BRAHMANBARIA
MEDICAL
COLLEGE



PHYSIOLOGY LAB MANUAL

Department of Physiology

A facility equipped with tools and instruments used for conducting experiments by the MBBS students

BRAHMANBARIA MEDICAL COLLEGE

Department of Physiology

PHYSIOLOGY LABORATORY MANUAL & USER HANDBOOK

For MBBS Phase-I Students

Prepared According to BMDC MBBS Curriculum 2021 and DGME Operational Manual 2022

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PREFACE

Physiology forms the scientific foundation of clinical medicine by explaining the normal functions of the human body. Practical teaching is an integral component of physiology education.

This manual has been prepared for MBBS Phase-I students of Brahmanbaria Medical College in accordance with the BMDC MBBS Curriculum 2021 and the DGME Operational Manual 2022. It provides guidance on laboratory practice, competencies, safety, assessment, and practical work.

Students are encouraged to use this manual throughout their practical sessions and to maintain accurate laboratory records.

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CHAPTER 1: INTRODUCTION TO PHYSIOLOGY LABORATORY

1.1 Introduction

The Physiology Laboratory is an integral component of Phase-I MBBS education. It provides students with opportunities to correlate theoretical knowledge with practical application through observation, experimentation, and interpretation of normal human physiological functions. The laboratory develops competencies in performing basic physiological investigations, handling laboratory instruments, recording observations accurately, and interpreting results in relation to normal and abnormal body functions. The practical curriculum is aligned with the BMDC MBBS Curriculum 2021 and the DGME Operational Manual 2022.

1.2 Philosophy of Practical Physiology

Practical physiology emphasizes competency-based learning through active participation. Students acquire cognitive, psychomotor, and communication skills while maintaining professionalism, ethics, and laboratory safety. The laboratory experience prepares future physicians to understand physiological principles underlying clinical medicine.

1.3 Importance of Physiology Laboratory

- Bridges theoretical knowledge with clinical application.
- Develops laboratory and observational skills.
- Promotes scientific reasoning and evidence-based interpretation.
- Enhances communication, teamwork, and professionalism.
- Provides the foundation for understanding pathology and clinical medicine.
- Develops competency in common physiological examinations and laboratory procedures.

1.4 General Learning Outcomes

- Perform basic physiology practical procedures safely.
- Handle laboratory instruments correctly.
- Record observations systematically.
- Interpret normal physiological findings.
- Maintain laboratory ethics, biosafety, and discipline.
- Communicate findings effectively in practical records and viva examinations.

1.5 Scope of Practical Training

The practical programme includes haematology, cardiovascular physiology, respiratory physiology, gastrointestinal physiology, renal physiology, neurophysiology, body temperature, and special senses. Students gain hands-on experience in blood examination, blood pressure measurement, ECG recording, spirometry, reflex testing, urine examination, sensory function assessment, and other practical competencies prescribed by BMDC.

1.6 Expected Professional Behaviour

- Respect patient privacy and confidentiality.
- Follow biosafety precautions.
- Maintain punctuality and discipline.
- Work collaboratively.
- Maintain an accurate practical notebook.

CHAPTER 2: DEPARTMENTAL OBJECTIVES AND COMPETENCIES

2.1 Departmental Objectives

The Department of Physiology aims to provide MBBS students with a sound understanding of normal human body functions and develop practical skills essential for clinical practice, in accordance with the BMDC MBBS Curriculum 2021 and DGME Operational Manual 2022.

- Demonstrate knowledge of normal physiological functions.
- Explain homeostatic mechanisms and body regulation.
- Differentiate normal from abnormal physiological function.
- Develop competency in performing and interpreting physiology laboratory experiments.
- Prepare students for clinical application, lifelong learning, and research.

2.2 Competencies to be Acquired

- Measure arterial blood pressure.
- Examine radial pulse.
- Record and interpret a normal 12-lead ECG.
- Auscultate heart sounds, breath sounds.
- Estimate haemoglobin concentration.
- Perform total RBC, WBC, and differential WBC counts.
- Determine bleeding time and clotting time.
- Determine ABO/Rh blood group.
- Determine ESR and packed cell volume.
- Measure pulmonary volumes and capacities by spirometry.
- Determine urine specific gravity.
- Elicit deep tendon and superficial reflexes.
- Record body temperature.
- Perform light reflex, visual acuity, Rinne, and Weber tests.

2.3 Competency Domains

The practical training develops competencies in four domains:

Domain	Description / Examples
Knowledge	Understanding normal physiological mechanisms
Psychomotor	Performing laboratory procedures accurately
Communication	Presenting findings and discussing results
Professionalism	Ethics, biosafety, teamwork, and discipline

2.4 Alignment with BMDC Curriculum

The practical competencies are distributed across haematology, cardiovascular, respiratory, gastrointestinal, renal, neurophysiology, body temperature, and special senses practical sessions as prescribed in the BMDC curriculum. Successful completion of these competencies forms the basis for formative assessment and OSPE preparation.

CHAPTER 3: LABORATORY RULES, SAFETY, BIOSAFETY, AND ETHICS

3.1 Code of Conduct

- Attend all practical classes punctually.
- Wear a clean laboratory coat and ID card.
- Maintain discipline and professional behaviour.
- Do not eat, drink, or use mobile phones during practical sessions.
- Follow instructions of faculty members and laboratory staff.

3.2 Laboratory Safety

- Know the location of fire extinguishers, first-aid box, and emergency exits.
- Handle glassware and electrical equipment carefully.
- Report accidents, injuries, or breakages immediately.
- Wash hands before leaving the laboratory.

3.3 Biosafety and Infection Control

- Treat all blood and body fluids as potentially infectious.
- Wear gloves when handling biological specimens.
- Dispose of sharps and contaminated waste in designated containers.
- Disinfect work surfaces after practical sessions.

3.4 Handling Laboratory Equipment

- Use instruments only after proper demonstration.
- Keep equipment clean and calibrated.
- Return all instruments to their designated locations.
- Do not attempt repairs without authorization.

3.5 Ethical Considerations

- Obtain voluntary consent before demonstrations on classmates.
- Respect privacy and confidentiality.
- Perform only approved educational procedures under supervision.

3.6 Practical Record Book

- Record date, title, principle, procedure, observations, results, and interpretation.
- Complete entries immediately after each practical.
- Present the notebook for faculty signature.

3.7 Emergency Procedures

- Remain calm during emergencies.
- Inform faculty immediately after any injury or chemical spill.
- Follow evacuation instructions during fire or other emergencies.

3.8 Summary

Strict adherence to laboratory rules, biosafety practices, and professional ethics ensures a safe learning environment and helps students develop the competencies expected of future physicians.

CHAPTER 4: ORGANIZATION OF THE PHYSIOLOGY PRACTICAL CURRICULUM

4.1 Introduction

The Physiology practical curriculum is designed according to the BMDC MBBS Curriculum 2021 and the DGME Operational Manual 2022. Practical teaching follows a competency-based approach, enabling students to acquire knowledge, psychomotor skills, and professional attitudes required for clinical practice.

4.2 Practical Curriculum Distribution

System	Major Practical Competencies	Practical Hours
Cellular Physiology / General	Microscope, laboratory equipment, blood collection	2
Physiology of Blood	Hb, RBC, WBC, DLC, ESR, PCV, BT, CT, Blood Grouping	45
Cardiovascular	Pulse, Blood Pressure, Heart Sounds, ECG	18
Respiratory	Respiratory examination, Breath sounds, Spirometry	8
Gastrointestinal	Auscultation of bowel sounds	2
Renal	Urine specific gravity	2
Neurophysiology	Motor, sensory examination and reflexes	10
Body Temperature	Recording body temperature	2
Special Senses	Light reflex, visual acuity, colour vision, Rinne & Weber	8

4.3 Learning Strategy

1. Brief demonstration by faculty.
2. Hands-on performance by students.
3. Observation and recording of findings.
4. Interpretation of physiological results.
5. Clinical correlation and discussion.
6. Continuous formative assessment.

4.4 Student Responsibilities

- Attend all practical sessions.
- Complete practical record book.
- Participate actively in demonstrations.
- Maintain laboratory discipline and biosafety.
- Prepare for viva voce and OSPE.

4.5 Time Allocation across Terms

The total practical teaching time is 97 hours, distributed over the three terms as shown below.

1st Term	2nd Term	3rd Term	Total
35 hours	32 hours	30 hours	97 hours

4.6 Marks Distribution (1st Professional MBBS Examination)

Type of Evaluation	Marks
OSPE	40
Traditional Practical Methods & Experiments	40
Practical Notebook	10
Assignment on Integrated Teaching	10
Total	**100**

CHAPTER 5: PHYSIOLOGY LABORATORY ORGANIZATION, FACILITIES, AND PERSONNEL

5.1 Introduction

An efficiently organized physiology laboratory provides an environment that promotes safe, effective, and competency-based practical learning. The laboratory should be equipped with appropriate instruments, audiovisual facilities, adequate workspace, and trained personnel to support undergraduate medical education.

5.2 Departmental Personnel

Designation	Primary Responsibilities	Name and Title
Head of the Department	Overall supervision, academic planning, quality assurance	Dr. Sayema Ainan, Associate Professor and Head
Faculty Members	Teaching, demonstration, assessment, and mentoring	Dr. Iffat Jahan, Associate Professor
		Dr. Noor Sourav, Assistant Professor
Lecturers	Practical demonstration, OSPE preparation, student guidance	Dr. Sakebin Chowdhury
		Dr. Fulkali Rani Das
		Dr. Saima Akter
Laboratory Technologist	Equipment maintenance, reagent preparation, laboratory support	Md. Mostafizur Rahman Milon
Laboratory Attendant	Cleaning, arrangement of instruments, logistics	Dipti Sen (Office Assistant)

5.3 Essential Laboratory Facilities

- Well-ventilated laboratory with adequate lighting.
- Demonstration area with multimedia facilities.
- Student work benches with water and electricity supply.
- Hand-washing facilities and first-aid box.
- Fire extinguisher and emergency exits.
- Storage for instruments, reagents, and consumables.

