stratified Epithelium Tissue made up of many layers of cells. The deepest cells called the 'germinal' layer, lies on the basement membrane and is columnar. As they divide, and this occurs frequently, the parent cells are pushed nearer the surface and become flattened. These cells on the surface become dead (as they do not get blood supply) and undergo chemical change. Dead cells get converted into keratin and get rubbed off from the skin. This is called replacement of old skin by new skin. These tissues are also found in mouth cavity and tongue.

3.2.2 Transitional Epithelium Tissue : It is like stratified epithelial tissue but surface cells instead of being flattened, are rounded and can spread out when the organ expands. Transitional epithelial tissue is found in lining of organs which must expand and must be waterproof, e.g. the bladder, rectum, anus.



4.0 CONNECTIVE TISSUE

The connective tissues are most wide-spread and abundant in the human body. They are number of types. The main function of connective tissues in connecting the various organs, covering the organs and supporting the organs to keep them in define place. Cells of connective tissues have vacant space in between them which is filed with 'Intra Cellular' substance (also called matrix). This substance is fibrous. Cells of connective tissues are of various shapes and colours. Connective tissues fill the cavities of the various organs and hence they are also called filler tissue.

Types of Connective Tissues :

1. White Fibrous
2. Yellow Elastic
3. Areolar
4. Reticular
5. Lymphoid
6. Adipose
7. Cartilage
8. Bone
9. Blood

4.1 White Fibrous Connective Tissue : This tissue consists of white fibres. These fibres are thin and donot branch. These fibres are in bundles. These fibres are wavy and various fibres branch out of bundles and join together in bundles. The empty space between fibres is filled with 'Areolar' Tissue.

These tissues are found in tendons, ligaments, duramater, the outer layer of pericardium, the fascia and fibrous covering of organs. These tissues join various organs and provide them strength and flexibility. White fibrous connective tissues contain collagen protein in them.

4.2 Yellow Elastic Connective Tissue : These tissues also consist of fibres but they are different from white fibrous connective tissues in following ways :

- Colour of these tissue is yellow.
- These tissue are bigger in diameter
- Branches come out of fibres and again join back forming structure similar to wire mesh.
- Sometimes these fibres found in single and sometimes in bundle.
- These are not wavy, remain straight
- These fibres have elasticity (a property in which after stretching when force is removed, fibre returns to relaxed length). They are made of a protein called 'Elastin'.

Yellow elastic fibrous tissue are found in :

- Vertebrae of spine
- Walls of trachea
- Cartilage of vocal chord
- Walls of blood vessel
- Wall of alveoli

Yellow elastic fibrous tissue provides flexibility, expandability and elasticity to the organs. This tissue is like strong elastic rope and holds the parts together e.g. the bony joints. Due to their elastic recoil property (returning back to relaxed position as soon as force or pressure is removed) these tissue help to regulate blood pressure and blood circulation. Similarly these tissues in alveoli help in external respiration process.

4.3 Areolar Connective Tissue : Areolar tissue may be described as the general packing and supporting tissue of the body. It is found under skin and mucous membrane, and surrounding blood vessels and nerves. It is loosely woven tissue containing white fibres, yellow or elastic fibres, various cells and a gelatinous substance between cells. It has following types of cells : 1. Fibroblast Cells 2. Histiocytes Cells 3. Basophile Cells 4. Plasma Cells 5. Pigment Cells.

These different cells are of different shapes and colours and have different functions e.g. pigment cells impart colour to the skin, eyes.

4.4 Reticular Connective Tissue : These tissue are similar to Areolar tissue i.e. fine interlacing fibres similar to white fibres. These fine fibres have branches and form fine mesh, space between fibres is filled with lymph or tissue fluid.

These are found in many placed in the body. They form the basement membrane of epithelial tissue. They form frame for many organs like liver, spleen and lymph nodes and help bind together smooth muscle cells. Additionally reticular fibres filter blood in spleen and remove worn-out cells. Reticular fibres in lymph nodes filter lymph and remove bacteria.

4.5 Lymphoid Connective Tissue : This tissue consists of lymph, lymph cells, lymph vessel, lymph node and lymph glands. It has valves so that flow of lymph is in one direction. Lymph is extra cellular fluid that flows in lymphatic vessels. Lymph is similar to blood plasma but with much less protein. Lymph is found in all parts of the body except central nervous system. Composition of lymph varies from one part of the body to another. For example, lymph leaving lymph nodes has many lymphocytes (a type of white blood cells), while lymph coming out of small intestines contain newly absorbed dietary lipids.

4.6 Adipose Connective Tissue : Adipose connective tissue is a variety of Areolar tissue, the bulk of which is made of globules of fat mounted on loose frame of Areolar tissue. These cells are large in round or oval shape. Most of the space in the cell is occupied by fat and due to this cell nucleus and cytoplasm are pushed to periphery.

Adipose connective tissue are found at number of places in the body which are storage or depot of fat e.g. under the skin, around eyes, heart, kidneys and mammary glands. Adipose tissue is a good insulator and reduces heat loss through the skin. As a person gains weight, adipose tissue increase and new blood vessels form. Thus obesse person has many more blood vessels as compared to lean person, a situation that can cause high blood pressure since the heart has to work harder.

4.7 Cartilage Connective Tissue : It is firm flexible tissue found mainly in connection with skeleton. The outer surface of cartilage is covered by a fibrous membrane, the perichondrium, which is supplied with blood vessels. Blood vessels, however, enter the cartilage itself, which is nourished by tissue fluid. These are three types : 1. Hayline Cartilage, 2. Fibro Cartilage, 3. Elastic Cartilage

1. Hayline cartilage : Consists of chondrocytes embedded in an apparently structure less matrix, which is glossy in appearance, and which has very fine collagen fibres running through it. It is found covering the ends of bones where they form joints (articular cartilage), in the coastal cartilages, trachea and larynx.

2. Fibro Cartilage : Contains more collagen (white fibrous) fibres than hyaline cartilage and is therefore stronger. It is found between bones forming slightly movable joints e.g. inter vertebral discs and semi lunar cartilage of the knee joint, where great strength combined with certain amount of elasticity is required.

3. Elastic Cartilage : Contains yellow elastic fibres and is found in the epiglottis and auricle of the ear.

Functions of Cartilage : From the point of view elasticity, hardness and strengths, cartilage is in between fibrous tissue and bone. It has following main functions.

1. Provides smooth surfaces at joints and also provides flexibility and support.

2. Provides mechanical buffer. Example intervertebral discs.
3. Provides base for cartilaginous development of bones.

4.8 Bones : Structurally bone is like reinforced concrete. It has matrix of collagen fibres impregnated with mineral salts, chiefly calcium. The collagen fibres make the bone tough and the mineral salts make it rigid, so it gives proper support to the soft tissues. Bone has outer covering of a dense white fibrous membrane - periosteum. Bone cells are of two types osteoblasts and osteoclasts. Bone in the middle has hollow space where bone narrow is found. Bones can be divided into two categories :1. Compact Bone, 2. Spongy Bone

4.8.1 Compact Bone : Compact bone is the hard dense ivory like bone which form the shafts of long bones and the surface layers of flat bones. It is built up of units which are called osteons or haversian systems. These are cylinders of bone, through the middle of which a minute circular canal, the Haversian canal runs longitudinally, parallel with the surface of the bone. Blood vessels and lymphatics run in the Haversian canals and nourish the bone substance. In the bone tissue surrounding the Haversian canal are number of small spaces, called lacunae, arranged in concentric rings (similar to tree trunk), which contain the bone cells. The lacunae communicate with one another and with central Haversian canal by minute canal (canaliculi) in which proto plasmic process of the bone cells lie.

4.8.2 Spongy (Cancellous) Bone : Spongy bone has a microscopic structure similar to that of compact bone but instead of being dense, it appears spongy, having more and larger spaces and less solid matter. Spongy bone makes bones lighter without loss of strength. Spongy bone has trabecular (little beams) internal arrangement of cris crossed pattern of small bars, beams and trusses. This arrangement adds to the strength of bone. Spongy bone has covering of endosteum membrane and is always surrounded by compact bone.

A soft pulpy tissue, bone marrow, is found in cylindrical cavities of long bones and in the spaces between trabecular and in the larger Haversian Canals of all bones. In early life it is all red bone marrow (blood forming) but after about 5th year it is gradually replaced by yellow marrow (mostly fat cells) by the age of 20 - 25 years. In adults redbone marrow is confined to the bones of the ribs, vertebrae, sternum and bone of the pelvis.

Bone receives its blood supply from two sources ; the surface of the bone from periosteum, the interior from the artery which enters shaft generally in the middle through a canal known as nutrient foreman.

4.8.3 Main functions of the Bones

1. Bones provide structural support to the body like RCC columns and beams to the buildings.
2. Bones protect vital organs of the body.
3. Bones help in detoxicating functions to remove poisonous substances like lead, chlorine, arsenic and radium from the body and stores in themselves.
4. Bones store bone marrow. All important processes related to bone marrow take place inside bones. Red bone marrow produces red blood cells, white blood cells and platelets.
5. Bone store minerals, nearly 97% of calcium is stored in the bones. Bones releases minerals specially calcium into blood when demanded. Blood further distribute calcium to other body parts to maintain mineral balance in the body.
6. Yellow bone marrow stores triglyceride.
7. Bones are seat of reticulolendo thelial Cells.

Bones Scan – A bone scan is a diagnostic procedure to find bone density particularly in ladies for detecting osteoporosis. This procedure takes advantage of the fact that bone is a living tissue. A small amount of radioactive tracer compound that is readily absorbed by bone (Particularly Calcium Compounds) is injected intravenously. Amount of absorption of tracer in the different bones will depend on the amount of calcium present. Amount of absorption of radioactive tracer is detected by scanning device (Gama ray monitor). Thus bone density in different parts of the body can be monitored.

4.9 Blood : Blood is a connective tissue. It is red colour vital fluid. It keeps on circulating in the body and acts as transport system to supply various nutrients to different body parts for their growth, functioning and maintenance. It also transports the waste from the various parts to the excretory system. Details of the tissue are given in Lesson - 15.

5.0 MUSCULAR TISSUE

The muscles are structures, which give power of movement to the body. Muscles are composed of thousands of elongated cells, called muscle fibres, each containing a small nucleus. Bundles of muscle fibres lie side by side like threads in a skein of wool and are bound together by a thin membrane of connective tissue.

Muscle cells have the power of contraction, in the process of which each one becomes shorter and thicker when it contracts. Muscles weigh abut 40 - 50 percent of total body weight. Muscles have four special characteristics which play an important role in maintaining haemstasis of the body.

1. Excitation - Muscles have capacity to respond to stimulus.
2. Contractility - Voluntary muscles contract as a result of stimuli reaching them from the nervous system and many nerves have their endings in muscles.
3. Expandability - Muscles can expand when required.
4. Elasticity - Muscle tissue is elastic and can be stretched by weight. When weight is removed, muscle returns to its normal length.

Fatigue : When a muscles contracts it uses energy. This energy is derived mainly from glucose carried by blood. Blood also carries oxygen which the muscle uses to burn glucose with the formation of lactic acid, which in turn is broken down into carbon dioxide and water. After a number of contractions the supply of glucose immediately available is used up and certain amount of lactic acid is also accumulated. The muscle then become tired and is unable to contract with the same degree of efficiency. It requires rest in order to replenish its supply of glucose and to remove the lactic acid.

5.1 Types of Muscles : Three types of muscles tissues are found in the body.

a) Voluntary Muscle (Striated) Or Skeleton Muscle found in the muscles attached to the skeleton.
b) Involuntary muscle (plain) or smooth muscle, present in various internal organs.
c) Cardiac muscle, a special type found only in the heart.

5.1.1 Voluntary (Striated) or Skeleton Muscle : Control of these muscles is under the individual will and hence they are called voluntary muscles. All skeleton muscles fall under this category. Each skeleton muscle is composed of hundreds to thousands of cells, which are called muscle fibres because of their elongated shape. The muscle fibre and muscle cells are two terms for the same structure.

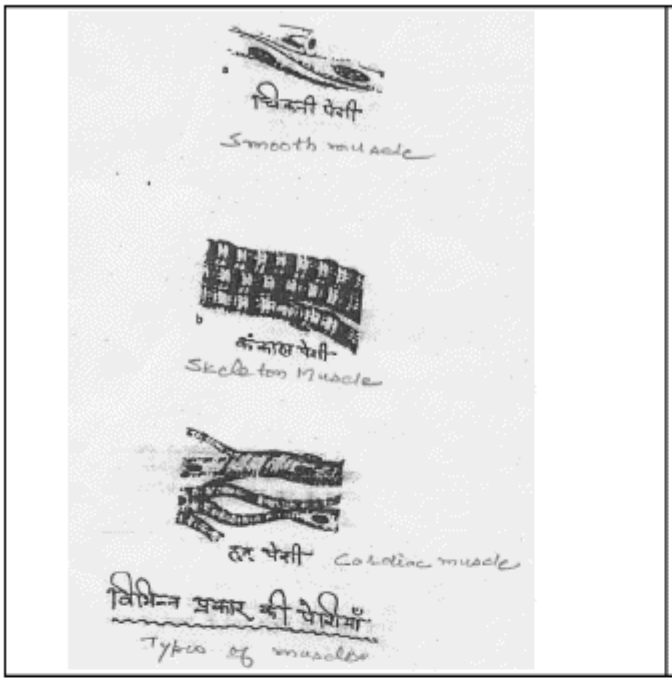
Muscle fibres are cylindrical and tapered at both ends. These muscle fibres are 25 mm in length and 1/20 mm in diameter. Bundles of fibres are tied together by areolar tissue. There are three layers of areolar tissue. First layer is Endomysium. Many muscle fibres are held together by the membrane Endomysium. Many such bundles are held together by second membrane Perimysium. Many such bundles are held together by third layer or membrane of areolar tissue called Epimysium. Thus all these skeletal muscles are made up of muscle fibres bundled in three stages.

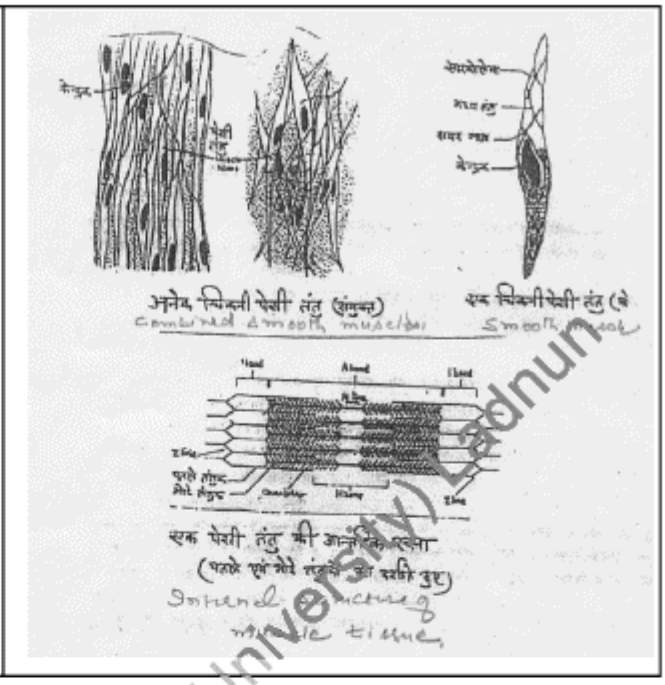
Skeletal muscle fibre has number of nuclei which are located just below the Sarcolemma (flesh sheath), the plasma membrane of a muscle cell. Within the Sarcolemns is the Sarcoplasm, the cytoplasm of a muscle fibre. In this nuclei are located near the membrane. Muscle fibre has mitochondria and golgicomplex.

When seen through high power microscope, the sarcoplasm appears stuffed with little threads. These small structures are called Myofibrils or Sarcostyles. Myofibrils are about 2 micrometer in diameter and extend entire length of muscle fibre. Their prominent striations (alternate white and black strips) make entire muscle fibre appear striated and due to this reason, these muscles are called striated muscles.

Skeletal muscles are attached to the skeleton and their function is to move the bones at their respective joints and to help in maintaining the posture of limbs and body as a whole. Skeletal muscles receive commands from motor cortex area of the brain through nerves.

5.1.2 Involuntary muscle / plain or unstriated or smooth muscle : Muscles of this category donot function under the influence of will, hence they are called involuntary muscles. They are under the control of Involuntary Nervous System. These muscles are found in internal tubular organs like ducts of glands, trachea, bronchi, digestive



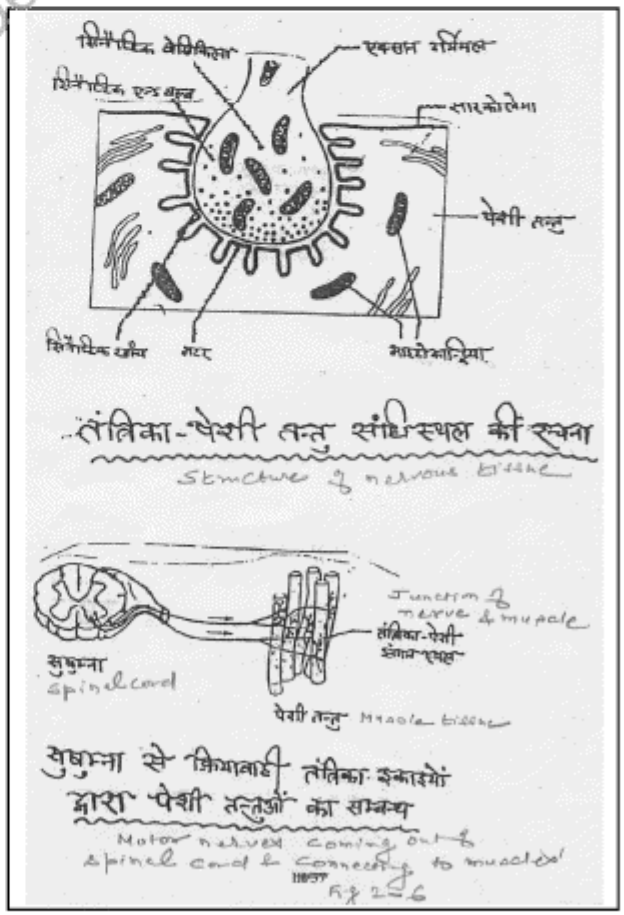


tract (alimentary canal) urinary track etc. and in hollow organs like uterus, bladder, spleen etc. These are also called visceral muscles. These are usually arranged in series of layers, i.e. circular and longitudinal thus forming part of the wall of the organ concerned. These donot have strips or are not striated and hence they are smooth. Smooth muscle fibre has number of nuclei similar to skeletal muscle firbe. Sarcolemma i.e. outersheath is unclear and incomplete in smooth muscles.

5.1.3 Cardiac Muscle : This is a special type of muscle found only in the heart, although it is an involuntary muscle. It has a form of striation resembling, that seen in stripped muscle. It has the special property, not observed in other varieties of muscles, of automatic rhythmic contractions which can occur independently of its nerve supply.

Cardiac muscle fibres are cylindrical with centrally placed nuclei. The fibres branch and connect with adjacent fibres and this allows impulse to spread from one fibre to next.

5.2 Neuro Endocrine Central of Muscles : Every muscle is related to some motor nerve which command its movement. End of axon of every motor nerve is into a muscle but it is not directly connected to muscle. This junction is called neuro muscular junction. Neuro transmitters are released by nervous system into the fluid sarcoplasm of muscle tissue. This fluid gives command to the muscle to expand or contract. In the same way hormones secreted by endocrine glands also control the expansion or contraction of muscles. Neuro transmitters or hormones are under the control of brain and spinal cord. Thus expansion or contraction of all muscles is under control of brain directly or indirectly. Even the control of involuntary muscles can be affected to some extent by practice e.g. respiration rate.



6.0 Nervous Tissue

Nervous tissue consists of nerve cells and nerve fibres. Apart from these two, there are neuroglial cells to support cells.

Nerve cell along with its associated processes (fibres) is called 'NEURON'. Neuron is basic functional and structural unit of nerve tissue.

Processes or fibres coming out of nerve cell are of two types : a) Axon or Efferent Process, b) Dendrite or Afferent Process.

(a) Axon : From the body of each nerve cell passes one main fibre known as Axon. It is along this fibre that impulses from the nerve cell pass, in one direction only, due to this reason it is called Efferent Process or Fibre. An axon comes out of special place in nerve cell called Axon - hillock. An axon may be of considerable length : for example, axon of certain cells in the lower part of spinal cord extend in the nerves as far as the foot. Every neuron has axon. Axons does not have Nissls Granules'.

(b) Dendrites : These small fibres extending from the body of nerve cells receive messages from other nerve cells and hence these are called afferent fibres or processes. These have Nissls Granules. These fibres are short in length and have number of branches unlike axon which is one in a neuron. Number of branches i.e. number of dendrites vary from Neuron to Neuron.

When impulses pass from one neuron to another they go from the axon of the first to the dendrites of the second. The point where axon and dendrite meet is called 'Synapse'.

All neurons have one axon and number of dendrites vary. Based on number of dendrites, neurons are classified. Accordingly neurons are four types :

Apolar (no dendrite, only axon), unipolar (one dendrite), bipolar (two dendrites) and multipolar (more than two dendrites).

Nerve cells are in different shapes like flat, tubular, oval, triangular and conical and star shape.

6.1 Structure of Nerve Cell : Nerve cells have following organelles :

1. Neurofibrills : Many fibres come out of cytoplasm and these fibre are called 'Neuro fibrills'. Some of these fibres go to axon and some fibres go to dendrites.

2. Nissls Granules : Nissls granules are not found in axons but present in both dendrites and organelles. Nissls' Granules contain nucleoprotein which affect functions and health of neuron. Nissls granules get destroyed due to fatigue and get generated during rest.

3. Nucleus : Nerve cells has big nucleus in which nucleoli and chromatin are quite clear.

4. Mitochondria : Nerve cell has many mitochondria

5. Golgi Apparatus : Nerve cell has quite matured golgi apparatus.

6. Superficial Reticulum of Golgi : Nerve cell has minute network near its cell membrane. No cell division takes place in nerve cells i.e. nerve cell once destroyed are not replaced.

7.0 Exercises

Descriptive Types : 1) What is tissue ? Describe various types of tissues.

Short Notes : 2) Describe types of simple epithelial tissue.

3) Write names of four types of connective tissue.

Objective Types : 4) Voluntary muscles are : (a) Striped (Striated) (b) Unstriped (Unstriated) (c) Both (d) None

5) Cells of the nervous system are called : (a) Neuroglia (b) Axon (c) Neuron (d) Dendrite

LESSON-4

SKELETON SYSTEM, VERTEBRAL COLUMN & ARTICULATION (JOINTS)

Outline Of The Lesson

1.0 Objectives

After study of this lesson, you will know :

1. Structure of skeleton
2. Number of bones in whole body and their function.
3. Importance of articulations in the body.

2.0 Introduction

Framework of human body is made up of bones. This framework is called skeleton. Skeleton supports and protects various organs of the body like flesh muscles, skin, arteries, veins, and other delicate organs inside the cavities. Muscles, nerve fibres and skin all surround the bones. Outer appearance of human body is according to this framework of bones (skeleton).

3.0 Skeleton : Structure And Function

Main functions of the skeleton are as follows :

1. It gives shape to human body
2. It provides stiffness to the body.
3. It protects inner delicate organs.
4. It assists in body movement by giving attachment in muscles and providing leverage at joints.
5. It manufactures blood cells in the red bone narrow.
6. It provides storage of mineral salts particularly phosphorous and calcium.
7. It stores triglyceride in yellow bone marrow. Triglycerides are chemical energy reserve.

Some bones are long, some are round, some are flat, some are cylindrical and some are irregular in shape. Length and width of bones vary. There are about 206 bones in total in the human body. Weight of bones is about 1/16th of total body weight (about 6% total body weight). Bones of the parts of the body which have to work hard, are long e.g. bones of limbs (hands and legs). Bones of wrist and ankle are short. Bones of vertebrae and most of the bones of face are irregular in shapes. Bone of the skull are mostly flat. Long bones have two heads (extremities) and one long central shaft.

3.1 Organization of the bones : Places where bones meet each other have soft covering of cartilage. This is called Articular Cartilage.

All bones are covered with fibrous membrane called periosteum. These membranes have blood arteries and veins. These arteries and vein from periosteum pass through the pores (Foramina) in the bone. So long as the periosteum is healthy, disorders of bones like fractures, dislocation can be treated as required nutrients can be transported through the blood.

Outer surface of bone is made of solid and hard tissues. Its inner part has hole and thus construction is like sponge. Red bone narrow is filled in these pores in the small irregular bones and ends of the long bones.

Central part of long bone has inner hollow space called Medullar Cavity.

Bone marrow found inside the bones are of two types : 1. Red bone marrow 2. Yellow bone marrow

Red bone marrow is found in the pores of small bones and yellow bone marrow is found at the ends of long bones.

All the skeleton bones are connected to each other by following three ways.

1. Sutures - Sharp ends of two bones meet together
2. Cartilage - Ends of two bones join through cartilage.
3. Ligaments - Ends of two bones join through ligaments.

All articulations (joints) are surrounded by hard, shining material called Articular Capsule. Articular capsule keeps the bones in their respective places and does not allow dislocation easily.

Bones are made up of two materials : 1. Organic Matter 2. Mineral matter

In adult organic matter is 33.3% and mineral matter is 66.7%.

In children, percentage of organic matter is more and that is why their bones are more flexible. Incase of injury bones of children does not get fractured. In old people percentage of mineral matter is more and due to this reason, bones of old people get fractured in case of injury.

3.2 Main Divisions of Skeleton :

Skeleton can be divided in two main parts :

1. **Axial Skeleton :** It covers the bones of head and trunk i.e. skull, face, vertebral column, ribs and sternum.
2. **Appendicular Skeleton :** It covers the bones of limbs and girdles.

For further convenience, skeleton can be divided into three parts: 1. Skull,2.Trunk,3. Upper and Lower Limbs.

4.0 Number Of Bones In The Skeleton

Human skeleton has 206 bones and their major division is as follows :

1.	Cranium	-	8
2.	Face	-	14
3.	Ear	-	6
4.	Spinal Column	-	26
5.	Ribs both sides (12 + 12) Total	-	24
6.	Sternum	-	1
7.	Hyoid Bone	-	1
8.	Upper Limbs (Both Hands) (32 + 32) Total	-	64
9.	Lower Limbs (Both Legs) (31 + 31) Total	-	62
		Total Sum-	**206**

Further details of above mentioned bones are as given below :

Skull Bones

A)	1. Cranium	-	8
	2. Face	-	14
	Trunk		

	3. Both ribs 12 + 12	-	24
	4. Sternum	-	1
	5. Collar Bone or Clavicle	-	2
B)	6. Shoulder Blade or Scapula	-	2
	7. Girdles	-	2
	8. Vertebrae	-	33
	Bones of Hands		
C)	9. Humerus	-	2
	10. Ulna	-	2
	11. Radius	-	2
	12. Corpal Bones	-	16
	13. Metal Carpuls	-	10
	14. Phalanges	-	28
	Bones of Legs		
D)	15. Femur	-	2
	16. Knee Cap, Patella	-	2
	17. Tibia	-	2
	18. Fibula	-	2
	19. Tarsals	-	14
	20. Meta Tarsals	-	10
	21. Phalanges	-	28
		Total Sum-	**206**

Brief description of above bones is given below :

4.1 Bones of the Head : Bones of the head (skull) can be divided into two parts : 1. Bones of the cranium 2. Bones of the face

4.1.1 Bones of the cranium : First boned of the cranium are described. These are the bones which form upper part of the skull. These bones are firmly fitted with each other and there is no relative movement. These eight bones are :

i) Frontal Bone – This is on the front of the forehead. It is one in the number.

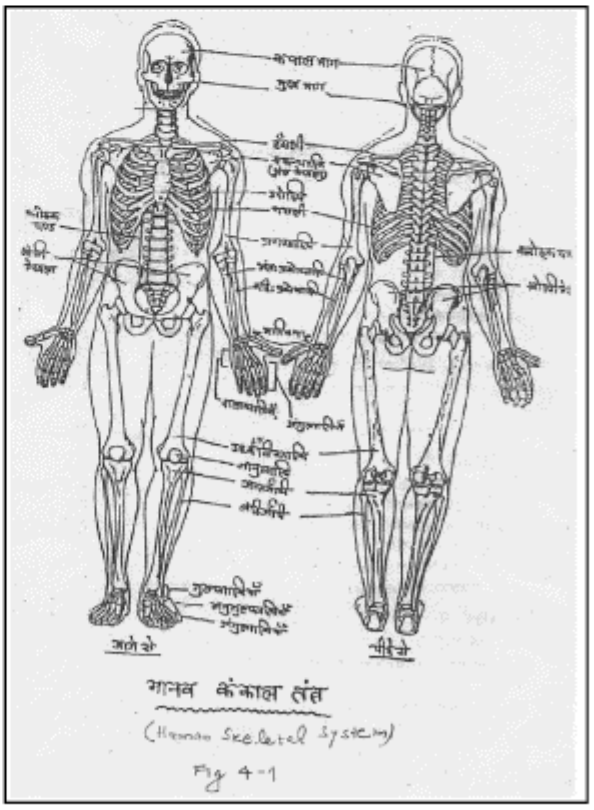
ii) Occipital Bone – This forms the back part of the skull. It is also one in number.

iii) Parietal Bones – There are two in number, one on each side. These make upper part of the skull.

iv) Temporal Bones – These are also two in number and are on both sides of the skull. These accommodate outer ear and mid ear. Inside these bones are small bones – 'Ossticles'.

v) Ethmiod Bone – It is situated above nose and behind the eyes. It is one bone.

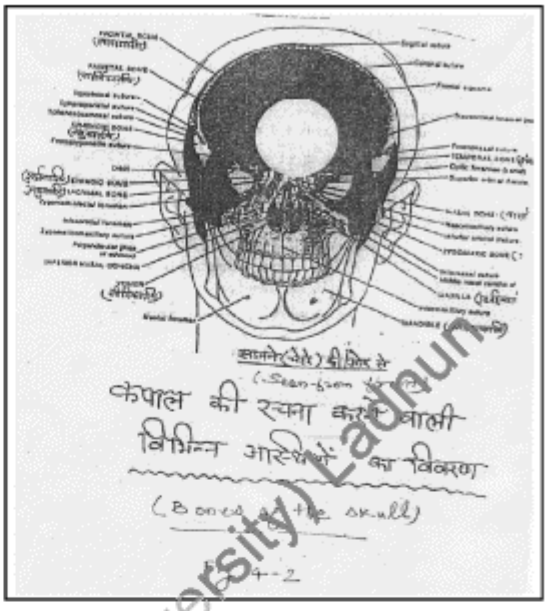
vi) Sphenoid Bone – It is situated at the base of the skull in front of the temporal bones.



Further details of these bones are as follows :-

4.1.1.1 Frontal Bone : The frontal bone is a large flat bone forming the forehead and most of the roof of the orbit. There are round prominences, called frontal tuberosities, one

on each side of the midline, which vary in size from one individual to another and which together form the forehead. A flat muscle is attached to this front part which is called 'frontalis'. This muscle contracts during the state of anger and releases during peaceful state of mind. Below frontal tuberosites are two curved supra orbital arches. Between these two arches is 'Nasal-bone'. Behind nasal bone is a perforated bone called 'Ethmiod Process'.



4.1.1.2 Occipital Bone : This bone forms the back of the skull, It carries a marked prominence, the external occipital protuberance which gives attachment to muscles. There is big oval opening in the middle of the bone called 'Foramen Magnum' through which the cranial cavity communicates with the vertebral canal i.e. lower end of medulla oblongata passes through this opening. On either side of foreman are two oval process called occipital condyles for articulation with the first cervical vertebra. This joint allows the nodding movement of the head.

4.1.1.3 Parietal Bones : These are two in number. They form the sides and roof of the cranium. They articulate with the frontal bone, the occipital bone and with each other to form sutures or joints of cranium. On the internal surface are small grooves to carry the blood vessels supplying the brain. During infancy, both bones are soft and not joined together till age of 5 – 6 months. After this, these bones slowly join together and become hard.

4.1.1.4 Temporal Bones : These bones are there on both sides of the head. They have two openings one for ear and other for 'Internal Carotid Artery'. This second opening is called 'Carotid Canal'. These bones have five parts.

i. **Squama :** The squamous part form the anterior and upper part of the bone and is thin and flat.
ii. **Mastoid Process :** It is posterior portion of the bone. It is below the opening for the ear.
iii. **Petrous Portion :** It is posterior portion of the bone between the occipital bone and the sphenoid, which contains the structures forming the internal ear.
iv. **Styloid Process :** It projects downwards and forwards from the underneath of the bone. It is in the shape of thin rod.
v. **Zygomatic Process :** A long arched process projects forward near the opening for ear & joints 'zygomatic bone'.

4.1.1.5 Ethmiod Bone : It is very light and irregular in shape. It is above nose and on the back of the eyes.

4.1.1.6 Sphenoid Bone : It is situated at the base of the skull, in front of temporal bones. It is shaped rather like a bat with outstretched wings. The body contains two large air sinuses, which communicate with the nasal cavity. The body has two deep impressions to locate pituitary gland and pineal gland. The greater and lesser wings are perforated by many openings for the passage of nerves and blood vessels.

4.1.2 Bones of the face : Face consists of 14 bones. These are as follows :-

1.	Superior maxillary	-	2 Nos.
2.	Inferior maxillary or Mandible (Lower jaw)	-	1 No.
3.	Malar or cheek bones	-	2 Nos.
4.	Palatine bones	-	2 Nos.
5.	Nasal bones	-	2 Nos.
6.	Inferior nasal conchae	-	2 Nos.
7.	Vomer bone	-	1 No
8.	Lacrimal bones	-	2 Nos.

Except inferior maxillary – lower jaw or mandible bone, all bones are non movable.

Further details of these bones are as follows :-

4.1.2.1 Superior Maxillary Bones : These are two bones. They are joined together. These help in formation of cheek. These have 3 main parts.

1. **Palatine** – These are two thin bones joined together. They take part in the formation of the hard palate, the floor and lateral wall of the nasal cavity and the floor of the orbit.
2. **Alveolar Process** – Each maxilla has an alveolar process containing sockets for eight teeth.
3. **Orbital** – This portion is socket for eyes.

4.1.2.2 Inferior Maxillary Bone : Mandible Bone – It is one in number. This is also called bone of the lower jaw. This is the only moving bone in the skull. Its shape is similar to horse shoe. It has vertical broad projection which is called 'Ramus of Mandible'. It has two surfaces. Muscles which provide movement to lips are on outer surface while the muscles which provide movement to the tongue are on inner surface.

Its lower part is thin from which one thin muscle called 'Platysma' comes out and is connected to the throat.

4.1.2.3 Malar or cheek bones : These are two in number. They are on both side of cheeks. They form the projections on cheeks. They have four parts – upper part forms eye orbit, it joins with nasal bone, back part joins with zygomatic process of temporal bone, lower part is in touch with inferior maxillary bone (Mandible bone). Its outer surface is covered with skin.

4.1.2.4 Palatine bones : These are also two bones. They are in the back of nose. Each bone takes part in the formation of head palate, the floor and lateral wall of nasal cavity and the floor of the orbit.

4.1.2.5 Nasal bones : These are two small bones lying side by side between frontal processes of the maxilla and forming the bridge of the nose.

4.1.2.6 Inferior Nasal Conchae : These are two in number. These scroll like bones form a part of the inferior lateral wall of nasal cavity and projection into nasal cavity. All three pairs of nasal conchae (superior, middle and inferior) help swirl and filter air before it passes into the lungs. However only the superior nasal conchae of the Ethmiod bone are involved in the sense of smell.

4.1.2.7 Vomer Bone : It is one in number. It forms the inferior portion of the nasal septum.

4.1.2.8 Lacrimal bones : These are two in number. These are smallest bones of the face, are posterior and lateral to the nasal bones and form a part of the medial wall of each orbit. The lacrimal bones each contain a Lacrimal fossa, a vertical groove formed with maxilla that houses the lactorimal sac, a structure that gathers tears and passes them onto the nasal cavity.

4.1.2.9 Eye Orbit : On both sides of the head, there are two sockets for housing eye ball and associated structure. These are called eye orbits or simply orbits. Seven bones of the skull join to form each orbit. These bones are : 1. Frontal bone 2. Ethmiod bone 3. Sphenoid bone
4. Lacrimal bone 5. Superior maxillary bone 6. Palatine bone 7. Malar or cheek bone

4.2 Vertebral Column : Vertebral column has 33 bones. Each bone is called vertebra. Vertebral column is situated in the centre of the back. It starts from bottom of the occipital bone in the head and goes upto near the anus.

These 33 bones are divided in 5 categories.

1. Cervical Vertebrae :- These are 7 vertebrae and are located in the neck.
2. Thoracic or Dorsal vertebrae. These are 12 vertebrae and are located in chest region of the back.
3. Lumber vertebrae – These are 5 vertebrae
4. Sacral vertebrae – These are 5 in number. These are joined together and appear as one.
5. Coccygeal vertebrae – These are 4 in number are joined together and appear to be one.

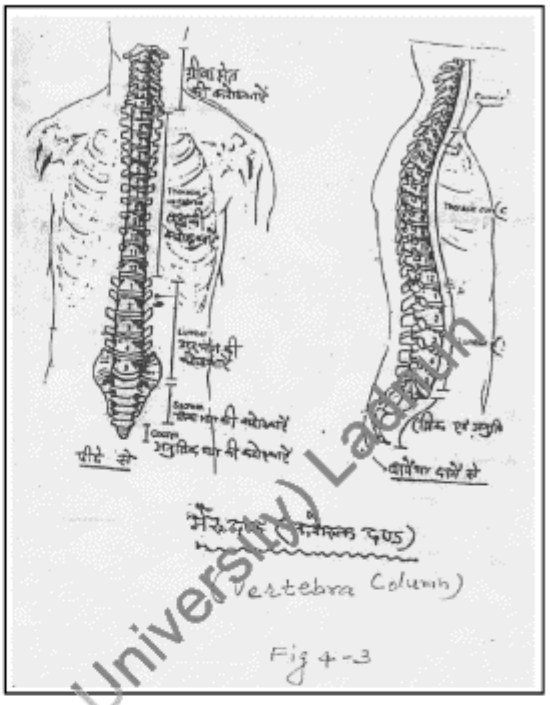
Thus there are 33 bones in vertebra column, however as bones of sacral region and coccygeal region are joined together, effectively there are only 26 bones.

All vertebrae are not identical they vary in size and thickness. They are kept one above other in such a way that

there is passage or hole (vertebrae formamen) in the centre from the beginning to the end through which spinal cord and passes.

The cervical, thoracic and lumbar vertebrae are movable but sacrum and coccyn are not.

When viewed from the side, the adult vertebral column shows four slight bends (double S). Relative to the front of the body, cervical and lumbar curves are convex (bulging out) the thoracic and sacral curves are concave (cupping in). The curve of the vertebral column increase its strength , help maintain balance in the upright position, absorb shocks during walking and help protect vertebrate from fracture.



