PREFACE

It is a privilege to write the Text Book of Anatomy and Physiology, for Intermediate Vocational Nursing Course from Board of Intermediate Education, Government of Andhra Pradesh.

The purpose of this book is to provide the student nurses and other health workers with the knowledge of the structure and functions of human body.

The principle of Anatomy and Physiology is designed for introductory course in Anatomy and Physiology and assumes no prior knowledge of the human body to the students. It is geared to students preparing for careers in the health related profession.

In this book, all facts about these subjects that a student nurse needs to know, are presented in clear and easy to understand, the text is accompanied by numerous illustrations to facilitate to get comprehensive knowledge of the body and the changes that take place when disease disrupt normal processes.

This book has been written in accordance with the revised Vocational Nursing Curriculum 2005-2006, Board of Intermediate, and Government of Andhra Pradesh and in the light of Health development in the Country based on Primary Health Care.

This is an attempt to provide the student with maximum knowledge in a compact form. This book helps the student in preparing for the exams as it consists of the topic prescribed in the syllabus.

It is hoped that this book will be more useful for the Multipurpose Health Workers and other workers in Medical Education.

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UNIT – I

THE BODY AS AN INTEGRATED WHOLE

The body is wonderfully made, like complex, perfect machine. Each part is especially built to carry out its own function, and to work as whole with the other parts.

Introduction

It is important to gain a basic understanding of how the human body is organized, how its different parts normally work, and how various conditions affect its operation to maintain life and health.

Anatomy is the study of structure and the relationships among structures.

Physiology is the study of the functions of the normal human body.

Sub-divisions of Anatomy are:

Surface Anatomy is the study of the form (morphology) and marking of the surface body.

Systemic Anatomy is the study of specific systems of the body such as the nervous or respiratory system.

Regional anatomy is the study of specific region of the body such as head or chest.

Sub divisions of physiology are;

Cell physiology is the study of functions of cells.
Patho physiology is the study of functional changes associated with disease and aging.

Immunology is the study of defense mechanisms

The human being is a very complex multicellular organism in which the maintenance of life depends upon a vast number of physiological and biochemical activities. The sum of these activities enables the human being to live in and utilize his environment, and to maintain the species by reproducing. As for human being there are many structures consisting of cells, tissues, organs and systems. According to the basic needs of the body the systems are formed.

ORGANIZATION OF LIVING THINGS

FACTORS DIFFERENCIATING FROM LIVING AND NON-LIVING THINGS

All living forms carry on certain processes that distinguish them from non-living things. Following are some of the important life processes.

1. Metabolism: Is the sum of all the chemical processes that occur in the body. This happens by two phases Anabolism and Catabolism.
2. Responsiveness: Is the ability to detect and respond to changes in the external or internal environment.
3. Movement: includes motion of the whole body, in dual organs, single cells or even organelles inside cells.
4. Growth: is an increase in size that result from an increase in the number or size of cells or both.
5. Differentiation: is the change that a cell undergoes to develop from an un specialized to a specialized state.
6. Reproduction: refers to either formation of new cells for growth, repair, replacement or the production of a new individual through reproduction, life continues from one generation to the next.
**Anatomical position:** a person standing with arms at the sides, palms facing forwards, the head erect and eyes looking straight in front, and this is described as the Anatomical position.

**The Parts of the Body:** The body consists of head, neck, trunk, upper limbs (the arms) and lower limbs (the legs).

**The following terms are used in Anatomy:**

- superior – higher
- inferior -- lower
- anterior – nearer, the front of the body
- posterior – nearer the back of body
- medial—nearer to the midline
- lateral—to the side
- proximal—nearer to the head or source
- distal—distance from the head or source
- internal—inside or nearer or to the trunk center
- external—outside or away from the trunk centre
- superficial—nearer the body surface
- deep—inside, away from the body surface.
- Border—this is ridge of bone which separates two surfaces

The whole body is built by strong bony framework is called skeleton. The skeleton is covered by muscles and other soft tissues and by skin on the outside of the bones.

**Cell:** All living things including the human body are made up of living cells. There is a considerable variation in the complexity of organisms. At one end the continuum there is a single cell organisms as the amoeba, and the other the highly complex multicellular human animal.
A cell is the smallest functional unit of an organism, thus a single cell organism is the simplest kind of organism that can exist independently. Among the many kinds of cells in our body, muscle cells, nerve cells and blood cells.

**Tissues** are group of cells that usually arise from common ancestor cells and work together to perform a particular function. The four basic types of tissues in our body; epithelial tissue, muscle tissue, connective tissue and nervous tissue.

**Organs** are made up of a number of different types of tissues.

**Systems** consist of number of organs and tissues. Each system contributes to one or more vital functions of the body. However, because of specialization of cells none of these systems can exist in isolation. A group of organs working together toward common goals.

There are 9 systems listed below all these systems work harmoniously together in a healthy body.

**Skeletal system** which composed of the bones and certain cartilages and membranes. Articulatory system which deals with the joints or articulations.

**The blood vascular system** include the circulatory system and lymphatic system. The circulatory system consists of the blood, the blood vessels and the heart.

**Blood** is the principal transport system it is pumped round the body by the heart oxygen is brought from the lungs and Co2 collected from the tissues. Food passes to the liver and then to the general circulation. Waste products are passed to the kidneys.
The Digestive system: consists of the alimentary canal and the glands and organs associated with it. Food is broken down by the blood to the liver and finally to the tissues.

The respiratory system contains the passage and organs concerned with breathing oxygen from the air is taken into the blood and carried to the tissues, the waste product, carbon dioxide, is carried by the blood from the body tissues to the lungs and breathed out in the expired air.

The Nervous system is composed of the central nervous system which includes the brain and spinal cord, the peripheral nervous system consisting of the nerves given off from the brain and cord and the autonomic nervous system. The central and peripheral system are often grouped together and described as the cerebrospinal nervous system. The autonomic nerves system includes the sympathetic and parasympathetic nerves. It is also described as the involuntary nervous system.

Muscular system consisting muscles, fascia and tendon sheaths, kinds of muscles (i) straighted (ii) non straighted (iii) cardiac muscle. Main functions are they cause movements by contracting and to maintain static’s skeletal postural support.

Endocrine system: the ductless glands are grouped together because of the internal secreotions they produce. They pour their content directly in to the blood stream. The structure and function of pituitary. Pancreas, thyroid parathyroid thymus, suprarenal glands etc.

The Excretory system is the term sometimes employed to describe collectively the organ that deal with the excretion of waste products from the body.
The organs include urinary system, structures and functions of skin, the lungs in their function of eliminating the Co2 and the colon which excretes certain in soluble substances in the faeces. Regulation of body temperature fluid and electrolyte balance.

**Special sense organs** includes (taste) tongue, nose (smell), eye (sight), ear (hearing) and also tactile function of the skin.

**Reproductive system:** the female reproduction system structure and functions of reproductory and accessory organs. Menstrual cycle, hormones and reproduction.

Male reproductive system structure and functions

**CAVITIES OF THE BODY**

![Diagram of the human skull and brain](image)

**CARNIAL CAVITY**
**The cranial cavity** contains the brain and its boundaries are formed by the bones of the skull.

- **Anteriorly** - 1 frontal bone
- **Laterally** - 1 temporal bone
- **Posterior** - 1 occipital bone
- **Superior** - 2 parietal bones
- **Inferiorly** - 1 sphenoid and 1 ethmoid bone parts of the Frontal, temporal and occipital bone.

**Orbital Cavity** containing the eyes.

**Nasal Cavity** Containing the nose.

**Buccal Cavity** containing mouth.

**THORASIC CAVITY**

This cavity is situated in the upper part of the trunk. Its boundaries are formed by a bony frame work and supporting muscles.

- **Anteriorly** -the sternum and costal cartilages of the ribs.
- **Laterally** -12 pairs of ribs and the intercostals muscle.
- **Posteriorly** -the thoracic vertebrae and the intervertebral Disc between the bodies of the vertebrae.
- **Superiorly** -the structures facing the root of the neck.
- **Inferiorly** -the diaphragm a dome shaped muscle.
Contents:  
The main organs and structures contained in the thoracic cavity are:

1 trachea  
2 bronchi  
2 lungs  
1-esophagus

1 heart  
1 aorta  
1 superior and inferior vena cava  
numerous other blood vessels  
lymph nodes,  
lymph vessels  
Nerves

The mediastinum is the name given to the space between the lungs.
Main structures in the Thoracic cavity

ABDOINAL CAVITY

This is the largest cavity in the body and is oval in shape.
It is situated in the main part of the trunk and its boundaries are:

Superiorly - the diaphragm which separates it from the thoracic Cavity.

Anteriorly - the muscle forming the anterior abdominal wall.

Posteriorly - the lumbar vertebrae and muscle forming the Posterior abdominal wall.

Laterally - the lower ribs and parts of the muscles of the Abdominal wall.

Inferiorly - the pelvic cavity with which it continuous.
Contents

Most of the space in the abdominal cavity is occupied by the organs and glands involved in the digestion and absorption of food. These are:
Stomach
Small intestine
Most large intestine
Liver
Gall bladder
Bile duct
Pancreas
Other structure include
Spleen
Kidneys and upper part of the urethras
Adrenal supra renal glands
Numerous blood vessels, lymph vessels nerves
Lymph nodes

Organs occupying the Anterior Part of the Abdominal Cavity and the Diaphragm
PELVIC CAVITY

The pelvic cavity is roughly funnel-shaped and extends from the lower end of the abdominal cavity.

The boundaries are:
Superiorly - the pubic bones
Posteriorly - the saerum and coccyx
Laterally - the innominate bones
Inferiorly - the muscles of the pelvic floor.
Contents

The pelvic cavity contains the following structures; Pelvis colon, rectum and anus same loops the small intestine urinary bladder, lower parts of the ureters and the urethra.

In female, the organs of the reproductive system: the uterus, uterine tubes, ovaries and vagina.

In the male, some of the organs of the reproductive system: the prostate gland, seminal vesicles, spermatic cords, deferent ducts (vas deferens), ejaculatory ducts and the urethra (common to the reproductive and urinary systems).

Regions of abdominal cavity
THE TISSUE CELL

The cell is one of the minor masses that makeup an organized tissue and consist cytoplasm and nucleus surrounded by a semi permeable membrane. Cell possesses the qualities of all leaving matter, including those of self preservation and reproduction.

The protoplasm of the cell is composed of a centrally placed body, the nucleus, and the cytoplasm or remainder of the protoplasm, which surrounded the nucleus.

Cytoplasm: The cytoplasm contains the following essential requirement.

1. **Mitochondria**: A small rod-like structure which are closely connected with catabolic, or respiratory, processes of the cell body.

2. **Golgi apparatus**: A canal-like structure lying next to the nucleus and involved in the secretory activities of the cell.
3. **Ground cytoplasm:** A highly complex colloidal material in which the other structures are embedded. It is largely concerned with the anabolic, or synthetic, activities of the cell.

4. **Centrosome:** A minute dense part of the cytoplasm, lying close to the nucleus. It plays an important part during cell division.

5. **Cell membrane:** The cell boundary is no static envelope many important functions are connected with it, but in particular it acts as a selective sieve through which certain substances are allowed to pass into the cell, or which prevent other substances from gaining access to it. Thus it is most important in maintaining the correct chemical composition of protoplasm.

6. **Nucleus:** The nucleus consists of more compact mass protoplasm separated from cytoplasm by the nuclear membrane which is also selectively porous, allowing substances escape from the nucleus into the cytoplasm or substances to pass into it. The nucleus controls the cell and all its activities. Without a nucleus the cell would die.

The nucleus contains many rich protein threads lying in nuclear sap. In the resting cell the threads are collectively called as chromatin. These are vital to the every day activity of the cell, and are responsible for determining the hereditary characteristics of the human body. On the chromosomes in linear arrangement sit the genetic or hereditary determinants, the genes. The number of chromosomes in the body cell is constant for particular species of organism. In man there are 23 pairs of 46 chromosomes.
FUCTIONS OF THE CELL:-

**Ingestion and assimilation:** The cell select from the intercellular or interstitial fluid which surrounds them chemical substances such as amino-acids, e.g., proteins, which make up protoplasm. This cell is a very active unit in which the nourishing food materials eaten by man are absorbed and assimilated.

**Growth and repair:** These materials brought to the cell may be used by the cell to synthesize new protoplasm, so that the cell increases by its size, that is, it grows. They may also be used to replace worn-out parts of the cell. These constructive activities, growth and cell repair, are spoken of as the anabolic functions of the cell, or anabolism.

**Metabolism:** On the other hand the cell needs supply of energy for it activities and it will use some absorbed food materials as a fuel. The food is broken down and the energy stored in it is released and used by the cell to provide heat, glandular secretion, movement, and nervous activity. Anabolism and catabolism make up the total activities of the cell, or metabolism.

**Respiration:** Oxygen brought from the lungs by the blood and the removal of the gaseous waste-product, carbon dioxide, are essential for the functions and survival of the Cell.

**Excretion:** The waste materials resulting from the catabolic processes are eliminated from the cell into the interstitial fluid, and carries away by the blood. The blood transports the carbonic acid waste to the lungs where it is removed from the body as carbon dioxide the other waste substances are eliminated, via the kidneys, the skin, lungs and from digestive system.
Irritability and conductivity: The cell has a property of responding to the outside stimuli which may be physical chemical or thermal.

Movement: The movement of the whole part of cell may occur. Cell moves with help of flagella and cilia.

Reproduction: To increase its number the cell has to undergo this process of reproduction. There are sexual and a sexual reproduction.

A cell does not go on growing indeﬁnitely in size but a certain optimum point divides into two daughter cells. Further, certain cells will undergo division to replace worn-out cells or those destroyed by disease. The kind of cell division is called mitosis or karyokinesis.

Activity begins in the nucleus, the nucleus membrane disappears and the chromatin changes character and becomes long ﬁlaments called chromosomes. The centrosome divides and the two new centrosomes move away from each other to each end of the nucleus call the poles. The chromosomes are attached to the poles and lie near the new centrosomes. The cromastin of which the nucleus is ﬁrmed now comes to rest and two new nuclei exist. Finally the protoplasm of the cell constricts and divides and the two new cells are complete.

Each new daughter cell resulting from mitosis contains 46 chromosomes, so that during mitosis each chromosome must duplicate itself the processes of chromosomal duplication is one of the least understood cells activates.
Mitosis is not the only kind of cell division. In the sex organs, the ovary and testis, another kind of cell division occurs called meiosis.

During the formation of sex cells or gametes, the number of chromosomes is halved, so that the spermatozoon contains only 23 chromosomes and the egg cell, or ovum, 23. When fertilization occurs the spermatozoa and ovum to form the cell (zygote) which develops into a new individual. The normal chromosomal complement of 46 is restored. By these means a mixing of the hereditary determinants or genes from male and female achieved.

THE ELEMENTARY OR FUNDAMENTAL TISSUES

The tissues of the body consist of a large number of cells, and they are classified according size shape and functions of the cell.

They are four types;

1. Epithelial tissue.
2. Connective tissue.
3. Muscle tissue or Muscular tissue
4. Nervous tissue.
**EPITHELIAL TISSUE**: The cells forming this tissue are very closely packed together. The intercellular substance called the matrix is minimal. They lie on the basement membrane.

Functions: Protection, excretion, secretion, absorption and reception of stimuli.

Epithelial tissue is divided into TWO types
1. Simple epithelium, 2. Compound epithelium

1. **Simple epithelium**: Consisting of the single layer of cells. Again the simple epithelium is divided into 4 types according to their shapes and functions.

   (i) **Squamous epithelium or pavement epithelium**: consisting of a single layer of flattened cells arranged together like flat stones and form a smooth membrane on basement membrane.

   **Functions**: they provide a thin, smooth, inactive lining of heart, blood vessels, alveoli of lungs are lymph vessels.

   ![Squamous epithelium](image)

   (ii) **Cuboidal epithelium**: cube shape cells, fitting closely together on a basement membrane.

   **Functions**: Forms the tubes of the kidneys found in glands, actively involved in secretion and absorption.
(ii) **Columnar epithelium**: Single layers of cells with elongated cubes and a basement membrane with the nucleus.

Functions: Helps in absorption of products of digestion. Some cells (goblet cells) secrete the mucous, sticky substance throughout the alimentary tract.

(iv) **Ciliated Epithelium**: These have fine hair-like processes called cilia, on their free surface they move in one direction. Single layered elongated cubes and a basement membrane having the nucleus. They are found lying on the respiratory passages and uterine tubes.
Functions: In the throat and in uterine tubes, it propels the ova towards the uterus.

2. Compound epithelium: consisting of a several layers of cells with different shapes. Basement membrane is absent the deeper layers are columnar in shape. And as they grow towards the surface, they become flattened.

Functions: to protect underlying structures. They are of two Types.

(1) Stratified epithelium: Composed of a number of layers of cells of different shapes and the deepest layers the cells are mainly columns in shape. And as they grow towards the surface, they become flattened.
They are of two types.

**I. Non-Keratinized stratified epithelium:**
It is found on wet surfaces such as the conjunctiva of the eyes and the lining of the mouth, pharynx and esophagus.

**II. Keratinised stratified epithelium:**
It is found on dry surfaces, i.e. Skin, hair and nails. The surface layers of keratinized cells are dead cells. They give protection and prevent drying of the cells in the deeper layers.

**2. Transitional epithelium:**
Composed of several layers of pear shaped cells or perform cells found lining uterus, and the urinary bladder.

**II. CONNECTIVE TISSUE:**
Provides the framework of the body, present in the matrix may be semi-solid, jelly, like consistency or dense.

**(1) Areolar connective Tissue:** The matrix is semi-solid with cells called fibro blastes separated by yellow elastic and white elastic found in almost
every part of the body – connecting and supporting other tissues for example under the skin, between the muscles supporting blood vessels and nerves. Alimentary Canal in glands supporting secretory cells.

AREOLAR TISSUE

(2) ADIPOSE CONNECTIVE TISSUE: Adipose connective tissue consists of a collection of Fat cells containing fat globules. These cells are present in matrix of areolar connective tissue found supporting the organs such as kidneys and eyes, between bundles of muscle fibers and with areolar tissue under the skin giving the body a continuous smooth outline.
(3) **White Fibrous tissue:** Strong-connecting tissue closely packed bundles of white fibers with little matrix. There are very few cells and lie in rows between the bundles of fibers. This forms the ligaments covering (periosteum) for bones together. Outer protective covering for bones, covering of kidneys, lymph nodes, and the brain forms the muscle sheets called muscle fascia, the tendon, that binds the muscle to bone.

![Fibrous Tissue Diagram](image)

**FIBROUS TISSUE**

(4) **Yellow Elastic tissue:** It is capable of extensic and recoil. There are few cells in the matrix, consisting of masses elastic fibers. They are found in organs where alteration of shape, is required. For example, in the arteries, particularly the large arteries, in the trachea, bronchi and in the lungs.
ELASTIC TISSUE

Lymphoid Tissue: It has a semi-solid matrix (intercellular substance) with fine branching fibres. The cells are specialized, are known as lymphocytes. Lymphoid tissue is found in the lymph nodes, in the spleen, in the palatine and pharyngeal tonsils, in the vermiform appendix, forming the solitary and aggregated glands in small intestine, in the walls of large the intestine. It is present in the reticuloendothelial system, consisting of liver, bone marrow, and lymph vessel.

Cartilage: Cartilage is a much firmer than any of the other connective tissues. The matrix is quite solid. The cartilage is divided into three types

a) Hyaline Cartilage (b) White – fibro Cartilage (c) Yellow or Elastic fiber.

a) Hyaline Cartilage: It appears as a smooth bluish white
Cartilage tissue, under the microscope the cells appear in groups of two or more, where they come in contact with solid matrix. Their edges appear to be flattened.

The matrix is solid smooth.

(i) It is found on surface of the parts of bones which form joints

(ii) Forming the costal cartilages which attach the ribs to the sternum.

(iii) Forming part of the larynx, trachea, and bronchia

(2) **White fibro Cartilage**: This cartilage consists of dense, white fibers in a solid matrix with the cells wildly of dispersed. It is a tough slightly, flexible tissue. It is found as pads between the bodies of the vertebra called the inter vertebral discs, between the articulating surfaces of bones of the knee joints known as the seminular cartilages, forms the sum of the bony (surface) sockets of the hip and shoulder joints, deepening the cavities.
(3) **Yellow Elastic – fibro Cartilage:**
It consists of yellow elastic fibres running through the solid matrix the cells lie between the fibres. It forms the pinna or lobe of the ear, and the epiglottis.

**Blood:** this is a fluid connective tissue and it is described in detail in Unit 4.

**Bone:** Bone is one of the hardest connective tissues in the body and when developed is composed of 25 % water, organic matter 30 %, inorganic Slats 45%.
There are two types of bone tissue one (i) compact bone tissue (ii) cancellous bone tissue.

This is described in detailed in unit 2

III. Muscle Tissue:
Muscle tissue is composed of 75% water 20% protein, mineral salt, glycogen, glucose and fat altogether 5%.

A. A STRIATED MUSCLE FIBRE B. A BUNDLE OF STRIATED MUSCLE FIBRE AND THEIR CONNECTIVE TISSUE.

There are three types of Muscles;
1. Striated, skeletal or voluntary Muscles.
2. Non-striated involuntary muscles, visceral or smooth muscle.
3. Cardiac muscle

1. Striated muscle or voluntary muscle:
This may be described as skeletal striated striped or voluntary muscle. It is known as voluntary because it is under the control of the will. When voluntary muscle is examined under the microscope the cells are found to be roughly cylindrical in shape, and the length varies from 10-40 cm. Each muscle fiber, has several nuclei situated just under the sarcolemma which is
a fine sheath surrounding each muscle fiber. The muscle fiber is parallel one to another and well-marked transverse dark and light bands are shown under the microscope. Hence the name striated or striped.

2. **Smooth, involuntary or visceral muscle:** Smooth muscle may be described as involuntary, plain or visceral muscle. It is not under the control of the will. It is formed in the walls of blood and lymph vessels, alimentary tract, the respiratory tract, the bladder and uterus. When examine under a microscope, the cells are seen to be spindle shaped with only one central nucleus. There is no distinct sarcolemma but very fine membrane surrounds each fiber. Bundles of fibers form sheets of muscle. Such as those found in the wall of the above structure.

![Smooth muscle fibres.](image)

**3. Cardiac Muscle:** Cardiac muscle is formed on in the muscle of the heart. It is not under the control of the will when seen under the microscope cross stripes which are characteristics of voluntary muscle, can be seen.

Each fiber has a nucleus and one or more branches. The muscle red in color. It posses
the special property of automatic rhythmical contractions, independent of its nerve supply

IV. NERVOUS TISSUE: The structure of nervous tissue is described in detail in Unit 3.
Membranes

Membranes – Classification: Membranes are layers of specialized cells which line the body cavities. They are divided into three types.

1. Mucous Membrane or Mucosa: Mucous membranes line the entire digestive, respiratory, excretory and reproductive tracts. The epithelial layer of mucous membrane secretes mucus which prevents the cavities from drying out. It also traps dust in the respiratory passageways, lubricates food, secretes digestive enzymes.

![Mucous Membrane Image]

2. Serous membrane or serosa lines a body cavity that does not open directly to the exterior and covers the organs that lie within the cavity. Serous membranes consist of thin layers loose connective tissue covered by a layer of mesothelium. The part attached to the cavity wall is called the parietal portion.

The part that covers the organs is called visceral portion. Example: Pleura, Pericardium, Peritoneum. The epithelial layer of a serous membrane secretes a lubricating fluid that allows the organs to glide easily against one another.

3. Synovial membrane lies the cavities of the joints. They line structures that do not open to
the exterior, they do not contain epithelium. Synovial membranes secrete Synovial fluid, which lubricates the ends of bones joints helps to maintain their stability. Synovial fluids also helps to nourish, the hyaline cartilage which covers the articular surfaces of the bones, and Synovial cells remove damaging material with thin the joint cavity.

**GLANDS**

A gland is a secretary organ. The number of secretary cells is greatly increased to form glands. The glands are varying in shape and complexity.

Types of Glands: There are two types of glands.  

**(I) Glands that have ducts:** Example, Liver, pancreas, salivary glands Glands which pour their secretions on the surface.  
They are classified as:

Simple, tubular glands: Branched tubular glands, Alveolar, compound alveolar or Racemose glands.

![Gland Diagram](image)

**(D) Compound racemose gland**

described as endocrine organs. These are the glands of internal secretion. Therefore they pour their contents into the blood stream directly. Example, Pituitary gland, thyroid gland.
UNIT-I

QUESTIONS

1. Define the following terms.
   (a). Anatomy & Physiology    (f). Membranes
   (b). Cell.                  (g). Mitosis
   (c). Tissues               (h). Gland
   (d). Organs                (e). Systems

2. List the cavities of the body.
3. Draw the diagram and explain the structure of living cell.
4. Write the function of the cell.
5. What are the elementary tissues of the body?
6. Describe the simple epithelium.
7. Write the classification of tissues and describe the epithelial tissues.
8. Write short notes on;
   (a) Membranes
   (b) Glands
   (c) Voluntary muscles
   (d) Involuntary muscles
   (e) Cardiac muscle.
UNIT - II

THE ERECT AND MOVING BODY SKELETAL SYSTEM

The Skeleton is the bony framework of the body providing support and protection for some of the soft organs like the skull and the Pelvis; acting as levers in movements and provides surfaces for the attachment of the skeletal muscles.

BONE STRUCTURE AND GROWTH

Bone is one of the hardest connective tissue in the body. (It is composed of 25% water, organic matter 30% in organic salts 45 %). It is composed of nearly 50% of water; the remaining solid parts are divided into a composition of mineral matter, principally calcium salts 67% and cellular matter 33% percent.

The structure of bone may be examined by the naked eye, when the gross structure is seen and with the aid of a microscope, when the minute structure is examined.

Bone consists of two kinds of tissue (i) compact tissue and (ii) cancellous tissue.
1. **COMPACT BONE TISSUE**: This is hard and dense. It is formed in flat bones and in the shaft of the long bones and as a thin covering over all bones. To the naked eye compact bone appears to be solid but on microscopic examination large numbers of Haversian system can be seen. These consist of a central Haversian canal, containing blood and lymph vessels and nerves, surrounded by concentric plates of bone (*lamellae*). Between these there are lacunae are spaces, containing lymph and osteocytes. Canaliculi link the lacunae with the lymph vessels in the Harversian canal and the osteocytes obtain nourishment from the lymph.

2. **CANCELLOUS BONE TISSUE**: To the naked eye, cancellous bone looks like a sponge, it is found principally in the ends of the large bones, in the short bones as a layer in between two layers of compact tissues flat bones such as scapula, cranium sternum ribs. Red bone marrow is always present in cancellous bone.

**Red Bone marrow**: It is tissue in which erythrocytes, leucocytes and thrombocytes are formed and grow to maturity before entering the blood.
**Yellow Bone marrow**: It is a flatly substance found in the hallow shafts of the long bones in adult. Before birth and in the early childhood all bone marrow is red and forms blood cells, by the time adult hood is reached, Red bone marrow is formed only in the cancellous bone. The outer surface of bone is covered by a vascular fibrous membrane called periosteum.

**Periosteum**: Periosteum covers bone except for those surfaces, which take part in the formation of freely movable joints where it is replaced by hyaline cartilage.

**Functions of Periosteum**: (i) It forms an outer protective covering the bones. (ii) It gives attachment to the muscles, tendons. (iii) It gives attachment to the muscles, ligaments. (iv) In its deeper layer there are many bones forming cells called osteoblasts, which are responsible for the development of new bone tissue.

**Development of long bones**: Long bone develop by a complicated series of changes causing the distraction of cartilage and its replacement by bone tissue. About the 8th week of fetal life a primary center of ossification appears in the middle of the rod of cartilage and by the action of enzymes on the bone cells (osteoblastes), enzymes of the bone cells on the primary center bone formation take place together with deposition of minerals slats mainly calcium phosphate. From this primary center of ossification that diaphysis of the bone is formed and ossification spreads from the middle towards each end. The thickening of the shaft occurs bone and inorganic salts are deposited by the osteoblastes present in the periosteum. Secondly center of ossification occurs in the parts of cartilage, which will eventually be the epiphysis of bone. From these centers ossification spreads upwards, outwards and downwards. Bone grows in length at the epiphysis.
cartilage, which found between each epiphysis and diaphysis. The growth of the bone is not complete until rate of ossification over takes the growth of epiphysis cartilage. Until the ossification is complete a thin clear epiphyseal line shows on x-ray plates. Flat, short, irregular and sesamoid: These bones develop from one or more primary centers of classifications.

**Stages of development of long bone**

**Development of bone**: This begins before birth and is not complete until about the 25th year of the life. Long short and irregular bones develop from cartilage. Flat bones from membrane and sesamoid bones from tendons.

These original tissues are gradually replaced by bones. **Bones Cells**: The cells responsible for bone formation are osteoblasts and osteoclasts.

**Osteobalsts**: These are bone forming cells and their function are not clear but they may be associated with
the movement of calcium between bones and the blood.

**Osteoclasts** These cells are derived from the same parent cells as osteoblasts. Their function is resorption of bone to maintain the optimum shape.

A fine balance of osteoblasts and osteoclasts activity maintains normal bone.

A mature long bone
The cells which form bones are called osteoblasts and after they are established in their lacunae, they are called osteocytes. The other cells found in the bone are the osteoclasts which are responsible for maintaining the shape of the growing bone; it forms the medullary canal in long and short bones; It also forms the sinuses in some of the bones of the face and skull.

**Functions of bones:** The bones of the skeleton has a number of functions.

1. To form a supporting framework for the body.
2. To form the boundaries for the cranial thoracic and pelvic cavities.
3. To give protection to delicate organs.
4. To form the joints which are essential for the movements of the body.
5. To provide attachment for the voluntary muscle which move the joints.
6. To form blood cells in red bone marrow in the cancellous bone.
7. To provide a store of calcium salts.

The **Axial Skeleton** is consisting the head and trunk, and includes the following bones:

(a) Skull (b) Vertebral Column (c) Hyoid bone.

The **Appendicular Skeleton** comprises the limbs, and limb girdles.

(a) Upper limb (b) Lower limb.

In addition, there are three small bones in each middle ear.
NUMBER OF THE BONES IN THE HUMAN BODY
AXIAL SKELETON

**SKULL**
Cranium - 8
Face - 14
Hyoid - 1
Auditory ossicles 6
Vertebral column 26

**THORAX**
Sternum - 1
Ribs - 24
Sub – total - 80

**APPENDICULAR SKELETON**

*Shoulder girdle*
Clavicle - 2
Scapula 2

*Upper limbs*
Humerous - 2
Ulna - 2
Radius - 2
Carpals - 16
Meta carpals - 10
Phalanges - 28

*Pelvic Girdle*
Hip bones (pelvic) 2

*Lower limbs*
Femur 2
Fibula 2
Tibia 2
Patella 2
Tarsals 14
Meta tarsals 10
Phalanges 28
Sub total 126
Total 80 + 126 = 206

The total numbers of bones are 206.
Classification of Bones: The bones of the skeleton are classified according to their shape and formation.

Long Bones: There are found principally in the limbs. Each long bone consists of a shaft and two extremities. Long bones act as levers in the body and make movement possible. Eg. Femur, Humorous bones.

Short bones: They are composed largely of cancellous bone tissue as they require to be light and strong. Short bones give strength in support, as in the strength shown in the wrist. Eg. Carpal, tarsal bones.

Flat Bones: consist of two layers of dense bone tissue with intervening layer of spongy bone. These are found where protection is needed, as in the bones of the skull, the innominate bones, ribs and scapula. Flat bones also afford large surfaces for the attachment of muscles, e.g. the scapula.
**Irregular Bones**: are those, which cannot be included in either of the other three classes. Examples of irregular bones are the vertebra and some of the bones of the face.

**Sesamoid Bones** are another group. These are developed in the tendons of muscles, and are found in the vicinity of a joint.

E.g. Patella.

**THE SKULL**

The skull is the body framework of the head, arranged in two parts. The cranium consists of eight bones. The facial skeleton of fourteen bones.

The cavity of the cranium presents on upper surface known as the vault of the skull; this is smooth on its outer surface, and marked by ridges and depressions to accommodate the brain and its blood vessels on the inner surface. The lower surface of the cavity is known as the base of the skull. It is perforated by many holes for the passage of nerves and blood vessels.

The bones of Skull and their joints or Sutures.
The bone forming the base of the skull and cranial fossae Viewed from above.

**Cranial Bones:** Occipital Bone 1, Parietal Bones 2, Frontal Bone, 1 Temporal Bones 2, Sphenoid Bone 1, Ethmoid Bone 1.

**Occipital Bone:** is at the back and lower part of the cranial cavity. It is pierced by the foramen magnum, through which the medulla oblongata passes to join the spinal cord. Each side of the foramen magnum are masses of bone which form the condyles of the skull and present articulating surfaces for the atlas.
**Parietal Bone:**

The two Parietal Bones together form the roof and sides of the skull. The outer surface is smooth, but the inner surface is marked by deep furrow about the middle of the bone lodges the middle meningeal artery.

Rupture of this artery causes pressure on the soft brain tissue with subsequent damage, first on the same side and later on the opposite side as well. This results in alteration in the size of the pupils, a very important nursing observation during the care of patients with head injuries.

**Frontal Bone**

The Frontal Bone forms the forehead and the upper part of the orbital cavities. The super orbital margin is marked by the supraorbital notch in its inner half; through this notch the supraorbital vessels and the supraorbital nerve pass. The inner surface of the frontal bone is marked by depressions, which are produced by the convolutions of the brain.

Two Temporal Bones form the lower part of the sides of the skull. Each bone consists of a number of parts.
The squamous part, squama, projects upwards and gives attachment to the temporalis muscle. From this the zygomatic process or zygomatic projects forwards to join the zygomatic bone. Bone and below the root of this process lies the external auditory meatus. The mastoid portion lies behind and it is continued downwards as a mastoid process. Its outer surface gives the attachment to the mastoid muscle. The mastoid process contains spaces known as the mastoid air cells and a particularly large surface lying a little in front of these is named the tympanic antrum. This space is lined with epithelium which is continuous with that of the middle ear of the tympanic cavity. Infections spreading from the middle ear may lead to suppuration in the tympanic antrum. The petrous part or portion of the temporal bone is wedged in at the base of the skull and contains the hearing apparatus.

**Occipital Bone:** This bone forms the back of the head and part of the base of the skull. It has immovable joints with the parietal, temporal and sphenoid bones. Its inner surface is deeply concave and the concavity is occupied by the occipital lobes of the cerebrum and by the cerebellum. The occiput has two articular condyles that form hinge joints with the first bone of the vertebral column, the atlas. Between the condyles there is the foramen magnum through which the spinal cord passes.
**Sphenoid bone:** This bone occupies the middle portion of the base of the skull and it articulates with the temporal, parietal and frontal bones. On the superior surface in the middle of the bone there is a little saddle-shaped depression. The hypophyseal fosse in which the pituitary gland rests. The body of the bone contains some fairly large air sinuses lined by ciliated mucous membrane with openings into nasal cavities.

![Diagram of the sphenoid bone](image.png)

**Ethmoid bone:** The ethmoid bone occupies the anterior part of the base of the skull and helps to form the orbital cavity, the nasal septum and lateral walls of the nasal cavity. On each side there are two projections into the nasal cavities. The upper and middle conchae or turbinated processes. It is a very delicate bone containing many air sinuses lined with ciliated epithelium and with opening into the nasal cavities. The horizontal flattened part, the crebriform plate, forms the roof of the nasal cavities and has numerous small foramina through which nerve fibers of the olfactory nerve pass upwards from the nasal cavities to the brain. There is also a very fine
perpendicular plate of bone that forms the upper part of the nasal septum.

**FACE Bones:**
The skeleton of the face is formed by 13 bones in addition to the frontal bone
- 2 Zygomatic or cheek bones.
- 1 Maxilla (originated as 2)
- 2 nasal bones
- 2 lacrimal bones
- 1 vomer
- 2 palatine bones
- 2 inferior conche or turbinated bones
- 1 mandible
**Zygomatic or cheek bone:** The zygomatic bones form the prominences of the cheeks and part of the floor and lateral walls of the orbital cavities.

**Maxilla or upper jaw bone:** This originates as two bones but fusion takes place before birth. The maxilla forms the upper jaw, the anterior part of the roof of the mouth, the lateral walls of the nasal cavities and part of the floor of the orbital cavities. The alveolar ridge, or process, projects downwards and carries the upper teeth. On each side there is a large air sinus, the maxillary sinus, lined with ciliated mucous membrane and with openings into the nasal cavities.

**Nasal bones:** These are two small flat bones which form the greater part of the lateral and superior surfaces of the bridge of the nose.

**Lacrimal bones:** These two small bones are posterior and lateral to the nasal bones and form part of the medial walls of the orbital cavities. Each is pierced by a foramen for the passage of the nasolacrimal duct which carries the tears from the medial canthus of the eye to the nasal cavity.