CHAPTER 6: LABORATORY EQUIPMENT, INSTRUMENTS, AND REAGENTS

6.1 Essential Laboratory Equipment

Equipment	Primary Use	Related Practical
Compound Microscope	Examination of blood cells and slides	Haematology / Microscopy
Haemocytometer (Neubauer chamber)	RBC and WBC counting	Blood cell counts
Sahli's Haemoglobinometer	Haemoglobin estimation	Hb estimation
Westergren ESR Apparatus	ESR determination	ESR
Microhaematocrit Centrifuge	Packed cell volume	PCV
Sphygmomanometer	Blood pressure measurement	Cardiovascular
Stethoscope	Heart, lung, and bowel sound auscultation	CVS / Respiratory / GIT
ECG Machine	12-lead ECG recording	Cardiovascular
Spirometer	Pulmonary function testing	Respiratory
Urinometer	Urine specific gravity	Renal
Reflex Hammer	Deep tendon reflexes and plantar response	Neurophysiology
Penlight / Torch	Pupillary light reflex	Special Senses
Snellen Chart	Visual acuity	Special Senses
Ishihara Chart	Colour vision	Special Senses
Tuning Fork (512 Hz)	Rinne and Weber tests	Special Senses
Clinical Thermometer	Body temperature	Body Temperature

6.2 Common Laboratory Reagents

- **Hayem's Fluid**: Diluting fluid for total RBC count.
- **Türk's Fluid**: Diluting fluid for total WBC count (lyses RBCs and stains WBC nuclei).
- **Leishman Stain**: Romanowsky stain used for peripheral blood smear staining and differential leukocyte count (DLC).
- **Buffered Distilled Water (pH 6.8–7.2)**: Dilutes Leishman stain and ensures uniform staining.
- **Wright Stain**: Alternate Romanowsky stain for cell differential counts.
- **N/10 Hydrochloric Acid (HCl)**: Used in Sahli's method to convert haemoglobin into acid haematin.
- **3.8% Trisodium Citrate**: Anticoagulant used in the Westergren ESR method.
- **Normal Saline (0.9% NaCl)**: Isotonic solution for cell suspension preparation and washing.
- **Anti-A, Anti-B, and Anti-D Antisera**: Commercial reagents for ABO/Rh blood grouping.
- **Immersion Oil**: Cedarwood (or synthetic) oil used for 100x high-power oil immersion microscopic observation.

CHAPTER 7: STUDY OF THE COMPOUND MICROSCOPE

7.1 Learning Objectives

- Identify the mechanical and optical components of a compound light microscope.
- Understand the principle of image magnification and resolution.
- Demonstrate correct illumination alignment (Köhler illumination/condenser adjustments) and focus procedures under low-power, high-dry, and oil-immersion objectives.
- Apply precautions for proper handling, cleaning, and storage of the microscope.

7.2 Principle of Compound Microscopy

A compound light microscope utilizes a two-lens optical system (objective lens and eyepiece/ocular lens) to achieve two-stage magnification of a specimen. The objective lens forms a real, inverted, and magnified primary image inside the optical tube. The eyepiece further magnifies this image, presenting a virtual, inverted final image to the observer's eye. Total magnification is calculated as:

Total magnification = Magnification of objective lens × Magnification of eyepiece

For example, a 10× eyepiece with the 40× objective gives 400×, and with the 100× oil-immersion objective gives 1000×.

7.3 Components of the Compound Microscope

- **Base & Arm**: Supporting structure of the microscope.
- **Substage Condenser & Iris Diaphragm**: Focuses light onto the specimen and controls light intensity/contrast.
- **Objective Lenses**: Mounted on a revolving nosepiece:
  - Low Power (10×): For locating specimens.
  - High Dry (40×): For preliminary cell scanning.
  - Oil Immersion (100×): Requires immersion oil to match the refractive index of glass, enabling high-resolution study of blood cells.
- **Eyepiece (Ocular)**: Typically, 10 × magnification.
- **Focusing Knobs**: Coarse adjustment for initial focusing under low power; fine adjustment for sharp focusing under high power/oil immersion.

7.4 Representative Schematic Diagram

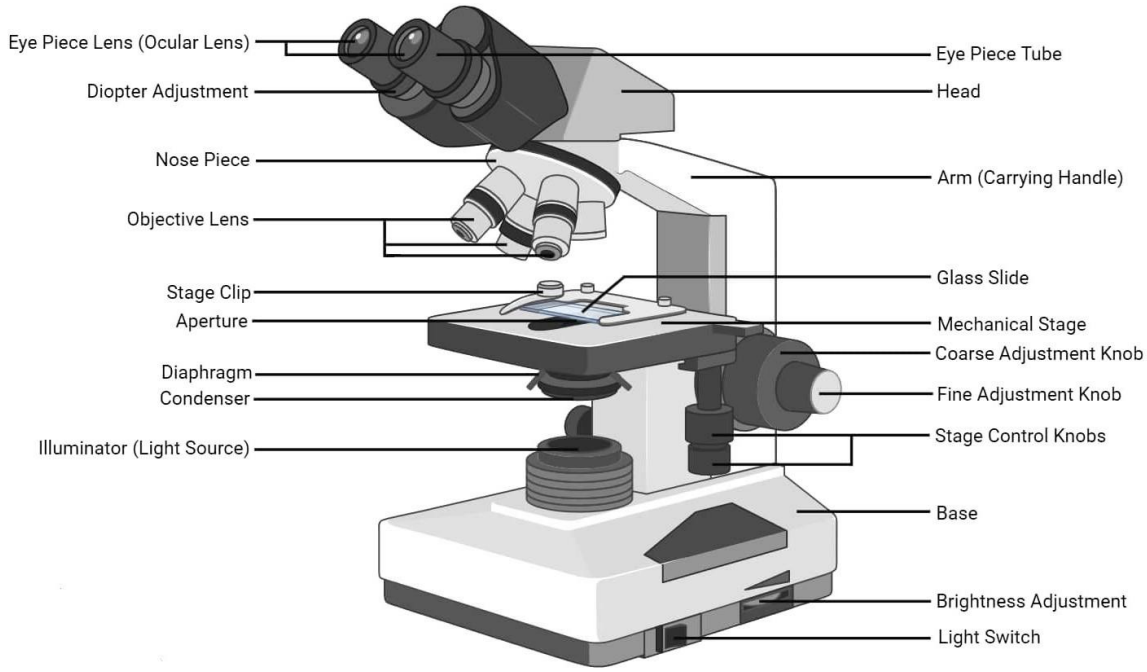


Figure 7.1: Diagram of a compound light microscope

7.5 Operating Procedure

1. Place the microscope on a stable, level workbench.
2. Turn on the light source and adjust the iris diaphragm for optimal contrast.
3. Place the blood slide on the stage and secure it with stage clips.
4. Focus first under low power (10×) using the coarse adjustment knob.
5. Switch to the high-dry objective (40×) for scanning. For oil immersion, place a drop of immersion oil on the smear and rotate to the 100× objective.
6. Fine-tune image clarity using only the fine adjustment knob.

7.6 Precautions

- Always carry the microscope with both hands (one supporting the base, the other gripping the arm).
- Never use the coarse adjustment knob while viewing under 40 × or 100× objectives to avoid breaking slides or damaging lenses.
- Clean optical lenses only with specialized lens paper; clean oil immersion lenses with xylene/alcohol wipe immediately after use.

7.7 Viva Questions

1. What is total magnification?
2. Why is immersion oil used?
3. Which objective is used first?
4. Difference between coarse and fine adjustment?

CHAPTER 8: HAEMATOLOGY PRACTICAL EXPERIMENTS

Experiment 8.1: Laboratory Equipment, Blood Sample and Blood Collection

1. Learning Objectives

- Identify blood collection equipment and anticoagulants.
- Perform capillary finger-prick and venous blood collection safely following aseptic protocols.

2. Principle

Blood collection is a fundamental pre-analytical procedure in haematology. Capillary blood is obtained by skin puncture, whereas venous blood is collected via venipuncture into tubes containing specific anticoagulants (e.g., EDTA, sodium citrate).

3. Apparatus & Reagents

- Sterile disposable lancets / 5 mL syringes and needles.
- Alcohol swabs (70% isopropyl alcohol), sterile cotton balls, adhesive bandages.
- Anticoagulant tubes (EDTA, Sodium Citrate).
- Personal Protective Equipment (gloves, lab coat).

4. Procedure

1. **Capillary Blood Collection**:
   - Clean the ring or middle fingertip with an alcohol swab and allow to air dry.
   - Puncture the lateral aspect of the fingertip using a sterile lancet.
   - Wipe away the first drop of blood with dry cotton.
   - Collect subsequent blood drops without squeezing the finger excessively.
2. **Venous Blood Collection**:
   - Apply a tourniquet 3–4 inches above the antecubital fossa.
   - Palpate the median cubital vein and disinfect the site.
   - Insert the needle at a 15°–30° angle, draw the required volume into a syringe, release the tourniquet, withdraw the needle, and apply pressure.

5. Observations & Results

Tabulate collection details in the practical record sheet.

6. Clinical Significance

Proper blood sampling technique prevents haemolysis, dilution with tissue fluid, or micro-clot formation, ensuring reliable diagnostic results for haematological profile assessment.

7. Precautions

- Maintain strict aseptic precautions.
- Never squeeze (milk) the punctured finger to avoid tissue fluid contamination.
- Dispose of sharps directly into yellow biohazard sharp containers.

8. Viva Questions

1. Name common anticoagulants and their modes of action.
2. Why is the first drop of blood wiped away during skin puncture?
3. What are the complications of improper venipuncture?

9. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.2: Preparation & Staining of Peripheral Blood Smear and Differential WBC Count

1. Learning Objectives

- Prepare a uniform thin blood smear.
- Stain the smear using Leishman stain.
- Identify different types of white blood cells and perform a 100-cell differential leukocyte count (DLC).

2. Principle

Leishman stain is a Romanowsky-type stain containing eosin (an acidic dye) and methylene blue (a basic dye). Basic cellular components (e.g., cell nuclei, basophilic granules) take up methylene blue and stain blue/purple, while acidic components (e.g., haemoglobin, eosinophilic granules) take up eosin and stain pink/orange.

3. Apparatus & Reagents

- Glass slides (spreader slide and specimen slide).
- Capillary blood sample or EDTA blood.
- Leishman stain solution, buffered distilled water (pH 6.8–7.2).
- Compound microscope and immersion oil.

4. Procedure

1. Place a small drop of blood near one end of a clean glass slide.
2. Hold a spreader slide at a 30°–45° angle, draw it back to touch the blood drop allowing it to spread along the edge, and push forward smoothly to form a tongue-shaped smear. Air dry.
3. Pour 8–10 drops of Leishman stain on the slide; wait 2 minutes (fixation phase).
4. Add double the volume of buffered water, mix by gentle blowing; wait 10–12 minutes (staining phase).
5. Wash under gentle tap water, dry, apply immersion oil, and examine under 100× objective in a zigzag pattern counting 100 WBCs.

