Mr. Deepak Singh Chaudhary holds a B. Pharm. and M. Pharm. degree and is currently pursuing a Ph.D. in the Faculty of Pharmacy at IFTM University, Moradabad, India. He is serving as an Associate Professor in the Department of Pharmacology, Pharmacy Academy, IFTM University. With over seven years of teaching and research experience, Mr. Chaudhary has published numerous research and review papers, many in Scopus-indexed journals. His academic and research interests lie in pharmacology and natural product-based drug discovery. He is dedicated to advancing pharmacy education and guiding young researchers in their scientific journey.

Mr. Bhaskar Kumar works as assistant professor at Pragati College of Pharmacy Kashipur Uttarakhand I am pursuing Ph.D. in pharmacognosy from IFTM University Moradabad I have published research paper and review paper and 2 patent Published and I have done M. Pharm and B. Pharm in IFTM University Moradabad, I have attended the National and international conference and faculty development program And I have Seven-year experience with pharmacy academy

Dr. Mohammad Ubaid holds a B. Pharm from Uttar Pradesh Technical University and completed his M. Pharm and Ph.D. from IFTM University, Moradabad, India. He is currently serving as an Associate Professor at the Ishan Institute of Pharmacy, Greater Noida, Uttar Pradesh. With more than nine years of teaching and research experience, Dr. Ubaid has published several research and review articles, many in Scopus-indexed journals. His primary academic and research interests are in pharmacology and natural product-based drug discovery. He is deeply committed to advancing pharmacy education and mentoring young researchers in their scientific careers.

CHYREN PUBLICATION
Rashulpur Road, Near Bijli Gate, Palwal, Haryana-121102
Mob.: +919812453031,47, Tel: +911275-455-202
E-mail:chyrenpublication@gmail.com
https://www.chyrenpublication.com/

ISBN 978-93-7143-447-8

Book Ref. No.: 701

Human Anatomy and Physiology I
A Practical Manual

Mr. Deepak Singh Chaudhary
Mr. Bhaskar Kumar
Dr. Mohammad Ubaid

Human Anatomy and Physiology I: A Practical Manual

Mr. Deepak Singh Chaudhary
Mr. Bhaskar Kumar
Dr. Mohammad Ubaid

CHYREN PUBLICATION

Office: Near Bijli Gate, Palwal, Haryana-121102
Reg. Office: 742, Maruti Chowk, Ghitorni, Delhi-30
Mob. +919812453047,66, Tel: +911275-455-202
E-mail: chyrenpublication@gmail.com
https://www.chyrenpublication.com

BOOK NO. 701
Publication: Ist Edition, 03/10/2025
ISBN: 978-93-7143-447-8
Price:249/-

Printed & Published By
CHYREN PUBLICATION
Palwal Haryana, India

Disclaimer

The views expressed by the authors in the book published by Chyren Publication, Palwal, (HR) are their own. They do not necessarily reflect the views of the publisher. The publisher is not responsible in any way for any liability arising from the content/text of the book.

Table of Contents

Acknowledgment

To write book of this magnitude, it required lot of patience, skill and expertise over the subject, which I have gain through various opportunities got in the field of teaching and academia. I would like to dedicate this book to my Almighty and My Family.

We would like to thank Shri. Rajiv Kothiwal, Honorable Chancellor, IFTM University, Moradabad, for motivating us to strive for greatness. Our sincere thanks to Mr. Abhinav Kothiwal, Honorable Pro Chancellor, IFTM University, Moradabad, for their constant support and guidance. We also want to express our gratitude to Prof. M.P. Pandey, Honorable Vice Chancellor, IFTM University, Moradabad, Prof. Sanjeev Agarwal, Registrar, IFTM University for their continuous motivations for hard work and Prof. Navneet Verma, Dean & Director of Pharmacy Academy, IFTM University for their constant support, guidance and motivation for hard works. We also thanks to our Prof. Arun Kumar Mishra, Director, SOS-School of Pharmacy, IFTM University, Moradabad for their guidance and support.

Also, I give my heartiest gratitude to my life partner for his Love, affection, blessing, support and continuous encouragement to accomplish this work. A special thanks to all the authors for sharing their valuable and quality work for publication in this book.

We would also want to thank the publishers, for their help; it's thanks to their efforts that this version is now available in its current form. Lastly, I would like to acknowledge all those people who made this possible including my entire family, all well- wishers, My friends and colleagues.

All Authors

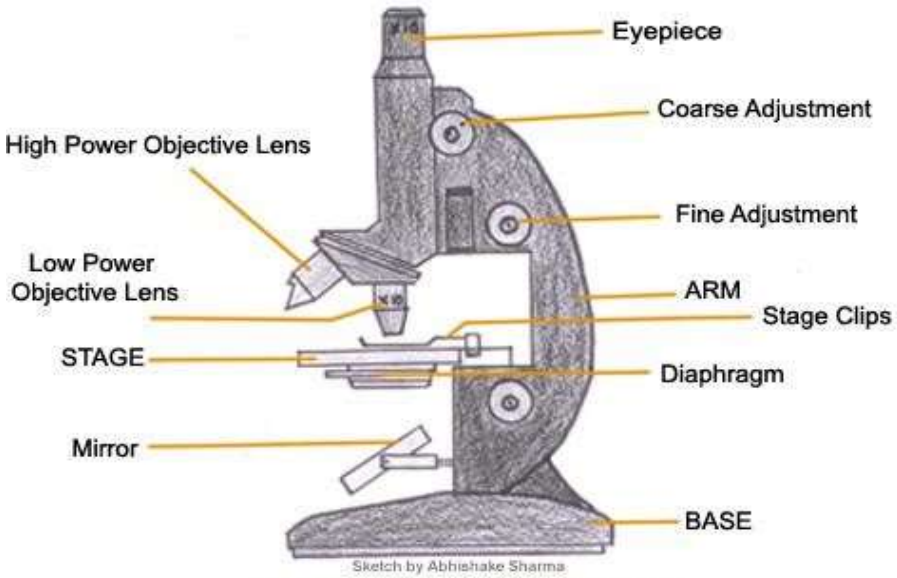
Experiment No. 1
To study the compound microscope.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 3-5.

Requirement: Microscope

Theory:

Parts and specification: Historians credit the invention of the compound microscope to the Dutch spectacle maker, Zacharias Janssen, around the year 1590. The compound microscope has two systems of lenses for greater magnification, 1) the ocular or eyepiece lens that one looks into and 2) the objective lens, or the lens closet to the object. Before purchasing or using a microscope, it is important to know the function of each part.



Labeled Microscope Diagram

Eyepiece lens: The lens at the top that you look through. They are usually 10X or 15X power.

Tube: Connects the eyepiece to the objective lenses.

Arm: Support the tube and connects it to the base.

Base: The bottom of the microscope, used for support.

Illuminator: A steady light source (110 volts) used in place of a mirror. If your microscope has a mirror, it is used to reflect light from an external light source up through the bottom of the stage.

Stage: The flat platform where you place your slides. Stage clips hold the slides in place. If your microscope has a mechanical stage, you will be able to move the slide around by turning two knobs. One moves it left and right, the other moves it up and down.

Revolving Nosepiece or Turret: This is the part that holds two or more objectives lenses and can be rotated to easily change power.
Objective Lenses: usually you will find 3 or 4 objective lenses on a microscope. They almost always consist of 4X, 10X, 40X and 100X powers. When coupled with a 10X eyepiece lens, we get total magnification of 40X, 100X, 400X and 1000X.
Condenser lens: The purpose of the condenser lens is to focus the light onto the specimen. Condenser lenses are most useful at the highest power.
Diaphragm or Iris: Many microscopes have a rotating disk under the stage. This diaphragm has different sized holes and is used to vary the intensity and size of the cone of light that is projected upward into the slides.
How to focus your microscope: The proper way to focus a microscope is to start with the lowest power objective lens first and while looking from the side, crank the lens down as close to the specimen as possible without touching it. Now, look through the eyepiece lens and focus upward only until the image is sharp. If you can't get it in focus, repeat the process again. Once the image is sharp with the low power lens, you should be able to simply click in the next power lens and do minor adjustments with the focus knob. If your microscope has a fine focus adjustment, turning it a bit should be all that's necessary. Continue with subsequent objective lenses and fine focus each time.

Result - The parts of compound microscope were studied.

Experiment No. 2
To study the microscopic structure of human epithelium tissue and human connective tissue.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 6-15.
Requirement: A compound microscope and permanent tissue slides

Theory:
Epithelial tissues (Epithelia): An epithelium is a tissue composed of onr or more layer of cells covering the external and internal surfaces of various body parts. The word 'epithelium' was introduced by Dutch anatomist Ruysch. It was applied originally to thin skin covering the nipple (epi=upon, thele=nipples). They are located on the outer surfaces of organs, including the skin. They form the linings of tracts, cavities, and vessels. The epithelial tissues arise from all the three primary germ layers: actoderm, mesoderm and endoderm. Epithelial tissues consist of variously shaped cells closely held together by intercellular junction like desmosomes, tight junctions, interdigitations etc. The cells of lowermost layers always rest on a nonliving basement membrane or basal lamina. Basement membrane is made up of no cell product of epithelial tissue. It is formed of mucopolysaccharides, glycoprotein and collagen or reticular fibres. Blood vessels are absent in the epiyhelial tissues. However, nerve endings may penetrate the epithelium. The free surface of cells may be smooth or may have fine hair like cilia, stereocilia, and microvilli. Epithelium is subjected to continuous wear and tear and injury.

Classification of epithelial tissue
It is mainly based on the location and fuctions of tissue.
A. Simple Epithelia
The cells are arranged in a single layer, forming one cell thick epithelium. Simple epithelia are further divisible as follows:
1. Simple Squamous Epithelium
Structure: It consists of only one layer of flat, scale like cells, usually polygonal cells which are

closely fitted together like the tiles on a floor. It is also known as **pavement epithelium**. There is a round flattened nucleus in the centre of the cell that produce bulging of the cell surface. In surface view the cells have polygonal outlines that interlock with those of adjoining cells.

2. Simple Cuboidal Epithelium

Structure: The simple cuboidal epithelium is composed of one layer of cuboidal or squarish shaped cells resting on a basement membrane. The nuclei are rounded and situated centrally. The cells of cuboidal epithelium often form microvilli on their free surface border called **brush bordered cuboidal epithelium**.

3. Simple Columnar Epithelium

Structure: It consists of a single layer of elongated cells placed side by side, many of which have modified structure. Three common modifications are **goblet, cilia and microvilli.** In the intestine plasma membranes of many columnar cells extend out in hundreds and hundreds of microscopic finger like microvilli, to increase the absorptive surface area and is called **brush bordered columnar epithelium.** Certain cells of this epithelium contain mucus or goblet cells along with underlying supporting connective tissue are called mucous membrane.

4. Simple Ciliated Epithelium

Structure: It bears numerous delicate hair like outgrowths called **cilia** arising from basal granules which help to create a current to transport the materials. Mucus secreting goblet cells also occur in the ciliated epithelium.

5. Pseudo-stratified Epithelium

Structure: The cells presnt in this epithelium are columnar shaped but unequal in size. The **long cells** extend upto the free surface whereas the **short cells** do not reach the outer surface. The long cells have oval nuclei and the short cells have rounded nuclei. Mucus secreting goblet cells are also present. It is called **pseudo- stratified** because the epithelium appears to be multi- layered although it is one cell thick.

B. Compound Epithelia

It is complex in structure and basically made up of two or more than two layers of cells. The compound epithelia may be stratified and transitional.

1. Stratified Epithelium

Structure: This epithelia comprises of many layers of cells in which the deepest layer is made

up of columnar cell or cuboidal cells. This epithelia is fur ther classified into following types on the basis of the shape of the cells present in the superficial layers:

2. Transitional Epithelium

This is a multi-layered epithelium and is 4-6 cells thick. It differs from stratified squamous epithelium in that the cells at the surface are not squamous. The deepest cells are columnar or cuboidal. The middle layers are made up of polyhedral or pear-shaped cells. The cells of the surface layers are large and often shaped like an umbrella. Because of its distribution in the urinary system, it is also called **urothelium**. When stretched this epithelium appears to be thinner and the cells become flattened or rounded.

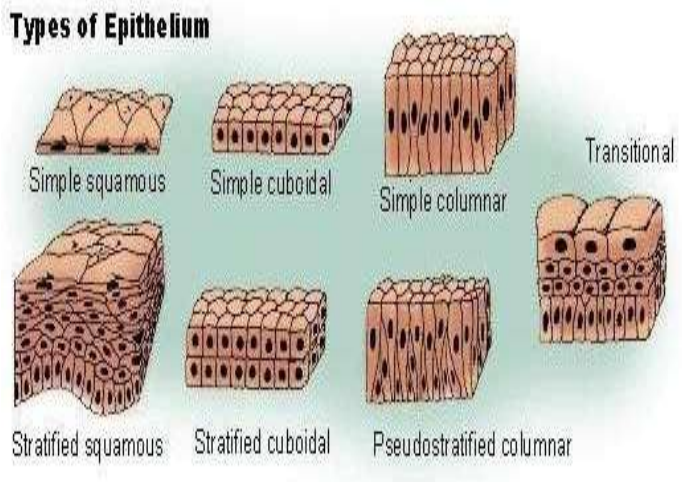


Figure: Showing Different Types Of Epithelial Tissue

CONNECTIVE TISSUE

Theory

This is the most widespread and abundant type of tissue in the human body. Its function is primarily to **support**, **anchor** and **connect** various parts of the body. Connective tissues are formed by the mesoderm of the embryo. Although connective tissue exists in a number of forms, all types have three basic structural elements -- cells, fibres and intercellular substance (ground substance).