**Vomer bone:** this is a thin flat bone which extends upwards from the middle of the hard palate to form the main part of the nasal septum.

**Palatine bones:** these are two L-shaped bones. The horizontal parts unite to form the posterior part of the hard palate and perpendicular parts project upwards to form part of the lateral walls of the nasal cavities.

**Inferior conchae or turbinated bones:** Each concha is a scroll-shaped bone which forms part of the lateral wall of the nasal cavity and projects into it below the middle concha.
**Mandible:** This is the only movable bone of the skull. It originates as two parts which unite at the midline. Each half consists of two main parts: a curved body with the alveolar ridge containing the lower teeth and a ramus which projects upwards almost at right angles to the posterior end of the body.

At the upper end the ramus divides into the condyloid process which articulates with the temporal bone to form the temporomandibular joint and the coronoid process that gives attachment to muscles and ligaments. The point where the ramus joins the body is the angle of the jaw.

![The mandible. Lateral view.](image)

**Hyoid bone:** this is an isolated horse-shaped bone lying in the soft tissues of the neck just above the larynx and below the mandible.

**SINUSES:** Sinuses containing air are present in the sphenoid, ethmoid, maxillary and frontal bones. They all communicate with the nose and are lined with ciliated mucous membrane.

Their functions are;

1. To give resonance to the voice.
2. To lighten the bones of the face and cranium, making it easier for the head to balance on top of the vertebral column.
**FONTANELLES OF THE SKULL**

At birth, ossification of the cranial sutures is incomplete. Where three or more bones meet there are distinct membranous areas, or fontanelles. The two largest are; the anterior fontanelle, not fully ossified until the child is 12 to 18 months old and the posterior fontanelle, usually ossified 2 to 3 months after birth.
It is a flexible structure formed by a number of bones called vertebrae. The length of vertebral column is 60-70 cms. There are 33 vertebral bones, 24 separate movable, irregular bones; the remaining 9 vertebrae are fused to form 2 bones, the sacrum (five fused bones) and the coccyx (four fused bones). The 24 separate bones are in three groups: 7 cervical, 12 thoracic and 5 lumbar.

![The Vertebral Column](image)

**CHARACTERISTICS OF A TYPICAL VERTEBRA**

The body of the each vertebra is situated anteriorly. The size varies with site. They are smallest in the cervical region and become larger towards the lumbar region.

The neural arch encloses a large vertebral foramen. The ring of bone consists of two pedicels that project backwards from the body and two lamina. Where the pedicles and laminae unite, transverse processes project laterally and form a spinous process. The neural arch has four articular surfaces, two articulate with the vertebra above and two with the
one below. The vertebral foramina form the neural canal that contains the spinal cord.

**Cervical vertebra:** It is smallest of the vertebral bones the first and second cervical vertebra are peculiar in shape the bodies are small and oblong in shape. The neural arch is large. The spinous process are divided or bified terminally. The transfers process are perforated by foramina for the passage of the vertebral arteries. The seventh cervical is the first vertebra with undivided spinous processes. The processes has a tubercle at its tip. It forms a distinct projection of the back of the neck.

The atlas: The atlas is the first cervical vertebra and it consists simply of a ring of bone with two short transfer processes.
The axis is the second cervical vertebra. The body is small and has the upward projecting odontoid processes that articulates with the first cervical vertebra the atlas. The movement at this joint is turning the head from side to side.

Thoracic Vertebrae: These are larger than the cervical vertebrae and they increase in size as they
extend downwards. The body is heart shaped, with facets on each side for the attachment of the ribs. The neural arch is small the spinous processes is long and is directed downwards. The transfers processes help to support the ribs or thick and strong and carry articular facets.

**Lumbar Vertebra:** Lumbar Vertebra is the largest. The body is very large, kidney shaped. The spinous process is broad and hatchet shaped. The transfers processes are long and slender. The fifth lumbar vertebrae articulate with the sacrum at the lumbo sacral joint.
Sacrum: This consists of the five rudimentary vertebrae fused to form a wedge shaped bone with a concave anterior surface. The upper part or base, articulates with the fifth lumbar vertebrae. On each side it articulates with the ilium to form a sacro iliack joint and its inferior tip it articulates with the coccyx.

Coccyx: This consists of four terminal vertebrae fused to form a very small triangular bone, the broad ways of which articulate with the tip of the sacrum.

The Sacrum and Coccyx

Vertebral Column as whole: -

Inter vertebral discs: The bodies of adjacent vertebrae are separated by intervertebral discs, consisting of an outer rim of fibro cartilage and a central are of soft gelatinous material,

Intervertebral foramina: When two adjacent vertebrae are viewed from the side, a foramen can be seen. Through the length of the column there is an intervertebral foramen on each side between every pair of vertebrae, through which the spinal nerves, blood vessels and lymph vessels pass.

Ligaments of the vertebral column: These ligaments hold the vertebra together and help to maintain the intravertibral discs in position.
Movements of the vertebral column: The movements between the individual bones of the vertebral column are very limited. There is more movement in the cervical and lumbar regions than elsewhere.

curves of the vertebral column: Presents four curves, two primary and two secondary.

Functions of the vertebral column:

1. It supports the skull
2. The pedicles of adjacent vertebrae form intervertebral delicate spinal cord lying within it.
3. Because of the numerous individual bones, a certain amount of movement is possible.
4. The intervertebral discs act as shock absorbers, protecting the brain.
5. It forms the axis of the trunk, giving attachment to the ribs, shoulder girdle and upper limbs, and the pelvic girdle and lower limbs.
6. Collectively the vertebral foramina form the vertebral canal which provides a strong bony protection for the delicate spinal cord lying within it.
THORACIC CAGE
The bones of the thorax or thoracic age: 1 sternum, 12 pairs of ribs and 12 thoracic vertebrae.

The Thoracic Cage-Anterior View

**Sternum or breast bone:** This flat bone can be felt just under the skin in the middle of the front of the chest.
The manubrium is uppermost and articulates with the clavicles at the sternoclavicular joints and with the first two pairs of ribs.
The body or middle portion gives attachment to the ribs.
The xiphoid process is the tip of the bone.
Ribs
There are 12 pairs of ribs which form the bony lateral walls of the thoracic cage and articulate posterior with the thoracic vertebrae. The first 10 pairs are attached anteroirly to the sternum by costal cartilages, some directly and some indirectly.

The last two pairs (floating ribs) have no anterior attachment.
Characteristics of a rib: The head articulates posterior with the bodies of two adjacent thoracic vertebrae and the tubercle articulates with the transverse process of one. The sternal end is attached to the sternum by a coastal cartilage. The superior border rounded and smooth while the inferior has a groove occupied by the intercostals blood vessels and nerves.

The first rib does not move during respiration. The spaces between the ribs are occupied by the intercostals muscles. During inspiration, when these muscles contract, the ribs and the sternum are lifted upwards and outwards increasing the capacity of thoracic cavity.

APPENDICULAR SKELETON
The appendicular skeleton consists of the shoulder girdle, with the upper limbs and pelvic girdle the girdle with the lower limbs.

SHOULDER GIRDLE AND UPPER LIMB

Each shoulder girdle consists of 1 clavicle and 1 scapula.

Each upper extremity consists of the following bones:

1 humerus  
1 radius  
1 ulna  
8 carpal bones  
5 metacarpal bones  
14 phalanges
Clavicle or collar bone: the clavicle is a long bone which has a double curve. It articulates with the manubrium of the sternum at the sternoclavicular joint and forms the acromioclavicular joint with the acromion process of the scapula.

The right clavicle

Scapula or shoulder blade: The scapula is a flat triangular-shaped bone, lying on the posterior chest wall superficial to the ribs and separated from them by muscles.

At the lateral angle there is a shallow articular surface, the glenoid cavity which, with the head of the humerus, form the shoulder joint.

On the posterior surface there is a spinous process that projects beyond the lateral angle of the bone that overhangs the shoulder joint called the acromion process. It articulates with the clavicle at the acromioclavicular joint.
The coracoid process, a projection from the upper border of bone, gives attachment to muscles that move the shoulder joint.

**Humerous:** This is the bone of the upper arm. The head articulates with the glenoid cavity of the scapula, forming the shoulder joint. Distal to the head there are two roughened projections of bone, the greater and lesser tubercles and between them there is a deep groove, the bicipital groove or intertubercular sulcus, occupied by one of the tendons of the biceps muscle.
The distal end of the bone presents two surfaces that articulate with the radius and ulna to form the elbow joint.

**Ulna and radius:** these are the two bones of the forearm. The ulna is medial to the radius and when the arm is in the anatomical position, i.e., with the palm of the hand facing forward, the two bones are parallel. They articulate with the humorous at the elbow joint, the carpal bones at the wrist joint and with each other at the superior and inferior radioulnar joints.

The bones of the wrist, hand and fingers

**Carpal or wrist bones:** there are 8 carpal bones arranged in two rows of four.

From without inwards they are:
Proximal row: scaphoid, lunate, triquetral, pisiform.
This row associated with wrist joint

Distal row: trapezium, trapezoid, capitate, hamate, this row form joint of carpal and metacarpal bones.

**Metacarpal bones:** The five bones form the palm of the hand. The proximal ends articulate with the carpal bones and distal ends with the phalanges.
Phalanges or finger bones; There are 14 phalanges, 3 in each finger and two in the thumb. They articulate with metacarpal bones and with each other.

**PELVIC GIRDLE AND LOWER LIMB**

The bones of the pelvic girdle are 2 innominate bones and 1 sacrum. The bones of the lower extremity are:

1. femur
2. tibia
3. fibula
4. patella
5. metatarsal bones
6. phalanges
7. tarsal bones

**Innominate or hip bones:** Each hip bone consists of three fused bones, the ilium, ischium and pubis. On its outer surface there is a deep depression, the acetabulum, which forms the hip joint with the almost spherical head of femur. The **ilium** is the upper flattened part of the bone and it presents the iliac crest, the anterior point of which is called the anterior superior iliac spine. 

The **pubis** is the anterior part of the bone and it articulates with the pubis of the other hipbone at a cartilaginous joint, the symphysis pubis.
The ischium is the inferior and posterior part. The union of the three parts takes place in the acetabulum.

The pelvis: The pelvis is formed by the two innominate bones which articulate anteriorly at the symphysis pubis and posteriorly with the sacrum at the sacroiliac joints which are synovial joints. It is divided into two parts by the brim of the pelvis, consisting of the promontory of the sacrum and the iliopectineal lines of the innominate bones. The greater or false pelvis is above the brim and the lesser or true pelvis below.

DIFFERENCES BETWEEN MALE AND FEMALE PELVES

The shape of the female pelvis allows for the passage of the baby during childbirth. In comparison with the male pelvis, the female pelvis has lighter bones, is more shallow and rounded and is generally roomier.
**Femur or thigh bone:** The femur is the longest and strongest bone of the body. The head is almost spherical and fits into the acetabulum of the hip bone to form the hip joint. In the centre of the head there is a small depression for the attachment of the ligament of head of the femur. This extends from the acetabulum to the femur and contains a blood vessel that supplies blood to an area of the head of the bone. The neck extends outwards and slightly downwards from the head to the shaft and most of it is within the capsule of the hip joint.

The posterior surface of the lower third forms a flat triangular area called the popliteal surface. The distal extremity has two articular condyles which, with the tibia and patella, form the knee joint.
Tibia or shin bone: The tibia is the medial of the two bones of the lower leg. The proximal extremity is broad and flat and presents two condyles for articulation with the femur at the knee joint. The head of the fibula articulates with the inferior aspect of the lateral condyle, forming the superior tibiofibular joint.

The distal extremity of the tibia forms the ankle joint with talus and fibula. The medial malleolus is a downward projection of bone medial to the ankle joint.

Fibula: the fibula is the long slender lateral bone of the leg. The head or upper extremity articulates with the lateral condyle of the tibia and the lower extremity articulates with the tibia then projects beyond it are form the lateral malleolus.

Patella or knee cap: This is a roughly triangular shaped sesamoid bone associated with the knee joint. Its posterior surface articulates with the patellar surface of the femur in the knee joint and its anterior surface is in the patellar tendon, i.e., the tendon of the quadriceps femoris muscle.

Tarsal or ankle bones: There are 7 tarsal bones which form the posterior part of the foot. They are:
The talus articulates with the tibia and fibula at the ankle joint. The other bones articulate with each other and with the metatarsal bones.

**Metatarsal bones:** These are 5 bones, numbered from within outwards, which form the greater part of the dorsum of the foot. At their proximal ends they articulate with the tarsal bones and at their distal ends, with the phalanges.

**Phalanges:** There are 14 phalanges arranged in a similar manner to those in the fingers, i.e., two in the great toe and three in each of the other toes.
ARCHES OF THE FOOT

The bones have a bridge-like arrangement and are supported by muscles and ligaments so that four arches are formed.

**Medial longitudinal arch:** This is the highest of the arches and is formed by the calcaneus, navicular, and three cuneiform and first three metatarsal bones.

**Lateral longitudinal arch:** the lateral arch is much less marked than its medial counterpart. The bony components are the calcaneus, cuboid and the two lateral; metatarsal bones.

**Transverse arch:** These run across the foot and can be more easily seen by examining the skeleton than the live model. They are most marked at the level of the three cuneiform and cuboid bones.
JOINTS

A joint is the site at which any two or more bones come together. Some joints have no movement (fibrous), some only light movement (cartilaginous) and some are freely moveable (synovial).

Fibrous or fixed Joints: These immovable joints have fibrous tissue between the bones, e.g., joints between the bones of the skull and those between the teeth and the maxilla and mandible.

Cartilaginous or slightly Movable Joints: There is a pad of fibro cartilage between the ends of the bones making up the joint which allows for very slight movement caused by compression of the pad of
cartilage. A cartilaginous or slightly movable joint e.g., between the bodies of the vertebra e.g. Include the symphysis pubis and the joints between the bodies of the vertebrae.

Synovial or Freely Movable Joints:
The movements possible at synovial joints are;
Flexion or bending usually forward but occasionally backward, e.g. joint.
Extension means straightening or bending backward.
Abduction is movement away from the midline of the body.
Adduction is movement towards the midline of the body;
Circumduction is the combination of the flexion extension, abduction and adduction.
Rotation is movement round the long axis of bone.
Pronation means turning the palm of the hand down. Supination means turning the palm of the hand up. Inversion is turning the sole of the foot inwards. Eversion is turning the sole the foot outwards.

**Synovial joints are classified** according to the range of movement possible or the shape of the articulating part of the bones involved.

**Ball and socket:** The shape of the bones allow for a wide range of movement. Those possible flexion extension abduction, adduction, rotation and circumduction. The joints are the shoulder and hip.

**Hinge joints:** These allow the movements of flexion and extension only. They are the elbow, knee, ankle, the joints between the atlas and the occipital bone, and the interphalangaeal joints of the fingers and toes.

**Gliding joints:** The articular surfaces glide over each other, e.g., sternoclavicular joints, acromioclavicular joints between the carpal bones and those between the tarsal bones.

**Pivot joints:** Movement is round one axis (rotation) e.g., proximal and distal radioulnar joints and the joint between the atlas and the odontoid process of the axis.

**Candyloid and saddle joints:** Movement take place round two axis, permitting flexion extension, abduction, adduction and circumduction e.g. the wrist, temporomanibular joint, metacarpophalangeal and metatarsophalageal joints.

**Characters of a Freely Movable Joint:** The ends of bones which enter into the formation of the joints are covered by hyaline cartilage. Ligaments are required to bind the bones together.

**A joint Cavity:** The cavity is enclosed by a capsule of fibrous tissue which is usually strengthened by ligaments.
Synovial membrane  this is composed of epithelial cells which secrete a thick sticky fluid of egg. White consistency (synovial fluid). It acts as a lubricant provides nutrient materials for the structures within the joint cavity and helps to maintain its stability.

MAIN SYNOVIAL JOINTS OF THE LIMBS
Joints of the lower extremity.

Hip Joint:
This ball and sockets joint is formed by the cup – shaped acetabulum of the in nominate bone and the almost spherical head of the femur. The capsular ligament includes most of the neck of the femur. The cavity is deepened by the acetabular labrum, a ring of fibro cartilage attached to the rim of the acetabulum. This adds stability to the joint without limiting its range of movement. The ligament of the head of the femur extends from shallow depression in the middle of the head of the femur to the acetabulum. It conveys a blood vessel to the head of femur. Synovial membrane covers both a sleeve around the ligament of the head of the femur. There are three important ligaments that surround and strengthen the capsules. They are the iliofemoral, ischiofemoral and pubofemoral ligaments.
The movements occurring at the hip joint are Flexion, Extension, Abduction, Adduction, Lateral rotation, Medial rotation.

A combination of all this movements is called circumduction.
KNEE JOINT

This hinge joint is formed by the condyles of the femur, the condyle of the tibia and the posterior surface of the patella. The anterior part of the capsule consists of the tendon of the quadriceps femurs muscle which also supports the patella. Intra capsular structures include two cruciate ligaments which cross each other extending from the intercondylar notch of the femur to the intercondylar eminence of the tibia.

They help to stabilize the joint.

Semi lunar cartilages or menisci are incomplete discs of white fibrocartilage lying on top of the articular condyles of the tibia. They are wedge – shaped being thicker at their outer edges. They help to stabilize the joint by preventing lateral displacement of bones.
ANKLE JOINT:
This hinge joint is formed by the distal end of the tibia and its malleolus (medial malleous) the distal end of the fibula (lateral malleolus) and the talus. There are four important ligaments strengthening the joint. They are the deltoid and the anterior, posterior, medial and lateral ligaments.
The left ankle joint. (A) Section viewed from the front. (B) Supporting ligaments, medial view.
JOINTS OF THE FOOT AND TOES

There are a number of synovial joints between the tarsal bones, between the tarsal and metatarsal bones, between the metatarsals and proximal phalanges and between the phalanges. Movements are produced by muscles in the leg with long tendons which cross the ankle joint, and by muscles of the foot. The tendons crossing the ankle joints are encased in strong transverse ligaments. They move smoothly within their sheaths as the joint moves. In addition to moving the joints of the foot these muscles support the arches of the foot and help to maintain body balance.

MAIN SYNOVIAL JOINTS OF THE UPPER LIMBS

SHOULDER JOINT

This ball and socket joint is formed by the glenoid cavity of the scapula and the head of the humerus. The capsular ligament is very loose inferiorly to allow for the free movement normally possible at this joint. The glenoid cavity is deepened by a rim of fibrocartilage, the glenoidal labrum, which provides additional stability without limiting movement. Extra capsular structure consists of;

1. The coracohumeral ligament extending from the coracoid process of the scapula to the humerus.
2. The glenohumeral ligament blends with and strengthens the capsule.
3. The transverse humeral ligament retaining the biceps tendon in the intertubercular groove.
Shoulder Joint

- Capsular ligament
- Synovial membrane
- Glenoid cavity of scapula
- Head of humerus
- Tendon of long head of biceps muscle
- Articular cartilage
- Glenoidal labrum
- Acromion process
- Coracoid process
- Glenoid cavity of scapula
- Glenoidal labrum covered with synovial membrane
- Capsular ligament (cut)
ELBOW JOINT

This is hinge joint is formed by the trochlea and the capitulum of the humerus and the trochlear notch of the ulna and the head of the radius.

The elbow and Prximal radio ulnar joints
PROXOMAL AND DISTAL RADIOULNAR JOINT

The proximal radioulnar joint, formed by the rim of the head of the radius in the radial notch of the ulna, is in the same capsule as the elbow joint. The annular ligament is a strong extra capsular ligament which encircles the head of the radius and keeps it in contact with the radial notch of the ulna.

WRIST JOINT

This is a condyloid joint between the distal end of the radius and the proximal ends of the scaphoid, lunate and triquetral. A disc of fibro cartilage separates the ulna from the joint cavity and articulates with the carpal bones. It is also separate the inferior radioulnar joint from the wrist joint.

Extra capsular structure consists of medial and lateral ligaments and anterior and posterior raidocarpal ligaments.
JOINTS OF THE HANDS AND FIGERS

There are synovial joints between the carpal bones between the carpal and metacarpal bones, between the metacarpal bones and baronial phalanges and between the phalanges. The powerful movements that occur at these joints are produced by muscles in the forearm which have tendons extending into the hand, many of the finer movements of the fingers are produced by numerous small muscles in the hand.
The carpal tunnel and synovial shaths in the wrist and hand
THE MUSCULAR SYSTEM

Myology is the term used to describe the study of muscle. A muscle is made up of bundles of fibers held together. These are the red flesh of the body.

Muscles are attached to bone, cartilage, and ligaments and to the skin. Those placed immediately beneath the skin are flat. The muscles which surrounds the trunk are broad and flat and those of the limbs are long. The muscles of skeleton form part of the four group of elementary tissues.

MUSCLES OF THE SKELETON

The skeletal muscles: They are named according to their shape as the deltoid according to the direction of their fibers as the rectos abdomens; according to the position of the muscle, as pectoralis major and according to their functions as flexor, extensors etc.

The skeletal muscles are usually attached to two definite points. The more fixed point is called as origin it is point from which the muscle arises. The insertion the point to which muscle passes to attach the bone, cartilage, ligament or the skin.

Eg. Biceps muscle arises from the arm to be inserted into the radius.

The skeletal muscle does not act individually, but in groups to perform the movement of the different part of the skeleton.
**Tendon:** Binds muscle to bone. These are white glistening elastic fibers tissue bands.

**Antagonist:** Group that apposes another is called Antagonist. Eg. Flexor Muscle are the antagonist of exteriors.

Synergists flexors of the wrist steady it when the fingers are extended.

**Aponeurosis:** are flattend sheets or bands of fibrous tissue.

**Fascia:** It is a mixture fibrous and areolar tissue found wrapping up and binding down, the soft structure of the body.

**Superficial fascia** lies beneath the skin.

**Deep fascia:** is dense and more fibrous it forms sheaths for muscles and portions which separate differnt group of muscle.

**Palmer fascia:** A special thickened portion of the deep fascia, spread out the palm of the hand and binding down the deep structure beneath.

**Plantar fascia:** is similarly placed bands of fascia, binding down the structures in the sole of the foot.

**Retinacula:** are the thickened portions of deep fascia, binding down tendons passing over the wrist and ankle to enter the hands and feet.

**The diaphragm** is a dome shaped musculo, tendionus structure lies in between the thoracic and abdominal cavities. It forms the floor of the thoracic cavity and roof of the abdominal cavities. It take origin from the posterior surface of the xiphoid process; from the inner surface of the lower six pairs of ribs and from lumbar
vertebrae. The height of the diaphragm changes with posture. It is highest when lying down and lowest when standing or sitting.

**Relations of the diaphragm:** Above the diaphragm apex of the heart, and pericardium, the base of the lungs and the pleura. Below the liver, stomach, spleen, both suprarenal glands and both kidneys.

The oesophagus, inferior venacava and the vagus nerve passes through the diaphragm. The aorta and thoracic duct passes behind it.

**FUNCTION OF DIAPHRAGM**

It is the principle muscle of respiration. During inspiration, contraction of the muscle flatters the dome of the diaphragm. Thus enlarging the vertical diameter of the thoracic cavity.

The decent of the diaphragm causes air to be drawn in to the lungs which expand to fill the thoracic cavity. During the expiration of the muscle fibers of the diaphragm relax, the dome rises, size of the thoracic cavity decreased and air is forced out of the lungs.

The diaphragm helps on the act of micturition defecation and in parturition by compressing the abdominal viscera when it descends.

**NERVE SUPPLY:** Phrenic and intercostals nerves.

**BLOOD SUPPLY:** Blood supply: Phrenic and intercostals arteries
THE MAIN GROUP OF MUSCLES AND THEIR ACTION

Many muscles are arranged in pairs and oppose each other in action. They are grouped according to function as follows:

- **Flexors** - bending of a joint.
- **Extensors** - straighten joint.
- **Abductors** - move the bone away from middle line.
- **Adductors** - move the bone towards the middle line.
- **Pronators** - turn the hand palm downwards.
- **Supinators** - turn the hand palm upwards.
- **Levators** - raise a part.
- **Spincters** - reduce the size of an opening.
**MUSCLES OF THE HEAD AND NECK**

The main muscles on the right side of the face, head and neck

Sterno – mastoid, a muscle attached to the mastoid process of the temporal bone and to the sternum. This pair of the muscles when used together flexes the head. Separately they help to turn the head to one side.

*Trapezius*, a large diamond shaped muscle attached to the occiput and dorsal vertebrae, it draws back the shoulders and extends the head, thus helping in good posture.

**Muscles that move the upper arm:**

Deltoid – a triangular muscle covering the shoulder joint, and attached to the shoulder blade, collar bone and humerus. It raises the arm out-wards to shoulder level (abduction).
**Pectoralis.** A muscle covering the front of the chest, attached to the humerus. It adducts the arm (draws the arm across the chest).

**Latissimus dorsi**- A large muscle of the back, attached to the upper posterior part of the humerus. It adducts the arm, drawing it down and back.

**Muscles that move the Forearm**

  Biceps- a muscle with two heads from the shoulder blade. It lies in front of the humerus and is attached to the radius. It flexes the elbow joint.

  Triceps- a muscle with three heads from the shoulder blade and humerus. It lies along the back of the humerus and is attached to the ulna. It extends the elbow joint.

**Muscles that move the thigh**

  Ilio-psoas- a muscle that passes from the front of the lumbar vertebrae and the ilium, to the femur. It flexes the hip joint.

  Gluteals-muscles of the buttocks. Attached to the posterior surface of the ilium, and sacrum, and to the femur, they extend the hip joint.
Muscles that move the lower Leg

Quadriceps femoris—a very strong group of four muscles which cover the front of the thigh, passing from the ilium and femur, they are attached to the patella and so by the patellar ligament to the tibia. They extend the knee joint.

Hamstrings—from the ischium and femur to the tibia and fibula, this muscle lies at the back of the thigh and flex the knee joint.

Sartorius—from the iliac spine to the inner side of the tibia, this long thin muscle helps to abduct and flex both the hip and knee, as when sitting cross-legged.
The Muscles of the Anterior Aspect of the Thigh
The superficial muscle of the back of the thigh and leg.

The Superficial Muscles of the back of the thigh and Leg, showing also the boundaries of the Popliteal Space
**Muscles of the abdominal wall**

Rectus abdominus—from the sternum and costal cartilages to the public bone, these are two straight muscles forming the front wall of the abdomen. They cause flexion of the spine, and help in defecation and in childbirth.

Oblique muscle, external and internal. These form the side walls of the abdomen, and help in side movements of the trunk.

Transversalis-inside the oblique muscles, is fibers run straight round the abdominal wall. It also helps in turning the trunk.
THE DEEP MUSCLES OF THE POSTERIOR ABDOMINAL WALL

Muscles that move the Chest Wall

Intercostals-situated between the ribs, these muscles elevate the ribs for breathing.

Muscles of the pelvic floor:

The pelvic floor is divided into two identical parts at the midline. Each half is made up of muscles and fascia which unite in the midline. The muscles are levator ani, Coccygeus
The muscles of the pelvic floor

**Levator ani**: are broad flat muscles, forming the anterior part of the pelvic floor. They originate from the inner surface of the true pelvis and unite in the midline. Together they form a sling which supports the pelvic organs.

**Coccygei** are triangular sheets of muscle and tendinous fibrous situated behind the levator ani. They originate from the medical surface of the ischium and are inserted into the sacrum and coccyx. They complete the formation of the pelvic floor which is perforated in the male by the urethra and anus, and in the female by the urethra, vagina and anus.
Muscles of the Anterior aspect of the shoulder and Chest.
When muscle is stimulated, (voluntary muscle) it becomes short and thick and finally relaxes and elongated by a single nerve impulse.
Individual fibers contacts vigorously for more than 50 times each second.

It contracts more forcibly when it is stretched and warm.

Fatigue and cold weaken the power to contract.

Muscle is always ready to respond and contracts because of its tone.

Posture is determined by the degree of muscle tone.

Involuntary muscle contracts much more slowly and or not determinant on nervous impulses.

Cardiac muscle posses special property automatic rhythmical contraction and independent of its nerve supply.

Functions of muscle

Motion and movement: An essential body functions due to the integrated functioning of bones, joints and muscles. Ex. Walking, running, nodding head and heart beating.

Posture maintenance: Contraction of skeletal muscles holds the body in stationary positions like standing, sitting etc.

Producing body heat: Skeletal muscle contracts produce heat and there by important in maintain normal body temperature.

Muscle tone: Muscle is always in a state of slight contraction ready at all times for action. This state of readiness is called “muscle tone” that helps in keeping our balance standing erect.
UNIT-II
QUESTIONS

1. Define skeleton
2. Write the functions of bone
3. Write the classification of bones giving example of each bone.
4. List the skull bones.
5. List the face bone
6. Describe the following bones.
   (a). Frontal bone           (b). Parietal bones
   (c). Temporal bone         (d). In nominate bone.
7. Describe mandible bone.
8. Describe the following bone with diagram.
   (a). Humorous,   (b) Femur.
9. List the functions of vertebral Column.
10. Name the bones of the upper limbs.
11. Name the bones of the lower limbs
12. Define joints.
13. Write the classification joints giving example of each joint.
14. Describe the following joints.
    (a). Hip joint           (b). Shoulder joint.
    (c). elbow joint.       (d). Knee joint.
15. Mention the functions of joints.
17. Write the junctions of muscles.
18. Describe in detail about skeletal muscles.
19. Describe the muscles move the chest wall.
UNIT - III
NERVOUS SYSTEM
INTEGRATION AND CONTROL OF THE BODY.

For the complete healthy functioning of the body we need a healthy nervous system and healthy sense organs including eyes and ears.

The nervous system receives stimuli from outside and inside the body. For descriptive purposes, the nervous system is divided as follows:

1) Central nervous system consisting of brains and spinal cord.
2) Peripheral nervous systems consisting of 31 pairs of spinal nerves.
3) 12 pairs of cranial nerves the autonomic part of nervous system.

NERVE TISSUE:- nerve tissue is composed of soft tissue made up of nerve cells and nerve fibres. The cellular mass constitutes the “gray matter” and the fibres form the “white matter”.

Nerve fibres are each connected with their own nerve cell, forming a unit called neurone.
**Properties of Nerve tissue:** Nerve tissue has the characteristics of **irritability** and **conductivity**

Irritability is the ability to initiate nerve impulses in response to stimuli.

1. Outside the body Eg: Touch
2. Inside the body Eg: Changes in the concentration of $\text{CO}_2$ in the blood alter respiration

Conductivity means the ability to transmit an impulse from

1. One part of the brain to another
2. The Brain to striated muscle
3. Muscles and joints to the brain
4. Brain to organs of the body
5. Organs of the body to brain
6. The outside world to the brain through sensory nerve.
**NEURONE:** The neurone is the structural and functional unit of Nervous system it is supported by connective tissue cells called neuroglial cells. Each neurone consists of a nerve cell body and its processes called dendrites and axons. Neurons are commonly referred to simply as nerves.

The Nervous system is stimulated by impulses which are the result of various stimuli that can be intrinsic and extrinsic.

The cell body consists of cytoplasm and nucleus there are special granules called nissils granules that are characteristic of the neurone.

The axon is that part of neurone that carries impulses away from the cell body. In some neurons; axons are covered by a sheath called myelin sheath from the cell body. Generally each neurone has one axon.

The cell body has processes called dendrites that carry the impulses towards the neurone.

Nerve impulses: when a stimulus is applied to the neurone a small electrical potential (current) 0.055 volts or 55 milli volts generated. The electrical potential
is called action potential commonly called as nerve impulse.

**NERVES ARE THREE TYPES:-**

1. **Sensory Nerves, or afferent nerves** which carry impulses from the brain and spinal cord to the periphery. (All parts of the body to the brain & spinal cord)

2. **Motor Nerves**, or efferent which carry impulses from brain and spinal cord to muscles and glands in all parts of the body.

3. **Mixed nerves**, consist of both sensory and motor fibers and carry the impulses in both directions.
The brain is the vital organ of the body. It is protected in the cranial cavity. It constitutes the following parts.

1. Cerebrum or fore brain
2. Mid brain
3. Pons vorolii
4. Medulla oblongata
5. Cerebellum or hind brain

The part of the central nervous system
Cerebrum constitutes the largest part of brain. It is divided into two parts, right and left cerebral hemisphere by a left called longitudinal cerebral fissure and both the lobes are connected by corpus callosum, which is a mass of white matter. The superficial part of cerebrum is composed of nerve cells or grey matter, forming the cerebral cortex and the deep part is composed of nerve fibers on white matter.

The cerebral cortex shows many infoldings or furrows of varying depth. The exposed areas of the folds are the gyri or convolutions these are separated by sulci or fissures.

For descriptive purpose each cerebral hemisphere is divided into.

Frontal
Parietal
Temporal
Occipital
FUNCTIONS OF CEREBRUM

1. The mental activities involved in memory, intelligence, sense of responsibility, thinking,
reasoning, moral sense and learning are attributed to higher centers.

2. Sensory perception including the perception of pain, temperatures, touch, sight, hearing, taste and smell.

3. Initiation and control of voluntary muscle contraction.

**BASAL NUCLEI.**

The area of grey matter lying deep within the cerebral hemispheres, is through to influence skeletal muscle tone. If control is inadequate or absent movements are jerky, clumsy and uncoordinated.

**THALAMUS:**
The thalamus consists of two masses of nerve cells and fibers situated within the cerebral hemispheres just below the corpus callosum, one on each side of the third ventricle. Sensory input from the skin, viscera and special sense organs are transmitted to the thalamus before redistribution to the cerebrum.

**Hypothalamus:** It is composed of a number of groups of nerve cells. It is situated below and in front of thalamus, immediately above the pituitary gland.
The hypothalamus is linked to the posterior to be of pituitary gland by nerve fibers and to anterior lobe by a complex of system of blood vessels. Through these connections the hypothalamus controls the output of hormones from both lobes of the gland.

Other functions of hypothalamus include control of autonomic nervous system, e.g., controls of hunger, thirst, body temperature, heart and blood vessels and defensive reactions such as those associated with fear and rage.

**MID BRAIN:** - The midbrain is the area of brain situated around the cerebral aqueduct between the cerebrum above and the ponsvaroli below. It consists of groups of nerve cells and nerve fibres which connect the cerebrum with lower parts of brain and with spinal cord. The nerve cells act as relay for the ascending and descending nerve fibres.

**PONS VAROLII:** - It is situated in from of cerebellum below the mid brain and above medulla oblongata. There are groups of cells in it which act as relay station and some of these are associated with cranial nerves.

**MEDULLA OBLONGATA:** - The medulla oblongata extend from pons varolii above and is continuous with the spiral cord below. It is 2.5cm long its anterior and
posterior surfaces are marked by central fissures. The outer aspect is composed of white matter and grey matter lies centrally. Medulla oblongate act as a conduction path way for motor and sensor impulses between the brain and spinal cord.

The vital centers concerned with autonomic reflex activity include:

The main feature of the medulla are that here the descending motor pathways cross from one side of the brain stem to the other. This is called the Motor decussating.

A similar arrangement of the sensory pathways occurs in the medulla and is referred to as the sensory decussating.

**Cardiac center:** - Regulates the rate of the heart and force of contraction

**Respiratory center:** Control the rate and depth of respiration.

**Vasomotor center:** Regulates the diameter of blood vessel.

**Reflex centers:** vomiting, coughing, sneezing and swallowing.

**Cerebellum:** - It is situated behind the pons varoli and immediately below the posterior portion of cerebrum it is ovoid in shape and has two hemispheres, separated by a narrow medium strip called the vermis.
Grey matter forms the surface of the cerebellum and the white matter lies deeply.

**FUNCTIONS OF CEREBELLUM:**

1. It is concerned with the coordination of voluntary muscular movement, posture and balance.
2. It activities are not under voluntary control.
3. It controls and co-ordinate the movements of various groups of muscles ensuring smooth, even precise actions.
4. It is concerned with maintenance of balance and equilibrium of body.
Damage to cerebellum results in clumsy uncoordinated muscular movements, staggering gait and inability to carry out smooth, steady, précis movements.

**RETICULAR FORMATION:**

The reticular formation is collection of neurons in the cone of brain stem, surrounded by neural pathways which pass nerve impulses between the brain and the spinal cord.

**SPINAL CORD:**

The spinal cord is the elongated, almost cylindrical part of central nervous system, suspended in the vertebral canal surrounded by the meninges and cerebrospinal fluid.
Section of the distal end of the vertebral canal
It is continuous with medulla oblongata and extends from the upper border of atlas to the lower border of 1st lumbar vertebra. It is approximately 45cms. Long and thickness of little finger.

Except for the cranial nerves, the spinal cord is the nervous tissue link between the main and rest of the body. The nerves conveying impulses from brain to various organs and tissues descened through the spinal cord.

**Functions of spinal cord:**
1. Sensory cells which carry impulses from the periphery of the body to brain. Eg. Pain, heat.
2. Cells of lower motor neurons which transmit impulse to the skeletal muscles. Eg. Voluntary muscles.