4.2.1 Structure of typical vertebra : Vertebra has three parts :- 1. Body, 2. Vertebra Arch, 3. Processes.

1. Body : The body, the thick disc shaped anterior portion is the weight bearing part of Vertebra. Its upper and lower surfaces are rough so that intervertebral disc can get attached properly between two vertebrae due to friction. The anterior and lateral surfaces contain nutrients foramina, openings through which blood vessel deliver nutrients and oxygen and remove carbon dioxide and wastes from bone tissues.

2. Vertebral Arch : Two short thick processes, the 'pedicles', project posteriorly from the vertebral body to unite with the flat 'laminae' to form vertebral arch. The vertebral arch extends posteriorly from the body of the vertebra. Together the body of the vertebra and the vertebral arch surround the spinal cord by forming the vertibral foramen. Collectively, the vertebral foramina of all vertebrae form the vertebral (spinal) cavity. The pedicles exhibit upper (superior) and lower (inferior) indentations called 'vertebral notches'. When vertebral notches are stacked on top of one another. they form an opening between adjoining vertebrae on both sides of the column. Each opening called an intervertebral foramen permits the passage of a single spinal nerve that passes to specific region of the body.

3. Processes : Seven processes (projections) arise from vertebral arch. At the point where a lamina and pedicle join, a 'transverse process' extends laterally on each side. A single 'spinous process (spine) projects posteriorly from the junction of the laminae. These three process serve as points of attachment for muscles. The remaining four processes form joints with other vertebrae above or below.

Intervertebral Discs : Intervertebral discs are found between the bodies of adjacent vertebrae from the second cervical vertebrae to the sacrum. Each disc has an outer fibrous ring consisting of fibro cartilage called 'annulus fibrous' and inner soft, pulpy highly elastic substance called the 'nucleus pulposus'. The discs form strong joints, permit various movements of the vertebral column and absorb vertical shock. Under compression they flatten and broaden : with age, the nucleus pulposus hardens and becomes less elastic. Narrowing of the discs and compression of vertebrae results in decrease in height with age.

5.0 Articulations (Joints)

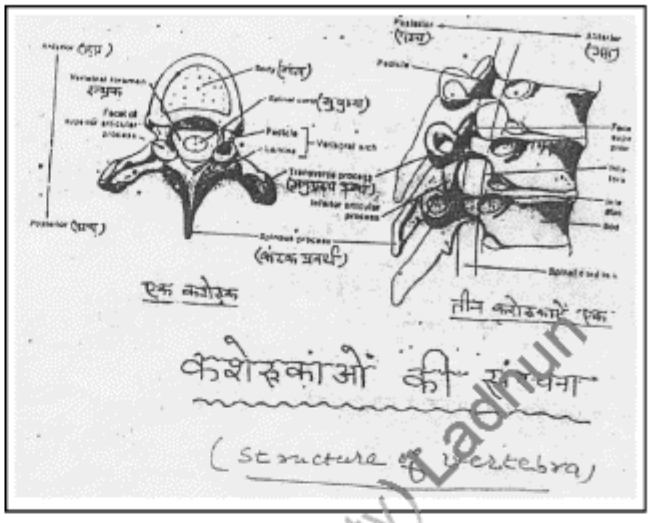
Human skeleton is made of number of bones. It has small, big, long, thin, flat – round, all types of bones. These bones form joints by joining with each other at different places. When two or more bones join together, they form articulation (joint). Body is capable of movement because of these joints.

Based on the structure, these joints are of three types : 1. Fibrous Joints, 2. Cartilaginous Joints, 3. Synovial Joints. As is clear from the name fibrous joint is made of two bones connected by a sheet of fibres.

In cartilaginous joint there is cartilage disc between the two bones at the joint. In synovial joint, the space between two bones if filled with synovial fluid. Due to this fluid, bones can move freely with respect to each other.

This division of joints is based on their structure. In actual case, most of the joints have mixture of all the three structures.

5.1 Classification of Joints based on movability : Some joint have no capability of movement, some are slightly movable while others are freely movable. Thus there are three types of joints : 1. Immovable Joint (Synarthroses), 2. Slightly Movable joints (Amphiapthroses), 3. Movable Joints (Diapthrases)



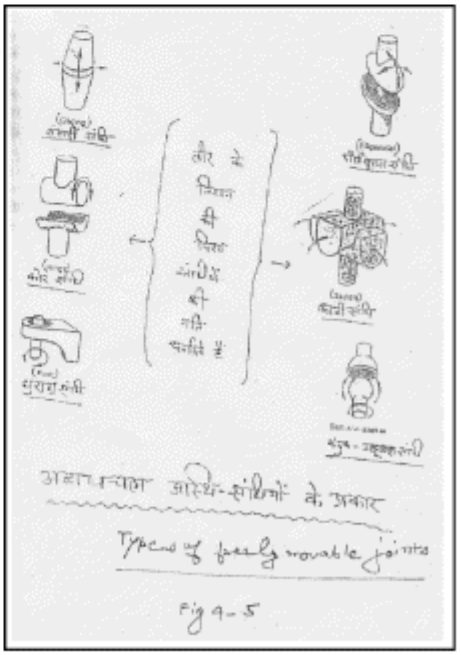
5.1.1 Immovable Joints : When two or more than two bones join in such a way that there is no movement, such joint is called immovable joint. There bones are more or less are in contact with each other as there is no cartilage between them.

Joints between bones of cranium are example of immovable joint. The edge of the joining bones have serrations of saw tooth which fit into each other forming dove tail joint. These joints in cranium are called 'suture'.

5.1.2 Slightly movable joints : In the skeleton, at some places, bones join in such a way that slight movement is possible and hence such joints are called slightly movable joint. There is cartilage pad between bones and these bones are connected by ligaments. The pad gets slightly compressed when pressure comes on it. During movement, one bone may slightly get bent relative to other bone. Example of such joint is joint between vertebrae.

5.1.3 Movable Joints : Movable joints are at number of places in the skeleton. These joints are at such places where more movement between adjoining bones is required. The ends, of joining bones are covered with hyaline cartilage and there is pad of cartilage between the ends of bones. Dues to this structure, ends of the adjoining bones do not get spoiled due to frequent movement. Details of structure of movable joints are given below.

5.1.3.1 Structure of Movable Joints : Movable joints are maximum in the body. Their structure is special. Ends of articulating bones are covered with 'articular cartilage'. Further these bones at the joint are covered with sac like structure called 'joint capsule'. Joint capsule is composed of two layers, an outer fibrous capsule usually consists of dense irregular connective tissue (mostly collagen fibres) that attaches to the periosteum of the articulating bones. The flexibility of the fibrous capsule permits considerable movement at a joint while its great tensile strength (resistance to stretching) helps prevent bones from dislocating. The fibres of some fibrous capsule (outer layer of joint capsule) are arranged as bundle called ligaments. The mechanical strength of these ligaments hold bones close together in this type of joint.



The inner layer of joint capsule is delicate synovial membrane. Synovial membrane secrets synovial fluid. Function of synovial fluid is to reduce friction by lubricating the joint. The synovial fluid is filled in the joint cavity. These joints are also called 'synovial joint'. These joints have following four characteristics.

1. The ends of articulating bones are covered with hyaline cartilage.
2. The joint is enclosed in a fibrous capsule, supported by ligaments.
3. The joint capsule has inner lining of synovial membrane.
4. The cavity of the joint contains viscous synovial fluid for its lubrication.

5.1.3.2 Types of movable joints : These are of following types :
a) Ball & Socket Joint b) Hinge Joint c) Pivot Joint d) Gliding Joint

(a) Ball & Socket Joint : Shoulder and hip joints are the examples of ball and socket joint. Shoulder joint is formed where arm and shoulder join. Similarly hip joint is formed where leg and hip joint. At these joints movement is possible in all directions.

Characteristic of ball and socket joint is one of the articulating bones has socket or concave end while end of the other bone is round or convex shape. One of the bones of these joints is long and the long bone joining end is round. Other bone is flat and spread out. At the shoulder joint, the head of humorous fits into the glenoid cavity of the scapula. At the hip joint, the head of the femur fits into the acetebulum of the hip bone.

(b) Hinge Joints : As the name suggest movement of this joint is similar to hinged door which can have angular motion in one direction.

Hinge joints are monoaxial because it allows rotation only around its single axis. In most joints, one bone remain in a fixed position, other moves an axis. Examples of hinge joints are the knee, elbow, ankle, finger.

(c) Pivot and Saddle Joints : In this joint one bone has projection (process) like nail (pivot). Another bone which makes joint has ring like structure and this bone slightly rotates around the pivot. Examples of pivot joint are atlento-axial joint, in which the atlas (first vertebra) rotates around axis and permits the head to turn from side to side as and when you shake your head.

Saddle joint is also a type of pivot joint. Saddle joint is at the base of the thumb. It permits movement in two planes at right angle.

(d) Gliding Joints : In these joints, movement is mainly a gliding (translation) of one plane surface across another. Movement of at these joints are limited by ligaments. Such joints are in vertebrae, other examples are intercarpal joint (between carpal bones at the wrist), intertarsal joints (between tarsal bones at the ankle.

Descriptive terms used in description of bones.

Articulation	–	A joint between two bones.
Condyle	–	A rounded knuckle shaped articular surface at the end of a bone usually covered by cartilage.
Crest	–	An elevated ridge on a bone
Foramen	–	An opening of hole
Forsa	–	A hollowed out area or depression in the surface of a bone, notch in the bone
Process	–	A projection from a bone.
Tubercle, tuberosity, trochanter	–	Broad rough projection.
Sinus	–	A hollow cavity in the bone.

6.0 Exercises

Essay Type : 1. Describe human skeleton with diagram.
2. Describe major bones of human skeleton.

Short Notes : 3. Which are the bones of hands and legs ?
4. Describe bones of vertebrae column.
5. What is articulation (Joints) ?

Objective Type :

6. Number of bones in human skeleton are : (a) 204 (b) 209 (c) 211 (d) 206
7. Types of joints : (a) 6 (b) 4 (c) 3 (d) 7

LESSON-5 :

NEURON-STRUCTURE, DIFFERENCES AND FUNCTIONS

&

LESSON-6 :

CONDUCTION OF NERVE IMPULSE, NEUROTRANSMITTER, STRESS, AGGRESSION AND PREKSHA-MEDITATION

Outline Of The Lesson

1.0 Aim

1. We will understand the control system of body.
2. What is a nerve cell?
3. What are the functions of 'Voluntary' and 'Autonomous' nervous system?
4. We will understand 'Sensory' and 'Motor' nerves.
5. How an impulse is conducted in our body.
6. What is aggression and neurotransmitter?
7. We will understand regulation of aggression through Preksha-meditation.

2.0 Preface

In a human body there is a system to control various actions. This is nervous system. This is a particular system to establish synchronization amongst various systems in human body. This system regulates all the other systems. There are particular organs in our body to perform particular tasks e.g. walking, eating, seeing etc. In these organs a thin web is spread which is made of fibers. These fibers are known as nerve fibers and the web is known as 'Nervous system'. These fibers combine to make a thick structure which is connected to brain. This system organizes the functions of our body. In absence of it, the body becomes inactive and senseless. This system regulates all the voluntary and autonomic functions, receives all the impulses and conducts them to brain. Its function is not only limited to memory and knowledge but it also serves as a leading force which makes accommodation possible in response to external and internal environment. Humans are sensitive to external impacts. Every chemical and physical change in external environment has effects on human body, to which body inevitably reacts. When we get a thorn prick on our sole, or we put our foot on fire or cold, we immediately withdraw. This is not just accomplished by

nerve cells present in feet. A thorn prick initiates an impulse in the nerve cells present in sole which traverses through nerve fibers to brain. This initiates a response in brain and a message again travels from brain to sole. This compels us to withdraw our foot. This way, any external impact is not limited to local nerve cells but it is impacted on the whole system. Conduction of nerve impulse is the only function of nervous system.

A human brain is more complex and complicated than other animals' brains. This is why humans have more intelligence. Brain regulates and controls all the actions of every organs. A message from any part of body reaches brain within no time, which is followed by conduction of impulse from brain to tissues giving rise to action. Nervous system establishes a synchronization between the functiors of numerous cells so that the whole body can perform as a unit. Every other systems are governed by nervous system. Without nervous system, no other system can perform. Internal organs of body like heart, kidneys, lungs etc. are also controlled by nervous system. The unit cell of nervous system is known as a 'Neuron'.

3.0 Nerve Cell

The functions that occur in a nervous system and its different parts are actually the functions of nerve cells. So for a proper knowledge of nervous system, it is necessary to understand a nerve cell.

A human body is a collection of innumerable living cells. But all these cells are not similar. Also all the cells have different functions. However, neuron is somewhat different from other types of cells, its basic structure is same. It has got a nucleus in centre and intra cellular substance just like other cells. But some varieties are seen in its structure which makes it compatible to its functions. Each neuron has two parts- Cell body and nerve fiber. Central nervous system includes both these parts. Nerve fibers emerge from these nerve cells. Nerves look like ordinary threads which are collections of fibers which form a bunch with connective tissues. Each fiber starts from a nerve cell. A peculiar thing is that fibers emerge from both the sides of a nerve cell. These are known as 'Bipolar Nerve Cells'. Some of the cells have more than two fibers which are known as 'Multipolar Nerve Cells'. Nerve cells of cerebral cortex are pyramid shaped which gives rise to a fiber from each of it's angles. These fibers again divide to form multiple branches. These are actually the parts of intra cellular substance because they are covered with cellular wall. One of these branches is longer and others are short. The longer branch is known as 'Axon' and the smaller branches are known as 'Dendrites'.

3.1 Axon : It is a tail like structure arising from one end of a nerve cell. It contains 'Terminal Brushes' at its end. These brushes are in contact with the dendrites of another nerve cell. Axon ultimately forms a 'Nerve Trunk'. Long branches arising from different neurons combine together to form a Nerve Trunk, which in its path again gets divided in to thin fibers. These thin fibers ultimately enter different tissues. Nerve cell is gray in colour where as fibers are white. There is a thin covering over nerve fibers which is called 'Medullary sheath.

3.2 Dendrite : Small branches of nerve fiber are known as 'Dendrites'. These branches stay closer to the small branches of other nerve cell. They are spread like branches of a tree. They perform two functions- receiving impulse from tissues and conducting them to neuron. Thus axon, dendrites, and nerve cell together form a unit of nervous system which is known as 'Neuron'.

3.3. Differences between nerve fibers : They have two colours – (1) White and (2) Gray

1. White nerve fibers contain medullary sheath and are found in brain, spinal cord.
2. Gray fibers do not have any sheath and are smaller in size. They are found in autonomic nervous system.

3.3.1 Functions of nerve fibers

1. Conduction of impulse : Some of the nerve fibers receive impulses from various parts of body and conduct them to brain or spinal cord. Such fibers are responsible for the sensations like touch, vision, smell, etc. some of the nerve fibers conduct impulse from brain or spinal cord to tissues and glands.

When we touch a hot iron, we feel burning. This creates an impulse in the tissues which is conducted to spinal cord via nerve fibers. From here again an impulse travels to tissues which activates the tissues of finger and we automatically withdraw our hand.

2. Creating secretions from glands : Some of the nerve fibers are related to glands of body. These fibers are responsible for the secretion of hormones from these glands. These fibers are known as 'Secretory Nerves'.

3. Supporting blood circulation : Nerve fibers are also related to blood vessels. These fibers cause constriction and dilatation of blood vessels.

3.4 Types of Neurons

Based on structure, they are of three types :

(1) **Multipolar :** They have multiple dendrites and an axon. They are found abundantly in brain and spinal cord.

(2) **Bipolar :** One dendrite and an axon are found in this category. They are found in retina of eyes, ears and nose.

(3) **Unipolar :** In this type of neuron, only one fiber arises from a nerve cell which gets divided in to two. One part acts as a dendrite and the other acts as an axon.

3.5 Functions of neurons

The complete nervous system is formed of neurons. A neuron can generate an impulse. They also receive and conduct impulses from other neurons. A nerve fiber does not contain any special ability to create such impulses but it serves to conduct impulses created by neurons just like a wire conducting electricity. When a neuron dies, the fiber arising from it becomes inactive. An impulse enters in a neuron via dendrite and exits via axon. Thus an impulse arising from a neuron reaches other neuron through dendrites. For example, a visual impulse arises when we see a clock on our table. This impulse is conducted to a neuron through dendrite. Dendrite receives this impulse. Axons conduct this impulse to a particular nerve center. So the axon of one neuron should be in connection with the dendrites of another neuron, but this is not the case. Axons have fine branches at its end. These branches are approximated with the branches of dendrite just like the branches of trees. Thus, axons do not come directly in to the contact with the other neuron, but there is a minimal gap between axons and dendrites. This gap is known as 'Synapse'. While crossing a synapse, nerve impulse becomes somewhat slow and then tries to jump the synapse. Sometimes two impulses coming from different sites unite at synapse, or impulses coming from the same site at different point of time unite. Because of this addition, nerve impulse becomes powerful. Impulses coming from different directions when unite at synapse, the powerful impulse obstructs the weaker one.

4.0 Parts of nervous system

Depending upon functions and characteristics, nervous system is divided in to two major parts-

1. Voluntary Nervous System or Cerebrospinal system.
2. Involuntary Nervous System or Autonomic Nervous System.

1. Voluntary Nervous System : All the fibers of this part enter voluntary tissues. These fibers conduct many types of impulses to brain. This part is made of brain, spinal cord, and the fibers arising from them. This system is under voluntary control and that is why it is called 'Voluntary Nervous System'. We receive various types of sensations through this system and thereby try to accommodate ourselves to function in accordance with the external climate.

2. Autonomic Nervous System : The fibers of this part of the system supplies involuntary tissues like lungs, heart, bladder, stomach, ovaries, intestines, etc. and also various glands. We do not have a direct control over them. These fibers conduct impulses from such tissues to brain. They function automatically and are not under our voluntary control. That is why it is known as 'Autonomic Nervous System'. The fibers of this system emerge from central nerves, but still they are autonomic. According to characteristics, this system has been again classified in to two parts – (1) Sympathetic Nervous System and (2) Parasympathetic nervous System. These two systems function opposite to each other. Their center lies in hypothalamus part of brain which controls both Sympathetic and Parasympathetic nervous systems.

4.1 Sensory and Motor nerve fibers : Nerve fibers conduct impulses from various organs to brain and

spinal cord, and again from there to body organs. This function is performed by different types of nerve fibers. Those Nerve fibers that conduct sensations from body parts to central nervous system are known as 'Sensory Nerves'. Sensations of vision, hearing and smell are conducted by sensory nerves.

There are some of the nerve fibers that conduct impulses from central nervous system to body tissues and glands. These fibers are known as 'Motor Nerves'. Some of the motor nerves stimulate tissues to cause contraction; whereas some of them induce secretion from gland, which are known as 'Secretory Nerves'. Those nerves that cause constriction and dilatation of vascular lumen are known as 'Vasomotor Nerves'. Nerves that conduct impulse from body parts to central nervous system are known as 'Sensory Nerves' e.g. nerves lying underneath the skin that conduct sensations of touch, temperature, pain etc. to central nervous system. The nerve which connects between eye and brain is also a sensory one. But the nerves conducting impulse from central nervous system to body tissues are known as 'Motor Nerves'.

Sensory and motor nerves stay in a single bunch. They also exist separately in body at places.

4.2 Nerve Impulse Conduction : Fibers are basically formed of similar types of cells which take functionally different forms and then develop. In a normal situation there is a remarkable difference between the saturation of ions that are present inside and outside the cellular wall of a neuron. This variation is because of unequal distribution of Sodium (Na^+) and Potassium (K^+) ions. In a normal situation, the number of potassium ions is 28 to 30 times more in inside than outside. On the other hand, the number of sodium ions in outside is 14 times more than inside. Besides these, presence of negative ions in a neuron is also remarkable. These negative ions are basically carbonic phosphate and protein. When there is no impulse in a neuron, there is an active transfer amongst ions outside and inside the cellular wall. Sometimes sodium comes out and sometimes potassium enters in, and then this order is reversed. This is known as Sodium-Potassium pump. In this process, energy is used which is derived from A.T.P. out of a cell.

The sodium-potassium pump gives rise to variation in the concentration of sodium and potassium ions as well as variation in electric charge. This leads to leakage of potassium to outside and entry of sodium inside. The permeability of cellular wall is 100 times more for potassium as compared to that for sodium; that is why potassium ions come out more rapidly. Because of this a difference of electric charge is created between outside and inside of the cellular wall-positive charge inside and negative charge outside. This difference in electric charge is known as 'Resting Membrane Potential'. In this situation the cellular wall is considered to be in a 'Polarised State'. In this state, a neuron is ready to receive any stimulus or impulse. The ability to receive stimulus and convert it into an impulse is known as stimulation. Any situation that brings such changes in a neuron is known as stimulation. This can be a change in atmosphere, touch or pain. Because of a sufficient stimulation, the permeability of cellular wall in a polarized state increases for sodium ions in the area of stimulation; the sodium ions start entering inside the cell and negative ions start coming out. This is known as depolarized state. Gradually the polarization area increases and it takes the form of an electric impulse. This is known as 'Nerve Impulse Conduction'. Here it is to be noted that as the impulse progresses forwards, the normal situation is left behind. Positive ions come out and negative ions enter inside, and the cellular wall again comes in polarized state.

5.0 Aggression

Aggression refers to the strongest impulse generation which creates a compulsion to perform more than normal. It has two parts – (1) Internal Aggression like fear, love, anger, happiness, anxiety, etc. (2) External Aggression like smile or laughter, perspiration, shouting, etc. There is a combine effort of Autonomic and Motor nervous systems to give effect to an aggressive behavior. Different parts of brain function to give effect to these two types of aggressions. In case of an internal aggression, cerebral cortex and limbic system are active, where as in case of an external aggression mainly hypothalamus and brain stem are active. Because increased activity of limbic system, various types of complex behaviours are expressed; and when there is a support of hypothalamus, the situation becomes more serious. These situations include rise in blood pressure, perspiration, increase in respiratory rate, redness of face, increase in blood sugar and epinephrine level, etc. Besides these tangible changes there are some indirect

changes like increase in bio-chemical reactions, changes in metabolic rate (some of them increase where as some of them reduce), chemical imbalance etc. If the biochemical and mechanical processes responsible for such changes continues for long then it may give rise to dire consequences.

5.1 Preksha-Meditation and Aggression : With regular and proper practice of preksha-meditation, the rhythm and intensity of electrical impulses generated by nerve cells can be changed. Besides, significant changes can be made in the amount of hormone secretions. These changes can be analysed with the help of special equipments. We can also establish positive commands and reactions with the help of 'Anupreksha' which affects autonomic nervous system, endocrine system, and immune mechanism through limbic-hypothalamic path. As a result internal and external aggressions can be regulated.

6.0 Neurotransmitter

There is no direct connection between two neurons. There is presence of a chemical secreted by neurons which is a medium for their contact. This secretion is known as 'Neurotransmitter'. This chemical acts on the dendrite of the next neuron. Even if these neurons connect to tissue fibers or glands, these neurotransmitters are equally effective. Their chemical composition is formed of amino acids. Once formed in cell body they get collected inside synaptic bulbs after passing through axons. There are thousands of molecules of neurotransmitters stored in a single synaptic bulb. When a neuron receives an impulse, these neurotransmitters are sent out because of electric stimulation. Its composition is coded according to the message it is carrying, which is received by the dendrites of fore coming neuron and sends this message to next neuron. Thus an impulse generated at one place reaches to brain or target organ through neurons. Normally each neuron generates a specific type of neurotransmitter. According to functions, neurons are of two types- one which increases stimulations in various tissues and cells, second which reduces stimulation in tissues and cells. These neurons can be described as follows :

- Neurotransmitters that increase stimulation
  Acetylcholine
  Norepinephrine
  Serotonin
  Glutomic Acid
  Aspartic Acid
- Neurotransmitters reducing stimulation
  Dopamine
  Glycine
  Gamma Aminobutyric Acid

7.0 Questions for study

1. Describe structure and structural classification of Neuron.
2. What do you understand by Sensory and Motor nerves?
3. What do a voluntary and autonomic nervous system mean?
4. The part in a neuron that collects a message is known as-
   (a) Dendrite (b) Axon (c) Synaptic Bulb (d) Neurotransmitter
5. How many types of neurons there are according to structure?
   (a) Three (b) Four (c) Two (d) Five

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LESSION – 7

BRAIN – STRUCTURE & FUNCTIONS OF ITS MAJOR PARTS

OUTLINE OF THE LESSON

1.0 OBJECTIVE

By study of this chapter you will know :-

1. Why brain is the main part of the central nerves system ? 2. Major parts of the brain.
3. Importance of Cerebrum. 4. How brain control the functions of the body ?
5. Role of cerebellum in controlling the body movements. 6. Functions of Cranial nerves.

2.0 INTRODUCTION

Brain is important part of the central nervous system. It is the centre that integrates, regulates and controls the body activities. It is the centre of consciousness, memories, intellect, creativity and emotions – love and hate, pleasure and pain. Brain receives informations from various parts of the body, processes it and issues commands to the various parts of the body.

The brain is a jelly like structure, covered with an intricate pattern of surface grooves and folds. It is enclosed in a hard bony helmet called skull. Following data shows the importance of the brain :

Weight in adult : about 1.3 kg (about 2% of body weight)

Blood circulation » 17%

Oxygen Consumption » 20%

3.0 STRUCTURE OF THE BRAIN :

Brain consists of about 30 billion neurons. In order to protect brain there are three protective layers of membranes or meninges between skull bones and brain. These three layers from outside to inside are.

(i) Duramater - Outer Layer
(ii) Arachnoidmater - Middle Layer
(iii)Piamater - Inner Layer

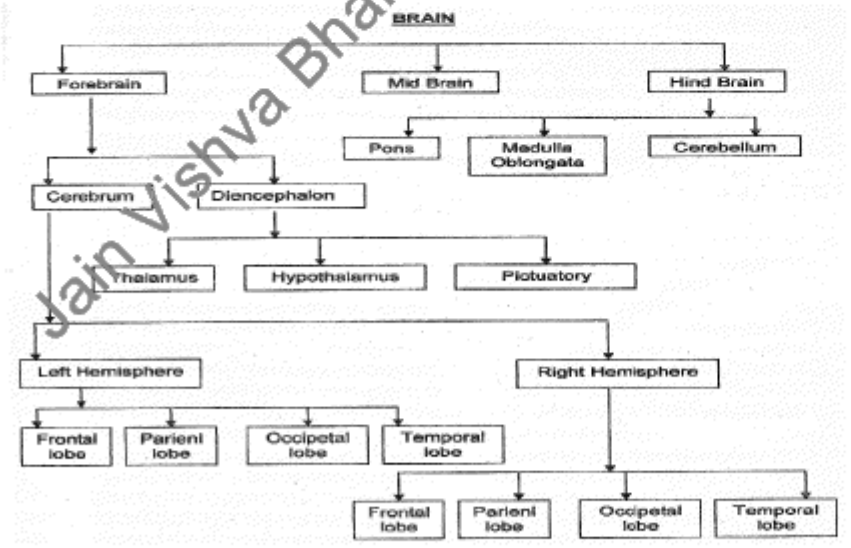
3.1 DURAMATER : This is made of thick, dense and tough fibrous tissue and is in contact with inner surface of the skull. Inner layer of Duramater at some places projects inside in such a way to keep the various parts of the brain in their respective places. The inner layer of duramater encloses the spinal cord and continues down as far as the sacrum.

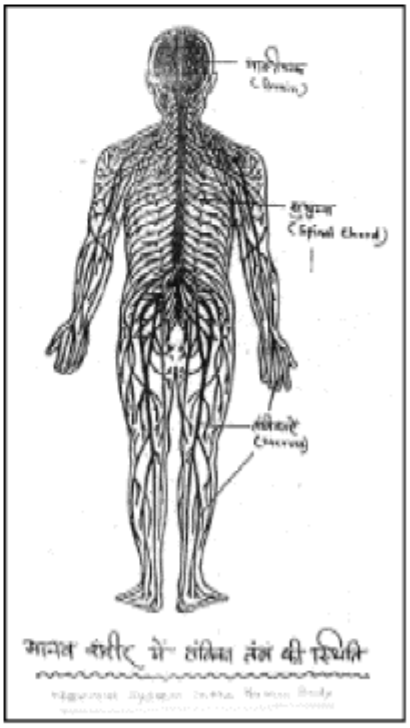
3.2 ARACHNOID MATER : Arachnoid matter is thin and delicate membrane as compared to Duramater and lies immediately beneath the dura and dips down with it between the main portion of the brain. There is serous fluid in between duramater and arachnoid mater which keeps inner surface of duramater and outer surface arachnoid mater watery and smooth.

3.3 PIAMATER : Pia mater is a thin, vascular membrane which is in contact with the surface of the brain and spinal cord into convolutions. It carries numerous small blood vessels which supply oxygen and nutritients to brain cells. All the three layers are not completely separated from each other. Some places they are in contact with each other while other places there is space between them. Space between duramater and arachnoid mater is called sub – duramater space and space between arachnoid mater and piamater is called sub – arachnoid space. These spaces are filed with cerebrospinal fluid (CSF). This fluid is similar to blood plasma and contains minerals, salts, proteins, glucose and lymph cells. The fluid is around brain and spinal cord and keeps flowing from one place to other place. Sub duramater space in spinal cord is more and so the fluid in it. This fluid is secreted by choroids Plexus in the third ventricle. Amount of this fluid increases in the disease **Meningetis.** The main function of the cerebrospinal fluid (CSF) is to protect the brain and spinal cord by forming a water cushion between the delicate nerve tissues and the walls of the skull in which they lie from mechanical and chemical damage. The fluid carries away waste and toxic substances.

9.0 PARTS OF THE BRAIN

Brain is composed of about 30,000 million neurons and five to ten times that number of glial cells. The brain receives about 17 percent of cardiac output and about 20 percent of the total oxygen consumed by the body even though it is only about 2 percent of body weight. Brain can be divided into following major parts.





(Surface of hemispheres consist of nerve cells or grey matter which is called cerebral cortex)

4.1 FOREBRAIN

Forebrain can be further classified into two parts : i. Diencephalon ii. Cerebrum

4.1.1 Diencephalon :- We shall discuss following major parts of this

4.1.1.1 Thalamus :- It is situated below forebrain and on front of cerebellum. This pair of egg shaped masses of grey matter is the central relay station for most sensory impulses (excluding smell) that reach primary sensory areas of the cerebral cortex coming from the spinal cord, brain stem and mid brain.

The thalamus contributes to motor functions by transmitting information from the cerebellum and basal ganglia to the primary motor area of cerebral cortex. It also relays motor impulses from cerebral cortex to spinal cord. The thalamus contributes to regulation of autonomic activities and maintenance of consciousness.

4.1.1.2 Hypothalamus :- It can be further divided in two parts.

a. Posterior and lateral portion b. Anterior and Central portion

Posterior or lateral portion helps in conducting actions of sympathetic nervous system and anterior and central portion helps parasympathetic nervous system in its functions. It is vital link in the physical and emotional life of the body. Sensory nerve fibres bring messages to it from the cerebral cortex, the thalamus and the brain stem while motor nerves link it to the thalmous, brain stem and spinal cord. It acts as central monitoring and control station for various activities of the body. It regulations respiration, heart beat, blood pressure, body temperature, food intake, water balance, sleeping and wakefullness, stimulation of sexual activity, emotions (anger, fear, pleasure etc). It also controls endocrine functions.

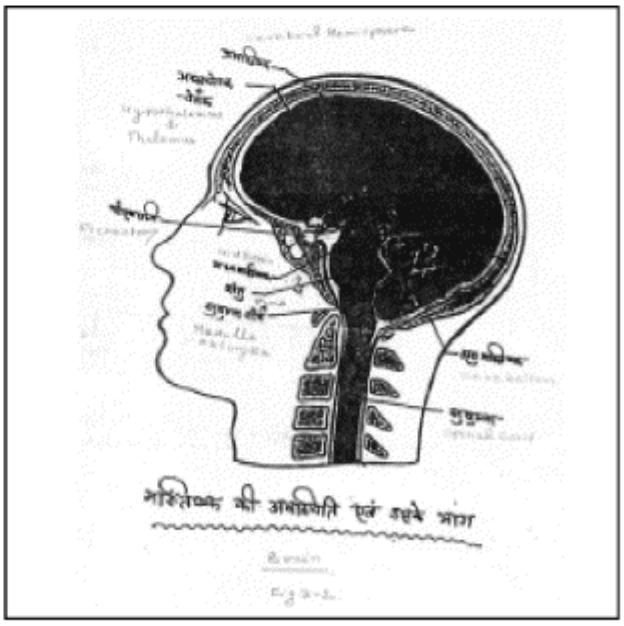
4.1.1.3 ituitary Gland :- It is master gland of endocrine system and is controlled by hypothalamus to a large extent. Further details of pictuatory are given in chapter on endocrine glands.

4.1.1.4 Basal Ganglia :- Deep within each cerebral hemisphere are three nuclei (masses of grey matter) that are collectively termed the basal ganglia

i. Globus pallidus (it is closer to thalamus)
ii. Putamen (It is closer to cerebral cortex)
iii. Coudate nucleus (It is away from other two but near to thalamus)

Together Putamen and caudate nucleus are known as corpus striatum.

Basal ganglia are specialized structures which are concerned in the planning and performing of muscular movement, including their modulation, so that they are not coarse and clumsy. This is achieved by a fine balance of excitation (Facilitation) and inhibition.



Basal ganglia also control sub conscious contractions of skeletal muscles. Examples include automatic arm swings while walking and laughing in response to a joke.

4.1.2 Cerebrum : This is largest part of the brain and is on the top of the other parts. It consists of right and left cerebral hemispheres, which are separated in the mid line by a fold of duramater. Left hemisphere controls all voluntary and involuntary activities of right side of the body and similarly right hemisphere control the activities of the left side of the body. Left hemisphere which is also called dominant hemisphere has attributes of verbal, linguistic mathematical, sequence and analytical . It seems to have a more direct link

to consciousness than does right hemisphere (also referred as non dominant hemisphere). The attribute of right hemisphere are : musical, geometrical, creative, spiritual. The two hemispheres are undoubtedly different in their specialization but it should be emphasized that they are united and that their abilities are complementary. The memory stores of each hemisphere appear to be accessible to other hemisphere, so that, total integration of function is possible.

Each hemisphere has following four lobes : i. Frontal lobe ii. parietal lobe iii. temporal lobe iv. occipital lobe

The surface of hemispheres consists of nerve cells or grey matter which is called the cerebral cortex. This is arranged in folds or convolutions thereby greatly increasing the total amount of grey matter. The convolutions are also called gyri and the furrows between them are called sulci or fissures.

Of the many fissures in cerebral cortex of each hemisphere, two are of special importance.

1. The Central Sulcus or fissure of Rolendo which runs downwards and forwards from the midline. Separating the frontal from the parietal lobes.
2. The lateral Sulcus or fissue of sylvious, which runs backwards and slightly upwards from the temporal pole (anterior part of the temporal lobe), separating the frontal and parietal lobes above from the temporal lobe below.

Different activities are controlled by different lobes of the brain e.g.

- Visual (seeing) is controlled by occipital lobe
- Touch – by parietal lobe
- Speech – by frontal lobe
- Hearing – by temporal lobe

From above it is seen that area of frontal lobe cortex is concerned with voluntary movement (e.g. Speech) while other lobes are concerned with sensory function. This is over simplified statement. So called sensory motor area are not exclusively sensory or motor but are of dual or sensorimotor nature. Each has afferent fibres conveying information towards it and efferent fibres transmitting motor impulses away from it. Motor area contains large number of pyramidal cells of varying size. The fibres projecting from these cells are known as pyramidal fibres and they synapse (connect) with the dendrites of cells in opposite side of brain stem or spinal cord. If there is any damage in motor area of left side, voluntary functions of the right side of the body will get paralysis and similarly damage in right side of motor area, voluntary functions of left side of the body will get paralysed.

Cerebrum not only receives information from sensory nerves and give commands to major nerves but also does associative functions of sending information to other right area and their results in higher level cognitive functions of the brain like, thinking, learning etc.

In summary functions of the cerebrum are as follows :-

i. To receive all sensory information and convey most of them to consciousness
ii. To initiate all voluntary actions.
iii. To correlate and retain all impulses received.
iv. To formulate and associate ideas giving rise to intelligence
v. To exercise unconscious control over many functions of the body.
vi. To exercise control over lower parts of the brain.

4.2 MID BRAIN : For descriptive purposes, mid brain is divided into two parts :-

1) Tectum (Upper part) 2) Floor (lower parts)

Tectum has two sensory controls

- Superior colliculi
- Inferior colliculi

Superior colliculi is responsible for seeing (visual), though occipital lobe is responsible for visual function but when that does not work, superior colleculi takes care of.

Inferior collucli is responsible for auditory function.

All sensory nerves going to higher brain centres pass through the floor similarly all motor nerves going to lower centre of the brain pass through the floor.

4.3 HIND BRAIN

Hind brain has three parts : 1) Pons, 2) Medulla oblongata, 3) Cerebellum.

4.3.1 Pons : It is derived from latin word 'Pons' which means bridge. It is bridge between mid brain and medulla oblongata. Nerves coming from cerebrum enter at one end and leave from other end. Change over i.e. nerves coming form left hemisphere go to right side of spinal cord, takes place in pons.

4.3.2 Medulla Oblongata : Medulla oblongata is about 3 centimeters in length and it is continuous above with pons and below with the spinal cord. It is cylindrical in construction with two longitudinal swellings, one on each side of midline fissure. It contains grey matter inside and white matter on outside. It connects spinal cord and other parts of the brain. Cranial nerves pass through medulla oblongata. Grey matter known as vital centres integrate complex reflexes which regulate heart rate, blood pressure and ventilation of lungs. In other words it has centres for controlling heart rate, blood pressure and rate and depth of respiration. In addition it has contras for vomiting, swallowing movement of stomach and for secretion of saliva and gastric juice.

The medulla oblongata centres are similar in function to the reflex centres in spinal and they receive afferent impulses from the peripheral nervous system and send out impulses in response to these stimuli. They may also be influenced by the higher centres of the brain. Thus thoughts may induce nausea or a quickening of the heart.

With so many vital structural contained in the small space of medulla oblongata together with the fact that all impulses to and from the brain pass through it, it is clear any disease, injury or pressure on the medulla oblongata is very serious and often fatal.

4.3.3 Cerebellum : It is smaller than cerebrum and the biggest part of the hind brain. It consists of two hemispheres joined in the centre. It is situated on the back side of the brain and below occipital lobes of cerebrum. Like the cerebrum, the cerebellum has a fissured outer cortex of grey matter and inner core of white matter. Some fibres from grey matter penetrate into inner white matter and give appearance like tree when seen after disection of the cerebellum.