Classification of Connective Tissue

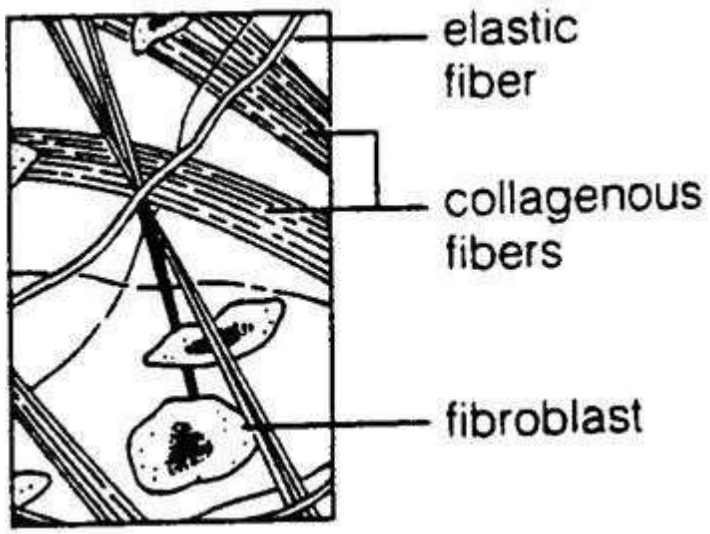
Connective Tissue Proper -- encompasses all organs and body cavities connecting one part with another and, equally important, separating one group of cells from another. This is a very large and diverse group of tissues and includes

adipose tissue (fat), areolar (loose) tissue, and dense regular tissue.

Specialized Connective Tissues -- this group includes cartilage, bone, and blood. Cartilage and bone form the skeletal framework of the body while blood is the vascular (transport) tissue of animals.

Connective tissue proper

Structure: The fibres of areolar connective tissue are arranged in no particular pattern but run in all directions and form a loose network in the intercellular material. Collagen (collagenous) fibres are predominant. They usually appear as broad pink bands. Some elastic fibres, which appear as thin, dark fibres are also present. The cellular elements, such as fibroblasts, are difficult to distinguish in the areolar connective tissue. But, one type of cells - the mast cells are usually visible. They have course, dark- staining granules in their cytoplasm. Since the cell membrane is very delicate it frequently ruptures in slide preparation, resulting in a number of granules free in the tissue surrounding the mast cells. The nucleus in these cells is small, oval and light- staining, and may be obscured by the dark granules.



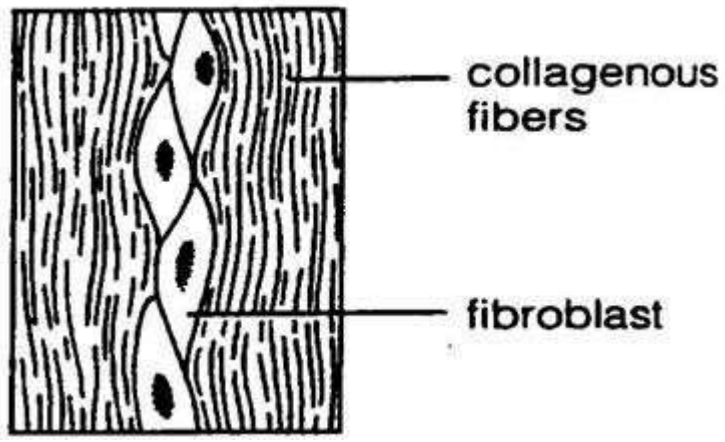
Adipose Connective Tissue

Structure: The cells of adipose (fat) tissue called adipocytes or fat cells are characterized by a large internal fat droplet, which distends the cell so that the cytoplasm is reduced to a thin layer and the nucleus is displaced to the edge of the cell. These cells are often called signet ring cells as they resemble a signet ring when seen in cross section. These cells may appear singly but are more often

present in groups. When they accumulate in large numbers, they become the predominant cell type and form adipose (fat) tissue.

Dense (Fibrous) Regular Connective Tissue

Dense connective tissue is characterized by an **abundance of parallel bundles of fibres fibres** with **fewer cells,** as compared to the loose connective tissue. It is divided into two types: White fibrous connective tissue and yellow elastic connective tissue.



Showing dense regular connective tissue

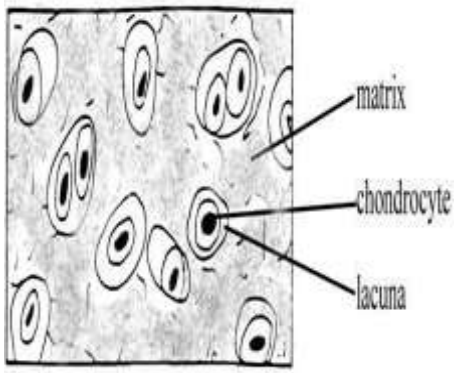
Specialized Connective Tissues

Cartilage (Gristle)

Cartilage is a somewhat elastic, pliable, compact type of connective tissue. It is asoft skeletal tissue. Cartilage is a non-vascular tissue. As such, the cartilage cells or chondrocytes rely on blood vessels in the tissue surrounding the cartilage for nutrient supply and waste removal.

Hyaline Cartilage: It contains clear, large amount of translucent, slightly elastic matrix with less fibres. It is bluish white in colour and shiny in appearance. It is flexible.

Fibrous Cartilage: It has well developed fibres in the matrix. It contains white fibres and yellow fibres. Its colour is glistening white and appearance is opaque. It is more firm.



Result: The microscopic structure of epithelium and connective tissue were studied.

Experiment No. 3

To study the microscopic structure of human muscular tissue and human nervous tissue.

Reference: Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 16-19.

Requirement: A compound microscope and permanent tissue slidesTheory Muscular Tissue

Study of muscle is called **myology**. Muscle tissue is able to contract and relax, providing movement within the body and of the body itself in response to stimuli. Contraction for motility results mainly from the interaction of two contractile proteins, actin and myosin. These proteins enter into the composition for microfilaments of cellular cytoskeleton. The muscle cells are always elongated, slender and spindle-shaped, fibre-like cells. These are therefore, called muscle fibres. These possess large numbers of myofibrils formed of actin and myosin. Muscle contraction requires an adequate of blood to provide sufficient oxygen, calcium and nutrients and to remove waste products.

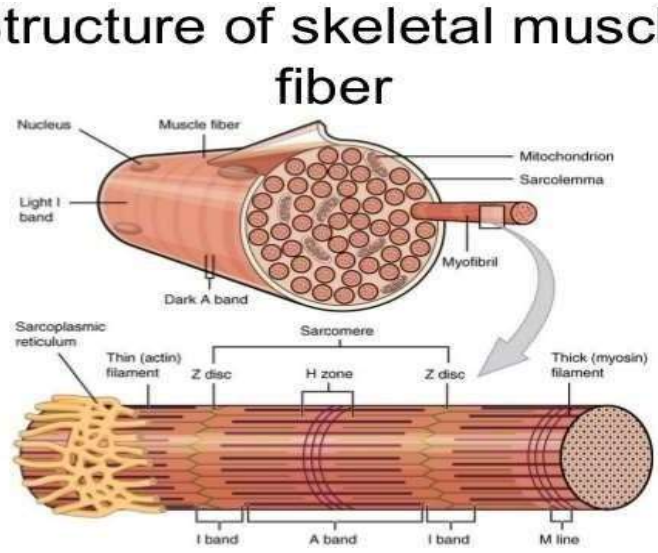
Types Of Muscle Are Following:

Striated or striped muscles (Skeletal Muscle Tissue):

Skeleton muscle is made up essentially of long, unbranched, cylindrical fibres. Striated muscle fibres are 0.01mm to 35 cm long, occurs in bundles and normally attached to the skeleton. The diameter of the fibre is also variable (10 to 60 micron). Each muscle fibre is an elongated cell surrounded externally by a delicate membrane called the **sarcolemma**. Just beneath the sarcolemma, many elongated shaped nuclei occur at irregular intervals along the periphery of the fibre. Thus, these fibres are **multi-nucleated** or **syncytial** in nature. The cytoplasm of each fibre called sarcoplasm is filled with large number of longitudinal fibrils called **myofibrils** which are tightly packed. Two types of fibres can be recognized in most striated muscles, viz white fibres and red fibres. The red fibres are shorter, have more numerous and more deeply situated nuclei, more myoglobin and more numerous mitochondria producing more ATP. These are thus, adapted for prolonged and continued muscle activity required to support the body against gravity and for long continuing athletic events like marathon races. These are therefore also called slow fibres. The white fibres are longer, peripherally situated nuclei and fewer mitochondria, but these degrade

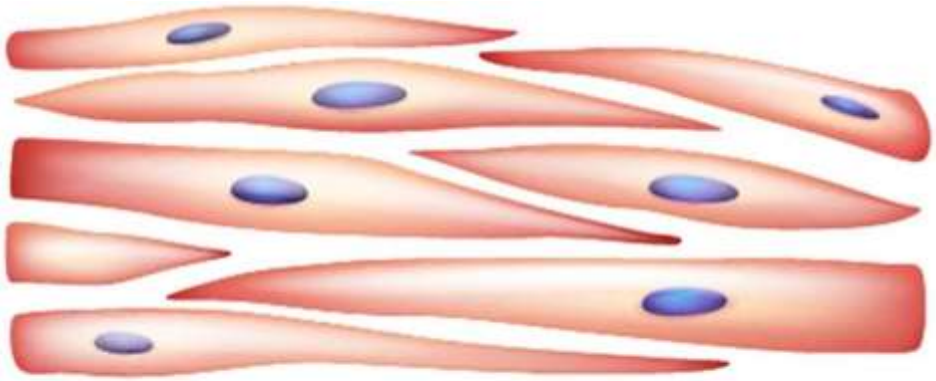
glucose rapidly by glycolytic process to obtain energy at a faster rate. Thus, these are adapted for very rapid and powerful muscle contractions required for jumping, fast running etc.

The most striking feature of skeletal muscle fibres is the presence of transverse striations in them. After staining with haematoxylin, the striations or stripes are seen as alternate dark and light bands that stretch across the muscle fibre. The dark bands are also called **A-bands** (Anisotropic bands). The light bands are also called **I-bands** (Isotropic bands). At the centre of A-band, a comparatively less dark zone called **H-Zone** is present. In the centre of the H-zone is the **M-line**. Each I-band has at its centre a dark membrane called **Z-line**. The part of the myofibril between two successive Z-lines is called **sarcomere**. Each sarcomere is a bundle of thick and thin myofilaments. The thick myofilaments consist mainly of myosin protein whereas thin myofilaments composed of three different proteins- actin, tropomyosin and troponin**.**



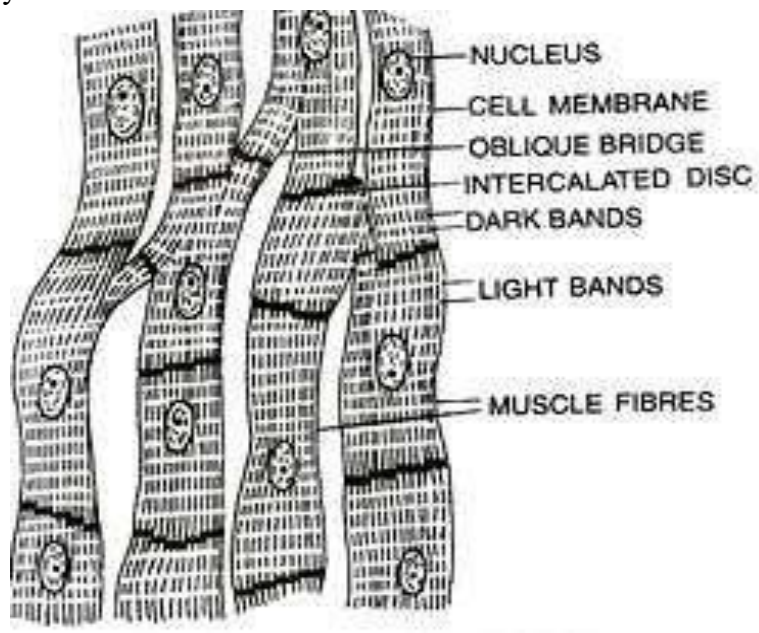
Showing light and dark bands

Smooth (visceral) muscle tissues: These are called smooth, plain, nonstriated, involuntary or unstriped muscles due to absence of striations and is not under conscious control. Contraction is slower and more sustained than skeletal muscle and under the control of autonomic nervous system (ANS). Smooth muscles has the intrinsic ability to contract and relax.