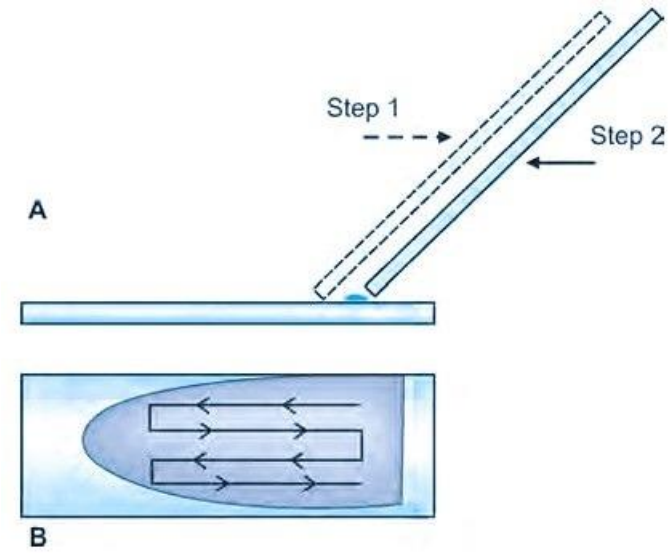


Figure 8.1: Method of spreading a blood film (A) and appearance of a well-prepared film (B)

5. Observations & Normal Values

WBC Type	Morphology	Normal Range (%)
Neutrophil	Multi-lobed nucleus (2–5 lobes), fine pink/purple granules 4	0–75%
Eosinophil	Bilobed nucleus (spectacle shape), coarse brick-red granules	1–6%
Basophil	S/S-shaped nucleus covered by coarse dark blue/black granules	0–1%
Lymphocyte	Large round nucleus filling most of the cytoplasm, thin blue rim	20–45%
Monocyte	Large kidney/horseshoe-shaped nucleus, abundant greyish cytoplasm	2–10%

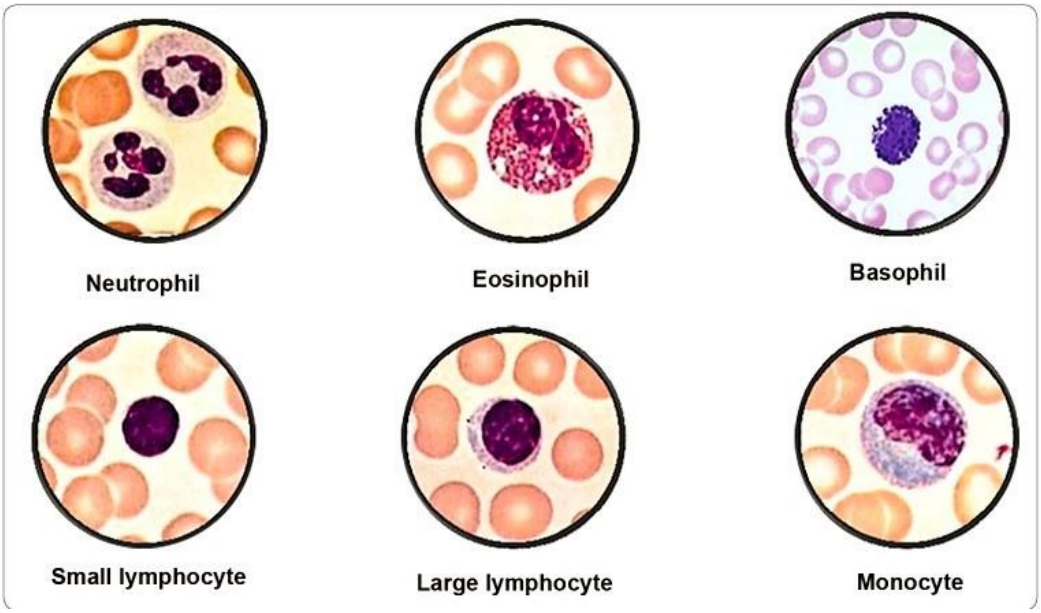


Figure 8.2: Types of white blood cells in a stained blood smear

6. Clinical Significance

- **Neutrophilia**: Acute bacterial infections.
- **Eosinophilia**: Allergic conditions, parasitic infestations.
- **Lymphocytosis**: Viral infections, chronic leukaemias.

7. Precautions

- Use clean, grease-free glass slides.
- Ensure smooth spreading to achieve a thin monolayer tail.
- Maintain correct staining time and buffer pH.

8. Viva Questions

1. What are Romanowsky stains?
2. What is shift to the left in neutrophils?
3. Mention causes of eosinophilia.

9. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.3: Determination of Total White Blood Cell (WBC) Count

1. Learning Objectives

- Perform total WBC count using a haemocytometer.
- Calculate the absolute leukocyte count per microliter (µL) of blood.

2. Principle

Blood is diluted 1:20 with Türk's fluid, which contains glacial acetic acid to lyse non-nucleated red blood cells and gentian violet to stain WBC nuclei. Diluted cells are charged into a Neubauer counting chamber and counted under a microscope.

3. Apparatus

Haemocytometer (Neubauer chamber, coverslip), WBC pipette (or micropipette), Türk's fluid, lancet, compound microscope.

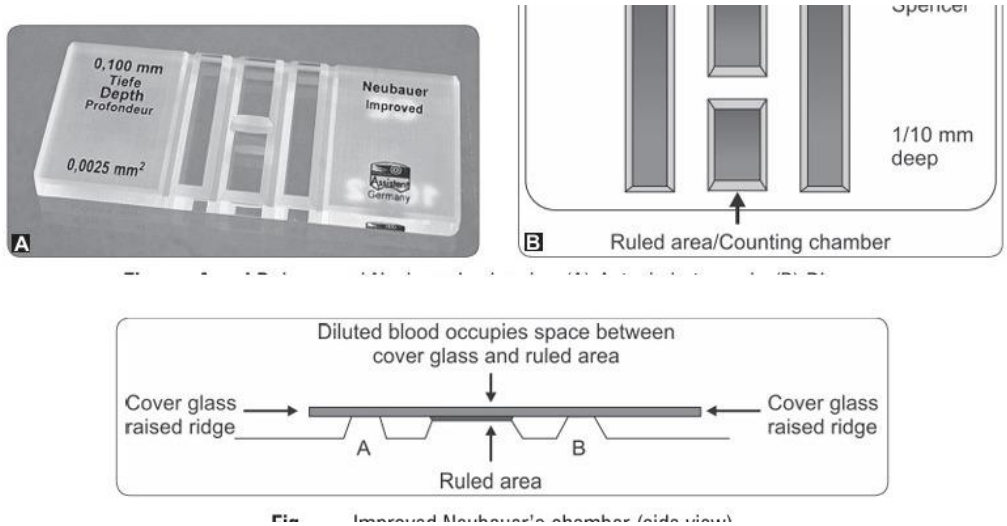


Figure 8.3: Improved Neubauer chamber: (A) photograph, (B) diagram and side view

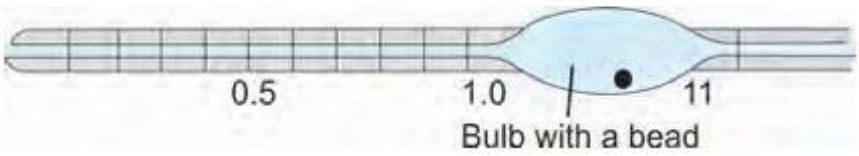


Figure 8.4: WBC pipette (marks at 0.5, 1.0 and 11)

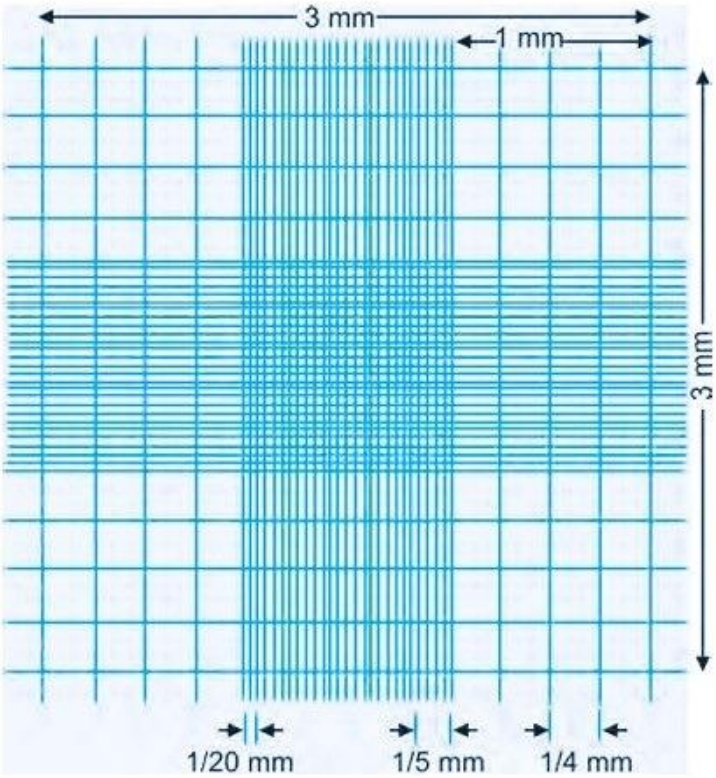


Figure 8.5: Neubauer counting grid; the four corner groups of 16 squares are used for WBC counting

4. Procedure

1. Draw blood up to the 0.5 mark on the WBC pipette.
2. Draw Türk's fluid up to the 11 mark (dilution 1:20). Mix thoroughly.
3. Discard the first 2 drops, then charge the Neubauer chamber under the coverslip.

4. Allow cells to settle for 2–3 minutes.
5. Count cells in the 4 large corner squares (1 mm² each) under 10× objective.

5. Calculation Formula

Total WBC count (/µL) = (N × dilution factor) ÷ (area counted × depth of chamber) = (N × 20) ÷ (4 × 0.1) = N × 50

(where N = total cells counted in 4 corner squares*)*

6. Normal Values & Clinical Significance

- **Normal Range**: 4,000–11,000/µL.
- **Leukocytosis (> 11,000/µL)**: Infections, inflammation, leukaemia.
- **Leukopenia (< 4,000/µL)**: Bone marrow depression, viral infections (e.g., typhoid, dengue).

7. Precautions

- Avoid air bubbles while filling pipette and chamber.
- Ensure the coverslip is properly placed to produce Newton's rings.

8. Viva Questions

1. What is the composition of Türk's fluid?
2. What are the dimensions of a Neubauer counting chamber?
3. What are the differences between WBC and RBC pipette?

9. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.4: Determination of Total Red Blood Cell (RBC) Count

1. Learning Objectives

- Perform total RBC count using a haemocytometer and Hayem's fluid.
- Calculate total erythrocytes per µL of blood.

2. Principle

Blood is diluted 1:200 with Hayem's fluid, which is isotonic to red blood cells, preventing haemolysis and aggregation. Cells are counted in the central 1 mm² grid containing 80 small squares.

3. Apparatus

Haemocytometer, RBC pipette (red bead), Hayem's fluid, microscope, skin prick equipment.

4. Procedure

1. Draw blood to the 0.5 mark of the RBC pipette.

2. Draw Hayem's fluid to the 101 mark (dilution 1:200).
3. Mix, discard initial drops, charge chamber, and let settle.
4. Count RBCs in 5 medium squares (80 small squares) within the central grid under 40× objective.

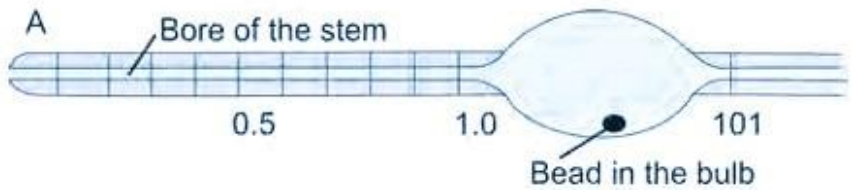


Figure 8.6: RBC pipette (marks at 0.5, 1.0 and 101)

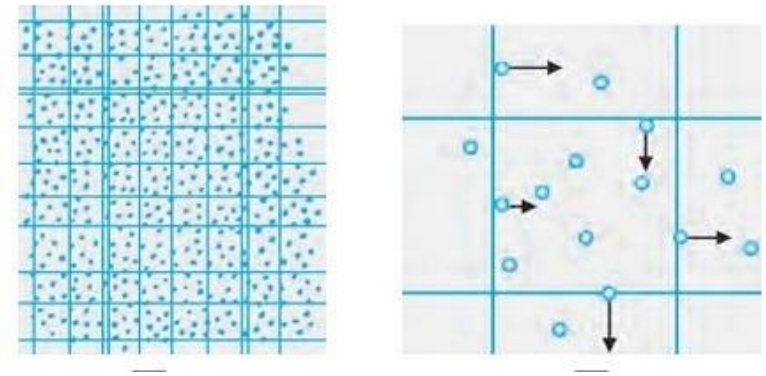


Figure 8.7: Charged chamber (A) and rules of counting (B)

5. Calculation Formula

Total RBC count (/µL) = (n × dilution × depth factor) ÷ area counted = (n × 200 × 10) ÷ (80/400) = n × 10,000

(where n = total RBCs counted in 80 small squares*)*

6. Normal Values & Clinical Significance

- **Male**: 4.5–5.9 million/µL
- **Female**: 4.1–5.1 million/µL

Abnormal counts assist in evaluating infection, anaemia, polycythaemia, bone marrow disorders and haematological diseases.