The cerebellum is connected to the mid brain, the pons and the medulla oblongata by the three bonds of fibres called the superior, middle and inferior cerebellar peduncles, respectively.

The cerebellum is responsible for co-ordination of muscular activity, control of muscle tone and maintenance of posture. It is able to do this because of the impulses it receive from the semicircular canals of the ears, joints and muscles. Based on this information it gives inputs to cerebrum motor areas which in turn issue commands through motor nerves to muscles and joints.

5. CRANIAL NERVES

The cranial nerves originate or terminate within the brain. Since they come out from the cranial cavity, they are called cranial nerves. There are total 12 pairs. They go to the different organs of the body. Some are sensory nerves, some are motor nerves, and some are mixed nerves. Their are type, function and distribution is given in the table below :-

Name	Type	Function & Distribution
1) Olfactory Nerve	Sensory	The nerve of smell. Starts in the nose and passes to the olfactory bulb in the brain.
2) Optic Nerve	Sensory	The nerve of sight. Starts in the retina (eye) and passes to the lateral geniculate body (brain).
3) Occulomotor Nerve	Motor	Arises in the midbrain and ends in the muscles which move the eye balls.
4) Trochleor Nerve	Motor	Same as third cranial nerve

5) Trigeminal Nerve	Motor & Sensory	Supplies the muscles of mastification and has three sensory branches – ophthalmic, maxillary and mandibular.
6) Abducent Nerve	Motor	Arises in the pons and end in one of the muscles moving the eye balls.
7) Facial Nerve	Motor & Sensory	Supplies the muscles of facial expression and is sensory from the tongue.
8) Vestibulocochlear Nerve	Sensory	This is sensory nerve consisting of two sets of fibres which convey impulses from the internal ear to the brain, one sets of fibre form the vestibular nerve, which is concerned with equilibrium. The other set forms the chochlear nerve, which is the nerve of hearing.
9) Glassopharynglal Nerve	Motor & Sensory	It contains sensory fibres which supply the pharynx, tonsil and taste buds of the tongue. The motor fibres of this nerve supply the muscle which helps to elevate the pharynx in swallowing and speaking.
10) Vagus Nerve	Motor & Sensory	The vagus nerve has most extensive course and distribution of all cranial nerves. It arises from medulla oblongata and passes through the base of skull. It is distributed to the pharynx, larynx, trachea, bronchi, lungs, heart, oesophagus, stomach, small intestine and kidneys.
11) Spinal Accessory Nerve	Motor Nerve	Supplies the muscles of the neck, most of the pharynx and soft palate.
12) Hypoglossal Nerve	Motor Nerve	Supplies the tongue
		Some cranial nerves are voluntary, some are involuntary and, some are para sympathetic. Some are mixture of voluntary and involuntary e.g. third, seventh and ninth.

6. QUESTIONS

Descriptive Type Questions

i. Describe the structure of human brain and its functions.

ii. Describe names of cranium nerves and their origin and functions.

Short Notes

3. Which are all cranial nerves ?

4. Which are all main parts of the brain ?

Objective Type

5. Brain is the part of

   a) Autonomic Nervous System b) Vertebral Column

   c) Spinal Cord d) Central Nervous System

7. Cerebral Cortex has _____ _____ parts

   a) Five b) Three

   c) One d) Four

LESSION – 8

SPINAL CORD – STRUCTURE AND IMPORTANT FUNCTIONS, REFLEX ACTIONS

OUTLINE OF THE LESSON

1.0 OBJECTIVE

After study of this lesson you will learn

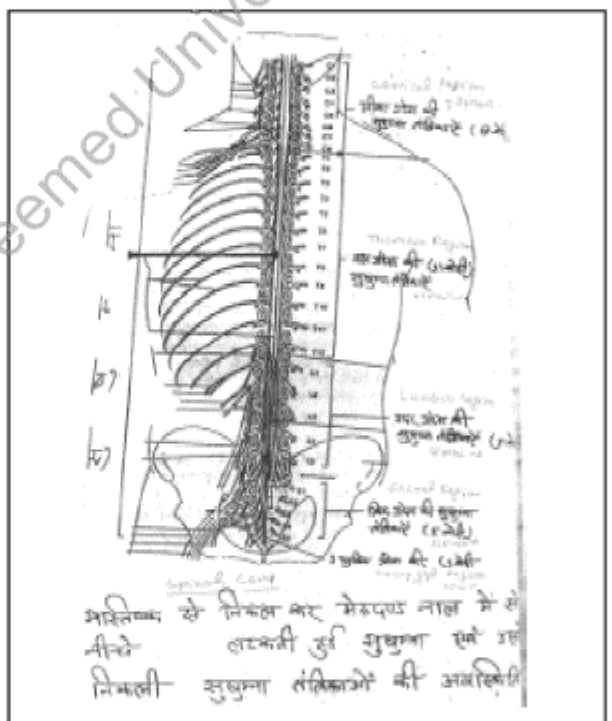
1. What are constituent matters of Spinal Cord ?
2. What is Cerebro Spinal Fluid ?
3. You will understand structure of Spinal Cord.
4. What are spinal nerves ?
5. Information on reflex actions.

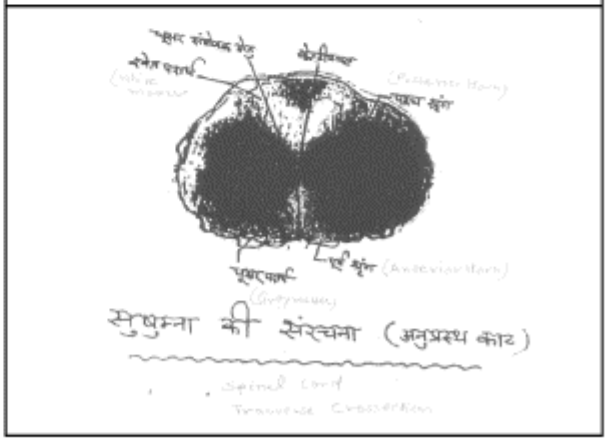
2.0 INTRODUCTION

Structure below medulla oblongata in the form of a rope is called Spinal Cord. In adult it is 42 to 48 centimeters (cms) long. It is approximately cylindrical in shape and is approximately 2.5 cms in diameter.

3.0 SPINAL CORD

The structure of the spinal cord is best understood by study of transverse cross sections. It has been noted that the grey matter of the brain is situated on the surface and white matter in the interior. In the spinal cord this arrangement is reversed, the white matter being on the surface while the grey matter is arranged in an H – Shaped manner in its interior. In the centre of grey matter, there is small hole from the top called central canal. This central canal is connected to 4th ventricle in the medulla oblongata and is filled with Cerebro Spinal Fluid (CSF). Grey matter has four arms (columns) two on anterior (front) and two on posterior (back) and are referred anterior horns and posterior horns respectively. Like cerebral cortex, grey matter of spinal cord contains cells of nerves. There is also a lateral grey column on each side, appearing as lateral horn in cross sections of the thoracic and upper lumbar segments of the cord. Lateral grey column contain the cells from which the fibres of sympathetic nervous system originate.





Nerves coming out of Anterior Horn go to trunk, legs and arms and hence these are motor nerves. Nerves coming out of Posterior Horn go to the skin of the body. These nerves bring sensations from the skin to the posterior horn and so these are the sensory nerves.

White matter is made of fibres going from various parts of the body to the brain carrying sensation and also the fibres going from the brain to the various parts of the body carrying commands for action.

4.0 ORIGIN OF SPINAL NERVES

Many nerves come out of spinal cord from top to the bottom of the spinal cord. These nerves are called spinal nerves. There are 31 pairs of spinal nerves on each side (right and left) of he spinal cord. Every spinal nerve has two roots. 1. Anterior (Ventral) Root 2. Posterior (Dorsal) Root

The nerves (from anterior root and posterior root) unite to form the main nerve trunk as they leave vertebral column. On each posterior (dorsal) nerve root there is a collection of nerve cells called the Spinal Ganglion (Posterior Root Ganglion).

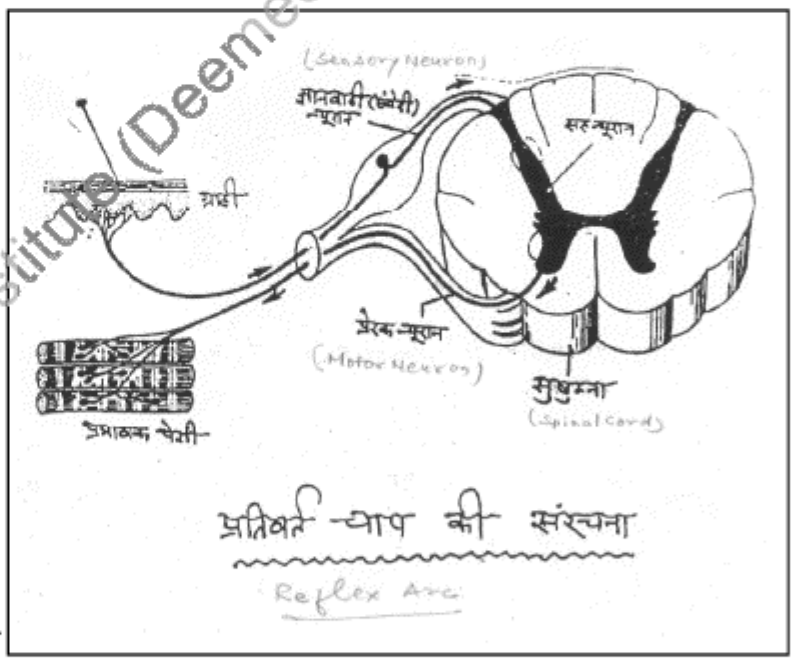
It has been mentioned earlier that all sensory nerve fibres reach the spinal cord by posterior root and all motor nerve fibres leave by anterior root. It follows that the peripheral nerve trunk is a mixed nerve containing both sensory and motor fibres.

The individual nerve trunks arising from certain regions of the spinal cord join up together to form what is called a plexus from which they emerge rearranged as the individual peripheral nerves. Two plexus are formed by the cervical nerves :- (1) Cervical Plexus, (2) Brachial Plexus and two by Lumbar and Sacral Nerves(1) Lumbar Plexus, (2) Sacral Plexus.

4.1 Spinal Nerves

Following are 31 pairs of spinal nerves :

Cervical Region	-	8 Pairs
Thoracic Region	-	12 Pairs
Lumber Region	-	5 Pairs
Sacral Region	-	5 Pairs
Coccygeal	-	1 Pair
Total	**-**	**31 Pairs**



5. FUNCTIONS OF SPINAL CORD

Spinal Cord has two main functions :-1. to connect brain with various parts of the body, 2. to take part in reflex actions.

5.1 Sensory Motor Function of Spinal Nerves : The white matter of the spinal cord is white because of the high proportion of myelinated fibres in it. Sensory fibres ascend in white matter to the brain and motor fibres descend from the brain. The motor fibres are situated in the lateral columns of white matter in a spinal tract, the lateral cortico spinal tract. The fibres cross over in medulla oblongata (Left side of brain connects to right side of the body and right side of brain connects to the left side of the body).

Injury or disease causing complete transaction of the lower part of the spinal cord results in paralysis of both lower limbs paraplegia. If lesion is higher in the Cord, all four limbs (hands and legs) may be affected quadriplegia. These conditions present many nursing and social problems, such as care of the bladder, prevention of bed sores etc.

8.2 Reflex Actions :

Reflex action may be defined as automatic motor response to a sensory stimulus, and is therefore independent of the will. The structures concerned in the production of a reflex constitute 'the reflex arc'. They consists of :

1. A sense organ such as the skin or the nerve endings in a muscle, tendon or other organ.
2. An afferent or sensory nerve passing from the sense organ via the peripheral nerve and posterior nerve root to the Spinal Cord.
3. The Spinal Cord
4. An efferent or motor nerve commencing in the anterior horn cells of the cord and passing via the peripheral nerve to the motor organ, for example muscle or gland.

It is clear if this route is taken, the time elapsing between the application of the sensory stimulus and the motor response will be much less than if the impulse had to pass the whole length of the spinal cord to the sensory area of the brain and then to the motor cortex, which in turn would send out a voluntary impulse down the motor path in spinal cord before it would reach the peripheral nerve and motor end organ.

It follows, therefore, that many reflexes are protective in character and designed to obtain the quickest possible motor response. For example, the finger is withdrawn from a hot object before we have time to think about it.

Other reflexes are concerned with automatic control of functions which do not require the supervision of consciousness, such as the secretion of gastric juice when food enter the stomach.

Other reflex actions are :-

- Watering of eyes when some particle has gone into the eye.
- Closing of eye lids quickly when some insect comes in front of eye.

Above actions take place immediately after the stimulus and donot require any conscious thinking.

Walking, climbing the stair, bicycling – these actions are voluntary in the beginning but after doing again and again, these become reflex actions and do not require any conscious thinking.

8.2.1 Characteristic of reflex actions

1. Reflex action are simple and faster than any other actions.
2. Reflex actions are innate
3. There is no conscious control over reflex actions
4. Reflex actins take place quickly on occurrence of stimulus
5. Reflex actions are protective actions in nature and has no long term purpose
6. Only a particular organ takes part in reflex action.

8.2.2 Type of Reflex Actions :

Reflex actions can be divided into two categories :

a. **Physical Reflex Actions :-** Physical actions which take place without the knowledge of conscious e.g. when high intensity light falls on eyes, eye balls get contracted immediately and automatically. If light is less, the eye balls expand automatically.

b. **Sensory Reflex Action :-** Sensory reflex actions are ones of which one is aware of but cannot be stopped e.g. coughing, touching hot plate with hand and immediate withdrawal.

9 EXERCISES

1) Describe structure and actions of spinal cord.
2) Describe reflex actions.
3) What do you understand by reflex action ?
4) Approximate length of spinal cord. : a) 45 – 50 Centimeter b) 42 – 48 Centimeter
   c) 50 – 55 Centimeter d) 30 – 35 Centimeter
5) Approximate diameter of spinal cord is a) 4 Cms b) 2.5 Cms
   c) 34.8 Cms d) 3 Cms

LESSION – 9

AUTONOMIC NERVOUS SYSTEM

OUTLINE OF THE LESSON

1.0 OBJECTIVE

By study of this lesson you will know :

1. What is Autonomous Nervous System ?
2. What are the divisions of Autonomic Nervous System ?
3. What is ganglia ?
4. Opposite actions of sympathetic & para sympathetic nervous system.

2.0 INTRODUCTION

In addition to central and peripheral nervous system with somatic sensory and motor functions, there is second system of nerve cells and nerve fibres which control internal organs and blood vessels. This system is called autonomic nervous system because these organs are self controlled and not under the control of will. The functioning of the internal organs (lungs, heart, stomach, kidneys, bladder, etc.) normally takes place without any conscious knowledge. The will does not normally affect them but the emotions do. They are affected by hypothalamus. In general, somatic part of nervous system is concerned with response of the body to external environment while autonomous nervous system is concerned with control of environment.

The essential feature of the autonomic nervous system is series of ganglia or masses of nerve cells outside CNS forming synapses between CNS & internal organs. Note all somatic nerves release only acetylcholine (Ach) as their neuro transmitter and autonomic motor neurons release either Ach or nonepinephrine (NE).

The autonomic nervous system is for the most part efferent (motor nerves). Its motor nerves are connected to a) involuntary muscles of walls of stomach, intestines, bladder, heart and blood vessels. b) to the glands such as the liver, pancreas and kidney.

There are some afferent nerves but they are comparatively few in number as internal organs or relatively insensitive.

3.0 AUTONOMIC NERVOUS SYSTEM & STRESS

The Autonomic Nervous System consists of two parts :-

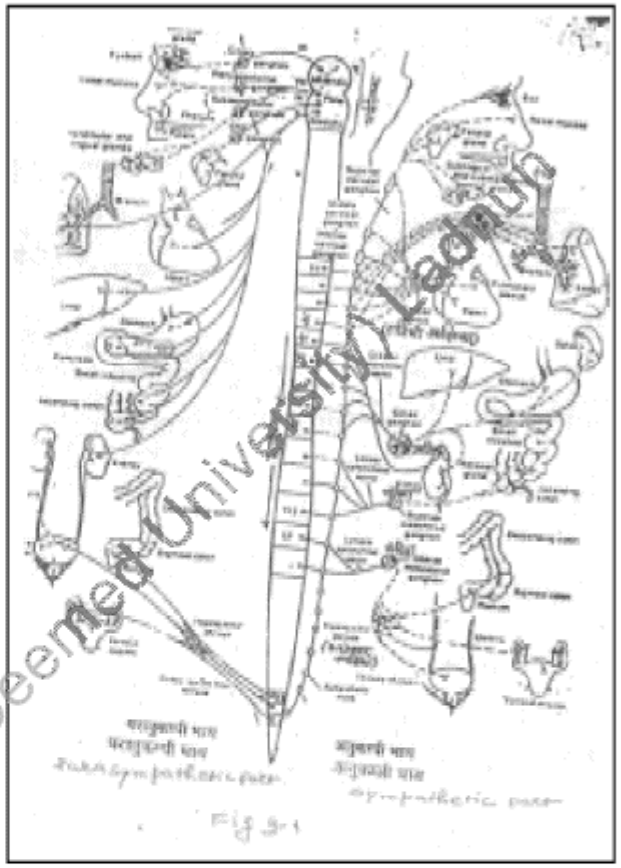
i. Sympathetic Nervous System
ii. Parasympathetic Nervous System

i. Sympathetic Nervous System : This consists of two chains of ganglia situated one on either side of the front of the vertebral column. Each of these ganglia has connecting fibres which pass to the corresponding nerve roots of the spinal nerves. There are 22 pairs of ganglia as per following details :

Cervical region – 3 pairs of cervical ganglia
Thoracic region – 11 pairs of thoracic ganglia
Lumber region – 4 pairs of lumber ganglia
Sacral region – 4 pairs of sacral ganglia

These ganglia are linked to one another by nerves. They receive nerves from the regions of the spinal cord. They give off nerves to the internal organs, the visceral branches and the nerves running back to the spinal nerves, the parietal branches. In certain regions where there are many organs requiring a nerve supply, there are additional ganglia between two chains, linked by nerves with the chains and with one another, giving off nerves to the neighbouring organs; these are called plexuses, e.g.

1. Cardiac Plexus : This lies behind heart in thoracic region and connected by nerves to heart and lungs.
2. Coeliac Plexus : This lies behind stomach and connected by nerves to stomach, intestine, suprarenal nerves and other organs in abdominal cavity.
3. Hypogastric Plexus : This lies in front of sacral region.



1. Function of Sympathetic Nervous System :-

i. Sympathetic nerves have stimulating effect on the heart and respiratory system. Consequently it raises blood pressure and respiratory rate, improving blood circulation and air in take.

ii. They increase secretion of sweat glands.

iii. They stop secretion of digestive juices from saliva glands and throughout the alimentary canal and check peristaltic action in its wall.

iv. They cause lever to release glucose to the blood stream

v. They increase blood supply in muscles which is rich in oxygen and glucose.

This stimulation of sympathetic nerves prepares body to produce more energy to face any emergency or run away from the situation (Fight or Fight). These nerves are stimulated by strong emotions, such as fear, anger and excitement. (It is because of this effect of emotions that they are called sympathetic). Their functions are thus closely related to those of adrenal gland which they stimulate. They are also responsible for arrest of food digestion when strong emotions are experienced and thus may produce vomiting and emptying of vowel as organs get rid of contents which they can not cope up for the time being.

ii. Parasympathetic System

It has two parts. 1. Upper Part or Cranial Autonomic System
2. Lower Part or Sacral Autonomic System

1) Upper Part or Cranial Autonomic System :- The fibres of these nerves come out from the special centres in the mid brain, pons and medulla oblongata. These fibres and ganglia are not separate nerves but these are associated with cranial nerves. The most important are :

a) fibres which control the caliber of the pupils of the eye and are associated with third or oculo – motor nerve.
b) fibres which run with tenth or vagus nerve to the heart, bronchi and alimentary tract (i.e. stomach, small intestines, large intestines, liver, pancreas etc.)

These fibres convey impulses opposite in action to those distributed by the sympathetic system to the same organs.

2) Lower Part or Sacral Autonomic System :- This supplies parasympathetic fibres to the large intestine and organs located in pelvis areas i.e. rectum, bladder, uterus and other reproductive organs.

It is seen from the above that heart receives fibres from both sympathetic and parasympathetic nervous systems. The parasympathetic fibres reaching the heart from vagus nerve carry impulses which tend to slow its rate (inhibitors), while those from the sympathetic (cardiac plexus) tend to increase its rate (accelerators).

It is also time to say that organs affected by autonomic (involuntary) system are also influenced by the secretions of endocrine glands (ductless glands). In particular, nor adrenalin from the adrenal gland stimulate smooth muscle, in the walls of small arteries and acts as a vasoconstrictor.

1. Function of parasympathetic nervous system : Parasympathetic system has action opposite to that of sympathetic nervous system.

Upper part of the parasympathetic nervous system i.e. the cranial autonomic system when stimulated affects the following,

i. pupil of eye – Contracts
ii. heart – slows down
iii. respiratory system – rate slows down
iv. digestion – improves secretion of saliva glands and production of other digestive juices and peristaltic action.

Lower part of the parasympathetic nervous system i.e. the sacral autonomic system when stimulated increases contraction of rectum, bladder, uteruses and other reproductive organs.

Parasympathetic nerves are stimulated by pleasant emotions (happiness, contended mind).

Summary of opposite actions of sympathetic and parasympathetic nervous system is as follows :-

Organ of the body	Effect of sympathetic nervous system.	Effect of parasympathetic nervous system
Heart	Heart rate increases & blood pressure goes up.	Heart rate decreases & blood pressure goes down.
Ailimentary Canal	Peristaltic rate reduces	Peristaltic rate increases
	Secretion of digestive juices reduces	Section of digestive juices increases
Eyes	Pupil expands	Pupil Contracts
Blood circulation in skin.	Reduces	Increases
Blood circulation in muscles	Increases	Reduces

10 EXERCISES

Descriptive Type Questions

1) What is autonomic nervous system & describe in brief.
2) Describe parasympathetic nervous system and its importance in human body.
3) Describe sympathetic nervous system and its functions.

Short Notes

1) Describe two differences in the functions of sympathetic and parasympathetic nervous system.
2) Describe three plexus formed by sympathetic nerves.

Objective Type

1) Autonomic nervous system has following parts :

(a) Three (b) Four (c) Five (d) Two

2) Parasympathetic nervous system increases heart rate.

(a) Yes (b) No (c) Neither Increases nor decreases.

LESSION – 10

PREKSHA MEDITATION & AUTONOMIC NERVOUS SYSTEM

OUTLINE OF THE LESSON

1. Objective

After reading the lesson you will know

1. Relationship between Autonomic Nervous System and Stress.
2. What is stress?
3. What is the effect of stimulation of sympathetic nervous system on the body?
4. What is the effect of stimulation of parasympathetic nervous system on the body ?
5. What are the possible causes of Stress ?
6. Is Kayotsarg (relaxation) is an effective system of stress relieving?

2. Introduction

Autonomous Nervous System controls the functions of internal organs e.g. dilation of pupil, focusing of vision, expansion and contraction of the walls of the arteries, heart rate, digestion process, secretion of endocrine glands. These activities are not under the control of our will. Hence autonomic nervous system is also called involuntary system. Most of the activities of autonomic nervous system are efferent (motor) in nature. Hence nerves of this system are called Visceral Efferent Fibres and the internal organs to which they carry messages are called Visceral Effectors.

3. Autonomic Nervous System & Stress

Autonomos Nervous System has two divisions : (i) Sympathetic Division, (ii) Parasympathetic Division

All internal organs (visceral effectors) receive visceral efferent fibres from both divisions, Messages from one division increases activity of a particular organ while messages from other division decreases the activity of that organ. Two divisions act like accelerator and brake of a car i.e. accelerator increases the speed while brake reduces the speed. Division which increases the activity of a organ could be sympathetic or parasympathetic; It depends on the organ, for example sympathetic division increases the heart rate and parasympathetic division reduces it. On the other hand parasympathetic division increases digestion activity and sympathetic division reduces it. These two divisions of autonomous nervous system play an important role in maintaining homeostasis (state of balance) of the body.

On the analysis of various physiological activities of the body, it will be clear that sympathetic division helps in organizing the activities related to production of energy particularly when a person is under intense physical or

emotional excitements. Under normal conditions (state of homeostasis) of the body, sympathetic division assists parasympathetic division that energy is produced to meet the demand of the normal activities of the body. Under the conditions of severe stress (fear, life threatening situations), sympathetic division becomes hyper active and increases the activity of internal organs (producing energy) manifold. Perhaps it is due to this reason, that a person under such extreme emotional excitement, does much difficult tasks which are not possible under normal conditions. Stimulation of sympathetic division triggers number of changes in physiological activities which together are referred as Flight or Fight, response. Following changes can be observed under the stimulations of sympathetic division

1. Pupils of eyes dilate
2. Heart rate increases
3. Blood pressure rises
4. Walls of some arteries (that of skin and internal organs) contract and consequently blood supply to these organs is reduced.
5. Walls of other arteries expand to allow more blood flow through them. As a result skeletal muscles and muscles of heart and lungs get more blood supply to prepare the body to face the danger.
6. Respiration becomes fast and deep. Bronchial tubes expand so that more air can flow in and out of the lungs.
7. Due to increased consumption of energy lever releases stored glycogen in the form of glucose into the blood. As a result blood sugar level goes up.
8. Secretion of epine-phrine and nor-pinephrine from adrenal gland increase which in turn further stimulates sympathetic division.
9. Those physiological activities get suppressed which do not contribute instant energy production. For example secretion of digestive juices gets reduced or stopped and reduces peristaltic action in the walls of alimentary canal. This happens due to reduced blood supply to digestive organs.

All above conditions happen as a result of severe state of emergency. If such situation keep happening again and again, sympathetic division will remain stimulated and parasympathetic division will not get chance to act. As a result body will remain under stress most of the time. Atonomous nervous system is responsible for creating and controlling this state of the body

4. Disorders due to Stress

Every living being has in – built mechanism to protect its survival in case of emergency by triggering 'Flight or Fight' response automatically and involuntarily. If such stressful situations continue for long or repeat again and again, then following serious disorders may occur :-

- Continuous high blood pressure, may result into heart attack or stroke (rupture of the arteries of the brain)
- Digestive disorders will occur due to reduced blood supply to digestive organs for long.
- Respiration rate remaining fast for long will result into respiratory disorders like asthama.
- Continuous strain on muscles for long will result into pain in back, shoulders and headache.
- Continuous stress may result into emotional disorders like irrational fear, depression.
- Secretion of hormones from endocrine glands get reduced. When adrenal gland stops secreting adrenalin, heart will beat slow and may not develop enough pressure to send blood to the brain. This will result in the state of coma.

It has been proved by number of research studies that stress is the major cause in number of diseases. If we want to protect ourselves against the ill effects of stress, then we shall find way to make parasympathetic division capable of doing its function and establish state of balance in the body.

5. Causes of Stress

From the above discussion, it will appear that stress has all harmful effects. It is not so. Some amount of stress helps to improve the performance. Bad effects e.g. fatigue, psychosomatic disorders (e.g. heart attack, stroke etc)

are due to excessive and frequent stress. One of the cause of such excessive stress or it persisting for long is sudden change in life style or occurrence of unpleasant events.

Dr. Holmes and Dr. R. Rahe have classified changes in life style or events according to the severity of stress they cause, some of these changes / events are given below.

Sr. No.	Event	Stress severity (Relative marks)
1.	Death of spouse	100
2.	Divorce	73
3.	Accident / disease	53
4.	Marriage	50
5.	Retrenchment	47
6.	Retirement	45
7.	Sexual Problems	39
8.	Change in job	29
9.	Change in life situations	29
10.	Change in routine of sleep / eating	10

This list is not complete. Marks indicated may not exactly same way to everyone. However if someone get total of the marks 300 or more, there is possibility of getting serious disorder and one should pay immediately attention to it. When score is about 100, one shall get warned and start taking curative measures. Total relaxation (Kayotsarg) is one such important and effective measure.

6. How to prevent stress

Use of tranquilizers to combat stress is only a temporary solution. When taken for long, side effects of these tranquilizers may cause serious disorders. Does this mean there is no way to combat stress and remain unaffected from its bad effects?

Fortunately there exists in-built protective mechanism in our body which when activated creates body response opposite to "Fight or Flight" response. Nobel Laurate Dr. Walter of Switzerland called this 'tropotrophic' response.

Dr. Herbert Benson, MD called this 'stress relieving mechanism? This mechanism can be activated by auto – suggestion. Activation of this mechanism reduces secretion of hormones from adrenal gland, increases the dominance of parasympathetic system over sympathetic nervous system. This makes skeletral and smooth muscles to get relaxed. Kayotsarg (auto– suggestion to relax each muscle and body part) is highly effective exercise to activate 'stress relieving mechanism' by regular practice of Kayotsarg one can prevent psychosomatic disorders.

7. What is stress relieving?

Relief from stress is very important. Stressed person can neither enjoy happiness nor can have good health and mental peace. Even if he / she has all luxuries. Kayotsarg is very simple and effective exercise of stress relieving Kayotsarg for 30 – 40 minutes will not only make one free from stress but also will improve one's efficiency and effectiveness.

In order to evaluate the importance of Kayotsarg, first let us understand the function of muscles. All our voluntary movements take place through skeleton muscles. Skeleton muscles get excitation from nerves (nerve current) based on the command from the brain. Muscles contract due to excitation. Muscles get relaxed when this excitation is reduced i.e. nerve current becomes minimum.

During sleep, nerve current is minimum as only very few body activities needed for sustaining life. As a result muscles are in relaxed condition.

During the day contraction of muscles and their relaxation keep on happening number of times normally. When state of acute contraction (sever stress) happens frequently or for longer duration again and again, then these muscles do not return to fully relaxed state and remain contracted. And this is very harmful.

It may be noted energy spent (and so the tiredness) depends on number of muscles getting excited and the strength of the nerve current. Size (small or big) of the muscle does not matter.

It may be further noted that the cells of other tissues in the body keep on dying and new one getting produced to replace lost one but in nervous system, no new neuron are produced to replace old damaged ones. Hence with age, no. of neurons keep decreasing.

Process of stress can be understood with analogy of electromagnet. Consider muscle as electromagnet and stress is iron-filing or iron dust, nerve current as electric current passing through the coil of electromagnet. As the current increases, more iron filling are attracted and when current is reduced, iron-fillings start dropping when current is nearly zero, all iron filling get dropped. During sleep or Kayotsarg, nerve current becomes very low and so stress gets away and muscles get relaxed. (This is only analogy for understanding the process of stress and relaxation and should not extend further)

7.1 Kayotsarg : In Kayotsarg by giving auto suggestion to the each part of the body to relax, nerve current is reduced to nearly zero and as a consequence of this, all muscles of the body get relaxed. Auto suggestions shall be given in loving manner. Kayotsarg done properly for half an hour will compensate disturbed sleep for few hours.

7.2 Healing power of auto suggestion : In olden days human beings and animals both had natural instincts which used to direct the behaviour of individual to keep oneself healthy in case of any disorder. With the development of human race, these natural instincts reduced slowly in human beings. In animals these instincts are still present. However there are still some people who have these natural instincts and they treat people particularly in the villages. These people are called healers and their methodology include prescribing restraints on diets, herbs and bone setting. Such people have knowledge of faith healing – process in which suggestion are given to the subject after hypnotizing him / her to the relaxed state. Thus suggestology is one of the oldest therapies in psychotherapy.

All the cultures in the world from the olden days till now have made efforts to go to the deeper level of consciousness. During the process they discovered the process of relaxation and auto-suggestion and their importance. Researchers have found that all the cultures adopted these processes in their religious activities by different names. Proof found in Egypt of 3000 years old culture demonstrate that there is marked similarity of these processes with the present age methodologies.

With the progress in scientific development, slowly people lost faith in faith healing. Today real faith healers are rare, only some quacks pretend to have this art and cheat people.

In the present age, **Mr. Franse Mesmer**, an Austrian Doctor used the process of relaxation and suggestion systematically to treat the patients and this methodology is called 'Mesmerism'. It is used by different names, some people call it hypnosys (in Greek hypnosys means sleep). Hypnosys & suggestology are being used increasingly by doctors and psychologists for treatment of many disorders at present.

7.3 Auto Suggestions : Auto suggestion or self hypnosis is suggestion therapy in which person treats himself by giving auto suggestions. By giving auto suggestion one can take himself / herself to the state of deep relaxation and reduce fatigue, headache and stress. In twentieth century French Doctor Emile Coue made auto – suggestion therapy popular among the masses. He taught that by giving auto suggestion, "I am becoming better and better day by day". One can improve his / her health.

Following physiological changes have been observed during the process of relaxation which can be measured:-

- Blood pressure
- Blood sugar
- WBC COUNT
- ECG
- EEG
- GSR

Effectiveness of auto suggestion therapy depends on two factors : (i) Steadiness of the body (ii) Depth of relaxation

8. Stress, Autonomous Nervous System and Preksha Meditation

Kayotsarg (Relaxation), Perception of deep breathing (Deergha Shvas Preksha) Perception of Psychic Centres (Chaitanya Kendra Preksha) are some of the important exercises of Preksha Meditation. We shall affect the autonomous nervous system and stress by practising these exercises. As we have seen in earlier lesson that though autonomic nervous system is not under the influence of will (conscious effort) but is influenced by emotions through hypothalamus. Further physiological activities of the body are controlled by both nervous system and endocrine glands in perfect co-ordination with each other.

We have seen that Kayotsarg produces the state of deep relaxation and physiological changes mentioned above correspond to parasympathetic activity of the autonomic nervous systems.

In order to understand the effect of "Deergha Shwas Preksha", we shall understand brain frequency (measured by EEG) Brain frequency is divided in four categories.

Frequency (Cycles per Second)	Name	State of the body
0.5 – 4	Delta	Deep Sleep
4 – 8	Theta	Sleep
8 – 13	Alfa	Awake & Relaxed
13 – 25	Beta	Awake

Alfa state of brain is the most desired state as all creative work happens under this state. When one is under stress e.g. loosing, temper, appearing for examination or interview, brain frequency goes above 25 Hz (cycles per second). Pattern of breathing is similar to brain frequency, mentioned above i.e. breathing rate is low during deep sleep and highest when one looses temper or under stress. Thus brain frequency and breathing rate are directly related. One does not have direct control on the brain frequency but one can make breathing slow or fast consciously for some time. By practicing slow and deep breathing (Deergh Shwas Preksha) for sometime (Say 20-30 minutes daily), one's normal breathing rate (autonomous activity) also decreases. One experiences reduction in the intensity of anger reduction in stress. In other words nervous system gets relaxed (Alfa state) i.e. para sympathetic activity improves. In perception of psychic centres (Chaitanya Kendre Preksha) one concentrate on endorcrine glands, this improves the secretion of harmones from the concerned gland. Hormones, of hypothalamus, pictuatory and pineal glands have relaxing effect (para sympathetic activity) on the body. Concentrating on hypothalamus (Jnan Kendra), pictuatory (Darshan Kendra), Pineal (Jyoti Kendra) will improve the secretion of the hormones of these glands and consequently produce parasympathetic activity.

9. Question

I. Descriptive Questions :

1. Explain phenomenon of stress in details.
2. Explain role of autonomic nervous system in stress management.

II. Answer in brief.

1. What are the possible causes of stress ?
2. How Kayotsarg can relieve body from stress ?

III. Objective Questions

1. How many divisions does autonomic nervous system have ?
   (a) Five (b) Seven (c) Two (d) four
2. Under stress breathing rate becomes
   (a) Fast (b) slow (c) very slow (d) No Change

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LESSON-11 :

GROUP OF ENDOCRINE GLANDS AND THEIR IMPORTANT FUNCTIONS

Outline Of The Lesson

1.0 Aim

1. How many types of glands are there in body?
2. Which are the endocrine glands?
3. We will understand the importance of glands.
4. What are hormones?
5. What mental and emotional processes are influenced by hormones?
6. Why pituitary gland is known as the master gland?

2.0 Preface

There are lots of chemical processes going on in human body and many glands are producing chemical compounds. These chemical secretions are for special functions.

3.0 Types of glands

There are two types of glands in human body. Some of the glands secrete in to blood through a duct or reaches some organ to function. Sweat glands, salivary glands, liver, pancreas are such glands which secrete either directly in to an organ or through a duct. Such glands have a minute form and their secretions come out though duct. These glands are known as exocrine glands. There are so many exocrine glands in our body especially in digestive tract and in skin.

There are some glands in our body which neither directly secrete in an organ nor are their secretions conducted through duct. These glands are ductless and they directly secrete their chemicals in the blood capillaries which are supplying them. These glands are known as endocrine glands or ductless glands and the chemical secreted by them is known as hormone. The word 'Hormone' has been derived from the Greek word 'Hormao' that means 'I arouse'. Hormone is a chemical substance which is importantly related to physical processes. In spite of its minute concentration in blood, it has a great deal of importance. They have a combine important influence in physiological processes in body.

4.0 Importance of glands

They are deeply related to activities and events of life. The hormones secreted by glands play important part in various processes in our lives. The hormone secreted by ovaries in a woman throughout her life span hardly weighs equal to a postal stamp. But this much minute amount of hormone is capable to convert her in to a woman from a girl and a mother from a woman. Thyroid gland secretes hardly a spoonful amount of hormone throughout the life span. But its deficiency makes a man dwarf or weak.

For the detail study of functions and importance of endocrine glands, experiments were done on hens, dogs, rats, and monkeys by removing their endocrine glands from their bodies. After removing glands these animals were given injections of the same hormones and then the changes were observed. These experiments showed that on injecting the hormones, all the deformities that were produced because of removal of the glands were healed. Progress in bio-chemistry has enabled us to purify hormonal elements. Thus we came to know about the chemical structure and functions of hormones by analyzing them. Hormones reach every viscera and tissues through blood. These hormones influence the metabolism in these viscera. Different hormones have different functions.

Hormones also regulate physiological processes. All the body parts are controlled by nervous system. Brain and spinal cord receive messages from all body parts through nerve fibers. Nervous system is closely connected with ductless glands blood is a great connective tissue of our body. There is a chemical substance in blood which is responsible for correspondence of impulses. This chemical substance is the hormonal only.

5.0 Major endocrine glands of human body

1. Pituitary gland	2. Pineal gland	3. Thyroid gland	4. Parathyroid glands
5. Thymus	6. Adrenal glands	7. Pancreas	

5.1 Pituitary gland

This is the smallest gland having reddish gray color. In spite of its small size it has got important functions. It is a round 10 mm sized gland which is situated in the central concavity of sphenoid bone. The concavity is known as Pituitary Fossa.

It is a dual gland in its structure as well as functions. It has got two parts- a. Posterior part, and b. Anterior part. Posterior part is known as posterior pituitary and the anterior part is known as anterior pituitary. There is a small part in between these two having a particular tissue. This part is known as 'Pars-Intermedia'.

a. Anterior Pituitary

It secretes many hormones. These hormones also control secretions of other hormones. These hormones are as follows.