Smooth muscle

Cardiac muscle tissue: Heart wall is made up of cardiac muscles and hence, called myocardium. Structurally, these muscles resemble striated muscle but, functioning independently of the conscious control of brain, these are involuntary like the smooth muscles.



Showing Cardiac Muscle Tissue

Nervous Tissue

A most complex tissue in the body composed of densely packed interconnected nerve cells called neurons. It is specialized in being able to communicate between the various parts of the body and in integration of their activities through impulses. Nervous tissue is ectodermal in origin. It forms the nervous

system of the body which controls and coordinates the body functions. Nerve cells are specialized to receive the external and internal stimuli. A stimulus of adequate strength (threshold stimulus) causes the depolarization or reversal of polarity of the neuron locally and initiates a nerve impulse. The neurons are capable of conducting this depolarization as a wave along their length in a particular direction either to other nerve cells or to effectors like muscles and glands which give the response. The response may be in the form of sensation such as pain or some activity such as muscle contraction or glandular secretion.

Structure of neurons

A neuron is a nerve cell with all its branches. Neuron is formed from neuroblast. It is the structural and functional unit of neural system. It is the longest cell of the body.

1) Cyton: It is also called perikaryon or soma or cell body. The cyton contains granular cytoplasm called neuroplasm. It also contains prominent spherical nucleus, mitochondria, golgi bodies, endoplasmic reticulum, lysosomes, fat globules, **Nissl's granules** and neurofibrils. Nissl's granules are irregular masses of ribosomes.

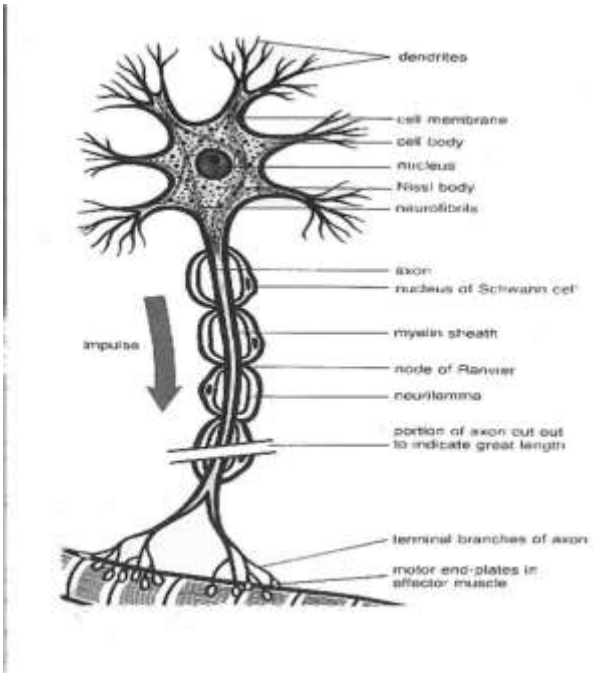
2) **Neuron processes**: The processes of neurons called neurites, extend varying distances from the cyton and are of two types-dendrites or dendrons and an axon or axis cylinder (neuraxon).

Dendron: These are several short, tapering much branched processes. The dendrites contain neurofibrils, neurotubules, Nissl's granules and mitochondria. The dendrites are characterized by the fact that they conduct nerve impulse towards the cell body.

Axon: This is a single very long, cylindrical process of uniform diameter. The axon arises from a conical projection, **the axon hillock**, of the cyton. The axon contains neurofibrils and neurotubules but lacks Nissl's granules, golgi bodies ribosomes and fat globules. As axon lacks nissl's granules, the axon is therefore dependent on the cell body for supply of proteins. The cell membrane of axon is called **axolemma** and its cytoplasm is called **axoplasm**. The axon conducts impulses away from the cell body. It may give off lateral branches termed collateral fibres. The latter arise from a node at right angle. Axon is usually branched only terminally into slender branches called telodendria. The latter have knobbed ends called endbulbs or axon terminlas or synaptic knobs or end plates. The synaptic knobs contain mitochondria and secretory vesicles.

The nerve fibre is either medullated or **myelinated** and non medullated or **non-myelinated**. In medullated nerve fibre medullary sheath is present whereas

medullary sheath is absent in non- myelinated fibre. The medullary is composed of **myelin**. Myelin contains lipids, proteins and water. The presence of myelin or medullary sheath increases the velocity of conduction and also reduces the energy expended in the process of conduction. An axon is related to a large number of **Schwann cells** over its length. Each schwann cell provides the myelin sheath for a short segment of the axon. The medullary sheath is continuous around the nerve fibres in the central nervous system. However, in the nerve fibres of the peripheral nerve fibres, myelin sheath is absent at certain points called the **nodes of Ranvier**. The part of a nerve fibre between two successive nodes of Ranvier is called **internode**. Outside the myelin sheath a thin layer of Schwann cell cytoplasm persists to form an additional sheath which is called the **neurilemma.**



Result: The microscopic structure of muscular and nervous tissue was studied.

Experiment No. 4
To study the axial skeleton system of human body.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 21-23.
Requirement: Charts and model showing skeleton system.

Theory: The skeleton system consists of bones (206 in adults) and joints along with the cartilage and ligaments that occur at the joints.

Functions of the skeleton:

1.Skeleton supports the body: The bones of the lower limbs support the entire body when we are standing and the pelvic girdle supports the abdominal cavity.

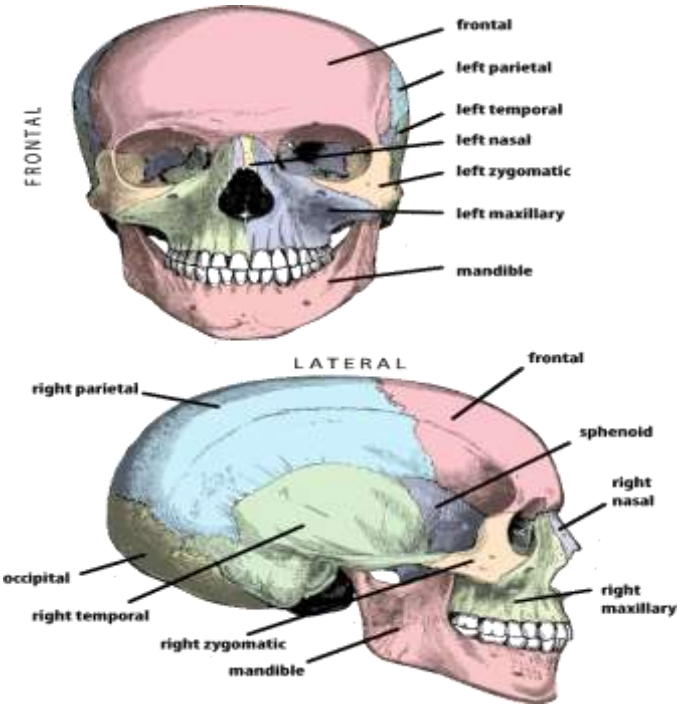
2.Skeleton protects soft body parts: The bones of the skull protect the brain; the rib cage protects the heart and lungs.

3.Skeleton produced blood cells: All bones in foetus have red bone marrow that produces red blood cells.

4.Skeleton stores minerals and fats: All bones have a matrix that contains calcium phosphate, a source of calcium ions and phosphate ions in the blood. Fat is stored in yellow bone marrow.

5.Skeleton along with the muscle permits flexible body movement: While articulation occurs between all the bones, we associate body movement in particular with the bones of the limbs. **Axial skeleton:** It consists of 80 bones – Skull, vertebral column, thoracic cage.

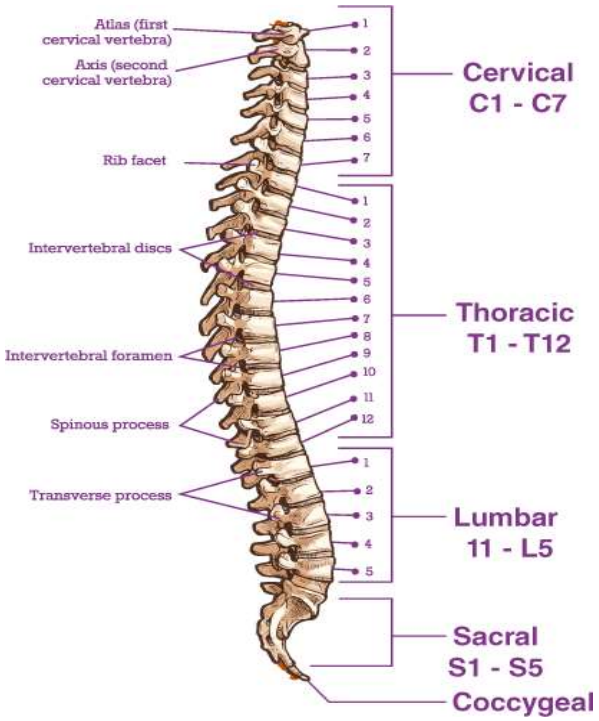
1) Bones of Skull: The skull is formed by the cranium and the facial bones. These bones contains sinuses, air spaces lined by mucous membrane that reduces weight of the skull and give the voice a resonant sound. Bones of skull comprises of two regions –



(a) Bones of cranium: The cranium protects the brain and is composed of eight bones. These bones are separated from each other by immovable joints called sutures. It is composed of one frontal bone, two parietal bones, one occipital bone, two temporal bones, one sphenoid bone and one ethmoid bone.

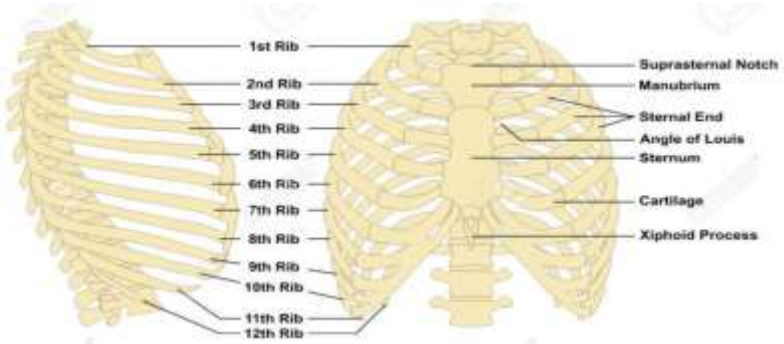
(b) Bones of face: The bones of face consist of two maxillae, one mandible, two zygotic, two palatine, two nasal, two lacrimal and two inferior nasal conchae.

2) Vertebral column or spine: The vertebral column extends from skull to the pelvis. It consists of series of separate bones. Vertebrae separated by pads of fibrocartilage called the intervertebral disc. The vertebrae are named according to their location: seven cervical (neck) vertebrae, twelve thoracic (chest) vertebrae, five lumbar (lower back) vertebrae, five sacral vertebrae fused to form sacrum and three to five coccygeal vertebrae fused into one coccyx.



3) Thoracic cage:

(a) Ribs: There is 12 pair of ribs. All 12 pairs connect directly to the thoracic vertebrae in the back. After connecting with thoracic vertebrae each rib first curves outward and then forward and downward. The upper seven pairs of ribs connect directly to the sternum by means of coastal cartilage. These are called true ribs. The next three pair of ribs is called false ribs. The last two pair of ribs is called floating ribs.



(b) Sternum: It is flat bone that has shape of a blade. It helps to protect heart and lungs. It is composed of three bones that fuse during foetal development. These bones are manubrium, the body and xiphoid process.

Result: The parts of axial skeleton were studied.

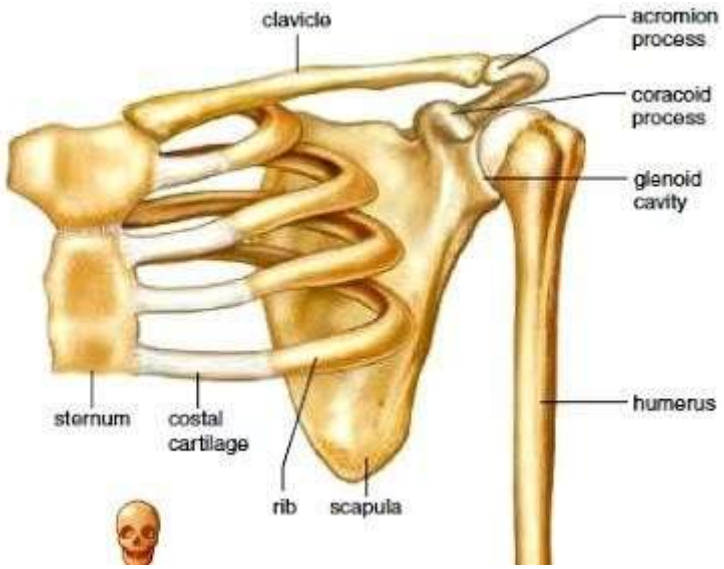
Experiment No. 5
To study the appendicular skeleton system of human body

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 24-26.
Requirement – Charts and model showing skeleton system.