- **Polycythaemia**: High RBC count (hypoxia, polycythaemia vera).
- **Anaemia**: Reduced RBC count.

7. Precautions

Mix blood thoroughly, avoid air bubbles, ensure correct chamber charging, keep the chamber clean and perform counting systematically. Use rule of inclusion: count cells touching top/left borders; exclude bottom/right borders.

8. Viva Questions

1. Why is dilution necessary?
2. Name the diluting fluid used.
3. What are the normal values?
4. Mention two causes of increased and decreased counts.

9. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.5: Estimation of Haemoglobin (Sahli's Acid Haematin Method)

1. Learning Objectives

- Estimate blood haemoglobin concentration using Sahli's haemoglobinometer.

2. Principle

Hydrochloric acid (N/10 HCl) converts haemoglobin into acid haematin, a brown compound. The intensity of brown colour is matched visually against a standard colour glass block by diluting with distilled water.

3. Apparatus & Reagents

Sahli's comparator, Sahli graduated tube, 20 µL Hb pipette, N/10 HCl, distilled water, glass stirrer.

4. Procedure

1. Add N/10 HCl into Sahli tube up to the lowest mark (2 g/dL).
2. Draw 20 µL capillary blood and transfer into the tube.
3. Mix and allow to stand for 10 minutes for complete acid haematin conversion.
4. Add distilled water dropwise while stirring until the solution colour matches the standard comparator blocks.
5. Read the lower meniscus level in g/dL.

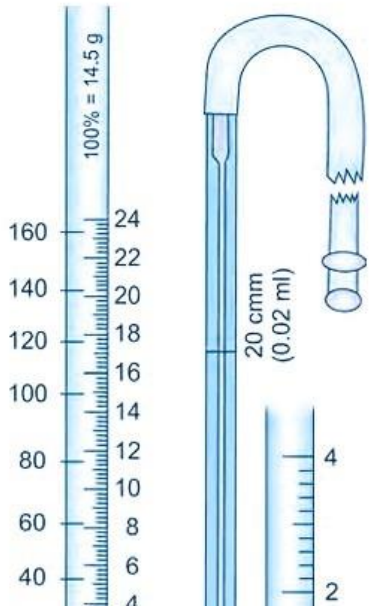


Figure 8.8: Sahli's haemoglobin tube (A) and haemoglobin pipette (B)

5. Normal Values & Clinical Significance

- **Male**: 13–17 g/dL; **Female**: 12–15 g/dL.
- Low haemoglobin indicates anaemia; elevated levels occur in polycythaemia and dehydration.

6. Precautions

Ensure accurate pipetting, avoid air bubbles, clean apparatus after use.

7. Viva Questions

1. What is the principle of Sahli's method?
2. Why is N/10 HCl used?
3. State the normal haemoglobin values.

8. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.6: Determination of Erythrocyte Sedimentation Rate (ESR)

1. Learning Objectives

- Measure ESR using the Westergren method.
- Interpret the clinical significance of elevated ESR.

2. Principle

Anticoagulated whole blood placed in a vertical tube undergoes red cell sedimentation due to gravity. ESR is the height of clear plasma column formed at the top after 1 hour.

3. Apparatus

Westergren tube (30 cm length, 2.5 mm bore), Westergren stand, 3.8% trisodium citrate anticoagulant.

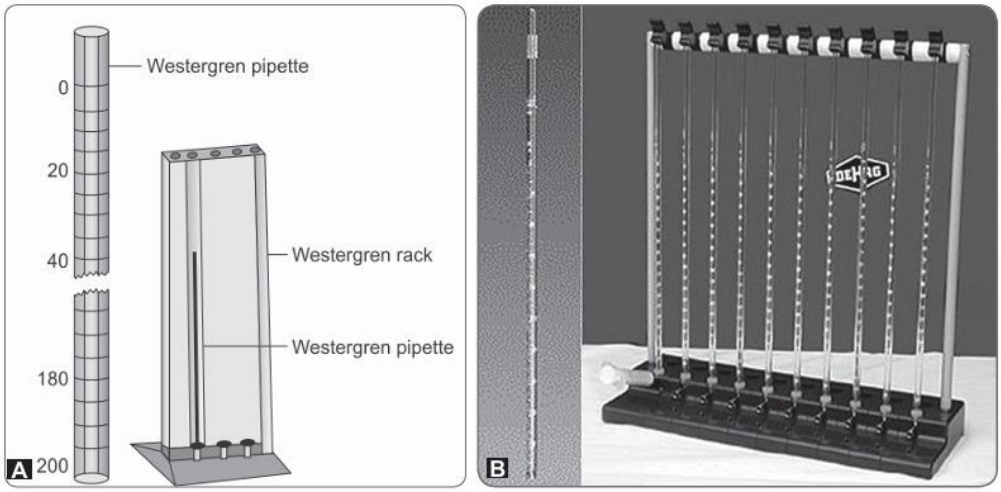


Figure 8.9: Westergren pipette and rack: (A) diagram, (B) photograph

4. Procedure

1. Mix 4 parts blood with 1 part 3.8% sodium citrate solution.
2. Draw blood into Westergren tube exactly to the '0' mark.
3. Mount the tube perfectly vertical in the ESR rack.
4. Leave undisturbed for 60 minutes and read the plasma level in mm/1st hour.

5. Normal Values & Clinical Significance

- **Male**: 0–15 mm/1st hour; **Female**: 0–20 mm/1st hour.
- Raised ESR indicates acute/chronic inflammation, tuberculosis, rheumatoid arthritis, or malignancies due to rouleaux formation promoted by elevated plasma fibrinogen/globulins.

6. Precautions

Keep the tube perfectly vertical, avoid vibration and air bubbles, perform the test promptly.

7. Viva Questions

1. Define ESR. Mention factors affecting ESR.
2. List three causes of raised ESR.

8. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.7: Determination of Packed Cell Volume (PCV/Haematocrit)

1. Learning Objectives

- Determine haematocrit using the microhaematocrit centrifuge method.

2. Principle

Anticoagulated blood in a capillary tube is centrifuged at high speed to pack the red blood cells. PCV is expressed as the percentage volume of erythrocytes relative to whole blood.

3. Apparatus

Heparinized microhaematocrit capillary tubes, sealing clay, microhaematocrit centrifuge, haematocrit reader scale.

4. Procedure

1. Fill capillary tube to 3/4 length with blood.
2. Seal one end with sealing wax/clay.
3. Place in centrifuge with sealed end outwards; spin at 12,000 RPM for 5 minutes.
4. Read percentage PCV on the reader board.

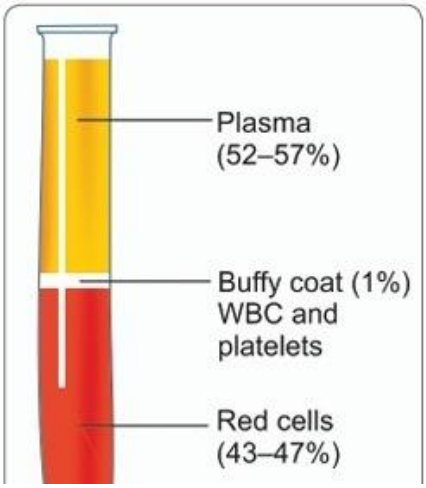


Figure 8.10: Layers of blood after centrifugation (average textbook values shown)

5. Normal Values & Clinical Significance

- **Male**: 40%–54%; **Female**: 36%–48%.
- Together with the RBC count and haemoglobin value, PCV is used to calculate red cell indices (MCV, MCH, MCHC).

6. Precautions

Seal tubes properly, balance centrifuge, avoid haemolysis.

7. Viva Questions

1. What is PCV?
2. How is PCV measured?
3. State normal PCV values.

8. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.8: Determination of Bleeding Time (BT) and Clotting Time (CT)

1. Learning Objectives

- Measure BT (Duke method) and CT (Capillary glass tube method).
- Differentiate primary and secondary haemostasis.

2. Principle

- **Bleeding Time**: Evaluates capillary vascular integrity and platelet plug formation (primary haemostasis).
- **Clotting Time**: Evaluates intrinsic and common coagulation pathways (fibrin clot formation).

3. Apparatus

Sterile lancet, filter paper, non-heparinized capillary glass tubes, stopwatch.

4. Procedure

I. Bleeding Time: Puncture earlobe or finger. Start stopwatch. Blot blood onto filter paper every 30 seconds without touching skin until bleeding stops.

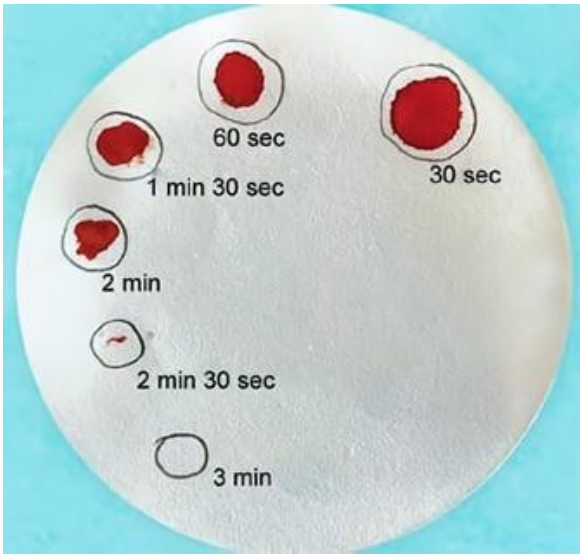


Figure 8.11: Bleeding time: blood spots blotted on filter paper at 30-second intervals

II. Clotting Time: Fill non-heparinized capillary tube with blood from puncture. Start stopwatch. Break 1 cm off tube every 30 seconds until a fibrin thread bridges the broken ends.