(i). Growth Hormone or Sometotropic Hormone : This hormone leads to growth of body especially that of long bones. It stimulates growth and development of bones in childhood. Because of its deficiency a person remains dwarf and its excess leads to development of excessive height known as 'Gigantism'. Sometimes this excess is localized e.g. only forehead, jaws, etc. grow excessively. This situation is known as 'Acromegaly'. In case of its deficiency, growth is hampered during childhood and leads to 'Dwarfism'

(ii). Gonadotrophic Hormone : It is the hormone for the growth of genital organs. There are three hormones in this group.

1. Follicle-Stimulating Hormone (F.S.H.) : This hormone facilitates growth of Graafian follicles in ovaries and sperm cells in testicles.

2. Luteinising Hormone (L.H.) : It controls secretions of Oestrogen and Progesterone in ovaries and Testosterone in testicles.

3. Prolactin : It stimulates and regulates secretion of milk after parturition.

(iii). Thyrotropic Hormone : It is required for the growth of thyroid gland and secretion of thyroxine. It stimulates Thyroid gland and induces secretion of thyroxin. This thyroxine then controls anterior pituitary.

(iv) Adrenocorticotropic Hormone : This hormone affects adrenal glands. It regulates cortisol which is secreted by adrenal glands. It is also known as A.C.T.H.

(v) Melanocyte Stimulating Hormone : This hormone possible controls the skin tone in a foetus.

(vi) Mammary Stimulating Hormone : This hormone in conjugation with growth hormone stimulates growth of breasts and also stimulation of milk secretion from them after parturition.

(vii)Luteotropic Hormone : It functions as the mammary stimulating hormone. Besides it also regulates conception.

b. Posterior Pituitary

Pituitary gland is connected with brain. Unlike other endocrine glands, it falls under central nervous system. This part of the pituitary secretes two hormones: 1. Antidiuretic hormone, 2. Oxytocin.

Antiduretic hormone is secreted when there is dehydration. After secreted from posterior pituitary it acts on kidneys after reaching there through blood. As a result water level is reestablished. This hormone is also known as 'Vasopressin'.

Oxytocin is secreted during the last trimenster of pregnancy. It induces contraction of uterus and thereby facilitating parturition. Besides it also induces contraction of breast tissues and thereby helps secretion of milk.

Thus we can see that every physiological process occurs with the help of pituitary. It also controls the functions of other endocrine glands. That is why it is also known as the 'Master gland'. The reason why pituitary gland has got these much abilities is its situation near hypothalamus in brain. Thereby the whole endocrine system is brought under the control of nervous system. Many functions like- physical growth, quantity of urine, genital activity, metabolism of carbohydrates, proteins etc.etc. depend on this small gland.

5.3 Thyroid Gland

Thyroid gland is located in throat just below larynx and spread like butterfly over both the sides of trachea. It has got two lobes. Both the lobes are connected by a connective tissue which makes it looking like the alphabet 'H'. This tissue is known as 'Isthmus of the Thyroid'. Thyroid has got lots of blood capillaries in it. On observing its transverse section under microscope we can see minute cavities which are surrounded by cylindrical cells. These cavities are filled with substance known as 'Colloid of the Thyroid'.

There are three hormones secreted by this gland.

1. Thyroxine (T4), 2. Triiodothyronine (T3), 3. Calcitonin

There hormones control and regulate metabolic rateand growth.

5.3.1 Hypothyroidism

Reduction in function of this gland leads to a situation known as 'Hypothyroidism'. If this situation arises in a child then it is known as 'Cretinism'. In this condition body growth is hampered. Height does not increase, mental growth is improper, genitalia do not develop, and there are no signs of puberty. Mouth looks opened, lower lip drooping and there is dribbling of saliva. These children look ugly.

Lack of thyroid gland hormones in youth leads to weight gain, dryness of skin. This condition is known as 'Myxoedema'. In this condition there is collection of fat under skin leading to weight gain, hair fall, swellings. Metabolic rate decreases. Concentration of sugar in blood reduces below normal. In this disease the body activities slow down to such an extent that it appears reasonable than that these hormones have a great deal of influence on the activities of our body.

5.3.2 Hyperthyroidism

Excessive activity of thyroid gland is known as 'Hyperthyroidism'. This leads to 'Goitre'. There is increase in metabolic rate and heart rate. Eyes begin to look big, increase in appetite, tremulousness in hands, increase in blood sugar-level, reduced weight, increased appetite, increased perspiration and weight loss are the symptoms. Because of increased production of glucose from glycogen in liver, blood sugar-level increases and it is excreted in urine.

Because of increased secretion of hormones all the physiological activities become intensified. Lack of iodine in food leads to this situation. Thyroid gland increases in size and is visible over throat.

5.4 Parathyroid glands : These are four small sized glands which are situated behind upper and lower edges of thyroid gland over both the sides. These glands are formed of glandular tissues. On each side they are situated one above and the other below the thyroid gland. Its colour is grayish red. The hormone secreted by these glands is known as 'Parathormone'. This hormone influences metabolism of calcium and phosphorus. It has an important role in controlling calcium and phosphorus in blood and in bones.

On reduction of parathyroid gland there is reduction of calcium in blood which leads to increased respiratory rate and spasms in extremities. There is raised heart rate, and fever. This disease is also known as 'Tetany'.

Because of increased function of parathyroid glands, there is reduction in phosphorus and rise in calcium saturation in blood. As a result bones become weak, deformed and fragile. Because of increased calcium tissue activities reduce and there is excretion of calcium and phosphorus in urine.

5.5 Thymus gland : This gland is comparatively bigger in size in childhood and becomes much smaller in youth. This is situated below thyroid gland and in front of trachea. With aging its size becomes smaller. At birth it weighs 10-13 grams which increases up to 30-40 grams and after youth it again reduces to around 10 grams. The hormone secreted by this gland has influence on the growth of genitals as well as on puberty. It is also related to physical growth. Till the completion of bone growth it controls over them. This glands also originates lymphatic cells which regulate immunity.

5.6 Adrenal glands : These are two small yellow coloured glands which are situated on kidneys like a Christmas cap one on each. They are triangular in shape and weigh about 3-4 grams each. With the prospect of structure and function is a dual gland made of strange types of glandular tissues. It has got two parts.

Outer part is known as 'Cortex' and internal part is known as 'Medulla'. Both these parts have got different hormones with different functions. Internal part is made of sympathetic nervous system and the outer part is made of those tissues which form genital glands. So some learned people consider them to be of separate entities.

A. Medulla

This part of the gland secretes two hormones : 1. Adrenaline (Epinephrine), 2.Nor-Adrenaline (Nor-epinephrine)

These hormones create increased blood pressure in arteries, increase in heart rate, arterial constriction in abdominal viscera, breakdown of glucose in blood and capillary constriction. This gives rise to increased blood pressure, along with dilatation of pupils, straightening of hair, reduction of peristalsis, increase in respiratory rate, release of glucose in blood from stored glycogen of liver are the effects of adrenaline. Some learned people say that it is the effect of adrenaline that when we fear, our heart rate increases and hair get straightened, when we prepare to fight our face become red and blood pressure increases. This hormone performs many important functions like dilatation and constriction of blood vessels of abdomen and skin, increased blood pressure, relaxation of soft tissues, etc.

According to Dr. Cannon during fear, anger or fight, sympathetic system with the help of adrenal medulla induces such reactions that make an animal able to face the situation. In such situations, heart rate increases giving rise to more blood supply to the tissues. Respiratory rate also increases providing more oxygen. This way body tissues receive more fuel and we do not feel tiredness easily.

B. Cortex

Adrenal cortex is the important part for our life. This secretes many hormones which can be divided in to three parts.

(i) Adrenal Corticoid : This again has two parts :

(a). Mineralo-corticoid–This hormone primarily affects water and electrolyte balance in our body. 'Deoxycortone' and 'Aldosterone' fall under this group. Aldosterone primarily affects electrolyte(Sodium, Potassium,

Chloride) metabolism. For the cells and tissues to function normally, it is essential that the electrolytes balance is maintained.

(b). Glucocorticoid–It mainly affects proteins, amino acids and carbohydrate metabolism. 'Cortisone' and 'Hydrocortisone' fall under this group. They increase blood sugar level and perform such actions, which are exactly opposite to that of insulin. They are anti-inflammatory. To treat inflammatory conditions, cortisone is used.

(ii) Adrenal Sex Hormone : Male hormone (Androgens) and female hormone (Oestrogen) fall under this group. These hormone resemble gonadal hormones. But as being of very minute quantity they do not have much influence.

(iii) Amorphous fraction : This hormone contributes in amino acid metabolism and is necessary for life.

Hypotrophy of Cortex :

The hypotrophy of cortex leads to anorexia, debility, reduced physical activity, etc. A person becomes weak and a diseases occurs which is known as 'Addison's disease. Body becomes copper coloured. On blood investigations there is reduction of sodium chloride and rise in calcium and potassium phosphates and nitrogen in blood. Sodium concentration reduces in blood and potassium concentration increases. Because of dehydration, blood pressure falls. Because of dehydration, kidneys' functions are reduced.

Importance of Cortex

This part exerts its influence by water and electrolyte balance on regulating protein and carbohydrate metabolism and thereby generally affecting whole body. Its secretion helps excreting normal levels of sodium and potassium from kidneys by affecting glomeruli of kidneys. It plays an important role in maintaining essential level of protein and carbohydrate in tissues and viscera. It also exerts its effects on connective tissues. Use of cortisone in osteoarthritis and arthopathy is beneficial.

5.7 Gonads

Testicles in males and ovaries in females are called 'Gonads'. Ovaries generate two and testicles generate one hormone.

Testicles have two parts. One part forms spermatozoa which is conducted through spermatic cord and comes out during sexual intercourse. The other part of the gland produces hormone which directly enters blood stream. The hormone secreted by this part is known as 'Testosterone'. This hormone gives rise to development of genital organs in males and male signs are developed. Sexual desire, heaviness of voice, hair growth on face and chest, etc. are the effects of this hormone. Its deficiency leads to hair loss, loss of lustre of skin, loss of sexual activity and the man looks old.

Ovarian hormones are known as 'Oestrogen' and 'Progesterone'. This gland is of the shape of an almond which lies in pelvic cavity in abdomen. It is situated one on each side of uterus. Oestrogen prepares female organs for conception. Changes that take place in uterus and vaginal tract are due to this hormone. Female signs are developed because of this hormone. These hormones organize development of internal and external genitalia in females and their cyclical activity initiates cyclical changes in uterus leading to appearance of menstruation. because of lack of these hormones, female signs do not develop. Development of organs, sexual activity, attraction towards males, are the results of these hormones.

Progesterone maintains and develops uterus. Development of placenta after conception is the result of the activity of this hormone. This hormone nourishes and grows foetus. Lack of this hormone can lead to abortion. Ovarion hormones have a particular function after parturition- induction of lactation.

5.8 Pancreas

In abdomen, behind stomach there is a long gland of the shape of a leaf. Basically this is a combine gland. Its external secretion helps digestive process which is known as bile. Moreover it also secretes two hormones named 'Insulin' and 'Glucagon'.

These hormones help maintaining optimum level of sugar in blood. Maintaining optimum glycogen level in liver and tissues and oxygenation of carbohydrate in tissues are also facilitated by these hormones. carbohydrate is a calorious substance which maintains physical activities. On observing pancreas under a microscope, we can see glands at places looking like islets. These are known as 'Islets of Langerhans'. These secrete the hormone 'Insulin'. Because of insulin, body tissues utilize more glucose and convert sugar in to glycogen to be stored in liver so that it can be utilized later. Lack of insulin gives rise to increased level of sugar in blood and it gets excreted through urine. When there is lack of carbohydrate in blood, glucagon converts the stored glycogen in to glucose and replenishes the need.

6.0 Questions for study

Assays :

1. Describe major endocrine glands of human body.
2. Describe any of the endocrine glands with figure and mention its importance.

Short questions :

1. Describe 'Hypothyroidism' and 'Hyperthyroidism'.
2. Mention the types and subtypes of Pituitary gland.

Answer in short :

1. What is 'Goitre'.
2. What is 'Dwarfism'?

Objective questions :

1. Lack of which hormone causes abortion?
   A. Progesterone B. Oestrogen
   C. Insulin D. Thyroxine
2. What is the amount of hormone secreted by ovaries?
   A. 1 gm. B. 0.5 gm
   C. Equivalent to the weight of a post stamp D. None
3. What is the shape of connective tissue of Thyroid gland?
   A. Y B. B
   C. I D. H
4. The central concavity of Pituitary gland is known as
   A. Cortex B. Medulla
   C. Pars-intermedia D. Acromegaly
5. The hormone which increases milk secretion
   A. Testosterone B. Thyroxine
   C. Insulin D. Prolactin

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LESSON-12 :

HORMONE-TYPES, CHEMICAL STRUCTURE AND FUNCTIONS, REGULATION OF HORMONAL SECRETION AND FUNCTIONS WITH PREKSHA-MEDITATION

Outline Of The Lesson

1.0 Aims

1. What are the functions of hormones in body?
2. How many types of hormones are there?
3. We will be able to understand the mode of action of hormones.
4. How feedback mechanism of hormonal secretion takes place.
5. Are hormones responsible for stress?
6. We will understand hormonal control with Preksha-meditation.

2.0 Preface

The two systems of human body, Nervous system and Endocrine system regulate various physical functions by conducting messages. Where the nervous system controls physical activities by generating impulses, the endocrine system make it possible by releasing various chemicals in blood stream, and thereby affect physical functions. The impulses generated and received by nervous system act on specific organ or tissues. On the contrary the messages generated by endocrine system can reach all the organs. Nervous system causes contractions and relaxations in tissues whereas the secretions of endocrine system are capable of changing metabolic rates in body tissues. The gist of the discussion is that the secretions of endocrine glands can bring about desired changes in all the body tissues and organs. The changes brought about by endocrine system are more deep and long lasting as compared to those by nervous system. The functions of both these systems are complimentary to each other. On one hand where nervous system stimulates endocrine secretions, on the other hand hormones are also of such types that they stimulate or suppress nerves.

3.0 Functions of hormones

Functions of hormones can be categorized in to five parts as follows.

1. They control chemical structure of internal atmosphere of the body and establish homoeostasis.
2. They help regulating emergency situation arising in the body due to external environmental changes; e.g. infection, aggression, starvation, dehydration, bleeding, and temperature changes, etc.

3. These hormones contribute in maintaining normal growth and development processes of body.
4. Reproductive functions- ova and sperms, conception, foetal development, parturition and nourishment of foetus are also remarkable under control of hormones.
5. Hormones are also of great assistance in metabolic activities and energy balance.

Hormones have been identified in many ways as per their chemical structures are concerned. But mainly they can be divided in to three parts.

4.0 Types of Hormones

4.1 Amines : These are the simplest forms of hormones regarding their structure. These hormones are formed by chemical changes in an amino acid which is known as 'Tyrosin'. 'T3' and 'T4' of thyroid gland, Adrenalin and Nor-adrenalin fall under this group.

4.2 Protein and Peptides : Hormones which are formed by amino acid chains fall under this group. 'Oxytocin' secreted by Thymus gland belongs to this series which is formed by small amino acid chains whereas 'Insulin' is a hormone which is formed by big chains of amino acids. These hormones are water soluble.

4.3 Steroids : These hormones are formed by changes in cholesterol. Aldosterone, Cortisol, Androgen and Testosterone are of this group. These are not water soluble. These are formed inside the Mitochondria and Endoplasmic Reticulum of cells of endocrine glands.

5.0 Mode of action of hormones

The amount of hormone secretion depends on the body requirement for that particular hormone. This is the basis of action of an endocrine gland. Hormone producing cells function under control of such systemic impulses that instruct them to produce hormones up to a certain extent of period and of a certain amount. secretion occurs in an optimum level of quantity; neither more nor less than required. After secretion the hormone reaches target tissues through blood stream which starts functioning under the control of that hormone. Usually all the tissues fall under the target of more than one hormone, but it is not necessary that all the tissues perform under the influence of a single hormone. When the target tissues start performing under the influence of hormone, the endocrine gland secreting that particular hormone receives feedback message from the target tissues. If this feedback is negative then the secretion will stop, and if it is positive then the secretion continues till the completion of objective.

5.1 Hormone receptor : After having been secreted from an endocrine gland, the hormone circulates in the whole body with blood stream. Thus it comes in to contact with each and every tissues of the body. But why is it so that it acts on selected cells only? Why is it so that only selected tissues function under that particular hormone? As an explanation we have an answer called 'Receptors'. Very minute protein particles found on cellular wall, intracellular substance or nucleus, are called 'Receptors'. Only those cells which contain receptors for a hormone are influenced by that particular hormone. Receptors have a quality that they identify their related hormone and they allow the hormone to enter cells and influence them. In fact, hormone and receptors have specific molecular structures which are complimentary to each other; and that is why a particular hormone can act on a particular group of cells. For an example, Thyroid Stimulating Hormone (T.S.H.) of pituitary gland has an ability to act only on the cells of thyroid gland and not on any other tissue. Besides, it has been found that different tissues have receptors for only single hormone but the influence on those tissues occurs in different ways. For an example, insulin receptors are found on liver cells, beta cells, and lipid cells. With the influence of insulin, lipid cells increase glucose usage and lipid synthesis, amino acid synthesis and glycogen synthesis; whereas, liver cells and beta cells stop glucagon secretion. Not only that, with increment of concentration of one hormone, we can also see increment in the number of receptors for other hormones. For example, increased concentration of oestrogen leads to rise in number of receptors of progesterone hormone.

When a hormone combines with specific receptors, it initiates a series of chemical reactions in cells. Hormone and receptors combine in two ways.

1. Hormone and cellular wall receptors combination.
2. Hormone and intracellular receptors combination.

When hormone combines with cellular wall, there is initiation of cyclic A.M.P. in intracellular substance and Protein-Phosphate and A.D.P are formed with the combination of protein and A.T.P. in presence of protein kinase enzyme. This leads to release of excessive energy. As a result the hormone instructed function is performed.

When hormone combines with intracellular receptors, the hormone-receptor complex enters nucleus and activates D.N.A. of genes to forms specific types of hormones which accomplish hormone instructed function.

5.2 Feedback mechanism of hormones : Hormonal secretion from endocrine glands is controlled by feedback mechanisms. Amongst them, negative feedback mechanism is the most effective one. In this mechanism the message is sent to that particular endocrine gland regarding the amount and intensity of effect of the particular hormone. This process takes place by three ways.

In the first negative feedback mechanism there is no direct involvement of nervous system in hormonal secretion. For example, concentration of blood calcium is maintained by the hormone secreted by parathyroid gland. If the calcium concentration falls due to any reason, the reduced concentration itself stimulates secretion of parathyroid hormone.

In the second mechanism, the hormonal secretion occurs as a result of nervous stimulation in endocrine glands. For example, adrenal gland secretes adrenaline and nor-adrenaline hormones only when it receives stimulation from sympathetic part of autonomic nervous system. Same way, A.D.H. secretion from posterior pituitary is induced by nervous stimulation form hypothalamus.

Besides these, in the third mechanism the interference of nervous system is not direct, but it occurs through the chemical secretions from hypothalamus. These chemicals are known as regulating hormones or regulating factors.

5.3 Stress, General Adaptation Syndrome and Hormone : Nature has arranged in many ways to maintain homoeostasis in body. So long as every arrangement runs smoothly, the internal chemical structure, temperature and pressure are maintained. But when a powerful, adverse and effective stimulus is there, these normal arrangements are not sufficient. In such cases, gross changes take place inside body as a reaction which is known as 'General Adaptation Syndrome'. In presence of 'General Adaptation Syndrome', functions occur opposite to homoeostasis and help the body to face emergency situations.

It is not possible to get rid of such adverse situations in routine life that create stress condition. There are some of the stressful conditions that help maintaining physical activities. Such a condition is known as 'Eustress' or helpful stress. Whereas, the stress condition that has adverse effects on body are known as 'Distress'.

Hypothalamus works as a vigilant guard in our body. It has got sensors that can identify minute changes in temperature, pressure or chemical changes inside body. Hypothalamus receives impulses for emotions through the channels of cerebral cortex. As a result a chain of chemical changes is initiated in hypothalamus which is known as 'General Adaptation Syndrome'. The stimulations that initiate this situation are known as 'Stressers'. Excessive temperature, cold, atmospheric toxins, bacterial or viral toxins, excessive bleeding, emotional situations, etc. are known as 'Stressers'.

Whenever stressers are faced, hypothalamus switches to General Adaptation Syndrome in two ways. In one, it stimulates various organs through sympathetic nervous system and increases activities of adrenal gland. As a result, crisis reactions take place immediately which is known as 'Alarm Reaction' or 'Fight or flight' situation. In this situation, remarkable changes take place in terms of, heart rate, blood pressure, respiration, tissue contractions etc. This provides an ability to face the stimulus. This has been described in details under the chapter of Autonomic Nervous system.

In facing stressers, hypothalamus takes another way known as 'Resistance reaction'. In this, hypothalamus releases important critical hormones that initiate reaction. These are known as regulating hormones. This reaction continues for long, giving rise to long lasting effects. Corticotrophin Hormone, Growth Hormone Releasing Hormone and Thyrotropin Releasing Hormone are the hormone responsible for this resistance reaction.

Corticotrophin Hormone releases A.C.T.H. which activates Adrenal gland and it releases its hormone. The

hormones of adrenal gland not only take part in alarm reaction but also the Mineralocorticoid hormones of adrenal gland help in protecting Sodium ions. The glucocorticcides of this gland balance protein metabolism, facilitate arterial wall constriction, and stop production of fibroblasts.

Because of T.R.H. , pituitary gland stimulates Thyroid Stimulating Hormone (TSH) which activates thyroid gland to stimulate T3 and T4 and ultimately control carbohydrate metabolism.

In presence of GHRH, growth hormone is secreted which helps in lipid metabolism and conversion of glycogen in to glucose.

Resistance Reaction enables body to face stimulation for a longer duration. Possibly it is because of this reaction that a human body withstands adverse situations. It is because of this reaction that optimum energy becomes available, optimum proteins are received.

6.0 Effects of Preksha-Meditation on Hormonal actions

It is now clear from the above descriptions that there is an intimate relationship between nervous system and endocrine glands. Under 'Chaitanya Kendra Preksha' if we do preksha of major nervous centers of endocrine glands and major nervous centers like brain and spinal cord, it helps in regulation of hormonal secretions. Hypothalamic activities are balanced because that is also regulated by various parts of cerebral cortex. Once hypothalamic functions are regulated, pituitary gland also comes under regulation and they secrete only those hormones in that much amount we program ourselves to react with desired intensity of reactions. The result is that, in spite of repeated stimulations we can control the mechanical, bio-chemical and metabolic actions and our mental balance is maintained.

7.0 Sample questions for study

1. Assays

1. Describe chemical nature and major functions of Hormones.
2. Describe hormonal actions during stress.

2. Short questions

1. What is the effect of preksha-meditation on hormonal actions?
2. How do thyroid hormones act?

3. Objective questions

1. How many types of Hormone and receptor combinations are there?
   (a) Two (b) Three
   (c) Four (d) Five
2. Which hormone is secreted in presence of GHRH?
   (a) Pituitary Hormone (b) Adrenal Hormone
   (c) Growth Hormone (d) Melatonin

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LESSION – 13

RESPIRATORY SYSTEM – STRUCTURE, FUNCTION, PROCESS AND EFFECT OF PREKSHA MEDITATION ON ENERGY PRODUCTION

OUTLINE OF THE LESSON

1. Objectives
2. Introduction
3. Respiratory Process
   - 3.1 Types of respiration
4. Organs of respiratory system
   - 4.1 Nose (Nasal Cavities)
   - 4.2 Pharynx
   - 4.3 Larnyx
   - 4.4 Trachea
   - 4.5 Bronchi
   - 4.6 Bronchiolex
   - 4.7 Alveoli or air sacs
5. Lungs
6. Respiration process
7. Functions of respiratory system
   - 7.1 Gas exchange
   - 7.2 Elimination
   - 7.3 Absorption
   - 7.4 Acid – Alkali balance
   - 7.5 Water balance
   - 7.6 Temperature control
   - 7.7 Effect on blood circulation
   - 7.8 Effect on lymph circulation
   - 7.9 Secretion
   - 7.10 Coughing & sneezing
   - 7.11 Voice Production
   - 7.12 Smell
8. Effect of Preksha Meditation on efficiency of respiration
9. Exercises

1.0 OBJECTIVE

After of this lesson you will understand :-

1. Breathing process.
2. Importance of breathing.
3. Important organs of respiration system.
4. Capacity of lungs
5. Function of respiration system.
6. Effect of Meditation on energy production.

2.0 INTRODUCTION

One can live for sometime without food and water but without breathing one cannot live even for few minutes. Every living being needs oxygen for survival. Body's cell continuously use oxygen for the metabolic reactions. At the same time these reactions release carbon dioxide. An excessive amount of carbon dioxide produces acidity that can be toxic to cells, excess carbon dioxide must be eliminated quickly and completely. The blood circulation system and respiratory system co-operate to supply oxygen and eliminate carbon dioxide. The respiratory system provides for intake of oxygen and elimination of carbon dioxide and the blood circulation system transports blood containing the gases between the lungs and the body cells. Failure of either system disrupts homeostasis (state of balance) by causing rapid death of cells from oxygen starvation and build up of waste products. In addition to functioning in gas exchange, the respiratory system also participates in regulating blood pH, contains receptors for the sense of smell, filter inspired air, produces sounds and rids the body of some water and heat in exhaled air.

3.0 RESPIRATION PROCESS

Oxygen is obtained from atmosphere. Gas exchange between atmosphere, blood and cells is called respiration. System of organs which perform this activity is called respiratory system. Respiratory system supplies oxygen to the every cell of the body. Respiratory system and cardiovascular system both participate equally in the process. If any one system does not function, haemostasis gets disturbed and cells may die soon. Respiratory system apart from supplying oxygen to the cells, also eliminates waste products from cells. Oxygen is required for metabolic reactions occurring in the cells to produce energy from nutrients. Body cells need energy for vast variety of activities in them. Some of these are :-

1. Synthesis of proteins from amino acids.
2. Production of enzymes
3. Contraction of muscles for movement
4. Conduction of electrical impulse in a nerve cell.
5. Production of new cells by cell division
6. Keeping body warm

Respiration process has two steps :

1. Take oxygen from atmosphere and supply to tissues.
2. Eliminate carbon dioxide and other waste products from tissues.

To take oxygen and discharge carbon dioxide is principal attribute of all living beings. As soon as baday is born he breathes air from atmosphere. Breathing rate is high for infants and slowly it decreases as child grows.

In case of single cell being, respiration process is direct. In case of multi cells beings, there is no direct contract of atmosphere with cells but oxygen is carried to cells by the respiratory system.

3.1 Types of Respiration

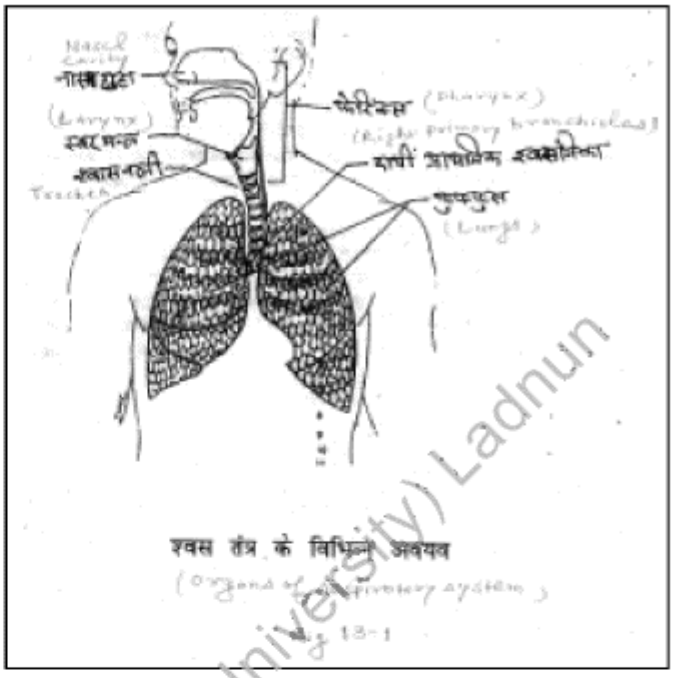
Respiration process consists of two sub gas exchange processes i.e. one at the lungs where air is sucked from atmosphere to lungs and oxygen is picked by the blood and carbon dioxide is given by blood to the lungs to give away to atmosphere. This is called external respiration or lung respiration as it happens at the lungs level. Second gas exchange is at tissue level where blood gives away oxygen to the tissues and pick up carbon dioxide and water vapour from the tissue. This is called internal respiration or tissue respiration.

3.1.1 External Respiration (Lungs Respiration)

This process takes place in lungs Air from atmosphere enters lungs; on the outer wall of air sacs are blood capillaries through which blood circulates. Gas exchange takes place at walls of air sacs which are very thin, air from lungs diffuses to the blood in capillaries and carbon dioxide from the blood diffuses to lungs. Following activities happen in external respiration :

i. Ventilation : This means breathing. In this activity dirty air is thrownout of the lungs and fresh air is taken into the lungs.
ii. Flow of blood to the lungs for purification.
iii. Distribution of air and blood in all parts of the lungs uniformly
iv. Exchange of gases by diffusion between air sacs & blood cells.

3.1.2 Internal Respiration or Tissue Respiration



श्वसन तंत्र के विभिन्न अवयव
(Organs of respiratory system)
Fig. 13-1

In respiratory system gas exchange takes place at another place also. Blood cells while flowing through capillaries in contact with lungs take oxygen from the lungs and transport it to all the tissues of the body. In tissues oxygen is given up by blood cells to the cells of tissues. This exchange takes place at walls of blood capillaries and membranes of tissue cells which are very thin. This process of gas exchange is called internal respiration or tissue respiration as tissue is the site of gas exchange.

In internal respiration, homoglobin in the blood absorbs oxygen and it becomes oxy homoglobin. Blood circulation system takes oxy homoglobin to all the tissues. Blood flows through capillaries which terminate into tissue are very narrow having thin wall. Hence blood flow rate through capillaries is slow and here oxyhomoglobin gives up oxygen to the cells of the tissue and picks up the waste product of chemical reaction between oxygen and glucose or fat. Though these two parts of respiration appear different but they are inseparable.

In summary, air is taken through nostrils then passes through throat, voice box, (Larynx), air pipe (trachea), and then branches to small air tubes (brochilex) and ultimately terminate in air sacs (alveolis) in the lungs. Here blood flowing through the blood capillaries which are in contact with outer surface of alveolis, gives carbon dioxide to alveolis and takes oxygen from the air in alveolis. Thus impure blood coming from the heart gives carbon dioxide away and becomes pure by taking oxygen and its colour changes to red, this pure blood returns back to heart where from it is pumped to all the tissues in the body. In a healthy adult this breathing process continues 16-24 times per minute. One can breath through mouth also but one should avoid this as there are hairs in the nostril which acts as filter to remove dust particles and bacterias from the air taken in.

In infacts, breathing rate is high as compared to adults. Breathing rate decreases as one becomes older. Breathing rate also depends on the mental state of the person. For example breathing rate increases during anger, anxiety and fear. Breathing rate will go up when one is running. During sleep breathing rate slows down.

Respiration takes place mainly through the lungs but some amount of respiration happens through the large number of small pores in the skin.

One of main functions of respiration is to purify the blood i.e. eliminate waste product carbon dioxide and take oxygen as can be seen from the composition of air taken during inhalation and air thrownout during exhalation.

Component	Inspired air	Expired air
Oxygen	20.96%	16.4%
Carbon Dioxide	0.04%	4.0%
Nitrogen	79.0%	79.0%
Water vapour	Low	High

4. ORGANS OF RESPIRATORY SYSTEM

Following are the main organs of the respiratory system through which air pass.

1. Nasal cavities
2. Pharynx
3. Larynx
4. Trachea
5. Bronchi
6. Bronchioles
7. Alveoli or air sacs

4.1 Nose Nasal Cavities

The nose can be divided into external and internal portions. The external nose consists of a supporting framework of bone and hyaline cartilage covered with muscle and skin and lined by a mucus membrane. The frontal bone, nasal bones and maxillae form the bony framework of the external nose. The cartilaginous frame work of the external nose consists of the septal cartilage, which form the anterior portion of nasal spectrum, the nasal lateral cartilages interior to nasal bones, and alar cartilages, which form a portion of the walls of the nostrils. Because it consists of pliable hyaline cartrlage, the cartilageious frame work of external nose is somewhat flexible. On the under surface of external nose are two openings called nares or nostrils. Small hairs inside the anterior nares act as a coarse filter for dust in the inspired air.

Nasal cavaties are separated into right and left portions by the nasal septum (formed by above by the perpendicular plate of the ethmoid, behind bythomer and in front by the cartilage of the spectum), Each cavity is lined by muscus membrane covered with ciliated columnar epithelium and is plentifully supplied with blood. The surface area of the nasal mucus membrane is increased by the presence of three (upper, middle and lower) tubonate bones (conchae) which project medially from the lateral wall of each cavity. The importance of this increased surface area is that air entering the respiratory tract may be warmed and moistened before reaching lungs. The floor of the nasal cavities is formed by the upper surface of the hard plate, and the rocf by portions of frontal, ethmoid and epheniod bones. The maxilla forms the main part of the lateral wall.

The ulfactory receiptors lie in a region of the membrane lining the superior nasal conchae and adjacent called olfactory epithelium. Inferior to the olfactory epithyelium, the mucus membrane contains capillaries and pseudostratified ciliated columnar epithelium with many goblet cells. As in hailed air whirls around the conchae and meatuses, it is warmed by the blood in the capillaries. Mucus secreted by the goblet cells moistens the air and traps dust particles. Drainage from the nasolacrimal ducts also helps moisten the air, and is sometimes assisted by secretions from paranasal sinuses. The cilia move the mucus and trapped dust particular toward the pharynx, at which point they can be swallowed or spit out, thus removing the particles from the respiratory tract.

The posterior nares are situated at the back of nasal cavities and constitute the entrances to the nasopharynx.

In addition to the anterior and posterior nares each nasal cavity has opening connecting with

a) The maxillary antrium

b) The frontal, ethornoidal and sphenoidal air sinuses

c) The nacolactrimal duct which conveys the tears from the conjunctival sac to the nose.

4.2 The Pharynx

The pharynx has three parts which, from above downwards, are :

- the nasopharynx; which lies behind the nose.
- the oropharynx' which lies behind the mouth.
- the laryngopharynx which lies behind larynx.

The nasopharynx lies at the base of the skull immediately behind nasal cavities, which open into it via posterior nares. On its lateral walls are the openings for auditory (eusta chian) tubes which are connected to the middle ear and air to carried to the middle ear through these tubes. On the posterior wall, there are patches of lymphoid tissue called the pharyngeal tonsils commonly referred to as adenoids. This tissue sometimes enlarges and blocks the pharynx, causing mouth breathing in children. The nasopharynx is lined with ciliated mucus membrane which is continuous with the lining of the nose.

The oropharynx is continous in front with the buccal cavity (mouth) and below with laryngo pharynx. The tonssil lie in its lateral walls. The laryngopharynx is continuous with the oesophagus (food pipe).

It can be seen from above that pharynx has connection to five organs :- ear, mouth, nose, stomach and lungs. There is perfect co-ordination in the sense when food is swallowed or drink is taken, connection to air pipe (lungs) is blocked and when breathing takes place, connection to food pipe (stomach) is blocked.

4.3 The Larynx : It is situated in the mid – line of the neck between the pharynx above and trachea below. It is placed in front of the oesophagus and corresponds with the levels of the fourth, fifth and sixth cervical vertebrae. Besides acting as part of the air passages, larynx also performs the function of sound production and due to this reason it is also called voice box.

Structure of Larynx : The larynx consists of a framework of the following hyaline cartilages :

(a) **The thyroid cartilage**, which is the largest and consists of two side wings united in the midline in front to form an angular projection, sometimes called the Adam's apple.

(b) **The cricoid cartilage,** forms the thyroid cartilage, forms the lowest part of the larynx which it connects to the trachea. It is circular in shape.

(c) **The arytenoid cartilages,** are two small structures situated on the upper surface of cricoid cartilage.

They are shaped like pyramids and give attachment to the posterior end of the true vocal cords. In front the vocal cords are attached to the posterior surface of thyroid cartilage. The tension of the cords is varied by muscles which rotate the artynoid cartilages and, in this way, the pitch of the voice is altered.

(d) **The Epiglottis**. This is a leaf shaped plate of yellow elastic fibro cartilage situated in an upright position between the base of the tongue and upper opening of larynx. The main function of the epiglottis is to prevent food from entering the larynx during the act of swallowing.

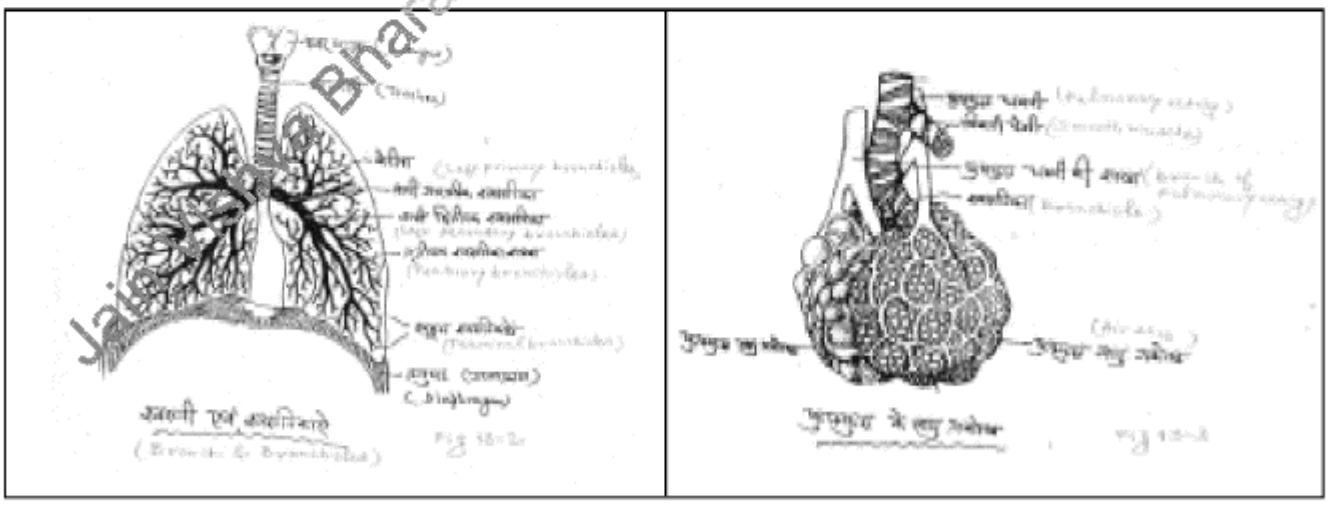
(e) **The hyoid** is a horse shine shaped born lying between the mandible above and the larynx below. It is situated at the base of the tongue and gives attachments to this and various other muscles.