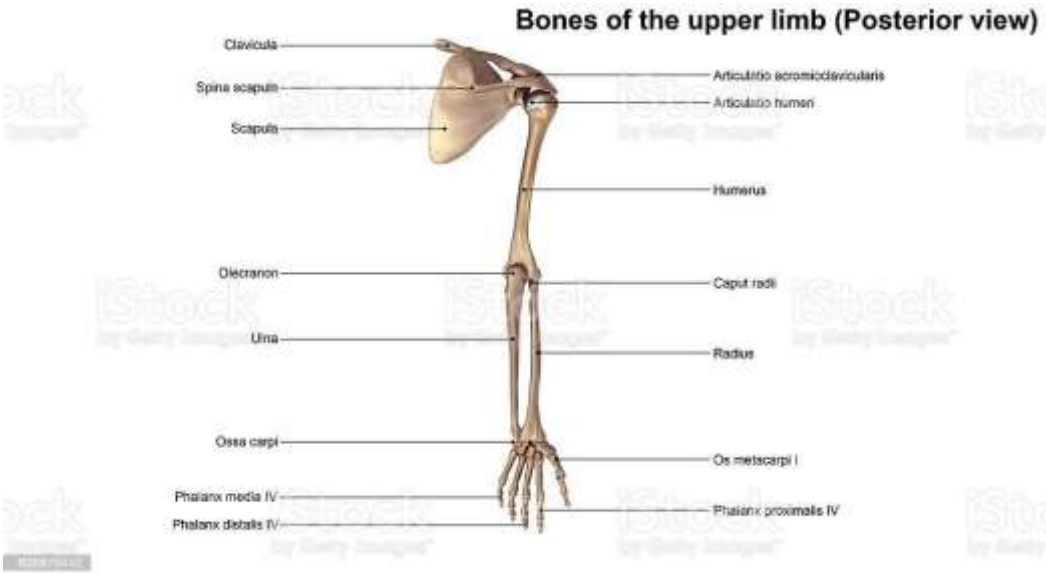
Theory – The skeleton system consist of bones (206 in adults) and joints along with the cartilage and ligaments that occur at the joints.

Appendicular skeleton – It consist of bones of upper limb and lower limb. There are 120 bones present in the appendicular skeleton. This type of skeleton can be studied under the following regions –

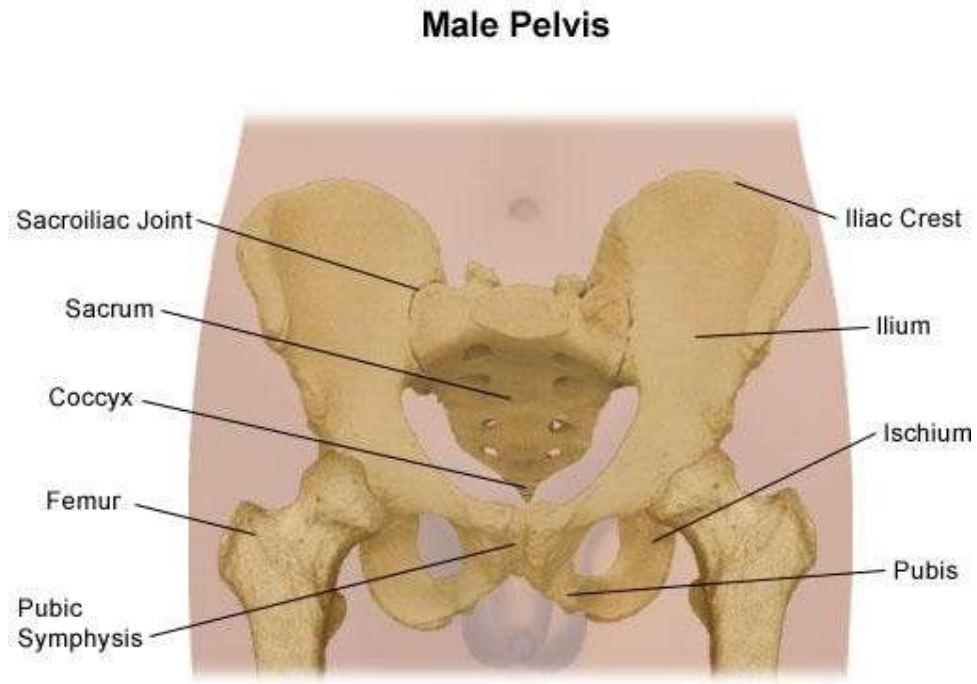
a) Pectoral girdle or shoulder girdle: It contains of a pair of clavicle bones and a pair of scapula i.e., on either side there is one clavicle (collar bone) and one scapula.



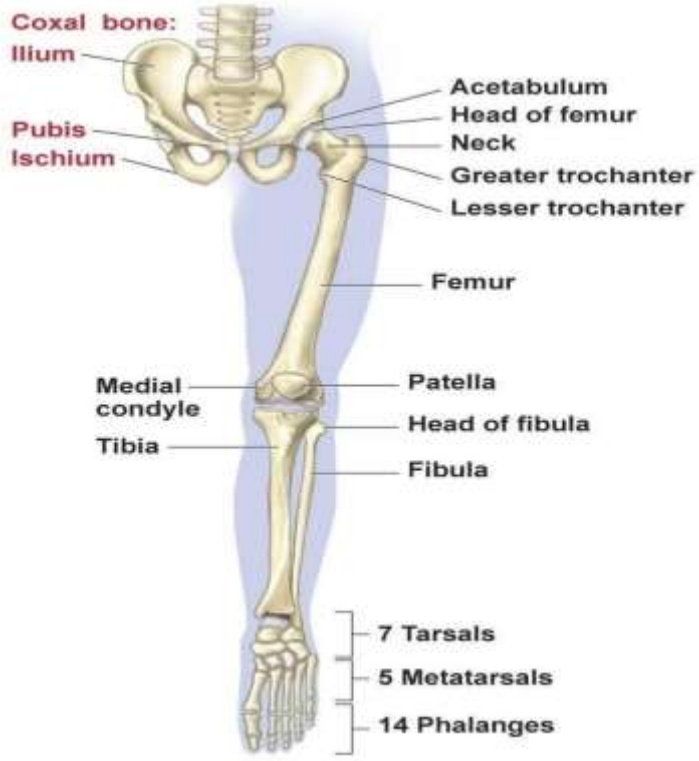
b) Bones of upper limb: It includes the bones of the arm (humerus), the forearm (radius and ulna), and the hand (carpals, metacarpals and phalanges).



c) Pelvic girdle: The pelvic girdle is formed by the bones of hip region which consist of 2 large bones of irregular shape called innominate and sacrum in the centre. Each innominate is made of three different bones joined together. They are ilium, ischium and pubis



d) Bones of lower limb – It includes the bones of the thigh (femur), the kneecap (patella), the leg (tibia and fibula) and the foot (tarsals, metatarsals and phalanges).



Result - The parts of appendicular skeleton were studied.

Experiment No. 6
To study the Neubauer's chamber for the counting of numbers of RBCs.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 27.
Requirement – Improved neubauer's counting

Theory:
This is a type of counting chamber which is frequently used in the laboratories. It is made up of a single colorless glass piece with platform, which consist of the rulings which are to be focused on the microscope and studied.
Neubauer's chamber when focused under the low power of the microscope shows five squares,
i.e. A.B.C.D.E. Improved neubauer's counting chamber the counting chamber was originally invented by crammer in 1885 and was later modified by neubauer's.

STANDARD DIMENSION:-

S.NO	TYPES OF SQUARES	AREA OF SQUARE (length x Breath)	VOLUME OF THE SQUARES (length x Breath x Depth)
1.	Whole big square	3mm x 3mm = 9sq mm.	3mm x 3mm x 1/10 mm. = (9/10 cubic mm
2.	Each ABCD Square.	1mm x 1mm = 1sq.mm	1mm x 1mm x 1/10 mm = 1/10 cubic mm
3.	Small square	1/4 X 1/4 = 1/16 Sq. mm.	1/4 x 1/4 x 1/4 = 1/16 Cubic mm.
4.	Small square in E (total 25)	1/5 x 1/5 = 1/25 Sq. mm.	1/5 x 1/5 x 1/10 = 1/250 cubic mm.

Standard operating Procedure

1.It is used to obtain a very thin film of and fluid or known glass for cellular counts. It consists of a thick glass slide with a polished central plant form divided by a short transverse Sutter into two portions of which is ruled with a counting grid.

2.On either side the central plat form is bounded by a groin called as moat. Each in turn is bounded on its outer side by another plat form, which is slightly higher than the central plat form.

3.A perfectly ground covers slip rests upon the two lateral plat form, thus bridging the moats.

4.The counting grid is made up of a ruled area of these the 4 square at the corners are used for WBC counting while the large square in the centre is based used for RBC counting.

5.Each of the 4 large squares at the corners of the ruled area is used for WBC counting and is called WBC squares.

6.The central large square is for the RBC counting and is called as RBC square. It have an arc of 8 square each medium sized square is further divided into 16 small square each with on.

7.For the total RBC count, the central square containing 400 smallest squares is used. Each smallest square has an area. If a cover slip is placed the depth of the chamber is 1/10 mm maintain the total volume over each of the smallest square as 1/400 cu mm.

Result - The neubauer's chamber was studied.

Experiment No. 7
To determine the total number of white blood cells (WBCs) in 1 mm^3 (1 cu mm.) of your own blood.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 27.
Requirement: Haemocytometer, WBC pipette with white bead, disposable needle, rectified Spirit or absolute alcohol, EDTA, cotton, concentrated hydrochloric acid for cleaning the haemocytometer and Turk's fluid.

Principle: The blood is diluted so that the number of WBCs is brought to a level at which they can be counted easily. For this purpose Turk's fluid containing a stain called Gentian violet is used. This stains the white blood cells and the acetic acid present in Turk's fluid hemolysis the RBC's so that they do not interfere with the counting of WBCs. This test is commonly known as TLC (total leucocyte count).

Procedure: Rinse the WBC pipette (with white head) with EDTA. Clean the finger tip with spirit and give a gentle prick with disposable needle. As soon as the blood oozes out, discard the first drop and suck the blood into the bulb up to 0.5 mm^3 mark. Suck Turk's fluid up to the mark 11 and mix it with blood sucked already into the pipette by making them flow into the bulb of the pipette. Thus the blood gets diluted 20 times instead of 200 times as in RBC count. Let some fluid, below the bulb, flow out. Put a cover slip on the counting chamber of the haemocytometer and touch the tip of the pipette with its edge by keeping the pipette in a slanting position. Fluid will automatically flow into the space between the slide and cover slip due to capillary action. Study the cells under suitable magnification of the microscope and count the number of WBCs in all four corner chambers, each of which is further subdivided into 16 smaller squares.

Observation
Number of WBCS counted in 1st square, say-32 Number of WBCS counted in 2nd square, say-35 Number of WBCS counted in 3rd square, say-33 Number of WBCS counted in 4th square, say-29
Total number of WBC counted from all the four comer chambers 129
Calculations: Mean value 129

Calculation: 129/4=32.25. Total no. of WBCS
=32.25x dilution factor
=32.25 x 20 x 10
=6450

Result: Total no, of WBC in 1 Cu mm (1 mm^3) = 6450 This expression can be developed as-
Mean value of WBCs in 4 comer squares = x 1/10mm^2 has WBCs = x
1 mm^3 of blood has WBCs
= 10x X dilution factor
= 10x X 20
=2000x

Experiment No. 8
To determine the total number of red blood cells in 1 mm^3 (1 cu mm.) of your own blood.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 27.
Equipment: Haemocytometer with Neubauer's counting chamber marked on a Neubauer's slide, RBC pipette with red bead, square cover slip, cotton, absolute alcohol, disposable needle, Haymen's fluid and a student's microscope.
Principles: For the estimation of RBCs, the blood is diluted so that the number of cells in brought to a level at which they can be easily counted. For this purpose Hayem's fluid in used for dilution of a blood sample.