**PERIPHERAL NERVOUS SYSTEM:** Spinal nerves:-
There are 31 pairs of spinal nerves. They are named according to the vertebra with they are associated.

- **8 cervical**
- **12 thoracic**
- **5 lumbar**
- **5 sacral**
- **1 coccygeal**
The spinal nerves arrive from both sides of the spinal cord and emerge through the inter vertebral foramen. Each nerve is formed by union of motor and sensory nerve root and is therefore a mixed nerve.

The spinal nerves form cervical plexus brachial plexus, lumbar plexus, sacral plexus and coccygeal plexus.
The Nervous system

The meninges covering the brain and spinal cord.
MENINGES: The brain and spinal cord are surrounded by the meninges which protect the delicate nerve structure, carry the blood vessels to it and by the secretion of a fluid called cerebrospinal fluid. The meanings are in 3 layers.

1. Duramater
2. Arachnoid mater
3. Pia mater

The dura and arachnoids matters are separated by subdural space, the arachnoids and piamater are separated by the subarachnoid space. The subarachnoid space contains cerebrospinal fluid.

Duramater: It is dense and tough. It consists of 2 layers. The outer layer lines the skull and the inner layer provides a protective covering.

Arachnoids matter.

This is a delicate serous membrane lying between duramater and piamater.

PIAMATER: This is a fine connective tissue containing many minute blood vessels. It closely invests and covers the brain. It dips into the fissures of the brain and cord and by this close contact supplies these structures with brain.
**Ventricles of the brain:** with in the brain there are 4 irregular shaped cavities or ventricles containing cerebrospinal fluid.

They are

1. **Rt. And Lt lateral ventricles** – each one located inside each cerebral hemisphere.
2. **Third ventricle** – situated between two parts of cerebral hemisphere.
3. **Fourth ventricle** – situated below and behind the third ventricle, between the cerebellum and pons varoiili.
Cerebrospinal fluid: This fluid is secreted into the ventricles by the choroid plexus. It is a clear alkaline fluid resembling plasma with a specific gravity of 1.005 consisting of water plasma proteins small amounts of (albumin and globulin) mineral salts glucose creatinine urea in small amounts.

Functions:
1. it supports and protects the brain and spinal cord.
2. it maintains a uniform pressure around these delicate structures.
3. it acts as a cushion and shock absorber between the brains and cranial bones.
4. it keeps the brain and spinal cord moist and there may be inter change of substances between CSF and nerve cells, such as nutrients and waste products.

REFLEX ACTION AND REFLEX ARC: Reflex action are part of the defense mechanism of the body and take place fast immediate, automatic and involuntary responses of the body. Eg. The closing of the eye when bright light is focused on eyes the closing of the eye when bright light is focused, the movement of the with drawing the hand from some article accidentally touched if
unpleasantly hot. Reflex action is inhibited by voluntary control the hand in stead of being withdrawn may for example beheld deliberately in contact with the hot surface.

**A reflex arc consist of**

**A sensory organs:** which receive the impulses.

Eg. Skin

A sensory nerve fiber which conduct this impulse to the cells in the poster root ganglia and then by their fibers to the gray matter of the posterior horn of the spinal cord.

The spinal cord where connector nerve pass impulses onto the anterior horn of the cord.
Cranial Nerves: There are 12 pairs of cranial nerves. All these leave the skull through the foramina of the skull. Cranial nerves that contain both motor and sensory fibres are called “Mixed nerves” and some nerves are motor only and some are sensory nerves only.

The names of the cranial nerves generally indicate their function.

I. olfactory nerve - The nerve of smell.

II. Optic nerve (Sensory) – The nerve of sight

III. Oculomotor nerve – Its function is movement of the eye lid and eye ball, contrition of pupil accommodation and also helps in proprioception
IV. Trochlear Nerve – Its function is movement of the eye ball and in proprioceptions.

V. Trigeminal nerve (mixed) It is the largest cranial nerve helps in chewing and conveys sensations for touches, pains, temperature and helps in proprioceptions.

VI. Abducens (Mixed) – Its function is movement of the eye ball and in proprioceptions.

VII. Facial nerve (mixed) It supplies the muscles of facial expression the sensory fibers convey impulses from taste buds in the anterior 2/3 rd of the tongue to the taste perception area to cerebral cortex.

VIII. Acoustic or Auditory or Vestibulocochlear nerve (Sensory) – It is the nerve of hearing. It has a cochlear part and vestibular part. The cochlear part helps in hearing and vestibular part is concerned with equilibrium.
**IX.** Glossopharyngeal nerve – (mixed) – Its function is in swallowing movements and secretion of saliva sense of taste, and regulation of blood pressure

**X.** Vagus nerve (mixed) – Visceral movements and swallowing movements.

**XI.** Accessory Nerve (Mixed) - It has 2 portions bulbar portion mediates swallowing movements and spinal portion medicates movement of head.

**XII.** Hypoglossal nerve (mixed) – It function is movement of tongue during speech and swallowing and in proprioception.

*The interior surface of the brain showing the cranial nerves.*
AUTONOMIC NERVOUS SYSTEM: - The autonomic or involuntary part of nervous system controls the functions of body carried out automatically i.e., initiated in the brain below the level of cerebrums. It is made up of sympathetic and parasympathetic nerves. It controls involuntary muscles and glands.

Sympathetic system: - It consists of two chains of ganglia one on each side of the vertebral column. The ganglia are attached by fibres to the spinal nerves the sympathetic nerves are stimulated by the emotions like fear, excitement and anger. This results in dilated pupils, quicker heart beats, quicker and deeper breathing, raised blood pressure, slow digestion, increased sweating and oral and urethral spinsters tighten up.

Parasympathetic system: - This system is in control during normal quite living. Some cranial nerves especially vagus have such actions. These action are pupils of eye contract, salina flows, digestion and peristalsis are stimulated hear beat and respiration slow down. The sacral nerves of this system help in passing urine and faeces.
Functions of Autonomic nervous system:

1. It coordinates the reflexes in the brain below the level of cerebrum.

2. Sympathetic stimulation effects (CVS) Cardiovascular system:-
   i) Dilatation of coronary arteries, increasing the blood supply to heart muscles.
   ii) Raises the blood pressure and increases blood supply to skeletal muscle, heart & brain.
   iii) Raises the volume of blood available for circulation in dilated blood vessels.
   iv) Blood coagulation occurs quick.

3. Parasympathetic stimulation – has effects opposite to those of sympathetic stimulation


   Parasympathetic – no supply to skin.
Genitalia:
Sympathetic simulation – ejaculation in males
parasympathetic stimulation – vasodilatation
erection of penis in male.
UNIT-III
QUESTIONS

1. List the organs of central nerves system.
2. What is neuron?
3. Write the functions of the Medulla oblongata.
4. Write the functions of the hypothalamus.
5. Write the functions of the cerebrum.
6. Write the functions of the cerebellum.
7. Write the functions of the cerebrospinal fluid.
8. Describe reflex action.
9. List the cranial nerves in order.
10. Write the function of autonomic nervous system.
Unit – IV

(D) EXCRETORY SYSTEM

Excretion means the elimination from the body of waste substances.

The urinary system consists of
(a) kidneys which secrete urine
(b) ureters to pass urine from kidneys to bladder
(c) bladder which acts as a reservoir of urine
(d) urethra for passing urine from the bladder.

This system helps to keep the body in homeostasis by controlling the composition and volume of blood.

The Organs, which form the Urinary Tract

The kidneys

The kidneys are bean shaped organs that lies on the posterior abdominal wall, mainly in the lumber region, one on each side of the vertebral column, deeply embedded in fat, behind the peritoneum, and therefore out side the peritoneal cavity.
Position and structure of kidneys

Each kidney measures 10 to 13 cm in length, 6 cm breadth and 2.5 to 4 cm in thickness. The weight of the adult kidney is about 140 grams. Each kidney is surrounded by a thin capsule of fibrous tissue forming a smooth covering beneath this kidney substance lies it is of a deep purple and consist of an outer cortical part and inner medullary part. Medullary part is made up of 15 to 16 pyramid shaped masses called the pyramids of the kidneys. The apices of these are directed towards helix and opens into calyces, which communicate with pelvis of the kidneys. Each kidney is surmounted by adrenal glands. The right kidney is shorter and thicker than the left.
Functions of kidneys:

- Regulates the composition and volume of blood.
- Excretes waste products from the blood in the form of urine.
- Excretes metabolic wastes.
- Helps regulate blood pH.
- Helps regulate blood pressure by secreting rennin that activates rennin.

**Nephron:** the minute structure of the kidney is composed of about 1 million functional units, the nephrones.

The nephrone consists of a tubules closed at one end, the other end opening into a collecting tubule. The closed or blind end is intended to form the cup shaped glomerular capsule (Bowman’s capsule) which almost completely enclosed a net work of arterial capillaries, the glomerulus.
The remaining part of the nephron is described in the three parts;

(i) The proximal convoluted tubule
(ii) The loop of Henle and
(iii) The distal convoluted tubule, leading into a collecting tubule.

In the kidney, the renal artery divides into smaller arteriols, Enter each glomerular capsule than subdivides into a cluster of capillaries forming the glomerulus. Between the capillaries there are phagocytic mesangial cells. The blood vessels leading away from the glomerulus is the afferent arteriole. It breakup into a second capillary network to supply oxygen and nutritional material to the reminder of the nephron. Venous blood drained from this capillary bed leaves is the kidney in the renal vein which convey blood from the kidney to the inferior venacava. The blood circulating through the kidney has a double set of capillary vessels.

The walls of the glomerulus and the glomerular capsule consists of a single layer of (flattened) epithelial cells. The reminder of the nephron and the collecting tubule are formed by the single layer of highly specialized cells.
The nerve supply: sympathetic and para sympathetic nerves.

**Formation of urine:** Urine is formed in the nephrones by three processes;
(a) Glomerular filtration
(b) Tubular reabsorption
(c) Tubular Secretion.

**Glomerular Filtration:** It is the passage of water and electrolytes through the glomerular filtering membrane as a result of difference in pressure the fluid that is filtered through glomerular semi permeable membrane is called glomerular filtrate. Glomerular filtration depends on hydrostatic and osmotic pressure gradients between glomerular capillaries and Bowman’s capsule, rate of renal blood flow permeability of glomerular Membrane. Glomerular membrane is impermeable to blood cells and plasma proteins. The result of the filtration process represent the first stage in the formation of urine this filtrates usually contains 94% water and 6% solute.

**TUBULAR REABSORPTION:** It is the process by which renal tubules retain the substances needed by the body including water glucose, amino acids and ions. The reabsorptive function of the renal tubular system returns about 99% of the glomerular filtrate to the body. Reabsorption take place through active transport, passivediffusion and by osmosis. Some substances are poorly reabsorbedthrough tubular membranes; they are urea, phosphate, uric acid,sulfate, nitrate etc., which are excreted
from the body. The kidneys produce dilute urine in the absence of anti diuretic hormone.

**TUBULAR SECRETION**: Chemicals not need by the body are discharged into the urine by tubular secretion. Secretion is a chemical activity allowing transport of substances from the blood into the tubules. Nitrogenous waste, ions certain drugs are into urine by tubular secretion discharged.

**Ureters**  The ureters are the tubes that convey urine from the kidneys to the urinary to the bladder. They are about 25 to 30 cm long with a diameter of about 3 mm. The ureter is continuous with the funnel-shaped renal pelvis.

**Function**: The ureters propel the urine from the kidneys into the bladder by peristaltic contraction of the muscle layer sending the little spurts of urine into bladder.

**THE URINARY BLADDER**
The bladder acts as a reservoir for urine; it is a pear-shaped organ. It lies in the true pelvis in front of the other contents, and behind the symphysis pubis. In the infant it lies higher. The lowest part in fixed and is called the base, the upper part or fundus rises, the bladder becomes distended with urine. The apex lies forward beneath and behind the symphysis pubis.
The bladder consists of:
An outer serous cost,
A muscular cost,
A sub-mucous cost, and
A mucous lining, of transitional epithelium.

Three vessels communicate with the bladder. The two ureters open obliquely into it at the base; their oblique direction prevents the regurgitation of urine into the ureters. The urethra opens out of the bladder inferiorly. The triangular area between the openings of the ureters and the urethra is the trigone of the bladder. In the female, the bladder lies between the symphysis pubis and the uterus and vagina. It is separated from the uterus by a fold of peritoneum—the utero-vesical pouch.

The **urethra** is a canal passing from the neck of the bladder to the external opening; it is lined with mucous membrane continuous with that lining the bladder. The urinary meatus is composed of circular muscle fibers, which form the sphincter urethra. The female urethra is 2.5-3.5 cm (1 ½ inches) long, the male 17-23 cm (7-9 inches).
Micturition is the act of passing urine. The act is brought about by contraction of the muscular coat of the bladder, and relaxation of the sphincter muscles. The bladder is controlled by the pelvic nerves, and sympathetic fibers from the hypogastric plexus.

Composition of Normal Urine: Urine is mainly water, urea and sodium chloride. In a man taking an average diet with 80 to 100 grams of protein in the 24 hours, the percentage of water and solids will be similar to the following:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>96%</td>
</tr>
<tr>
<td>Solids</td>
<td>4%</td>
</tr>
<tr>
<td>Urea</td>
<td>2%</td>
</tr>
<tr>
<td>Other solids</td>
<td>2%</td>
</tr>
</tbody>
</table>

Urea is one of the end products of protein metabolism. It is prepared from amino-acids, which are delaminated in the liver and reach, the kidneys in the circulation, being excreted at the rate of 30 grams a day. The normal blood urea level is 30 mg per 100 ml of blood, but this depends on a normal intake of protein food and the function of the liver in the formation of urea.

Uric acid: The normal level of uric acid in the blood is 2 to 3 mg per 100 ml – 1.5 to 2 g being excreted daily in the urine.

Creatinine is a waste product of creatinine in muscle. Other products of metabolism include purine bodies, oxalates, phosphates, sulphates and urates.

Electrolytes or salts such as sodium, potassium chloride are excreted to balance the amounts taken by mouth.

Characteristics of normal urine. The quantity averages 1-2 liters daily in man, but varies greatly with the amount of fluids taken. It is also increased when excess protein is taken, in order to provide the fluid necessary to carry the urea in solution.

The colour is clear pale amber with no deposits, but a light flocculent cloud of mucus may be seen floating in the specimen.

The odour is aromatic.
The reaction is slightly acid to litmus with an average pH of 6. The specific gravity varies from 1010 to 1025.

**WATER AND SODIUM BALANCE**

Water is needed by the body.
- For tissues and for body fluids such as blood and lymph water forms 2/3 of body weight.
- The making of digestive juices and lubricating fluids.
- A solvent provision of the moist internal environment which is required by a living cells in the body.
- Providing the medium for the excretion of waste products eg; urine and faces.
- Dilution and moisturizing food.
- Regulation of body temperature as a constituent of sweat which is secreted on to the skin it evaporates cooling the body.
- Dilution of waste products and poisonous substances in the body.
- In addition to the water contained in food we need to drink 1.5 to 2 liters of fluids every day to supply the above needs.
- Water is usually lost from the body in urine farces, sweat and expired air.
- The kidneys are the most important organs for the for main ting the fluid balances of the body.
- The salts of a number of chemical elements are important in metabolism. They also have an effect on water balances in the body and the reaction of the blood. Salts are taken into the body in form of food. Salts are taken into the body in for food. They may be acid, alkaline or neutral in recreation.
- The blood is always very slightly alkaline and their reaction is kept constant by salts in the blood. Salts must be left in
the blood or taken away by the kidneys in correct quantities. So that the blood is kept at its normal reaction and the water and salt balance in the body is maintained.

**SKIN**

The skin completely covers the body and is continuous with the membranes lining the body orifices.

- It protects the underlying structure from the injury and from invasion by microbes.
- It contains sensory (somatic) nerve endings of pain, temperature and touch.
- It involved in the regulation of the body temperature.

**STRUCTURE OF THE SKIN**

There are two main layers to the skin;
Epidermis
Dermis or corium
Between the skin and underlying structures there is a layer of subcutaneous fat.

**EPIDERMIS**

The epidermis is the most superficial layer of the skin and is composed of stratified epithelium which varies in thickness in different parts of the body. It is thickest on the palms of the hand and soles of the feet. There are no blood vessels on nerve ending in the epidermis, but its deeper layers are bathed in interstitial fluid which is drained away as lymph.
There are several layers of cells in the epidermis which extend from the deepest germinative layer to the surface stratum corneum (horny layer). The cells on the surface are flat, thin, non-nucleated, dead cells in which the protoplasm has been replaced by keratin. These cells are constantly being rubbed off and replaced by cells which originated in the germinative layer and have undergone gradual change as they progressed towards the surface.

The maintenance of healthy epidermis depends upon three processes being synchronized:

1. Desquamation of the keratinized cells from the surface.
2. Effective keratinisation of the cells approaching the surface.
3. Continual cell division in the deeper layers with cells being pushed to the surface.
Hairs, secretion from sebaceous glands and ducts of sweat glands pass through the epidermis to reach the surface.

The surface of the epidermis is ridged by projections of cells in the dermis different in every individual and the impression made by them is the ‘fingerprint’. The downward projections of the germinative layer between the papillae are believed to aid nutrition of epidermal cells and stabilize the two layers, preventing damage due to shearing forces.

The colour of the skin is affected by three main factors:

1. Melanin, a dark pigment secreted by melanocytes in the deep germinative layer, which is absorbed by surrounding epithelial cells. The amount varies between different parts of the body, between members of the same race and between races. The numbers of melanocytes is fairly constant so the differences in color depend on the amount of melanin and secreted. Sunlight darkness existing melanin and promotes its secretion.

2. The level of origination of hemoglobin and the amount of blood circulating in the dermis gives the skin its pink colour.

3. Bile pigments in blood and carotenes in subcutaneous fat give the skin a yellowish colour.
DERMIS

The dermis is tough and elastic. It is composed of collagen fibers interlaced with elastic fibers underlying its deepest layer there is areolar tissue and varying amounts of fat.

The structures in the dermis are:

Blood vessels
Lymph vessels
Sensory (somatic) nerve endings.
Sweat glands and their ducts
Hair roots, hair follicles and hairs sebaceous glands.
The arrectores pilorum – involuntary muscles attached to the hair follicles.
1. **Blood vessels**: Arterioles form a fine network with capillary branches supplying sweat glands, sebaceous glands, hair follicles and the dermis. The epidermis has no blood supply. It obtains nutrition and oxygen from interstitial fluid derived from blood vessels in the papillae of the dermis.

2. **Lymph vessels** from a network throughout the dermis and the deeper layers of the epidermis.

3. **Sensory nerve endings**. Nerve endings which are sensitive to touch, change in temperature, pressure and pain are widely distributed in the dermis. The skin is an important sensory organ through which individuals are aware of their environment. Nerve impulses that originate in the nerve endings in the dermis are conveyed to spinal cord by sensory (somatic cutaneous) nerves, there to the sensory area of the cerebrum where the sensation are perceived.

4. **Sweat glands** are found widely distributed throughout the skin and are most numerous in the hand, soles of the feet, axilla and groins. They are composed of epithelial cells. The bodies of the glands lie coiled in the subcutaneous tissue. Some ducts open on the skin surface at tiny depressions, or pores and others open into hair follicles. Glands opening into hair follicles do not become active until puberty. In the axilla they secrets an odorless milky fluid which, if decomposed by surface microbes, causes an unpleasant odour.
4. **Hair follicles** consist of a downward growth of epidermal cells into the dermis or subcutaneous tissue. At the base of the follicle there is a cluster of cells called the bulb. The hair is formed by the multiplication of cells of the bulb and as they are pushed upwards, away from their source of nutrition, the cells die and are converted to keratin. The part of the hair above the skin is the shaft and the remainder, the root. The colour of hair depends on the amount of melanin present. White hair is the result of the replacement of melanin by tiny air bubbles.
6. **The sebaceous gland** consists of secretary epithelial cells derived from same tissue as the hair follicles. They pour their secretion, sebum, into the hair follicles. So they are present in the skin of all parts of the body except the palms of the hands and the soles of the feet. Sebaceous glands of hair pellicles secreting sebum directly on to the surface. **Sebum** is an oily substance that keeps the hair soft and pliable and gives it a shiny appearance. On the skin it provides some water – proofing and acts as bactericidal and fungicidal agent, preventing the successful invasion of microbes it also prevents drying and cracking of skin, especially on exposure to heat and sunshine.

7. **The arrectores pilorum** are little bundles of involuntary muscles fibers attached to the hair follicles. Contraction makes the hair stand erect and hair rises. The muscles are stimulated by the sympathetic nerve fibers in response to the fear and cold.
NAILS

The nails in human being are equivalent to the claws, horns and hoofs of animals. They are derived from the same cells as epidermis and hair and consist of a hard horney type of keratinized dead cells. They protect the tips of the toes. The root of the nail is embedded in the skin, is covered by the cuticle and forms the hemispherical pale are called the lunula.

The body of the nail is the exposed part which has grown out from the germinative zone of the epidermis called the nail bed. Finger nails grow more quickly than toe nails and growth is quicker when the environment temperature is high.
FUNCTIONS OF THE SKIN

Protection:
The skin is one of the main protective organs of the body. It protects the deeper and more delicate structure and acts as the main barrier against the invasion of microbes and other harmful agents.

Due to the presence of the sensory nerve endings in the skin the body reacts by reflex action to unpleasant or painful stimuli, protecting it from further injury.

FORMATION OF VITAMIN D3

There is a fatty substance, 7-dehydrocholestrol, in the skin and ultraviolet light from the sun converts it to vitamin D. This circulates in the blood and is used, with calcium and phosphorus, in the formation and maintenance of bone. Any vitamin D in excess of immediate requirements is stored in the liver.

REGULATION OF BODY TEMPERATURE

The temperature of the body remains fairly constant at about 36.8 degree (98.4 F). In health, variations are usually limited to between 0.5 and 0.75 degree centigrade, although it is raised slightly in the evening exercise and in women just before ovulation. If the temperature is raised the metabolic rate is increased and if it is lowered the rate of metabolism is reduced. To ensure this constant temperature a fine balance is maintained between heat production in the body and heat lost to the environment.
HEAT PRODUCTION

Some of the energy release in the cells when carbohydrates, fats and deaminated aminoacids are metabolized is in the form of heat. Because of this most active organs, chemically and physically, produce the most heat.

The principal organs involved are:

The muscles: Contraction of voluntary muscles produces a large amount of heat and the most strenuous the muscular exercise the greater the heat produced, shivering involves muscles contraction and produces heat when there is the risk of the body temperature falling below normal.

I. The liver is very chemically active, and heat is produced as by-product.

II. The digestive organs produce heat by the contraction of the muscles of the alimentary tract and by the chemical reactions involved in digestion.

III. The specific dynamic action, i.e., the increase in the metabolic rate occurs when food is eaten produces heat.
‘D’ Excretory System

1. Draw the diagram of urinary system.
2. Draw the diagram of kidney and explain briefly the structure of kidney.
3. Write functions of the kidney.
4. Explain briefly the structure of Nephron.
5. Write the characteristics of normal urine.
6. Explain excretory organs role in maintaining fluid and sodium balance.
7. Draw the diagram of skin and describe the structure of the skin.
8. Write the function of skin.
THE ENDOCRINE SYSTEM

The Endocrine organs or ductless glands are grouped to gather under this name because the secretion they make does not leave the glands by means of a duct; instead it is passed into the blood, circulating through the substance of the glands. The word endocrine comes from the Greek, and means ‘internal secretion’ the active principle of an internal secretion is called hormone, from a Greek word meaning ‘to excite ‘some of the endocrine organs produce a single hormone, others two hormones or more; the pituitary gland, for example produces a number of hormones which control the activity of many other endocrine organs; for this reason the pituitary has been described as ‘the master gland of the body.

The endocrine organs are

- The Pituitary, anterior and posterior lobes.
- The Thyroid gland
- Para thyroid glands.
- The Adrenal or suprarenal glands.
- The Thymus gland possibly also the pineal body.
- Pancreas (the formation of an internal secretion is an important function also of many other organs and glands such as insulin from the Islets of langerhans in the pancreas).
- Ovaries (estrogens and progesterone).
- Testes (testosterone).
PITUITARY GLAND

The Pituitary gland lies at the base of the skull, in the pituitary fossa of the sphenoid bone. It consists of two lobes, anterior and posterior lobe.
The secretions anterior pituitary gland.
It produces a number of hormones which are instrumental in controlling the production of the secretion of all the other endocrine organs.

The growth hormone (Somatotrophic hormones) controls the growth of the body.

The Thyrotrophic hormone control the activity of the Thyroid gland in the production of thyroxin.

The Adrenocorticotropic hormone (ACTH) controls the activity of the adrenalin glands in the production of cortisol from the cortex of the gland.

The Gonadotrophic harmones are:
The follicle-stimulating hormones (FSH) which stimulates the development of Graafian follicles in the ovary and the formation of the spermatozoa in the testis.

The luteinising or interstitial cell stimulating hormone (LH) controls the secretion of the oestrogens and progesterone in the ovary and testosterone in the testis.
The *luteotrophin or prolactin*, controls the secretion of milk, and maintains the existence of the corpus luteum during pregnancy.

**Secretions of Posterior pituitary lobe:**
It secretes two hormones: (a) **Anti diuretic hormone** (ADH) which regulates the amount of water passed by the kidneys, and the (b) **Oxytocic hormone** stimulating the contraction of the uterus during the birth of a baby and the release of milk during breast feeding.

**Thyroid gland**

The thyroid gland consisting of two lobes placed one on each side of the trachea, and connected together by a strip of thyroid tissue, called the isthmus of the thyroid, which lies across in front of the trachea.

The thyroid gland is composed of number of vesicles lined with cubical epithelium, abundantly supplied with blood, held together by connective tissue. These cells secrete sticky fluid, the colloid of the thyroid, which contains an iodine compound; the active principle of this compound is a hormone thyroxin. This secretion fills the vesicles and from here passes to the bloodstream either directly through the lymphatic.

**Function:** The secretion of the thyroid is regulated by a hormone of the anterior lobe of the pituitary gland, the **thyrotrophic hormone**.
The thyroid gland is intimately concerned with the metabolic activities regulating the chemistry of the tissues and is instrumental in stimulating oxidation processes and in regulating the consumption of oxygen and consequently the output of carbon dioxide.

Hypo secretion (hypothyroidism): Deficiency of the secretion of the gland at birth production a condition known as cretinism, in which mental and physical growth are retarded. In adults deficiency of the secretion produces myxoeedema; the general metabolic processes slow down, there is a tendency to gain weight, movements are lethargic; there is slowness of mind and speech, the becomes thickened and
dry, and the hair falls out or get thin. The temperature is subnormal, and the pulse slow..

**Hyper secretion:** In enlargement of the gland and increased secretion. Hyperthyroidism, the symptoms are the opposite of those of myxoedema. The metabolic rate is raised and the body temperature may be higher than normal. The patient loses weight, is nervous and excitable, the pulse rate is raised, the cardiac output increased, and cardiovascular symptoms may include atrial fibrillation and heart failure.

In the condition known as Graves’ disease or exophthalmic goiter the eyeballs protrude. This effect is due to over-activity of the thyroid hormone. It may not disappear when the disease is treated.

**THE PARATHYRIOD GLAND**
The parathyroid gland is four small glands placed, two on each side of the thyroid gland in the neck. Parathyroid glands secrete hormones called parathyroid hormones (PTH) or “Para hormones” which regulates calcium metabolism and controls the amount of calcium in blood and bones. Hyperparathyroidism in which there is a deficiency of calcium content, hypocalcaemia, causes a condition described as tetany. Hyperparathyroidism, over activity of the glands usually, associated with enlargement of the glands.

Functions of Parathyroid Gland:
- Increases blood calcium level and decreases blood phosphates level by increasing rate of calcium absorption from gastrointestinal tract in the blood.
- Increases number and activity of Osteoclasts.
- Increases calcium absorption by kidneys.
- Increases phosphate excretion by kidneys.
- Activates Vitamin
The thymus gland lies in the thorax about the level of the bifurcation of the trachea. It is pinkish-grey in colour and consists of two lobes. At birth the gland is quite small, weighing about 10 grams or a little more; it increases in size and at puberty weighs from 30 to 40 grams and then shrinks again. Its functions are unknown, but thought to be concerned with the production of antibodies.

THE ADRENAL GLAND

The Adrenal or Suprarenal glands lie on the upper pole of each kidney. The adrenal glands consist of an outer yellowish part, the cortex, which produces cortisol (hydrocortisone), a close relation of cortisone, and an inner medullary portion producing both adrenaline (epinephrine) and noradrenaline (nor epinephrine).

These substances are secreted under the control of the sympathetic nervous system. The secretion is increased in conditions of emotion such as anger and fear, and in states of asphyxia and starvation and an increased output raises the blood pressure in order to combat the shock produced by these emergencies.

Noradrenaline raises the blood pressure by stimulating the muscular fiber in the walls of the blood vessels, causing them to contract. Adrenaline aids carbohydrate metabolism by increasing the output of glucose from the liver.

The important hormones secreted by the adrenal cortex are hydrocortisone, aldosterone and corticosterone, which are intimately concerned with metabolism, growth, renal function and muscle tone. These functions are essential to life.
In adrenal insufficiency (Addison’s disease) the patient becomes wasted and prostrated and gradually weaker, chiefly due to the fact that in the absence of this hormone, the kidneys fail to conserve sodium, which therefore is excreted in too large amounts. This disease is treated with cortisone.

The Islets of Langerhans of the pancreas constitute an endocrine organ secreting insulin, the antidiabetic hormone, given in the treatment of diabetes. Insulin is a protein which can be acted on by the protein digestive ferments and therefore is not given by the mouth but by subcutaneous injection. Insulin controls and, when prescribed in a deficiency, such as in diabetics, restores the ability of the body cells to absorb and use glucose and fats.

The deficiency leads in hyperglycemia, a high blood sugar, loss of weight, fatigue and polyuria, with increased thirst, hunger, dry skin, dry
mouth and tongue, increase rate of breathing causes ketosis with acidosis.

**Hypoglycemia** is a opposite condition of hyperglycemia, a low blood sugar may be produced by an over dose of insulin; or by a patient not eating food taken after his injection of insulin when excess in his blood may lead to hypoglycaemic coma which is treated with glucose.

**THE PINEAL GLAND**

It is a small red body similar in shape to a pine cone situated near the corpus callous. Its function obscure.

Other sex glands which produce internal secretion are described in unit 6.

**MECHANISM OF REGULATION OF BODY TEMPARATURE**

Normal body temperature of 37 degree centigrade is maintained in spite of variations in the surrounding air. This is achieved by a balance between heat production and heat loss controlled by a heat loss controlled by a heat regulation centre (Hypothalamus) in the brain.

Heat is produced in the body by metabolic process like (a) Burning of glucose in the muscles (b) Activities of the liver and other glands.

Heat loss from the body takes place mainly through the skin (a) By radiation to the surrounding air and conduction to the clothing (b) Evaporation of sweat. The heat required for sweating is taken from the skin (c) some heat is
lost from the lungs in the air we breathe out; (d) some heat is lost in urine and faeces

In hot weather heat loss is increased by (a) Dilatation of blood vessels in the skin to increase heat loss by radiation and conduction, (b) Increased sweating for more heat loss by evaporation. In cold weather heat loss is decreases by decreased sweating.

The heat regulating center in the brain is sensitive to the temperature of the blood flowing through it, also by the sensory nerve messages from the skin and other tissue. The center controls both heat production and heat loss Eg. by dilatation or contraction of blood vessels in the skin and by decreases or increased sweating. It also has an effect on the endocrine gauuds to stimulate tissue activity in order to increase heat production when this heat regulating enter is affected by infection. Temperature raised called pyrexia.
**QUESTIONS**

**‘E’ Endocrine glands**

1. Define endocrine glands.
2. Mention the endocrine glands.
3. Write the function of a pituitary gland.
4. What are hormones secreted by thyroid gland.
5. Write the function of thyroid gland.
6. Write the functions of Para thyroid glands.
7. Write the locations of the following glands are situated.
   (a). Pituitary gland, (b). Para thyroid glands
   (c). Thyroid gland (e). Adrenalin glands.
   (f). Thymus gland.
8. What is hypothyroidism?
9. What is the hormone secreted by the pancreas.
10. What is hypoglycemia?
11. Explain the mechanism of regulation of body temperature.
The circulatory or vascular system is divided for descriptive purposes into two main parts.

1. **The blood** circulatory system which consists of **heart** which is the great pumping organ maintaining the circulation throughout the body. The **blood vessels** through which the blood circulates.

2. The lymphatic system which consists of lymphatic glands (nodes) Lymphatic vessels and capillaries through which a colour less fluid known as lymph circulates. The two systems communicated with one another and are intimately associated.

**BLOOD:** Blood is described as a fluid tissue. It provides one of the means of communication between the cells of different parts of the body and the external environment. Eg. It carries oxygen from the lungs to the tissues and Carbon dioxide from the tissues to the lungs for excretion.
Blood is fluid tissue composed of two parts the intercellular substance is a fluid called plasma in which float formed elements the blood cells or corpuscles. Blood is viscous fluid. Blood constitutes about 8% of the total body weight. The total volume of blood in the body is about five liters and it is slightly alkaline.

The volume of blood is constant in health being regulated to a great extent by the osmotic pressure in the vessels and in the tissues.

**Composition of Blood:** Blood is composed of a straw coloured transparent fluid plasma in which different types of cells are suspended plasma constitutes about 55% and cells about 45% of blood volume.
**PLASMA:** - The constituents of plasma are water (90 to 92%) and dissolved substances are:-

**Plasma Proteins:** Albumin, Globulin, fibrinogen, clotting factors.

**In organic salts:** (Mineral Salts) Sodium, chloride, sodium bicarbonate, potassium, magnesium, phosphorus, iron, calcium, copper, iodine, cobalt.

**Nutrient Materials** (form digested food)
Monosaccharides (glucose) from CHO Aminoacids, from protein, fatty acids and glycerol from fats, & vitamins

**Organic waste materials:** Urea, uric acid, creatinine.

Hormones
Enzymes
Antibodies
Gases
Oxygen, Corbondioxide and Nitrogen.

**BLOOD PLASMA:** - is a straw colored fluid slightly alkaline in reaction the composition of plasma and the list of substances contain
Water 91.0%
Protein 8.0 percent (Albumin, Globulin, fibrinogen)
Salt 0.9 percent (Sodium, chloride, sodium bicarbonate, salts of calcium, phosphorus, magnesium and iron etc.)
The balance is made up of traces of a number of organic materials- glucose, fats, urea, uric acid, creatinine cholesterol and amino acids.

**FUNCTIONS OF PLASMA:** - Plasma acts as the medium for the transmission of nutriment, salts, fats glucose, and amino acids to the tissues and as the medium for carrying away waste material urea, uric acid and some of the carbon dioxide.

**PLASMA PROTEINS:** Albumin: There are normally 3 to 5 gm of albumin in each 100 ml of blood. It has three functions

1. It is responsible for the osmotic pressure which maintains the blood volume.
2. Many special substances are carried in combination with the albumin.
3. It provides protein to the tissues.
**GLOBULIN:** There are normally 2 to 3 g of globulin in each 100 ml of blood globulin is much more variable than albumin in composition and really comprise a very large number of different proteins. It is less important in providing osmotic pressure than albumin but more important in other ways for instance all the protective antibodies are globulins.

   Fibrinogen is essential for blood coagulation.

**FUNCTIONS OF BLOOD:**

1. Blood transports oxygen from the lungs to all cells of the body.
2. Blood transports Co2 from the cells to the lungs.
3. Blood transports nutrients from the digestive organs to the cells.
5. Hormones secreted by endocrine glands to the target glands and tissues.
7. Blood plays a role in the regulation of normal body temperature.
8. Blood regulates the water content of cells mainly through dissolved sodium ions.

9. Protective substances eg., Antibodies to area of infection: (Blood protects the body against Toxins & foreign microbes through special combat unit cells.)

**CELLULAR CONTENT OF THE BLOOD:**

Formed element:- Formed elements or blood cells constitute 45% of total volume of the blood. They are three types of blood cells.

1. Erythrocytes or red cells
2. Thrombocytes or platelets
3. Leucocytes or white cells.

*Blood cells after staining in the laboratory viewed through a microscope*
**Erythrocytes:** They are biconcave discs without nuclei, containing hemoglobin their life span 120 days. Erythropoiesis occur in bone marrow of short flat and irregular bones RBC transport oxygen and carbondioxide. Normal range is 4.5 to 5.5 million/ mm 3 Red blood cells have Hemoglobin in their cytoplasm. Hemoglobin gives to the blood its red colour. Aged erythrocytes are destroyed by reticulo endothelial cells in the liver and spleen. Normally balance is maintained between red cells production and destruction.