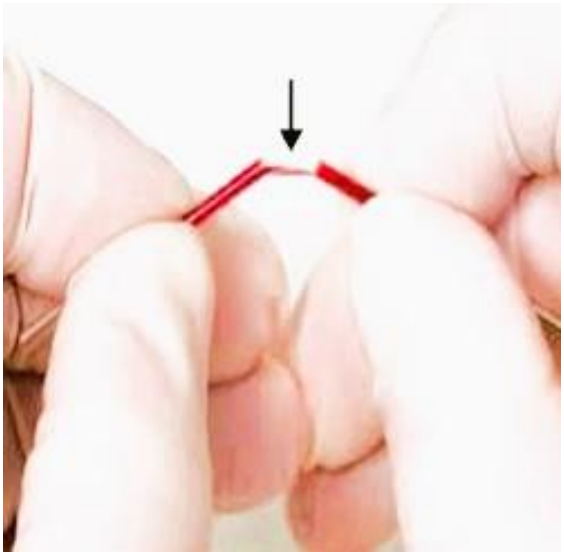


Figure 8.12: Clotting time: fibrin thread bridging the broken ends of the capillary tube

5. Normal Values & Clinical Significance

- **BT**: 2–7 minutes; **CT**: 5–11 minutes.
- Prolonged BT seen in thrombocytopenia, von Willebrand disease; prolonged CT in haemophilia and severe liver disease.

6. Precautions

- Use sterile technique, avoid squeezing the finger excessively, use a stopwatch accurately.

7. Viva Questions

1. Define bleeding time.
2. Define clotting time.
3. Mention causes of prolonged BT and CT.

8. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 8.9: ABO and Rh Blood Group Determination

1. Learning Objectives

- Determine ABO and Rh (D) blood groups using agglutination slide test.

2. Principle

Based on antigen-antibody agglutination. Specific antisera containing antibodies (Anti-A, Anti-B, Anti-D) clump red blood cells expressing corresponding membrane antigens (A, B, or Rh D).

3. Apparatus & Reagents

Clean glass slide, Anti-A (blue), Anti-B (yellow), Anti-D (clear) antisera, applicator sticks.

4. Procedure

1. Label three sections on a glass slide: A, B, and D.
2. Add one drop of respective antiserum into each section.
3. Add a drop of blood to each antiserum and mix with separate sticks.
4. Rock slide gently for 2 minutes and inspect for clumping/agglutination.

5. Interpretation Matrix

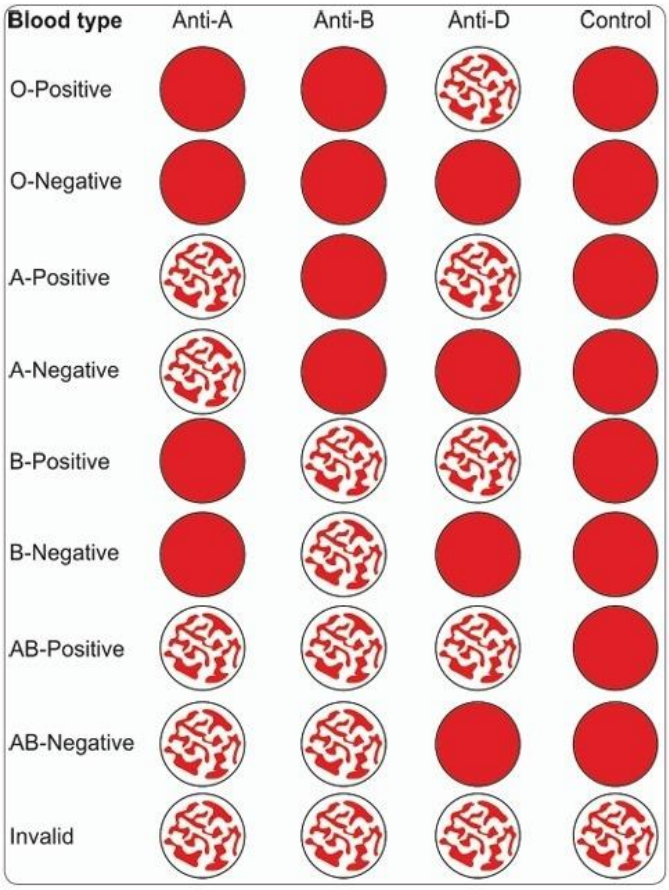


Figure 8.13: Agglutination patterns in ABO and Rh blood grouping

Blood group	Anti-A	Anti-B	Anti-D
A positive	+	–	+
A negative	+	–	–
B positive	–	+	+
B negative	–	+	–
AB positive	+	+	+
AB negative	+	+	–
O positive	–	–	+
O negative	–	–	–

Key: + = agglutination; – = no agglutination. Absence of agglutination with Anti-D indicates Rh-negative blood.

6. Clinical Significance

Blood grouping is essential before blood transfusion, organ transplantation and antenatal care to prevent transfusion reactions and haemolytic disease of the newborn.

7. Precautions

Use separate applicator sticks for each antiserum, avoid contamination, use fresh antisera and read reactions within the recommended time.

8. Viva Questions

1. What is the principle of blood grouping?
2. What is the universal donor blood group?
3. What is the universal recipient blood group?
4. Why is Rh typing important?

9. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

CHAPTER 9: CARDIOVASCULAR PHYSIOLOGY PRACTICALS

Experiment 9.1: Examination of the Radial Pulse

1. Learning Objectives

- Palpate and assess the radial pulse systematically (rate, rhythm, volume, character, vessel wall state).

2. Principle

The arterial pulse represents the expansion wave propagated along arterial walls generated by left ventricular ejection during systole.

3. Procedure

Palpate radial artery at the wrist using tips of index, middle, and ring fingers for 60 seconds. Assess the following:

- Rate
- Rhythm
- Volume
- Character
- Condition of the arterial wall

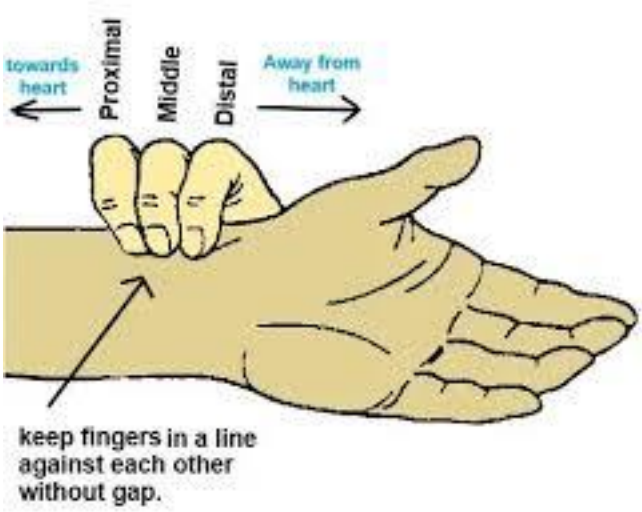


Figure 9.1: Technique of palpating the radial pulse

4. Normal Values

60–100 beats/min, regular rhythm, normal volume.

5. Clinical Significance

Abnormal pulse findings help diagnose arrhythmias, shock, fever and cardiovascular disease.

6. Precautions

Avoid using the thumb, ensure the subject is relaxed.

7. Viva Questions

1. Define pulse.
2. What is the normal pulse rate?
3. Name two abnormal pulse patterns.

8. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 9.2: Measurement of Normal Blood Pressure and Effects of Exercise on Blood Pressure

1. Learning Objectives

- Measure resting arterial blood pressure by both palpatory and auscultatory methods.
- Record systolic and diastolic blood pressure accurately.
- Measure blood pressure immediately after exercise and during recovery.
- Compare resting and post-exercise blood pressure values.
- Explain the physiological changes in blood pressure following exercise.
- Interpret normal and abnormal blood pressure values.

2. Principle

Arterial blood pressure is the lateral pressure exerted by flowing blood on the walls of arteries. It is measured indirectly using a sphygmomanometer. An inflatable cuff placed around the upper arm exerts external pressure on the brachial artery. When cuff pressure exceeds arterial pressure, the artery is completely occluded and blood flow stops.

During gradual cuff deflation:

- **Phase I Korotkoff sound** indicates the **Systolic Blood Pressure (SBP)**.
- **Phase V Korotkoff sound** (disappearance of sounds) indicates the **Diastolic Blood Pressure (DBP)**.

Exercise increases sympathetic activity, resulting in:

- Increased heart rate
- Increased cardiac output
- Rise in systolic blood pressure
- Little change or slight fall in diastolic blood pressure due to vasodilatation in exercising muscles.

3. Apparatus

- Mercury or aneroid sphygmomanometer
- Stethoscope
- Chair

- Stopwatch or timer
- Step stool (20–30 cm) or open space for spot jogging
- Data recording sheet

4. Procedure

A. Measurement of Resting Blood Pressure

1. Allow the subject to rest quietly for **5 minutes**.
2. Seat the subject comfortably with the arm supported at heart level.
3. Wrap the cuff snugly around the upper arm approximately **2.5 cm above the cubital fossa**.
4. Palpate the radial pulse.
5. Inflate the cuff until the radial pulse disappears.
6. Note the pressure (palpatory systolic pressure).
7. Place the bell of the stethoscope over the brachial artery.
8. Inflate the cuff to **30 mmHg above the palpatory systolic pressure**.
9. Deflate the cuff slowly at **2–3 mmHg per second**.
10. Record the pressure at which the first Korotkoff sound appears (**systolic BP**) and the pressure at which the sounds disappear (Phase V, **diastolic BP**). This is the resting blood pressure.

B. Assessment of the Effect of Exercise on Blood Pressure

1. Ask the subject to perform one of the following exercises:
   - Step test for **3 minutes**, or
   - Spot jogging/running for **2–3 minutes**.
2. Immediately after exercise, measure blood pressure using the auscultatory method.
3. Repeat BP measurement at:
   - 1 minute
   - 3 minutes
   - 5 minutes after exercise.
4. Compare the values with resting blood pressure.

5. Observation Table

Time	Systolic BP (mmHg)	Diastolic BP (mmHg)	Pulse Rate (beats/min)
Resting			
Immediately after exercise			
1 minute			
3 minutes			
5 minutes			

6. Result

- Resting BP = _____ / _____ mmHg
- Immediate post-exercise BP = _____ / _____ mmHg

Interpretation:

- Systolic BP increased following exercise.
- Diastolic BP remained unchanged or decreased slightly.
- Blood pressure gradually returned to resting level during recovery.

7. Normal Values and Blood Pressure Classification

Parameter	Normal Value
Systolic BP	90–120 mmHg
Diastolic BP	60–80 mmHg
Average adult BP	120/80 mmHg

Classification of blood pressure in adults (2017 ACC/AHA guideline):

Category	Systolic (mmHg)		Diastolic (mmHg)
Normal	< 120	and	< 80
Elevated	120–129	and	< 80
Hypertension, Stage 1	130–139	or	80–89
Hypertension, Stage 2	≥ 140	or	≥ 90
Hypotension	< 90	or	< 60

Note: The diagnosis of hypertension requires elevated readings on repeated measurements. Many national guidelines, including WHO, use ≥ 140/90 mmHg as the threshold for hypertension.

8. Physiological Effect of Exercise on Blood Pressure

Parameter	Change During Dynamic Exercise
Heart Rate	↑ Increases
Stroke Volume	↑ Increases
Cardiac Output	↑ Markedly increases
Systolic BP	↑ Increases by 20–50 mmHg
Diastolic BP	Usually unchanged or slightly decreased
Pulse Pressure	Increases

9. Clinical Significance

- Screening for hypertension and hypotension.
- Assessment of cardiovascular fitness.
- Evaluation of autonomic nervous system function.
- Monitoring response to exercise training.
- Detection of abnormal cardiovascular responses to physical activity.
- Assessment of cardiovascular disease risk.