Procedure: Rinse the RBC pipette (with red bead) with EDTA. Sterilize the tip of the finger with rectified alcohol or absolute alcohol and give a prick with disposable needle. Discard the first drop and suck the blood into the pipette up to the 0.5 mm mark Dilute the blood by sucking Haymen's fluid into the same pipette containing blood up to 101 marks. This will dilute the blood 200 times; mix the blood in the bulb of the pipette. Release this diluted blood under the cover slip placed over the counting chamber. The blood will move in, due to capillary action when the pipette is touched with its edges in a slanting position.
Count the number of RBCs from the blood that occupies the central chamber and any of the other 5 squares randomly out of a total of 25 such squares. Since each is further subdivided into 16 small squares the total number of squares counted will be 80 small squares. Hence the observation will be:

Observations:
No. of RBCs counted in 1st square, say-81 No. of RBCs counted in 2nd square, say-91 No. of RBC counted in 3rd square, say-91
No. of RBCs counted in 4th square, say-91 No of RBCs counted in 5 square, say-91 **Calculation:**

Total No. of RBCs in 1/10mm^3 of blood
=5X 425
Total no. of RBCs in 1/10 mm^3 of blood – (1/10 or 0.1 mm is the distance between coverslip and the platform carrying counting chamber measuring 3X3 sq. mm)

= 5 X 425X 10 X 200

Total no. of RBCs = 4.25 million RBCs in 1mm^3 of blood. This observation is developed as follows-
In small squares, no. of RBCs = X
In 40 small squares, no. of RBCs = 5x Has = 5 X RBC
1mm^3 blood has = 50 x X dilution factor 50 x X 200
10,000 x
Result: Total No. of RBCs in 1 mm^3 of blood is 4.24 million.

Precaution

(a) Use disposable needle.
(b) Rinse pipette with EDTA
(c) Clean the finger tip with rectified spirit
(d) Mix the blood in the bulb of the pipette properly with Haymen's fluid
(e) Use low power of microscope.

Experiment No. 9
To determine the bleeding time of your own blood sample.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 34.
Requirements – Pricking needle, filter paper, cotton swabs and stop watch.

Theory:
Bleeding Time – It is the time taken from the puncture of the blood vessel to stoppage of bleeding. Bleeding time measures the capillary and platelet functions in haemostatis. The time is in minutes, which is taken for a standardized skin wounds to stop bleeding is called bleeding time. There are many ways of determining the bleeding time. The results of different methods are not strictly comparable since they depend very much on the exact details of the technique. Normally it is 1-4 min. for normal human's blood.

Procedure:
Bleeding time: The methods commonly used for the determining the bleeding time is Duke's method

Duke's method: It is convenient and commonly used method in practice.
1.Set the stop watch at zero
2.The tip of a finger is cleaned thoroughly with spirit and allowed to dry. Make a puncture deep enough to ensure free flow of blood without squeezing.
3.Immediately stat to stop watch or note the time. The time of puncture of finger is referred as zero time.
4.Thirty seconds later escaping blood is dried on the edge or a clean piece of filter paper.
5.Repeat the procedure in even 30 seconds using a fresh area of the paper on each occasion until bleeding ceases and no further blood spot appears on the filter paper. Therefore each blot of blood on the filter paper represents 30 seconds flow of blood.

Result –
Bleeding time of your own blood by Duke's method is……

Precautions:

- Time should be noted properly.
- Needle should be sterilized.

Experiment No. 10
To determine the clotting time of your own blood sample.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 35-37.
Requirements – Pricking needle, Capillary tubes, cotton swab and stop watch.

Theory: Normally blood remains in the blood vessels in liquid form. When it is a drawn from the body it changes into a semi-solid gel. The mechanism of formation of gel is called blood clotting or coagulation. Blood does not clot inside vessels due to presence of heparin and anti- thrombin III. A blood clot is a gel that contains the formed elements of the Blood, arrested in the stable fibrin mesh.
Clotting time is time taken to coagulate the blood after rupture of blood vessels. Normally it is 3-8 minutes for a normal human blood depending upon platelets count (2-3.5L/cu. mm.) and other clotting factors inside the plasma.

Procedure: This is the most convenient and commonly used method in practice
1.Set the stop watch at zero
2.The tip of a finger is cleaned thoroughly with spirit and allowed to dry. Make a puncture deep enough to ensure free flow of blood without squeezing.
3.Immediately stat to stop watch or note the time. The time of puncture of finger is referred as zero time.
4.When a large drop of blood has collected introduce the end of capillary tube into drop holding the tube such that it is other end will be at a lower level. Blood flows rapidly into the capillary tube.
5.Hold the capillary tube filled to the blood in the palm of hand so as to maintain it at body temperature.
6.At the end one minute break off about 1 cm of the tube from one end and notice if a thread of fibrin connects the broken ends of tube. If there is no fibrin thread, repeat the procedure every 30s sec till a fibrin thread appears. The appearance of fibrin thread of about 5 mm length indicates that the blood has clotted.
7.The total time taken from the time of puncture till the formation of a fibrin thread is the CT. Normal value of CT by this method is 3-8 minutes.

Result: Clotting time of your own blood by Capillary method is……

Precautions:

- Time should be noted properly.
- Needle should be sterilized.
- Capillary should be touched properly in finger.

Experiment No. 11
To estimate the haemoglobin content of your own blood by using Sahli's haemoglobinometer.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 38-39.

Requirements – Sahli's haemoglobinometer, N/10 HCl, distilled water, pricking needle, stirrer and dropper.

IntroduDection:

Haemoglobin is a red conjugated protein present in RBC's and produced in the normoblasts and to some extent in the reticulocytes by the incorporation of four HAEME into one roughly spherical GLOBIN molecule which acts as a carrier of oxygen to the tissue and remove CO_2 from the tissues.

Haemoglobin is converted to acid haematin by addition of N/10 HCl and resulting brown color is compared with standard brown glass of reference block. Acid haematin is insoluble and is present as colloidal. Formation of acid haematin depends upon the amount of Hb in the blood sample. The amount of the haemoglobin can be estimated by conversion of known volume of blood into acid-haematin by addition of dil. HCl and subsequent caloriemeter comparision with a suitable standard.

Procedure –

1.With the help of dropper, take N/10 HCl in the graduated haemoglobinometer tube upto its lowest mark (usually 10% or 2 gm).

2.Prick the finger under aseptic precautions. When a drop of reasonable size has collected, hold the pipette horizontally, apply its tip to the drop and draw exactly 20 cumm of blood into pipette, taking care that there should be no air bubbles. Take the pipette away and wipe off any blood adhering to the tip.

3.Immediately transfer the blood from the pipette into the N/10 HCl in the graduated haemoglobinometer tube and rinse the pipette several times by drawing the N/10 HCl used for mixing the blood. Avoid foaming.
4.Mix the content thoroughly and leave the solution to stand for about 10 minutes for maximum conversion of haemoglobin in blood to acid haematin (brown in colour)
5.Dilute the acid haematin by adding distilled water in drops. Keep mixing it with the stirrer thoroughly.
6.Continue dilution till its colour matches with that of the standard. Before comparing colour, the stirrer should be lifted above the solution only.
7.Note the reading of the meniscus from the scale provided on the haemoglobinometer tube and expresses the haemoglobin content as gm per 100 ml of the blood.

Observations:
Table: Reading of dil. acid haematin as compared to the standard colour –

S. No.	When darker	When lighter	Average (gm %)
1.			
2.			

Result – Haemoglobin content of my blood is ……

Precautions
- **After Step no. 5,** at no stage the stirrer should be completely taken out of the tube.
- Since the colours may seem to match over a wide range of dilutions, it is advisable to take the average of 2 readings during the course of dilutions; the first when it is just discernably darker and the second when it is just gets a shade lighter than the standard.

Experiment No. 12
To determine the blood group of your own blood

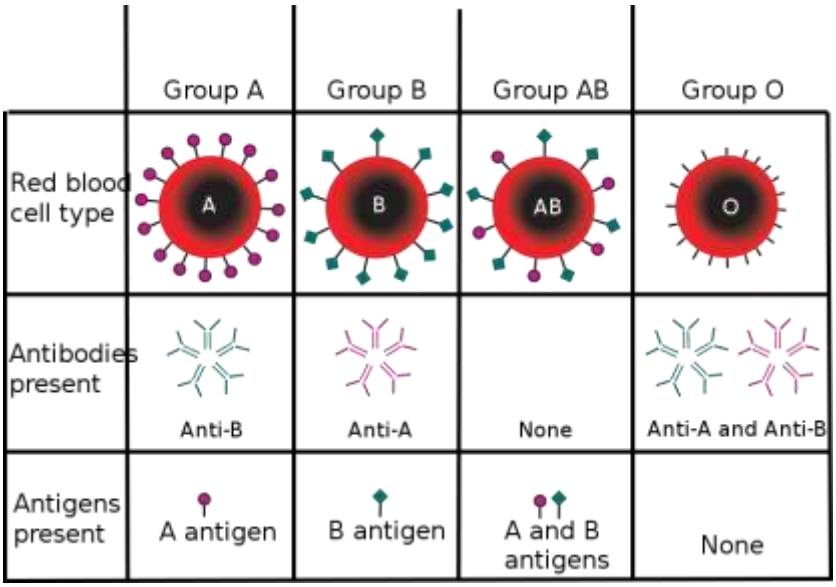
Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 38-39.

Requirements – Antiserum – A, Antiserum – B, Antiserum – Rh, isotonic saline (0.9%NaCl), glass slides, applicator sticks, compound microscope, glass marking pencil and capillary dropper.

Principle – More than 30 blood groups specific antigen (i.e. agglutinations) can be recognized on the membrane of human RBCs. These antigens enable the blood groups of different individuals to be differentiated. The chief blood groups are:

1.Classical ABO blood groups

2.Rhesus (Rh) blood group



1.The ABO blood group system was first discovered by Landsteiner in 1900. It is based on the presence or absence of blood group specific substances A, B and O in the RBCs. Accordingly human beings can be divided into 4 main group viz., A, B, AB and O blood groups.

2.The Rh blood group system was discovered by Landsteiner and Weinar in 1940. RBCs of rhesus monkeys when injected into rabbits, the rabbits responded to the presence of an antigen in these cells by forming an antibody which agglutinated Rhesus RBCs. If the immunized rabbits serum is tested against human RBCs, agglutination occurs in 85% of men, these people are called Rh '+' (positive) and their serum contains no Rh antibody. No agglutination occurs in 15% these are called Rh '-' (negative) and their serum contains no Rh antibody.

3.The procedure is based on the principle of agglutination i.e. clumping of RBCs. The phenomenon of agglutination is due to interaction between the factors – agglutinogen (antigen) present on the RBCs membrane and agglutinin (antibody) present in the plasma.

4.Normal human RBCs possessing a particular antigen will show agglutination in presence of the corresponding antibody. This may occur quite soon but may not develop for several minutes, if the agglutinin titre of the serum is low.

Procedure –

A. Preparation of red cell suspension –

Take 3 ml of isotonic saline (0.9% NaCl) in a clean test tube. Finger is pricked under aseptic precautions so as to assure free flow of blood, the first drop of blood is wiped away with a clean piece of cloth and a drop of blood is added to the test tube. Alternately, red cell suspension may be prepared simply by inverting the test tube over the finger pricked.

B. Determination of blood groups –

1.Take an ordinary grease free, clean glass slide and one drop each of antiserum-A, antiserum- B, antiserum-Rh (i.e. serum containing antibodies α, β and anti-D respectively) is placed there on with the help of a dropper. In addition, one drop of isotonic saline (used as control) is also placed on the slide. The slides are accordingly labelled as anti-A, anti-B, anti-D and control.

2.The red cell suspension is drawn from the bottom of the test tube into capillary dropper and a drop of it is added to each of the drops on the slide. (Take utmost care that the nozzle of dropper should not touch any of the drops). The two are mixed with the help of separate application sticks.

3.Wait for 10 minutes, the slides is then gently rocked back and forth and examined for the presence of agglutination (clumping of RBCs) confirm the finding under the low power microscope:

i. If there is no agglutination, the RBCs remain separated and evenly distributed; and

ii. If agglutination occurs, the RBCs are massed together in clumps and lose their outline.

4.**The blood group is determined as indicated in the table below.**

Blood Group	**Reaction with serum**		
	A or Anti-B (antibody: β)	**B or Anti-A (antibody: α)**	**Anti-Rh (antibody: anti-D)**
A	**-**	+	
B	+	**-**	
AB	+	+	
O	**-**	**-**	
Rh+			+
Rh-			**-**

'+': Agglutination i.e. RBCs are massed together in clumps and lose their outline. '-': No agglutination i.e. RBCs remain separate and evenly distributed.

Observation

Table – Reaction of the subject's cells:

Antiserum - A	**Antiserum – B**	**Antiserum - Rh**	**Blood group**

'+': Agglutination present '-': Agglutination absent

Result: My blood group was found to be…….

Experiment No. 13
To measure and record the arterial blood pressure.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 48-51.

Requirement: An examination couch, sphygmomanometer, stethoscope.

Theory:

1.The arterial blood pressure is the pressure exerted by a column o blood on the vessel wall while flowing through it.

2.Components

(a) Systolic BP. It is the maximum pressure exerted during systole; normal: 100-130 mmHg (average 120mmHg).

(b) Diastolic BP. It is the minimum pressure exerted during diastole, normal: 60-90 mmHg (average 80 mmHg).

(c) Pulse pressure. It is the difference of systolic and diastolic BP; normal: 40 mmHg (average).

(d) Mean BP. It is the average pressure throughout the cardiac cycle and computed as; Diastolic BP + 1/3 pulse pressure; normal: 95-100 mmHg (average 96 mmHg).