**FUNCTIONS OF (R.B.C) RED BLOOD CELLS:**
- Red blood cells are highly specialized for their transport function of carrying oxygen to the tissues.
- The erythrocytes have the maximum surface area for the diffusion of the gas molecules that pass through the membrane to combine with hemoglobin.
- Red blood cells maintain the viscosity of the blood.
- Red blood cells maintain acid base balance.
- The disintegration of erythrocytes result in the formation of aminoacids which can be used as protein in the tissues, and iron is used for the formation of future red blood cells.
Erythrocytes

**THROMBOCYTES OR PLATELETS:** They are disc shaped structure without nuclei. They are involved in the process of blood clothing. The life span of platelets is between 8 and 11 days. Normal range from 2, 50,000 to 4, 00,000/mm³.

Functions: They play an important part in the control of bleeding after injury and in the clotting of blood.

Platelets

**LEUCOCYTES:** These are otherwise called as white blood cells or corpuscles. They do not have the pigment,
hemoglobin and are therefore colour less. They are nucleated cells and less number than the red blood cells. The life span of white cell is 12 to 13 days.

White blood cells more like amoeba and feed on the foreign germs that enter the body therefore they also called phagocytes. Normal bloods contain 5,000 – 10,000 W.B.C/ per cubic milli meter their number increases under disease conditions.

There are two major types of mature white blood cells.

I. Granulocytes.

II. Agranulocytes.

I). Granulocytes: they are formed in the bone marrow. These cells have different types of granules in their cytoplasm. The nucleus in there are irregular in shape and has many lobes.. there are three different types of granulocytes.

a). Neutrophils

b). Oesinophils

c). Basophils.

a). **Neutrophils:-** these cells can be stained with neutral dyes. Nucleus in these cells 5 to 6 lobes and cytoplasm has large number of closely packed granules.
They also called as polymorphonuclear leucocytes. Neutrophils compose 60% of the circulating white blood cells.

**FUNCTIONS:** Phagocytes of injuries agents (they kill and engulf bacteria) they are the bodies first line of defense against bacterial infection.

**b). Eosinophils:** These can be stained with acid dyes therefore they are called acidophils. The nucleus of these cells has two lobes the cytoplasm of these cells has a very large size of granules. These attack the parasites and also help to reduce the allergic reactions in the body. The number of eosinophils increases during allergy condition.

**FUNCTIONS:**
* They play a major role in allergic reaction by releasing enzymes to inactivate histamine.

*They engulf the particles formed due to antigen and antibody reactions and destroy toxins that enter the body.
c). **BASOPHILS**: These cells can be stained with basic dyes: therefore they are called basophils. In these cells the nucleus is elongated and is in the shape of the letter S. The granules in the cytoplasm are round, large and are few in number compared to all white blood cells, these are few in number, they represent less than 1% circulating white blood cells. They increase in number during inflammation and allergy.

**FUNCTION**:- Basophils liberate heparin, histamine, and serotonin in allergic reactions that mediate inflammatory response.

These cells are phagocytic in nature and play a part in healing process.

**II. AGRANULOCYTES**:- As the name indicates, these cells do not have any granular material in their cytoplasm. The nucleus in these cells is large. They are of two types (i) lymphocytes (ii) monocytes.
a). **LYMPHOCYTES**:- these are the smallest cell of all the white blood cells. These cells have a thin layer of cytoplasm and around large nucleus. These cells recognize the antigen that enter the blood and produce antibodies against them. These cells protect the body against viral and fungal infections and also against a few bacteria.

**FUNCTIONS**:- These cells play a key role in the development of immunity against diseases.

**MONOCYTES**:- they are the biggest of all white blood cells. The nucleus is kidney shaped these cells invade the infected area and kill bacteria, dead cells, and other foreign material present in the infected area. Their number increase in leukemia (blood cancer).
FUNCTIONS:- they migrate to areas of injury and phagocytize large number of bacteria.

HAEMOGLOBIN:- Is a complex protein rich in iron. It has an affinity for oxygen, and combines with it forming oxyhemoglobin in the red cells. By means of this function oxygen is carried to the tissue from the lungs and it is transported around the body to maintain a continues oxygen supply to all cells. The amount of hemoglobin present in normal blood is about 15 gms per 100 ml of blood and this amount is usually called 100% any thing over 90% is considered normal.

A normal diet containing meat, eggs, whole meal bread and green vegetables, contain more iron than the daily requirement, women loose blood during menu
station and need more iron throughout the reproductive years and during pregnancy to supply the foetus.
In many forms of anemic the amount of hemoglobin present in the blood is diminished. In some severe forms it may fall below 30% that is 5g per 100 ml. As Haemoglobin contains the iron necessary to combine with oxygen it will readily be understood that these patients present symptoms of deficient oxygen such as breathlessness often one of the first indication of iron deficiency anemia.

**THE COAGULATION OF BLOOD:**
Clotting is a mechanism developed by the body to limit blood loss. The process of blood clothing is called **Coagulation.** The chemicals involved in clotting are called “**Coagulation factors**”

If shed blood is microscopically examined very fine threads will be seen, the insoluble **fibrin** threads formed from the fibrinogen in the blood plasma by the action of a ferment **thrombin.** These threads entangle the cells and together with them form the **clot** if shad blood collected in a test tube, the clot float in the serum.

The clotting of blood is a complicated process and several factors are necessary to bring it about. As already
stated the ferment thrombin is instrument in covering fibrinogen into fibrin threads.

Thrombin is not present in normal unshed blood but its precursor prothrombin is present and is covered into the active ferment **thrombin** by the action of **thrombokinase** or **thrombo plastin** is an activating agent liberated on injury to the blood cells, it is thought largely by injury to the blood platelets, which provided that calcium salts are present in the blood, will convert **prothrombin** into **thrombin** so that clotting can take place.

To produce a clot therefore four factors are necessary.

1. Calcium salts – (Normally present in blood)
2. Cell injury which liberates thrombokinase)
3. Thrombin formed from prothrombin in the presence of thrombokinase.
4. Fibrin formed from fibrinogen in the presence of thrombin.

Prothrombin + Calcium + thrombokinase = Thrombin
Thrombin + Fibrinogen = Fibrin
Fibrin + Blood cells = clot.
Prothrombin is made in the liver. Vitamin –K is necessary for its production.

A thrombus is a clot formed in the circulation. The condition is called as thrombosis.

A clot in a coronary artery is called coronary thrombosis.

When a portion of clot becomes detached and enters the circulating blood it is called an embolus.

The embolus passes through the heart and enters to the lungs by one of the pulmonary arteries. Small or large vessels might be blocked by it constituting a pulmonary embolism.

**BLOOD CLOTTING FACTORS:**

I. Fibrinogen
II. Thrombin
III. Tissue factor
IV. Calcium
V. Labile factor
VI. Stable factor
VII. Antihaemophilic factors Antihaemophilic factor A
VIII. Christimus factor
IX. Stuart factor.
X. Antihaemophilic factor- C
XI. Hageman factor
XII. Fibrin stabilizing factor.
BLOOD GROUPING AND CROSS MATCHING.

When a blood transfusion is to be given, the blood groups of both the person giving blood the donor and the person receiving must be known. And also the two blood groups should be cross matched. Individuals are divided into four blood groups: 1. Group-A 2). Group – B, 3). Group –AB, 4). Group – O

If blood of different groups mixed, the cells may forms clumps and are destroyed this is called incompatibility. (or) Agglutination. If this happens in the blood vessels of a person, this clump block and prevents the blood flow, leading to the death of the person who is receiving the blood.

BLEEDING TIME: - The normal bleeding time 2 to 3 minutes for a finger prick. This is done before operations.

In addition, some people have blood which is Rhesus positive (Rh- positive), which others rhesus negative (Rh- negative). The Rh or Rhesus factor in blood is of importance in the newly born baby. When the blood of the foetus may be incompatible with that of the mother. And also in pregnancy when a Rh positive man has married an Rh negative women. Group O RH
negative blood usually safe for transfusion for a person of any blood group. Even so cross matching should be done for make quite sure.

In considering donors of blood
Group AB may give blood for AB
Group A to A and AB
Group B to B and AB
Group O is a universal donate for all groups.

Recipient:-
Group AB is universal recipient
Group A may receive blood from group A and O
Group B may receive blood from B and O
Group O may receive blood from O

It is customary to transfer blood of the same group as the patient, and only in emergency to give the blood of a universal donor.

Before transfusion of blood the blood group of the patient is determined by test in laboratory. Then suitable group of blood that matches with blood of patient is obtained.
BLOOD GROUPS:-

Four blood groups have been recognized in the human being they are.

GROUP – A: person having the blood group will have antigen “A” on their red blood cell, and antibody “B” in their plasma.

GROUP – B: Persons having this blood group will have antigen “B” on their red blood cells and antibody “A” in their plasma.

GROUP – AB: Persons having this blood group will have both antigen A and Antigen B on their red blood cells but they do not have antibody ‘A’ a antibody ‘B’ in their plasma.

Blood Group- O: persons having this blood group will not have either antigen ‘A’ or Antigen ‘B’ on their red blood cells but have both antibody ‘A’ and antibody ‘B’ in their plasma.
<table>
<thead>
<tr>
<th>Donors Blood Group</th>
<th>Recipient's Blood Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>A</td>
<td>![Image]</td>
</tr>
<tr>
<td>B</td>
<td>![Image]</td>
</tr>
<tr>
<td>AB</td>
<td>![Image]</td>
</tr>
<tr>
<td>O</td>
<td>![Image]</td>
</tr>
</tbody>
</table>

- **No Clotting - Matches**
- **Clotting - No Match**
HEART

The heart is a roughly cone shaped hollow muscular organ. It is about 10 cm long and is about the size of the owner’s fist. It weighs about 225 gms in women and is heavier in men 300 gms.

**Position:** The heart is in the thoracic cavity in the mediastinum between the lungs. It lies obliquely, little more to the left than the right and presents a base above and an apex below. It is 12 cm long, 9 cm wide and 6 cms thick. Apex is formed by the tip of the left ventricle in the 5th intercostals space. Base is formed mostly by the left atrium. It lies inferior to the 2nd rib.

Heart is having 4 borders and 2 surfaces namely Rt.border, Lt Border, Superior border, inferior Border surfaces: - Anterior surface and inferior surface.

Heart is enclosed in a loose fitting serous membrane called “parietal pericardium”.

The position of the heart
STRUCTURE:-
The heart is composed of three layers of tissue
1. Pericardium
2. Myocardium
3. Endocardium

PERICARDIUM: - Is an outer thin transparent layer. Pericardial cavity is the space between the serous pericardium and fibrous pericardium this cavity contains a watery fluid called pericardial fluid.

MYOCARDIUM: - is the middle layer contains cardiac muscle tissue which is voluntary, striated and branches. The myocardium is responsible for the contraction of the heart.

ENDOCARDIUM: - Is the inner thin layer of Endocardium. It lines the inside of the myocardium and covers the valves of the heart. It is continuous with the large vessels of the heart.
**INTERIOR OF THE HEART**

The heart is divided into a right and left side by septum. Each side is divided by an atrioventricular valve into an upper chamber the atrium and a lower chamber, the ventricle. The atrioventricular valves are formed by double folds of endocardium strengthened by a little fibrous tissue.

The valves prevent the back flow of the blood. The valves are two types.

- **Atrioventricular valves**: Tricuspid valve between right atrium and right ventricle made up of three flap of the mitral cusps valve between the left atrium and left ventricle and is made up
(composed) of three flaps of cusps. The mitral valve between the left atrium and left ventricle and made up (composed) of two flaps or cusps.

- **Semilunar valves:** The aortic semilunar valve between aorta and left ventricle the pulmonary semilunar valve between pulmonary trunk and right ventricle.

**Blood supply to the Heart:** The heart is supplied with arterial blood by the right and left coronary arteries and coronary sinus, which are branches of the ascending aorta.

**Nerve supply:** Through the Autonomic nervous system these are sympathetic and Para sympathetic nerves and they are antagonistic to one another.
FLOW OF THE BLOOD THROUGH THE HEART.

(1) The two largest veins of the body the superior and inferior venacava empty their contents into the right atrium the blood passes via the right atrioventricular valve into the right ventricle and from there it is pumped into the pulmonary artery or trunk. The opening of the pulmonary artery is guarded by the pulmonary valve formed by three semilunar cusps. This valve prevents the back flow of the blood into the right ventricle. When the ventricular muscle relaxes after leaving the heart. The pulmonary artery divides into right and left pulmonary arteries which carries the venous blood to the lungs.
where the inter change of gasses take place
carbon dioxide is excreted and oxygen absorbed.

**Summary:**
The right of the heart deals with **deoxygennated** blood.
The left of the heart deals with **oxygenated** blood.

**FUNCTIONS OF THE HEART:**
- The hearts is to maintain a constant circulation of blood through out the body.
The Heart act as a pump and its action consists of a series of events called as cardiac cycle

**CARDIAC CYCLE:** The events that occur in the heart during blood circulation is called cardiac cycle. The normal number of cardiac cycle per minute ranges from 60-80.
Taking 74 as on example, each cycle lasts about 0.8 of a second and consists of
Arterial systole – Contraction of atria. 
Ventricular systole – contraction of the ventricle
Complete cardiac diastole – Relaxation of the atria and ventricles.
The heart action originates in the cino-artrial node then the atria contract the electrical impules moves along the bundle of His and the ventricles then contracts. This action is described in two parts, contraction are systole
and relaxation or diastole. Contraction of the atria occurs almost simultaneously and is called the arterial systole; their relaxation, the arterial diastole. Similarly contraction and relaxation of the ventricules are the ventricular systole and diastole respectively. The ventricular contraction last 0.3 seconds, the relaxation phase is longer, 0.5 seconds. In this way the heart beats continues, night and day throughout life and only rest the cardiac muscles gets is during the period of ventricular diastole.

**Stages of one cardiac cycle**

**HEART SOUNDS:** - Two sounds separated by a short pause can be clearly distinguished they are described in words as “lub dub” the first sound is lub is fairly loud and
is due to the contraction of the ventricular muscle and the closure of the atroventricular valves.

The second sound is “dub” softer is due to the closure of the aortic and pulmonary valves. Normally the heart makes no other noise, but if the flow of blood is rapid or if there are deformities in the valves or other chambers there may be extra noises usually called “murmurs”.

**CONDUCTION SYSTEM OF THE HEART:**

The conduction system of heart consists of tissue specialized for generation and conduction of action potentials. The conduction system assures that cardiac chambers become excited to contract in coordinated manner, which makes the heart an effective pump.

![Diagram of the Heart and Electrical Conduction System](image)

**COMPONENTS OF CONDUCTION SYSTEM OF THE HEART**

**SINOATRIAL NODE (SA NODE):** It is located in right atrial wall. It is also called normal pacemaker of the heart.
because it normally initiates impulses more rapidly than other group of neuromuscular cells.

**ATRIOVENTRICULAR NODE (A.V.NODE):** This is located in the wall of the atrial septum near the atrioventricular valves. Normally the A.V.node is transmitted by impulses that sweep over the Atrial myocardium. However, it too is capable of initiating impulses that cause contraction but at a lower rate than the S.A node.

**Atrioventricular bundle (AV bundle or bundle his):** it is located in superior portion of interventricular septum. It receives (Electric activity) action potentials from A.V.node and passes them to right and left bundle branches.

**Right and left bundle branches:** They are located in interventricular septum. It receives action potentials from AV bundle and passes them to conduction myo fibers.

**CONDUCTON MYOFIBERS:** (Purkinje fibers) they are located in ventricular myocardium. It receives action potentials from bundle branches and rapidly passes them to ventricular myocardium about 20 seconds after the atria contract and the ventricles contract.
Impulse conduction through the heart generates electrical activity (action potentials) which leads to the mechanical response (contraction of the atria and ventricles) the conduction system of the heart enables it to act as an effective pump.

**SYSTEMIC CIRCULATION**

Blood from lungs > Pulmonary vein > Lt. Auricle.

Oxygenated blood

Arteries < only aorta < Lt. Ventricle

Body organs

(except lungs) → Deoxygenated blood

Superior and inferior venacava → Rt. Auricle.
SYSTEMIC CIRCULATION:- The venous blood returns to the heart from the limbs through systemic circulation. Heart is the chief organ for blood circulation. Flow of blood from the left ventricles to all parts of the body and back of the right atrium is called systemic circulation.

1. The blood leaves the left ventricle of the heart by the aorta, the largest artery in the body. The aorta divides into small arteries which convey blood to different parts of the body. These have varied muscular wall which narrow their channels and resist the flow of blood. This has two functions. (1) It maintains the arterial blood pressure and by varying the size of the channel it regulates the flow of blood into the capillaries. Capillaries have very thin walls so that exchange of gasses and nutrients take place between the plasma and interstitial fluid. Inferior vena cava collects deoxygenated blood from the lower extremities and the superior vena cava collects the deoxygenated blood from the heart and upper extremities of the body. Both these vessels empty deoxygenated blood in and the right atrium of the heart. From here blood enter into pulmonary circulation for
oxygenation in the lungs. From the lung oxygenated blood through pulmonary veins enters left atrium and into left ventricle for another cycle.

**AORTA:** The Aorta begins at the upper part of the left ventricle, and after passing upwards for a short way. If arches backward and to the left than descends behind the heart through the thoracic cavity a little to the left of the thoracic vertebrae.

Aorta is composed of 3 layers namely outer tunica adventitia, middle tunica media and inner tunica intima. Aorta is a large sized elastic artery which contains more elastic fibres.

Through out its length the aorta gives off numerous branches some of the branches are paired, some are single or unpaired. Aorta is divided into 3 main branches.

1. **Ascending aorta:** - It is about 5 cm long and dies behind the strurnum. It is the first part of the aorta divided into right and left coronary arteries which supply blood to the heart.

2. **Arch of the aorta:** - The arch of aorta is begins behind the manubrium of the sternum and runs upwards and backward and to the left in front of
the trachea and it continues with the descending aorta. It is divided into 3 main branches namely brachiocaphalic artery, left common carotid artery and left subclavian artery. They supply blood to the upper extremities, face and neck.

3. **Descending Aorta**: - It is subdivided into thoracic aorta and abdominal aorta.
   a). **Thoracic aorta**: - Its main branches are pericardial arteries, bronchial arteries, esophageal arteries, intercostal and gill costal arteries, arteries and superior phrenic arteries. They supply blood to organs in thoracic cavity.
   b). **Abdominal Aorta**: - Its main branches are celiac artery, common hepatic artery, gastric arteries, splenic artery, suprarenal and renal arteries, common iliac arteries, ovaries and testicular arteries, lumbar arteries sacral arteries. All these supply blood to abdominal organ.
Aorta and its main branches

PULMONARY CIRCULATION.

Blood from body \(\rightarrow\) Superior and inferior venacava \(\rightarrow\) RT- Auricle

Except lungs

Deoxygenated Blood

Lungs \(\leftarrow\) Pulmonary trunk \(\leftarrow\) Rt. Ventricle

Oxygenated Blood

Pulmonary Vein \(\rightarrow\) Lt. Auricle
PULMONARY CIRCULATION:

This consists of the circulation of deoxygenated blood from the right ventricle of the heart to the lungs and the return of oxygenated blood from the lungs to the left atrium is called pulmonary circulation. In the lungs carbon dioxide is excreted and oxygen is absorbed.

The blood passes into the right ventricle which contracts and pumps it into the pulmonary artery. This divided to carry the blood to the right and left lungs. The lungs offer very little resistance to the blood in the vessels flowing through them. In the lungs each artery breaks up into numerous smaller arteries, then into arteriols and finally into pulmonary capillaries which surround the alveoli in the lung tissue where the blood takes up oxygen and gives off carbon dioxide.

The pulmonary capillaries unite until veins are formed and the blood is returned to the heart by four pulmonary veins which empty into the left atrium. The blood then passes into the left ventricle which contracts
and pumps it into the aorta to begin the systemic circulation again.

**PORTAL CIRCULATION:** blood from the Stomach intestine and spleen is collected by the portal vein. In the liver this breaks down into the capillary system and uniting with capillaries of the hepatic artery, which brings blood from the aorta to the liver, transverse the substances of this organ. This dual blood supply is collected by a system of veins which unite to form the
hepatic vein. Conveying the blood to the inferior venacava and thence to the heart.

Portal obstruction occurs in severe injury to the liver and in some instances in hepatitis when severe an obstruction is complicated by an excess of fluid collection in the peritoneal cavity is termed as Ascitis.
BLOOD VESSELS.

TYPES OF BLOOD VESSELS:

There are mainly three types of blood vessels in the body.

1. **Arteries or Arteriols**: They carry oxygenated blood from heart to the tissue with the exception of pulmonary artery which carries venos blood they very considerable in size consisting of three layers of muscles tissue (1) Tunica adventitia or outer layer of fibrous tissue (2) Tunica media or middle layer of smooth muscles and elastic tissue (3) Tunica intima or inner lining of squamous epithelium called endothelium

2. **Veins and vennules**: They carry de oxygenated blood from the tissue to the heart. With the exception of pulmonary vein which carry oxygenated blood. The veins composed of the same three layers as the arteries but the
middle muscular layer is thinner, less form, more collapsible and much elastic then the arteries.

3. **Capillaries**: - They are very small blood vessels where arteriols terminate and venules begun. Uniting the arteries and veins and forming the capillary lake where the traffic between nourishment and waste matter proceeds and the inter change of gases take place in the extra cellular or interstitial place.

4. **Lymphatic**: - it consists of a number of lymphvessles which collect, filter and pass back to the blood stream. The lymph which has exuded through the minute capillary walls to bathe the tissues.
**DIFFERENCES:-**

<table>
<thead>
<tr>
<th>ARTERIES</th>
<th>VEINS</th>
<th>CAPILLARIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tunica media has more elastic tissue and less muscle.</td>
<td>Tunica media have less Elastic tissue and less muscle.</td>
<td>Single layer of endothelial cells.</td>
</tr>
<tr>
<td>2. Carry pure blood away from the heart except the pulmonary artery.</td>
<td>Carries impure blood to the heart except pulmonary vein</td>
<td>Neutral</td>
</tr>
<tr>
<td>3. Bright red colour.</td>
<td>Dark red or purple cover</td>
<td>Change of the colour from time to time.</td>
</tr>
<tr>
<td>4. Valves are absent.</td>
<td>Valves are present.</td>
<td>Link between arteriols and venules.</td>
</tr>
<tr>
<td>5. Arteries are divided into arteriols</td>
<td>Veins are divided into venules.</td>
<td>Blood oozes onto the surface.</td>
</tr>
<tr>
<td>6. Spruts out into jet corresponding with the heart beat.</td>
<td>Flows out as an even stream.</td>
<td>Capillaries surround the tissues.</td>
</tr>
<tr>
<td>7. Arteries pass on deeper layer.</td>
<td>Veins pass on superficial layer.</td>
<td></td>
</tr>
</tbody>
</table>
MAIN ARTERIES OF THE BODY

The oxygenated blood leaves the left ventricle through the aorta. After leaving the heart the aorta forms an arch convex up wades. This is the arch of the aorta.

The aorta then runs down wares in relation to the lower thoracic vertebrae as the descending thoracic aorta. At the lower end of the twelfth thoracic vertebra the aorta pierces the diaphragm and passed into the abdomen where it is called the abdominal aorta.

Three large branches arise from the arch of the aorta. The font branch is the brachio cephalic artery. It ends by dividing into the right common carotid artery which supplies the right half of the head and neck and the right subclavian artery which carries blood to the right upper limb. The second branch of the arch of the aorta is the left common carotid artery for the left half of the head and neck, and the third branch is the left subclavian artery for the left upper limb.

On each side the common carotid artery ascends into the neck and ends by dividing into the internal carotid artery and the external carotid artery. The
internal carotid arteries supply the brain and other structures within the cranial cavity. Each external carotid artery gives off numerous branches to tissues of the head and neck.

The right subclavian artery lies in the lower part of the neck the left subclavian artery first runs upwards through the upper part of the thorax and then lies in the lower part of the neck. Here it gives off some branches the most important of which is the vertebral artery. This artery takes part in supplying the brain and spinal cord.

Each subclavian artery is the first part of a long arterial trunk that supplies the upper limb from the lower part of the neck this trunk enters the axilla (arm pit) and is now called the axillary’s artery from the axilla the artery enters the arm and is then called the brachial artery. In front of the elbow the brachial artery ends by dividing into the radial artery and the ulnar artery both of which descend into the forearm. The tissue of the upper limb are supplied branches of the axillary’s, brachial radial and ulnar arteries. A few branches arising directly from the subclavian artery also enter the upper limb.
The descending thoracic aorta gives off many branches the most conspicuous of which are the **intercostal arteries**. There are eleven pairs of intercostal arteries. One for each intercostal space (i.e., the space between two adjoining ribs) another branch the **subcostal artery** is similar to the intercostal arteries but runs along the lower border of the twelfth rib. The abdominal aorta given off several branches. One either side it gives off a **renal artery** to the corresponding kidney from the front of the aorta three unpaired arteries arise to supply structures belonging to the digestive system. These are **celiac trunk** the superior mesenteric and the inferior mesenteric arteries.

The celiac trunk is responsible for supplying the liver the spleen, the stomach and parts of the duodenum and pancreas the superior mesenteric artery supplies almost the caecum the ascending colon and part of the transverse colon. The inferior mesenteric artery supplies the rest of large intestine.

Apart from the large branches named above the abdominal aorta gives off a number of smaller branches to other structures.
At its lower end the abdominal aorta ends by dividing into the right and left common iliac arteries. Each common iliac artery divides into an external iliac artery and an internal iliac artery. The internal iliac artery gives off branches to structures in the pelvis. The external iliac artery is the uppermost part of a long arterial trunk that supplies the lower limb. It lies in the pelvis. Its continuation into the front of the thigh is called the femoral artery. The femoral artery winds round the medial side of the femur to reach the back of the knee. The part of the arterial trunk that lies behind the knee is called the popliteal artery. The popliteal artery ends by dividing into the anterior tibial artery and the posterior tibial artery. The two arteries descend into the leg and foot.
Main arteries of the body
**Main veins of the body** - Blood from the upper limb is drained through a number of small veins that join to form the *axillary’s vein* (lying alongside the axillary’s artery). The axillary’s vein continues into the neck as the *subclavian vein*. The main veins from the head and neck are the right and left internal *jugular veins*. Each internal jugular vein joins the corresponding subclavian vein to form the right on left *brachiocephalic vein*. The two brachiocephalic veins...
join to form the **superior vena cava** which opens into the right atrium of the heart from the above it follows that tall blood from the head and neck and from both upper limbs enters the heart through the superior vena cava.

The lower limbs are drained through small veins that join to form the **popliteal vein** at the back of the knee joint. The popliteal vein ascends into the thigh where it becomes the **femoral vein**. The popliteal and femoral veins lie alongside the corresponding arteries at the upper end of the thigh each femoral vein enters the abdomen and is now called the **external iliac vein**. Structures in the pelvis are drained by the internal iliac veins. The external and internal iliac veins of each side join to form the corresponding **common iliac vein**. The right and left common iliac veins joins to **inferior vena cava**. The inferior vena cava ascends alongside the abdominal aorta of the upper end of the abdomen of pierces the diaphragm to end in the right atrium of the heart.

**Coronary sinus:** Main vein of the heart located in the coronary sulcus open into the right atrium
Pulse:- The pulse is described as wave of distention and elongation felt in an artery wall due to the contraction of the left ventricle forcing about 60-80 ml of blood into the already full aorta. The pulse can be felt by the fingers on a point where an artery crosses a bone close to the surface of the skin.

Information that may be obtained form the pulse includes
1. The rate at which the heart is beating.
2. The rhythm or regularity with which the heart beats occur i.e., length of time between beats should be the same.
3. The volume or strength of the beat.
4. The tension

Factors affecting the pulse rate:
Position: When the individual is standing up the pulse rate is usually more rapid than when he is lying down.
Age: The pulse rate in children is more rapid than in adults.
Increased body temperature: When the body temperature the pulse rate tends to rise.
Sex: - The pulse rate tends to be more rapid in females than in males.
Exercise: - Any exercise –walking, running or playing games will increase the rate of the pulse.

Emotion: - In strong emotional state the pulse rate is increased eg. Excitement, fear, anger, grief.

Before birth (F.H.S) 140 to 150 per minute.
At birth (new born) 130 to 140 per minute
First year 115 to 130 per minute
Second year 100 to 115 per minute
Third year 90 to 100 per minute
4 to 8 year 86 to 90 per minute
8 to 15 year 80 to 86 per minute
Adult 70 to 80 per minute
Old age 60 to 70 per minute

Rate: rate is the number of pulse beats per minute. The normal rate in resting adult is 60 to 100 per minute. A pulse rate is over 100 per minute is referred to be tachycardia. A pulse rate below 60 per minute is referred to be bradycardia.

Blood pressure
Blood pressure may be defined as the force or pressure which the blood exerts on the walls of the blood vessels.

The arterial blood pressure is the result of the discharge of blood from the left ventricle in to the already full aorta. When complete cardiac diastole occurs and the
heart is resting following the ejection of blood. The pressure within the arteries is called diastolic blood pressure. When the left ventricles contracts and pushes blood into the aorta the pressure of produced is called the systolic blood pressure.

Arterial blood pressure is measured by the use of a sphygmomanometer and is usually expressed in the following means. B.P. 120/80 mm Hg or B.P 16/11 Kpa.

**Maintenance of normal blood pressure:** The blood pressure is maintained aimed with in normal limits by fine adjustments involving a number of factors including.

- Cardiac output
- Blood volume
- Peripheral resistance
- Viscosity of the blood
- Elasticity of the artery walls.

**Cardiac output:** - It is the amount of blood ejected by the left ventricle into the aorta each minute. Normal cardiac output is 5 to 6 liters.

The cardiac output = stroke volume \times \text{heart rate}.

Blood pressure varies directly with cardiac output, if cardiac output increases blood pressure increases. If cardiac output decreases blood pressure decreases.
Blood volume: A sufficient amount of blood must be circulating in the vessels to maintain the normal blood pressure. The normal volume of blood is about 5 liters. If there is any decrease in the blood volume, blood pressure drops and if there is increase in blood volume blood pressure increases.

Peripheral or arterial resistance: It is the resistance offered by the blood vessels for the flow of blood. The main resistance to the flow of the blood in the systemic circulation lies in the arteries and capillaries the smaller diameter of the vessel, the more resistance it offers to the blood. Any factor that increases peripheral resistance increases blood pressure. Any decrease in peripheral resistance decreases blood pressure.

Viscosity of the blood: The Viscosity of the blood is a function of the number of red blood cells and amount of plasma proteins. It is the ratio of red blood cells and solutes to the fluid. Any condition that increases viscosity of blood such as dehydration increases blood pressure. Any condition that decreases blood viscosity such as depletion of R.B.C.or plasma protein decreases blood pressure (due to anaemia and haemorrhage).
**Elasticity of the artery walls:** - There is a considerable amount of elastic tissue in the arterial walls, especially in large arteries. The pressure is greater in arteries than in veins.

<table>
<thead>
<tr>
<th></th>
<th>Diastolic</th>
<th>Systolic</th>
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<tbody>
<tr>
<td>In infancy the blood</td>
<td>50</td>
<td>70 to 90</td>
</tr>
<tr>
<td>pressure is</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In child hood</td>
<td>60</td>
<td>80 to 100</td>
</tr>
<tr>
<td>During the adolescent</td>
<td>60</td>
<td>90 to 110</td>
</tr>
<tr>
<td>period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In the young adult</td>
<td>60 to 70</td>
<td>110 to 125</td>
</tr>
<tr>
<td>As age advances it</td>
<td>80 to 90</td>
<td>130 to 150</td>
</tr>
<tr>
<td>is increased</td>
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</table>

Hyper tension implies a blood pressure raised above normal. Hypotension is condition abnormally low blood pressure. The average blood pressure for the healthy adult usually about 120/80 mm Hg.

The position of body: Gravity assists the venous return for the head and neck when the individual is standing or sitting.

Muscular contraction: The contraction of muscles, particularly skeletal muscles exerting pressure on the veins.

Effects of respiratory movement: - The movements produced by breathing in particular by the rise and fall of the diaphragm which acts as a pump.
The lymphatic system
All the body tissues are bathed in tissue fluid consisting of the diffusible constituents of blood and waste material from cells. Some tissue fluid return to the capillaries at their Venus and the remainder diffuses through the more permeable walls of the lymph capillaries. The lymphatic system returns plasma proteins and tissue fluid top the blood.

The lymphatic system consist of
- lymph vessels
- lymph nodes
- spleen
- thymus glands

Lymph vessels
These originate as blinded tubes in the area containing structurally they are similar to veins and blood capillaries but the pores in the walls of the lymph capillaries are larger than those of the blood capillaries. Because of this the water containing large molecule substance figments of damaged cells and foreign matter such as microbes drain away by passing into the lymph vessels. In side them there are valves which help the flow lymph towards the largest lymph vessels they empty lymph into large veins near the heart.
**Lymph nodes**: There are collections of tissue called lymph nodes situated at various points along the length of the lymph vessels. They are found mainly grouped together in the neck, axilla, groin, and in the pelvic abdominal cavities. Lymphoid tissue is also found in the tonsils, pharyngeal, and intestines. Lymph glands help to protect the body from infection. Lymph, derived from tissue fluid is filtered as it passes through the lymph nodes and microbes, noxious substances and some waste materials are removed and the lymph produce new lymphocyte for blood.
Lymph is a fluid like plasma and the tissue fluid but in cases of infection it may contain bacteria. Lymph is a really tissue fluid which fluid its way into the lymphatic vessels.

**The spleen**: - This is a dark purple colour organ situated in the left side of the upper abdomen behind the stomach. It is about 12.5 cms long and 8 cms broad and is protected by the lower ribs. In some diseases such as typhoid and malaria, it becomes enlarged and can be palpated in the upper abdomen.

Functions of the spleen are:-

1. It produces new lymphocytes for the blood.
2. It helps to fight infection.
3. It destroys worn out red blood cells and removes the iron from then to be reused.
4. It acts as a reservoir for R.B.C’s which it released blood case of demand such as during sudden haremorage.
Spleen

*Thymus glands:* The location, structure and function of the Thymus gland described in unit IV endocrine glands.
QUESTIONS

‘A’ Circulatory System

1. Write the composition of blood.

2. Write short notes on.
   (a). R B C   (b). W B C   (c) Haemo goblin.   (d) Blood groups.
   (e). Mechanism of clotting blood.

3. Write the function of blood.
4. Write the function of heart.
5. Draw the diagram of heart and label them.
6. Describe with illustration the pulmonary circulation.
7. Describe with illustration the systemic circulation.
8. List the types of blood vessel.
9. Compare and contrast between Arterial, veins and capillaries.

10. Define the following terms.

11. List the factors which maintain blood pressure.
12. Describe the aorta briefly.
13. Describe the cardiac cycle.
14. Describe the conduction system of the heart.

15. Write short notes.
    (a). Spleen. (b). Lymphatic system.
Respiration is an act of breathing. The Respiratory system is composed of various organs, the structure of which ensure a clear pathway for air to enter and leave the lungs, the mechanism for the exchange of air between the blood and the lungs are called external respiration and that between the blood and the cells internal respiration.

The organs of the respiratory system;
Nose
Pharynx
Larynx
Trachea
Two Bronchi – one branches to each lung
Bronchioles and smaller air passages
Two Lungs and their covering - pleura
Muscles of respiration – Inter costal muscles.
- Diaphragm.
The nasal cavity is the first of the respiratory organ consists of large irregular cavity divided by a septum.

The roof is formed by the base of the skull
The floor is formed by the roof of the month.
The medial wall formed by the septum.

The lateral wall formed by the maxilla, the ethmoid bone and inferior conchae. The posterior wall is formed by the posterior wall of the pharynx.

**NOSE AND NASAL CAVITIES**

**Position and structure:**
The nasal cavity is the first of the respiratory organs and consists of a large irregular cavity divided into two equal parts by a septum. The roof is formed by the cribiform plate of the ethmoid bone and the sphenoid bone, frontal bone and nasal bone.

**Lining of the Nose:** The nose is lined with ciliated epithelium, which contains mucus-secreting goblet cells.
**Opening in and the nasals cavity:** Anterior nares and posterior nares.

**The Sinuses:** These are cavities in the bones of the face a cranium, which contain air. The Main Sinuses: The main sinuses are maxillary, frontal and ethmoid.

**The Nasoalacrimal ducts** extend from the lateral wall of the nose to the conjunctival sac of the eye.

**Function:** (i) The nose is the first of the respiratory passage though air passes it is warmed, moistened and filtered.

(ii) Olfactory function of the Nose. The nose is the organ of the sense of the smell. There nerve endings that detect smell located in the roof of the nose in the area of the cribriform plate of the ethmoid bones and the superior conchae. The resultant nerve impulses are conveyed by the olfactory nerves to the brain where the sensation of the smell is perceived.
Pharynx: The pharynx is a tube 12 to 14 cm long that extends from the base of the skull to the level of the sixth cervical vertebra. It lies behind the nose, mouth and larynx and is wider at its upper end.

Function: The pharynx is an organ involved in both the respiratory and digestive system, air passes through the nasal and oral parts, and food through the oral and laryngeal parts.