(f) The true **vocal cords** are fibro-elastic bonds extending from the posterior aspect of the thyroid cartilage in front to the arytenoids cartilages behind. The false vocal cords are two loose folds of mucous membrane situated above the true cords which do not appear to play any special part in voice production.

The larynx is lined by mucous membrane which, except for vocal cords, is covered with ciliated columnar epithelium.

4.4 The Trachea : The trachea or wind pipe is 12 cms long and about 2..5 cms in diameter. Its upper half is situated in the mid-line of the neck, its lower in the superior media stinum of thorax. It lies in front of oesophagus and ends opposite the fourth thorasic (dorsal) vertebra where it divides into the two main bronchi.

The trachea consists of a number of C- shaped rings of cartilage connected by fibrous tissue and having the opening of C posteriorly. The function of the rings is to keep wind pipe permanently open (distended, swollen) so that its wall do not collapse. It is also lined with ciliated columnar epithelium cells which secrete mucus.



4.5 The Bronchi : Close to the lungs opposite the level of the fourth & fifth thoracic vertebra, trachea divides into two tubes, called the bronchi (singular : bronchus), which enter the respective lungs. From each main bronchus numerous small bronchi are given off, like the branches of a tree.

The structure of the bronchi is similar to that of the trachea, consisting of incomplete hopes of hyaline cartilage lines with mucus membrane covered with ciliated columnar epithelium. In addition, they have some smooth involuntary muscles in their walls.

Right bronchus is smaller and wider as compared to the left one because the heart lies a little left to the midline.

4.6 The Bronchioles : are subsequent still finer tubes of bronchi. They have no cartilage but are composed of muscular, fibrous and elastic tissue, lined with cuboid epithelium. As the bronchioles become smaller, the muscular and fibrous tissue disappears and the smallest tubes called terminal bronchioles , are a single layer of flatted epithelium cells. Spasm of muscle fibres in the walls of the bronchi and bronchiolex occurs in asthema. The contraction of these muscles causes narrowing of bronchial tubes and obstruction to the passage of air through them. This spasm is relaxed by adrenalin during stress (fear, anger etc.)

4.7 Alveoli or Airsacs : Each bronchiole terminates in an irregular sac made up of a number of air pockets. These pockets are lined with a delicate layer of flattened epithelian cells and are surrounded by numerous capillaries, through the walls of which the interchange of gases take place. The deoxygenated blood in the capillaries is conveyed to the lungs by pulmonary artery and from the lungs oxygenated blood to the left atrium by pulmonary veins.

The walls of blood capillaries and the walls of air sacs are very thin and capillaries are in contact of air sacs. Thin walls perfect contact facilates gas exchange i.e. carbon dioxide going from blood to air sacs and oxygen coming to the blood from the air sacs. This gas exchange takes place due to the diffusion property of gases.

5.0 LUNGS

The lungs are pair of conical shopped organs, each enveloped in a serous membrane, the fleura. They occupy the greater part of the thoracic cavity. The lungs are separated from each other by the mediastenum which contain the heart and great vessels, the oesophagu and in its upper part, the trachea. Each lung is divided by deep fissures into lobes. The right lung has three lobes, upper, middle and lower, and the left has two, upper and lower. The lung is described as having mediastinal and a coastal surface, an apex and a base.

The outer or coastel surface is in contact with the wall of the pleural cavity which consists of the ribs and intercoastal muscles and is lined by pleura. Pleura consists of two layers. The two layers are smooth and moistened of a small amount of serous fluid which acts as lubricant so that two surfaces canglide smoothly over each other during the act of breathing.

The medial surface of the lung is applied to the mediastenum. Its chief feature is the presence of hilum where the main bronchus and pulmonary artery enter and pulmonary veins leave the lung. Also at the hilum are lymph nodes which may be enlarged by disease, for example tuberculosis or cancer.

The apex rises into the root of the neck for about one inch (2.5 cms) above clavicle. The base is concave is related to the upper surface of the diaphragm.

On examination the lung feels spongy and, if a portion is dropped into water, it will float because of the air it contains. For an healthy adult, right long weighs 620 gramms and left lung weighs 570 gramms. These weights may vary slightly from person to person. In general lungs of man weigh more than that of woman.

6.0 RESPIRATORY PROCESS

The renewal of the air in the lungs is secured by the respiratory movements of inspiration (breathing in) and expiration (breathing out). The thorax may be regarded as completely closed box (air tight compartment) which alters its size and shape with each ventilation, with inspiration. The cavity of thorax is enlarged and the lungs being elastic expand to fill up the increased space. This expansion of lungs causes air pressure inside lungs to fall which result in sucking of air into air sacs (alveolis) through upper air passages and trachea.

With expiration, the thorax returns to its former size and so the lungs. This results in increase of pressure inside the lungs expelling air from air sacs. The increase in the size of the thoracic cavity during inspiration is brought about by two factors : 1. Upward movement of the ribs, 2. Downward movement of the diaphragm.

When at rest of diaphragm is dome shaped, having its concavity towards the abdomen. When the muscle of the diaphragm contracts during inspiration, it becomes flattened and, therefore, depressed towards abdomen. This results in increase in volume of the thoracic cavity. During quiet expiration the chest return to its resting size mainly on account of elasticity of inter coastal muscles and diaphragm.

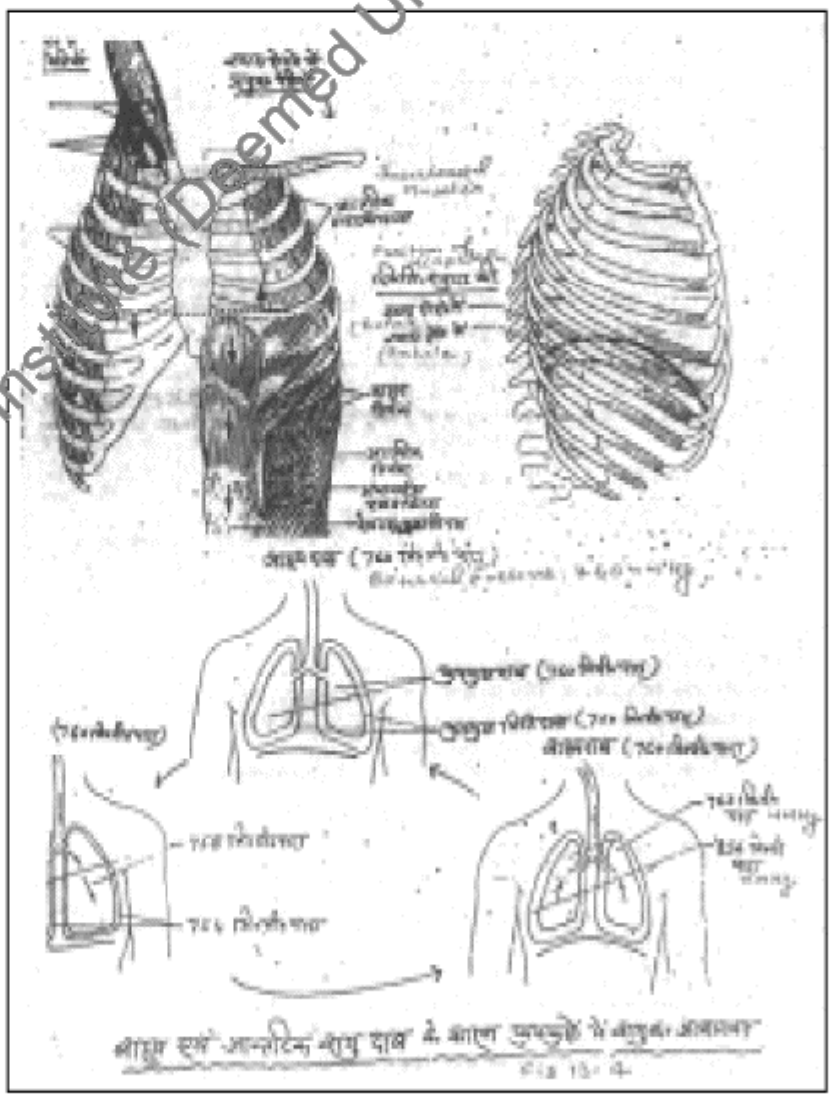
Lung Capacity

Capacity of lungs or the respiratory volumes are as follows :-

1. Total lung capacity - maximum air which can at any time be held in two lungs = 6 litres.
2. Residual volume : some air is always left in the lungs even after forcibly breathing out = 1.5. litre
3. Tidal volume : Air breathed in and out in a normal quiet (unforced) breathing = 0.5 litre
4. Inspiratory reserve volume – Air that can be drawn in forcibly over and above the tidal air = 3 litre
5. Expiratory reserve volume – Air that can be forcibly expelled out after an ordinary expiration = 1 litre
6. Vital Capacity : The volume of air that can be taken in and expelled out by maximum inspiration and expiration = 4.5 litre

7.0 FUNCTIONS OF RESPIRATORY SYSTEM

1. Gas Exchange
2. Excretion
3. Absorption
4. Acid – Alkali Balance
5. Water Balance
6. Temperature Control
7. Effect on Blood Circulation
8. Effect on Lymph Circulation
9. Secretion
10. Coughing & Sneezing
11. Voice Production
12. Smell



7.1 Gas Exchange :- Oxygen from the lungs go to blood which it carries to the tissues in whole body. Carbon dioxide produced in the tissue is picked by the blood and taken to the lungs where from it is expelled out.

7.2 Excretion :- Vapours of ammonia, ketone-bodies, alcohol and water produced in tissue are excreted to atmosphere through respiratory system.

7.3 Absorption :- Some medicines in the form of vapour are absorbed by the blood through respiratory system.

7.4 Acid Alkali Balance :- There are chemoreceptors in the nervous system which control the amount of carbon dioxide

in the blood. By controlling carbon dioxide acid - alkali balance (or pH of the blood) is maintained.

7.5 Water Balance :- Water balance in the body is maintained by elimination of water vapour in the air exhaled.

7.6 Temperature Balance :- About 20% of heat produced in tissues is used in heating up exhaled air and by regulating this quantity, respiratory system helps to maintain body temperature constant.

7.7 Effect on Blood Circulation :- If breathing rate suddenly increases in response to command from respiratory control, blood pressure also increases. Thus respiratory system has effect on blood circulation system.

7.8 Effect on Lymph Circulation :- Respiratory system indirectly affects lymphatic system also.

7.9 Secretion :- Upper air passages of respiratory system secrete mucus which catches all foreign particles and these are throwout by the action of cilia.

7.10 Coughing & Sneezing :- These are protective reflex actions of respiratory system to throw away foreign particles.

7.11 Voice Production :- Voice production takes place in larynx, organ of the respiratory system.

7.12 Smell :- olfactory cells are located in the mucous membrane of the upper part of the nose.

8.0 EFFECT OF PREKSHA MEDITATION ON EFFICIENCY OF RESPIRATION

There are two exercises of perception of breathing.

- Perception of slow and deep breathing (Deergha Shwas Preksha)
- Perception of alternate breathing (Samvrati Shwas Preksha)

In perception of slow and deep breathing one takes slow and deep breath and holds for convenient duration and then breath slowly completely and keeps his mind concentrated on watching the breathing process i.e. abdomen expands (as diaphragm moves down) while breathing in and abdomen contracts (diaphragm comes up) while breathing out. This process helps in improving efficiency as follows:-

(i) By breathing slowly and deeply one takes upto 4.5 litre of air (vital capacity of lung) in one cycle against 0.5 litre of air (tidal volume) in normal breathing (quiet inspiration and expiration). Thus one gets more air by once use of muscles of respiratory system. So energy consumed by muscles per litre of air taken is much less.

(ii) By making breathing process and also holding for some time, more time is available for exchange of gases. More oxygen is absorbed by the blood and hence more energy production in tissues.

(iii) As more time is available for gas exchange, carbon dioxide transfers from the blood to the lungs completely and from there it is expelled to atmosphere completely by contracting abdomen (taking diaphragm up) (forced expiration). Since carbon dioxide is toxic gas, its complete excretion from the body helps to improve health.

Perception of Alternate Breathing

In this exercise, one breathes slowly and deeply through right nostril, holds for convenient time and then exhale slowly and completely through left nostril.

In addition to the advantages of slow and deep breathing mentioned above one gets following additional benefits of alternate breathing;

1. Breathing through right nostril affects left hemisphere of the brain and breathing through left nostril affects right hemisphere of the brain. Thus alternate breathing maintains balance between the activities of two hemispheres. In other words balance between activities of parasympathetic and sympathetic nervous system is maintained which helps to avoid unnecessary wastage of energy on stimulation of anger, reaction, etc.

2. In alternating breathing, all muscles of respiratory system gets used equally and hence all muscles are kept healthy which results in better efficiency of respiratory system.

In addition to above, two others benefits are obtained by above exercises which result in better efficiency or optimal use of energy.

- By consciously practicing slow and deep breathing for long time has effect on brain (particularly respiratory centre in the medulla oblongata) and normal breathing rate also slows down resulting in improvement of respiration efficiency. Also anger and anxiety get reduced as a result of slow breathing rate, this helps in reducing energy loss.

- Concentration improves which results in better efficiency.

9.0 EXCERSIES

Description Questions

1. Describe basic structure of respiratory system.
2. Explain effect of Preksha Meditation on respiration and its efficiency.

Reply in Brief

1. Explain difference between internal respiration and external respiration.
2. Explain what is respiration process.
3. Describe functions of lungs.
4. Clarify difference between bronchi and bronchioles.

Objective Questions

1. Parts of respiratory system. :
   (a) One (b) Two
   (c) Three (d) Five
   (e) Seven
2. What is name of the part after larynx in air pathway ? :
   (a) Pharynx (b) Bronchiole
   (c) Trachea (d) Bronchi
3. Where does trachea get bifurcated ? :
   (a) After second vertebrae (b) Near lungs
   (c) Near fourth and fifth vertebrae (d) Near Fifth vertebrae
4. What is the colour of lungs ? :
   (a) Red (b) Yellow
   (c) light pink (d) blue.

LESSION – 14

DIGESTION SYSTEM – STRUCTURE, FUNCTION, PROCESS & EFFECT OF PREKSHA MEDITATION ON THE PROCESS

OUTLINE OF THE LESSON

1.0 OBJECTIVE

After studying this lesson you will understand.

1. Nutrition & Digestion
2. Organs of Digestion System
3. Various Enzymes
4. Digestion Process
5. Functions of Liver & Pancreas
6. Effect of Preksha Meditation on Digestion Process.

2.0 INTRODUCTION

Number of activities keep happening inside the body. As a result of these activities there is always wear and tear of the parts of the body like any other machinery which keeps working. We get various nutrients from the food to repair these parts (tissues) and also for their growth (in children). Also food is the only source of chemical energy our body needs to do all these activities. Molecules of the food stuff we eat are too large to pass through the membranes of living cell. Hence they need to be broken into smaller molecules and the process by which it is done is called digestion.

3.0 OVERVIEW OF THE NUTRITION & DIGESTION

We need various nutrients for growth and repair of tissue and producing energy. These nutrients are carbohydrates, proteins, mineral salts, vitamins, water and indigestible fibre. Details of these nutrients are described in Chapter 16. We take these nutrients through food. These nutrients as present in the food cannot be absorbed by the blood which distributes them to all the tissues because of one of the two or both the reasons mentioned below:-

- Not soluble in water
- Size of the molecules is too large to pass through cell membrane.

In digestion both mechanical and chemical processes takes place. In mechanical process, foods is broken into smaller parts and made in the form of slurry which can be easily swallowed and moved through alimentary canal. In chemical process food molecules are broken into smaller molecules by the reaction of various enzymes secreted by the glands all along the walls of alimentary canal. These enzymes are specific i.e. particular enzyme acts on specific food element e.g. pepcin acts on protein and byline acts on starch and sugars. Limit of absorbed or used nutrients is calories (Joules). An average adult consumes 3000 kilo calories (12,500 kilo joules) for 24 hours. If body absorbs more than this quantity, unconsumed amount is stored in the body and so body weight increases. If we eat less and consumption is more, additional requirement is drawn from the storage and body weight decreases.

4. ORGANS OF ALIMENTARY CANAL

Digestive system consists of two parts : - Alimentary canal - Accessory organs

Alimentary canal has tubular construction, it starts from mouth and end at anus. It is about 10 metres long. Its width various at different places. It has different parts (organs) along the length and these parts have different functions. These organs are mouth, pharynx, esophagus, stomach, duodenum, small intestine and large intestine. Walls of every organ of alimentary canal has glands which secrete different enzymes which react with food stuff and convert food into simpler molecules. These simpler molecules get absorbed in the blood in small intestines and large intestines. Food stuff which is not digested and not absorbed is excreted through anus.

Accessory organs are liver, pancreas etc. They do not come in direct path of movement of food. They secrete digestive juices (enzymes) which get into alimentary canal to help digestion.

4.1.1 MOUTH -

Mouth has following digestive organs. 1) Mouth cavity, 2) Teeth, 3) Tongue, 4) Saliva glands

4.1.1 Mouth Cavity : The mouth cavity is bounded externally by the lips and cheek and leading into the pharynx. The roof is formed by the hard and soft palates and the anterior two thirds of the tongue fill the floor of the mouth. The walls are formed by muscles of the cheeks. The mucous membrane which lines the mouth is continuous with skin of the lips and with the mucous lining of the pharynx. The hard palate is formed by parts of the palatine bones and maxillae; its upper surface forms the floor of the nasal cavity. The soft palate is suspended from the posterior border of hard palate and extend down between the oral and nasal parts of pharynx. Its lower border hungs like a curtain between the mouth and pharynx and a small conical process, called the ureula, hungs down from it. Two curved folds of mucous membrane extend sideways and downwards from each side of the base of ureula, called the palato-glossel and palato-pharyngeal arches, between which lie the masses of lymphoid tissue known as the palatine tonsils.

4.1.2 Teeth : Mouth cavity has total 32 teeth, 16 on upper part and 16 on lower part.

Each tooth consists of three parts

- Crown – Projecting beyond the gum
- Root – embeded in the alveolus of the maxilla or mandible (a tooth may have one, two or three roots).
- Neck – The constricted part between the crown and the root.

In the centre of all these parts is pulp and immediately outside the pulp is a yellowish white layer, called dentine, which form the main part of the tooth. The outer layer of the tooth is in 2 parts, that carrying the crown is called enamel and is a hard white layer while that carrying the root is called cement and is a thin layer resembling bone in structure. Sequence of teeth in both lines is as follows :-

1. Incisor – These teeth have Chisel – shaped crown giving a sharp cutting edge for biting the food.
2. Next to incisor one on both side is canine (total 4 Nos.). These teeth have large conical crowns.
3. Premolar – 2 Nos. on each side. These teeth have almost circular crowns with two cusps for grinding the food.

4. Next to premolar, are three molar on each side (Total 12 Nos.). Molar are the largest, and they have broad crowns with four or five cusps.

The function of teeth is to cut and chew the food to make it suitable for absorption.

The development and maintenance of strong healthy teeth depends on adequate supply of calcium, phosphates, and vitamin A& D in the diet. If a pregnant woman's diet is deficient in these constituents her own body stores will be depleted to supply the fetus. For this purpose emphasis is placed on dental care during pregnancy.

4.1.3 Tongue

Functions of the tongue are :-

1. It is the organ of taste
2. It assists in the mortification of food
3. It assists is swallowing.
4. It assists with speech

The tongue is a muscular organ which is attached to the hyoid bone and the mandible. It is curved in certain areas with modifications of the mucous membrane which appears as projections to increase the surface area and are called papillae. In addition specialized cells called taste buds are wide spread over almost the entire area of the tongue. Sensation of taste is because of these buds. Sensation from the taste buds is transmitted through the nerves to the brain. Top of the tongue has last buds for sweet, side has taste buds for sour and taste buds for bitter taste are at the back side of the tongue. Taste buds for salt are spread all over the tongue.

4.1.4 Salivary Glands

There are three pairs of salivary glands on each side. The parotid gland is the largest and lies just below the ear; its duct is about 5 cms long and opens into mouth opposite the second upper molar tooth. It is this gland which is affected by the disease commonly known as mumps. The submandibular gland and sublingual gland both open into the floor of the mouth.

Saliva is mixed secretion of the three pairs of salivary glands. It is a fluid consisting of 99.2% water and 0.8% other fluids. Saliva contains, the enzyme ptyalin (salivary amylase) which begins the digestion of carbohydrate. It also contains mucin, a thick lubricant, and a small amount of sodium, potassium and calcium salts.

Function of Saliva

1. Saliva constantly moistens the mouth and tongue.
2. It moistens and lubricates food so that it can be rolled into a soft mass, or bolus, suitable for swallowing.
3. Ptylin (salivary amylase) begins to act on cooked starches and converts them to dextrin's and maltose.
4. Saliva dissolves part of the food which stimulates taste buds.
5. It has cleaning action and helps to keep the mouth and teeth free of debris.

Secretion of Saliva

The secretion of saliva is under the control of the superior and inferior salivary nuclei in the brain stem. The salivary glands are supplied with both para sympathetic and sympathetic nerves. Parasympathetic nerves stimulate the flow of saliva, while sympathetic nerves inhibit the production.

The sight, smell or thought of food stimulates an initial increase in secretion of saliva. When food is put in the mouth, there is further increase in secretion of saliva.

Inhibition of the secretion of saliva is caused by activity of sympathetic nerves as in fear and excitement, leading to dryness of the mouth.

4.2 The Pharynx

The pharynx or throat, is an expanded muscular tube lying behind the nose and mouth. It is about 13 cms (5 inches) long and extends from the base of the skull to the level of the cricoids cartilage, where it becomes continuous with the oesophagus. It lies just in front of the cervical veribrae.

The pharynx is anatomically divided into three parts : 1. The nacopharynx, 2. The oropharynx, 3. The laryngopharynx.

The nasopharynx lies immediately behind the nasal cavities and extends to the level of the soft palate.

The oropharynx is situated behind the mouth extending from the soft palate above to the hyoid bone below.

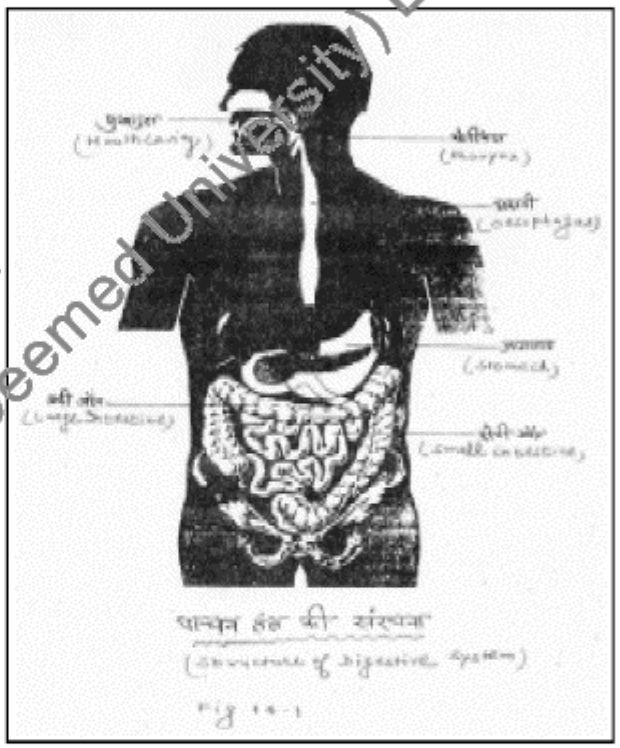
The laryngopharynx is narrower than the other parts and lies behind the larynx. Above it is continuous with the oropharynx and below it merges into the oesophagus.

The nasopharynx is not a functional part of the alimentary tract, but belongs to the respiratory system. The oropharynx is shared entrance for the respiratory and alimentary tracts, since air must pass through it to reach the larynx and food to reach the oesphagus.

The walls of the pharynx are composed of muscles arranged in thin over lapping sheets (layers), these form constrictor muscles which contract in the act of swallowing. There is middle layer of fibrous connective tissue and a lining of mucous membrane similar to that of the mouth.

4.3 The Oesophagus

The oesophagus is a muscular tube about 25 cm long, extending from the pharynx to the stomach. It begins at the level of the sixth cervical vertebra and descends through the mediastinum in front of the vertebral column and behind the trachea. It passes through the diaphragm at the level of the tenth thoracic vertebra and ends at the cardiac orifice of stomach at the level of eleventh thoracic vertebra.



The oesophagus has four layers and is similar in structure to the remainder of alimentary tract :

1. Fibrous outer layer – consists of areolar tissue containing many elastic fibres.
2. Muscular layer – has two layers, the outer fibres running longitudinally and the inner layer consisting of circular fibres.
3. Areolar or sub-mucous layer – connects the mucous and muscular coats and entrances. The larger blood vessels and nerves, as well as the mucous glands.
4. Inner lining of mucous membrane secrets mucous.

The muscular coat of the upper two – thirds of oesophagus is of stripped voluntary muscle, the lower one third contains unstriped involuntary muscle,. The oesophagus is innervated by the vagus nerve. Movement of food through the oesophagus is by peristaltic action. Peristaltic action is a form of muscular action and occurs through the whole of alimentary tract for the purpose of passing the food.

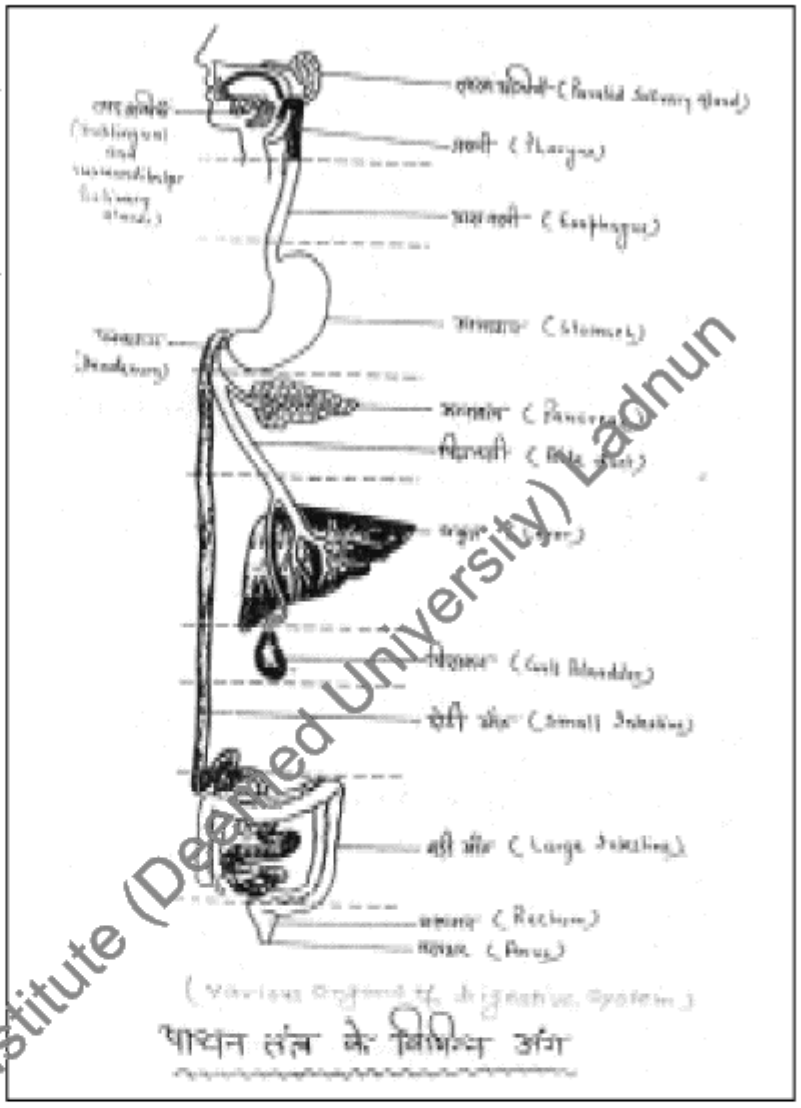
The circular muscle of the tube immediately behind the bolus contracts, whilst that directly in front relaxes. This results in the bolus being forced into relaxed portion. The contraction of muscle follows closely behind the bolus and further relaxation occurs in front of it, thus the bolus is passed steadily forward.

4.4 The Abdomen

Abdomen is the largest cavity in the body. It is separated from the chest cavity by the diaphragm muscle, at its bottom is pelvis. It has following digestive organs located in it.

1. Stomach
2. Small intestine
3. Large intestine
4. Liver
5. Gall Bladder
6. Spleen
7. Pancreas

All these organs are enclosed in a thin membrane which is called peritoneum.



4.4.1 The Stomach : It is main organ of digestive system. It is a part after oesophagus in alimentary tract. It is below diaphragm and heart. It is slightly towards left from midline. It is muscular, distensible organ and its shape and size vary according to the amount and type of its contents and the pressure exerted on it by surrounding organs.

The stomach has two openings, cardiac orifice at the upper end where oesophagus get connected to stomach and pyloric orifice (valve) at lower and which connects stomach to duodenum (the first part of small intestine). Pyloric orifice acts as check valve i.e. allows contents to pass in one direction.

To the left of cardiac orifice domeshaped upper part of the stomach is called the 'fundus'. The main part of the stomach is called the body and this is narrow at its lower end to become pyloric antrum.

The walls of the stomach consists of four layers of tissue.

1. An outer covering of serous membrane (the peritoneum)
2. A muscle layer, which actually consists of three layers of visceral muscle fibres.
   a. Longitudinal muscle fibres are the most superficial and are continuous with the longitudinal fibres of the oesophagus.
   b. Circular muscle fibres form the middle layer. They are continuous with those of the oesophagus, and are thickness ed around pylorus forming the pyloric spincter.
   c. Oblique fibres, the inner most layer, are found mainly in the body of the stomach.
3. A submucous layer consisting of loose areolar tissue carrying blood vessels, lymphaties and nerves.
4. Lining of mucous membrane which is thick and has a smooth, soft velvety surface when the stomach is distended. When the stomach is empty it is thrown into numerous irregular fold or rogue.

The mucous membrane contains microscopic depressions, these are gastric pits and they are particularly numerous in the fundus and body of the stomach. Embedded in the gastric pits are glands which secrete gastric juice.

The glands around cardiac orifice mainly secrete mucous, whilst those in fundus and body secrete digestive enzymes and hydrochloric acid. The glands in pyloric antrum secrete mainly mucous and a protein compound called intrinsic factor. Stomach is about 26 cms long and 10 cms in width.

The gastric glands in stomach contains three types of exocrine gland cells that secrete their product into stomach, mucous cells, chief cells and parietal cells. Mucous cells secrete, mucous, parietal cell produce intrinsic factor (needed for absorption of Vitamin B12) and hydrochloric acid. The chief cells secrete pepsinogen and gastric lipase. The secretion from mucous, parietal and chief cells form gastric juice, which totals about 2 – 3 litres per day.

Constituents of gastric juice :-

1. Water, mineral salts and mucous.
2. HIydrochloric acid (4% concentration)
3. Pepsinogen, which is converted by hydrochloric acid into the active enzyme, pepsin. Pepsin turn proteins into peptides.
4. Renin, which coagulates milk protein into casein, in which form it can be acted upon by pepsin. This is active in babies.

The hydrochloric acid in gastric juice serves several purposes.

- It gives the acid reaction required by the gastric enzymes.
- It kills bacteria
- It controls the pylorous
- It stops the action of ptyalin
- It converts pepsinogin to pepsin.

4.4.2 Small Intestine : The small intestine is a convoluted tube, extending from right end of stomach i.e. the pylorus of the stomach to the ileo – caecal valve, where it joins the large intestine. In active or living condition it is about 6.5 metres long and 2.5 cms wide but after death it is only about 2 metres 44 cms long because during this condition muscles loose their tension. It is situated in central lower part of the abdomen. It consists of three parts : 1. Duodenum, 2. Jejunum, 3. Ileum.

4.4.2.1 Duodenum : The duodenum is the first part of the small intestine. It is approximately 25 cms long, ad lies in a C-shape around the head of pancreas. About half way along the concave surface of the duodenum the bile duct and the pancreatic duct enter the duodenal lumen together at a small papilla called the ampulla. Duodenum is important part of the digestive system. When food is digested well in stomach and converted into a solution called chime, this solution is acidic. When this process of preparing solution (which takes about 2 to 3 hours) is over, pyloric valve opens and allows food to pass to the duodenum. To neutralise most of the acid, alkaline juices from the gall bladder and pancreas pour into duodenum. As duodenum does not have protective lining against acid as stomach have, opening pyloric valve automatically adjusts itself to allow flow of chime which gets neutralized. Alkaline juices of gall bladder and pancreas contain three enzymes which separate the proteins, fats, and carbohydrates into basic building blocks.

4.4.2.2 & 4.4.2.3 Jejunam & Ileum : The Jejunum is upper two third of the remainder of small intestine and the lower three fifth is called ileum. Although two names are given but there is no clear demarcation between jejunum and ileum. They lay coiled in the central lower abdominal cavity.

The small intestine, like the stomach, has four layers of tissue.

1. an outer serous layer (peritoneum)
2. a muscular coat consisting of longitudinal and circular muscle fibres (but no oblique fibres)
3. a sub mucous layer
4. an inner layer of mucous membrane.

In small intestine the mucous membrane is arranged in permanent folds. Their effect is to greatly increase the surface area for secretion and absorption. Surface of mucous membrane is covered with minute finger like processes called villi, which give the surface a soft velvety appearance.

The villi are highly vascular and each villus contains a network of blood capillaries and a central lacteal (an intestinal lymphatic vessel), supported by loose connective tissue and some smooth muscle fibres. The surface of the villi are covered by a single layer of epithelial cells, which have a brush border forming thousands of microvilli. The micro villi further increase the total absorptive area of the small intestine.

Between the villi lie simple tubular glands which secrete alkaline intestinal juice. At the base of these glands lie cells of paneth which secrete digestive enzymes into intestinal juice.

The small intestine also secrets mucous from its entire surface as a protective lubricant, but this is an essentially important function in the duodenum because of extreme acidity of the chyme from the stomach. In the first few centimeters of duodenum are large mucous glands called Brunner's glands, which protect duodenul mucosa from the powerful effects of hydrochloric acid and pepsin until the acidity of chime has been neutralized by pancreatic juice which is alkaline.

Intestinal juice

Intestinal juice has many constituents which convert food into basic building blocks which can be absorbed. These constituents are :-

1. Enterokinase	-	Converts trypsinogen secreted by pancreas to active trypsin.
2. Peptidase	-	Acts on peptones and turns them into Amino acids
3. Maltase	-	turns maltose into simple sugar, such as Glucose
4. Sucrase	-	Turns can sugar (Sucrose) into simple sugar
5. Lactase	-	Turns lactose into simple sugar
6. Lipase	-	Completes the conversion of fats to fatty acids and glycerol

These juices are mixed with food by peristalsis, the muscular action of the wall of the small intestine. The absorption of proteins, carbohydrates and fats takes place almost entirely through the villi in the small intestine.

4.5 The Large Intestine

Large intestine is the last processing station of digestive system. It starts from the end of small intestine and extend upto rectum. It is about 2 metres long and 7 cms in width. It forms an arch which encloses most of the small intestine and is divided into following three major parts : 1. The Caecum, 2. The Colon, 3. The Rectum.

4.5.1 The Caecum : It is junction of small intestine and large intestine. The Caecum lies in the right iliac fossa. It is a dilated area with a blind lower end but is continuous above with ascending colon and where one passes into the other, the ileum opens into the caecum through the ileo – caecal valve. The valve is a sphincter and prevents the caecal contents passing back into ileum.

The Vermiform appendix is a narrow blind ended tube which opens out of the caecum about 2 cms below the ileo – caesal valve. It is about 5 to 15 cms long. The sub-mucous coat of appendix contains considerable amount of lymphoid tissue. It has no known useful functions for human but is important for grass eating animals. Inflammation of the appendix (known as appendicitis) is a relatively common condition which may affect both children and adults. It is characterized by pain. The main danger is that appendix may perforate and liberate its infected contents into the peritoneal cavity, causing peritonitis.

4.5.2 The Colon : The colon is about 1.5 meter long and 6 cm wide. It starts from the upper end of the caecum and moves up (ascends) and it is called 'ascending colon'. It bends when it reaches the bottom of the liver and remain horizontal upto the spleen. This is known as transverse colon. It, then bends downwards and is called 'discending colon' descending colon widenly as it enters pelvic cavity and this portion is called pelvic colon or sigmoid colon. Further part takes the shape of simple tube.

4.5.3 The Rectum : The rectum is simple tube having lot of muscular tissues in its walls. It is about 13 cm long and narrows to form the anal canal. Anal Canal passes downwards and backwards to end at the anus. At the junction of the anus and the rectum the unstriped circular muscle becomes thickened to form the internal anal sphincter, which surrounds the upper three quarter of anal canal. The external sphincter surrounds the whole length of the anal canal and it is tone of these sphincters which keeps the anal canal and the anus closed. The external sphincter can be contracted voluntarily to close the anus more firmly (as in the case of 'moolbandh')

The structure of large intestine is similar to small intestine. Large intestine does not have villi (finger like process) and less number of folds compared to small intestine.

By the time food reaches large intestine, almost all the useful nutrients have already been digested and absorbed. What remain are indigestible stuff together with salts, bile pigments, and large valuable quantities of water (the

digestive juices are 95% water). The function of large intestine (bowel) is to extract salt and water (that can be usefully recycled), which is absorbed through mucous membrane lining, and the formation of the faeces from the indigestive food stuffs like cellulose and bacteria. Lower parts of large intestine contain many organisms which manufacture variety of useful substances including vitamin k and several vitamins of B group as well as smelly components responsible for the odour of faeces. It takes about 12 – 20 hours for the food to reach rectum.

Body has many tissues which keep on secreting fluids. These fluids are called secretions and these tissues are called glands. Human body has many such glands. Liver, pancreas and spleen are some of such glands whose secretions are important for digestive process.

5.0 LIVER

The Liver is the largest gland of the body. It lies in the upper part of the abdomen on the right side beneath (and loosely attached to) the diaphragm. About four to fibre ribs from below cover it from the front. Sometimes its lower end can be felt below the ribs. Liver weighs about 1.4 kilograms and is reddish brown in colour. Its shape from the front appears to be triangular. Normally when the liver swells, it swells in the downward side which can be felt by pressing fingers on the abdomen below the last ribs. It consists of two lobes – right lobe and left lobe. Right lobe is bigger than the left lobe.