3.Clinically BP is exposed as SBP/DBP; normal: 120/80 mmHg.

4.Systolic BP undergoes considerable fluctuation; eg. Increased excitement, anxiety, nervousness, after meals, etc. and decreased by rest, and during sleep. Therefore for resting measurement the subject should be quiet for at least five minutes before the measurement are made.

Systemic arterial BP can be measured by two methods.

1.Direct method
2.Indirect method

Indirect method –

Principle – It involves balancing of pressure in a bag i.e. Air pressure against the pressure of the blood in an artery. The air pressure is estimated by means of mercury or air manometer.

Apparatus – Sphygmomanometer

Procedure – Two methods all in early hours of for measurement of systemic mmHg due to generalized palpatory and ausculatory method.

Palpatory Method –

(1) Allow the subject to sit comfortably in a chair or to lie supine on the examination couch for 5 minutes.

(2) The uninflatted cuff of sphygmomanometer us wrapped firmly around the upper arm 2.5-3 cm above the elbow joints at the heart level.

(3) Feel for radial pulse and inflate the rubber bag to increase the pressure sufficient enough so as to occlude the branchial artery the radial pulse will disappear at the wrist.

(4) Now deflate the cuff slowly releasing the pressure @ 2-3 mmHg; while lowering the pressure keep palpitating the radial artery and reading is taken just when pulse starts reappearing. This gives the systolic BP.

Ausculatory method – This method was introduced by Russian physician Korotkoff in 1905. Take the following steps –

(1) Allow the subject to sit comfortably in a chair or to lie supine on the examination counch for 5 minutes.

(2) The uninflected cuff sphygmomanometer is wrapped firmly around the upper arm 2.5-3 cm above the elbow joints at the heart level.

(3) Place the chest piece of stethoscope over the arm medial. To the tendon of biceps where pulsation of bronchial artery are felt. Under ordinary circumstances if a stethoscope is placed over an artery no sound can be heart as the streamline flow of blood through the unconstructed blood vessel produces no sound.

(4) Inflate the cuff rapidly until the pressure in it well above the systolic BP. As

(5) The pressure in the cuff is further progressively lowered @ 2-3 mmHg/sec, while listening for the appearance of the sound of Korotkoff's. The sound under goes a series of changes in quality and becomes dull and muffled to finally

disappear. The cuff pressure at which the sound becomes muffled or disappears in the diastolic BP.

(6) Express the BP as SBP/DBP (mmHg) take two or three reading.

Result:

1.1st reading

.....

.....

2.2nd reading

.....

.....

	Systolic B.P. (mmHg)	**Diastolic B.P. (mmHg)**	**Pulse Pressure (mmHg)**	**Mean B.P. (mmHg)**
1.1st reading 2.2nd reading				

Experiment No. 14
To measure and record the pulse rate of your own body.

Reference: Randhawa S.S., Kabra A., Human Anatomy and Physiology-I Practical, Published by S. Vikas and Company, 1st Edition 2018, p.p. 46-47.
Requirement: An examination, stethoscope and Stopwatch.

Principle: Pulse can be defined as the wave of distension which moves along the artery in such a way that it coincides with the heat of the heart. The elastic walls of the artery expand when blood Dows through it with pressure. This pressure in exerted when the blood is forced out of the left ventricle. With each beat additional amount of blood is forced out of heart into the arteries. It is a type of wave that passes along the artery, therefore it is also called pulse wave. The expansion and contraction of the artery with each wave can be felt with finger tips. The rate of contractions and expansion of the pulse not only indicates the condition of the heart but also the general condition of the patient. One can feel the pulse in the radial, brachial, carotid, femoral, axillary, temporal arteries

Procedure: The pulse can be felt at any place where a large artery can be pressed against a bone below it. The most convenient is the radial artery in the wrist. It can be pressed against the radius bone. If this is not possible for some reason then the pulse can be taken from the temporal branch (lying close to the ear) of the external carotid of the common carotid. The person whose pulse has been to be taken must be calm and relaxed. The tips of the three middle fingers of the hand should be placed over the radial artery and pressure exerted to press it against the radius hone. Count the beats of the pulse for one minute and record the same.
The pulse rate or the number of heart beats per minute ranges from 60 to 80 for adults and 90 to 130 for children.

Result: The average Pulse rate was found to be……...

Precautions:

- The pressure should be applied on the artery in such a way that it does not stop the pulse wave completely.
- The pulse should be counted for one full minute
- Unless indicated for specific purpose, the pulse should not be recorded immediately after exercise, excitement or emotional stress.

Practical Viva Voice
Experiment 1
Study of Compound Microscope

A. Multiple Choice Questions (MCQs)

1. **The resolving power of a compound microscope depends on:**
   a) Numerical aperture
   b) Magnification only
   c) Tube length
   d) Light source only

2. **The total magnification of a microscope is obtained by:**
   a) Adding eyepiece and objective magnifications
   b) Dividing eyepiece by objective magnification
   c) Multiplying eyepiece and objective magnifications
   d) Subtracting one from another

3. **The part of microscope that regulates light is:**
   a) Stage
   b) Condenser
   c) Diaphragm
   d) Mirror

4. **Which part of microscope is used to place the specimen slide?**
   a) Nosepiece
   b) Stage
   c) Condenser
   d) Arm

5. **The mirror in a compound microscope is usually:**
   a) Plano-concave
   b) Plano-convex
   c) Biconcave
   d) Convex

6. **The lens nearest to the specimen is called:**
   a) Objective lens
   b) Eyepiece lens
   c) Condenser lens
   d) Diaphragm

7. **Immersion oil is used in which objective lens?**
   a) 4x
   b) 10x
   c) 40x
   d) 100x

8. **The fine adjustment knob is used for:**
   a) Coarse focusing
   b) Precise focusing
   c) Light adjustment
   d) Image inversion
9. **Which objective is known as the "high power lens"?**
   a) 4x
   b) 10x
   c) 40x
   d) 100x
10. **The principle of compound microscope is based on:**
    a) Reflection of light
    b) Refraction of light
    c) Polarization of light
    d) Diffraction of light

B. Short / One-Word Questions

1. Lens close to the specimen?
   Answer: Objective lens
2. Lens close to the eye?
   Answer: Eyepiece
3. Lens system used in compound microscope?
   Answer: Objective + eyepiece
4. Lens used to concentrate light on specimen?
   Answer: Condenser
5. Adjustment knob used for rough focusing?
   Answer: Coarse adjustment
6. Adjustment knob used for fine focusing?
   Answer: Fine adjustment
7. Numerical aperture increases with use of ___?
   Answer: Immersion oil
8. What is the magnification of eyepiece lens generally used?
   Answer: 10x
9. Light source in a simple microscope?
   Answer: Natural sunlight / mirror
10. Father of microscopy?
    Answer: Antonie van Leeuwenhoek

Experiment 2
Microscopic Study of Epithelial & Connective Tissue

A. Multiple Choice Questions (MCQs)

1. The epithelial tissue lining the alveoli of lungs is:
   a) Simple squamous epithelium
   b) Simple cuboidal epithelium
   c) Simple columnar epithelium
   d) Transitional epithelium

2. **Which epithelial tissue is specialized for absorption in intestines?**
   a) Ciliated epithelium
   b) Simple columnar epithelium
   c) Stratified squamous epithelium
   d) Transitional epithelium

3. **Transitional epithelium is found in:**
   a) Skin
   b) Urinary bladder
   c) Stomach
   d) Blood vessels

4. **Keratinized stratified squamous epithelium is seen in:**
   a) Buccal cavity
   b) Esophagus
   c) Skin
   d) Trachea

5. **Connective tissue that stores fat is:**
   a) Areolar tissue
   b) Cartilage
   c) Adipose tissue
   d) Bone

6. **Cartilage is an example of:**
   a) Muscular tissue
   b) Nervous tissue
   c) Connective tissue
   d) Epithelial tissue

7. **Which connective tissue connects muscle to bone?**
   a) Ligament
   b) Tendon
   c) Cartilage
   d) Fascia

8. **Which connective tissue connects bone to bone?**
   a) Tendon
   b) Ligament
   c) Cartilage
   d) Muscle

9. **Which connective tissue has fluid matrix?**
   a) Bone
   b) Blood
   c) Cartilage
   d) Adipose tissue

10. **Which of the following is a specialized connective tissue?**
    a) Blood
    b) Areolar tissue
    c) Adipose tissue
    d) Ligament

B. Short / One-Word Questions

1. Tissue lining kidney tubules?
   Answer: Simple cuboidal epithelium
2. Tissue forming tendons?
   Answer: Dense regular connective tissue
3. Tissue forming ligaments?
   Answer: Dense regular connective tissue
4. Tissue with microvilli for absorption?
   Answer: Simple columnar epithelium
5. Tissue present in urinary bladder?
   Answer: Transitional epithelium
6. Protein providing strength to connective tissue?
   Answer: Collagen
7. Most abundant connective tissue in body?
   Answer: Areolar tissue
8. Connective tissue rich in fat storage?
   Answer: Adipose tissue
9. Connective tissue forming framework of ear?
   Answer: Elastic cartilage
10. Connective tissue forming skeleton?
    Answer: Bone

Experiment 3
Microscopic Study of Muscular & Nervous Tissue

A. Multiple Choice Questions (MCQs)

1. **Skeletal muscle is:**
   a) Voluntary and striated
   b) Involuntary and striated
   c) Involuntary and non-striated
   d) Voluntary and non-striated

2. **Cardiac muscle is:**
   a) Voluntary, striated
   b) Involuntary, striated
   c) Involuntary, non-striated
   d) Voluntary, non-striated

3. **Smooth muscles are found in:**
   a) Heart
   b) Bones
   c) Walls of hollow organs
   d) Tongue

4. **The basic functional unit of skeletal muscle is:**
   a) Myofibril
   b) Sarcomere
   c) Actin
   d) Myosin

5. **Intercalated discs are present in:**
   a) Skeletal muscle
   b) Cardiac muscle
   c) Smooth muscle
   d) All muscles

6. **Which muscle is multinucleated?**
   a) Skeletal
   b) Cardiac
   c) Smooth
   d) None of the above

7. **The contractile proteins of muscle are:**
   a) Tubulin and collagen
   b) Actin and myosin
   c) Myelin and elastin
   d) Keratin and fibrin

8. **Functional unit of nervous tissue:**
   a) Axon
   b) Neuron
   c) Dendrite
   d) Ganglion

9. **The insulating covering around axons is:**
   a) Collagen sheath
   b) Myelin sheath
   c) Sarcolemma
   d) Endothelium

10. **Neurotransmitter released at neuromuscular junction:**
    a) Dopamine
    b) Acetylcholine
    c) Serotonin
    d) Norepinephrine

B. Short / One-Word Questions

1. Contractile unit of muscle?
   Answer: Sarcomere

2. Basic contractile proteins in muscle?
   Answer: Actin and Myosin

3. Muscle attached to bones?
   Answer: Skeletal muscle

4. Muscle found in walls of intestine?
   Answer: Smooth muscle

5. Muscle forming walls of heart?
   Answer: Cardiac muscle

6. Junction between two neurons?
   Answer: Synapse

7. Insulating sheath around axons?
   Answer: Myelin sheath

8. Supportive cells of nervous system?
   Answer: Neuroglia

9. Gap between two Schwann cells along an axon?
   Answer: Node of Ranvier

10. The structural and functional unit of nervous system?
    Answer: Neuron

Experiment 4
Identification of Axial Bones

A. Multiple Choice Questions (MCQs)

1. **The axial skeleton includes:**
   a) Skull, vertebral column, thoracic cage
   b) Limbs and girdles
   c) Pectoral and pelvic girdle
   d) All bones of upper limb

2. **Total number of bones in the axial skeleton is:**
   a) 80
   b) 126
   c) 206
   d) 64

3. **The number of bones in the human skull is:**
   a) 20
   b) 22
   c) 26
   d) 32

4. **Which of the following is a cranial bone?**
   a) Maxilla
   b) Mandible
   c) Frontal
   d) Zygomatic

5. **The vertebral column consists of how many vertebrae in adults?**
   a) 28
   b) 30
   c) 33
   d) 26

6. **The bone forming the lower jaw is:**
   a) Maxilla
   b) Mandible
   c) Zygomatic
   d) Temporal

7. **The sternum is part of:**
   a) Skull
   b) Vertebral column
   c) Thoracic cage
   d) Appendicular skeleton

8. **The hyoid bone is unique because:**
   a) It is the strongest bone
   b) It does not articulate with any other bone
   c) It forms the base of skull
   d) It is the smallest bone

9. **The rib cage consists of how many pairs of ribs?**
   a) 10
   b) 12
   c) 14
   d) 16

10. **The atlas vertebra is:**
    a) First cervical vertebra
    b) Second cervical vertebra
    c) Last lumbar vertebra
    d) First thoracic vertebra