Larynx: lies in front of the lowest part of the pharynx, which separates it from the vertebral column, extending from the pharynx to level of the 6th cervical vertebra. It is the upper prominent part of the windpipe and opens into the trachea below. The larynx is composed of several irregularly shaped cartilages attached to each other by ligaments and membranes.

The main cartilages are;
1  Thyroid cartilage
1  Cricoid cartilage
2  Arytenoid cartilage
1  Epiglottis.

During the swallowing the larynx is closed by epiglottis, which act as a lid to the box.

EPIGLOTTIS: Is a leaf shaped cartilage attached to the inner surface of the anterior wall of the thyroid cartilage immediately below the thyroid notch.

Inside the larynx are the vocal cords. These are made of elastic tissue stretched across from front to back. They tighten and come close together to produce.
High sound, and slacken to produce low sounds of the voice. Sound has the properties of pitch, loudness and quality.

The quality and resonance of the voice depends upon the shape of the mouth, the position of the tongue and lips, the facial muscles and the air sinuses in the bones of the face and the skull.

Speech consists of the manipulation of the sound produced by the vocal cords by the tongue and cheeks.

**Function:** (i) The larynx provides a passageway for air between the pharynx and trachea. (ii) The vocal cords produce sounds of varying loudness and pitch (iii) during swallowing the larynx moves upwards occluding the opening into it from the pharynx.
**TRACHEA**: the trachea or windpipe is about 10 cm long; it extends from the larynx to about the level of the 5th thoracic vertebra where it divides into two bronchi. It is composed of 16 to 20 in complete rings of cartilage connected by fibrous tissue. The trachea is lined by mucous membrane composed of ciliated epithelium and goblet cells.

**THE BRONCHI**: It formed by the bifurcation of the trachea at about the level of the 5th thoracic vertebra.

The left bronchus is about 5 cms long and is narrower than the right bronchus. The right bronchus is a wider, shorter tube than the left bronchus and it lies in more vertical position. After entering the lung it divides into two branches, one of which goes to each lung.

**Structure**: The bronchi are composed of the same tissues as the trachea. They are lined with ciliated epithelium. The bronchi sub divided into bronchioles, terminal bronchioles, alveoli ducts and finally alveoli. The exchange of gases during respiration takes place across two membranes, the alveolar and the capillary membranes.
**Blood supply:** by the branches of the left and right bronchial arteries. Venus returns mainly through the bronchial veins.

**LUNGS POSITION AND STRUCTURE**

There are two lungs, one lying on each side of the midline in the thoracic cavity. They are cone shaped and are described as having an apex, a base, costal surface and medial surface. The base is concave and semi lunar in shape and is closely associated with the thoracic surface of the diaphragm. The costal surface is convex and is closely associated with costal cartilages, the ribs and the inter costal muscles. The medial surface is concave and has a roughly triangular shaped area called the hilus at the level of 5th, 6th, 7th, vertebrae. The structure which enter and leave the hilus are 1 bronchus, 1 pulmonary artery, 2 pulmonary veins, 1 bronchial artery, bronchial veins, and lymph vessels, para sympathetic and sympathetic nerves.
The left lung is divided into only two lobes; superior and inferior. The right lung is divided into three distinct lobes superior, middle and inferior. **Function:** Is the interchange of the gases oxygen and carbon dioxide.

**PLEURA:** The pleura consists a closed sac of double serous membrane, which contains a small amount of serous fluid. The parietal pleura are the outer layer attached to the wall of the thoracic cavity visceral pleura is the inner layer, which covers the lungs.

**Pleural Cavity:** Is the small potential space between the parietal and visceral pleura and it contains a lubricating fluid is called pleural fluid, is secreted by the epithelial cells of he membrane. This fluid prevents friction between them during breathing. In a healthy individual the two layers of the pleura are in tact with one another. In abnormal states air or fluid accumulates between the two layers of the pleura, causing collapse of lungs.
**PHYSIOLOGY OF RESPIRATION:**

**External respiration:** Expansion and contraction of the lung ensure that a regular exchange of gasses takes place between the alveoli and the external air. In pulmonary are external respiration oxygen is taken in, through breathing; it flows along the trachea and bronchial tubes to the alveoli, where it comes into intimate contact with the blood in the pulmonary capillaries. The alveolar capillary membrane separates the oxygen from the blood. Oxygen passes across this membrane and is taken up by the hemoglobin of the red blood cells and carried to the heart.

Four processes are concerned with the external respiration are;

- Pulmonary ventilation or breathing which replaces the air in the alveoli with outside the air.
- The flow of blood through the lungs
- The distribution of airflow and blood flow reach all parts of the lungs in correct amounts.
- Diffusion gases passing across the alveolar capillary membrane corbondioxide diffusion rapid than oxygen.

**Mechanism of respiration:** This is the process by which the lungs are expanded to take then contracted to expel it. This cycle of events occur about 16 times per minute. The cycle of respiration consists of three phases.

Inspiration
Expiration
Pause

The expansion of the chest during inspiration occurs as a result of muscular activity. The main muscles of respiration in normal quite breathing are the inter costal muscles and the diaphragm.
The Inter Costal Muscles: There are 11 pairs of intercostals muscles, which occupy the spaces between these ribs. They are arranged in two layers, the external and internal intercostals muscles.

The external intercostal muscle fiber extend in a downwards and forwards direction from the lower border of the rib above to the upper border of the rib below. The internal intercostal muscle fibers extend in a downward and backward direction from the lower border of the rib above to the upper border of the rib below, crossing the external intercostal muscle fiber at right angles.

The first rib is fixed. When the intercostal muscles contract they pull the other rib towards the first rib. Because the shape of the ribs they move outwards when pulled upwards. In this way thoracic cavity is enlarged anteriorly and laterally. The intercostal muscles are stimulated to contact by the intercostal nerves.
**DIAPHRAGM:** The diaphragm is a dome shaped structure, which separates the thoracic cavity from the abdominal cavity. It forms the floor of the thoracic cavity and roof of the abdominal cavity and consists of the central tendons from which muscle fibers radiate to be attached to the vertebral column, the lower ribs and the sternum which the muscle of the diaphragm is relaxed the central tendon is at the level of the 8th thoracic vertebra when contracts its muscle fiber shorten and the central tendon is pulled downwards enlarging the thoracic cavity in length this decrease pressure in the thoracic cavity and increases in the abdominal and pelvic cavities.

The inter costal muscles and the diaphragm contract simultaneously ensuring the enlargement of the thoracic cavity in all directions that is from back to front, side to side and top to bottom. The diaphragm is supported by the phrenic nerves.
Internal Cell respiration: This is name of the interchange of gasses which takes place between the blood and the cells of the body oxygen is carried from the lungs to tissue dissolved in plasma and in chemical combination with the hemoglobin the exchange in the tissues take place between the external end of the capillaries and the tissue fluid. The process occur by diffusion from a higher concentration of O2 is in the blood and the lower concentration is in the tissue fluid (the CO2 is the waste product of CHO and fat metabolism). The tissue cells take oxygen from the rich hemoglobin to enable oxidation to go on and the blood receives in exchange the waste product of oxidation, corbandioxide.
AIR CAPACITY OF THE LUNGS

The total air capacity of the lungs is from 4,500 to 5,000 ml or 4 ½ to 5 liters of air. During quite breathing about 500 ml (1/2 liter) of air is exchanged at every breath.

VITAL CAPACITY OF THE LUNGS: forcible inspiration and expiration. It is measured by spirometer. In a normal man it is 4-5 liters in a normal woman it is 3-4 liters.

In deep breathing the chest is expanded and can take an extra 2 liter of air. The total capacity of the lungs therefore about 4 liters.

The vital capacity is reduced by diseases of the lung by heart diseases and by weakness of the muscles of the reparation.

Respiratory Rate: In normal breathing expiration succeeds inspiration, and is followed by a slight pause. Normally the act of respiration takes place 15 to 20 times per minute.
Both the rate and depth of breathing are controlled by the respiratory nerve centre in the medulla; this centre receives message about the amount of carbon dioxide circulating in the blood. The more Co2 in the blood cause respiratory centre to stimulate the muscle of respiration to more action. The results we breathe more quickly and deeply eg. When exercising, breathing is slower eg. Sleeping.

Normal rate per minute

- In the newborn: 40
- At 1 year: 30
- From 2 to 5 years: 24
- In adult: 10 to 20

**Composition of Air:**

Breathed in (fresh air) - breathed out

<table>
<thead>
<tr>
<th>Component</th>
<th>Inhaled</th>
<th>Exhaled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>79 %</td>
<td>79 %</td>
</tr>
<tr>
<td>Oxygen</td>
<td>20 %</td>
<td>16 %</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>0.04 %</td>
<td>4 %</td>
</tr>
</tbody>
</table>

About 4 % the Co2 is exchanged for 4 % of oxygen. Fresh air which is moving is very important for health.
QUESTIONS
‘B’ Respiratory System

1. What are the organs of respiratory system?
2. Draw the diagram of respiratory and label it.
3. Describe the physiology of respiration.
4. Describe the structure and function of the lungs with a neat diagram.

5. Explain briefly;
   (a). External respiration.
   (b). Internal respiration
   (c). Pleura.
   (d). diaphragm.
Alimentary tract: The digestive system is the collective name used to describe the alimentary canal, some accessory organs and a variety of digestive processes, which take place at different levels, in the canal. The alimentary canal begins at the mouth passes through thorax abdomen and pelvis and ends at the anus.

The complex of digestive processes gradually simplifies the foods eaten until they are in a form for suitable for absorption. It therefore goes through a series changes, which release its constituent nutrients amino acids, mineral salts, fat and vitamins. Chemical substances or enzymes which effect these changes are secreted in the canal by special glands, some of which are in the walls of the canal and some out side the canal with the ducts.
**Enzyme:** Is a chemical substance which produces change in the chemistry of other substances without undergoing any change.

After they are absorbed, the nutrients are used in the synthesis of constituents of the body. The energy needed for these and other processes and for the disposal of waste materials. The activities of the digestive system are:

**Ingestion**, taking food into the alimentary tract.

**Propulsion:** Moves the contents along the alimentary tract.

**Digestion divided into**

1. Mechanical breakdown of food by eg. Mastication
2. Chemical breakdown of food by enzyme and accessory organ of the digestive system.

**Absorption:** Is the process by which digested food substances pass through the walls of the organs of the alimentary canal into the blood and lymph capillaries for circulation round the body.

**Elimination:** Food substances which have been eaten but cannot be digested and absorbed are excreted by the bowel as faeces.

**Organs of the Digestive System**

**Alimentary Tract:** This is a long tube through which food passes. It commences at the mouth and terminates at the anus. It includes:

- Mouth
- small intestine
- Pharynx
- large intestine
- Oesophagus
- rectum and anal canal
- Stomach

**Accessory organs:** Various sections are pouted the alimentary tract, some by glands in the living membranes of the organs. Eg. Gastric juice secreted by glands in the lining of the stomach and some by glands situated outside the tract. The latter are the accessory organs of digestion and their secretions pass through ducts to enter the tract.
They consist of 3 pairs of salivary glands. Pancreas, liver and biliary tract.

**Anatomy of alimentary canal:** The walls of alimentary canal are formed by four layers of tissue. Adventitia or outer covering.
Muscle layer
Submucous layer
Mucous membrane layer.

**Adventitia (outer covering):** In the thorax this consists of loose fibrous tissue and in the abdomen the organs are covered by a serous membrane called peritoneum.

**Peritoneum:** It is the largest double serous membrane of the body, consists of a closed sac, containing a small amount of serous fluid with in the abdominal cavity, it has two layers. The parietal layer which lines the abdominal wall. The visceral layer which covers the organs with in the abdominal and pelvic cavities. The arrangement of the peritoneum is such that organs are invaginated into the closed sac from below behind and above that they are least partly covered by the visceral layers.

**The functions of peritoneum:**
It covers most of the abdominal and pelvic organs, forming a smooth lining which enables these organs to move upon each other without friction.
It attaches the organs together and keeps them in position and maintains the organs in relation to the posterior abdominal wall.
The numerous lymphatic nodes and vessels with which the peritoneum is supplied help in protecting it from infection.

**Muscle layer:** This consists of two layers of smooth muscle. The muscle fibers of the outer layer are arranged longitudinally and those of the inner layer
encircle the walls of the tube. Contraction of these muscle layers occur in waves, which push the contents of the tract onwards. In between the two layers of muscles there are blood vessels, lymph vessels and a plexus of sympathetic and parasympathetic nerves called the myenteric or Auerbach’s plexus. The contraction of smooth muscle is called peristalsis.

**Sub Mucous layers:** This layer consists of loose connective tissue with some elastic fibers with in this layers. There are plexus of blood vessels and nerves, lymph vessels and varying amounts of lymphoid tissues. The nerve plexus is sub mucous or Meissner’s plexus.

**Mucous membrane:** This layer has three main functions – protective, secreatory and absorptive. The mucous membrane consists of columnar epithelial cells interspersed with mucous secreting goblet cells. Mucous lubricates the walls of the tract and protects them from digestive enzymes. They contain digestive enzymes that chemically simplify food.

**Nerve Supply:** Both parts of the autonomic nervous system

**Oral cavity**

**Mouth:** The mouth or oral cavity is bounded my muscle and bones. It is lined through with mucous membrane consisting of stratified squamous epithelium containing of small secreting glands.

**Tongue:** The tongue is a voluntary muscular structure which occupies the floor of the mouth. It is attached by its base to the hyoid bone and by a fold of its mucous membrane covering called the frenulum to the floor of the mouth.

**Teeth:** The teeth are embedded in the alveoli or sockets of the alveolar ridges of the mandible and the maxilla. Each individual has two sets the temporary or deciduous teeth and the permanent teeth. The temporary teeth are 20 in number. 10 in each jaw, they began to erupt when the child is 6 months old.
The permanent teeth begin to replace the deciduous teeth from 6 to 12 years they gradually fallout and replaced by 32 permanent teeth 16 in each jaw.

**Structure of teeth:**
- **The crown** – the part that protrudes from the gum.
- **The root**: the part embedded in the bone.
- **The neck** – The slightly constricted part where the crown merges with the root.

In each jaw there are:
- 4 incisors at the front for cutting
- 2 canine one each side for tearing
- 4 pre molars
- 6 molars for grinding.
A tooth is made of very hard material. Dentin, in the centre of the structure is the pulp cavity. Tooth pulp contains connective tissue cells, blood vessels and nerves. The crown the dentin is further covered by enamel which is much harder than dentin.

Pharynx: is a passage way both for food and for air. The pharynx is divided into three parts, the nasal, pharyngeal and laryngeal parts. Food passes from the oral cavity to the pharynx then to esophagus below with which it continuous. It is made of muscles which help in swallowing.

During swallowing the wall of the pharynx grasp the food from the back of the tongue. At the same time, the larynx rises up under the epiglottis and the soft parts rises to shut off the nose, so that the food passes safely to the esophagus.

The Tonsils: Tonsils are masses of lymphoid tissue placed one on each side of the pharynx between the pillars of the fauces. They are permeated with blood and lymphatic vessels and contain masses of lymphocytes. The surface of tonsil is covered with mucus membrane continuous with that of the lower
part of the pharynx. This surface studded crypts and into these crypts new numerous mucus secreting glands pour their secretion this mucus contain many lymphocytes. Tonsil act as the first line defense in infection spreading from nose, mouth and throat.

There are 3 types of tonsils


When the tonsil fail to resist the infection tonsillitis or a peri tonillar abscess may develop surgical removal of the tonsil is called tonsillectomy.

**Salivary glands:** There are 3 pairs of compound racemose glands which pour their secretions in to the mouth. They are; 2 parotid – situated one on each side of the face just below the external acoustic meatus. 2 sub mandibular – these lie on each side of the face under the angle of the jaw. 2 sub lingual: - These lie under the mucus membrane of the floor of the mouth.
Structure of the salivary glands:
The glands are all surrounded by a fibrous capsule. They consist of a number of lobules made up of small alveoli lined with secretory cells.


Oesophagus: The esophagus or the gullet is the first part of the alimentary tract. It is about 25 cms long and about 2 cms in diameter. The upper cricopharyngeal sphincter prevents air passing in the esophagus during inspiration and the aspiration of the esophageal contents.
**Formation of bolus:** The food taken into the mouth mixed with saliva and formed into a soft mass or bolus.

![Diagram of peristalsis]

Movement of the bolus through the esophagus by peristalsis

**Deglutition or swallowing:** This occurs in three stages after mastication is completed and the bolus has been formed. It is initiated voluntarily but latter it is under autonomous nerve control.

The mouth is closed and the voluntary muscle of the tongue and checks push the bolus back wards into the pharynx. The muscles of the pharynx propel the bolus down into the esophagus. The soft palate rises up and occludes the nasal part of the pharynx, the tongue and the pharyngeal folds close the way back in to the mouth and the larynx is lifted up and forward so that its opening is occluded by the over changing epiglottis.

The presence of the bolus in the pharynx stimulates a wave of peristalsis, which propels the bolus through the esophagus to the stomach.
Stomach: The stomach is a J-shaped dilated portion of the alimentary tract situated in the epigastric, umbilical and left hypochondriac region of the abdominal cavity.

Structure: The stomach is continuous with the esophageal at the cardiac orifice and with the duodenum at the pyloric orifice. It is described as having two curvatures. The lesser curvature is short lies on the posterior surface of the stomach and is the downward continuation of the posterior wall of the oesophagus. Just before the pyloric sphincter it curves upwards to complete the J-shape. Where the oesophagus joins the stomach the anterior part angles acutely upwards, curves downwards forming the greater curvature than slightly upwards to wards the pyloric orifice.

The part of the stomach above the cardiac orifice is the fundus; the main part is the body and the lower part the pyloric antrum. When the stomach is in active the pyloric sphincter is relaxed and open. When it contains food the sphincter is closed.
Functions of the stomach:
1. The stomach acts as a temporary reservoir for food, allowing the digestive enzymes time to act.
2. It produced gastric juice, which begins the chemicals digestion of proteins.
3. Muscular action mixes the food with the gastric juice then moves it on to the small intestines.
4. The digestion of fat commences in the stomach.
5. An anti anemic factor is formed.
6. Milk is curdled and casein set free.

Gastric juice: The glands in the mucous coat of the stomach secretes an important digestive fluid, gastric juice about, 2 to 3 liter of gastric fluid secreted daily. This is clear colour less acid fluid. It contains 0.4% of free hydro choric acid (HCL). It consist of

Water
Mineral salts
Mucus secreted by goblet cells in the glands and on the stomach surface.

Hydrochloric acid
Intrinsic factor

secreted by gastric glands
secreted by parietal cells in the gastric glands

Inactive enzyme precursors: Pepsinogens secreted by chief (peptic or zymogen) cell in the glands.

Function of gastric juice:
1. Water further liquefies the food swallowed
2. Hydrochloric acid.
   a. Acidifies the food and stops the action of salivary amylase.
   b. Kills many microbes, which may be harmful to the body.
   c. Provides the acid environment needed for effective digestion by pepsins.
3. Pepsinogens are activated to pepsins by hydrochloric acid and by pepsins already present in the stomach. They begin in digestion of proteins breaking them into smaller molecules. Pepsins act most effectively.
4. Intrinsic factor (a protein compound) is necessary for the absorption of vitamin B12. The anti anemic factors from the alimentary tract in the ileum.

5. Mucus prevents mechanical injury to the stomach wall by lubricating the contents. It prevents chemical injury by acting as a barrier between the stomach wall the other constituents of gastric juice. Hydrochloric acid is present in potentially damaging concentrations and pepsins digest protein.

**Small intestine:** The small intestine is continuous with the stomach at the pyloric sphincters and leads into the large intestine at iliocaecal valve. In the small intestine the chemical digestion of food is completed and most of the absorption of nutrient materials takes place. It is a little over five meters long and lies in the abdominal cavity surrounded by the large intestine. It comprises of 3 parts i) Duodenum ii) Jejunum iii) ileum

**Duodenum:** - It is about 25 cms long and curves around the head of pancreas. At its midpoint there is an opening common to pancreatic duct and bile duct guarded by sphincter of oddi.

**Jejunum:** It is the middle part of small intestine and is about 2 meters long.

**Ileum:** It is the terminal part and is about 3 meters long and ends at the ileocaecal valve.
Structure of small intestine:

**Peritoneum:** A double layers of peritoneum called the mesentery attaches the jejunum and ileum to the posterior abdominal walls. It is fan-shaped.

**Mucous membrane:** The surface area of small intestine mucosa is greatly increased by circular folds and villi. The villi are tiny fingers shaped projections into the intestinal lumen. Their walls consist of columnar epithetical cells or enterocytes with tiny microvillus on their free border. Goblet cells are interspersed between the enterocytes.

**Intestinal glands:** These are simple tubular glands situated below the surface between the villi. The digestive enzymes together with intestinal juice complete the chemical digestion of carbohydrates, proteins and fats.

**Blood supply** – Superior mesenteric artery supplies the whole of the small intestine Venus drainage by the superior mesenteric Venus which joints other Veins to from the portal vein. Nerve supply sympathetic and parasympathetic nerves.
Intestinal Juice: (success entericus)
About 3 liters of intestinal juice with pH 7.8 to 8.0 are secreted daily by the glands of the small intestine. It consists of water, mucous, mineral salts, and enzyme.

Functions of the small intestine:
The functions are:
1. Onward movement of its contents, which is produced by peristaltic, segmental and pendular movements.
2. Secretion of intestinal juice.
3. Completion of digestion of carbohydrates, protein and fats in the enterocytes of the villi.
4. Protection against infection by microbes by the solitary lymph follicles and aggregated lymph follicles.
5. Secretion of hormones cholecystokinin – pancreozymin (CCK) and secretion.
Digestion in small intestine:
As the acid chyme passes into the small intestine it is acted upon by the pancreatic, bile and intestinal juices. The digestion of all nutrients is completed i.e., carbohydrates to monosaccharide. Proteins to amino acids, fats to fatty acids and glycerol.

Pancreatic juice: It enters the duodenum at the ampulla of the bile duct and consists of water, mineral salts.

Enzymes – amylase, lipase, peptidase, including. Trypsinogen and chymotrypsinogen. Pancreatic juice is alkaline with a pH of 8.

Functions:
1. The trypsinogen – chymotrypsinogens are converted to active forms trypsin –chymotrypsin by enteropetidase. They convert polypeptides to amino acids or to dipeptides and tri peptides.
2. Pancreatic amylase converts all digestable polysaccharides to disaccharides.
3. Lipase converts fats to fatty acids and glycerol.

Bile: It is secreted by liver and stored in gal bladder. After a meal as the sphincters of oddi relaxes the bile juice is secreted into the duodenum.

The constituents of bile juice are
Water  bile salts
Mineral salts  bile pigments
Mucous  cholesterol

Functions.
1. The bile salts Na taurocholate and Na glycocholate emulsify fats in the small intestine.
2. Stercobilin is exerted in faces – it colours and deo dories the faces.
3. Bile is necessary for absorption of Vitamin K and digested fats.
ABSORPTION OF NUTRITIONAL MATERIALS:
The process involved in the absorption of nutrients includes

1. Carbohydrates as monosaccharide, proteins as amino acids and fats as fatty acids and glycerol may be slowly absorbed by diffusion but more rapidly by active transport.

2. Carbohydrates as disaccharides and proteins as dipeptides and tri-peptides are actively transported into the microvilli where chemical digestion is completed to monosaccharide and amino acids before transfer to the capillaries in the villi. Monosaccharide and amino acids pass into the capillaries in the villi and fatty acids and glycerol into the lacteals. Some proteins are absorbed unchanged eg. Antibodies present in mothers milk and oval vaccines, such as poliomyelitis vaccine. The extends of protein absorption is believed to be limited. Other nutritional materials such as vitamin mineral salts and water are absorbed from the small intestine into the blood capillaries. Fat soluble vitamins are absorbed into the lacteals along with fatty acids and glycerol. Vitamin B12 combines with intrinsic factor in the stomach and is absorbed in the small intestine is greatly increased by the circular folds of mucous membrane and by the very large number of villi and micro villi present. It has been calculated that the surface area of the small intestine is about five times that of the whole body. Large amount of fluid enter the alimentary tract each day of this only about 500 ml is not absorbed by the small intestine and passes into the large intestine.
The caecum is the first part of the colon. It is a dilated portion which has a blind end inferiorly and is continuous with the ascending colon superiorly. The vermiform appendix is a fine tube, closed at one end which leads from the caecum.

The ascending colon passes upward from the caecum to the level of the liver where it bends acutely to the left at the right colic flexure (hepatic flexure) to become transverse colon.

The transverse colon is a loop of colon which extends across the abdominal cavity in front of the duodenum and stomach to the area of spleen where it forms the left colic flexure (splenic flexure) by
bending acutely down wards to become the descending colon.

The descending colon passes down the left side of abdominal cavity then curves towards the midline. After it enters the true pelvis it is known as pelvic colon. The pelvic colon describes an S-shape curve in the pelvis then continues down wards to become the rectum.

**The rectum** is a slightly dilated part of the colon, which is about 13 cm long. It leads from the pelvic colon and terminates in the anal canal. The anal canal is a short canal about 3.8 cms long in the adult and leads from the rectum to the exterior.

There are two sphincter muscles, which control the anus. The internal sphincter, consisting of smooth muscle fibers is under the control of autonomic nervous system and the external sphincter formed by striated muscle is under voluntary nerve control.

**Structure:** 4 layers of tissue described in the general plan are present in the colon, the rectum and the anal canal.

The arrangement of the longitudinal muscle fibers is modified in the colon. They do not form a smooth continuous layers of tissue but collected into three bands called taeniae coli, situated at regular intervals around the colon. They stop at junction of pelvic colon and rectum. As these bands of muscle tissue are slightly shorter than the total length of the colon they give a sacculated or puckered appearance to the organ.

In the sub- mucous layer there are large numbers of goblet cells forming simple tubular glands, which secrete mucus. They are not present beyond the junction between the rectum and the anus. The lining membrane of the anus consists of
stratified squamous epithelium which is continuous with the mucous membrane lining the rectum above and merges with the skin beyond the external anal sphincter.

Functions of the large intestine, Rectum and Anal canal:

Absorption: In the large intestine absorption of water continues until the familiar, semisolid consistency of faces is achieved. Material salts, vitamins and some drugs are also absorbed into the blood capillaries from the large intestine.

Microbial Activity: There are large number of microbes in the colon which synthesis vitamin k and folic acid. The large intestine has microbicidal activity.

Defaecation: The large intestine does not exhibit peristaltic movement as it is seen in other parts of digestive tract. Only at fairly long intervals does a wave of strong peristalsis sweep along the transverse colon forcing its contents into the descending and pelvic colons. This is known a mass movement.
Defaecation occurs by reflex action which is not under voluntary control. The external anal sphincter is under voluntary control. Thus defecation involves involuntary contraction of the muscle of rectum and relaxation of internal anal sphincter.

Contraction of abdominal muscles and lowering of diaphragm increases the intra abdominal pressure and so assists the process of defecation. Repeated suppression of reflex of defalication may lead to constipation.

**Constituents of faeces:** The faeces consists of a semi solid brown mass. The brown colour is due to the presence of stercobilin.

**LIVER**

**Liver:** Liver is the largest gland in the body, weighing between 1-2.3 kg. It is situated in the abdominal cavity occupying the greater part of the right hypochondriac region. Its upper and anterior surface are smooth and curved to fit the under surface of the diaphragm. Its posterior surface is irregular in outline.
**Organs associated with the liver:** Superiorly and interiorly – diaphragm and anterior abdominal wall. Inferiorly – stomach, bile ducts, duodenum, right caliciflexure of colon, right kidney and adrenal gland. Posterior – Esophagus, inferior venacana, aorta gall bladder, vertebral columns and diaphragm.

Laterally – Lower ribs and diaphragm.

The liver is enclosed in a thin capsule and incompletely covered by a layer of peritoneum. Folds of peritoneum form supporting ligaments attaching the liver to the inferior surface of diaphragm. It is held in position partly by these ligaments and partly by the pressure of the organs in the abdominal cavity. The liver has four lobes. The large right lobe and a small wedge shaped left lobe. The other two, the caudate and quadrate lobes are areas on the posterior surface.

**Portal fissure:** This is the name given to the part on the posterior surface of the liver where various structures enter and leave the gland.
1. The portal vein enters carrying blood from stomach, spleen, pancreas and small and large intestines.
2. The hepatic artery enters, carrying arterial blood. It is a branch from celiac artery which is in turn a branch of abdominal aorta.
4. Right and left hepatic ducts leave, carrying bile from the liver to gall bladder.
5. Lymph vessels – leave the liver and drain lymph to abdominal and to some thoracic nodes.

**Blood supply:** The hepatic artery and portal vein take blood to the liver. Hepatic veins leave the posterior surface and immediately enter the inferior vena cava.
The lobes of liver are made of tiny lobules. These lobules are hexagonal in outline and are formed by cubical shaped cells, the hepatocytes arranged in pairs of columns radiating from a central vein. Between the two pairs of columns of cells there are sinusoids. This arranged facilitates the arterial blood and venous blood to mix and come in close contact with liver cells. Some cells, lining the sinusoids are hepatic macrophages called kupffer cells.

Blood drains from the sinusoids into central or centribular veins. These then join with veins from other lobules forming larger veins, and eventually they become the hepatic veins. Which leave the liver and empty the blood into the inferior venacava, just below the diaphragm.

Liver secretes bile. Bile canaliculi run between the columns of liver cells. This means that each column has a blood sinusoid on one side and bile canaliculus on the other. The bile canaliculi join up to form, large bile canals until eventually they form the right and left hepatic ducts which drain bile from the liver.

Lymphoid tissue and a system of lymph vessels are present in each lobule.

**FUNCTIONS:** The liver is an extremely active organ and performs wide variety of functions.

1. It deaminates amino acids
   (a) Removes the nitrogenous portions from the amino acid and forms nitrogenous potion, which is excreted in urine. (b) Breaks down the nucleoprotein of worn out cells of the body to form uric acid, which is excreted in the urine.

2. It converts glucose to glycogen in the presence of insulin – glycogenesis.

3. It desaturates the fat i.e. emulsification of foods.

4. The liver produces heat.

5. It secretes bile. These include bile salts, bile pigments and cholesterol.
6. Stores:
   (i) Vit. B12 (antinanemic factor)
   (ii) Fat soluble vitamins – A, D, E, K.
   (iii) Water soluble vitamins eg. Riboflavine, niacin, pyridoxine, folic acid.
   (iv) Iron and copper minerals.

7. Synthesis of vitamin A from carotene (provitamin of vitamin -A)

8. Synthesis of non-essential amino acids, plasma proteins and most of the blood clotting factors.

9. Detoxicates drugs and noxious substances such as toxins produced by microbes.

10. Metabolises ethanol in alcoholic drinks.

11. Inactivates hormones, including insulin, glucagon cortisol, aldosterone, thyroid and sex hormones.

THE PANCREAS
The pancreas is a compound racemose gland, similar in structure to the salivary glands. It is about 23 cms long, extending from the duodenum to the spleen and is consisting three parts.

1. The head of the pancreas, the broadest part lies to the right of the abdominal cavity and in the curve of the duodenum which practically encircles it.

   The body of the pancreas is the main part of the organ; it lies behind the stomach and in front of the first lumbar vertebra.

   The tail of the pancreas is a narrow part of the left which actually touches the spleen.

FUNCTION:
1. Production of pancreatic juice which is sent through the pancreatic duct to the duodenum this juice contain enzymes for the digestion of CHO, fat and proteins.
2. Production of insulin by tissue called "Islets of Langerhans" insulin is a hormone is necessary for CHO metabolism.

**GALL BLADDER:**

Gall bladder is a pear shaped sac attached to the under surface of the liver by a connective tissue. It is measuring about 7 to 10 cm in length. It is located in fossa of the visceral surface of the liver. It is divided into fundus, body and neck. The gall bladder consists of three coats. (a) The outer coat is the visceral peritoneum (b) The middle coat is the muscular tissue with smooth muscle fibers (c) the inner coat is the mucus membrane in the form of rugae.

Bile ducts are formed by the union of the bile capillaries which collect the bile from the liver cells. Bile from the liver enters the small intestine through the common bile duct.

The hormone cholecystokinin helps in emptying of the gal bladder by ejection of bile into the small intestine to participate in the digestive process.
FUNCTIONS: OF GALL BLADDER: It acts as a reservoir of bile and can hold about 60ml of bile.

COMPOSITION AND FUNCTION OF BILE: Bile is a greenish alkaline fluid secreted by the liver cells. Daily 500 to 1000 ml of bile is secreted continuously. Bile contains about 86% of water, bile, salt, bile pigment, cholesterol, mucin and other substances.

- Bile helps in digestive process.
- Bile pigments are excretory products.
- Bile salts are digestive and they help in the absorption of digested fat.
- If colours and deodorizes the faeces.
METABOLISM

Metabolism is the word used to indicate the chemical changes, which take place in the body necessary for the fulfillment of its vital functions. Each cell is makeup of protoplasm which has the power to take in oxygen and other necessary substances and to discard certain other properties as waste matter, including carbon dioxide, but between these changes taking place in the cells lies a large field of chemical activity upon which all the functions of the body intimately depend.

There is a continues balance between the building up, anabolism of complex substance and tissues with the consumption of energy and the breakdown, catabolism of complex substances with other liberation of energy. During growth or recovery from illness anabolism is predominant. During starvation or illness catabolism predominates.

**BASAL METABOLISM:** The minimal energy expender for the maintenance of respiration, circulation, peristalsis, muscles tonus, body temperature glandular activates and other function of the body.

**RATE OF METABOLISM:** basal metabolism is the term used to describe the sum total of metabolic activities with the body in a condition of physical and mental rest. In this state the minimum of oxygen will be required as the tissues are working at a minimum.

The basal metabolic rate is estimated on persons who are resting in bed, have not had any food or fluid during the night and who have not been disturbed. Either the intake of the oxygen or the output of carbon dioxide is measured.

The principle factors which influence the rate metabolism include body size, age sex, climate including the degree of heat, the type of clothing worn the nature of the work. It is obvious that the rate of metabolism will depend on the activity of the
individual. It will be higher in a manual worker than in an office worker leading a more sedentary life.

The state of nervous tension is a most important factor, as this will affect the rate of breathing and the rate and force of the action of the heart.

The basal metabolic rate in disease is influenced by some abnormality of the thyroid gland. Over-activity of the thyroid gland raises the metabolic rate, as in hyperthyroidism. Under-activity of gland lowers. The metabolic rate, as in cretinism and myxoedema.

The foods which provide heat and energy are carbohydrates, fats and under certain conditions, proteins.

**Metabolism of carbohydrates** – Carbohydrates are widely distributed in plants and they are formed from carbon dioxide of the atom by photosynthesis. CHO are the cheapest some of energy and easily digested and assimilated type of food.

**Host stage digestion** – starts in the mouth when food is chewed. Salivary – amylase called ptyalin – acts upon it cooked starch ptyalin maltose.

In the stomach amylase acts best at neutral PH food mixes ease with gastric juice.

CHO digestion occurs in small intestine with the action of pancreatic amylase, intestinal amylace, sucrose, lactose, and maltose.

Starch – Amylase in saliva – maltose + iso maltose + pancreatic.

Maltose – internal juice maltose juice – Glucose – Sucrose – Sucrose – Glucose + fructose.

Lactase – lactose – Glucose +Galactose.

In final products of CHO are glucose, fructose. Galactose are observed in the intense. Glucose is manufactured by the hydrolysis of starch. Glucose is stored in the liver and skeletal muscles as glycogen.
Liver glycogen is re-converted to glucose as required by the body with the help of blood sugar level is 100 mg glucose per 100 ml of blood. Glucose is readily diffused into the tissue fluid and into cells and there is uniform concentration of it in other body fluids. Muscles glycogen is vest during muscles activity and replenished from the blood sugar glucose as required. Carbohydrates yield 17KJ(4.1Kcal) per gram.

**Metabolism of fats** — Fats are not immediately required after its absorption hence they are stored in the fat deposits of the body in adipose tissue. When needed it is with drawn from these depots and in the liver is converted into glycerol and fatty acids. The form in which it can be utilized in the body.

When fat is metabolized by the liver there is a residue ketone substances which can only be used by the body to a limited extends. If they are produced by the liver faster than they can be used they accumulate in the blood, causing the condition of Ketosis. This happens in starvation, when the fats yield – 38KJ (9.3 K Cal) per gram body has nothing but the fat in its adipose tissue.

**Digestion** — Gastric lipase produces slight hydrolysis of fat. Pancreatic lipase — Intestinal lipase — break down fats into glycerin and fatty acids.

**Absorption** — of glycerin and fatty acids by the lacteals which are then passed to the thoracic duct and enter the blood stream.

In the blood fat is carried to every cell of the body.

In liver assists in the oxidation of fats and prepares fats for deposition in the tissue.

In the tissue some of the fat is oxidized (in the presence of CHO) to give heat energy. Some of the fat solved in the fat depots, which contains vitamin A and D.
In waste products which result from the combustion of fat in the tissue are excreted by the lungs, water & Co2,
By the skin – water
By the kidneys – water.