10. Precautions

1. Use an appropriately sized cuff.
2. Keep the arm supported at heart level.
3. Ensure the subject is relaxed before recording resting BP.
4. Do not allow the subject to talk or move during measurement.
5. Deflate the cuff slowly (2–3 mmHg/sec).
6. Place the stethoscope lightly over the brachial artery.
7. Avoid repeated inflation without allowing adequate rest.

8. Measure BP immediately after completion of exercise for accurate assessment.

11. Sources of Error

- Incorrect cuff size.
- Loose cuff application.
- Rapid cuff deflation.
- Improper placement of the stethoscope.
- Arm not at heart level.
- Observer bias or digit preference.
- Subject talking or moving during measurement.

12. Viva Questions

1. Define arterial blood pressure.
2. What are Korotkoff sounds?
3. Name the five phases of Korotkoff sounds.
4. Which Korotkoff phase indicates systolic blood pressure?
5. Which phase indicates diastolic blood pressure?
6. What is the normal blood pressure in adults?
7. Why does systolic blood pressure increase during exercise?
8. Why does diastolic blood pressure remain unchanged during dynamic exercise?
9. What factors affect arterial blood pressure?
10. What are the causes of hypertension?
11. What is pulse pressure?
12. Differentiate systolic and diastolic blood pressure.

13. Practical Record Sheet

Date	Resting BP (mmHg)	Post-exercise BP (mmHg)	Observation	Result Interpretation	Teacher's Signature

14. Expected Conclusion

- During dynamic exercise, systolic blood pressure increases due to increased cardiac output, whereas diastolic blood pressure remains unchanged or decreases slightly because of vasodilatation in active skeletal muscles.
- Blood pressure gradually returns to resting values during the recovery period in healthy individuals.
- This experiment demonstrates the normal cardiovascular adaptation to exercise.

Experiment 9.3: Auscultation of the First and Second Heart Sounds

1. Learning Objectives

- Identify normal heart sounds (S1 and S2).
- Locate standard cardiac auscultation areas.
- Recognize the clinical significance of heart sounds.

2. Principle

Heart sounds are produced by closure of cardiac valves and vibrations within the cardiovascular system.

- **First Heart Sound (S1)**: "LUB" — closure of AV valves (mitral and tricuspid) at onset of ventricular systole.

- **Second Heart Sound (S2)**: "DUB" — closure of semilunar valves (aortic and pulmonary) at onset of ventricular diastole.

3. Apparatus

Stethoscope, examination couch, stopwatch.

4. Procedure

Position the subject comfortably. Auscultate over the aortic, pulmonary, tricuspid and mitral areas. Identify S1 and S2 and note any additional sounds.

Auscultation Sites

- **Mitral Area**: 5th intercostal space in left midclavicular line.
- **Tricuspid Area**: Lower left sternal border (4th/5th ICS).
- **Aortic Area**: 2nd right intercostal space near sternum.
- **Pulmonary Area**: 2nd left intercostal space near sternum.

5. Observation

Record the presence, intensity and rhythm of heart sounds.

Normal findings: S1 and S2 are normally heard without added sounds or murmurs.

6. Clinical Significance

Auscultation assists in detecting valvular heart disease, heart failure and congenital cardiac abnormalities.

7. Precautions

Ensure a quiet environment, place the stethoscope correctly and compare all valve areas.

8. Viva Questions

1. What produces the first heart sound?
2. Name the four auscultation areas.
3. What are heart murmurs?

9. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 9.4: Recording and Analysis of the Normal 12-Lead ECG

1. Learning Objectives

- Define an electrocardiogram (ECG).
- Explain the physiological basis of ECG recording.
- Identify the components of a normal ECG tracing.

- Record a standard 12-lead ECG correctly.
- Measure heart rate from an ECG tracing.
- Determine the cardiac rhythm.
- Calculate PR interval, QRS duration, QT interval, and electrical axis.
- Recognize the features of a normal ECG.

2. Principle

An electrocardiogram (ECG) is a graphical recording of the electrical activity generated by the heart during depolarization and repolarization.

Electrical impulses originate from the sinoatrial (SA) node and spread through the atria, atrioventricular (AV) node, bundle of His, bundle branches, and Purkinje fibres, producing characteristic waves and intervals on the ECG.

The standard ECG consists of 12 leads, providing electrical views of the heart from different planes:

- 3 Bipolar limb leads (I, II, III)
- 3 Augmented unipolar limb leads (aVR, aVL, aVF)
- 6 Precordial (Chest) leads (V1–V6)

Recording speed is usually 25 mm/sec, and calibration is 10 mm = 1 mV.

3. Apparatus

- Digital 12-lead ECG machine
- ECG electrodes
- Conductive gel (if required)
- Alcohol swabs/cotton
- Examination couch
- Tissue paper

4. Procedure

Preparation of the Subject

- Explain the procedure to the subject.
- Allow the subject to rest quietly for 5–10 minutes.
- Remove metallic ornaments from wrists and ankles.
- Position the subject comfortably in the supine position.
- Clean electrode sites with alcohol if necessary.
- Apply conductive gel (if required).

Placement of Chest (Precordial) Electrodes

Lead	Position
V1	Fourth intercostal space, right sternal border
V2	Fourth intercostal space, left sternal border
V3	Midway between V2 and V4
V4	Fifth intercostal space, left midclavicular line
V5	Left anterior axillary line at the same horizontal level as V4
V6	Left midaxillary line at the same horizontal level as V4

Placement of Limb Electrodes

Electrode	Position
RA	Right wrist/forearm
LA	Left wrist/forearm
RL	Right ankle (ground)
LL	Left ankle

Recording the ECG

- Switch on the ECG machine.
- Verify calibration (10 mm = 1 mV).
- Set paper speed to 25 mm/sec.
- Ensure all electrodes are firmly attached.
- Ask the subject to remain relaxed, breathe normally, and avoid talking or moving.
- Record all 12 leads.
- Print or save the ECG tracing.

5. Observation

Record the following findings:

Parameter	Observation
Heart rate	_____ beats/min
Rhythm	Regular/Irregular
P wave	Present/Absent
PR interval	_____ sec
QRS duration	_____ sec
QT interval	_____ sec
Mean electrical axis	_____°
ST segment	Normal/Elevated/Depressed
T wave	Normal/Inverted
Overall interpretation	Normal / Abnormal

6. Analysis of Normal ECG

A. Heart Rate

Calculate using:

Heart Rate = 300 ÷ Number of large squares between two consecutive R waves

or

Heart Rate = 1500 ÷ Number of small squares between two R waves

Normal: 60–100 beats/min

B. Cardiac Rhythm

A rhythm is considered normal when:

- P wave precedes every QRS complex.
- Each P wave has one QRS complex.
- RR intervals are regular.
- Rhythm originates from the SA node.

C. ECG Components

P Wave

Represents: Atrial depolarization

Normal duration: <0.12 sec

Normal amplitude: <2.5 mm

PR Interval

Represents: Conduction from atria through the AV node to the ventricles.

Normal: 0.12–0.20 sec

QRS Complex

Represents: Ventricular depolarization

Normal duration: 0.06–0.10 sec

ST Segment

Represents: Period between ventricular depolarization and repolarization.

Normally: Isoelectric; No elevation or depression

T Wave

Represents: Ventricular repolarization

Normally: Upright in most leads except aVR

QT Interval

Represents: Total duration of ventricular depolarization and repolarization.

Normal: Approximately 0.35–0.44 sec (heart rate dependent)

D. Electrical Axis

The mean electrical axis is estimated from the net QRS deflection in leads I and aVF. The normal axis lies between −30° and +90°.

Lead I	Lead aVF	Axis
Positive	Positive	Normal axis (0° to +90°)
Positive	Negative	Left axis deviation (normal only up to −30°)
Negative	Positive	Right axis deviation
Negative	Negative	Extreme axis deviation

7. Normal ECG Values

Parameter	Normal Value

Parameter	Normal Value
Heart rate	60–100 beats/min
Rhythm	Sinus rhythm
P-wave duration	<0.12 sec
PR interval	0.12–0.20 sec
QRS duration	0.06–0.10 sec
QT interval	0.35–0.44 sec
ST segment	Isoelectric
Electrical axis	−30° to +90°

8. Clinical Significance

ECG is useful for:

- Assessment of heart rate and rhythm.
- Diagnosis of cardiac arrhythmias.
- Detection of myocardial ischaemia and infarction.
- Diagnosis of conduction defects.
- Detection of chamber enlargement.
- Diagnosis of electrolyte disturbances.
- Monitoring patients receiving cardiac medications.
- Evaluation before surgery and during routine health check-ups.

9. Precautions

- Ensure the subject is relaxed before recording.
- Place electrodes correctly according to standard positions.
- Use proper skin contact to reduce electrical interference.
- Avoid movement and talking during recording.
- Keep electrical equipment away to minimize artefacts.
- Ensure correct calibration (10 mm = 1 mV).
- Record ECG at the standard paper speed (25 mm/sec).

10. Sources of Error

- Incorrect electrode placement.
- Loose electrodes.
- Patient movement.
- Muscle tremors.
- Electrical interference.
- Poor skin contact.
- Incorrect machine calibration.

11. Viva Questions

1. Define electrocardiogram (ECG).
2. What is the physiological basis of ECG?
3. How many leads are present in a standard ECG?
4. Name the bipolar limb leads.
5. Name the augmented limb leads.

6. Name the chest leads.
7. What does the P wave represent?
8. What does the QRS complex represent?
9. What does the T wave represent?
10. What is the normal PR interval?
11. What is the normal QRS duration?
12. What is the normal heart rate?
13. What is meant by sinus rhythm?
14. What is the significance of the ST segment?
15. State two clinical uses of ECG.

12. Practical Record Sheet

Date	Heart Rate (beats/min)	Rhythm	PR Interval (sec)	QRS Duration (sec)	QT Interval (sec)	Interpretation	Teacher's Signature

13. Expected Conclusion

- A normal 12-lead ECG demonstrates sinus rhythm with a heart rate of 60–100 beats/min, a P wave preceding each QRS complex, a PR interval of 0.12–0.20 seconds, a QRS duration of 0.06–0.10 seconds, an isoelectric ST segment, and a normal upright T wave in appropriate leads.
- Proper recording and systematic analysis of the ECG provide valuable information about the heart's electrical activity and form the basis for diagnosing many cardiovascular disorders.

CHAPTER 10: RESPIRATORY PHYSIOLOGY PRACTICALS

Experiment 10.1: Auscultation of Breath Sounds

1. Learning Objectives

- Define auscultation and breath sounds.
- Explain the physiological basis of breath sound production.
- Perform systematic auscultation of the lungs using a stethoscope.
- Identify normal breath sounds (vesicular, bronchial, bronchovesicular).
- Recognize common abnormal (adventitious) breath sounds.
- Differentiate normal from abnormal breath sounds.
- Appreciate the clinical importance of lung auscultation.