B. Short / One-Word Questions

1. **Total number of bones in skull?**
   Answer: 22
2. **Largest cranial bone?**
   Answer: Frontal bone
3. **Bone forming cheek prominence?**
   Answer: Zygomatic bone
4. **Bone forming upper jaw?**
   Answer: Maxilla
5. **Bone forming lower jaw?**
   Answer: Mandible
6. **First cervical vertebra is called?**
   Answer: Atlas
7. **Second cervical vertebra is called?**
   Answer: Axis
8. **Number of thoracic vertebrae?**
   Answer: 12
9. **Number of lumbar vertebrae?**
   Answer: 5
10. **Flat bone in front of chest?**
    Answer: Sternum

Experiment 5
Identification of Appendicular Bones

A. Multiple Choice Questions (MCQs)

1. **Appendicular skeleton consists of:**
   a) Skull and vertebral column
   b) Upper and lower limbs with girdles
   c) Ribs and sternum
   d) Skull and rib cage

2. **Total number of bones in the appendicular skeleton is:**
   a) 80
   b) 126
   c) 206
   d) 64

3. **The clavicle is commonly called:**
   a) Shoulder blade
   b) Collar bone
   c) Breast bone
   d) Arm bone

4. **The scapula is also known as:**
   a) Collar bone
   b) Shoulder blade
   c) Hip bone
   d) Knee cap

5. **The humerus is located in the:**
   a) Arm
   b) Forearm
   c) Thigh
   d) Leg

6. **The longest bone of the human body is:**
   a) Tibia
   b) Humerus
   c) Femur
   d) Fibula

7. **The patella is commonly known as:**
   a) Ankle bone
   b) Knee cap
   c) Elbow bone
   d) Wrist bone

8. **Which bone forms the forearm along with ulna?**
   a) Humerus
   b) Radius
   c) Scapula
   d) Clavicle

9. **The pelvic girdle consists of:**
   a) Clavicle and scapula
   b) Ilium, ischium, pubis
   c) Femur and tibia
   d) Sacrum and coccyx

10. **The number of phalanges in each hand is:**
    a) 12
    b) 14
    c) 16
    d) 18

B. Short / One-Word Questions

1. **Total bones in appendicular skeleton?**
   Answer: 126

2. **Bone forming upper arm?**
   Answer: Humerus

3. **Bone forming thigh?**
   Answer: Femur

4. **Bone forming forearm (lateral side)?**
   Answer: Radius

5. **Bone forming forearm (medial side)?**
   Answer: Ulna

6. **Common name of scapula?**
   Answer: Shoulder blade

7. **Common name of clavicle?**
   Answer: Collar bone

8. **Small sesamoid bone in front of knee joint?**
   Answer: Patella

9. **Number of carpal bones in one hand?**
   Answer: 8

10. **Number of tarsal bones in one foot?**
    Answer: 7

Experiment 6
Introduction to Hemocytometry

A. Multiple Choice Questions (MCQs)

1. **The instrument used for counting blood cells is**:
   a) Sphygmomanometer
   b) Hemocytometer
   c) Colorimeter
   d) Hemoglobinometer

2. **Hemocytometer was originally designed by:**
   a) Robert Koch
   b) Louis Pasteur
   c) Louis-Charles Malassez
   d) William Harvey

3. **Hemocytometer consists of:**
   a) Counting chamber with ruled grid
   b) Capillary tubes
   c) Microscope slides
   d) Glass pipettes only

4. **Depth of the counting chamber in hemocytometer is:**
   a) 0.01 mm
   b) 0.02 mm
   c) 0.1 mm
   d) 1.0 mm

5. **Total area of central large square in Neubauer's chamber is:**
   a) 0.5 mm^2
   b) 1 mm^2
   c) 2 mm^2
   d) 3 mm^2

6. **RBCs are usually counted in:**
   a) 25 small squares of central square
   b) 5 small squares of central square
   c) 16 small squares of corner squares
   d) Whole chamber

7. **WBCs are usually counted in:**
   a) Four corner large squares
   b) Central large square
   c) Middle row squares
   d) All 9 squares

8. **Diluting fluid for RBC count is:**
   a) Turk's fluid
   b) Hayem's fluid
   c) Normal saline
   d) Acetic acid

9. **Diluting fluid for WBC count is:**
   a) Hayem's fluid
   b) Turk's fluid
   c) Formalin
   d) Gower's fluid

10. **The ruled area of Neubauer's hemocytometer consists of:**
    a) 1 large square divided into 9 squares
    b) 9 large squares divided into smaller squares
    c) 16 squares only
    d) No subdivisions

B. Short / One-Word Questions

1. **Device used for blood cell counting?**
   Answer: Hemocytometer
2. **Inventor of hemocytometer?**
   Answer: Louis-Charles Malassez
3. **Thickness of coverslip used in hemocytometer?**
   Answer: 0.4 mm (special coverslip)
4. **Depth of Neubauer chamber?**
   Answer: 0.1 mm
5. **Area of central square?**
   Answer: 1 mm^2
6. **Number of large squares in Neubauer ruling?**
   Answer: 9
7. **Fluid used for RBC count?**
   Answer: Hayem's fluid
8. **Fluid used for WBC count?**
   Answer: Turk's fluid
9. **Diluting fluid that stains nuclei of WBCs?**
   Answer: Turk's fluid (with acetic acid & gentian violet)
10. **Microscope used with hemocytometer?**
    Answer: Compound microscope

Experiment 7
Enumeration of White Blood Cell (WBC) Count

A. Multiple Choice Questions (MCQs)

1. **Normal WBC count in adults per mm³ of blood is:**
   a) 2000–4000
   b) 4000–11000
   c) 12000–15000
   d) 15000–20000

2. **An increase in WBC count is termed:**
   a) Leukopenia
   b) Leukocytosis
   c) Anemia
   d) Polycythemia

3. **A decrease in WBC count is called:**
   a) Leukocytosis
   b) Leukopenia
   c) Thrombocytopenia
   d) Erythropenia

4. **Diluting fluid used in WBC count is:**
   a) Hayem's solution
   b) Turk's solution
   c) Normal saline
   d) Gower's solution

5. **Turk's solution contains:**
   a) Acetic acid and gentian violet
   b) Formalin
   c) Sodium chloride
   d) Eosin

6. **The counting chamber used for WBC enumeration is:**
   a) Neubauer hemocytometer
   b) Sphygmomanometer
   c) Spectrophotometer
   d) Microscope slide

7. **WBCs are counted in which squares of Neubauer chamber?**
   a) Central square
   b) Four large corner squares
   c) Middle row
   d) All small squares

8. **WBC count is expressed as:**
   a) Cells/mm³
   b) g/dL
   c) mmHg
   d) Ml

9. **WBCs are also called:**
   a) Erythrocytes
   b) Leukocytes
   c) Thrombocytes
   d) Platelets

10. **Which of the following may lead to leukocytosis?**
    a) Viral infection
    b) Bacterial infection
    c) Bone marrow suppression
    d) Severe anemia

B. Short / One-Word Questions

1. **Another name for WBCs?**
   Answer: Leukocytes
2. **Normal adult WBC range?**
   Answer: 4000–11000/mm³
3. **Decrease in WBC count?**
   Answer: Leukopenia
4. **Increase in WBC count?**
   Answer: Leukocytosis
5. **Staining fluid used in WBC count?**
   Answer: Turk's solution
6. **Counting device used?**
   Answer: Hemocytometer
7. **Number of large squares used for counting WBCs?**
   Answer: 4
8. **WBCs help in:**
   Answer: Immunity
9. **Main type of WBC involved in bacterial infection?**
   Answer: Neutrophils
10. **Main type of WBC involved in allergic reaction?**
    Answer: Eosinophils

Experiment 8
Enumeration of Red Blood Corpuscles (RBC) Count

A. Multiple Choice Questions (MCQs)

1. **Normal RBC count in adult males per mm³ of blood is:**
   a) 3–4 million
   b) 4.5–6 million
   c) 7–8 million
   d) 10 million

2. **RBC count in adult females per mm³ is approximately:**
   a) 4–5 million
   b) 4.5–5.5 million
   c) 5–6 million
   d) 6–7 million

3. **RBCs are also called:**
   a) Leukocytes
   b) Erythrocytes
   c) Thrombocytes
   d) Platelets

4. **RBCs are responsible for:**
   a) Clotting
   b) Oxygen transport
   c) Immune defense
   d) Hormone transport

5. **Diluting fluid used in RBC count is:**
   a) Hayem's solution
   b) Turk's solution
   c) Normal saline
   d) Gower's fluid

6. **The hemocytometer used for RBC count is:**
   a) Neubauer chamber
   b) Wintrobe tube
   c) Sphygmomanometer
   d) Spectrophotometer

7. **RBCs lack:**
   a) Nucleus
   b) Hemoglobin
   c) Cytoplasm
   d) Membrane

8. **Lifespan of RBCs is approximately:**
   a) 60 days
   b) 90 days
   c) 120 days
   d) 150 days

9. **RBC count is expressed as:**
   a) Cells/mm³
   b) Cells/L
   c) g/dL
   d) mmHg

10. **Increase in RBC count is called:**
    a) Anemia
    b) Polycythemia
    c) Leukopenia
    d) Thrombocytopenia

B. Short / One-Word Questions

1. **Another name for RBCs?**
   Answer: Erythrocytes
2. **Protein responsible for oxygen transport?**
   Answer: Hemoglobin
3. **Normal RBC count in adult males?**
   Answer: 4.5–6 million/mm³
4. **Normal RBC count in adult females?**
   Answer: 4–5.5 million/mm³
5. **Diluting fluid used for RBC count?**
   Answer: Hayem's solution
6. **Counting chamber used?**
   Answer: Hemocytometer
7. **Shape of RBC?**
   Answer: Biconcave
8. **Lifespan of RBC?**
   Answer: 120 days
9. **RBCs are produced in:**
   Answer: Bone marrow
10. **Condition of decreased RBC count?**
    Answer: Anemia

Experiment 9
Determination of Bleeding Time

A. Multiple Choice Questions (MCQs)

1. **Normal bleeding time in adults is approximately:**
   a) 1–2 minutes
   b) 2–7 minutes
   c) 8–12 minutes
   d) 10–15 minutes

2. **Bleeding time measures:**
   a) Clotting factor activity
   b) Platelet function
   c) Hemoglobin content
   d) WBC count

3. **Which method is commonly used for bleeding time?**
   a) Wintrobe method
   b) Duke's method
   c) Sahli's method
   d) Capillary tube method

4. **Prolonged bleeding time is seen in:**
   a) Leukemia
   b) Hemophilia
   c) Anemia
   d) Polycythemia

5. **The site commonly used for bleeding time test is:**
   a) Earlobe
   b) Fingertip or forearm
   c) Toenail
   d) Palm

6. **Normal platelet count in adults is:**
   a) 50,000–100,000/mm^3
   b) 1,50,000–4,00,000/mm^3
   c) 400,000–600,000/mm^3
   d) 5,00,000–7,00,000/mm^3

7. **Bleeding time test evaluates the function of:**
   a) RBCs
   b) WBCs
   c) Platelets
   d) Plasma proteins

8. **Which anticoagulant is used to collect blood for bleeding time test?**
   a) EDTA
   b) Heparin
   c) Citrate
   d) None (fresh capillary blood)

9. **Bleeding time may be prolonged in:**
   a) Thrombocytopenia
   b) Leukocytosis
   c) Polycythemia
   d) High hemoglobin

10. **A standard incision for Duke's method is:**
    a) 2 mm depth
    b) 5 mm depth
    c) 1 mm depth
    d) 10 mm depth

B. Short / One-Word Questions

1. **Normal bleeding time?**
   Answer: 2–7 minutes
2. **Method commonly used for bleeding time?**
   Answer: Duke's method
3. **Cell responsible for primary hemostasis?**
   Answer: Platelet
4. **Prolonged bleeding time seen in?**
   Answer: Hemophilia
5. **Common site for test?**
   Answer: Forearm / Fingertip
6. **Blood collected with anticoagulant?**
   Answer: None (capillary blood)
7. **Bleeding time assesses function of?**
   Answer: Platelets
8. **Low platelet count is called?**
   Answer: Thrombocytopenia
9. **High platelet count is called?**
   Answer: Thrombocytosis
10. **Unit of bleeding time?**
    Answer: Minutes

Experiment 10
Determination of Clotting Time

A. Multiple Choice Questions (MCQs)

1. **Normal clotting time in adults is approximately**:
   a) 1–3 minutes
   b) 5–8 minutes
   c) 10–12 minutes
   d) 15–20 minutes

2. **Clotting time measures:**
   a) Platelet function
   b) Activity of clotting factors in plasma
   c) RBC count
   d) WBC count

3. **Common method used to determine clotting time:**
   a) Capillary tube method
   b) Duke's method
   c) Sahli's method
   d) Wintrobe method

4. **Clotting involves conversion of:**
   a) Hemoglobin to oxyhemoglobin
   b) Fibrinogen to fibrin
   c) Albumin to globulin
   d) Collagen to elastin