**Metabolism of protein** – After CHO protein and next used for the production of heat and energy.
Proteins yield 17KJ (4.1) K ca. per grm.
Digestion in the stomach.
Proteins Pepsin with HCL – peptones.
Rennin produces casein from caseinogens and pepsin (with HCL) turns casein into peptones.

**In the Intestine**
Trypsin reduces protein & peptones to polypeptides and erepsin further reduces polypeptides to amino acid.

**Absorption** - In to the blood – the amino acids bring nitrogen and Sulphur to every cell in the body. The body cells select the special amino acid each cell needs for repair and growth.

In liver deaminates amino acids and from this process urea is farmed. Carbon compounds are liberated for oxidation.

The waste products which result from the metabolism of proteins are urea, uric acid and creatinine. These are excreted in the urine proteins are not stored in the body but excess in excreted, principally in urine. Actually only nine of the amino acids (essential amino acids) one essential for the growth and repair of the body tissues. When diet contains an excess of protein the surplus amino acid are denominated in the liver to remove nitrogen, leaving only carbon, hydrogen and oxygen which can be used for the production of heat and energy. When protein intake is in sufficient as in starvation not only are the CHO and fat stores are depleted, but this is a loss of body protein shown by wasting of the muscles eg. KWASHIORKOR.
Unit IV

‘C’ Digestive System

Questions

1. List the organs of digestive system
2. Name the layers of tissues covering the alimentary canal.
3. Draw the diagram of alimentary system and label them.
4. Describe the structure and functions of stomach with diagram.

5. Write the short notes on the following;

6. Explain briefly the structure and junctions of small intestine.
7. Write the function of bile.
8. Write briefly the structure and functions of pancreas.

9. Describe briefly the structure of liver with neat diagram.
10. Write the junctions of liver.
11. Define metabolism.

12. Describe briefly the following;
UNIT - V

SENSE ORGANS

The organs of special sense are specially adopted end organs for the reception certain kind of stimuli. The nerves, which supply them from the sense organs to the brain, where sensation is interpreted.

There are 5 sensory organs
1. Eye - for sight.
2. Ear – for hearing
3. Nose – for smell
4. Tongue – for taste
5. Skin – for touch.

**EAR**

Ear is the organ of hearing. It is supplied by the eighth cranial nerve, which is stimulated by vibrations caused by sound waves.
STRUCTURE: Ear is divided in three distinct parts.

- External Ear
- Middle ear
- Internal ear.

EXTERNAL Ear: External ear consists of auricle (pinna), the external acoustic meatus. It is designed to collect sound waves and pass them inward.

The Auricle or pinna: The auricle is the expanded portion projecting from the side of the head. It is made up of fibroelastic cartilage covered with thick skin. The prominent outer ridge is called Helix lower soft pliable part is called lobule.

External auditory canal: It is slightly S shaped tube about 2.5cm long extending form auricle to the tympanic membrane (eardrum).

It contains numerous sebaceous and ceruminous glands which secrete cerumen (wax), it helps to prevent entry of foreign bodies into ear.

Middle ear or tympanic cavity: An irregular shaped cavity with in the petrous portion of the temporal bone. The cavity contain air. It is separated from external ear by eardrum and from internal ear by thin
bony partition containing two small opening called the oval window and round window.

**Auditory ossicles:** - These are three very small bones that extend across the cavity from the tympanic membrane to the oval window. They form a series of movable joints with each other and with the medical wall of the cavity at the oval window. They are malleus, (hammer shaped bone), Incus (Anvilshaped bone) and Stapes (Stirrup-shaped bone).

![Diagram of Auditory Ossicles](image)

**Internal ear:** The internal ear contains organs of hearing and balance it is described into two parts (1) Bony labyrinth (2) Membranous labyrinth.

**Membranous Labyrinth:** This is the cavity within the temporal bone. It is divided into bony labyrinth consist of water fluid called labyrinth consists of water If fluid called perilymph; membranes labyrinth contains a fluid called endolymph. These membrane channels contain fluid and nerve endings for hearing and balance.
The bony labyrinth: it consists of three parts.

1  Vestibule 1. Cochlea and 3 semicircular canals.

VESTIBULE: is the oval central portion of the bone labyrinth it contains oval and round windows in the lateral wall.

The Cochlea: - Is resembles snails shell the coils are arranged around a central bony cone shaped axis called mediolus. It has broad base where it continous with the vestibule.

The semicircular canals: - are three tubes arranged so that one is situated in each of the three planes of space they are communicates with the vestibule.

The membranous labyrinth: - is the same shaped as it is bony counter part and is separated from it by
perilymph. It contains endolymph and having the same three parts vestibule, cochlea, semicircular canals.

The auditory nerve innervates the ear; it divides into 2 portions. The vestibular portion is concerned with equilibrium and cochlear portion is called the true nerve of hearing.

**PHYSIOLOGY OF HEARING:**

Every sound produces sound waves or vibrations in the air, which travel at about 332 meters (1088 feet) per second. The auricle, because of its shape, concentrates the waves and directs them along the auditory meatus causing the tympanic membrane to vibrate. Tympanic membrane vibrations are transmitted through the middle ear by movement of the ossicles. At their medial end of the footplate of the stapes rocks to and fro in the oval window. Setting up fluid waves in the perilymph. These indent the membranous labyrinth, causing a wave motion in the endolymph, which stimulates the neuroepithelial cells of the organ of corti. The nerve impulses generated
pass to the brain in the cochlear portion of the **vestibulocochlear** nerve (8th cranial nerve). The fluid wave is finally expended into the middle ear by vibration of the membrane of the round window. The vestibuloucochlear nerve transmits the impulses to the hearing area in the cerebrum where sound is perceived and to various nuclei in the pons varolii and the midbrain.

**Balance:** The vestibular nerve distributed to the semicircular canals conveys to the brain the impulses generated there by alterations in the position of the fluid in these canals, which have so much to do with the knowledge of the sense of the position of the head in relation to the body. If a person is suddenly thrown to one side, the tendency is for the head to bend towards the opposite side in order to maintain balance so that weight is adjusted, the erect position maintained, and a fall is prevented.

It is the change in the position of the fluid in the semicircular canals which stimulates the impulse, obeyed as reflex, by the quick response of the body to transfer weight and maintain equilibrium.
SENSE OF TASTE

The tongue is principally concerned in the special sense of taste. The tongue lies in the floor of the mouth. The anterior portion of the tongue is free. The mucus membrane of the tongue is moist and pink in health person. On the upper surface it has a velvety appearance and covered by papillae. Taste buds are formed in the papillae of the tongue and widely distributed in the epithelium of the tongue, soft palate, pharynx and epiglottis they consists of small bundles of cell bodies and nerve endings of cranial. Nerve VII, IX and X. the nerve cells are stimulated by chemicals substance that enter the pores. Nerve impulses are generated and transmitted to the thalamus than to the taste area in the cerebral cortex, one each hemisphere where taste is perceived.

PHYSIOLOGY OF TASTE: Sweet, sour, bitter, salt are the four fundamental sensations of some taste consistently stimulate taste buds in specific parts of the tongue.

- Sweet and salty mainly at the tip.
- Sour at the sides.
- Bitter at the back.
**EYE :-**

The eye is an important source organ of sight the optic or second cranial nerve is the sensory nerve of sigh. The visual center lies in the cortex of the occipital lobe of the brain.

**Optic chiasma**: This is situated immediately in front and above the pituitary gland which is in the hypophyseal fossa of the sphenoid fore. In the optic chiasma the nerve fiber of the optic nerve from the nasal side of each retina cross over to the opposite side the fibers from the temporal side do not cross but continue back wards on the same side.

The eye ball is continued in the bony orbit and protected by appendages such as the eye lids, eye brows, conjunctiva and the lacrimal apparatus.
STRUCTURE: The eye ball is oval and not circular it is about an inch in diameter, transparent in front and compared of three layer:-

1. Outer fibrous, the supporting layer
2. Middle, vascular and
3. Inner nervous layer.

Six muscles move the eye, fore straight and two oblique. These lie inside the orbit passing from the bony walls of the orbit to be attached to the sclerotic coat of the eye behind the cornea. The straight muscles are the superior, inferior, medial and lateral rectus muscles of the eye. These move the eye upwards down ward inwards and outwards respectively. The oblique muscles are inferior and superior the superior oblique moves the eye down wards and out wards, the inferior oblique upwards and out wards. The movements of the eyes are combined, both eyes move to right or left, up or down. The nerves supplying these muscles are the motores aculi, the third fourth and 6th cranial nerve.
THE SCLERA: Sclera is the tough outer fibrous coat. It forms the white of the eye and is continue in front with a transparent window membrane, the cornea. The sclera protects the delicate structure of the eye and helps to maintain the shape of the eye ball.

The choroid: A middle vascular layer coat contains the blood vessels which are the ramifications of the ophthalmmic artery, a branch of the internal carotid. This vascular coat forms the iris with the central opening a pupil of the eye. The pigmented layer behind the iris given it colour and determines whether the eye is blue, brown a gray etc., the choroid is continuous in front with the iris and just behind the iris this coat is thickened to form the ciliary body to contains circular muscle fibres and radiating fibres, contraction of the former contracts the pupil of the eye.

To gather there form the used tract, consisting of iris, ciliary body and choroids coat. Inflammation of the individual parts is described as iritis, cyclitis, and choroiditis and uveitits.
**The Retina**: Retina is the inner nervous coat of the eye compared of a number of layers of fibrous nerve cells rods and cover. The delicate nerve tissue conducting the nerve impulses from without inward to the optic disc, the point where the optic nerve leaves the eye ball. This is the **blind spot**, at it possess no retina. The most acutely sensitive part of the retina is the macula which ties just external to the optic disc and exactly opposite the center of the pupil.

**CORNEA**: The transparent front portion continuous with the dense white sclera. It consists of several layers. The superficial layer is stratified epithelium continous with the conjunctiva.

**ANTERIOR CHAMBER**: between cornea and iris.

**Iris**: the colored curtain in front of the lens which is continous with the choroids coat. The iris contain two sets of involuntary and plain muscle fibres one set contract the size of the pupil and the other set dilates the pupil.

**PUPIL**: the dark central spot which is an opening in the iris through which light reaches the retina.

**POSTERIOR CHAMBER**: Between the iris and lens both antenia and posterior chambers are filled with **aqueous humour**.

**AQUEOUS HUMOUR**: of the eye – this fluid id derived from the ciliary body and it is reabsorbed in the blood steam at the angle between iris and cornea by a tiny vein known as the canal of schlemm.

**LENS**: a biconvex transparent body made up of several layer. It lies just behind the iris. It has both in front and behind a membrane known as the suspensors ligament, by which the lens is attached to the ciliary body, the slackened of the lenses is controlled by the contraction of the ciliary muscle.
VITREOUS HUMOURS: the remaining back portion of
the eye ball extending from the lens to the retina is
filled with a jelly like aluminous fluid the vitreous
humour of the eye which serves to give it shape ad
firmness and to keep the retina in contact with the
choroids and sclerotic coats.

FUNCTION OF THE EYE: the eye is the special sense
organ of sight. It is constructed to receive the stimuli
of rays on the retina and by means of the optic nerves
to transparent these to the visual centers of the brain
for interpretation.

The cornea acts as a transparent window
protecting the delicate structure behind it and helping
to focus images on to the retina it does not contain any
blood vessels.

The iris with its central opening the pupil is
movable disc, which act as a curtain to protect the
retina, controlling the amount of light entering the eye.

The lens is the principal organ of focus, bending
the rays light reflected from object lens to a clear
image on the retina.

The lens is contained in an elastic capsule,
attached to the ciliary body of the choroids by a
suspenory ligament. By means of the ciliary muscle
the interior body of the choroids by a suspenory
ligament. By means of the ciliary muscle the anterior
surface of the lens is made maiden convex to focus near a distant object, this is visual accommodation.

The pigmented choroid coat darkens the inner chamber of the eye, comparable to the blackened interior of a photographic camera.

The retina is the nervous mechanism of sight of contains the ending of the optic nerves, and is comparable to a sensitive photographic plate.

When an image is perceived rays of light from the object scan pass through the cornea aqueous humour lens in team body to stimulate the nerve endings in the retina the stimuli received by the retina pass along the optic tract to the visual area of the brain to be interpreted. Both areas receive massages from both the eyes thus giving perspective and contour. In an ordinary camera one lens is provide. In the eye shiest the crystalline lens is very important in focusing the image on the retina in the normal eye these rays converge to strike a point on the retina. Where the image is focused.
Clinically abnormalities of refraction: result in defect of visual accommodation either as a result of alteration in the shape of the eyeball a abnormalities of the lens. In hypermetropia a long sight, the eye is short from back to front and therefore the lens focuses the image behind the retina, whilst in myopia a short sight the eye ball is longer than normal from back to front and the lens focus the image in front of the retina.

Astigmatism is an error of refraction, which occurs when rays of light fall upon lines on the retina and not on sharp points. This is due to alteration in the curves of the lens and is corrected by spectacles in the lenses which are convex in the direction which is lacking in the abnormal lens and so make good the deficiency.

PRESBYOPIA: Is the term used to describe the defect of accommodation, which occurs in advancing age. The lens loosen its elasticity and becomes lens resilient and fails to focus the image of a near object. Distant vision is unimpaired. Due to this the person with presbyopia is seen holding a paper a distance away in order to be able to read it. This defect is connected by providing convex lens.

APPENDAGES OF THE EYE: -

Side view of some Structures which protect the eye.
**EYE BROWS:** These are two arches of thick skin from which hairs grow. The eye brows are attached to the muscles beneath and serve to protect the eye from great light.

**EYE LIDS:** There are two plates, the tarsal plates which are compared of very dense fibrous tissue, covered by are compared of very devise fibrous tissue, covered by skin and lined with conjunction. The tissue beneath the skin does not contain fat. The upper eyelid is larger than the lower and is raised by the levator palpebrae muscle. The lids are closed by a circular muscle, orbicularies oculi. Eye lashes are attached to the free managing of the lids and protect the eyes from dust and light.

**CONJUNCTIVA:** This is the mucous membrane lining the eye lids and covering the front of the sclera. It is continuous with the lining membrane of the lacrimal ducts, the lacrimal sac and with the nose-lacrimal ducts. When the lids are closed the conjunction forms a closed sac. Drops should be placed at the outer side of the fornix, which is the cut-de-sac where the conjunctive which cover the eyeball is reflected upon the eyelid. The drops thus may exert their effect on the eye before being washed away in the tear ducts.
LACRIMAL APPARATUS: The lacrimal glands are compound racemes glands, situated at the upper outer cornea of the orbital cavity and secrete the **tears**, which at the upper and outer margins of the eye are poured into the conjunctival sac from the ducts of lacrimal glands. As the eye lids move is blinking. The tears are distributed across the surface of the eyeball. A considerable amount of this fluid is evaporated and any excess passes from the inner angle of the eye into the lacrimal ducts and then by the nose lacrimal duct into the nose, the flow of tear is increased by irritants (tear gas for example) and by emotions.

**NOSE:** The organ of sense of smell Described in digestive system unit-IV.

**Skin:** discussed under excretory system unit – V.
UNIT-V

QUESTIONS

1. Name the sensory organs.
2. Draw the diagram showing the internal and external parts of an ear.
3. Describe the structure of an ear.
4. Describe briefly the physiology of hearing.
5. Draw the diagram showing the parts of Eye ball and label it.
6. Write the function of accessory structure of the eyes.
7. Write the function of an eye ball.
8. Write the functions of accessory structure of the eyes.
9. Describe briefly about the refraction.
10. Write the 2 function of the nose.
11. Write the physiology of taste.
UNIT – VI

HUMAN REPRODUCTION

REPRODUCTIVE SYSTEM

The ability to reproduce is one of the properties which distinguish living from non-living matter. In humans as in all the higher animals, new individual are produced by sexual reproduction, in which the male and female organs differ anatomically and physiologically. This means that each new creature has two parents, male and female.

Both males and females produce specialized reproductive germ cells called gametes. In the male they are spermatozoa and in the female, ova. The gametes contain the genetic material, or genes, on chromosomes, which pass it on to the next generation. In other body cells there are 46 chromosomes arranged in 23 pairs but in the gametes there are only 23, one from each pair. Gametes are formed by meiosis. When the ovum fertilized by a spermatozoa the resultant zygote contain 23 pair of chromosomes, one of each pair obtained from the father and one from the mother.

THE FUNCTIONS OF THE FEMALE REPRODUCTIVE SYSTEMS:-

- formation of female gametes, ova.
- Reception of female gametes, spermatozoa.
- Provision of suitable environment for fertilization of the ovum by spermatozoa and development of the foetus.
- Parturition (Child birth)
- Lactation, nourishment for the baby with breast milk.
Functions of male reproductive system.

- Production of male gametes, spermatozoa.
- Transmission of spermatozoa to the female.

THE FEMALE REPRODUCTIVE SYSTEM

The female reproductive organs are genitalia are divided into external and internal organs.
EXTERNAL ORGANS: The external genitalia are known collectively as the 'vulva' which consists of
- The mons veneris
- Labia majora
- Labia minora
- Clitoris
- Vestibule
- Hymen
- Greater vestibular glands.

THE MON'S VENERIS:- It is a pad of fat lying in front of the symphysis pubis. This area becomes covered with hair at puberty.

THE LABIA MAJORA:- These are two large thick folds which form the boundary of the vulva. They are composed of skin, fibrous tissue and fat and contain large number of sebaceous glands.

THE LABIA MINORA:- These are the two smaller folds of skin between the labia majora, containing numerous sebaceous glands. Posteriorly they fuse to form fourchette.
CLITORIS: The clitoris corresponds to the penis in the male and contain sensory nerve ending and erectile tissue.

HYMEN: The hymen is a thin layer of mucous membrane, which partially occludes the opening of the vagina.

GREATER VESTIBULAR GLANDS: The greater vestibule glands (Bartholin glands) are situated one on each side near the vaginal opening. They are about the size of a small pea and have ducts. They secrete mucus that keep the vulva moist.

PERINEUM: The perineum is the area extending from the fourchette to the anal canal. It is roughly triangular and consists of connective tissue muscle and fat. It gives attachment to the muscles of the pelvic floor.

INTERNAL ORGANS: The internal organs of the female reproductive system lie in the pelvic cavity and consists of the vagina, uterus, two uterine tubes and ovaries.

VAGINA: The vagina is a fibro muscular tube lined with stratified epithelium, connecting the external and internal organs of reproduction. It runs obliquely upwards and back wards at an angle of about 45 degree. Between the bladder in front and rectum and anus behind.

STRUCTURE: The vagina consists of three layers an inner layer of mucous membrane (is of squamous stratified epithelial cells) characterized by ridges or rugae. The outer layer covering a muscular coat composed of areolar tissue, middle layer consisting of smooth muscle.
UTERUS: The uterus is hollow muscular pear shaped organ it is flattened anteroposteriorly. It lies in the pelvic cavity between the urinary bladder and the rectum in an antiverted, (lean forward) ant flexed position (Bend forward)

It is about 7.5cm long, 5cms wide out its wall are about 2.5cm thick. It weights from 30 to 40 grams.

The parts of the uterus are the fundus, body and cervix.

THE FUNDUS: The fundus is the dome-shaped part of the uterus above the opening of the uterine tubes.

THE BODY: it is the main part extends up to the level of internal as it is narrower below and continuous with the cervix.

THE CERVIX: It is about 2.5cm in length it protrudes through the anterior wall of the vagina, opening into at the external as.
**STRUCTURE:** The walls of the uterus is composed of three layers of tissue.

**PERIMATRIUM:** Consist peritoneum, which is distributed differently on the various surfaces of the uterus.

**MYOMATRIUM:** It is the thickest layer of tissue in the uterine wall. It consists of smooth muscle fiber interlaced with areolar tissue, blood vessels, and nerves.

**ENDOMATRIUM:** It is the inner layer that consists of columnar epithelium. It contains a large number of mucus-secreting tubular glands.

**SUPPORTS OF THE UTERUS:** The uterus is supported in the pelvic cavity by surrounding organs, muscles of the pelvic floor, and ligaments.

**THE SUPPORTING STRUCTURES:**

**The broad ligaments:** are formed by a double fold of peritoneum one each side of the uterus.

**Two round ligaments.** Are bands of fibrous tissue between the two layers of broad ligaments one on each side of the uterus.
The female reproductive organs in the pelvis and their associated structures. Lateral view.

The main ligaments supporting the uterus. Only one side shown.
FUNCTIONS OF UTERUS:-

After puberty the uterus goes through a regular cycle of changes, the menstruation occur once in 28 days.

Uterus prepares the endomatrium to receive, nourish and protect the fertilized ovum for 40 weeks of gestation period.

It provides environment for the growing foetus.

During labour, the muscles of the uterus contracting a retracting intermittently and dilates.

At the end of gestational period Labour begins and ends when the baby is born and the placenta expelled.

- As the labour progress the uterine contractions become stronger and more frequent. When the cervix is fully dilated, the mother assist the birth of the baby by holding her breath, and bearing down during the contractions.
- The uterus returns to its normal size by process known as involution.

BLOOD SUPPLY:- uterine arteries & uterine veins

NERVE SUPPLY:- Sympathetic and parasympathetic nerves.

UTERINE TUBES (FALLOPIAN TUBES)

The uterine tubes are about 10 cms long body and funds. They lie in the upper free border of the broad ligament and their lateral ends penetrate the posterior wall, opening into the peritoneal cavity close to the ovaries. The end of each tube has finger like projections called fimbriae.

STURCTURE:- The uterine tube have on outer covering of peritoneum, a middle layer of smooth muscle and one lived with ciliated epithelium.

FUNCTION: The uterine tubes convey the ovum from the ovary to the uterus by peristalsis and ciliary movement.
The mucus secreted by the lining membrane provides ideal conditions for movement of ova and spermatozoa.

Fertilization of the ovum usually takes place in the uterine tube than the zygote is moved in to the uterus.

Blood and nerve supply: These are the same for the uterus.

**OVARIES:** The ovaries are two almond shaped glands placed on each side of the uterus. They are 2.5 to 3.5 cm long, 2 cm wide and 1 cm thick. Each is attached to the upper part of the uterus by the ligament of the ovary to the back of the broad ligament.

**STRUCTER:** The ovaries have two layers of tissue medulla lies in the center the cortex surrounds the medulla the ovaries contain a large number of immature ova, called primary oocytes. At each menstual cycle, one of the premature ova began to mature and develops into a ovarion follicles (Graafian), which contain an ovum. The ovum is situated at the end of the graafian follicle and is encircled by “Perivillelline space” the clear membrane called zone pellucida develops around the ova. The
whole follicle is lined with granulose cells and contains follicular fluid) under the influence of FSH hormones the graffian follicle matures and at the same time it swells and become tense and it causes rupture and the fluid and ovum escape via the peritoneal cavity into the uterine tube during each menstrual cycle.

Ovulation is the rapture of the graffian follicle with release of the ovum. Ovulation occurs on the 14th day in a 28 days cycle as a result of decrease in LH and FSH. Ovulation occurs. After ovulation the follicle living cells develops into the corpus leutum (yellow body) If the ovum is not fertilized. The corpus leutum degenerates and new cycle began with menstruation.

If the ovum is fertilized it embeds itself in the wall of the uterus where it grows and develops and produces Human chorionic gonadotrophic hormone, which stimulates the corpus leutem to continue secreting progesterone for first 3 months pregnancy.

**BLOOD SUPPLY:** ovarian arteries & ovarian veins.

**NERVE SUPPLY:** Sympathetic and Para sympathetic nerves.
A summary of the stages of development of the ovum and the associated hormones

**MENSTRUAL CYCLE:**

Menstruation is a normal physiological processes. In a healthy woman it starts with "menarche" this involves a series of events occurring regularly every 26 to 30 days throughout the child-bearing period of about 36 years.

The cycle consists of a series of changes that take place in ovaries and uterine walls, stimulated by changes in the blood concentrations of hormones. The menstrual cycle divided into three phases.

Menstrual phase  4-5 days  
Proliferative phase  10 days  
Secretory phase  14 days
The beginning of the menstruation usually lasts for 4 to 5 days with discharge of 25 to 65ml of blood, tissue, fluid, mucus and epithelial cell through vagina.

It is caused by a sudden reduction in the levels of estrogen and progesterone hormones. (FSH levels are higher during the menustal phase because of another ovaries follicle is stimulated and the cycle start again.) when the amount of progesterone in the blood falls to a critical level another ovarian follicle is stimulated by the FSH and the proliferate phase begins.

ii). Proliferative Phase: - At this stage cells present in the follicle, fallopian tubes, uterus and vagina increases in number by repeated mitotic divisions. during these phase, the follicle matures and releases ovum from the follicle (ovulation) this phase occur first 14 days of the cycle. And ovum is released usually on the 14th day of cycle. Repair of the endomatrium takes place under the influence of oestrogens secreated by ovarian follicles.

SECRETARY PHASE: This stage lasts from 13th to 28th day it represents to time between ovulation and the onset of next mensus. After ovulation raptured follicle, is converted to corpus leuteum and endomatrium becomes oedematous and the secretary glands produce increase amounts of watery mucus. Uterus waits for the embryo to reach uterus and get attached to the walls of the uterus. If the fertilization does not occur a new ovarian cycle is initiated by the decrease secretion of leutenising hormone.
If the ovum is fertilized there is no breakdown of the endometrium and no menstrual flow. The fertilized ovum (zygote) embedded in the wall and produces the human chorionic gonadotrophin (HCG) hormone keeps the corpus luteum intact enabling it to continue to secrete progesterone for the first 3 to 4 months, inhibiting the maturation of ovarian follicles. During this time the placenta develops and produces oestrogens, progesterone and gonadotropins. The placenta provides a link between the circulation of the mother and the foetus.
HARMONES -

Hormones are most important in the working of the reproductive organs at puberty, hormones from the anterior pituitary glands stimulate the sex glands ovary in the female, testes in the male, to produce their sex hormones.

The anterior pituitary hormones FSH & LH and adrenal cortex. Hormones also have effect on the development of sexual characteristic both in the male and in the female.

Male reproductive organs are stimulated by the gonadotrophic hormones from the anterior lobe of the pituitary gland.

The follicle stimulating hormone stimulates the seminiferous tubules of the testes to produce male germ cells the spermatozoa.

The male hormone testosterone promotes the development male characteristics
Female reproductive hormones and target glands

HYPOTHALAMUS

Leutuinising Hormone Releasing hormone

Anterior pituitary

Follicle Stimulating Hormone

Leutuinising Hormone

Ovarian follicle
corpus Luteum

Oestrogen progesterone.

MENOPAUSE: It occurs between 45 – 55 years. Menstration ceases making the end of the child bearing period. It is caused by the changes in the concentration of the sex hormones.

The ovaries gradually become less responsive to the FSH &LH and ovulation. Menastral cycle become irregular and ceasing. Several other phenomena occur at the same time including.
➤ Short term un predictable vasodilatation with flushing, sweating and palpitations causing discomfort and disturbance, of the normal sleeping pattern.
➤ Shrinkage of breasts.
➤ Axillary and pubic hair sparse.
➤ Episodes of uncharacteristic behavior sometimes occur eg. Irritability, mood changes.
➤ Loss of bone mass that predisposes to osteoporosis
➤ Slow increases in blood cholesterol level that predisposes post menopausal women to cardiovascular disorders.
➤ Gradual thinning of the skin.

**BREASTS**

Breast are accessory organ of the female reproductive system. They are present in an undeveloped form in the female until puberty. There after they develop and active by influence of estrogen and progesterone hormones they also present in male in a rudimentary form.

**STRUCTURE:** The mammary glands consist of granular tissue fibrous tissue and fatty tissue. Each breast consist of about 20 lobules. The lobules consist of a cluster of alveoli, which open into small ducts and these unite to form large excretory ducts, called lactiferous ducts. The lactiferous ducts converge towards the center of the breast. Fibrous tissue provide support and fat covers the surface of the gland.

The nipple is a small conical eminence at the center of the breast surrounded by pigmented areola, sebaceous glands lubricate the nipple in pregnancy.
FUNCTION:

- The mammary glands are active only during pregnancy and after the birth of baby.
- After the baby is born the prolactin hormone stimulates the production of milk.
- The oxytoicin hormone stimulates the release of milk when the baby starts sucking the nipple.
MALE REPRODUCTIVE SYSTEM

The male reproductive system consists of the following organs

2 testes
2 epididymis
2 deferent ducts (vas deferens)
2 spermatic cords
2 seminal vesicles
2 ejaculatory ducts
1 prostate glands
1 penis

Scrotum: It is a pouch of deeply pigmented skin, fibrous, connective tissue and smooth muscle. It is divided into two compartments each of which contains one testis, one epididymis and testicular end of a spermatic cord. The testis lies in scrotum.

Testes: These are the reproductive glands measuring 5 cm in length and 2.5 cm in diameter. They weigh 10 to 15 grms. They lie in the scrotum obliquely
suspended by the spermatic cords. Testes produce sperms by a process called spermatogenesis and secrete the important male hormone called testosterone.

**Epididymis:** It is a small comma shaped organ lying in the posterior border of tests. The sperms are transported from the tests into vas deferens by coiled efferent ducts in the epididymis.

**Spermatic cords:** There are two spermatic cords, one leading from each testis. It suspends the testis in the scrotum. It passes through the inguinal canal.

**Vas deferens:** It is a duct measuring 45 cm long passing from lower aspect of the epididymis. It ascends along the posterior border of the testes, penetrates the inguinal canal and enters the pelvic cavity.

**Ejaculatory duct:** It is 2 cm long and is formed by the union of the duct from seminal vesicle and vas deferens. It lies posterior to the urinary bladder and ejects spermatozoa into prostatic urethra.

**Seminal Vesicles:** They are convoluted pouch like structures 5 cm in length lying at the base of the bladder in front of the rectum. They secrete an alkaline, viscous fluid rich in sugar fructose which passes into ejaculatory duct. This secretion constitutes about 60% of the volume of semen and contributes to sperm viability.

**Prostate gland:** It is a single large walnut shaped gland located inferior to the bladder and surrounds superior portion of urethra. The prostate secretes an alkaline fluid into prostatic urethra which contributes to sperm motility. Enlargement of prostate obstructs the urethra and causes retention of urine.

**Penis:** The penis is composed of spongy tissue and it is expanded to form the glands penis the part where
urethra opens. The skin covering the penis is prepuce or foreskin. The penis is supplied by autonomic and somatic nerves. Parasympathetic stimulation leads to engorgement with blood and erection of the penis. Circumcision is the removal entirely or part of the prepuce or foreskin.

In the male genital track and the urinary tract are closely associated. The male urethra discharges both urine and semen.

**URETHRA**: It is a terminal duct leading from the floor of the urinary bladder to the exterior. In the male, urethra is about 20 cms long it leaves the bladder and passes through the prostatic gland, and is known as prostatic urethra. which leads to membranous urethra, which in turn leads to penile, urethra takes a curved course, passes through the perineum to penis. It’s function is to discharge urine and semen from the body.
EMBRIOLOGY DEVELOPMENT

FERTILIZATION:- It is the result of the fusion of male reproductive cells the spermatozoa with the ovum or egg cell which normally take place in the uterine tube following sexual intercourse. The fertilized ovum continous its journey down the tube towards the uterus and this takes about a week. The implantation normally taken place on the upper part of the body of the uterus near the opening of the uterine tube.

After implantation the conceptus become embedded cell in the uterine endomatrium deriving nutrients from the maternal blood the fertilized ovum rapidly grows, and the multiplying cells are organized into a pattern. (The embryo which will develop into the foetus) The embryo enclosed with in two membrane the inner amnion and an outer chorion, which constitute a bag of membranes or the amniotic sac. This is filled with a fluid, liquor amnii which surrounds the embryo and protect it yolksac for nourishing the embryo, this is joined to the embryo by a stalk which develops in to the umbilical cord.
Chorian the outer membrane, which attach to the inner living of the uterus from the chorion placenta develops about the 8th weeks of pregnancy.

**Functions of Placenta**

- To provide the foetus with nourishment derived from the maternal blood.
- To act as the “fetal lung” by providing for the oxygenation of the fetal blood and the removal from the fetus of waster products.
- Acts as a barrier in preventing certain microorganisms of disease reaching the foetus.
- The placenta helps the ovaries in the production of hormones necessary for the continuation of pregnancy.

The embryo is the name given to the growing organism from 3 to 8 weeks of pregnancy. At 4 weeks embryo is about 1 cm long a has a head, with beginning of eyes and limbs. At 8 weeks it is 3cm s long and has hands and feet and is seen to be human foetus.

- From 8 weeks the embryo called foetus the foetus grows and develops rapidly. At 12 weeks formation of all the organs complete by sixteen weeks and sex can be made out. 17th week fetal movements may be noticeable by the mother. At 20 weeks foetal parts can be distinguished by abdominal palpations. The heart beat can be heard through the mother abdominal wall (foetal heart sounds.)

- The foetus is growing size and changes gradually into a fully developed baby at the end of 40 week. The average wt. Is 2.5kgs and length is 30 cms.
MATURATION OF REPRODUCTIVE ORGANS

As the child’s body grows the reproductive organs also grow in size and develop, but the reach maturity only at puberty.

PUBERTY:- The endocrine glands start producing special hormone, which stimulates the reproductive organs to start functioning. The hormones also produce changes in the body (Puberty is a difficulty period of life and boys and girls begin to have sexual urges. They need understanding and guidance. The age of puberty various from 10 and 14 years and a number of physical and psychological changes take place at this time.

PUBERTY IN THE FEMALE:- Internal reproductive organs reach maturity. The ovaries are stimulated by the gonado trophine from the anterior pituitary, the follicular stimulating Hormone and the leutinizing hormone.

- The uterus, the uterine tubes and the ovaries reach maturity.
- The menestral cycle and ovulation begins.
- The breasts develop and enlarge
- Pubic and auxiliary hair began to grow
- There is an increase in the rate of growth in height and widening of the pelvis.
- There is an increase in the amount of fat deposited in the subcutaneous tissue.
PUBERTY IN THE MALE:

The age of puberty various from 14-18 years. The production of testosterone hormone influence the development of the body. Sexual maturity the changes occur at puberty are

- Body becomes more muscular and marked increase in height and weight.
- Voice deep enlargement of the larynx deepening of the voice.
- Hair appear on the face, chest axillae abdomen and pubis
- Male sex glands start producing semen.
- Enlargement of penis, scrotum a prostate glands
- The skin thickness and becomes more oily

Human reproduction is not nearly a natural function, but the result of the planned decision on the part of the couple.
UNIT-VI

QUESTIONS

1. List the organs of female reproductive system.
2. Draw the internal organs of female reproductive system and label it.
3. Describe the structure and functions of uterus.
4. Describe the structure and functions of an ovary.
5. Write the stages of menstrual cycle and explain them briefly.

6. Define the following terms.
   (e) Menarche, (f). Menopause.

7. Write short Notes on.

8. List the organs of male reproductive system.
ANATOMY AND PHYSIOLOGY

GLOSSARY

1. Agranulocyte -- Awhile blood vessel cell without granules in it cytoplasm. The term includes monocytes and lymphocytes.


3. Anæmia -- deficiency in either quality are quantity of red corpuscles in the blood, giving rise to symptoms anæxiaemia.

4. Aemia -- of the blood.

5. Agiotensin -- A substance that raises the blood pressure.

6. Anti -- against.

7. Anti diuretic -- a substance that reduces the volume of urine excreted.

8. Anticoagulant -- a substance that prevents blood from clotting.

9. Antigen -- any substance (bacterial) which in suitable conditions can stimulate the production of immune response.

10. Anti bacterial -- A substance that destroys or suppresses the growth of bacteria.

11. Antimicrobial -- A substance that destroys or suppresses the growth of microbes.
<table>
<thead>
<tr>
<th>Number</th>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Afferent</td>
<td>conveying towards the centre</td>
</tr>
<tr>
<td>13</td>
<td>Anuria</td>
<td>cessation of the secretion of urine.</td>
</tr>
<tr>
<td>14</td>
<td>Anatomy</td>
<td>the science of structure of the body.</td>
</tr>
<tr>
<td>15</td>
<td>Articulation</td>
<td>the junction of two or more bones.</td>
</tr>
<tr>
<td>16</td>
<td>Blast</td>
<td>an immature cell, a wave of high a pressure caused by the explosion</td>
</tr>
<tr>
<td>17</td>
<td>Bartholins glands</td>
<td>small glands in the labia major</td>
</tr>
<tr>
<td>18</td>
<td>Bowman’s capsule</td>
<td>expanded proximal end of a renal tubule surrounding the glomerulus’s of the kidney</td>
</tr>
<tr>
<td>19</td>
<td>Bronchi</td>
<td>pleural or bronchus.</td>
</tr>
<tr>
<td>20</td>
<td>Chole</td>
<td>Bile</td>
</tr>
<tr>
<td>21</td>
<td>Cholecystitis</td>
<td>inflammation of the gall bladder</td>
</tr>
<tr>
<td>22</td>
<td>corti</td>
<td>organ of part of internal ear</td>
</tr>
<tr>
<td>23</td>
<td>Choloangitis</td>
<td>inflammation of bile duct.</td>
</tr>
<tr>
<td>24</td>
<td>Cyto toxic</td>
<td>having a deleterious effect upon cells an agent or drug that damages or destroys cells used to treat various forms of cancer.</td>
</tr>
<tr>
<td>25</td>
<td>Condyle</td>
<td>a rounded eminence occurring at the end of some bones and articulating with another bone.</td>
</tr>
<tr>
<td>26</td>
<td>Derm</td>
<td>skin</td>
</tr>
</tbody>
</table>
27. Dysuria -- difficult and painful micturition

28. Dyspnea -- difficult or labored breathing

29. Dysmenorrhoea -- painful menstruation occurring without apparent cause.

30. Dysplasia -- Abnormal development of tissues.

31. Emphysema -- the abnormal presence of air in the tissues or cavities of the body.

32. Eustachian tube -- pharyngo tympanic tube of the internal ear.

33. Endo -- inside, inner

34. Erythro -- red

35. Erythropoietin -- a hormone produced by the kidney which stimulates the production of red blood cells in the bone marrow.