5.1 Structure of the Liver : Internal structure of the liver is very complex. It consists of large number hepatic lobules which appear hexagonal in shape. Each is abou1 millimeter in diameter. These lobules are composed of liver cells, which are large cells with one or two nuclei and fine granular cytoplasm. A remarkable features of the liver is that it receives double supply of the blood

1. Fresh arterial blood from the hepatic artery arising from the aorta which is rich in oxygen.

2. From the portal vein carrying the finished products of the digestion from stomach and intestine. Both these blood vessels branch repeatedly forming the capillary network for the supply of blood to the liver cells. Thus liver is a highly vascular organ. Blood from the liver carrying nutrients reaches the vena cava through the hepatic vein. Thus nutrients processed by the liver reach the blood circulation through vena cava.

Liver secrets bile juice which is carried through bile duct to the gall bladder.

5.2 Functions of the Liver : The Liver is a big chemical factory, only after the nutrients are processed by the liver become usable by the tissues. In addition to secretion of bile, liver plays a vital role in body metabolism. Its important functions are :-

1. Secretion of bile
2. Formation of urea
3. Detoxification
4. Conversion of glucose into glycogen and its storage.
5. Manufacture of Heparin 'Chemical'
6. Production of plasma proteins – albumin, globulin and fibrinogen.
7. Storage of vitamins A,D and B12
8. Separate iron from hemoglobin of worn-out red blood cells and store it.
9. Production of heat for maintaining body temperature
10. Production of clotting factors.

6.0 THE PANCREAS

The pancreas is versatile organ, the second largest gland (largest is the liver), and functions both as digestive organ (exocrine gland) and as an endocrine gland. In fact, it is two unrelated organs into one.

The pancreas is an oblong, rather flattened, boneless, fleshy gland about 15 cms long and 4 cms wide, gray pink in colour. It consists of a head, body and a tail, its head rests in the curve of the duodenum through the pancreatic duct which extends throughout its length. It has two types of cells :- 1. Alveolar cells, 2. Islet cells.

6.1 Action of pancreatic juice on digestive process : Pancreatic juice has capacity to digest all components of food i.e. protein, carbohydrates and fats. It has three enzymes which acts on carbohydrates, proteins and fats which are not digested in stomach. These enzymes are :-

1. Trypsin (converts proteins into amino acids)
2. Lipase (splits fats into fatty acids and glycerol)
3. Amylase (turns starches into maltose)

6.2 Endocrine Functions : Pancreas functions as endocrine gland. It secrets insulin which is directly added into blood stream. Presence of insulin in the blood in sufficient quantity helps in absorption of glucose by the cells from the blood. Deficiency of insulin cause glucose (sugar) level to rise in the blood (as it is not absorbed much by the cells) and starts passing through urine. This disorder is called 'diabetes'.

7.0 THE GLALL BLADDER

Attached to the lower surface of the liver is a small blind pear shaped pouch called the gall bladder which receives, stores, and concentrates bile. When filled with bile, gall bladder looks green. It is about 10 cms long and can hold about 50 to 60 milliliter of bile. It has three parts. a) Fundus, b) Body, c) Neck

The wall of the gall bladder has three layer :-

1) Outer Peritoneum Layer
2) Middle striped muscular tissue.
3) Inner mucous membrane

There are following ducts :-

- The right & left hepatic ducts from the liver which unite to form the common hepatic duct
- The cystic duct, leading from the gall bladder
- The bile duct formed by the junction of the common hepatic duct & cyctic ducts.

The cystic duct, which is about 3-4 cm long, passes backwards & downwards to join the common hepatic duct and together they form the bile duct. If the bile secreted by the liver is not required immediately for digestion, it passes up cystic duct in to the gall bladder where it is both stored & concentrated. When food enters the duodenum the sphincter at the entrance to bile duct relaxes and bile stored in gall bladder is driven into the intestine by contraction of the walls of the gall bladder. Bile is alkaline & bitter in taste. A healthy person secrets 500-1000 milliliter of bile everyday. Secretion of bile continues all the time but secretion is increased when fatty food is eaten. Bile has about 86% water & rest is salts, cholesterol, mucous, mucin, sodium bicarbonate & other chemicals.

8.0 THE SPLEEN

Refer lesson 15.0 for details of this organ.

9.0 DIGESTIVE PROCESS:

We take food two to four-five times in the day. When people eat food, attention is only on the food & no attention is paid on the process of eating. If we become conscious of the process of eating, we will chew the food properly. Required amount of saliva will get added and also food will be converted into small particles in the form of slurry. This will reduce the load on the stomach & these organs will function more efficiently. In such case we will be able to avoid indigestion problems.

As mentioned in the beginning of the lesson, nutrients from the food we eat, can not be directly used by the cells as these are large, molecules. So in the digestion process, these large complex molecule are broken into small, simple molecules which can be absorbed by the cells.

Digestive process consists of two processes : 1. Physical, 2. Chemical.

Physical process starts right from cooking the food. By cooking, food becomes soft, binding fibers become loose & membranes of cells get broken. As a result food can be easily chewed in the mouth. By chewing food is broken into small particles & mucus is added to form slurry which can be easily swallowed.

When food reaches stomach, hydrochloric acid is added. This mixture is churned for 3-4 hours. In this process food gets converted into fine particles & with the help of hydrochloric acid, mixture is converted into fine solution. During this churning process, both ends of stomach (cardiac orifice & pyloric orifice) remain closed.

Glands in the mouth, stomach & small intestine become active when one takes food. These glands secrete digestive juices which contain different enzymes. Different enzymes chemically react on different food components to convert them into final nutrients which can be easily absorbed. Vitamins help to increase the rate of chemical reaction of enzymes. Enzymes secreted by different glands and their actions to change the food stuff are summarized in the table below :-

Sr.	Gland	Enzyme	Changes
01	Salivary Glands	Salivary amylase (styalin)	Starch into dextrin & maltose.
02	Stomach	Pepcin	Protein into peptides
		Renin	Milk protein into casein which can be acted upon by pepcin.
03	Small intestine	Peptidase	Peptone into amino acids
		Maltase	Maltose into simple sugar such as glucose.
		Sucrose	Turns cane sugar (sucrose) into simple sugar.
		Lactase	Turns lactose into single sugar.
		Lipase	Fats into fatty acids & glycerol
		Nucleases (also present in pancreatic juice)	RNA, DNA into pentoses & nitrogenous base.
04	Pancreas	Trypsin	Proteins into amino acids
		Lipase	Fats into fatty acids & glycerol
		Amylase	Starch into maltose.
		Chymotrypsin	Proteins into peptides
		Carboxy peptidase	Proteins into peptides and amino acids

Chemical reactions taking place in three major processing platforms (mouth, stomach & small intestine) of digestive tract are mentioned below:

When we chew food in the mouth, salivary glands secrete saliva which contains styaline enzyme (also called salivary amylase). The enzyme acts only on starch and converts them into dextrin and maltose disaccharides. But this conversion is not complete as food does not stay for long in the month and immediately swallowed into stomach. If we chew roti, rice or potato for long time, we feel sweet taste in mouth, it is due to formation of sugar from starch under the influence of this enzyme.

In stomach hydrochloric acid is added to the food and the food is churned to form fine solution (chime). Gastric juice secreted in stomach reacts on this solution effectively during this churning process. Pepcin and rennin enzymes in the gastric juice convert proteins into peptides.

There is no reaction on lipids in stomach except these are broken into small pieces. After staying for 3 – 4 hour in stomach, food passes to small intestine through the opening of pyloric orice. Liquids like water, fruit juice stay in stomach only for 15 – 30 minutes.

Small intestine is about 6.5. metres long and here food (chime) gets enough resident time and surface area for digestive reactions to take place. Food takes about 2 – 5 hrs to pass through small intestine. Bile and pancreatic juice get added into starting end of the small instine through respective ducts. These chemicals are alkaline in nature

and neuralise acidity of chime and make it slightly alkaline. This helps enzymes secreted in small intestine (as indicated in the table above) to react more effectively. These enzymes convert all the three components of the food stuff i.e. carbohydrates, proteins and lipids into absorbable components completely. Digestive process is complete in the small intestine. Chemical reactions in digestive process are mentioned below :-

Carbohydrates – monosachrides (glucose fructose)

Proteins – peptide –amino acids

Lipids – glycerol + fatty acids.

It may be noted that enzymes act as catalysts (one which makes reaction to happen but does not take part in the reaction).

After absorption of nutrient in small intestine, remaining indigestible portion of food and water passes to large intestine. Large intestine does not have any enzyme. Water is absorbed in large intestine for reuse in the body. Cellulose forms roughage in the large intestine and helps the movement of waste (fausces) towards rectum. If this waste material remains in the large intestine for longer time, fermentation occurs which produces gas and also more water gets absorbed causing constipation.

10.0 PREKSHA MEDITATION & DIGESTION PROCESS

Food provides energy and also the necessary material for growth and maintenance (repair) of the body.

Objective of Preksha Meditation is to become physically, mentally, emotionally and spiritually healthy. Considering this objective, following aspects of food are considered in Preksha Meditation.

1. What to eat ? 2. How much to eat ? 3. When to eat ? 4. How to eat ?

Diet shall contain all required components to meet above mentioned objective. Diet shall contain required nutrients. Which nutrients are found in which food are mentioned in chapter on nutrition. In short, diet shall be balanced. Also it is important not to eat foods which has adverse effect on overall health.

One should eat according to his body needs, age and season. Overeating causes problems of indigestion.

One should eat at regular reasonable intervals. One should not eat too many times in the day. Regular timing for eating is important for having proper rhythm of working of digestive organs.

While eating one should concentrate only on eating process. One should not read news paper or watch TV or talk during eating. This will enhance secretion of salvia in saliva glands and also more chewing will take place in mouth which will help proper digestion.

11.0 EXERCISES

Essay Type

1. Describe accessory organs of digestive system with figure.
2. Explain digestive process along with functions of digestive organs.

Short Notes

1. Preksha Meditation & Digestion
2. Absorption of nutrients

Reply in brief

1. What are nutrients for human body ?
2. Name of juices secreted by accessory organs of digestive system.

Objective type

1. Pepcin reacts on : (a) Vitamin (b) Lipid (c) Protein (d) Mineral Salts
2. How many parts does phyranx have ? (a) Two (b) Four (c) Three (d) One
3. What is the name of lower part of abdomen ? (a) Stomach (b) Small instine (c) Pancreas (d) Diaphragm
4. What is the nature of pancreatic juice? (a) Acidic (b) Alkaline (c) Acidic & Alkaline (d) Neither Acidic or Alkaline
5. What is the name of enzyme found in saliva ? (a) Trypsin (b) Ptyalin (c) Lypase (d) Renin

LESSION – 15

BLOOD CIRCULATION SYSTEM : COMPOSITION OF THE BLOOD & ITS FUNCTION, STRUCTURE OF THE HEART AND ITS FUNCTION, EFFECT OF PREKSHA MEDITATION ON BLOOD PRESSURE AND FUNCTIONING OF THE HEART

OUTLINE OF THE LESSON

1.0 OBJECTIVE

After studying the lesson you will understand :

1. What is blood ?
2. What are the types of blood cells ?
3. Which blood cells do protect body from diseases ?
4. Functions of the blood.
5. Structure of the Heart.
6. Heart valves & their function.
7. Function of pace maker
8. Blood Pressure
9. Heart Attack
10. Blood Groups
11. Effect of Preksha Meditation on Heart & Blood Pressure

2.0 INTRODUCTION

In modern age science has progressed a lot and its effect can be seen in every walk of life. Inspite of so many development in science in general and medical science in particular, still it is not found what is the energy which keeps body functioning and when it leaves body or its absence in the body brings all body functions to halt though all other things remain as it is and body become dead. However as a result of development one has understood clearly what nutrients are needed to keep the body healthy.

The circulatory system is transport system of the body by which nutrients (food), oxygen, water and all other essentials are carried to the tissue cells and their waste products (as a result of metabolic reactions taking place in the tissues) are carried away. Heart is the pump which pressurizes the blood to circulate it to the all parts of the body. Blood circulatory system consists of three parts :

- The blood – the fluid in which materials are carried to and from the tissues
- The heart – the driving force (pump) which propels the blood
- The blood vessels – the routes by which the blood travels to and through the tissues, and back to the heart.

Blood is classified as connective tissue.

3.0 BLOOD VOLUME & COMPOSITION

Blood is about 8 percent of body weight in men and about 7 percent of body weight in women and volume wise it is about 5 – 6 litres in men and 4 – 5 litres in women.

The blood is a thick red fluid, it is bright red in arteries, where it is oxygenated, and a dark purplish – red in the veins, where it is deoxygenated, having given up some of its oxygen to the tissues – the cause of the colour changes received waste products e.g. carbon-dioxide taken in from them. It is slightly alkaline (pH is 7.35 – 7.45). Temperature of the blood is about 38°C and it is viscous.

When blood in a test tube is centrifuged, one can see that blood consists of a fluid and solid part. Solid part is large number of small round bodies known as blood corpuscles or cells and liquid part in which these round bodies float in normal case is plasma. The cells form 45% percent and plasma forms 55% of total blood volume.

3.1 Blood Plasma : Plasma or fluid part of the blood is a clear, straw colour watery sticky fluid. It is composed of the following :

- Water : It forms about 90% (percent) of the total volume.
- Mineral salts : These include chlorides, phosphates and carbonates of sodium, potassium and calcium.
- Plasma proteins : albumin, globulin, fibrinogen, prothrombin and heparin.
- Food stuffs in their simplest forms : glucose, amino acids, fatty acids, glycerol and vitamins.
- Gases in solution : Oxygen, carbon dioxide and nitrogen.
- Waste products from the tissues : Urea, uric acid and creatinine
- Antibodies and antitoxins
- Harmones
- Enzymes

The water in the plasma acts as solvent for mineral salts and solution is electrolyte. It also dissolves proteins and glucose. The salts in the plasma are necessary for the bidding of protoplasm and they act as buffer substances neutralizing acids or alkali in the body and maintaining the correct pH.

The proteins which plasma contains gives the blood sticky, consistency prosperity, called viscosity, which is necessary to prevent too much of blood passing through the capillary walls into tissues.

Albumin is thought to be formed in the liver. Globulin is derived from the group of white blood cells called lymphocytes. Fibrinogen and prothrombin are produced in the liver and are both necessary for blood clotting. Plasma without fibrinogen is called serum ; this can be seen as yellow fluid which oozes from a cut after clot is formed. Heparin is also formed in the liver and prevents clotting in the blood vessels. Food stuffs in their simplest form of glucose, amino acids, fatty acids and glycerol are absorbed in intestines into the blood. Urea, uric acid and creatinine are waste products from protein metabolism. They are made in the liver and carried by the blood for excretion by the kidneys.

Antibodies and antitoxins are complex protein substances which provide protection against infection and neutralize the poisonous bacterial toxins.

Enzymes, which are chemical substances produced by the body, produce chemical changes in other substances without themselves entering into the reaction.

4.0 THE BLOOD CELLS

There are three types of blood cells :-

1. Erythrocytes (red blood cells)
2. leucocytes (white blood cells)
3. Thrombocytes (platelets blood cells constitute 4.5 percent of total blood volume).

4.1 Erythrocytes (Red Blood Cells) : The red blood cells are minute disc shaped bodies, concave on either side. They are very numerous, numbering about 50 lacs per cubic millilitre of blood. They are very minute having diameter of 7.2 micrometer only (1 micrometer -= $\frac{1}{1000000}$ meter). Their life is about 120 days, this means they shall be continuously produced in large number. Seen through the microscope, individual cells are of light yellow colour. However these cells always are in groups and the mass effect of yellow bodies make blood of red colour. On the outer surface, these cells have transparent, elastic membrane.

Red blood cells are without nucleus and mitochondria but contain a special protein haemoglobin which helps metabolic reactions taking place in the cell. Haemoglobin has light yellow colour. Haemoglobin acts as carrier of oxygen. Haemoglobin, is made of iron containing protein globin and hemation. Hence Iron is essential for production of haemoglobin, a man requires about 10 mg of iron per day, women require about 15 mg to replenish the menstrual loss and the depletion of iron reserves which occur during pregnancy, labour and lactation. Iron containing foods are green vegetables, peas, beans and lentils. Red cells are destroyed in spleen but the iron from haemoglobin is recovered and hence daily requirement of iron is not so high. Normal level of haemoglobin is 13.0 – 18.0 grams / decilitre (100 milli litre) for men and 11.5 to 16.5 grams / deciliter for women. Haemoglobin has a very high affinity for oxygen, as they come into contact, the oxygen is taken up forming oxyhaemoglobin. This process normally takes place in lungs where the venous blood deficient in oxygen, is able to absorb and bind oxygen from the air in alveoli and leave the lungs by the pulmonary veins as arterial blood.

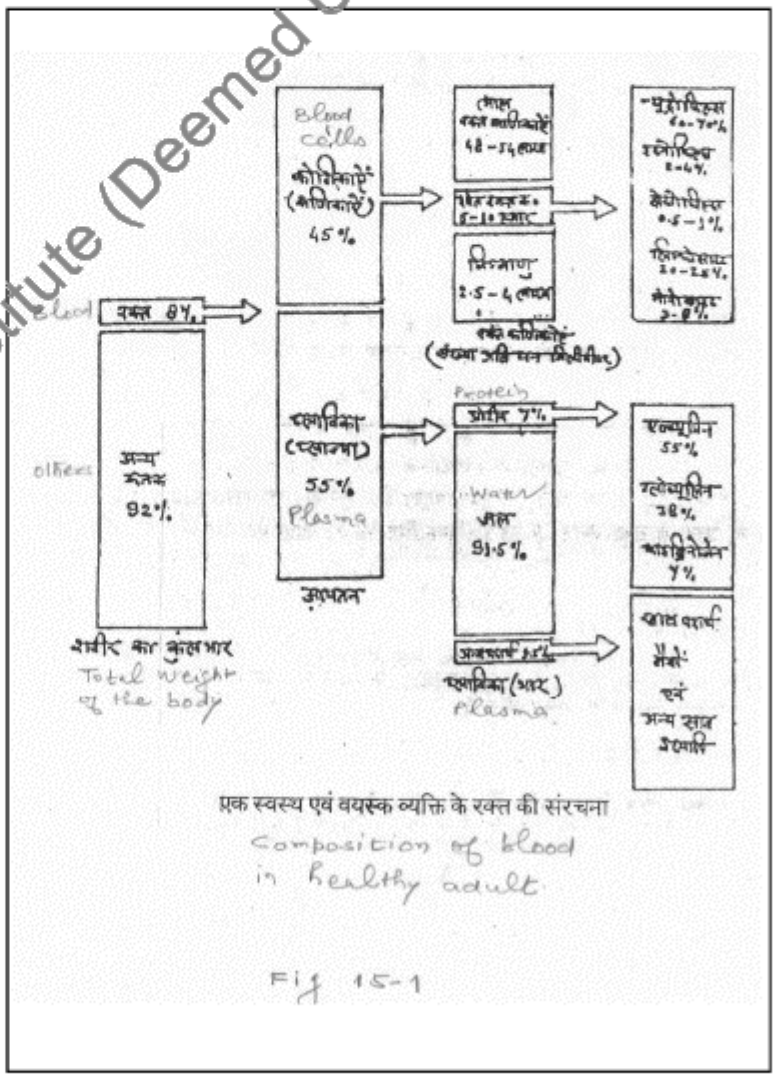


Fig 15-1

Oxygenated arterial blood has a bright red colour, while that in the veins, having lost its oxygen has a bluish purple colour. Haemoglobin after giving up oxygen in the tissues pilts up carbon dioxide produced as result of reaction between oxygen and glucose and brings carbon dioxide to the lungs and gives up there. Red blood cells have to pass through narrow capillaries but these cells are elastic and adjust their size to pass through these narrow capillaries. Red blood cells are produced in liver and spleen during pregnancy and after birth these are produced in bone - narrow.

4.2 Leucocytes (White Blood Cells) : These are colourless cells containing nuclei and are little larger in size than the red cells (10 micro meter) but much less numerous (1 WBC to 625

RBC). Their number normally varies between 4,000 to 11,000 per cubic millimeter, but 8000 per cubic millimeter is normal average. Their number increases drastically in some diseases like pneumonia and plague. Their life is few days to few weeks.

Two main variations are found in the blood :

1) Polymorphonuclear or granular leucocytes (75 percents)
2) Non-granular leucocytes (25 percent)

1) The Polymorphonuclear or Granular Leucocytes

This is so called because its nucleus is irregular and variable in shape and its cytoplasm contains granules. It forms about 75 percent of white cells. They have two important functions :

1) to protect the body against the invasion of bacteria.
2) to remove dead or injured tissue.

If bacteria enter the tissues, the granular leucocytes immediately attempts to surround the organisms and engulf them into their own bodies. Some times the toxins of the bacteria are powerful enough to kill the leucocytes and it is the accumulation of leucocytes destroyed in this manner, together with liquefied dead tissue, which forms pus.

After the bacteria have been killed it is leucocytes which remove tissues which have been damaged or destroyed by the action of toxins and thus they play their part in the first stages of the process of healing.

It is because of this power of engulfing bacteria and debris and digesting them by means of various enzymes that the granular leucocytes are sometimes called phagocytes and the process they carryout is called phagocytosis.

The polymorphonuclear leucocytes or granulocytes are derived from special cells in the bone marrow called myeloblasts. These are three types :

(i) **Neutrophil :** These are 60 – 70 percent. Their nucleus has 2 to 5 lobes. They have fine granules.
(ii) **Eosinophil :** These are 3 – 5 percent. Their nucleus has two lobes. Their granules are coarse.
(iii) **Basophil :** These are 0 – 1 percent. Their nucleus has 2 – 3 lobes. Their granules are also coarse.

2) Non granular leucocytes : These are two types :
(i) Lymphocytes
(ii) Monocytes

(i) **Lymphocytes :** These are about 20 percent of WBC count. They have only one big nucleus. These are made in lymph nodes, thymus gland and spleen. They are not phagocytic. They produce antibodies which protect body from infection.

(ii) **Monocytes :** These are about 55 of the WBC count. These are longest of white blood cells and have a horse shoe – shaped nucleus. They have phagocytic capability by which they remove killed bacteria and damaged tissues. These are made in bone morrow, lymph nodes and spleen.

4.3 Thrombocytes (Platelets) : These are minute spherical structures present in the blood numbering about 2,50,000 in one cubic millimeter. The average life is 5 – 9 days. They are smaller than white cells in size. Their wall (membrane) is not very stable and due to this reason, whenever there is slight damage, its contents easily come out. They are produced in the bone morrow and destroyed in the spleen. Their main function is whenever there is a cut on the body and bleeding occurs, blood platelets decompose and forms a new substance called thromboplastin with other constituents of the blood. This new substance blocks the bleeding.

5.0 FUNCTIONS OF THE BLOOD

Functions of the blood are :

1. To carry nutrients and vitamins to the tissues
2. To carry oxygen to the tissues and cells with the help of haemoglobin
3. To carry away waste products (urea, carbon dioxide, excess water) to the organs which excrete them.

4. To distribute secretions (harmones) of ductless glands (endocrine glands) and enzymes.
5. To distribute heat evenly throughout the body, and so regulate the body temperature.
6. To fight bacterial infection through the white cells and antibodies
7. To arrest haemorhage through clotting.
8. To provide materials from which gland make their secretions.

6.0 HEART

Heart is main and important organ of the circulatory system. The heart pumps blood to all the tissues and cells of the body through the network of arteries and capillaries. Blood gives oxygen and nutrients to the cells and picks up waste product carbon dioxide etc. return back to the heart through veins. While returning back from the digestive system, it picks up nutrients. The heart pumps impure blood (blood with waste product carbon dioxide) to the lungs where carbon dioxide is given up and oxygen is picked up. This now pure blood returns back to the heart through pulmonary veins. Blood vessels or tubes which carry away the blood (under pressure) from the heart are called arteries and the ones which bring back blood to the heart are called veins.

Under resting conditions the heart pumps about 70 millilitre (ml) of blood into the arteries or main artery called aorta in one stroke or one beat. With an average heart rate of 70 – 72 beats per minute, a volume of 5 litres (70 x 71 @ 4970 ml) which is equal to the total blood volume in the body pass through the heart in one minute. This volume is called cardiac output, cardiac output does not remain constant but is adjusted to meet varying needs of the body. The heart is capable of increasing its output 5 fold or more when oxygen demand is high. Heart rate steadily slows done as one gets older, it is 140 before birth, so as a child and 70 – 72 as an adult (actually normal range is 60 – 100).

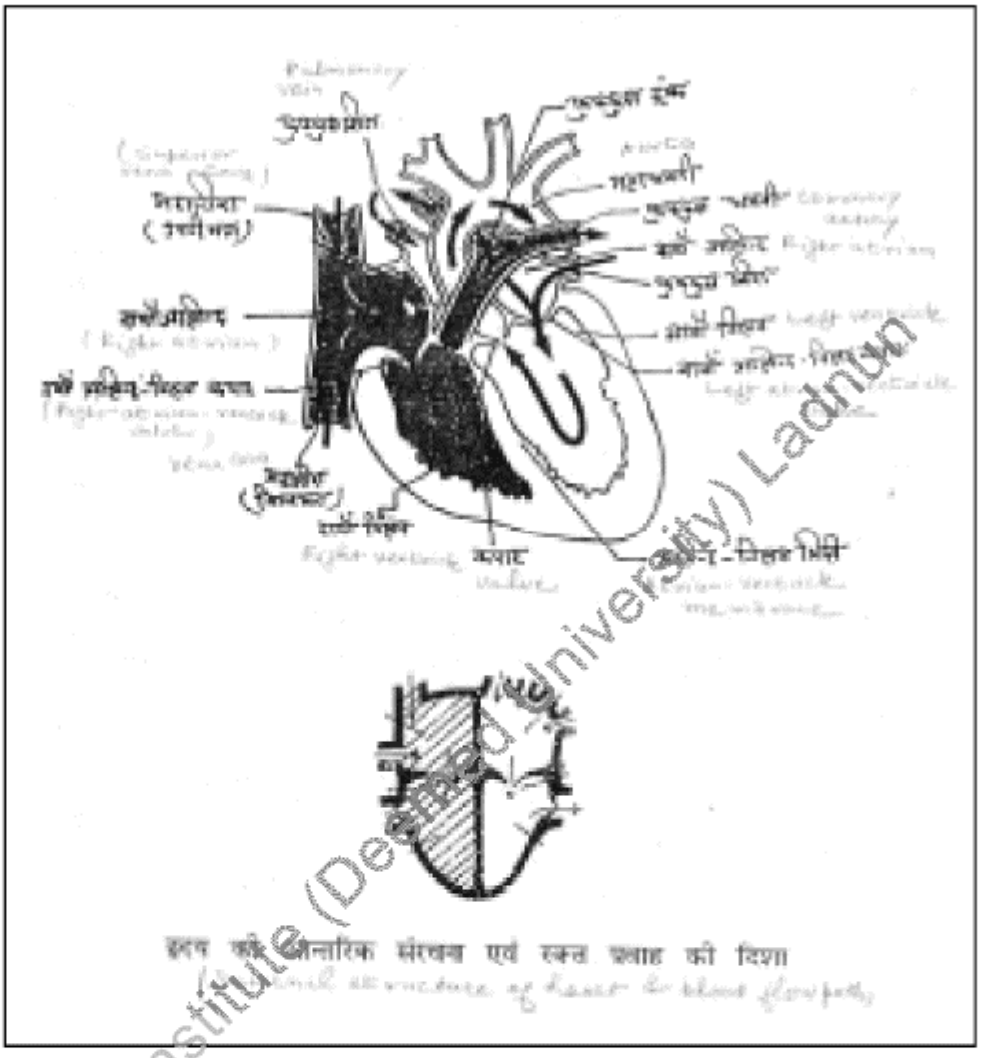
The heart is divided into two parts by muscular partition called the septum. The two sides of the heart have no communication with each other in a healthy person, additionally each side is sub divided into an upper and lower chamber. The upper

chamber on each side, the atrium, is smaller and is receiving chamber into which the blood flows through veins. The lower chamber, the ventricle, is discharging chamber from which the blood is driven into arteries. Each atrium communicates with the ventricle below it on the same side of the heart through an opening, guarded by a valve called the atrio – ventricular valve. Right side sends blood in the lungs for purification while left side sends pure blood (blood with oxygen and nutrients) to the whole body.

6.1 Location and Structure of the heart : The heart is a hollow, muscular, cone – shaped organ. It lies between the lungs in an area called mediastenum, behind the body of the strenum with two thirds of its bulk on the left side. The heart is about 12 cms long, about 9 cms in width and is about 6 cm thick.

The heart is composed of cardiac muscle, the myocardium, on the action of which the circulation of blood depends. The myocardium varies in thickness, being thickest in the left ventricle, thinner in the right ventricle and thinnest in the atria.

The atria and ventricles are lined with a thin, smooth, glistening membrane called the endocardium which consists of a single layer of endothelial cells and which is continuous with the valves and with the lining of the blood vessels.



हृदय की आन्तरिक संरचना एवं रक्त प्रवाह की दिशा

The pericardium covers the heart and the roots of the great vessels and has two layers. The outer layer of fibrous pericardium is securely anchored to the diaphragm, the outer coats of the great vessels and the posterior surface of the sternum and therefore maintains the heart in its position in the chest. The inner layer, the serous pericardium, lines the fibrous pericardium and is invaginated by the heart, it therefore also has two layers. The inner layer is known as the visceral portion, or epicardium, and it is reflected back to form the outer or parietal layer. The layers are normally all in close contact and are moistened by fluid which exudes from the serous membrane; this prevents any friction as the heart continually contracts and relaxes.

6.2 Valves of the Heart : There are total four valves of heart. These valves have important function not to allow blood flow in wrong direction. Thus they act as check valves i.e. flow can take place in one direction, in opposite direction valve will get closed and so no flow. These valves have special construction having three flaps or two flaps. Four valves are

1. Right atrio – ventricular (tricuspid) valve.
2. Left atrio – ventricular (mitral) valve.
3. Aortic valve
4. Pulmonary valve

A brief description of each of these valve is given below.

The Right Atrio – Ventricular (Tricuspid) Valve lies between the right atrium and right ventricle. It has three flaps or cusps. Blood can flow from right atrium to right ventricle. When right ventricle contracts, pressure of flood in right

ventricle builds up and blood tries to flow toward right atrium but it is prevented as the flaps move in the direction due to this pressure to close the valve.

The Left Atrio – Ventricular (Mitral) Valve is located between left atrium and left ventricle. Its function is allow flow from left atrium to left ventricle but blood flow from left ventricle to left atrium when left ventricle contract. Its construction is similar to right atrio ventricular valve except that it has two flats. The Aortic Valve is located at the entrance of aorta at the left ventricle. It has three flaps. Its function is to allow the blood to flow into aorta when left ventricle contracts but prevent the blood flow back from aorta into left ventricle when left ventricle relaxes. The Pulmonary Valve guards the opening from the right ventricle into pulmonary trunk (artery). It is similar in structure and action to aorta valve.

6.3 Function of the Heart : The heart is a pump whose purpose is to drive the blood into and through the arteries. Blood from all parts of the body is returned to the right atrium through the two large veins, the superior and inferior Venae Cavae. When it is full the right atrium contracts and drives the blood through the right atrio – ventricular valve into the right ventricle which in turn contracts sending the blood through the pulmonary valve into pulmonary trunk. The pulmonary trunk divides into right and left pulmonary arteries which carry the blood to the lungs where the gaseous exchange occurs. The blood is finally collected into four pulmonary veins which return the blood to the left atrium. When it is full the left atrium contracts, simultaneously with the right atrium, the blood is driven through the left atrio – ventricular valve into the left ventricle. This chamber contracts, simultaneously with the right ventricle, and sends the blood into the aorta, the main artery of the body.

7.0 BLOOD PRESSURE

For any fluid to flow, fluid shall have pressure. For blood circulation in the body, blood shall have pressure and this pressure is provided by the heart which acts as a pump. The blood pressure is the force which the blood exerts on the walls of the blood vessels. It varies in the different blood vessels and also with heart beat. The pressure is greatest in large arteries leaving the heart, and gradually falls in the arterioles until, when it reaches the capillaries (It is for this reason that is so important to change frequently the position of a patient confined to bed, as the tissue carrying the body's weight has little blood circulatory through it). In the veins pressure is lower still until ultimately in the big veins approaching the heart there is suction, i.e. negative pressure instead of positive one, on account of the suction exerted by the heart as its chambers relax.

The pressure is highest when ventricle contracts (this is called systolic pressure) and lowest when the ventricle relaxes (this is called diastolic pressure).

The pressure of the blood is measured by the weight of the column of mercury which it will support. The height is calculated in millimeter (mmHg). The normal arterial pressure is 110-130 mm Hg systolic pressure and 70 – 80 mm Hg diastolic pressure. Blood pressure higher or lower than these valves is called high BP or low BP. Both are not good and are indication of some disorder. These disorders could be kidney disorder, heart disease, mental tension, worries, excitement etc. while high blood pressure can cause bursting of blood vessels, in case of low BP, some tissues may not get enough nutrients and organs associated with such tissues may not function properly.

Blood pressure depends on five factors :

(i) The cardiac output (amount of blood pumped per minutes)
(ii) The peripheral resistance
(iii) The total blood volume
(iv) The viscosity of the blood
(v) The elasticity of arterial walls

The Mechanism of Circulation

When the blood is pumped out of the left ventricle the aorta is already full, so it must distend in order to accommodate the additional blood. As the left ventricle relaxes the aortic valve closes and elastic aorta recoils to its original diameter and next portion of aorta distends to accommodate the additional blood. The distension and recoil of aorta sets up a wave of distention and recoil called the pulse, which travels along all the large arteries and which

can be felt with finger wherever on artery can be compressed gently against bones. Since the heart beat produces the pulsation the rate and character of the beat can be judged by taking the pulse.

8.0 BLOOD GROUPS

In early days of blood transfusion, it was observed that sometime transfusion cured the patient while sometime it was fatal. This mystery was solved with the discovery of blood groups. There are two agglutinogens (antigen) called A & B are present in red blood cells. Based on presence of these agglutinogens, blood groups are clarified as mentioned below :

Group A	where antigen A is present
Group B	where antigen B is present
Group AB	where antigen A & B both are present
Group O	where no antigen is present

Further blood plasma contains substances called agglutinins (antibody) which cause agglutination (making red cells sticky & forming clumps) of red cells if incompatible blood groups are mixed. Agglutinins are called Anti - A & Anti - B and plasma contains all agglutinins which will not affect its own red cells. Therefore plasma of :

Group A	contains Anti – B agglutinins
Group B	contains Anti – A agglutinins
Group AB	contains no Anti agglutinins
Group O	contains both agglutinins

From the above it can be seen that plasma of person with blood Group AB does not have any agglutinins present & so can accept blood of any group and hence called universal acceptor. Blood Group 'O' contains no agglutinogen in the red cells and therefore they can not be made to agglutinate by agglutinins in any blood plasma. Blood of this group can be given to any person and therefore person belonging to this group is called universal donor. In practice compatibility of blood is always checked very carefully before it is given to a patient.

Rhesus Blood Group

The Rh blood group is so named because the antigen was discovered in the blood of the Rhesus monkey. People whose RBCs have Rh antigen are designated Rh^+ (Rh Positive), those who lack Rh antigen are designate Rh (Rh Negative). About 85 percent population is Rh^+. Normally blood plasma does not contain Anti – Rh antibodies. If Rh^- person receives on Rh^+ blood transfusion, the immune system starts to make Anti – Rh antibodies that will remain in the blood. If second transfusion of Rh^+ is given later, the previously formed Anti – Rh antibodies will cause agglutination and hemolysis (destruction) of red blood cells in the donated blood and may be fatal.

The most common problem with Rh in compatibility may arise during pregnancy. If mother is Rh negative and feutus is Rh positive, blood of feutus through placenta may to the blood of mother. Rh positive blood leaked into mother will produce Anti – Rh antibodies which will remain in mother's blood. During next pregnancy, mother's blood having these Anti Rh antibodies may leak to feutus through placenta. If feutus blood is Rh positive, then these antibodies will cause agglumination of red blood cells of feutus and may be fatal. Most of these blood leakage happen at the time of delivery.

9.0 EFFECT OF PREKSHA MEDITATION ON BLOOD PRESSURE AND FUNCTIONING OF THE HEART

Cardiac muscles, unlike skeletal muscle has the property of being able to contract rythmatically independent of nerve supply. The autonomic nervous system modifies the speed of the heart beat. The impulse to contact heart arises through spontaneous depolarisation in an area of specialized tissue near the entry of superior uena cava into the right atrium – called sino – atrial node – the pacemaker of the heart.

The heart rate is also controlled reflexly by two sets of receptions – pressure receptor (baroreceptors) and chemoreceptors. If blood pressure increases, baroreceptors reduces sympathetic stimulation and increases para sympathetic stimulation to reduce the heart rate to bring one's blood pressure. Chemoreceptors are sensitive to the

amount of oxygen and carbon dioxide in the blood. In case of lack of oxygen supply to the tissues, impulses are conveyed to cardiac centre in the medulla oblongata to increase the heart rate to increase the blood supply and therefore the oxygen supply to the tissues. These are the examples of homeostatic mechanism which works by negative feedback.

Apart from autonomic nervous system, heart and so the blood pressure is also affected by harmones particularly the one released by adrenal gland – epinephrine.

Exercises of Preksha Meditation affects the functioning of the heart and so the blood pressure. Let us see the effect of each exercises.

Kayotsarg (Relaxation) : In this exercise, all parts of the body are relaxed. The arteries which were contracted due to stress, come back to their normal state and reduce restriction to blood flow. So heart has to beat less and blood pressure decreases.

Perception of deep breathing (Deerga Shwas Preksha) : Slow and deep breathing is best exercise for relaxing nervous system. It enhances para sympathetic activity and consequently reduces heart rate and lowers the blood pressure.

Perception of pshychic centres (Chaitanya Kendra Preksha) : This exercise balances the secretion of endocrine glands. Increase in secretion of serotonin from pictuatory gland reduces the secretion of adrenalin (epinephrine) which reduces heart rate and blood pressure.

Anto suggestion and contemplation (Anu Preksha) : By giving auto suggestion in the relax state that 'heart is healthy and functioning in normal way' results into heart rate coming down.

10.0 EXERCISES

Descriptive Type Questions :

1. Describe composition of the blood and its functions.
2. Describe the structure of the heart and its functions. Analyze the effects of Preksha Meditation on the functioning of the heart.

Short Notes

1. Describe main parts of the blood circulation system
2. Describe structure of the heart.

Reply in Brief

1. What is blood pressure ?
2. Describe effect of Preksha Meditation on Blood Pressure.

Objective Type

1. What is the colour of blood plasma ?
   (a) Yellow (b) White (c) Light Yellow (d) Red
2. How many types of white blood cells found in human body blood ?
   (a) Two (b) Four (c) Five (d) Seven
3. What is sestolic pressure of an adult ?
   (a) 110-130 mmHg (b) 110-120 mmHg (c) 70-80 mmHg (d) 80-100 mmHg
4. Which blood cells are without nucleus ?
   (a) Red blood cells (b) Lymphocytes (c) Monocytes (d) White blood cells

LESSON – 16

DIET – NUTRITION, VEGETARIANISM & BALANCED DIET, FASTIGN AND HEALTH

OUTLINE OF THE LESSON

1.0 OBJECTIVE

By study of this lesson you will know :

1) What is health ?
2) What is the relationship between health and diet ?
3) What are various nutritients.
4) What is the importance of vegetarian diet ?
5) What are bad affects of non-vegetarian diet on the body ?
6) How does diet influence mind and emotions ?
7) What is balance diet ?
8) Importance of fasting
9) Effects of fasting on health
10) Spiritual basis of fasting.
11) Scientific basis of fasting.