5. **Clotting time is prolonged in:**
   a) Hemophilia
   b) Polycythemia
   c) Leukocytosis
   d) Anemia

6. **The primary protein required for clot formation is:**
   a) Hemoglobin
   b) Fibrinogen
   c) Albumin
   d) Myosin

7. **Vitamin essential for clotting factor synthesis:**
   a) Vitamin A
   b) Vitamin D
   c) Vitamin K
   d) Vitamin C

8. **Site commonly used for capillary tube method:**
   a) Fingertip
   b) Earlobe
   c) Forearm
   d) Tongue

9. Time taken for fibrin clot formation is expressed in:
   a) Seconds
   b) Minutes
   c) Hours
   d) Days

10. Which anticoagulant should NOT be used before clotting time test?
    a) EDTA
    b) None (fresh blood)
    c) Citrate
    d) Heparin

B. Short / One-Word Questions

1. **Normal clotting time?**
   Answer: 5–8 minutes
2. **Common method used?**
   Answer: Capillary tube method
3. **Protein forming clot?**
   Answer: Fibrin
4. **Precursor protein converted to fibrin?**
   Answer: Fibrinogen
5. **Vitamin required for clotting**?
   Answer: Vitamin K
6. **Blood used for test?**
   Answer: Fresh capillary blood
7. **Prolonged clotting time seen in?**
   Answer: Hemophilia
8. **Unit of clotting time?**
   Answer: Minutes
9. **Cell involved in clot formation?**
   Answer: Platelet
10. **Time measurement starts immediately after?**
    Answer: Blood collection

Experiment 11
Estimation of Hemoglobin Content

A. Multiple Choice Questions (MCQs)

1. **Normal hemoglobin (Hb) content in adult males:**
   a) 8–10 g/dL
   b) 11–12 g/dL
   c) 13–18 g/dL
   d) 20–22 g/dL

2. **Normal hemoglobin content in adult females:**
   a) 8–10 g/dL
   b) 11–16 g/dL
   c) 13–18 g/dL
   d) 20–22 g/dL

3. **Hemoglobin estimation is important to detect:**
   a) Leukemia
   b) Anemia
   c) Polycythemia
   d) Both b and c

4. **Common method used for Hb estimation:**
   a) Sahli's method
   b) Wintrobe method
   c) Duke's method
   d) Capillary tube method

5. **In Sahli's method, blood is mixed with:**
   a) Distilled water
   b) Hydrochloric acid
   c) Sodium chloride
   d) Hayem's solution

6. **Hemoglobin is a protein present in:**
   a) WBC
   b) RBC
   c) Platelets
   d) Plasma

7. **Hemoglobin carries:**
   a) Carbon dioxide only
   b) Oxygen only
   c) Both oxygen and carbon dioxide
   d) Hormones

8. **Low hemoglobin levels indicate:**
   a) Polycythemia
   b) Anemia
   c) Leukocytosis
   d) Hemophilia

9. **Hb estimation is expressed in:**
   a) g/dL
   b) Cells/mm³
   c) mmHg
   d) mg/mL

10. **The color of standard solution in Sahli's method:**
    a) Red
    b) Brownish red
    c) Green
    d) Yellow

B. Short / One-Word Questions

1. **Protein present in RBCs for oxygen transport?**
   Answer: Hemoglobin
2. **Normal Hb in adult males?**
   Answer: 13–18 g/dL
3. **Normal Hb in adult females?**
   Answer: 11–16 g/dL
4. **Method commonly used in lab for Hb estimation?**
   Answer: Sahli's method
5. **Acid used in Sahli's method?**
   Answer: Hydrochloric acid (HCl)
6. **Hb estimation helps detect?**
   Answer: Anemia
7. **Hemoglobin carries which gas?**
   Answer: Oxygen
8. **Unit of hemoglobin measurement?**
   Answer: g/dL
9. **Low hemoglobin condition is called?**
   Answer: Anemia
10. **High hemoglobin condition is called?**
    Answer: Polycythemia

Experiment 12
Determination of Blood Group

A. Multiple Choice Questions (MCQs)

1. **Blood groups were discovered by:**
   a) Louis Pasteur
   b) Karl Landsteiner
   c) Robert Koch
   d) William Harvey

2. **ABO blood group system is based on presence of:**
   a) Antibodies in plasma
   b) Antigens on RBC membrane
   c) Platelet count
   d) Hemoglobin type

3. **Which antigen is present in blood group A?**
   a) Antigen B
   b) Antigen A
   c) Both A and B
   d) None

4. **Which antibody is present in blood group B plasma?**
   a) Anti-A
   b) Anti-B
   c) Both Anti-A and Anti-B
   d) None

5. **Universal donor blood group is:**
   a) A
   b) B
   c) AB
   d) O

6. **Universal recipient blood group is:**
   a) A
   b) B
   c) AB
   d) O

7. **Rh factor is also known as:**
   a) Rhesus factor
   b) Red cell factor
   c) ABO factor
   d) Platelet antigen

8. **Rh-positive indicates:**
   a) Absence of D antigen
   b) Presence of D antigen
   c) Presence of A antigen
   d) Absence of A antigen

9. **Rh-negative person can safely receive blood from:**
   a) Rh-positive donor
   b) Rh-negative donor
   c) Either positive or negative
   d) None

10. **Blood grouping in lab is done using:**
    a) Hemocytometer
    b) Anti-sera
    c) Capillary tube
    d) Sahli's method

B. Short / One-Word Questions

1. **Discoverer of blood groups?**
   Answer: Karl Landsteiner
2. **Blood group system used commonly?**
   Answer: ABO
3. **Universal donor?**
   Answer: O
4. **Universal recipient?**
   Answer: AB
5. **Antigen present in blood group A?**
   Answer: A
6. **Antibody in blood group B plasma?**
   Answer: Anti-A
7. **Rh-positive means presence of?**
   Answer: D antigen
8. **Rh-negative lacks?**
   Answer: D antigen
9. **Blood grouping is done using?**
   Answer: Anti-sera
10. **Blood groups are determined on?**
    Answer: RBC membrane

Experiment 13
Determination of Erythrocyte Sedimentation Rate (ESR)

A. Multiple Choice Questions (MCQs)

1. **ESR measures:**
   a) RBC count
   b) Rate at which RBCs settle in a column of blood
   c) WBC count
   d) Platelet function

2. **Normal ESR in adult males:**
   a) 0–5 mm/hr
   b) 1–10 mm/hr
   c) 20–30 mm/hr
   d) 30–40 mm/hr

3. **Normal ESR in adult females**:
   a) 0–5 mm/hr
   b) 1–10 mm/hr
   c) 2–15 mm/hr
   d) 20–30 mm/hr

4. **ESR is increased in:**
   a) Anemia
   b) Inflammation
   c) Leukopenia
   d) Polycythemia

5. **ESR is decreased in:**
   a) Anemia
   b) Polycythemia
   c) Infection
   d) Inflammation

6. **Common method to measure ESR:**
   a) Westergren method
   b) Sahli's method
   c) Capillary tube method
   d) Duke's method

7. **ESR depends on:**
   a) RBC shape and plasma proteins
   b) Platelet count
   c) WBC function
   d) Hemoglobin only

8. **ESR is measured in:**
   a) Minutes
   b) Hours
   c) Cells/mm³
   d) g/dL

9. **ESR is a non-specific test for:**
   a) Infection and inflammation
   b) Hemoglobin level
   c) Blood group
   d) Clotting time

10. **Blood used for ESR test is:**
    a) Fresh venous blood with anticoagulant
    b) Capillary blood
    c) Arterial blood
    d) Serum

B. Short / One-Word Questions

1. **Full form of ESR?**
   Answer: Erythrocyte Sedimentation Rate
2. **Normal ESR in males?**
   Answer: 1–10 mm/hr
3. **Normal ESR in females?**
   Answer: 2–15 mm/hr
4. **Method commonly used?**
   Answer: Westergren method
5. **ESR measures what?**
   Answer: Rate of RBC sedimentation
6. **ESR increased in?**
   Answer: Inflammation
7. **ESR decreased in?**
   Answer: Polycythemia
8. **Blood used in ESR test?**
   Answer: Venous blood with anticoagulant
9. **ESR is a ___ test?**
   Answer: Non-specific
10. **ESR depends on?**
    Answer: RBC shape and plasma proteins

Experiment 14
Determination of Heart Rate and Pulse Rate

A. Multiple Choice Questions (MCQs)

1. **Normal resting heart rate in adults is:**
   a) 40–60 bpm
   b) 60–100 bpm
   c) 100–120 bpm
   d) 120–140 bpm

2. **Tachycardia refers to:**
   a) Slow heart rate
   b) Fast heart rate
   c) Normal heart rate
   d) Irregular heart rate

3. **Bradycardia refers to:**
   a) Slow heart rate
   b) Fast heart rate
   c) Normal heart rate
   d) Irregular heart rate

4. **Pulse is caused by:**
   a) Contraction of atria
   b) Expansion of arteries due to ventricular contraction
   c) Relaxation of veins
   d) Movement of RBCs

5. **Common site to feel pulse is:**
   a) Carotid artery
   b) Radial artery
   c) Brachial artery
   d) All of the above

6. **Heart rate is usually expressed in:**
   a) mmHg
   b) Beats per minute (bpm)
   c) Cells/mm^3
   d) g/dL

7. **Pulse rate can be measured by:**
   a) Palpation
   b) Stethoscope
   c) Both a and b
   d) Spectrophotometer

8. **Arrhythmia refers to:**
   a) Normal heartbeat
   b) Irregular heartbeat
   c) Rapid heartbeat
   d) Slow heartbeat

9. **The first heart sound “lub” is due to:**
   a) Closure of AV valves
   b) Closure of semilunar valves
   c) Opening of AV valves
   d) Opening of semilunar valves

10. **The second heart sound “dub” is due to:**
    a) Closure of AV valves
    b) Closure of semilunar valves
    c) Opening of AV valves
    d) Opening of semilunar valves

B. Short / One-Word Questions

1. **Normal resting heart rate?**
   Answer: 60–100 bpm
2. **Term for a fast heart rate?**
   Answer: Tachycardia
3. **Term for slow heart rate?**
   Answer: Bradycardia
4. **Pulse is felt due to?**
   Answer: Arterial expansion
5. **Common site for pulse measurement?**
   Answer: Radial artery
6. **Heart rate unit?**
   Answer: Beats per minute (bpm)
7. **Device to listen to heart sounds?**
   Answer: Stethoscope
8. **Irregular heartbeat is called?**
   Answer: Arrhythmia
9. **First heart sound “lub” caused by?**
   Answer: AV valve closure
10. **Second heart sound “dub” caused by?**
    Answer: Semilunar valve closure

Experiment 15
Recording of Blood Pressure

A. Multiple Choice Questions (MCQs)

1. **Normal adult blood pressure is approximately:**
   a) 90/60 mmHg
   b) 120/80 mmHg
   c) 140/90 mmHg
   d) 160/100 mmHg

2. **The first sound heard while measuring BP is called:**
   a) Korotkoff sound I
   b) Korotkoff sound II
   c) Systolic sound
   d) Diastolic sound

3. **The last sound heard during BP measurement corresponds to:**
   a) Systolic pressure
   b) Diastolic pressure
   c) Pulse pressure
   d) Mean arterial pressure

4. **Systolic blood pressure represents:**
   a) Pressure during ventricular relaxation
   b) Pressure during ventricular contraction
   c) Average pressure
   d) Pressure in veins

5. **Diastolic blood pressure represents:**
   a) Pressure during ventricular contraction
   b) Pressure during ventricular relaxation
   c) Pressure during atrial contraction
   d) Pulse pressure

6. **Which instrument is commonly used to measure BP?**
   a) Sphygmomanometer
   b) Hemocytometer
   c) Stethoscope
   d) Both a and c

7. **BP cuff should be placed on**:
   a) Thigh
   b) Forearm
   c) Upper arm
   d) Wrist

8. **High blood pressure is called:**
   a) Hypotension
   b) Hypertension
   c) Tachycardia
   d) Bradycardia

9. **Low blood pressure is called:**
   a) Hypertension
   b) Hypotension
   c) Arrhythmia
   d) Polycythemia

10. **BP measurement depends on:**
    a) Heart contraction and arterial elasticity
    b) RBC count
    c) Platelet function
    d) WBC count

B. Short / One-Word Questions

1. **Normal adult BP?**
   Answer: 120/80 mmHg
2. **Instrument used for BP measurement?**
   Answer: Sphygmomanometer
3. **Device to listen to BP sounds?**
   Answer: Stethoscope
4. **First Korotkoff sound indicates?**
   Answer: Systolic pressure
5. **Last Korotkoff sound indicates?**
   Answer: Diastolic pressure
6. **High blood pressure is called?**
   Answer: Hypertension
7. **Low blood pressure is called?**
   Answer: Hypotension
8. **Unit of blood pressure?**
   Answer: mmHg
9. **BP cuff placement?**
   Answer: Upper arm
10. **Systolic BP occurs during?**
    Answer: Ventricular contraction