36. Erythropoiesis -- a manufacture of red blood corpuscles.

36. Exo -- outside

37. Extra -- outside, additional or beyond

38. Efferent -- conveying from the centre to the periphery

38. Foramen -- an opening or hole, especially in a bone.

39. Fallopian tubes -- the urine tubes

40. Gastric -- relating to the stomach
41. Graphian follicles -- ovarian follicles
42. Globin -- protein
43. Groove -- a long narrow furrow or channel within the surface of something.
44. Haemangima -- a benign tumour formed by dilated blood vessels. A birth mark which may become very large but frequently disappears.
45. Haem -- of the blood
46. Haemorrhage -- an escape of blood from a ruptured blood vessel externally or internally.
47. Havesian canals -- canals containing blood within compact bone
48. Hydro -- Water
49. Henley loop -- the looped part uniferous tubule
50. Hepatic -- relating to the liver
51. Hyper -- excess, above
52. Hypertension -- persistently high B.P
53. Hyper pyrexia -- an excessively high body temperature
54. Hypotension -- abnormally low arterials blood pressure
55. Hypovolaemia -- A reduction in the circulating blood volume due to external loss of body fluids or to les from the blood into the tissues as in shock.
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>57. Hepato toxic</td>
<td>--</td>
<td>applied to drugs and substance that cause destruction of liver cells</td>
</tr>
<tr>
<td>58. Hae maturia</td>
<td>--</td>
<td>the presence of blood in the urine due to injury are disease of any of the urinary organs.</td>
</tr>
<tr>
<td>59. Intra</td>
<td>--</td>
<td>within</td>
</tr>
<tr>
<td>60. Intra cellular</td>
<td>--</td>
<td>within a cell</td>
</tr>
<tr>
<td>61. Intra cranial</td>
<td>--</td>
<td>within the skull.</td>
</tr>
<tr>
<td>62. Intra occlur</td>
<td>--</td>
<td>within eye ball</td>
</tr>
<tr>
<td>63. Itis</td>
<td>--</td>
<td>inflammation</td>
</tr>
<tr>
<td>64. Ism</td>
<td>--</td>
<td>a moment</td>
</tr>
<tr>
<td>65. Kupffer cell</td>
<td>--</td>
<td>stellate cells lining the sinusoids of the liver</td>
</tr>
<tr>
<td>66. Langerhans islets</td>
<td>--</td>
<td>clumps of cells lying in the inter alveolar tissue of the pancreas.</td>
</tr>
<tr>
<td>67. Lymph adenoma</td>
<td>--</td>
<td>used to donate any malignant condition of the lymphoid tissue.</td>
</tr>
<tr>
<td>68. Lysollysin</td>
<td>--</td>
<td>a specific antibody present in the blood that can destroy cells.</td>
</tr>
<tr>
<td>69. Malpighian corpuscles</td>
<td>--</td>
<td>splenic corpuscles</td>
</tr>
<tr>
<td>70. Meibomian glands</td>
<td>--</td>
<td>sebaceous follicles of the eye lids.</td>
</tr>
<tr>
<td>71. Mega</td>
<td>--</td>
<td>large</td>
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<td>---</td>
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</tr>
<tr>
<td>72. Micro</td>
<td>--</td>
<td>small</td>
</tr>
<tr>
<td>73. Myo</td>
<td>--</td>
<td>Muscle</td>
</tr>
<tr>
<td>74. Neo</td>
<td>--</td>
<td>New</td>
</tr>
<tr>
<td>75. Nephro</td>
<td>--</td>
<td>Kidney</td>
</tr>
<tr>
<td>76. Neuropathy</td>
<td>--</td>
<td>A disease process of nerve degeneration and loss of function</td>
</tr>
<tr>
<td>77. Nocturia</td>
<td>--</td>
<td>the production of large quantities of urine at night.</td>
</tr>
<tr>
<td>78. Osteoblast</td>
<td>--</td>
<td>a cell which develops into an osteocyte and turns into bone.</td>
</tr>
<tr>
<td>79. Oedeoma</td>
<td>--</td>
<td>an excessive amount of fluid in the body tissues.</td>
</tr>
<tr>
<td>80. Oma</td>
<td>--</td>
<td>tumour</td>
</tr>
<tr>
<td>81. Opth</td>
<td>--</td>
<td>eye</td>
</tr>
<tr>
<td>82. Osteo</td>
<td>--</td>
<td>Bone</td>
</tr>
<tr>
<td>83. Osteocyte</td>
<td>--</td>
<td>a bone cell</td>
</tr>
<tr>
<td>84. Osteoarthritis</td>
<td>--</td>
<td>inflammation of one or more joints.</td>
</tr>
<tr>
<td>85. Pathy</td>
<td>--</td>
<td>disease</td>
</tr>
<tr>
<td>86. Pneumo</td>
<td>--</td>
<td>lunglair</td>
</tr>
<tr>
<td>87. Pneumo thorax</td>
<td>--</td>
<td>accu mulation air or gas in the plural cavity resulting in collapse of the lung on the affected side.</td>
</tr>
<tr>
<td>88. Pneumonia</td>
<td>--</td>
<td>inflammation of the lung with consolidation and Exudation</td>
</tr>
<tr>
<td>89. Polycythaemia</td>
<td>--</td>
<td>an abnormal increase in the number of red cells in the Blood.</td>
</tr>
</tbody>
</table>
90. Polyuria -- An abnormality large output of urine due to an excessive intake of liquid or to disease, often diabetes.

91. Physiology -- the science of the functioning of living organisms.

92. Rhagia -- Excessive flow

93. Rhoca -- Discharge

94. Ridge -- A long narrow part higher than the rest of something.

95. Schlemm canal of -- canal at the junction of cornea and sclera

96. Spine -- the backbone or vertebral column consisting of 33 vertebrae. A sharp process of bone.

97. Sub -- under

98. Sub lingual -- beneath the tongue

99. Sylvius aqueduct of -- canal joining the third to the fourth ventricle within the brain.

100. Tachy -- excessively fast

101. Tachy cardia -- abnormally rapid action of the heart and consequent increase in pulse rate.

102. Thromb -- clot

103. Thrombin -- An enzyme that converts fibrinogen to fibrin during the later stages of blood clotting.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Thrombus</td>
<td>A stationary blood clot caused by coagulation of the blood in the heart or in an artery or a vein.</td>
</tr>
<tr>
<td>Tuberosity</td>
<td>An elevation or protuberance on a bone to which tendons are attached.</td>
</tr>
<tr>
<td>Uric acid</td>
<td>Lithic acid, the end product of nucleic acid metabolism, a normal constituent of urine.</td>
</tr>
<tr>
<td>Urine</td>
<td>The clear fluid of a carrying straw colour recreated by the Kidneys and excreted through the bladder and urethra.</td>
</tr>
<tr>
<td>Vasovasov</td>
<td>Vessel or duct.</td>
</tr>
<tr>
<td>Vaso constrictor</td>
<td>Any agent that causes contraction of a blood vessel wall and therefore a decrease in the blood flow and a rise in the B.P.</td>
</tr>
<tr>
<td>Vasodilator</td>
<td>Any agent that caused an increase in the lumen of blood vessels and therefore an increase in the blood flow and fall in the B.P.</td>
</tr>
<tr>
<td>Vater, ampulla of</td>
<td>Ampulla of the common bile duct.</td>
</tr>
<tr>
<td>Willis circle of</td>
<td>Arterial circle at the base of the brain.</td>
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Anatomy and Physiology
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2. Basic Anatomy and Physiology by Morgaret, B.


5. Man’s Anatomy, Physiology, Health and Environment by Raper, Nancy.


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PREFACE

It is a privilege to write the Text Book of Anatomy and Physiology, for Intermediate Vocational Nursing Course from Board of Intermediate Education, Government of Andhra Pradesh.

The purpose of this book is to provide the student nurses and other health workers with the knowledge of the structure and functions of human body.

The principle of Anatomy and Physiology is designed for introductory course in Anatomy and Physiology and assumes no prior knowledge of the human body to the students. It is geared to students preparing for careers in the health related profession.

In this book, all facts about these subjects that a student nurse needs to know, are presented in clear and easy to understand, the text is accompanied by numerous illustrations to facilitate to get comprehensive knowledge of the body and the changes that take place when disease disrupt normal processes.

This book has been written in accordance with the revised Vocational Nursing Curriculum 2005-2006, Board of Intermediate, and Government of Andhra Pradesh and in the light of Health development in the Country based on Primary Health Care.

This is an attempt to provide the student with maximum knowledge in a compact form. This book helps the student in preparing for the exams as it consists of the topic prescribed in the syllabus.

It is hoped that this book will be more useful for the Multipurpose Health Workers and other workers in Medical Education.

June, 2005

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Preface

The principles of hygiene, whether, personal, Hospital, Community are based on the knowledge of Microbiology.

The knowledge of Microbiology for the nurses is very essential so that they could take precautions to avoid diseases caused by them and also to prevent its spread to others in the hospitals.

The book deals with the basic concepts of Microbiology, which is useful for the Nursing students.

This book gives a general introduction to the subject of Microbiology which is a new subject altogether.

The language and presentation is very simple in order to facilitate easy understanding and written according to the latest Revised syllabus approved by the Board of intermediate Education.

This is an attempt to provide the student with maximum knowledge in a compact form. This book helps the student in preparing for the exams as it consists of the topic prescribed in the syllabus. To lessen the burden on the students and to emphasize on only the most practicable fundamentals of Microbiology.

I thank the Board of Intermediate Vocational Education, Government of Andhra Pradesh, for giving me this opportunity.

June, 2005

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MICRO BIOLOGY

Microbiology is the study of micro organisms. Micro means small bios means life and logia means treatise. It is the study of small living micro organism that can be seen only with the help of micro scope.

Micro biology is one of the sciences which forms the foundation of professional Nursing medical microbiology is concerned with the infectious agents which cause disease in man.

They were first discovered about 200 years ago by Leuwen hock of Holland, who invented the microscope later the discoveries of Louis Pasteur, koch and Lister they added a great deal to the knowledge about micro organisms.

They are widely distributed in nature. They can be pathogenic or non pathogenic. Pathogenic are harm full and produce diseases they are called as germs. Non pathogenic are useful which in making curds, cheese, bread and alcohol. They do not produce diseases study of Microbiology is essential for a student Nurse.

The principles of personal, hospital and community hygiene are based on an understanding of microbiology. It explains the body mechanisms that
help in resisting and fighting diseases. An understanding of the properties of the different infectious agents, gives us an idea of how diseases are spread. So, it is essential for a student nurses to apply the principles of asepsis and those involved in the control of infections.

The nurse should use microbiology to the utmost in daily life in order to get the maximum benefits and also to protect the humans from dreadful diseases.

**Branches of microbiology are:**

- Bacteriology :- The Study of the bacteria.
- Virology:- The study of the viruses.
- Parasitology : The Study of the parasites.
- Mycology: The study of the fungus
- Protozoology: The study of the protozoan’s
- Phychology: The study of the algae.

**Study of Microbiology is essential for a student Nurse:**
1. How micro organisms enter the body and how they are discharged from the body and how the infection spreads from person to person.
2. How Micro organisms multiply and how they affect the human beings
3. They importance of proper collection of specimen for bacteriological examinations and to interpret the reports form laboratory.
4. How the sera and vaccines are used in treatment and prevention of diseases.
5. The importance of aseptic techniques, safe and appropriate use of disinfection and sterilization methods and safe disposal of used goods etc.
6. The knowledge of vaccine and immunity is important for the prevention of communicable diseases and promotion of health and recovery.
7. The knowledge of these will help the student to understands the precautions that are help her to protect herself and spread of infection to others.
HISTORICAL REVIEW OF MICROBIOLOGY

From the first century BC, it was believed that diseases are caused by invisible beings. The knowledge of medicine as brought out in Vedas included cleanliness of nails of the doctor, instruments, and ventilation.

The microorganisms are too small to be seen through naked eyes. Antony van Leeuwenhoek (1632-1723) is called "the father of Microscopy" because
he was the first person to see and describe microorganisms. He gave his experiments to the Royal society, London. He is not only called the “father of Bacteriology” and even “Father of Protozoology”.

LOUIS PASTEUR (1822-1895)
FATHER OF BACTERIOLOGY

Louis pastur (1822- 1895) “father of modern microbiology” was a great French scientist succeeded in defining “spontaneous generation theory” Pastuer demonstrated on the prevention of Anthrax and
Rabies. He also introduced the terms aerobic and anaerobic, pasteurization and sterilization.

Robert Koch (1843-1910) of the Germany developed Koch’s Postulates which means a specific microorganism is responsible for the cause of specific disease. He discovered the organism which causes tuberculosis. He is the first person to define infection.

**OTHER OUTSTANDING DISCOVERIES ARE:**

- Malarial parasites by Ronald Ross - 1902.
- Yellow fever by Walter Reeds - 1899.
- Blood groups by Karl Land Steiner – 1900.
- Discovery of Penicillin by Alexander Fleming -
1929.
> BCG vaccine against Tuberculosis by Calmette and Gurein.

**Classification of Microorganisms**

**Definition:** It may be defined as living creatures that are microscopic in size. They can be classified into Eight groups.


**ALGAE:** - The Algae are the green plants ant require sunlight for growth. They contain chlorophysts. They are autotrophic and pathogenic. They multiply by fission and sexually. They are larger than bacteria and cannot ingest solid particles like protozoa.

**Protozoa:** The group of microorganisms deistically belongs to the animals kingdom.

- They are the lowest form of animal life
- They are photosynthetic unicellular organisms with protoplasm clearly differentiated into nucleus & cytoplasm.

**Diseases caused by protozoa are:**

**MOULDS:** These are wolly growths of black green, yellow, brown and white colour. They take active part in decomposition of organic mater. Penicillin is produced from a mould known as penicillin notatum.

**YEAST:** Yeast commonly occur on grapes and other fruits and plants. They are found in dung soil, milk and frequently in throat cultures. They are gram positive. They are responsible for fermentation. It is useful to man in making breads cakes, wines etc.,

**Fungi:** These are microscopic plants without green Colouring matter they have rigid cell wall they are multiple sexual & asexual

**Mycoplasma:** They lack a cell wall
- They are round or oval bodies.
- Micro plasma pneumonia cause type of a typical pneumonia in man.
- They can be cultivated on artificial cell free nutrient media, enriched with serum.
**Rickettsiae:** These are simple unicellular organisms that are rod shaped or spherical.
- They are 3 micron in length and 0.5 micron in diameter.
- They are non motile and don’t form spores.
- Rocky mountain spotted fever and rickettsiae pox are the diseases caused by Rickettsiae.

**Viruses:**
They are the Smallest of all the Micro-organisms and different species range in Size from 1/100 to 1/3 micron in diameter.

There are 3 important ways in which viruses differ from other micro organisms.

They are two small unicellular to be visible under light microscope. They can be studied with an electron microscope.
- They multiply by complex processes.
- They possess either DNA or RNA but never both types of nucleic acid.
Neither viruses nor rickettsiae can grow on culture media except coxiella burnetti a rickettsial organism, but only within living susceptible cells.

**Bacteria**: Are grouped under “Protista” which means first formed animals or primitive animals. Bacteria are very minute structures seen through Micro Scope, but present everywhere. They are minute single celled organisms usually classified as members of the plant kingdom. They differ from higher plants in that they do not contain chlorophyll. Bacteria are unicellular, but the cells may grow attached to one another in clusters, chains, rods or filaments. They devied by binary fussion.
Shapes and arrangement of Bacteria

I. Streptococci
II. Staphylococci
III. Diplococci
   (lancolate shape
   Pneumococci
IV. Diplococci
   Kidney shaped)
   eg. Gonococci
Classification of Bacteria

Bacteria: Bacteria are classified according to their shape arrangement as under
- Bacilli (Rod shape)
- Cocci (from Kokkos, Meaning berry) are spherical or oval cells.
- Vibrios are comma shaped or curved rods.
- Spirilla are rigid spiral farms
- Spirochetes (from speria meaning coil, chaite meaning hair) are flexuous spiral forms
- Actino mycetes are branching filamentous bacteria.
- Mycoplasmas are deficient in cell wall and are round oval ring or shar shaped.

* Bacilli: Bacilli are straight rod shaped bacteria. Their size is 0.3 to 1.0 micron in width. Some of the bacilli are gram positive and some are gram negative.
BACILLI

V. Bacilli - straight rods
vi. Vibrio (Curved, comma shaped)
vii. Spirilla
viii. Spirochactes

Shapes and arrangement of Bacteria
1. **Gram Positive**: Corny bacterium, Listeria,
   
   (a) Spor forming anaerobic Bacilli. Gram positive (Spor forming) belongs to the genus of clostridium which can grow in the absence of air. Tetanus is caused by clostridium tetani. Gas gangrene is caused by Clostridium welchi. Food poisoning is caused by clostridium botulinum.
   
   (b) Spor forming aerobic Bacilli: Anthrax Bacillus is a straight rod shaped rectangular bacillus arranged in chains surrounded by a capsule. They are gram positive, it causes anthrax in man.
   
   Bacillus subtilis is non-pathogenic.

2. **Gram Negative**: Escherichia, Salmonella, Shigella: All these cause gastrointestinal infections.

   Acid Fast Bacilli: It is a species of mycobacterium. It has two main pathogenic varieties.
   
   1. Tubercle bacilli cause tuberculosis.
   2. Lepra bacilli cause leprosy.

   They take a special stain which is resistant to acid, due to the presence of lipids (Mycolic acid) in their cell wall.
**Cocci**: They are spherical in shape. They exist in several different patterns or groupings. They are single in pairs, in long chains in accordance with the manner in which the cells divide and subsequently adhere after division.

a). **Diplococci**: those which form pairs. There are pneumococci, Gonococci and Meningococci. Pneumococci cause Pneumonia, Gonococcicause Gonorrhea and Meningocci cause Meningitis.

b). **Streptococci**: They occur in chains. They cause nasal and throat infection: scarlet and rheumatic fever.

c). **Staphylococci**: they form irregular masses. They occur in irregular cluster like clusters of grapes. They are responsible for skin and wound infections, such as boils and carbuncles.

**Spiral form**: This group if formed by cylindrical convoluted bacteria. There are three types.

1. Vibrio
2. Spirilla

Vibrio is a short curved rod-like bacteria. It is actively motile and gram negative. Most of them are pathogenic. The pathogenic species is the cholera Vibrio and Eltor Vibrio which caused cholera and grows in alkaline media.
**SPIRILLA:** These are rigid, curved or spiral organisms, similar in size to bacilli.

**SPIROCHEATES:** These are long spiral filaments which are capable of flexing and wriggling their bodies. They are about 0.2 to 2 microns in diameter and in length 5 to 50 micron.

They live in soil in the decaying organic matter and in stagnant pools. They can be observed only with the dark field microscope and phase-contrast techniques.

**Pathogenic Spirocheates:**
1. Treponema Pallidum causes syphilis.
2. Leptospira causes Haemorrhagic Jaundice.
3. Borrelia causes relapsing fever.

![Structure of Bacteria](image)
CHARACTERISTICS OF BACTERIA:-

1. **Enzyme Production**: They are diffused through
   a) Digestive enzymes prepare food for cell wall.
   b) Some enzymes help to oxidize the absorbed food.
   c) Still other enzymes help in building new cell substances from the food so that the cell could grow and reproduce.

2. **MOTILITY**: Bacteria are able to swim and more around when suspended in suitable liquid. This movement is due to flagella which are fine hair.

3. **REPORDUCTION**: Most bacteria multiply by simple fission or by dividing into halves.

4. **SPORE FORMATION**: Some of the rod shaped organisms have the forming spores.
   A spore is formed with in the body of the bacterium by the collection of protoplasm in the compact mass usually round or oval in shape.
The important pathogenic spore forming bacteria are those that cause.
   a) Tetanus
   b) Gas Gangrene
   c) Anthrax.

5. **CAPSULE FORMATION**:
   Many bacteria have a gelatinous envelope called a capsule. They are very thin white in colour.

   Some of the bacteria have thick covering that help resistant to protective mechanisms of the body.
CLASSIFICATION OF VIRUSES
1. **Pneumotrophic:** - The lung tissue is affected and the disease caused Eg. Viral pneumonia, influenza.

2. **NEUROTROPIC:** - Nerve tissue are affected and the diseases caused eg:- Viral encephalitis, Polio, Rabies.

3. **VISCEROTROPIC:** - Internal organs are affected and the diseased caused Eg. Infective Hepatitis, yellow fever, Dengue fever.

4. **Dermotrophic:** - Skin and mucus membrane are affected and the diseases caused are eg:- Measles, Chicken pox, warts.

CHARACTERISTICS OF VIRUSES:-
1. They are unicellular, ultramicroscopic.
2. They contain only one type of nucleic acid, either RNA or DNA.
3. They multiply by complex processes.
4. They do not grow in inanimate media.
5. They are not affected by antimicrobials and antibiotics.
6. They lack enzymes necessary for proteins and nucleic acid synthesis, so depend upon synthetic machinery like host cells.
They cause fatal diseases like AIDS, Rabies infective hepatitis etc.

**FACTORS AFFECTING THE GROWTH OF BACTERIA.**

1. Moisture
2. Food Metabolism
3. Temperature
4. Acidity and Alkalinity
5. Oxygen
6. Osmotic pressure
7. Light & Radiation.

**MOISTURE:**

- Bacteria are sensitive to their environment.
- Water is necessary for growth because they cannot absorb food unless it is in solution.

**FOOD AND METABOLISM:**

Bacteria obtain their nourishment from organic and inorganic matter some live on minimal nourishment salts and water. While others need more nourishment such as carbon oxygen, hydrogen and other mineral salts.

- Some of them oxidize glucose just as higher animals do and some are capable of building up protoplasm through complex and intricate processes.
**TEMPERATURE:** Each species of Bacteria require a certain temperature range for growth.

Low temperatures check the growth of most bacteria, the temperature at which growth occurs best is known as optimum temperature i.e. $37^{\text{degree}}$ Centigrade and very high temperatures destroys the Microorganisms and very low temperature inhibits the growth of most bacteria.

- Refrigeration for preservation of foods and sterilization by heat are based on these principles.

**ACIDITY ALKALINITY:**

An acid medium prevents the growth of many bacteria

- Pathogenic bacteria grow best in a neutral or slightly alkaline medium.

**OXYGEN:**

Organisms that grow in the presence of free oxygen are called aerobes

Those that cannot grow in the presence of free oxygen are known as anaerobes.

**OSMOTIC PRESSURE:**

Many bacteria are sensitive to a concentrated solution of salt or sugar because of their high osmotic pressure.
LIGHT AND RADIATION:- Many bacteria are destroyed by direct by sun light with in a few minutes or hours.

Ultra violet rays and radiations are also destructive to bacteria.
Bacteria grow well in the dark.

Special lamps producing ultraviolet rays are sometimes used in treatment of skin infections.

UNIVERSAL PRESENCE OF MICRO ORGANISMS:-
They are widely distributed in nature (they present in air, especially dust and in the soil)
They are found on the skin, in the air, in the water and food we take.
A number of them are found in the upper layers of soil.
Nearly two thousand species of micro organisms are known today.

Useful bacteria: Saprophytes are the organisms which are able to live in the outside world on dead material.
The main activities of saprophytic organisms are putrefaction and fermentation.

Putrefaction means the breaking down of protein and is very useful in the decomposition of dead animal and vegetable matter by this process the complex
Substances contained in refuse are converted into simple elements which can be utilized by plants as foods.

Fermentation refers to changes which are brought about by microorganisms in carbohydrates.

For example, the production of alcohol from the sugar of fruit juices. Therefore certain kinds of microorganisms are utilized in industries to manufacture alcohol, lactic acid, butter, cheese, and other substances.

**Microorganisms in the human body normal flora, sterile areas and cavities.**

1. **Normal flora:** The skin and mucus membranes always harbour a variety of micro-organisms because they are in contact with the environment.
2. **Commensal organisms:** Those which normally live in specific sites of the body without invading tissue or causing infection. Some intestinal commensally are known to synthesize vitamin K others to aid in the absorption of nutrients.
3. Staphylococcus albus lives in the pores of all healthy, undamaged skin without causing infection.
The normally present bacteria generally do not harm us and are called normal flora. Eg. Bacillus coli in bowel. The micro-organism may be transferred from their normal sites in the skin, nose, mouth, throat, respiratory tract, vagina, conjunctiva and intestine to another vulnerable site where they may cause infection.

**Sites which are normally sterile:**

* Bone marrow
* Blood
* Cerebrospinal fluid
* Serous fluids
* Tissues
* Urine.
* Lower Respiratory Tract
* Middle and inner ear.

1. **Identification of Micro organisms:** We can identify the different organism through pictures and the use of micro scope to examine specimens however the bacteria have no colour and need to be stained to identify them.
Special laboratory techniques are used, such as growing bacteria on culture media most bacteria have some medium (food) on

2. Which they grow best by symptoms of disease.

**WATER BORN DISEASES:**

Most of the disease in developing countries can be attributed to the lack of safe drinking water.

Water is the basic need of the human being it should be safe and wholesome. Such water is called potable water.

Safe water is one that should not harm those who consume them.

Water is said to be contaminated when it contains infective and parasitic agents, poisonous, chemicals substances, industrial or other wastes or sewage.

Faecal pollution of drinking water may introduce a variety of intestinal micro organisms. These organisms cause diseases that vary in severity from mild gastroenteritis to severe and some time fatal diseases.
**Water born disease Classified into**


2. Viral:  
   - Hepatitis –A
   - Hepatitis –E
   - Poliomyelitis
   - Rotavirus diarrhoea

3. Protozoal : Amoebiasis
   - Giardiasis
   - Balantidiasis

4. Helminthic:(Worms) – Schistosomiasis
   - Round worm
   - Thread worm
   - Whip worm
   - Hydatid diseases

5. Others: Guinea, Worm,
   - Leptospirosis
Milk borne disease:
Infections that can be transmitted to man from animals:
Tuberculosis.
Brucellosis
Streptococcal infections - tick born encephalitis
Staphylococcal diarrhea
Salmonellosis typhoid paratyphoidfever
Q- Fever
Cowpox
Anthrox
Leptospirosis
Diarrhea due to
- campylobacter
- Yesinia Enterocolitica

Micro organism in the soil.
Pathogens can survive in the soil for very long periods.

1. Spores of tetanus bacilli remain viable in the soil for several decades and serve as source of infection.
2. Fungi: Histoplasma capsulatum, Nocardia asteriodes.
3. Parasites such as round worm and hookworm.
Infections that can be transmitted from man to man:
- Enteric fever
- Cholera
- Shigellosis
- Enteropathogenic Escherichia coli diarrhea
- Staphylococcal food poisoning
- Streptococcal infections
- Diphtheria
- Tuberculosis
- Hepatitis

Respiratory tract infection

**Air borne disease:**
- Tuberculosis
- Influenza
- Chicken pox
- Measles
- Q-Fever
- Respiratory infections – Common cold
- Important diseases transmitted by dust particles included
  - Streptococcal
  - Staphylococcal infection
  - Tuberculosis
  - Q-Fever
  - Psittacosis
  - Coccidiodomycosis
QUESTIONs

1. Define Microbiology.
2. Give brief historical review of microbiology.
3. What is the purpose and uses of study microbiology by a student Nurse?
5. Write the classification of micro organisms and describe them briefly.
6. Write the classification of bacteria with examples.
7. Write characteristics of bacteria.
8. Write the characteristics of viruses.
9. Write the classification of viruses and describe briefly about viruses.
10 List factors promoting the growth bacteria and Describe them briefly.
11. How bacteria useful to mankind.
12. Define normal flora.
13. List the sterile areas and cavities in the human body.
14 Name the micro organs found in soil.
STERILIZATION

Sterilization is the process of killing or removing all living microorganisms (pathogenic and non-pathogenic) including spores.

The methods used in sterilization are three main types (1) Mechanical (2) Physical (3) Chemical.

MECHANICAL: - For removing microbes there are three chief mechanical methods
(a) Scrubbing
(b) Filtration
(c) Sedimentation

SCRUBBING: - This is done to clean hands and body with water and some chemical agents such as soap. The process of scrubbing removes many microorganisms chemically.

FILTRATION: - Bacterial filtration is the process of passing a liquid containing bacteria through a material which has very small pores so that the bacteria are held back. Filtration is an important step in the purification process of a city water supply.

SADIMENTATION: - It is the process by which suspended particles settle down at the bottom of water by natural or artificially way.
II. PHYSICAL

Physical methods are:-

a). Heat (Moist, dry)
b). Sunlight
c). Ultraviolet radiation
d). X-ray other ionizing radiation.
e). Ultrasonic
f). Action of fluorescent dyes

**BOILING**:- Vegetative bacteria are killed at 100 Deg. Centigrade. Boiling in water for at least 20 minutes kill all germs, boiling for 30 minutes may kill all spores. Boiling is suitable for disinfection of metal instruments, Syringe glass, needle etc.

Boiling is the easiest and less costly method although it is not used safely for contaminated dishes bed pans, urinals etc.

**STEAM UNDER PRESSURE**

Steam under pressure compressed steam the most effective methods of sterilization steam under pressure attains a higher temperature, and has greater powers of penetration than ordinary steam it destroys bacteria and their spores.

**AUTOCLAVE**:- The articles usually exposed to a pressure of 15 to 20 lbs, for 20 to 30 minutes . it is effective method for sterilizing linen, dressing, gloves syringe, Surgical instruments.
Free flowing steam:- It is occasionally used in laboratories for preparation of culture media and also for processing canned food.

PASTEURIZATION:- The process of making milk safe by destroying all the pathogenic bacteria. Pasteurization does not change the taste, composition, flavour and nutritive values of milk. Pasteurization kills 90% bacteria in milk, but it will not destroy bacterial spores.

It is a special method of heating milk at an increased temperature for short time.

METHOD OF PASTEURIZATION:-

(1) **Holder Method**:- In this method, milk is heated at temperature of 63 Deg. Centigrade to 66 Deg. Centigrade for 30 minutes followed by rapidly cooling to 5 deg. Centigrade.

(2) **High Temperature and short time method** (HTST) :- In this method milk is rapidly heated to temperature of 72 deg. Centigrade for 15 seconds and is rapidly cooled to 4 Deg.Centigrade.
(3) **Ultra high temperature method**: In this method, milk is rapidly heated in two stages for 125 deg. Centigrade, few seconds (second stage under process) followed by rapid cooling and bottling as quickly as possible.

**DRY HEAT**

The methods of using dry heat are (a) incineration, (b) flaming (c) hot air oven.

a) **INCINERATION**: It is an excellent method for a rapidly destroying material such as dressing, soiled linen, sputum swab and garbage.

b) **FLAMING**: In the laboratories platinum wire loops, scalpels, glass slides, cover slips etc can be passed a few times through bunsun flame. The bacteria gets destroyed.

c) **HOT AIR OVEN**: This is widely used method the oven is heated by electricity up to 160 Deg. Centigrade. Temperature for one hour. It is used to sterilize glass ware, test tubes, glass syringes, forceps bottles gauze dressing chemical products like dusting powder, liquid paraffin fat grease etc.,

**SUN LIGHT**: Direct and few hours exposure to sunlight is destructive to many disease producing agents, the ultra violet rays of sunlight are particularly lethal.
to bacteria and some viruses. Cloth blankets pillows should be exposed to sunlight for 4-8 hrs.

**ULTRAVIOLET RADIATION**:- ultraviolet lamps used to prevent air borne spread of disease producing agents in public places. Hospital, operating rooms and in microbiological Laboratories. They also used to suppress surface growing moulds and other organisms in meet packing and bakeries.

**X-ray and Ionizing radiation**:- It is used in industries Beta rays or electrons are used to sterilize pre packed material such as sutures and plastic tubing.

**ULTRASONIC**:- Sound waves are mechanical vibration these waves coagulate protein solution and to destroy bacteria this is used in dish water.

**ACTION OF FLURESCENT DYIES**:- some dyes will have the property of florescence, such as auranine, Rhodamine are lethal to bacteria and viruses when placed in contract with these microbes in strong visible light.

**STERILIZATION BY CHEMICALS**:-
Articles which cannot be sterilized by boiling or autoclaving may be sterilized by this method.
**DISINFECTANTS:** are chemical substances which kill bacteria.

**ANTISEPTICS:** Prevents the growth of bacteria.

**GERMICIDE:** A chemical capable of killing microorganisms. Most chemicals substances are disinfectants and also antiseptic, depending on the strength used.

**CARBOLIC ACID OR PHONOL:** It is a corrosive poison its action is bacteria static or bactericidal depending upon the concentration used.

**CARBOLIZATION OF THEATRE** is done with 5% lotion phenol is an excellent disinfectant for faeces blood, pus and sputum.

**CRESOL:** It has a higher germicidal then phenol 1% cresol lotion is used so far floor cleaning.

**LYSOL:** It is a solution of cresol with soap. Articles contaminated by tubercular patients should be soaked in Lysol lotion 1 to 2% for 24 hrs. It also used for disinfections of instruments, furniture, floor, walls rubber goods.

**SAVALON:** It is used as antiseptic 1 in 100 to 1 in 200 strength. It is used for cleaning of wounds and
dressing salvacon 30% in spirit is used for sterilization of sharp instruments. Immersing them for 3 minutes will kill the microbes. For the storage of sharp instruments salvacon with sodium nitrate 5% is used instruments do not rust in it.

**DETTOL:** - It is less toxic and can be tolerated by most skins. It is used as an antiseptic as well as deodorant on wounds and injuries.

**POTASSIUM PERMANGANATE:** - It is a powerful oxidizing agent. It is used in the treatment of the genito urinary tract.

**HYDROGEN PEROXIDE:** - 3% solution is harmless but very week disinfectant. It is useful for cleaning up septic wounds and cavities by loosening adhesive sloughs and also used for mouth wash or gargle.

**HALOGEN:** - Halogen compounds used as antiseptic and chlorine and iodine.

**CHLORINE:** - It has been widely used in water, swage and disinfections of dishes and other utensils.

**CHLORINE GAS:** - It is widely used to disinfect drinking water and in the purification of swimming pools.
**BLEACHING POWDER:** (chloride of Lime) Is a white amorphous powder with a pungent smell of chloride. It is used for disinfections of water supply 5% solution used for disinfecting stools, urine and discharges.

**IODINE:** This is the most effective bactericide of the halogen group 2% solution of iodine in 70% alcohol is most commonly used. It is used for cuts, abrasions and preparation of skin for surgery.

**ALCOHOL:** Alcohol and ether are usually act as a disinfectant, but actually they have no methylated spirit is often used for germicidal action, disinfections the skin before hypodermic injections, but it only removes dirt and grease.

**ACIDS:** Nitric acids, Hydrochloric acid and sulphuric acid are powerful germicides 1:20 solution kills non spooling bacteria in a few minutes.

**BORIC ACID:** A mixture of potassium bichromate sulphuric acid commonly used as a cleansing agent for glass ware.

**FORMALIN:** It is used to preserve the specimen in laboratory, blankets, mattresses and linen of infected cases are treated with for formalin gas for 6hours in a closed room.
SOAPS AND DETERGENTS: - Detergents may be defined as an agent which removes the foreign matter from solid surface in a solvent (water) washing procedure eg: savalon.

Bacteria along with oil and other particular are removed by through washing with soap and water eg: Cinthol soap.

FORMALDEHYDE: - It is a gas used for sterilizing instruments and heat sensitive catheters.

GLUTARALDEHYDE: - It is effective against TB bacteria virus and fungi. It is used to sterilize rubber tubes, face masks, Endotracheal tubes metal instruments and polyethylene tubing.

GASSES.