2.0 INTRODUCTION

Food is an integral part of our life. One can not live without food. All living being continue to strive for the food. All living being continue to strive for the food. Animals, birds, insects strive to get food and eat whatever they get to satisfy their hunger. Human being is the most intelligent creation of nature among all living beings. He has reasoning and intellect. So he does not eat only for satisfying hunger but he chooses the diet which is nutritious, balanced and

appropriate for him. Hence it is important for one to have knowledge of various constituents of food and their contribution to the development and maintenance of the body.

3.0 HEALTH & DIET

World Health Organisation (WHO) has defined health, "Health is the state of complete Physical, Mental and Social Well-being and not only the absence of disease and infirmity". Good health is dependent on satisfactory nutrition which in turn is dependent on plentiful supplies of foods which are necessary to healthy life. Substances which can serve as food for the body are those which it can use as fuel for combustion, or building material for the repair and growth of tissues. Fuel is required to produce energy for the activities of every living being and to maintain the heat at which everybody lives. Building material are necessary to repair the body tissues since they are constantly active and being worn out by their activities; in addition, in infant and children extra building material is required for building the tissues for growth. In addition to these, some other materials are required to enable tissue to use fuel and building material, and there are known as vitamins. In absence of adequate quantity of vitamins in food stuff, nutrition suffer and diseases appear which can both be prevented and cured by ensuring that sufficient quantities of vitamins are present in the diet.

There are six essential food stuffs with which the body must be constantly supplied through the foods we eat :

- Proteins
- Carbohydrates
- Fats
- Water
- Mineral Salts
- Vitamins

The proteins, water and salts act as building material and carbohydrates and fats act as fuel, though the body can and does use protein as fuel when it is taken in excess than required or in case of lack of other fuel as in starvation. In a Indian person weighing 55 kg., approximate proportion of above constituents in the body is as follows :-

Nutrient	Weight (Kg.)	Percentage
Proteins	8.80	16
Carbohydrates	0.55	1
Fats (Lipids)	6.60	12
Minerals	3.30	6
Water	35.75	65
Total	**55.00**	**100**

Weight wise, vitamins are in very small quantity, hence ignored in the above table.

3.1 Protein : Protein is nitrogenous organic matter. In 1838, Mr. Mulsder, a Dutch Chemist proved that main constituent of tissues is protein (derived from the Greek word protious meaning 'comes first'). Protein obtained from food are different from those of cells. Metabolic reactions in the body converts proteins obtained from the food into cell proteins. Protein is major constituent of every cell.

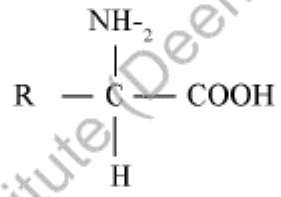
Division of protein in the body is as follows :-
Muscles, 1/3 of total protein in the body
Bones, cartilage,
Teeth, skin, 1/5 of total protein in the body
Other tissue,
Cerebrospinal fluid,
Harmones, hemoglobin etc., balance

All enzymes and harmones have protein as major constituent. Nucleus of all cells have protein in the form of nucleoprotein. In other words all tissues have protein. Only urine does not have protein directly but metabolic waste of protein in the form of creatinine of urea.

Protein is a complex organic substance consisting of 21 compounds of carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorous. These compounds are called amino acids. Out of these 10 amino acids are essential to be present in the food as these are not synthesized in the body. Other amino acids are non-essential because, although they are vital to life, they do not need to be supplied in food, but can be synthesized by the body itself. Different combination of amino acids (by number and ratio), produce number of types of proteins.

Essential Amino Acids	Non-Essential Amino Acids
a. Leucine	1) Glycine
b. Isoleucin	2) Glutamic acid
c. Lysine	3) Proline
d. Methinonine	4) Alanine
e. Phenyl - alanjine	5) Aspartic Acid
f. Threonine	6) Serine
g. Valine	7) Tryosine
h. Trptophan	8) Cystine
i. Arginine	9) Aspargene
j. Histidine	10) Glutamine

3.1.1 Chemical Structure of Protein : Smallest unit of protein is amino acid. One molecule of amino acid has one carbon atom 'C' to which one hydrogen atom 'H', one carboxyl group COOH, one amino group NH_2 and one radical group R are attached. R is other molecule of amino acid. Thus structure is represented as follows :-



3.1.2 Uses of Protein : Human Body is made of cells. After conception, cell multiplies, from one to two, two to four, four to eight, eight to sixteen and so on. After 9 months, number of cells become few billions.

Protein stimulates digestion. After digestion nutrients are absorbed and heat is produced. This is called specific dynamic activity of food. For this activity food having proteins is more effective. For adults every 1 gram / kg weight of the person and for children 2 – 3.5 gram / 1 kg weight (to meet growth requirement) is necessary to be taken in food. Protein in our food gets converted into amino acids by the reaction of enzymes in stomach and intestines. Amino acids are absorbed in the blood capillaries in intestine and transported through the blood to tissues in the whole body. Tissues absorb amino acids according to their requirement. Unutilized amino acids are stored in the lever where it is converted to fuel (glucose). One gram of protein produces four calories of heat.

In summary following are the uses of protein :

1. Formation, development and maintenance of the cells. Replacement of dead cells. Growth of the body of infants right from the pregnancy to the youth state.
2. Main constituent of all enzymes.
3. Main constituent of hormones i.e. insulin, thyroxin adrenaline etc. of endocrine glands.
4. Formation of antibodies.
5. Regulates liquid balance in the body.

3.1.3 Effect of protein deficiency

1. Inadequate growth of the body in proportion to age.
2. Weakness of muscles.
3. Dullness

4. Dry skin and wrinkles
5. Deficiency of blood.
6. Slow development of brain – particularly mental retardness in children who did not get adequate protein from food in their early years. (Infancy)
7. Irritation, anger, emotional weakness etc.
8. Dryness of hairs, falling of hair while combing
9. Dryness of nails, white spots on nails.
10. Swelling of stomach and liver
11. Lack of antibodies and weakening of immune system.
12. Deficiency of hormones, lack of inner strength
13. Oedema

3.2 CARBOHYDRATE

Carbohydrates are obtained from plants. They are easily digested and absorbed in the blood and easily burnt in the tissues to produce heat and carbon dioxide. These are the main fuel of the body. Since they are grown more, easily transported from one place to other place, easily stored and are cheap compared to protein and fat containing foods, they form major part of the food for poor people.

CHEMICAL STRUCTURE

Carbohydrates include sugar and starch. They consist of carbon, hydrogen and oxygen. Hydrogen and oxygen are in the same ratio as in water i.e. hydrogen is twice the amount of oxygen. Simplest sugar is monosacharides such as glucose and its chemical formula is $C_6H_{12}O_6$. i.e. it contains 6 atoms of carbon, 12 atoms of hydrogen and 6 atoms of oxygen. Sugars are classified in 3 groups :- (i) Monosaccharides (ii) Disaccharides (iii) Polysaccharides

(i) Monosaccharides ($C_6H_{12}O_6$) : This is simple sugar. All sugars are converted to this form during digestion. This form only can be absorbed in the blood. This sugar after absorption in the blood is called glucose and this is easily burnt in tissue i.e. get converted into heat, carbon dioxide, and water. This is immediate source of energy for all body functions and one gram of glucose produces four calories of energy. Examples of monosaccharides are :-

- Glucose (the main blood sugar)
- Fructose (found in fruits e.g. grapes, sweat potato, vegetables, honey)
- Galactose (found in milk sugar)
- Deoxyribose (in DNA)
- Ribose (in RNAf)

(ii) Disaccharides ($C_{12}H_{22}O_{11}$) : Two monosacchoride molecules can combine by dehydration synthesis to from disaccharide molecule and one molecule of water. Disaccharides are soluble in water like monosacchorides. Example of disaccharides are :-

- Sucrose (table sugar) – Glucose and Fructose
- Lactose (milk sugar) – Glucose – Galactose
- Maltose – Glucose + Glucose

Disaccharides can be split into smelled, simpler molecules by hydrolysis. A molecule of sucrose, for example, may be hydrolyzed into its components glucose and fructose by the addition of water.

(iii) Polysaccharides ($C_6H_{10}O_5$) : Each polysaccharide molecule contains tens or hundreds of monosacchorides joined together through dehydration synthesis reactions. Unlike simple sugars, polysaccharides usually are not soluble in water and don't taste sweat. Examples of polysaccharides are :-

- Glycogen :- the stored from of carbohydrates in animals and humans
- Starch : the stored form of carbohydrates in plants and main carbohydrate in food.
- Cellulose : part of cell walls in plants, not digested by humans but aids movement of food through intestines. A small amount of carbohydrates are stored as glycogen in liver and skeletal muscles. Like disaccharides, polysaccharides can be broken down into monosaccharides through hydrolysis reactions. For example

when the blood glucose level falls, liver cells have the ability to breakdown glycogen into glucose and release it into the blood.

Starch are insoluble in water. Plant store sugar in the form of starch to prevent it from escaping in solution into the water in the soil in which they live.

3.3 LIPIDS (FATS)

Fats are compounds of carbon, hydrogen and oxygen but percentage of oxygen is less as compared to that in carbohydrates. Fats also serve as body fuel. Since fats contain more carbon and hydrogen, they produce more than double the energy as produced by carbohydrates (1 gram of glucose produces four calories and 1 gram of fat produces 9 calories). Fats are not so easy to digest and absorb and not so easily burnt in the tissues. Fats can be used by tissues to produce energy only in the presence of sufficient glucose. If sufficient glucose is not metabolised (reacted) with fats, breakdown of fat into carbondioxide and water is incomplete and acid or acetone are formed in the tissues. Acetones causes fatigue in the muscles and if present in large quantities, alter the pH of the blood. pH may reduce (more acidic), this condition is known as acidosis which may lead to coma and death. Sever acidosis is likely to occur under following conditions :-

i. Diabetic condition where sugar can not reach into tissue due to lack of insulin in the blood.
ii. During starvation when the small quantity of sugar which body can store, has already been used up and large quantity of fat which body stores is available as fuel.

Fats in digestion system get converted into glycerol and fatty acids by reaction of various enzymes. Glycerol and fatty acids are absorbed in the blood in intestines. These components again combine in the blood and form fats. One adult needs about 35 – 60 gram of fat in his daily diet. Fats are stored in the body and these are about 13.8% of the body weight.

All oily substances like ghee, butter, oils, have fats and form about 40% of our fat supply. About 60% supply of fats comes from indirect sources like milk, paneer, dry fruits, coconuts, groundnut, soyabeen etc.

3.4 MINERAL SALTS

Salts are required for body building and are also regulators of tissue activity. There are about 20 mineral elements present in our body. These minerals produce various salts by action of acid on them, for example, sodium chloride or common salt is produced by the action of hydrochloric acid on Sodium, Calcium lactate is produced by the action of lactic acid on calcium. Salts are contained in all foodstuffs, but added salt used in cooking and in eating is necessary to maintain electrolyte (solution of salt in water) balance and replace the salt lost in urine and sweat, 3 – 4 gram of common salt or sodium chloride is needed daily. Chlorides, carbonates and phosphate of sodium, potassium and calcium are particularly important.

Sodium is present in all the tissues, body contains it in the form of sodium chloride to the extent of 9 grams per litre (0.9 percent). Sodium carbonate and sodium phosphate are also always present in the blood and tissues. The carbonates give alkaline nature to blood by neutralizing carbonic acid produced by combustion of fuel and maintains the body pH. Phosphate is the carrier of acids produced by the breakdown of the body building foods (proteins) and carries them to the kidneys, by which they are excreted.

Potassium is present in all tissue cells where it replaces sodium of blood and tissue fluid as base to maintain acid – base balance.

Calcium is present in all tissues particularly in bones, in teeth and in blood, and is necessary for normal functioning of nerves and heart. It helps in clotting of the blood in case of injury.

Iron is essential for the formation of haemoglobin of red blood cells.

Phosphorous is needed for building body tissues. Iodine is required for the formation of hormones secreted by thyroid gland.

Calcium, iron and iodine are only minerals likely to be insufficient. The others are present in adequate amount in the diet.

Functions of different minerals are summarised of below :-

Group	Minerals	Functions
I	1) Calcium 2) Phosphorous	Mainly formation of bones & body growth
II	Sodium Potassium	Acid – base balance
III	Iron Copper Cobalt	Formation of Blood
IV	Chlorine Iodine Fluorine	Formation of HCL in stomach and thyroxin in thyroid gland.
V	Magnesium Manganese Zinc Sulphur	Stimulates Secretion of hormones.

3.5 WATER :

Water is important constituent of our body. About 65% of the total body weight is water i.e. there will be about 35 kg water in a person weighing 55 Kg. A person can live without food for 100 days or more but without water one can not survive for more than 4 – 5 days. We meet water requirement of the body from following sources.

- Vegetables and fruits contains on an average about 90% of water.
- About half a kg water is produced as a result of oxygenation of the food.
- We drink about 2 – 3 litres water daily.

Water is lost from the body through sweating, urine, excretion and breathing.

3.5.1 Utility of water in the body.

1. All digestive reactions in the body take place in solution. Water is an important solvent for all our foods. It also act as lubricant to move food along alimentary canal.
2. Blood contain nearly 65 percent of water and thus it helps in transport of nutrients and supplying them to the tissues all over the body.
3. It helps fauces to excrete.
4. It removes metabolic waste through sweat and urine.
5. Water in the form of cerebrospinal fluid (CSF) acts as buffer to protect brain and spinal cord from external shock.
6. It supplies many minerals like sodium, calcium, potassium, chlorine, iodine, fluorine etc.
7. It control body temperature.

3.5.2 Effects of deficiency or excess of water in the body :

- If water quantity gets reduced by 10 percent, condition of dehydration occurs. Its symptom are blood pressure becomes low, pulse becomes low and not able to sense easily, dry mouth, urine frequency comes down, cold hand and feet etc. it shall be treated immediately by taking saline water with glucose. If no improvement is found by this, immediately contact doctor for injecting saline – glucose through veins. Dehydration occurs mainly because of loose motions or vomiting.
- When there is excess (more than 10 percent), it causes swelling in the body.

3.6 VITAMINS

Protein, carbohydrates, fats, mineral salts and water alone are not sufficient to keep body healthy. One needs some other substances to make these foodstuffs suitable to be utilized by the body. Body cannot utilize these foodstuffs in their natural form. These substances are found in fresh vegetables, fruits, milk, curd etc. and are called vitamins. Vitamins are of no value as food as it is neither fuel nor building material but deficiency of these cause diseases which are known as deficiency diseases. Vitamins are in very small quantity. Digestion of food & subsequent absorption of nutritients in cells happens with the help of enzymes. Enzymes contain different vitamins. Deficiency of vitamins affects the production of the enzymes in the body & thus short supply of enzymes will affect growth and maintenance of the body adversely. Discovery of vitamins dates back to 1912 when a scientist named Crasiore Funk discovered these nutrients. Their composition was not known exactly and so these are named by alphabets e.g. A, B, C, D, E, K …… Some vitamins are also manufactured in small quantity in the Human Body e.g. vitamin E, K, C & B- Complex.

Vitamins are classified in two categories : a) Fat Soluble b)Water Soluble

a) Fat Soluble : There are five vitamins in this category :

1. Vitamin A 2. Vitamin D 3. Vitamin E 4. Vitamin K

b) Water soluble : There are two vitamins in this category : 1) Vitamin B 2) Vitamin C

Vitamins B is also called Vitamins B-Complex & has six Vitamins :

(i) B1 - (Thiamin)
(ii) B2 - (Ribo & Alavin)
(iii) B6 - (Nicotinic Acid)
(iv) Folagene or Folic Acid
(v) B 12 - Cobalamine
(vi) Bayotin

Differences between fat soluble & water soluble vitamins.

S.No.	Fat Soluble Vitamins	Water Soluble Vitamins
1.	Soluble in fat or fat solvents.	Soluble in water
2.	If taken in excess of requirement, get stored in the liver	Cannot be stored. Unused vitamin passes away through urine
3.	Symptoms of deficiency of vitamins in the body is felt late (because of some storage in the liver)	Symptoms of deficiency is felt immediately as there is no storage available.
4.	These have precursors	These do not have precursors
5.	These have carbon, hydrogen & oxygen elements in their composition	In addition to carbon, hydrogen, and oxygen, these vitamins have nitrogen and some have Sulphur & cobalt also.

Vitamin's quantity is specified in International Unit (IU) or milligrams or sometimes in micrograms. Every vitamin has importance, hence these are described below in detail :

VITAMIN 'A'

Vitamin A is soluble in fat, oil and wax. It helps in growth of the body and keeps immune system strong. It helps in keeping skin smooth and throat, mucus membranes healthy.

Its deficiency causes :-

- Stunted growth & lowered resistance to infection.
- Mucus membranes become unhealthy and easy prey to bacteria.
- Conjunctivitis
- Night blindness.

It is found in animal fats, (milk, butter, cream). In carrots and green vegetables, and in all yellow fruits, a subsistence called carotene is found, which like green colouring chlorophyll, is formed under the influence of sunlight. This is precursor of Vitamin – A. Animals, including man, can turn the carotene present in their food into Vitamin A within their bodies.

VITAMIN – 'D'

Vitamin D is fat soluble and is found with Vitamin A in animal fats (milk, butter, cream) provided animal has been in the sun. Cod-liver (fish oil) is rich in Vitamin – D. Vitamin D is also produced in the skin by the action of sun light (ultra violet rays) on the body.

Vitamin – D is essential for the development of bone and teeth. Absorption of calcium and phosphorous by the body takes place only in presence of this Vitamin. Lack of Vitamin D causes 'rickets' disease and due to this reason this vitamin is also called Antirickatic Vitamin.

VITAMIN – 'E'

Vitamin – E is soluble in Fat. It is essential for reproduction. Lack of Vitamin – E may cause abortion of pregnant woman. Its deficiency may make men, women impotent. Its deficiency also make skeletal muscle and heart muscle weaker.

It is found in vegetables, sprouted cereals, fruits, milk, butter, dry fruits, ghee, coconut oil and cotton seed oil.

VITAMIN – 'K'

Vitamin – K is fat soluble. People who have had deficiency of this vitamin in their diet show a tendency to haomorrhages, since Vitamin K helps to form prothrombin, which is essential for blood clotting, its deficiency also affects function of digestion and nervous systems. It does not get absorbed in the body when one has jaundice disease.

Vitamin K is found in green vegetables, soyabin and tomatoes. It is also synthesized in the intestines by bacterial action.

VITAMIN 'B'

Vitamin B is water soluble. It has number of vitamins and together referred as Vitamin B Complex. These are found in fruits and vegetables particularly in tomatoes, oranges, sweet lemon, grapes, almond, akhrot and milk. They are found in abundance in husk & germs of cereals & pulses.

Different vitamins of this group have different effects on the body. Some help in producing energy in the cells while others help in production of red blood cells (RBC).

VITAMIN B1 (Thaimine)

This is essential for carbohydrate metabolism and controls the nutrition of nerve cells and muscles. Deficiency of Vitamin B1 leads to 'beri –beri' disease in which there is inflammation of nerves causing paralysis and loss of tone and activity in intestinal muscles with constipation, while patient complains of loss of appetite and a burning sensation in feet.

VITAMIN B2 (Riboflevin)

This is essential for proper functioning of cell enzymes. Its deficiency causes inflammation in lips, eyes, tongue and skin, falling of hairs. Digestion and eye sights get affected due to deficiency of Vitamin B2.

VITAMIN B6 (Nicotinic Acid)

This is essential for carbohydrate metabolism. A lack of this vitamin causes pellagra, which leads to skin eruptions, gastro – intestinal changes (blood in stool etc.) and mental changes (irritation and anxiety).

FOLIC ACID

It is necessary for maturation of red blood cells. It is essential for synthesis of nucleo – proteins and for cell division. It is widely distributed in food and is also produced by bacteria in the large intestine.

VITAMIN B12 (Cyanocobalamin)

This is anti-anaemic substance absorbed by villi of small intestine and stored in the liver. It is satisfactorily absorbed only in the presence of an intrinsic substance produced by the lining of the stomach and hydrochloric acid. Vitamin B12 is essential for the proper development of red blood cells in red bone narrow. Lack of it or its absorption causes pernicious anaemia.

VITAMIN C (Ascorbic Acid)

It is water – soluble and is found in fresh fruit particularly citrus fruits (oranges, grape fruit and lemons), green vegetables, tomatoes, pears, ambla, carrots, potatoes and onion. It helps in making bone and teeth strong. It is important in tissue respiratory activity, wound repair and resistance to infection. It affects the condition of capillary walls, which become abnormally fragile if it is not present in plentiful supply in the diet. Lack of it causes 'scurvy' diseases and hence it is called 'anti scorbutic' Vitamin. It is particularly readily destroyed by heat, hence some fresh fruit or salad should be included in the daily diet. Cabbage and other greens provide a very rich source of Vitamin – C.

4.0 VEGETARIAN DIET

Our life starts with food. Life is dependent on food. Behaviour, thoughts and actions of a person are dependent on the type of food he eats. As every food involves some injury to living being (even plants have life), hence to have highest degree of character, one shall not eat anything at all. But this is not possible for survival. Hence the principle of absolute necessity and minimum harm come into picture. Vegetarian food is must but non-vegetarian is not must.

The scholar and saints of every religion of the world – Hindus, Muslims, Sikhs, Christians, Jains, Buddhists and others have described violence, cruelty, untruth, anger and hatred as sins. They not only condemned eating of flesh for food but also taught mankind to treat all living beings, animals, birds etc. with compassion.

Non vegetarian food affects the person's health physically, mentally and emotionally. Those who consume flesh have less patience, forbearance and are more cruel and violent.

Today doctors and scientists from every corner of the world are warning that flesh food induce cancers and other incurable disease and shorten the life span, whereas vegetarian food yield more nutrition and enhance the body immunity to fight diseases, promoting health and long life. Most of the animals used for food eat all sorts of unhygienic eatables and are likely to have harmful infection in their body. Imagine the plight of a person who consumes such flesh and becomes prone to innumerable diseases.

Before slaughtering animals for good, no adequate examination is made of the diseases they harbour in their bodies and thus their diseases enter the bodies of those who consume their flesh. Besides this, cruel and torturous atmosphere in which these animals are killed, creates a lot of fear, tension and anger which further makes meat poisonous. This poisonous & disease-infested meat, on consumption, induces lots of incurable diseases and it seems that it fulfills the killed animals curse, "As you consume me, so will I consume you".

It is wrong understanding that vegetarian food does not have enough proteins. It is clear from recent research that vegetarian food not only have high class proteins but also has other nutritients like vitamin, minerals. It provides enough calories. Lentils, soyabeen and ground nuts and green vegetables not only have more protein than meat and eggs but also provide other nutritients to form balance diet. Studies done in Japan and elsewhere indicate that vegetarians are not only healthy and strong but also live longer and are also more intelligent. Vegetarian food contain fibre which helps to remove waste and keep body free from diseases, is practically absent.

A healthy person has blood pH (acid – alkali balance) of 7.4 (slightly alkaline). As a result of metabolic reactions in the body, uric acid, lactic acid etc. are formed. If our food does not contain alkaline producing elements, these acids will not get neutralized and pH will reduce and this is harmful for the body. Non vegetarian food produces more acids and thus its consumption will make body prone to diseases.

There is distinct difference in the structure in vegetarian (herbivores) and non-vegetarian (carnivores) animals as far as their bodily structure, hands, feet, teeth, intestines, sense of seeing, smelling, style of eating, drinking etc. are concerned. For Example –

1) Carnivores have sharp pointed teeth and claws with such nails as help them in tearing apart their prey easily. Herbivores have teeth embedded in flat jaws. Their claws do not have sharp nails but are framed as such to pluck fruits etc. easily.

2) The lower jaws of carnivores move only upward and downward and they swallow their food without mastification. The jaws of herbivores can move up and down, left and right i.e. in all directions. They swallow their food after chewing.

3) The tongue of meat eating animals is very rough. They protrude it upwards to drink waters. The tongue of vegetarian animals is quite smooth. They use their lips rather than a protruding tongue to drink water.

4) The length of intestines of carnivores is less and kidneys are larger, so that they throw out flesh food early and easily, before it gets contaminated and poisoned. Herbivores have long intestines and small kidneys and it will be difficult to throw out meat faster.

5) The hydrochloric acid content in the digestive system of flesh – eating animals is ten times more as compared to that of human beings which digest the meat easily. The hydrochloric acid content in vegetarian species is much less.

6) The saliva of flesh eaters is acidic and saliva of vegetarian species is alkaline.

7) Flesh eaters have low blood pH i.e. it tends to be acidic. Saliva of vegetarian species have higher blood pH i.e. it tends to be alkaline.

From the above it is clear that non-vegetarian food is harmful from physical, mental and emotional health point of view. It can cause incurable diseases and also affects our moral values and character.

5.0 BALANCED DIET

Branch of medical science which deals with obtaining necessary elements from food by digestion required for growth, repair and maintenance of the body, replacing, wornout tissues and cells, producing heat and energy is called nutrition. These elements are called nutritients. These nutritients are carbohydrates, fats, proteins, mineral salts, vitamins and water. These have been described in detail in Section 3. Food which provide these nutritients in adequate quantity to the body is called balanced diet. In other words balanced diet is one

1) Which is made of proper food stuff
2) Which has nutritients in proper quantity
3) Which provides required calories
4) Which is easily digestible and has enough indigestible fibre to have clear motion.
5) Which is delicious and attractive. Otherwise people will not eat even though it may be balanced diet.
6) Which is according to social and religious traditions of the individual.
7) As far as possible it shall be according to local crops so that it is easily available.

Our body is made of organs which are made of tissues. Tissues in turn are made of cells as we have studied in earlier chapters. Bio-chemical reactions take place in cells and as a result some waste products are also produced. These waste products are toxic and are continuously eliminated from the body. If these toxins start accumulating in the body, it will result in disease. There are number of reasons for accumulation of toxins in the body, some of them are :-

- Improper food
- Too much hard work
- Too much fear
- Mental tension
- Toxic medicines
- Too much sex
- Too much worries
- Lack of sleep.

If we take balanced diet and follow balanced life style and do regularly Asan, Pranayam, Preksha Meditation, we can avoid diseases and remain healthy. Body has in built mechanism to eliminate waste (toxin) as early as possible, however when we misuse body as mentioned above, this mechanism is not able to work efficiently.

Food we eat not only affect our physical health but also our mental and emotional health. Those who pay attention to the food they eat i.e. food is balanced diet, does not contain prohibited substances (which affect our mental and emotional state, and in less quantity, remain healthy and do not need doctor. Lot of emphasis is put in Jain Religion on the awareness of proper diet and complete absence of smoking, drinking which affect mental health. There is lot of similarly in awareness of food and practice of spirituality e.g. both are depending on self-restraint, self-awareness and self-practice. As in the case of spiritual practice, guru can only guide, one has to practice himself, doctor can only guide about proper diet but one has to follow himself for proper health.

6.0 FASTING AND HEALTH

Fasting is one of the important spiritual practices in Indian life style. It is called "Nirjara", meaning freedom from the effects of old deeds (karmas) in Bhagwan Mahavir's way of spiritual practice. Eating is important as one can not live without eating for long. Equally important is fating or 'not eating for certain duration'. Our discussion on the diet is not complete unless we consider the effects of fasting on our health. Those who attach too much importance to eating and do not practice any restrains on eating fall prey of not only obesity but many other diseases.

Hence it is very important to have full knowledge of our diet i.e. when to eat, what to eat, how much toe at and how to eat.

6.1 Diet & Fasting : Fasting means both – not eating or eating less. We shall consider this broader meaning of fasting in all our discussion which follows :- Fasting has effect on our emotional health. All our lower glands adrinal, gonads get stimulated when we eat normally. In absence of food or during fasting these glands gets relaxed. It can be compared with army not getting its ration, can not move ahead. So is with these glands, these will not be active or less active when food supply is cut-off or fasting is done. Food is one of the stimulants and by reducing or cutting off, you are reducing their stimulation, activity.

6.2 Spiritual basis of Fasting : Fasting improves tolerance power and also increases determination. As mentioned in previous section, fasting reduces stimulation of lower glands which results in reducing impulses, urges and sexual emotions. Right way of fasting is first day one shall take light meal, second day fasting and third day again light meal. Following this routine will give maximum benefit of fasting. In general, people start spiritual practice from Asan, Pranayam, Bhagwan Mahavir started with fasting. This is probably due to the reason that if one can control hunger, other controls will be easier.

6.3 Scientific Basis for Fasting : After World War - II, a survey done in Germany showed that many of the diseases are caused due to overeating. Right way of eating is that one shall fill half of the stomach with food and one quarter with water. Last quarter shall be left free space for gas produced as a result of digestion. But many a times people eat more than hunger so that they donot feel hungry soon.

Dr. John Keith Bedo conducted some experiments on rats to see the effect of fasting. Outcome of these experiments is mentioned in his book 'stay young reduce your rate of aging'. Outcome of these experiments is as follows :-

1. Fasting can retard aging process. One group of rats were given facility of overeating. Other group of rats were given limited amount simple food, and third group were given food alternate day i.e. one day eating, next day fasting and so on. 2nd group of rats lived longer than first group and 3rd group lived longer tan 2nd group.

2. During fasting immune system becomes stronger. Strength of white blood cells i.e. phagocytes and lymphocytes improve which enable them to destroy antigens.

3. Fasting is helpful in reducing the risk of cancer. Dr. Bedo himself observed fasting alternate day for 3½ years and experienced the beneficial effects on health.

It was also observed that rats of first group looked tired and older while rats of 3rd group were observed young and very active.

6.4 How does fasting affects body ? : Burning of fuel takes place inside our body to produce energy and heat to maintain body temperature. Fuels are carbohydrates and fat. In normal case, glucose produced by

carbohydrates burns. When one does fasting, this fuel get exhausted soon and then fat is used as fuel. Stored fat in the body burns during fasting resulting in reduction of obessity. Along with the fat also burn any waste product accumulated in the tissues of the body. During fasting reduction in weight of different organs take place in following proportion.

Fat	-	97%	Liver	-	62%
Spleen	-	57%	Muscles	-	31%

During fasting one feels weak but mentally remains strong as there is no reduction in brain mass. One gets good sleep, good thoughts. Memory also improves.

During fasting one feels hungry for two, three days afterwards one does not feel so hungry and also hunger gets reduced due to drinking of more water. Sometimes one gets following symptoms in initial period of fasting.

- Bad Breath - Stickness on teeth - White deposit on tongue.

One should not get unduly worried of these symptoms. These donot last long. These symptoms are indication of elimination of accumulated waste in the body. As a result one feels lighter, active and enthusiastic.

6.5 Fasting & Diseases : Fasting is great medicine. In a survey in Germany after World War – II, it was found that most of the diseases are due to over eating. People eat more than required and fall sick. If we divide our hunger in four parts, two parts shall be for food, one part for food containing more water like salads fruits etc. water and remaining one part shall be left free for gas. This is ideal eating. Many of the chronic diseases like asthama, hyper tension, piles, axima, diabetes, which donot have effective aelopathic cure, have been cured by fasting. Dr. Deward Deby in America had treated his children suffering from diphtheria. Fasting is very effective cure for indigestion and other related diseases.

6.6 Duration of Fasting : Fasting can be done from 2 - 3 days to 2 months. Duration of fasting doest not depend only on disease but also on health of the person (physical and mental). If disease is not persisting for long, fasting for shorter duration say for a week may be adequate. However for treating old disease, longer duration fasting is desirable. Longer duration fasting when done properly does not cause any harm.

6.7 Precautions during Fasting : Sometimes fasting may be harmful. Hence following precautions shall be taken while fasting.

- Fasting can treat number of diseases but one shall keep in mind its limitations e.g. fasting will not help in following cases :
- TB patient at 2nd or 3rd stage of disease.
- Diabetic patients at the last stage.
- Fasting will not help in following diseases :
- Heart disease
- Kidney problems
- Fasting & particularly of longer duration is like shock treatment. Therefore it shall be under guidance of experienced person.
- One should take light meal one day earlier to fasting and shall also take light meals after ending fast for a day. Slowly diet shall be increased.

7.0 EXERCISES

Descriptive Type

1) Explain the need of energy and role of nutrients in production of energy.
2) What do you understand by fasting and explain the effect of fasting on health.

Short Notes

1) What is Vitamin – B and how it helps in energy production ?
2) Explain what is balanced diet ?

LESSON – 17

IMMUNE SYSTEM

Outline of the Lesson

1.0 Objective

After reading the chapter your will know :

1. What is immunity ?
2. What is innate and acquired immunity ?
3. Influence of mind over immune system.

2.0 Introduction

All body activities physical or chemical in nature are controlled by the brain. Messages about internal or external environment are brought to the brain by sensory nerves. All information about external environment is sensed through five senses i.e. ear, eyes, nose, mouth and skin. These massages are analysed in the cereberum part of the brain. Hypothalamus and limibic system play an important role in the process of analysis. After analysis, there are three channels of response (actions) :

1. Through sympathetic part of autonomous nervous system. Sympathetic nervous system makes concerned organ active by releasing neurotransmitters in to it
2. Through endocrine glands. Hypothalamus gives command to pictuatory gland which in turn stimulates the other glands to secrete the related harmones which in turn activate the concerned organs.
3. Through immune system.

It can be seen that brain is responsible directly or indirectly for any changes occurring in the body. It maintains state of equilibrium of body through above mentioned three routes.

3.0 Immunity

Among number of other systems of human body, there is one system called immune system. From the point of view of physical structure, it is not a separate system. Some specific cells of cardiovascular system and lymphatic system together works as body defence system (immune system). Functioning of this system is complex and not yet fully understood. Function of immune system is to protect the body from microbial (bacteria and virus etc.) invaders.

Immunity is two types : (i) Innate immunity (ii) Acquired Immunity

Innate Immune mechanisms are present from birth and that is why they are called innate, they are non-specific in that they counter act a wide variety of infective agents. In contrast, acquired immune mechanisms are specific, each being directed against a particular microorganism. These mechanisms get activated when there is attack of specific bacterias, viruses etc.

3.1 Innate Immunity

Innate immune system include :

- Skin
- Many secretions of the body
- Some enzymes

- Some type of white blood cells (WBC)
- Lysozyme
- Poly peptides
- Some special type of proteins.

These mechanisms attack the micro organisms which enter the body and destroy them in the blood stream itself. These destroyed microorganism are taken out of the body through excretory mechanism. White blood cells (WBC) play an important role in the process of destruction. A healthy adult has about 7000 WBC per cubic millimeter. WBC are of five types and their composition is as follows :-

1. Neutrophils 62%
2. Eesionphils 2.3%
3. Basophils 0.4%
4. Monocytes 5.3%
5. Lyphocytes 30%

Neutrophils and monocytes have major contribution is destroying viruses and bacteria's. Neurophils destroys the bacterias and viruses in blood stream itself while monocytes go to the site of wound and increase their size to nearly five times and engulf (swallows) the bacterias and other foreign material and destroys them and also get destroyed themselves. These cells are called macrophages.

Innate immune defences are following types :

i. Skin and mucus membranes.
ii. Phagocytosis
iii. Inflammation
iv. Fever
v. Antivirus proteins

3.1.1 Skin & Mucus Membranes :- Skin and mucus membrane are first line of body defence against microorganism. These protect the body from microorganism through mechanical and chemical reactions.

Skin is strong outer covering of the body. It has two layers of epidermis and dermis. Inner side of epidermis has layer of keratin which is tough protein and is waterproof, hence does not allows microorganism to enter the body. Apart from this, cells on outer layer of epidermis keep on dying and getting away from the body and take away the microorganism sticking to the outer layer. Mucus membrane secrets sticky fluid called mucus which hold microorganism and does not allows to go inside the body. Examples are hair and mucus in nasal cavity which do not allow dust and microorganism to go inside the body. Air going to lungs get filtered by these hairs and mucus. Similar arrangements is there to protect eyes from dust and microorganism. Tear glands secrete liquid which washes away dust etc. from the eyes. Whenever some big particle goes to eyes, these tear glands automatically increases their secretions and wash away the particle from the eye.

Skin secrets sebum (an oily substance) through sebaceous glands. It keeps skin soft and smooth. It contains unsaturated fatty acids which protects skin from bacterias and fungus by not allowing their growth. Similarly sweat secreted by sweat glands helps to control body temperature and remove bacterias out of the body. Sweat contains an enzyme called lysozyme which helps in destroying the bacterias.

3.1.2 Phagocytosis :- If some bacterias, viruses reach inside the body in the blood stream after crossing outer protections, these are destroyed by phagocytosis process. In this process phagocyte cells ingest (swallows) the bacterias and destroy them. Neutrophil white blood cells are major contributors to phagocytosis action and to some extent eosinophils white blood cells.

3.1.3 Inflammation :- When body tissue is damaged by physical injury, by chemicals or attack by bacterias, then chemicals are released from the damaged tissue which initiate inflammatory response. Inflammation is identified by four major symptoms :- 1. Redness of injured portion 2. Pain 3. Heat 4. Swelling

Sometimes fifth symptom is stopping of function. Inflammation is a protection system to remove harmful bacterias microorganism and foreign material away from the injured part of the body so that these foreign agents donot spread in the body. As healing of the wound starts, these symptoms slowly disappear.

3.1.4 Fever :- Fever (rise of body temperature) is because of the attack of viruses or bacterias on the body. Rise in body temperature for prolonged period stops the growth of viruses and accelerates the healing process. Thus fever is not a disease but is a indication of inner injury caused by viruses and initiates repair mechanisms in the body.