2. Principle

Breath sounds are produced by turbulent airflow through the respiratory tract during inspiration and expiration. These sounds are transmitted through the lung tissue to the chest wall, where they can be heard using a stethoscope.

Normal breath sounds vary depending on the location of auscultation and reflect the normal movement of air through the conducting airways and alveoli. Alterations in airflow or lung tissue, such as airway obstruction, consolidation, or fluid accumulation, produce abnormal or adventitious breath sounds that aid in the diagnosis of respiratory diseases.

3. Apparatus

- Stethoscope
- Examination couch or chair
- Alcohol swabs (for cleaning the stethoscope)
- Quiet examination room

4. Procedure

Preparation of the Subject

- Explain the procedure to the subject and obtain consent.
- Ask the subject to sit comfortably with the chest adequately exposed while maintaining privacy.
- Ensure the examination room is quiet.
- Warm the diaphragm of the stethoscope before placing it on the skin.
- Ask the subject to breathe slightly deeper than normal through the mouth.

Technique of Auscultation

- Use the diaphragm of the stethoscope.
- Auscultate directly over the skin; avoid listening through clothing.
- Compare corresponding areas on the right and left sides of the chest.
- Listen systematically from the lung apices to the bases.

Examine:

- Anterior chest
- Lateral chest
- Posterior chest

Listen to one complete respiratory cycle (inspiration and expiration) at each site.

Note:

- Type of breath sound
- Intensity
- Symmetry
- Duration of inspiration and expiration
- Presence of added (adventitious) sounds

5. Observation

Record the following findings:

Parameter	Observation
Respiratory rate	_____ breaths/min
Symmetry of breath sounds	Symmetrical / Asymmetrical
Vesicular breath sounds	Present / Absent
Bronchial breath sounds	Present / Absent
Bronchovesicular breath sounds	Present / Absent
Added sounds	Present / Absent
Overall interpretation	Normal / Abnormal

6. Normal Breath Sounds

Breath Sound	Characteristics	Normal Location
Vesicular	Soft, low-pitched; inspiration longer than expiration; no pause between phases	Over most peripheral lung fields
Bronchovesicular	Moderate intensity; inspiration equals expiration	First and second intercostal spaces anteriorly and between the scapulae posteriorly
Bronchial	Loud, high-pitched; expiration longer than inspiration with a brief pause	Over the trachea and manubrium

7. Adventitious (Abnormal) Breath Sounds

Sound	Characteristics	Common Causes
Crackles (Crepitations/Rales)	Discontinuous popping sounds	Pulmonary oedema, pneumonia, fibrosis
Wheeze (Rhonchi)	Continuous musical sound, mainly during expiration	Asthma, COPD, bronchospasm
Pleural Friction Rub	Grating or rubbing sound	Pleuritis, pleural inflammation
Stridor	Loud, high-pitched inspiratory sound	Upper airway obstruction

8. Normal Values

Parameter	Normal Value

Parameter	Normal Value
Respiratory rate (Adult)	12–20 breaths/min
Breath sounds	Vesicular over most lung fields
Symmetry	Equal bilaterally
Adventitious sounds	Absent

9. Clinical Significance

Auscultation of breath sounds is an essential component of respiratory examination and helps in:

- Assessing normal lung ventilation.
- Detecting airway obstruction (e.g., asthma, chronic obstructive pulmonary disease).
- Diagnosing lung consolidation (e.g., pneumonia).
- Identifying pulmonary oedema and interstitial lung disease.
- Detecting pleural diseases such as pleuritis or pleural effusion.
- Monitoring disease progression and response to treatment.

10. Precautions

- Perform the examination in a quiet environment.
- Place the stethoscope directly on the skin.
- Warm the stethoscope before use.
- Ask the subject to breathe through the mouth.
- Compare corresponding areas on both sides of the chest.
- Avoid excessive pressure with the stethoscope.
- Clean the stethoscope before and after examination.
- Stop the examination if the subject becomes dizzy from deep breathing.

11. Sources of Error

- Auscultating over clothing.
- Incorrect placement of the stethoscope.
- Background noise.
- Inadequate patient cooperation.
- Failure to compare both sides of the chest.
- Rapid or shallow breathing by the subject.

12. Viva Questions

1. Define auscultation.
2. What is the physiological basis of breath sounds?
3. Which part of the stethoscope is used for auscultation of breath sounds?
4. Name the normal breath sounds.
5. What are vesicular breath sounds?
6. Where are bronchial breath sounds normally heard?
7. What are bronchovesicular breath sounds?
8. What are adventitious breath sounds?
9. What is the difference between crackles and wheezes?
10. What is a pleural friction rub?
11. What is stridor?
12. Mention two clinical conditions associated with wheezing.
13. What is the normal adult respiratory rate?

14. Why should breath sounds be compared on both sides of the chest?
15. State the clinical importance of auscultation.

13. Practical Record Sheet

Date	Respiratory Rate (breaths/min)	Normal Breath Sounds	Adventitious Sounds	Observation	Interpretation	Teacher's Signature

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Experiment 10.2: Spirometric Measurement of Lung Function: FVC, FEV_1 and FEV_1/FVC Ratio

1. Learning Objectives

- Define spirometry and pulmonary function tests.
- Explain the physiological basis of spirometry.
- Record Forced Vital Capacity (FVC) using a spirometer.
- Measure Forced Expiratory Volume in one second (FEV_1).
- Calculate the FEV_1/FVC ratio.
- Interpret normal spirometric values.
- Differentiate obstructive and restrictive ventilatory disorders using spirometry.

2. Principle

Spirometry is a simple, non-invasive pulmonary function test that measures the volume and flow of air entering and leaving the lungs. During the test, the subject inhales maximally to total lung capacity and then exhales as forcefully and rapidly as possible until no more air can be expelled.

The principal spirometric parameters are:

- Forced Vital Capacity (FVC): Total volume of air forcibly exhaled after a maximal inspiration.
- Forced Expiratory Volume in One Second (FEV_1): Volume of air exhaled during the first second of forced expiration.
- FEV_1/FVC Ratio: Percentage of the FVC exhaled in the first second.

These parameters help assess airway obstruction and restrictive lung diseases.

3. Apparatus

- Computerized spirometer
- Disposable mouthpiece
- Nose clip
- Computer/monitor with spirometry software
- Alcohol swabs or disinfectant wipes

4. Procedure

Preparation of the Subject

- Explain the procedure to the subject.
- Record age, sex, height, weight, and ethnicity.
- Ask the subject to avoid smoking, heavy meals, and strenuous exercise for at least 1 hour before the test.
- Seat the subject comfortably or allow standing as recommended.

- Apply a nose clip to prevent nasal air leakage.
- Attach a clean disposable mouthpiece.

Recording Spirometry

- Ask the subject to breathe normally through the mouthpiece.
- Instruct the subject to inhale maximally until the lungs are completely filled.
- Immediately exhale as forcefully, rapidly, and completely as possible until no more air can be expelled (at least 6 seconds in adults).
- Encourage maximal effort throughout expiration.
- Repeat the manoeuvre at least three times.
- Select the best acceptable recording according to spirometry criteria.

5. Observation

Parameter	Observed Value	Predicted Value	% Predicted
FVC (L)			
FEV_1 (L)			
FEV_1/FVC (%)			
Peak Expiratory Flow (PEF)			

6. Calculations

FEV_1/FVC Ratio:

FEV_1/FVC ratio (%) = (FEV_1 ÷ FVC) × 100

Example,

FVC = 4.2 L

FEV_1 = 3.5 L

FEV_1/FVC = (3.5 ÷ 4.2) × 100

= 83.3%

7. Interpretation

Finding	Interpretation
Normal FVC, normal FEV_1, FEV_1/FVC ≥70% Norm	al pulmonary function
Reduced FEV_1 with low FEV_1/FVC ratio	Obstructive lung disease
Reduced FVC with normal/high FEV_1/FVC ratio	Restrictive lung disease
Reduced FVC & reduced FEV_1/FVC ratio	Mixed ventilatory defect

8. Normal Values

Parameter	Normal Value
FVC	≥80% of predicted value
FEV_1	≥80% of predicted value
FEV_1/FVC Ratio	≥70% in adults (typically 75–85%)

Parameter	Normal Value
Peak Expiratory Flow (PEF)	Depends on age, sex, and height

9. Clinical Significance

Spirometry is useful for:

- Assessment of pulmonary function.
- Diagnosis of obstructive lung diseases (bronchial asthma, chronic obstructive pulmonary disease).
- Diagnosis of restrictive lung diseases (pulmonary fibrosis, chest wall disorders).
- Monitoring progression of respiratory diseases.
- Evaluating response to bronchodilator therapy.
- Preoperative respiratory assessment.
- Occupational health screening.

10. Precautions

- Explain the procedure clearly before testing.
- Use a clean, disposable mouthpiece for each subject.
- Ensure a tight seal around the mouthpiece to prevent air leakage.
- Apply a nose clip throughout the test.
- Encourage maximal inspiration and forceful expiration.
- Repeat the test until three acceptable and reproducible recordings are obtained.
- Avoid coughing during the first second of expiration.
- Ensure proper calibration of the spirometer before use.

11. Sources of Error

- Poor patient cooperation.
- Incomplete inspiration before expiration.
- Inadequate expiratory effort.
- Air leakage around the mouthpiece.
- Coughing during the manoeuvre.
- Improper calibration of the spirometer.
- Incorrect body posture.
- Loose nose clip.

12. Viva Questions

1. Define spirometry.
2. What is Forced Vital Capacity (FVC)?
3. Define Forced Expiratory Volume in one second (FEV_1).
4. What is the FEV_1/FVC ratio?
5. Why is a nose clip used during spirometry?
6. What is the normal FEV_1/FVC ratio?
7. Which diseases show a reduced FEV_1/FVC ratio?
8. Name two restrictive lung diseases.
9. Name two obstructive lung diseases.
10. Why should the manoeuvre be repeated three times?
11. What is Peak Expiratory Flow (PEF)?
12. Mention the clinical applications of spirometry.

13. Practical Record Sheet

Date	FVC (L)	FEV_1 (L)	FEV_1/FVC (%)	Observation	Interpretation	Teacher's Signature

14. Expected Conclusion

- Spirometry provides an objective assessment of lung function by measuring Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), and the FEV_1/FVC ratio.
- In healthy individuals, FVC and FEV_1 are generally ≥80% of the predicted values, and the FEV_1/FVC ratio is typically 75–85% (≥70% in adults).
- A reduced FEV_1/FVC ratio suggests obstructive airway disease, whereas a reduced FVC with a normal or increased FEV_1/FVC ratio is indicative of a restrictive ventilatory defect.
- Spirometry is an essential pulmonary function test for the diagnosis, monitoring, and management of respiratory disorders.

CHAPTER 11: RENAL PHYSIOLOGY PRACTICALS

Experiment 11.1: Determination of Urine Specific Gravity

1. Learning Objectives

1. Define urine specific gravity.
2. State the physiological basis of urine specific gravity.
3. Determine the specific gravity of urine using a urinometer.
4. Correct the reading for temperature when necessary.
5. Interpret normal and abnormal urine specific gravity values.
6. Correlate changes in urine specific gravity with hydration status and renal function.