ETHYLENE OXIDE: - It is effective against all microorganisms, viruses and spores, used for sterilizing heart lung machines, respirators, sutures , dental equipment, glass & matel and paper surfaces it is useful for fumigation.
PATHOGENIC ORGANISMS TRANSMITTED FROM RESPIRATORY TRACT:

I. VIRUS DISEASES TRANSMITTED BY DROPLET INFECTION:

1. Common cold (coryza)
2. Sore throat, bronchitis, bronchiolitis.

Measles, Rubella, Chicken pox, Varicella

Herpes Virus
Herpes simplex type –I causes gingivitis in children.
Herpes simplex type –II causes of genital herpes trach.
Whooping cough which is a serious disease in children caused by –Bordetella pertusis.
Homophiles influenza – Broncho pneumonia other respiratory infections.
Bacilli associated with respiratory infection.
Mycobacterium tuberculosis :- There are two types T. Bacilli one is human kind affects the human being other bovine type which affects the cattle.
Corne bacterium diphtheria (Klebs, loeffler bacillus)
The bacillus found in the throat, nasal passage, upper respiratory tract of a person suffering from diphtheria. It may enter the Respiratory tract via inhalation.

Streptococci causes tonsillitis and bronchopneumonia.
Penumococcus: The disease caused by penumococcus are lobar pneumonia, it is found in the saliva and sputum of the person who is suffering from disease – meningococcul.

**PATHOGENIC ORGANISAM TRANSMITTED FROM AIMENTARY TRACT (GASTRO INTESTINAL)**

Organisms: Hepatitis virus type A (infectious hepatitis)
Polio myelitis virus.
Salmonella typhi – typhoid fever
Salmonella typhi – A, B, C (paratyphoid fever)
Vibrio cholera
Bacillus coli
Shigella (bacillary dysentery)
Entamoeba hystolica (amoebic dysentery)
Giardia lamblia
Clostridium welchi (bacillus of gas gangrene infection of wounds)
Clostridium tetani – Bacillus of tetanus

**Food poisoning organisms :-**

Staphylococcus – contamination by food handles. Eg. Septic fingers.
Salmonella – contamination by human carries or rodents. clostridium botulimum (grows in tin food E. coli – found in the intestines.
PATHOGENIC ORGANISAM TRANSMITTED THROGH FOOD:-
CLASSIFICATION OF FOOD BORNE INFECTION

<table>
<thead>
<tr>
<th>BACTERIAL</th>
<th>FOOD TOXINS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonella species campylobacter jejune, yestinia entero colitica vibrio Para haemolyticus, listeria monocytogenes, shigella species Escherichia coli, brucella species</td>
<td>Lathyrus sativum epidemic dropsy, alfa toxins</td>
</tr>
<tr>
<td><strong>VIRAC</strong></td>
<td>Toxic causes</td>
</tr>
<tr>
<td>Hepatitis A Norwalk agent</td>
<td>Staphy cococcus auresus clostridium botulinum, clostridium perfringens, bacillus cereus.</td>
</tr>
<tr>
<td><strong>PARASITES</strong></td>
<td></td>
</tr>
<tr>
<td>Entamoeba Histololytica</td>
<td></td>
</tr>
<tr>
<td>Taenia species</td>
<td></td>
</tr>
<tr>
<td>Trichinella spirals</td>
<td></td>
</tr>
<tr>
<td>Ascaris</td>
<td></td>
</tr>
<tr>
<td>Giardia lamblia</td>
<td></td>
</tr>
<tr>
<td><strong>CHEMICAL POISIONING</strong></td>
<td></td>
</tr>
<tr>
<td>Pesticides</td>
<td></td>
</tr>
<tr>
<td>Heavy metals such as arsenic, lead, cadmium</td>
<td></td>
</tr>
</tbody>
</table>

**FOOD POISONING:** Food poisoning is an acute gastroenteritis caused by the ingestion food or drink contaminated with either living bacteria or their toxins of chemical substances.
**Types of food poisoning:**

a) **Non – Bacterial:** caused by ingestion of chemical poisons such as arsenic.

b) **Bacterial:** caused by the ingestion of living bacteria or their toxins.

c) **Salmonella food poisoning:** The bacteria organisms involved are commonly salmonella typhimurium and s.etneritidis. man gets the infection through contaminated food. Eg. Milk & milk products, egg, custard once ingested, the organism multiply in the intestines and caused illness in 12 to 24 hours. The symptoms are nausea, vomiting abdominal pain and diarrhea.

d) **Staphylococcal food poisoning:** Man gets infection by eating food contaminated by staphylococcus organisms i.e., s. aureus which produces a heat stable entero toxin subsequent heating may sterilize the food, but not destroy the toxin. The toxin acts an the intestine and produces nausea, vomiting, abdominal cramps diarrhea and dehydration causes illness usually 2-4 hours.
e) **Botulism**: This caused by exotoxin which is a heat labile neurotoxin caused by *clostridium botulinum* which occurs in soil, dust and intestinal tract of animals. Man gets the infection by eating food which has been contaminated. Foods usually improperly canned or bottle, vegetables and fish. Prevention of food poisoning consists of avoiding of raw food, proper storage and handling of food, personal hygiene and proper processing of meat, and milk products.

**BLOOD BORN PATHOGENIC ORGANISMS:**
Microorganisms which can transmitted through blood transfusion.
A large number of microorganisms have been transmitted through blood transfusion.
Some important diseases that can be transmitted through blood transfusion are AIDS hepatitis, malaria and certain bacterial diseases.

The blood and blood products was recognized as an important mode of transmission of AIDS.

Hepatitis B, C & D are common types of hepatitis which are be transmitted through blood and blood products. Great risk for hepatitis B because of a large number of carriers of HBS Ag in the world.

Malaria occurs who the donor blood contains malarial parasite at a very low. Bacterial infection transmitted by blood. Mainly because of inadequate cleaning of the Venus puncture site, air born or direct contaminated of the needle or tubing connections or prolonged storage of blood at higher temperature may result in transmission of bacterial infection. The infection depends upon the concentration of the organism and its nature. The screening of blood prior to transfusion is must and should followed strictly.
UNIT -II
SOURCE AND MODE OF INFECTION:-

Infection implies that microorganisms capable of causing disease have gained access into body tissues, with subsequent establishment and multiplication, which actually produces clinical signs of infection.

The factors essential to the process of infection

- A pathogenic organism
- An entry route in to the host
- Establishment and multiplication within the host. The type of tissue and conditions in which it can grow and multiply.
- An exit route and means of transmission from the host to new host.
- The entry and development or multiplication of a diseases producing agent in the body of man or animals. An infection may or may not lend to a disease state.

Classification

1. Primary infection: The initial attack of pathogen un a host system.
2. Secondary infection: When in a host whose resistance is lowered by already existing infection disease, a new organism may enter and set up an infection.
3. **Re infection**: Subsequent infection by same organism in a host.

4. **Focal infection**: It is a condition, where due to infection at localized sites like tonsil, general effects are produced.

5. **Cross Infection**: Infection spreading from one person to another person by direct or indirect contact.

6. **Iatrogenic infection**: Infection introduced by medical and Para medical professionals.

7. **Congenital Infection**: An infection acquired by the baby from the mother.

8. **Sub clinical infection**: Clinical feature are not visible.

9. **Latent Infection**: Some parasites remain in tissue in latent or hidden form. When the host resistance is lower they produce clinical disease.

10. **Acute and chromic infection**: Acute infection occurs, suddenly and it is serious chromic infection lash for several months to years.
**SOURCES OF INFECTION:**

1. **Man:** Man himself a common source of infection from a patient or carrier.
2. **Carrier:** A person who harbour the disease agent without having any outward signs and symptoms. In other words a carrier is an out worldly healthy person who is capable of infecting others.
   - Carrier is often the cause of out breaks of infection and they are more dangerous than the patient as they are silently discharging pathogens.
   - **Healthy Carrier** is one who harbours the pathogens in his body but has not suffered from any of its ill effects.
   - **Convalescent carrier** is one who had suffered from the ill effects of the pathogen and got cured but still he continues to harbour the pathogen in his body without suffering from any of its ill effects.
   - **Contact Carrier:** He is one, who had received a pathogen from a patient and harbours the pathogen without any suffering.
   - **Paradoxical Carrier:** He is one who acquires the pathogen from another carrier.
**Water:** Infection can spread through Contaminated water

3. **Soil:** Soil may serve as a source of parasitic infection like round worm and hookworm.

4. **Food:** Contaminated food can also be the source of infection.

5. **Insects:** The insect causes diseases likely mosquitoes, fleas, lice etc., these diseases are called as arthropod bond diseases. Some vectors act as reservoir host.

**MODE OF TRANSMISSION**

The mode of transmission may be classified into 2 broad categories – 1. Direct 2. Indirect

Contract: By having contact with infection persons

<table>
<thead>
<tr>
<th>DIRECT TRANSMISSION</th>
<th>INDIRECT TRANSMISSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Direct contact</td>
<td>1. Vehicle borne transmission</td>
</tr>
<tr>
<td>2. Droplet Infection</td>
<td>2. Vector borne transmission</td>
</tr>
<tr>
<td>3. Contact with infected soil</td>
<td>3. Air borne transmission</td>
</tr>
<tr>
<td>4. Inoculation into skin or Mucus membrane</td>
<td>4. Fomite borne transmission</td>
</tr>
<tr>
<td>5. Transplacental or vertical transmission</td>
<td>5. Unclean hands and fingers.</td>
</tr>
</tbody>
</table>
**Direct contact:** Some diseases are transmitted from person to person by direct contact.
Eg. Kissing, Sexual contact.

**Droplet:** When a person with respiratory infection causes or sneezes fine droplets of saliva containing millions of microorganisms blown infection when inhaled by the susceptible persons in the vicinity. Eg. Common cold, diphtheria, measles etc.

**Contact with soil:** The disease agent acquired by direct contact with soil eg. Tetanius, hook worm.

**Inoculation into skin mucosa:** The disease agent may be inoculated directly in to the skin or mucosa eg. Rabies, (dog bite)
Hepatitis (Contaminated needles and syringes)

**Transplacental Transmission:** Disease agents transmitted in utero from mother to the foetus.
**Eg:** Aids, toxoplasmosis, rubella syphilis

**Indirect contact:** Transmission happens where there is a mediator on which the pathogenic deposited by a patients or a carrier and from where it is acquired by a healthy person to become a carrier. Eg. Cloths, Towel, etc.
**Indirect:**

**Vehicle born transmission:** These are water, milk, food, blood serum, plasma and others biological products (water born, food born and blood born infection)  
Eg. Enteric fever, cholera, diarrhea, and hepatitis A & B food poisoning.

**Vector born transmission:** Air transmitted by insects  
Eg. Malaria, Filaria, Plague.

**Air born transmission:**

**Transmission from droplet nuclei:** These are extremely small 0.1 mm infective particles floating in the air. These are produced during coughing and sneezing.  
Eg. Tuberculosis, Measles, Influenza.

**Infected dust:** Some droplets which are expelled during coughing and sneezing settle down on the floor, cloths, linen and became the part of the dust. During sweeping, dusting the infected dust released in the atmosphere and when inhaled causes disease. Eg. TB., Pneumonia.

**Fomite born transmission:** Fomites are article that convey infection to others because they have been contaminated by pathogenic organisms. They play important part in indirect infection. Eg. Handkerchief, tumblers, door handles, towels toys etc.
Unclean hands and fingers: Hands are most common medium by which pathogenic agents are transferred to food from the skin, nose, bowel etc. Eg. Staphylococcal, dysentery hepatitis, intestinal parasites.

PATH OF ENTRY AND EXIT OF INFECTION

ROUTE OF ENTRY:-

INHALATION: Through the mouth and nose for the respiratory tract eg. TB., Diphtheria, mumps.

INGESTION: Through the mouth to the alimentary tract, eg. Dysentry, hepatitis A, poliomyelitis.

INOCULATION: Through the skin or mucus membranes to deeper tissues. Eg. Trauma, insect bites, surgery, injections and wounds.

A wider variety of organisms are able to enter the body by this route and to cause conditions ranging from a boil to severe wound infection or viral hepatitis.

PORTAL OF EXIT: The disease agent must find its way out of the body that it may reach a new host and this perpetuates it’s species the “Portal of exit” depends upon the organism.
The main portals of exit are

1. **Nose and throat secretions**: Some organisms leave the body by way of nose and throat secretions they includes T.B., Virus of common cold, mumps, measles etc.

2. **Faeces**: Some organisms are excreted in faeces. These are salmonella, shigella, polio virus, hepatitis, cholera vibrio, round worm and hook warm etc.,

3. **Urine**: Some organisms are excreted in urine eg. S. Typhi,

4. **Skin**: The organisms which leave the body by way of skin wounds and discharges are Lepra bacilli, agents of STD(Sexually transmitted Diseases), scabies, skin infection etc.,

   Organisms like the malaria are filarial parasites leave the body by way of skin through insect bites.

**FACTORS WHICH FAVOUR AND HINDER OF INFECTION**

Infection by bacteria is successful invasion on the host tissue and such bacteria causing infection are called pathogens. There are natural pathogens or true pathogens which have got the inherent capacity to invade a normal tissue also whereas an opportunistic pathogen
can cause infection only when the host defense mechanisms are altered or lowered.

**FACTORS INFLUENCING VIRULENCE**

The successful invasion on the issue by bacteria depends upon the virulence of the bacteria (defined as the degree of invasive capacity). The factors which influence the virulence of the bacteria are:

**TOXICITY**

Some organisms produce poisonous substance called toxins. These are tow types:

i). **Exotoxins**: These are liberated into the medium as secondary metabolites they are proteins, heat labile and highly toxic. By adding formal in they can be converted into harmless or nontoxic substance called toxoids. These toxoids when they are administered they give rise to resistance to infection.

ii). **Endotoxins**: these are liberated due to autolysis of the bacteria. They are lipopolysaccharides and are heat resistant. They can cause variety of effects like, fever, intravascular coagulation, shock endothelial damage cell degeneration, inhibition of enzyme activity or enzyme synthesis.

**ENZYMES**

Many bacteria secrete enzymes like hyaluronidase, lecithinase, lipases callagenase, coagulase, which act on
the host tissue and cause dissolution of the basement membrane of the cells or phospholipids of the cells or the connective tissue of the host and such damage to the tissue render the bacteria to invade the host more easily.

**HEMOLYSINS**

Some bacteria produce a variety of protein substances that cause lysis of the RBC. This again facilities the spread of infection.

**CAPSULE**

The bacteria that are capsulated or resistant to phagocytosis, capsular material can cause damage to the living tissue.

**FACTORS INFLUENCING INFECTION**

**TISSUE AFFINITY**

Different bacteria show different affinity towards tissue. Example, typhoid bacilli-payers’s patches of intestine; diphtheria – pharyngeal or laryngeal epithelium, streptococci; gonococci, mucous membranes.

**CHANGE OF THEIR NORMAL HABITAT**

Bacteria, which are usually commensals in particular area, become pathogenic when they enter other tissues.

**HYPERSENSITIVITY**

Some bacteria sensitize the host tissue and infection due to such bacteria will lead to severe, generalized infection.
For example, streptococci can sensitize the heart and cause rheumatic heart disease.

**INFECTIVE DOSAGE**

The number of organisms required to cause infection is called an infective dose. This depends on the nature of the organism.

**PORTAL OF ENTRY.**

Not only the dosage but the portal or route of entry of a microorganism is also important. The microorganisms can gain entry into the body either by ingestion, inoculation, and inhalation, through an abrasion in the skin or by inoculation (introduction of malaria parasite by the bite of mosquito).

**COMMUNICABILITY**

Spread of a particular infection from person to person depends upon, the rapidity by which the bacteria are transmitted. This usually occurs by:

1) Direct contact with an infected patient.
2) Flies, mosquitoes, which can spread infection, they are called vectors of infection.
Contact with infected article like clothing, beds, food, and water, droplet infection, which spread due to coughing or sneezing, beds, food, and water, droplet infection which spread due to coughing or sneezing, animal bites, etc.

1. Contact
2. Airborne
3. food and water
4. Insect – Born

Thus; in conclusion, the development of infection depends upon a number of factors cofactors, bacterial virulence, factors influencing the infection.

Host factors
Bacteria Factors
Resistance
Infection.

**FACTORS WHICH HINDER INFECTION**

_Prevention_ is better than cure:- Many infection can be controlled and even they can be eradicated if we follow the principles of prevention. These principles are very simply but need dedication and awareness in implementing them in the routine practice. So that these factors helps to hinder infection.

**MAINTAINING PERSONAL HYGIENE:**

Good health habits should be practiced by taking care of skin, teeth, eyes, hair, hands, feet etc.,
HAND HYGIENE

Hand washing reduces the incidence of infections
As a fundamental life time hygiene practice hand washing must be valued, taught, learned and practiced from an early age.
Hand washing is a complex learned behavior and requires continuous education and motivation
The transient microbial flora is loosely attached to the upper layer of the skin are relatively short lived and can be removed easily by soap and water
Recognizing the importance of hand washing for preventively the spread of nosocromial infections, medical and nursing schools are increasingly teach the skills and rationale for effective hand washing

NUTRITION:
A Well balance nutritious diet helps in preventing many infectious diseases malnutrition is the one of the important factors. That decides the outcome of many diseases like diarrhea, tuberculosis.
SAFE DRINKING WATER SUPPLY: Water is essential for life 80 to 90% of the body weight is due to water content – Normally persons should take 1 to 1.5 ml / day to replace the loss through perspiration, urine and stools. Water not only required for digestion of food. But also is essential to maintain body complexion and skin elasticity. The water we drink everyday should be free from infection agents. And it should be tasty and refreshing. Blocking the channels of transmission of infection by disinfect by disinfection of water supplies and household purification of water by

1. Boiling 2. Chemicals eg:- bleaching powder potassium permanganate, chlorine tablets etc. 3) Domestic filters.

SAFE DISPOSAL OF HUMEN EXCRETA, SOLID WASTES AND REFUSE
Should be done properly Biological waste management done properly insects and rodent control done by use of insecticides thus killing vectors causing diseases.

BIOMEDICAL WASTE means, any waste, which is generated during diagnosis, treatment or immunization of human beings or in research activities pertaining there to or production or testing of biological products. Disposal of waste done carefully segregate waste should be disposed carefully as per the category.
**FOOD SANITATION AND HYGIENE:** Improve the standard of food hygiene, washing of hands before eating and after defecation food handlers should follow hand washing technique.

**ENVIRONMENTAL SANITATION:** Much of ill health in India is due to poor environmental sanitation, that is unsafe water, polluted soil, unhygienic disposal of human excreta and refuse, poor housing, insects and rodents etc., Air pollution is also growing concern in many cases, Housing standards should be improved, good lighting is essential over crowding is avoided.

**PREVENTION OF NOSE COMIAL INFECTION:**
(Nosokome = Hospital) can be controlled by basic hygiene such as hand washing use of mask. Gown gloves in orders to prevent the transmission of infection by contact. Barrier nursing such as keeping the patients with infection is a separate ward with careful attention to hygiene reduce the risk of transmission infection.

Aseptic precautions before under taking any procedure on patient. The environment should be kept clean the floor, walls should be washed with a detergent or 5% phenol if necessary should be fumigated.
**IMMUNIZATIONS:** Immunization is possible to prevent many infectious diseases by artificially exposing the person to the killed or live attenuated bacteria and viruses. Who is not exposed to these infectious agents before. When a person is given either whole bacteria or viruses or its component, the individual resistance power gets boosted up and subsequently he will be prevented from developing the diseases even if he comes in contact with the infectious agent most of the communicable diseases can be controlled by immunization vaccines. School authorities should arrange health check ups for students.

**HEALTH EDUCATION:** to general public by mass media regarding prevention of illness, infection and communicable diseases.
CLASSIFICATION OF IMMUNITY

Immunity

Natural                Acquired

Species               Racial               Individual          Active                  Passive

Natural      Artificial          Natural                   Artificial

a) After an attack            a) by inclusion of             (from mother          By injection
of infections diseases               bacteria B.C.G             via placenta              of serum
b) Repeated exposure              or vibrio cholera    or milk)                actively
   to infection in sub-clinical                                   immunized
   doses.       b) Virus (dead) rabies          man or animal
   or (attenuated) small pox
   b) Virus (dead) rabies
   or (attenuated) small pox
C)Toxoid tetanus, deptheria,
Local by oral route (sabin's polio)
Vaccine

By injection
of serum
actively
immunized
man or animal
Immunity

Immunity is the power of the body to fight infection. It means the power to resist and overcome infection caused by particular organisms. The resistance is produced by the action of antibodies against organisms or by phagocytes destroying the organism. The body naturally possesses the power to resist their attacks. There is some immunity present in every individual at birth. This is called **natural immunity**. There are several ways in which immunity develops in the body after birth. This is called **acquired immunity**.

Natural immunity is an inherited resistance to infection and not acquired during the life time of an individual. This is concerned with species, races or individual depending on constitutional make up of the subject.

The immunity acquired during the life time of an individual is known as acquired immunity. It may be active or passive.

Natural immunity can be classified into

1. Species immunity
2. Racial immunity
3. Individual immunity
**Species immunity:** This indicates immunity present among the members of a particular species.

**Racial immunity:** Certain groups of people are naturally resistant to some diseases. Hebrews are more resistant to tuberculosis than other people. Various races within the same species show marked difference in the degree of resistance to certain infection.

**Individual immunity:** Some authorities believe that it is possible for some people to have a strong natural resistance or immunity to certain diseases. This is referred to as individual immunity.

**Acquired immunity:** immunity may be acquired naturally or artificially

**Acquired natural immunity:** It is naturally acquired by suffering from the diseases. This is acquired after an infection and recovery from the disease or sub-clinical infection after repeated exposure to small doses of the infective organism. The antibiotics may be transmitted from mother to child through the placenta. A certain amount of immunity may also be acquired without actually becoming ill by being exposed to the disease for a length of time, or by unknown contact with the particular organism.
**Acquired artificial immunity:** Immunity may be acquired artificially by the introduction of

a) Vaccine
b) Toxoid
c) Serum

Artificial immunity can be classified as a) Active b) Passive

**Active immunity:** is produced by vaccines and toxoids. It may be acquired artificially by inoculation of bacteria and virus or their product of attenuated virulence, especially in virus infection, eg. Small-pox virus.

**Vaccine:** is a suspension of dead or weakened bacteria or a preparation of killed or weakened virus. When introduced into the body, it acts as an antigen stimulating the formation of antibodies. This method of producing immunity is known as “active immunization as the individual has an active part in manufacturing the antibodies. Vaccines do not always give complete protection against the disease but if the person becomes ill the disease takes a milder from. Protection by vaccines has to be maintained by revaccination or booster doses at certain intervals.

Active immunity may also produced by modified toxins called toxoids which are prepared from bacterial
toxins. When injected into the body toxoid stimulates the production of anti toxin. Toxoids are used for active immunization against diphtheria, tetanus and scarlet fever.

**Passive immunity:** A subject is immunized by prepared antibodies and the body cells do not take any active part in the production of immunity. A temporary immunity may be produced in the body when required, by the injection of ready made anti bodies contained in the serum of an animal or man. This process is known as “passive immunization” since the individual has no active part in producing the antibodies but just receives them.

This type of immunization is of special value for immediately stopping the further spread of toxin. When the person has already developed the symptoms of disease. Passive immunity is produced by serum contain prepared antibodies.

**Immunization:** Immunization is the method through which artificial immunity is raised in the individual or it is the means by which immunity against infective agents is exalted or immunization may be described as the process of increasing the resistance of a person to a particular infection by artificial means.
**Purposes of immunization:** 1. to provide protection before the child is exposed to infection or likely to be encountered in childhood by use of patent specific antigens that are available.

1. To control the infection in the community in addition to providing individual protection.

Vaccines are biological substances given to induce immunity against specific diseases. They may be:

1. Live attenuated bacteria known as B.C.G
2. Virus – measles vaccine, oral polio vaccine
3. Killed bacteria – Typhoid, Cholera, pertussis vaccine or viruses- rabies vaccine
4. Modified toxins called toxoids - tetanus toxoid.

The diseases against which routine immunization is advised are:

1. Diphtheria
2. Pertussis
3. Tetanus
4. Polio myelitis
5. Measles
6. Tuberculosis

Vaccination against smallpox is no longer recommended as a routine procedure in early childhood. Routine vaccination against rubies is not usually considered necessary because the long incubation period allows time for prophylactic active immunization after exposure to an infected animal or to the disease.
### IMMUNIZATION SCHEDULE

<table>
<thead>
<tr>
<th>Age</th>
<th>Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td>At birth</td>
<td>BCG &amp; OPV (0 dose)</td>
</tr>
</tbody>
</table>
| At 6 weeks   | BCG (if not given at birth)  
               | DPT-1 & OPV-1             |
| At 10 weeks  | DPT – 2 OPV -2            |
| At 14 weeks  | DPT – 3 OPV-3             |
| At 16-24     | DPT & OPV                 |
| At 5-6 years | DT – the second dose of DT should be given at an interval of one month if there is no clear history or documented evidence of previous immunization with DPT. |
| At 10 & at 16 years | TT the second dose of TT vaccine should be given at an interval of one month if there is no clear history or documented evidence of previous immunization with DPT, DT or TT vaccines. |
| For pregnant women early in pregnancy. | TT-1 or Booster one month after TT-1 – TT-2. |

- Interval between 2 doses should not be less than one month.
- Minor coughs, colds and mild fever are not a contraindication to vaccination.
In some states Hepatitis B vaccine is given as routine immunization.

**Hyper sensitivity:** The term hyper sensitivity (allergy) refers to the reaction that occurs when a foreign substance is introduced into the body.

There are 2 types of hyper sensitivity reaction.
- immediate or anti body mediated eg. Anaphylactic shock
- delayed or cell mediated type.

**Anaphylactic shock:** In man there are two types of anaphylactic reaction 1. **Systemic**  2. **Local**

1. **Systemic reaction:** Is seen when penicillin or (ATS) Anti tetanus serum is injected in to a sensitive person. The reaction beings with in minutes after contact with the antigen and disappear with in one hour eg. Symptoms like dyspnea, bronchial spasm, fall of B.P., skin rash etc.

2. **Local type:** The local type of reaction we can see in eg. Asthma and urticaria (skin rash)

   **Antigen:** is a sub stance that stimulates for formation of an antibody.

   **Anti bodies:** Are protein that are formed in response to an antigen and react. Specifically with the antigen that provoked their production.
Anti bodies are produced by B lymphocytes a type of white blood cells.

**Immunity**: Is the ability of the body to recognize destroy and eliminate antigenic material i.e., bacteria, viruses and foreign proteins.

The immunity mechanisms has two components
1. Humoral immunity is based on production of antibodies.
2. The cellular immunity is based on a type of white cells known as T- Cells. The humoral and cellular components of immunity cooperate with one another and help the individual to withstand or resist many infection in every day life.

**Immunizing agents**
Immunizing agents may be classified as vaccines, immunoglobulin and antiseera.

**Vaccines**:
Vaccine is a preparation of disease agent or its toxic product which when administrated stimulates specific antibody formation.

- Administration of vaccine inducer active immunity.

Vaccine are prepared from
- Live attenuated organisms –eg. Polio vaccine
- Killed organism eg. Cholera and typhoid vaccines
- Toxoids -eg. Diphtheria and tetanus vaccine, typhoid (bivalent)
**Combined (Mixed) Vaccine:** To reduce the cost and minimize the number of injections, more one immunizing agent may be included in the vaccine (1) eg. DPT –which protects against diphtheria, whooping cough, tetanus (2) DT –protects diphtheria and tetanus

Delayed type of hypersensitivity reaction: eg. Tuberculin hyper sensitivity, allergy to fungi, skin graft rejection etc, the reaction is delayed and may begin several hours after contact and may last for days.
Collection of specimens for Bacteriological examination:
A specimen may be defined as a small quantity of a substance or object which shows the kind and quality of the whole (Sample)

**Purpose of collecting specimens:** –
- To make diagnosis and to help in treatment
- To note progress and reason of a disease.
- To observe the effects of special treatments and drugs.
- To assess the general health of the patient.

**Principles:**
- Specimens should be delivered to the laboratory as soon possible.
- Contaminated and improperly collected specimen it gives false result, which will adversely affect the diagnostics treatment of patients.
- Specimens allowed to stand at the room temperature for a long time will give a false results due to
  - Destruction of specimen
  - Multiplication of undesirable bacteria.
  - Detraction of pathogenic bacteria.
- The accuracy and reliability of findings depend up. On the correct method of collection, transportation of the specimen to the laboratory and recording of reports. In accurate results may mislead the physian in the diagnosis and treatment.
- Specimens serve as a media for transmission of disease producing organisms to the personnel who handle them carelessly.
- **Different kinds of specimens** – urine, stool, blood sputum, vomit, vaginal sections, throat swab, secretion of the eye, ear discharge, wound discharge cerebrospinal fluid and fluids from body
cavities are the various kinds of specimen used for laboratory tests.

- **Nurses responsibilities in collecting specimens** – specimens that can be refrigerated before inoculation. Urine, feces, respiratory exudates, wound specimens. Specimens that should not be refrigerated, spinal or other body fluids, genital / cervical specimen when for gonococcal isolation blood culture bottles.

Note: - All specimens one to be treated as contaminated and adequate care must be taken while handling.

1. **Preparation of the patient** - the patient should be prepared physically and mentally. Explain to the patient when to collect, what specimen to be collected, how to collect and the amount. Tell the patient not to Contaminate the outside of the bottle, so that it may be safe for others to handle it.

2. **Preparation of the equipment to be used in collecting specimens**:

1. For routine examination use clean penicillin bottles and a little large one.
2. For stool a small clean bottle is used.
3. Large glass bottles are used for 24 hrs urine specimen.
4. Sputum cups are used to collect sputum (covered)
5. Sterile test tubes are sterile bottles are used for blood and body fluids with necessary chemicals.
6. Culture bottles - sterile are used for blood culture.
7. Clean slides are used for smear.
8. Formalin in sterile container is used for liver biopsy tissue. The specimen container should clean and sterile. They should not be broken and cracked.
There should not be any anti septic present in the specimen bottles.

3. **Collection of specimen**:- Specimens are collected by nurses, lab technicians and by doctors. The nurses should see that all specimens are labeled and sent along with a properly filled and signed laboratory farm with

- **Name of the patient**
- **Reg. No.**
- **Age.**
- **Bed No.**
- **Ward.**
- **Name of the specimen**
- **Nature of the test to be done**
- **Date of collection**
- **Method of collecting specimen**

**Collection of single urine specimen** – External genitalia are should be washed with soap and water. In the patient is instructed to take the mid stream specimen in the container without contaminating the outer side of the bottle. It should be sent to lab with proper labeling and requisition.

**Urine for culture**:- It should be collected in sterile containing. Only mid steam urine to be collected catheterization may be necessary to get specimen from unconscious patient and menstruating patients. As far as possible catheterization is avoided to prevent infection or cause trauma to the urinary tract.

**Method of collecting 24 hours urine specimen** – 24 hours urine specimen means to collect all the urine voided in 24 hours. The collection of urine begins at 6 A.M. ask the patient to void at 6 A.M. and discard the whole urine. All the subsequent
voiding should be measured and collected in the bottle which is labeled. Continue to collect till the next morning. Ask the patient void at 6 A.M. the next day and add it to the urine previously collected. It is necessary to add preservative to the urine to prevent decomposition and multiplication of bacteria. boric acid, concentrated hydrochloric acid formaline, chloroform etc are used as preservatives.

**Collection of faeces and stool** – water proof disposable container should be given for the patients. A clean bed pan is given for passing stool. Flush the toilet before using. With the help of a clean spatula, a sample is take for the meddle & placed in the sterile bottle for culture. In an ordinary bottle for routine exam water proof disposable container is best if available.

**Collection of sputum:** - water proof disposable sputum cups and other sterile sputum cups are used for culture and ordinary clean bottles for A.F.B (Acid fast bacilli) mainly specimen before food is collected. Septum should be observed for amount, colour and odour and consistency. Instruct the patient to cough out and bring the sputum and not the saliva into the bottle.

**Methods collection of blood smear:**
A tray with
- clean slides -2
Sterile needle in a container
Spirit
Cotton swab.
Paper bag and kidney tray.
Steps of procedure:-
- Explain the procedure to the patient.
- Make him sit in a chair or in bed
- Clean the finger tip with spirit.
- Divert his attention to the opposite side away from you.

Press the finger tip and give a prick with a sterile needle. Allow a drop of blood to fall on each slide and quickly make the smear by taking one slide on your left hand and another with your right hand make the smear with the edge of the slide by spreading the blood. Make 2 or 3 slides. Dry and send then to lab, specially malaria and filarial cases.

Throat swab:- The client’s tongue is depressed and the swab passed well over the tonsils and surrounding areas and also where there is inflammation. Remove and place in the sterile test tube.
UNIT-II

QUESTIONS

1. Define infection and carrier and write classification
2. Write the classification of infection
3. Explain about the sources of infection.
4. Explain about the mode of transmission of infection.
5. Describe the path of entry and exit of infection.
6. Write the factors which hinder infection.
7. Define sterilization, and what disinfection is.
8. Describe the methods of sterilization.
9. Write the short notes on Pasteurization.
10. Define immunity.
11. Describe the types of immunity.
12. Describe about natural immunity.
13. Describe about the acquired immunity.
14. Write the differences between the active and passive immunity.
15. Write the immunization schedule.
16. Define the following terms;
17. List the pathogenic organisms causing the diseases of (a). Respiratory tract, (b). Alimentary tract.
18. List the food born diseases.
19. What is food poisoning?
20. What is the organism responsible for food poisoning?
21. List the blood born pathogenic organism.
22. Define specimen.
23. Write the principals of specimen collections.
24. Methods of collections of specimen
25. Write the Nurses role in collection and handling of specimens.
GLOSSARY

01. Anerobe: A micro organism that can live and thrive in the absence of free oxygen

02. Antigen: Any substance bacterial or otherwise which is suitable conditions can stimulate the production of antibodies.

03. Antibiotic: Substance produced by certain bacteria and fungi, that prevent the growth of or destroy other bacteria.

04. Antiseptic: A substance which prevents the growth of bacteria eg. Dettol.

05. Antitoxin: An immune serum which neutralizes the action of a toxin.

06. Aseptic: Free from the living micro organisms.

07. Attenuated: Living but non virulent eg. polio drops, BCG.

08. Bacillus: Rod shaped bacteria.

09. Carrier: One who harbour the pathogen without manifestation of infection.


11. Convalescence: Period of recovery following illness.

12. Culture: The propagation of microorganisms are of living tissue cells in special media conducive to their growth.

14. Communicable: Capable of being transmitted from one person to another.

15. Diagnosis : Determination of the nature of disease.

16. Dreadful : Fearful

17. Disinfectant : An agent which kills or destroys pathogenic organisms.

18. Deodorant : A substance that destroys unpleasant adours.


20. Epidemic : A disease that attacks a large number of persons in a community at the same time.

21. Fluorescent : Giving off a special type of bright light.

22. Flagella : Long hair like structure which by their lashing activity cause the organisms to move.

23. Fomites : Substances other than the food that may transmit infection.

24. Fumigation : Exposure to the fumes of gasses that destroys bacteria, viruses etc.

26. Host: The animal plant or tissue on which a parasite lives and multiples.

27. Helmenth: A worm.

28. Infection: invasion of the body by pathogenic agents with their subsequent multiplications and the production of diseases inflammation due to living agents.

29. Immune: Protected

30. Innate: Inborn, inherent

31. Inoculation: Introduction of pathogenic organism, infected material, serum or other substance into tissue of living organisms or into culture media.

32. Immune response: The reaction to infection via the production of antibodies.

33. Lethal: Deadly.

34. Morphology: The form or structural appearance of microbe.

35. Microbe: A bacterium, a very minute organism causing disease.

36. Microscope: An instrument to observe microbes.

37. Naked: clothed, uncovered, bare.
38. Pasteurization. : The process of checking fermentation in milk by heating and then cooling.

40. Pathogen. : Any disease producing agent or microorganisms.

41. Purulent : Containing for resembling pus.

42. Pathogenic : Capable of causing disease.

43. Sepsis : Poisoning by microbes or their products remitting inflammation.

44. Sterilization : The process of destroying or removing all microbial life.

45. Spore : 1) A reproduction stage of some of the lowest form of vegetable life eg: moulds.

2) A protective state, which some bacteria are able to assume adverse conditions such as lack of moisture, food or heat. In this form the organisms can remain alive for years.

46. Species. : Soft, kind esp. of animals etc.

47. Slide : Glass amount for object to be viewed under microscope.

48. Susceptible : Capable.

49. Serology : The scientific study of serum
50. Swab: A pad of surgical wool etc for cleaning. Taking specimen etc.

51. Toxoid: A toxin which has been deprived of some of its harmful properties but is still capable of producing immunity. Eg. Inj. T.T.

52. Toxin: A poisonous agent of plant or animal origin.

53. Virulent: The ability of microbe to cause disease. The result of invasiveness and toxicogenicity.

54. Vector: The animal that carries organism or parasite from one host to another either of the same species or to one of another species.
Reference books:

1. Microbiology for Nurses by Dr. Glenn A. Pereira
2. Medical Microbiology by Stephen A. Morse
3. Essential of community Health Nursing by J.E. Park and K. Park
4. Elementary Bacteriology and immunity for Nurses by Marnal, Stanley.