3.1.5 Antivirus Proteins

Apart from mechanical and chemical protections mentioned above, body produces some antivirus proteins which protect body from invaders in different ways. Some of the important antivirus proteins are as follows :- 1. Interferon, 2. Compliment, 3. Properdine

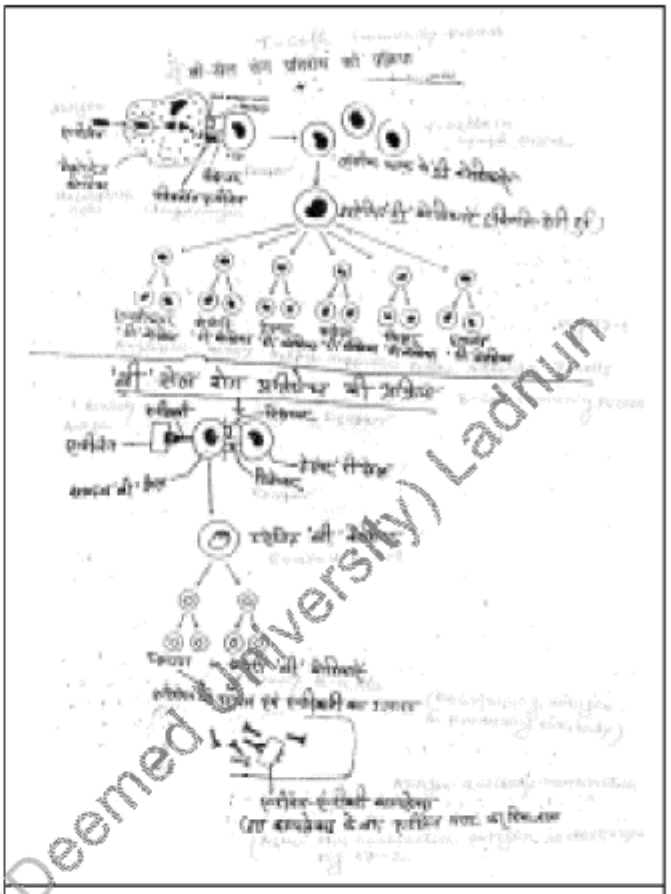
3.1.5.1 Interferon :- Many cells when attacked by viruses and bacteria's, produce interferon which is a special type of protein. It is of three types :- alfa, beta and gama. In humans it is mainly produced in lymphocytes type of white blood cells. This is a family of proteins which blocks multiplication of viruses both in cell which produce interferon and in other cells. Expressed simply, it interferes with synthesis of new virus by the cells of the host.

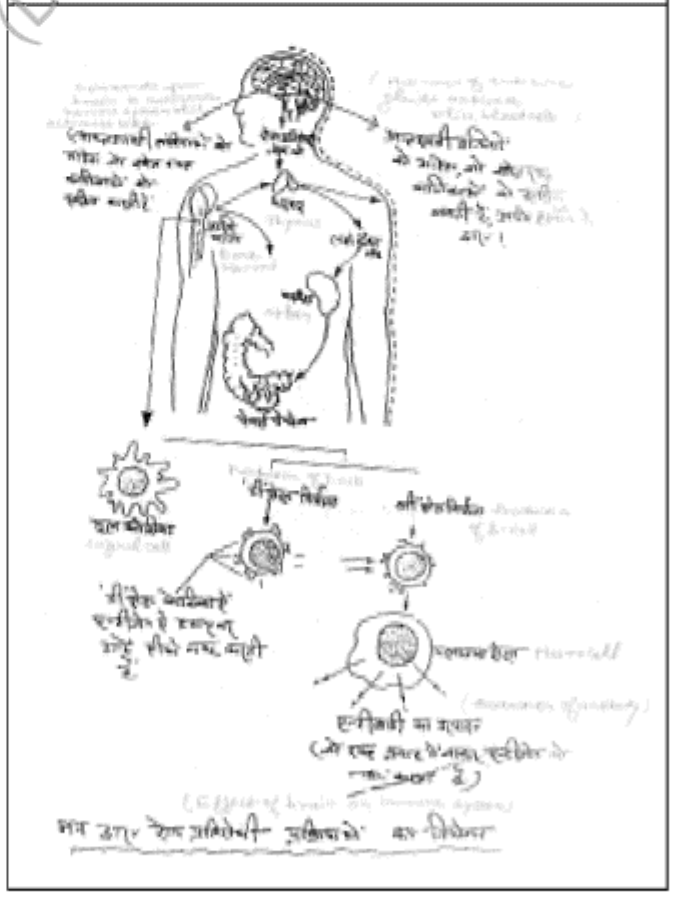
3.1.5.2 Compliment : It is a complex group of 20 proteins which have large molecular size. These are found in healthy human blood. When attacked by viruses or bacterias, these special proteins bind with them and destroy them.

3.1.5.3 Properdine : Like compliment, it is also a group of three complex proteins which destroys the viruses when they attack the body.

3.2 Acquired Immunity

Acquired immunity is specifically developed immunity against some bacteria's viruses & other harmful microorganisms. This immunity does not get developed till body is attacked by these viruses and bacterias and is not present from birth like innate immunity. Hence it is called acquired immunity. Further defences so acquired are not common to all viruses and bacterias but are specific to particular type of viruses and bacteria's and hence it is referred specific immunity. Viruses, bacterias and other harmful micro organisms are collectively called antigen.





Acquired or specific immunity is classified into two categories.

1. Cell – mediated immunity
2. Humoral immunity or antibody – mediated immunity

Cell – Mediated Immunity

In response to the attack of antigen on the body, T-lymphocyte cells get converted into T-Cells. T-Cells gets enlarged and divide into following major type of T-Cells :

1.	Amplifier T-Cell	Increases Power of other T-Cells
2.	Memory T-Cell	Recognise antigen
3.	Helper T-Cell	Helps in production of antibody (Antibody-Mediated Immunity)
4.	Suppressor T-Cell	Stops production of antibody
5.	Killer T-Cell	Attacks antigen and destroys it.
6.	Allergy T-Cell	Causes allergy.

T-Cells spread in the whole body through blood circulation, recognize antigen and destroy them.

Humoral Immunity or Antibody Mediated Immunity

When some antigen attack body, B-lymphocyte cells get converted into B-Cells. These B-Cells enlarge and get converted into plasma, B-Cells and memory B-Cells. Plasma B-Cells produce a chemical called antibody. Antibody gets attached to the antigen. By attaching to antigens, they are inactivated and resulting immune complexes are later ingested by the eosinophils. Memory B-Cells recognize all antigens present in the blood and helps to destroy them.

4.0 Influence of Brain on Immune System :

As mentioned earlier there are three channels of reactions of protecting the body in response to sensations received about environment. Immune system directly acts to protect the body from harmful effects of attack of viruses, bacterias and other microorganism. But this system is also assisted by other two channels namely autonomic nervous system and endocrine system. T-Cells have receptors for neurotransmitters – acetylcolin, nor-epinephrine, ensophiline. These neurotransmitters improve the power of T-Cells. Similarly T-Cells also have receptors for endocrine harmones ACTH, vasoprecin, oxytoxin and adrenaline and these harmones improve strength traight of T-Cells and B-Cells. Apart from increasing power of T-Cells and B-Cells, these cells also produce harmones called immuno-transmitters which give feedback to pictuatory gland and hypothalamus to continue immune activity till all antigens are destroyed. Thus brain not only affects immune system but also regulates its activity.

5.0 Vaccination :

Vaccination has been used to produce acquired immunity against specific diseases. A person can be vaccinated by injecting dead organism which are not capable of causing disease but still have their chemical antigen. Body responds producing antibodies which remain in the blood to protect body from attack from the antigens and many diseases are prevented by this immunity, examples are whooping cough, diphtheria, measles, small pox and tuberculosis.

6.0 Questions

Description Type

1. Describe innate immunity of human body in detail.
2. Describe acquired immunity and influence of brain on it.

Short answer questions

1. What is acquired immunity ?
2. How the brain responds to the sensation of external environment ?
3. What is acquired immunity ? Describe its types.
4. Specific count of white blood cells and its types and their percentages.

LESSON-18 :

MEMORY ENGRAM, BIO-CHEMICAL CHANGES IN THE PROCESS OF LEARNING AND MEMORIZING

Outline of the Lesson

1.0 Aims

1. We will learn about Memory and Engram.
2. We will understand the principle of neurophysiology of learning
3. We will know the principle and process of memory.

2.0 Preface

Without memory we cannot learn anything and we make repeated mistakes. We have succeeded in learning. Scientists have been studying memory and learning for years but they still have not got a satisfactory answer for this question as to how do we store matters in our memory and recollect them. Up to some extent they have explained as to how the brain received information and stores it safely.

3.0 Memory and Engram

According to scientists, the ability to achieve knowledge or expertise about some topic on the basis of instructions or experience is known as grasping. Grasping is very closely related to punishment or reward. In other words, a person is ready to learn only if there is some hope of getting a reward or fear of punishment. Ability to recollect thoughts is known as memory. When an incident or an experience becomes a part of our memory, then some specific changes occur in the part of brain which represents that memory or where it is analyzed. These changes

leave their image. This image is known as 'Engram'. The areas of brain that take part in the process of memory and grasping are frontal, parietal, temporal, and association cortex of occipital region. Besides these, diencephalon (Thalamus and Hypothalamus), limbic system also take an active part.

3.1 Types of memory : There are two types of memories-Short term memory and long term memory. The period of short term memory is limited to a few seconds to a few hours. Even if it is tried to be recollected after this period of time, it is memorized in pieces, and rest of the part is permanently forgotten. For example, if a person is told to make a call to an unknown person, he will forget the telephone number after certain period of time. This happens because the telephone is not much important or useful. The period of long term memory is stretched from a few days to few years; for example our own telephone number. Because of frequent repetitions, it can be recollected whenever it is required. Not only that, the more it is repeated, the stronger the memory becomes. The process of strengthening of memory is called Memory reinforcement.

Our brain gets various messages and stimuli. Amongst these we are conscious to only some. According to a survey, only one percent of memories go to long term memory and its major part is forgotten again. It's a pleasant coincidence that the brain stores only some of the messages and allows other messages to vanish. If this had not been the case, there would have been bunches of information difficult to be stored; and this may have led to a mismanaged situation.

It is a peculiarity of memory that it can recollect short listed information more easily than long listed information. Like a magnetic tape, all the information is not recorded but only selected information is stored. Another peculiarity of memory is that even if long listed information is forgotten, some of the points can still be recollected. This is the reason why we cannot represent memorized topics in their original form but we represent its expressions in our own words.

4.0 Neurophysiology of learning

Under this section we will describe the neurological and physiological basis of learning. We already know that learning is defined according to three theories (i) Classical Conditioning (ii) Discrimination Learning (iii) Hypothetic learning. However majority of the experiments on neurophysiology of learning were conducted on animals-cats, dogs, rats etc. because it is not possible to disturb the human physiology.

5.0 Neurophysiology and classical conditioning

The Russian physiologist Pavlov established the famous principle of 'Conditioned reflex' in 1906. He used ring as a Conditioned Stimulus in his experiments. He presented food before a dog just one second after buzzing the ring. After repetition of this experiment he found that the conditioned reflux (ring) induced salivation (unconditioned reaction). This process is known as Conditioned response. Defensive condition can also be included under classical condition. In this experiment an animal is given electric shock after a conditioned stimulus (light or ring). In this process an animal learns to lift his limbs. Now we will describe the neurological and physiological changes that occur in conditioned and defensive learning. In conditioning, anatomical structure will be described under four groups -(i) Brain lesion, (ii) Brain Stimulation, (iii) Electrical correlates and (iv) Physical basis

5.1 Brain lesions : It is the most ancient method to study physiology and processes of brain after dissecting it. Besides other modern methods, this method is also equally in vogue. Initially this method was limited to studying cerebral cortex to learn its functions after removing and dissecting it, but the modern developed stereo taxic methods have enabled us to go deeper and destroy deep cells to throw light over the functions of subcortical areas. This method describes the functions of cerebral cortex, limbic system, thalamus, mid-brain, and spinal cord in the process of learning through conditioning.

5.1.1 Cerebral Cortex : The functions of cerebral cortex can be divided in to four groups – Complete decorated, Semi-decorated, stimulatory system, and frontal cortex.

5.1.2 Limbic System : The majority of its part comprises of sub-cortical system but it also includes the sigulate gyrus of cerebral cortex. In this system, the effects of destruction of septum, hippocampus, amidola, and hypothalamus, conditioned reflexes, and defensive reflexes experiments are studied.

Isolation of septum increases sensitivity and its effect vanishes after a certain period of time. Effects of isolation of Amidola are less observed in the behavior of pet animals. Its effect makes wild animals calm and less sentimental. So, isolation of amidola primarily destroys Conditioned Emotional Responses (CER) and Conditioned Avoidance Responses (CAR). Sigulate gyrus plays an important role in conditioned defense, but its parts are related to various types of defense.

5.1.3 Thalamus : Three areas of thalamus are for defensive and classical conditioning- (i) Posterior Nuclei which is related to visual stimulation. Some rats developed jumping as defensive reflex in response to light stimulus, others were observed to develop same reflex in response to a sound of one thousand hertz. After isolation of posterior nuclei it was observed that the rats which responded to auditory stimulus were more affected- (ii) Dorsomedial Nuclei, which are related to defensive conditioning. After its isolation the animals were found to have difficulty in learning again – (iii) Diffuse Thalamic Nuclei which is the upper part of reticular system which supplies some parts of cerebral corted as well as receives fibers from it. After isolation of this part, the re-learning process is more diminished.

5.1.4 Lower Brain stem : Lower brain stem also plays an important role in conditioning.

5.1.5 Spinal Cord : Some learned people consider spinal cord to be the important part of conditioning whereas others are not of the same opinion.

5.2 Brain Stimulation : In the other process of learning neurophysiology of conditioning, various parts of brain are stimulated with electricity. In this process, saliva is used as chemical stimulus.

5.2.1 Conditioning stimulus : In classical conditioning, visual and auditory stimuli are replaced by electric stimulus in cerebral cortex. In this situation a dog was conditioned to produce saliva by showing food and lift its limbs to defense against shock. Psychologists are of the opinion that in learning, stimuli are related to normalization. This means, the learned stimuli create those reactions which are learned. In studying the process of neurophysiology of learning, anatomical pathways are very much important. While investigating the functions of corpus callosum that connects both sides of cerebral cortex and other centers, it was found that sub-cortical pathways are having more importance.

5.2.2 Unconditioned Stimulus : Various parts of brain can be stimulated using electricity as unconditioned stimulus, but the motor area of cerebral cortex is more sensitive. In case of a dog on stimulating the motor area just one second after buzzing ring gave rise to contraction of legs. When this procedure was repeated, no response was observed. But when the dog was presented food as a reward on lifting limbs, conditioned reflex was observed. This ultimately concludes that if the action created by stimulation of cerebellum is combined with a proper conditioned stimulus, then it can be conditioned.

5.2.3 Interference effects : When a brain stimulus has an effect on conditioned reflex then it is known as interference effect. This happens because cortical stimulus gives rise to number of neurological processes at the site of stimulus or near to the site of stimulus. This process inhibits of interferes the normal reaction. Many experiments were carried out in this context and it was found that only visual distance, hippocampus, hypothalamus etc. are affected.

5.3 Electrical Correlates : The events that are stored under conditioning are correlated with the condition and are classified in to two classes- (i) electroencephalographic change i.e. change in the rhythmic pattern of brain and (ii) Evoked potential.

6.0 Discrimination learning

In the process of learning, an animal learns in context with the stimulus and environmental objects. This is called discrimination or direct learning because there is supplementary evidence of the environment. The study of physiological reflex of discrimination learning is done under following three parts

6.1 Somesthetic discrimination : In 1939 Smith tried experiments on rats as to whether they are able to discriminate roughness of surface. He placed two sand-papers in equipment, one of which was rough and the other was slimy. Rats had to walk through both of the sand-papers to achieve their food. To understand the extent of

discrimination, Smith made lesions in various parts of cortex. No lesion could prove the habit of discrimination of roughness in rats.

Allen (1940-1947) tried conditioning process to study extent and intensity of tactile discrimination in dogs. When he removed somatic area I, the tactile discrimination was reduced in dogs, but the memory of discrimination was not lost. When somatic area II was removed, then the dogs were found to have a habit of forgetfulness. Thus, Allen concluded that tactile discrimination in dogs is related to somatic area II.

By the experiments carried out by others in order to find out the habit of tactile and kinetic discrimination it was found that when the posterior parietal lobe was removed in monkeys, the memory of discrimination of roughness was lost. This way so many experiments were carried out and efforts were made to measure the effects on achieving the habit of discrimination. It was also found that chimpanzees have more tendency of forgetfulness compared to monkeys once their posterior parietal lobe was removed. To achieve kinetic discrimination, monkeys were educated for weight discrimination. After that their pre-central, post-central and posterior parietal lobes were removed one by one and together. After removing any of the areas it was found that monkeys lost weight discrimination. But after training, the memory was restored. Moreover, it was also found that on removing pre-central areas, memory loss was minimal. But if post-central area was removed, it was found that it leads not only to extensive memory loss but total loss of memory. Thus, it can be stated concisely that eligibility of learning discriminative actions in monkeys does not just depend on a single particular area.

6.2 Auditory discrimination : There is no definite information as to how brain processes are related to auditory discriminative habits, and as many experiments that are done so far are at least not unsatisfactory. There are two important points in auditory discrimination (1) Intensity of discrimination, and (2) Learning. Under the section one, various experiments are conducted to train animals to understand the discrimination of sound intensity. For example, a cat is left in a running cage and a sound is created. If the cat does not run on hearing the sound, it is punished. Under the section two, animals are studied in relation with auditory discrimination process. Scientists believe that animals develop this habit without listening from auditory cortices. They also believe that memory loss is related to the auditory area of brain. When an animal learns an ordinary habit on some grounds, then this habit is lost when the animal's both auditory cortices are removed. It has been found in rats that their habits are deeply related to their auditory areas. If auditory area is removed in rat, then they need a special training to reestablish their lost habits. It has not still been decided as to whether a rat re-learns its habits that are lost due to removal of auditory area or not. We are surer about dogs and cats. In them, there is an extensive loss of habits once their auditory areas are removed, but they relearn their habits quite easily.

6.3 Visual discrimination : Till today maximum experiments have been carried out on visual discrimination because these experiments are comparatively easier and more scientific. Secondly, vision related activities and related areas in brain have been thoroughly understood. The study of visual discrimination can be divided in to four parts- Intensity, movement, pattern and colour.

6.3.1 Intensity : Scientists have concluded that thalamus and upper brain have a good contribution in learning because of intensity of visual discrimination. From experiments it was seen that if thalamic nuclei are injured then there is reduction in learning. According to Giselle's studies if both the sides of upper brain are removed, it does not affect learning ability, visual discrimination or memory. If upper brain is removed after removing visual cortex then it creates a loss of memory for discrimination. However, animals can re-learn the habit of discrimination on training. Thus it can be said that upper brain does not have any relation with discrimination of intensity, but if visual cortex is removed than discrimination is lost.

6.3.2 Movement and Colour : This is also an important problem in visual discrimination. We have highlighted at many places as to how humans and animals discriminate colours. Loss of memory of movements is related with striate cortex in animals as far as movement discrimination is concerned. Those animals in whom striate cortex is removed are deprived of movement discrimination.

6.3.3 Pattern discrimination : Visual command is limited from retina to visual cortex. We also know that any

pattern and its distinctiveness are materialized to us through visual cortex. On this basis it can also be said that if any lesion is made in visual cortex then it gives rise to loss of pattern discrimination, and its learning ability. On experiments on rats it was found that upper brain does not have any impact on learning pattern discrimination. Whereas, pretectual nuclei which are exactly in front of upper brain have an important role in learning pattern discrimination. It was also found that thalamic nuclei also have an important role in the same but not so much as the pretectual nuclei have. Lisle has proved that if some part of striate cortex is removed or injured then animals are not deprived of learning pattern discrimination. But if the removed part is in a big mass, then the ability is totally lost.

7.0 Hypothetic learning

Following principles have been established on the basis of neurophysiologic learning.

7.1 Cappers's principle of Association : Initially, psychologists were of the opinion that some unstable structural relations are created because of contractions and relaxations in dendrites due to which the learning process changes its form. Cappers cleared on the basis of his experiments that the growth of axons and dendrites due to bio-electric current leads to some stable relationships which are related to learning process. This principle cannot be authenticated much because it explains co-existence but does not explain the way of co-existence.

7.2 Lesley's growth principle : According to Lesley if nerve cells are stimulated then they grow up in size, moreover the intensity of nerve impulse also increases in the equal proportion of their size. If the controlling substances inside a nerve cells are changed then it will give rise to some other distinctiveness.

7.3 Mc Dougel's principle : According to this principle the learning process is related to a specific type of energy which gets collected inside nerve cells.

7.4 Tanzie's principle : According to this principle, the changes that take place inside a brain-cell are the same as in a unicellular organism (e.g. Amoeba). The way changes take place in an amoeba in dendrites and axons because of intracellular metabolism, the cell becomes long shaped and deep. These changes take place due to nerve impulse in a cell. If these impulses come repeatedly, they it leads to approximation of dendrites of one cell with axon of another which leads to conduction of central impulses. Thus it becomes association of cells and becomes the basis of memory.

7.5 Child's principle : According to this principle the conduction of impulse from unconditional stimulus pathways occurs basically through natural stimulus pathways, and in a secondary form it takes place through conditional pathways. As a result the brain-cells that conduct natural stimuli are more stimulated and negative ions get centralized on outer surface. But the cells that conduct conditioned stimuli get comparatively much less stimulated and there is accumulation of positive ions on their surface. This leads to attraction among the above mentioned both types of brain cells and they form a functional unit.

7.6 Holt's principle : According to Holt during embryonic development in an animal there is following situation in nervous system.

(i) Stimulatory cells are related only to external receptors and not with central nervous system.
(ii) Central nervous system is neither related to stimulatory cells nor with inductive cells.
(iii) Inductive cells even if related with inductive organs can initialize at any level in central nervous system.

7.7 Young's principle : According to this principle the process of memory takes place in those areas of cerebrum which we know as 'Association areas'. These areas are very much complex as per their cellular structure.

Young's principle is the modified form of Lesley's principle according to which recall is just the reverberation of random connections of cells. Young on the other hand showed that the above mentioned principle is applicable only to short term memory. But the term memory is the localized modification of random connection of cells. Localized changes in cells take place in long term.

8.0 Principles and process of memory

According to a principle short term memory can be due to the reverberating circuit established between unit neurons of nervous system. In this process an impulse reaches to first neuron and then reaches consecutive neurons

by nerve impulse conduction and ultimately reaches its end. After that the impulse returns back through the branches of neurons and thus the cycle goes on. Because of this the information gets stored as memory.

There is one more hypothesis that short term memory is related to the electric and chemical processes that occur in brain and not with constructive changes. Comma, unconsciousness, electric shocks etc lead to reduction in short term memory because there processes interfere the electric and chemical changes in brain.

The ability of long term memory depends on the structure of neurons as well as the bio-chemical changes that take place in synapses. Structural changes take place in neurons when either they are repeatedly stimulated or they stay inactive for long. These structural changes include increase in terminal branches of neurons, increase in the size of synaptic bulbs, and increment in the branches of dendrites. Because of these changes the performance of neurons increases. Bio-chemical changes include growth of neurotransmitter, improvement in their quality, increase in neurotransmitters receptors, and rapid conduction of neurotransmitter.

It was also found that the increment in the amount of D.N.A. and R.N.A. is also responsible for the improved performance of neurons which has a positive impact on the long term memory.

Latest experiments have put forward a new concept; according to which there are series of chemical reactions in neurons resulting in a stable or unstable synchronization between them. This change possible forms the basis of memory. When a nerve impulse reaches synapse through neuron, there is secretion of neurotransmitter which fits with the post-synaptic neuron. This opens up calcium channels and there is a tide in ions and ultimately an enzyme gets activated. The activity of this enzyme is helpful in memory.

According to another hypothesis there are some neurons in which there are two pathways for impulse generation. In these neurons there are some receptors called N.M.D.A. which give rise to enhancement of incoming flow of ions. This leads to enhancement in storage of messages in synapses which accounts for long term memory.

9.0 Sample questions for study

Assays :

1. Define memory and describe its principles.
2. Describe the principles of neurophysiology of learning.

Short questions :

1. Define long term memory.
2. What is the principle of conditioned reflex.

Objective questions :

1. Where is a memory engram found?

A.	Head	B. Eyes	C. Gall bladder	D. Brain

2. Who gave the principle of association?

A.	Cappers	B. Lesley	C. Tanzie	D. Child

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LESSON-19 :

PHYSIOLOGICAL BASIS OF EMOTION AND PREKSHA-MEDITATION

Outline Of The Lesson

1.0 Aims

1. What are the emotions?
2. We will learn about the predispositions and facets of emotions
3. We will be able to learn the theories of emotions.
4. We will learn as to how emotions can be controlled with Preksha-Meditation.

2.0 Preface

Emotion is a mental condition in which an animal gets extremely excited. During this kind of excitement the behavior and personality of the animal gets scattered and various body parts function distinctively. Not only that but the animal affected by this emotion is conscious about the excitement.

3.0 Emotion

Emotion is an induced behavior in which (in humans) there is presence of a high level state of consciousness and there is manifestation of attraction and repulsion. Also there are independent activities in the whole central nervous system. For example, in case of fear, anger and happiness there is expression of high level influence and accordingly attractive (in case of happiness), repulsive (in case of fear) and violent (in case of anger) behavior results.

3.1 Emotion as a conscious state : According to psychologists and other visionaries, various kinds of awareness result as consequences of manifestations of external events. Means those conscious states are known as emotions which are responsible for various emotional behaviours since birth. This implies that conscious states are necessary for emotional behavior.

3.2 Emotion as a behaviour : Some learned people consider emotion as a kind of behavior. According to them a persons' behaviour varies in different emotional experiences. Emotion includes various behaviours like smile, laugh, shout, fear, some facial expressions etc. In case of animals, wading tail, breathing, roar, etc. Besides these, some autonomic behaviours are also responsible for emotions e.g. blood congestion due to anger, changes in blood pressure, hormonal changes etc. These are the examples of autonomic emotional reactions.

3.3 Emotion experience : People can verbally define the emotion experience e.g. experience of fear, getting excited, etc. These experience are so much complex and blended that it is difficult to understand them scientifically on physiological basis.

3.4 Emotion as a mental and physiological event : Modern physiologists and psychologists define emotion as a mental and physiological event. According to them emotional consciousness and emotional behavior result from mental and physical events. Emotional behavior is mainly under control of autonomic nervous system and endocrine glands. When a person feels emotion his heart rate increases.

We will mention some emotions under this definition because we will study emotions in this chapter only as a mental and physiological event.

(i) According to some psychologists, emotion is a behavior pattern that occurs in the viscera and other bodily parts.

(ii) According to other learned people emotion is a cortical event which depends upon response patterns that have occurred elsewhere in the viscera, in the hypothalamus or in some combination of three.

(iii) According to some people emotion is a bodily pattern which is preceded either by psychological event or subsequent mental events.

(iv) William James says while defining emotion that, "Emotion is a mental event. It is the feeling of change occurring in the viscera and the skeletal muscles which changes have been initiated directly by perception of a appropriate stimulus."

(v) According to Lange, "Emotion is a vasomotor disturbance."

(vi) According to Cannon and Ward, " Emotion is a mental event. It depends upon change in the hypothalamus which have been initiated by an appropriate situation."

4.0 Why are we affected with emotions?

A question arises here as to is there any person who has never felt any kind of emotional pains? The simple answer is that no one. Emotion is one of the mental and physical evens in human lives. persons of every race and age are unexceptionally affected by emotions. It can also be said that emotional situations are neither useful for mind and body nor they are beneficial. Emotional situation is a negative aspect of physical balance. It arises only in case there is difficulty in accommodation with situations. For example, fear arises only when the 'Flight or fight' ability becomes weak.

Because of emotions our behavioural ability increases. In the presence of emotions we are capable of distinctive reaction instead of typical reaction arising as a result of external stimuli because these reactions are based on

contemporary conditions. It's a different thing if these reactions are mostly negative. Physical changes occur according to the intensity and type of emotions; and based on this their reactions can be analysed.

5.0 Predisposition and facets of emotions

We can learn the art of expressing or hiding our emotions but one thing is for sure, and that is that emotions always result in to something. Figure (1) illustrates inherited and basic emotions which have four pairs of opposite qualities- e.g. joy-sorrow, fear-anger, surprise-surmise, acceptance-disappointment. Besides these, there are modified or expanded forms of emotions-e.g. love is the blended form of happiness and acceptance, whereas exclamation is the blended form of fear and surprise. Recent analysis clears that emotions have both inherited and acquired causes.

6.0 Theory of emotion

This subject has been there since ancient times. There have been optimum discussions on this subjects beginning from ancient Unani visionaries till modern times. All the theories of emotion have particularly emphasized over its physiological aspect. In other words, all the theories have considered physiological facts to be of more importance in expression of emotions. There are so many theories in vogue, but they are of different opinion in considering its physiological aspects. Where Canon and Ward are of the opinion that hypothalamus is the origin of emotions, James and Lange attribute peripheral factors to be the origin of emotion. In other words it can be said that physical and mental changes take place in case of emotions. But the question is that which one initiates first and which one is having more importance. To decide this, many physiologists and psychologists established principles of emotion which have physiology on their bases. Now we will define some major theories of emotion.

6.1 Common sense theory : According to this principle emotion first affects mental functions and then it affects physical ones. Before manifestations of emotional situation, mental changes take place, after that physical changes occur. Thus, emotions are experienced before manifestation. But there is no scientific proof or this theory. It is the opinion of various people which we have decided after their own experiences. because of practical basis of modern psychology, it is not possible to except simple explanation of events.

6.2 James Lange's Peripheral theory of emotion : James Lange's principle is being considered to be the most important one for many years. According to him emotion is a conscious state which is the cause of emotional behavior. He attributed physical reactions to the stimuli like happiness, anger, fear to this conscious state. His principle tries to explain as to how emotional experience and emotional behavior are connected to physiology. The motto of this principle is that emotional reaction is the first one to arise and emotional experiences are as a result of this emotional reaction.

This principle was established in around 1880 by the American psychologist James and the physiologist of Denmark Lange. Their principle was exactly opposite to the common sense theory. James published an article in 1884 with the name of 'Mind' in which he tried to explain the interrelations between emotions and their expressions. He was of the strong belief that emotions arise basically from hormonal and tissue reactions. Lange independently published this type of theory in 1885. He proved form his studies that emotions completely arise from only physical changes. So, the combination of these two theories was known as James Lange's principle.

Any stimulation or event when arises which we know as emotion, there takes place some tissue and hormonal reactions in physical aspect. As a result the impulse reaches to the cortex and emotional reactions are expressed with an experience of emotion. The major point of this principle is as to where the emotional experience origins from, internal viscera or tissue stimulation.

According to Freeman, "This principle confirms that internal processes create consciousness and stimulation originates physiological processes and as a result to these we feel emotional experience. In short, tendency of physiological changes is the emotional experience." So, after studying this principle we have come to the conclusion that because of manifestation of emotional condition physical and behavioural changes take place and their expressions arise. Thus, the main reason of emotion is the physical and behavioural processes and not the mental ones. James says that we fear because we escape and we get angry. We become sad because we shout; we become angry

because we fear. For example, when we see a snake or a tiger in a forest, then first we give emotional response and then we feel emotional experience. We run after seeing a tiger. During emotion there is increase in blood pressure, changes in respiratory rate, digestive disturbances, movements of pupils of eyes, and other internal and external physical changes take place. It is after these changes that we fear from the tiger.

According to James and Lange we can derive emotion according to following.

Thus, according to James and Lange, we cannot even think about emotion without physical and behavioural changes. If these changes are removed from emotions then an emotional condition will be merely virtual, an actual emotional condition will be absent. James says here, In such a situation we will take a good decision to run on seeing a bear, we will consider it to be our right to hit someone on getting insulted, but in actual we will neither be feared nor angry."

Thus, emotions cannot arise without physical and mental changes. Until these changes take place, no emotional experiences take place.

6.3 Central theory of Cannon and Ward : This is also known as 'Thalamus theory'. According to this theory emotional experience and functions of internal viscera take place independently and at a time. The stimulation that arises in receptors goes directly to thalamus and then it bifurcates to reach cortex at one side and effectors to the other. The stimulation that reaches cortex gives emotion experience and the one reaching effectors initiates physical and mental changes. Thalamus supports initiation of these two processes independently. This theory believes that emotions arise due to the stimulation of hypothalamus.

It is obvious through experiments and looking in to the internal functions that hypothalamus has an important role in emotional experience and manifestations. It still cannot be said unquestioningly that the principle is a whole truth. The major fault of this principle is its being too much simple; secondly, it does not explain a satisfactory relation between emotional experience and emotional behavior.

6.4 Watson's behaviouristic theory of emotion : Watson denied role of consciousness in behavior. Not only that, according to him behavior occurs due to external manifestation of stimulus, in which senses and central nervous systems play their parts. According to Watson anger, fear, joy are the behaviours. He experienced in his work as to which of these as well as other emotional responses are inherited, in which form they are represented and which are the stimuli controlling them.

Watson resolved from his experiments that three emotional behaviours are inherited in children. These are anger, fear, and desire; respectively: X, Y, and Z. According to him complex emotional behavior takes place due to conditioning. In case of fear, anger natural processes are controlled by brain centers according to training.

6.5 Autonomic response theories of emotion : Many learned people have considered autonomic response to be related to emotion. Majority of these learned people have studied that parasympathetic responses are necessary for positive or pleasurable emotions, where as sympathetic responses are necessary for anger and fear. Some psychologists believe that various autonomic responses are inherited. In other words, it can be said according to this theory that autonomic responses themselves are emotions and they are always necessary for emotions. Some writers believe that autonomic responses are necessary only during initial phase, but once learning process starts, only brain processes are necessary.

6.6 Papaz-Mc Lean theory of emotion : According to this theory nervous system controls that center where emotional behaviour and emotional experiences are organized. In the control of these emotional behaviours various centers and pathways are set, like-septal area of the cortex, cortical cingulated and entorhinal areas, hipp[ocampus, and most of the amygdaloid nuclei. Papaz described the circuit of these centers and pathways as – the entorhinal cortex to the hippocampus, thence to the hypothalamus via the fornix, from here to tha anterior thalamus, and finally to the cingulate gyrus. However most of these structures are related to smell, Papaz found from his studies that they are also related to emotions. After that Papaz's opinions were supported by Mc Lean who also mentioned that the arrangement of emotional behavior is done in diencephalon and hypothalamus as well as brain structures.

7.0 Physical and neurological basis of emotional behaviour

Now we will define some physical basis of emotional behavior :

1. Endocrine glands
2. Autonomic nervous system
3. Somatic and visceral system
4. Limbic system
5. Medulla
6. Mid-brain
7. Hypothalamus
8. Thalamus
9. Cerebral cortex
10. Hippocampus
11. Amygdala

Here we will only cover some important basis.

7.1 Endocrine glands : Endocrine glands are considered to be the major physical basis of emotional behavior; because various endocrine glands affect various emotional behaviours in different ways. It has been proved from experiments that thyroid gland does not function well in the situations like fear, anger, etc. and thereby causes unfavourable effects on health. Exactly opposite to this situation, it has positive effects on health in situations like happiness and enthusiasm. Parathyroid gland alleviates sentimentality. Adrenal gland secretes adrenaline which affects emotional behavior like sympathetic emotions. In other words it can be said that endocrine glands have sound relationship with emotions. On improper functioning of these glands, a person's personality becomes feeble and his emotional behavior becomes imbalanced. These glands are active in all kinds of emotions especially anger, fear, happiness. When our body needs extra blood supply during an emotional condition, the adrenal glands secretes adrenaline into our blood giving rise to increased heart rate, hampering of digestive process. This alleviates tiredness and helps a person maintaining his composure. Pituitary gland is also helpful in emotional conditions while maintaining control over other glands. If this gland doesn't stimulate adrenal gland then a person becomes short-tempered and weak. Same way sexual glands are also having an important influence over emotions. They express happiness when two persons having opposite sex meet. Thus, it is clear that various endocrine glands support emotional behavior.

7.2 Autonomic nervous system : Both the parts of autonomic nervous system viz. sympathetic and parasympathetic nervous systems have distinctive roles over emotional processes. When an emotion arises in emergency situation, sympathetic nervous system is activated. It increases heart rate, blood pressure and blood circulation during conditions like anger, and fear. It hampers digestive process and stimulates adrenal gland. The other part of nervous system parasympathetic nervous system controls stimulated viscera and smooth muscles during emotional condition. It decreases heart rate during emotion. Thus, autonomic nervous system has got important functions in emotional situations.

7.3 Medulla : Medulla controls many autonomic reactions like hear rate, blood pressure, pupils, etc. It has many centers to control autonomic reactions which function under higher centers especially hypothalamus. Besides, visceral changes that take place during stress situation of emotional arousal are controlled by medulla. It also brings change in internal environment by this process.

7.4 Mid-brain : Localized stimulation brings about changes in ablation from mid brain to cortex during an emotional behavior. Localized stimulation stimulates pathways of any part of medulla that lead to higher centers. Whereas on other side ablation hampers the pathways leading to higher centers. For example, stimulation in mid-brain stimulates pathways of pain leading to emotional behavior. On stimulating central gray substance in various parts of brain stimulates pathways for anger, fear and escape. On studies, it has been found that mid-brain regulates some security emotional reactions.

7.5 Hypothalamus : Hypothalamus is considered to be the major center of emotions. Some psychologists like Canon and Ward believe it to be the origin of emotions. It functions in three aspects- at first impulses conduct from receptors to cerebral cortex through it and initiate emotional behavior. Second, they bring impulses from cerebral cortex. And third, it is through hypothalamus that the impulses reach viscera. hypothalamus unites emotions like fear, anger etc. in a very important way. Anterior hypothalamus originates anger and lateral and posterior hypothalamus initiates behavior of escape.

7.6 Cerebral cortex : It has a definite and major part in emotional behaviour.

8.0 Emotions and Preksha-meditation

Nervous system and endocrine system are the two major control centers of human body which together control and regulate all the physical actions. There is such a harmonious correlation between their functions that scientists have given them a single name Neuro-endocrine system. Nervous system increases bio-electric currents inside nerves as per requirement and thereby stimulates relative organs. With that, pituitary activity increases under the influence of hypothalamus. Other endocrine glands regulate metabolic activities through their secretions. With the joint efforts of these two systems emotions are enhanced.

When we perform preksha of the energy centers of nervous system under 'Chaitanya Kendra preksha', we get three results- first, it brings about purity in the bio-electric currents in nerves and its related electromagnetic field. Also brings about purity in the amount and quality of neurotransmitters. As a result their influences are also changed. The second result is arousal of center of pleasure which gives rise to reduction in the rate of reactions. The third impact of chaitanya Kendra preksha is arousal of energy. As a result of this, all those centers of body are roused that function as antidotes. As a result intensity and frequency of emotions are reduced.

'Shwas preksha' and 'Karyotsarg' also regulate energy centers of body.

9.0 Questions for study

A. Assays

1. Define emotion and describe its principles.
2. Describe predisposition of emotion and mention how it can be regulated by preksha-meditation.

B. Short questions

1. What is emotion?
2. Mention major aspects of emotion.

C. Objective questions

1. Which organ/system of body has major part in emotions?

   a. Kidney b. Liver c. Autonomic nervous system d. Stomach

2. What increases in case of emotion?

   a. Small intestine b. Heart rate c. Pancreatic movements d. Teeth movements

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YOGA AND SCIENCE OF LIVING

PAPER-III

APPLIED PHYSIOLOGY & ANATOMY

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