2. Principle

Specific gravity (SG) is the ratio of the weight (density) of a given volume of urine to the weight of an equal volume of distilled water at the same temperature.

Specific gravity (SG) = Density of urine ÷ Density of water

Water has a specific gravity of **1.000**. Urine contains dissolved substances such as:

- Urea
- Sodium chloride
- Creatinine
- Uric acid
- Sulphates
- Phosphates

These solutes make urine heavier than water. Therefore, normal urine specific gravity ranges between **1.003 and 1.030**, depending on hydration status and the kidney's concentrating ability.

3. Apparatus

- Fresh urine sample (50–100 mL)
- Urinometer
- Urinometer cylinder
- Thermometer
- Tissue paper
- Gloves
- Disinfectant solution

4. Procedure

- Collect a fresh, well-mixed urine sample in a clean urinometer cylinder.
- Fill the cylinder sufficiently so that the urinometer can float freely without touching the sides or bottom.
- Gently lower the urinometer into the urine.
- Rotate it slightly to remove any air bubbles adhering to its surface.
- Allow the urinometer to float freely.
- Read the specific gravity at the **lower meniscus** while keeping the eye at the same level as the liquid surface.
- Record the temperature of the urine.
- Apply temperature correction if required.

Temperature Correction

The urinometer is usually calibrated at **20°C (or as indicated on the instrument).**

For every:

- **3°C above the calibration temperature: Add 0.001**
- **3°C below the calibration temperature: Subtract 0.001**

Example

Observed SG = 1.020

Urine temperature = 26°C

Difference = +6°C

Correction = +0.002

Corrected SG = **1.022**

5. Observation Table

Sample	Temperature (°C)	Observed SG	Corrected SG	Interpretation
Urine Sample				

Normal Values

Condition	Specific Gravity
Normal adult	**1.003–1.030**
Average random urine	**1.015–1.025**
First morning urine	**1.020–1.030**

6. Interpretation

Low specific gravity (hyposthenuria; SG < 1.010) occurs in:

- Excess water intake
- Diabetes insipidus
- Chronic renal failure
- Acute tubular damage
- Diuretic therapy

Fixed specific gravity (isosthenuria; SG ≈ 1.010) is seen in:

- Chronic kidney disease
- Severe renal tubular damage

Indicates loss of concentrating and diluting ability of the kidneys.

High specific gravity (hypersthenuria; SG > 1.030) occurs in:

- Dehydration
- Fever
- Excessive sweating
- Glycosuria (Diabetes mellitus)
- Proteinuria
- Vomiting
- Diarrhoea

7. Physiological Significance

Urine specific gravity reflects:

- Hydration status
- Renal concentrating ability
- Amount of dissolved solutes
- Effect of antidiuretic hormone (ADH)
- Overall renal tubular function

8. Precautions

- Use a fresh, well-mixed urine sample.
- Ensure the urinometer does not touch the sides or bottom of the cylinder.
- Remove air bubbles before taking the reading.
- Read the lower meniscus at eye level.
- Apply temperature correction when necessary.
- Clean and disinfect the urinometer after use.
- Handle urine samples using standard biosafety precautions.

9. Viva Questions

1. Define urine specific gravity.
2. What is the normal range of urine specific gravity?
3. Name the instrument used to measure urine specific gravity.
4. Why is temperature correction necessary?
5. What is hyposthenuria, hypersthenuria and isosthenuria?
6. Which hormone mainly regulates urine concentration?
7. Why is urine specific gravity increased in dehydration?
8. Why is urine specific gravity low in diabetes insipidus?

10. Expected Result

The specific gravity of the given urine sample is determined using a urinometer.

Example: Observed SG = **1.018;** Temperature = **20°C;** Corrected SG = **1.018**

Interpretation: Normal urine specific gravity indicating adequate renal concentrating ability and normal hydration status.

11. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

CHAPTER 12: NEUROPHYSIOLOGY AND SPECIAL SENSE PRACTICALS

Experiment 12.1: Elicitation of Knee Jerk and Plantar Response

1. Learning Objectives

- Demonstrate the correct method of eliciting the knee jerk (patellar reflex).
- Identify and describe the normal response of the knee jerk.
- Demonstrate the plantar response using appropriate technique.
- Identify the normal plantar response in an adult.
- Explain the reflex arc and spinal segments involved in these reflexes.
- Recognize the clinical significance of exaggerated, diminished, absent, or abnormal reflex responses.

2. Introduction

A reflex is an involuntary, stereotyped response to an appropriate sensory stimulus.

Reflexes are clinically useful for assessing the integrity of the sensory pathway, spinal cord segments, motor pathway, neuromuscular junction, and muscles involved in the reflex arc.

Two important reflexes examined during routine neurological examination are:

- Knee jerk (patellar reflex) – a deep tendon reflex.
- Plantar response – a superficial cutaneous reflex.

3. Part A: Elicitation of Knee Jerk

(I) Principle

The knee jerk is a monosynaptic stretch reflex. Tapping the patellar tendon suddenly stretches the quadriceps muscle. The muscle spindle afferents are activated and impulses travel through the femoral nerve to the spinal cord. The sensory fibres synapse directly with α-motor neurons supplying the quadriceps, producing contraction of the quadriceps and extension of the leg.

Reflex arc: Patellar tendon → muscle spindle of quadriceps → femoral nerve → dorsal root → spinal cord (L2–L4, predominantly L4) → α-motor neuron → femoral nerve → quadriceps → extension of leg

(II) Apparatus

- Reflex hammer
- Chair or examination couch

(III) Procedure

Method 1: Sitting position

1. Ask the subject to sit comfortably on a chair.
2. Allow the lower leg to hang freely with the knee flexed approximately at a right angle.
3. Ensure that the quadriceps muscle is relaxed.
4. Locate the patellar tendon just below the patella.
5. Strike the patellar tendon briskly with the rubber head of the reflex hammer.
6. Observe the movement of the lower leg.

7. Compare the response on both sides.

Method 2: Reinforcement

If the response is difficult to elicit:

1. Ask the subject to hook the fingers of both hands together.
2. Ask the subject to pull the hands against each other strongly.
3. Strike the patellar tendon while the subject maintains this contraction.

This is called Jendrassik's manoeuvre which helps reinforce deep tendon reflexes.

(IV) Normal Response

A normal knee jerk produces:

Contraction of quadriceps → extension of the leg at the knee joint.

The response should be brisk but not exaggerated and should be approximately symmetrical on both sides.

Grading of the knee jerk

Grade	Response
0	Absent
+ D	iminished
++	Normal
+++	Brisk/exaggerated
++++	Very brisk, often with clonus

(V) Clinical Significance

Finding	Possible significance
Absent/diminished knee jerk	Peripheral nerve lesion, femoral neuropathy, L2–L4/root lesion, peripheral neuropathy, or lower motor neuron involvement
Exaggerated knee jerk	Upper motor neuron lesion above the L2–L4 spinal segments
Asymmetry	May indicate a localized neurological lesion
Pendular knee jerk	May occur in cerebellar lesions

4. Part B: Elicitation of Plantar Response

(I) Principle

The plantar response is a superficial cutaneous reflex produced by stimulation of the sole of the foot. In a normal adult, stimulation of the lateral border of the sole produces plantar flexion of the toes, often accompanied by flexion of the foot.

The reflex involves mainly the S1 spinal segment, with contributions from L5, and is mediated through the tibial nerve.

Reflex Arc of Plantar Response

Receptors in skin of sole → tibial nerve → spinal cord (mainly S1, with L5 contribution) → motor neurons → tibial nerve → flexor muscles of toes

The normal adult response is predominantly flexor.

(II) Apparatus

- Blunt-ended neurological/reflex hammer or another suitable blunt object

Note: The stimulus should be firm but not painful and should not cause injury to the skin.

(III) Procedure

1. Ask the subject to lie comfortably in the supine position.
2. Ensure that the leg and foot are relaxed.
3. Hold the ankle in a neutral position if necessary.
4. Using a blunt object, stimulate the lateral border of the sole.
5. Start near the heel and move the stimulus forward along the lateral border.
6. Curve the stimulus medially across the ball of the foot.
7. Observe the movement of the toes.
8. Compare both feet.

Direction of stimulus

Heel → lateral border of sole → forward → curve medially across the ball of the foot

(IV) Normal Response

In a normal adult:

Flexion of the toes (down-going toes) occurs.

This is called a normal plantar response or flexor plantar response.

(V) Abnormal Plantar Response – Babinski Sign

An extensor plantar response is characterized by:

- Dorsiflexion/extension of the great toe
- ± Fanning/abduction of the other toes

This is known as a positive Babinski sign.

An extensor plantar response in a neurologically mature adult suggests involvement of the corticospinal (pyramidal) tract, usually indicating an upper motor neuron lesion.

[Important: An extensor plantar response can be physiological in infants because corticospinal tract myelination is not yet complete].

5. Observation Table

Reflex	Side	Stimulus	Normal response	Observation
Knee jerk	Right	Tap on patellar tendon	Extension of leg	__
Knee jerk	Left	Tap on patellar tendon	Extension of leg	__
Plantar response	Right	Stroke lateral sole	Flexion/down-going toes	__
Plantar response	Left	Stroke lateral sole	Flexion/down-going toes	__

6. Expected Result

Knee jerk: Present and normal bilaterally, with extension of the leg at the knee joint.

Plantar response: Flexor response present bilaterally, with downward movement of the toes.

7. Precautions

- The subject should be relaxed during examination.
- Avoid striking the patella directly while eliciting the knee jerk; strike the patellar tendon.
- The lower leg should hang freely during knee-jerk testing.
- Use an appropriate reflex hammer.
- The stimulus for plantar testing should be firm but not excessively painful.
- Use a blunt object to avoid injury to the sole.
- Compare the response on both sides.
- Avoid repeated stimulation at the same site, as this may alter the response.
- Do not suggest the expected response to the subject.
- Use reinforcement such as Jendrassik's manoeuvre when a deep tendon reflex is difficult to elicit.

8. Viva Questions

1. What type of reflex is the knee jerk?
2. Which spinal segments are involved in the knee jerk?
3. Which nerve mediates the knee jerk?
4. Which muscle contracts during the knee jerk?
5. What is the normal response to knee-jerk stimulation?
6. What is Jendrassik's manoeuvre?
7. What is the normal plantar response in an adult?
8. What is a Babinski sign?
9. What does a positive Babinski sign indicate in an adult?
10. Is an extensor plantar response always pathological?

9. Summary of Key Reflexes

Reflex	Stimulus / Method	Normal Response	Spinal Level
Biceps Reflex	Tap biceps tendon over thumb	Forearm flexion	C5, C6
Triceps Reflex	Tap triceps tendon above olecranon	Forearm extension	C6, C7
Knee Jerk	Tap patellar tendon below patella	Leg extension	L2, L3, L4
Ankle Jerk	Tap Achilles tendon	Plantarflexion	S1, S2
Plantar Reflex	Stroke lateral sole of foot	Plantarflexion of toes	L5, S1

10. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 12.2: Recording of Oral and Axillary Temperature and the Effect of Exercise on It

1. Learning Objectives

- Explain the physiological basis of body temperature regulation and the differences between core and peripheral temperature.
- Demonstrate the correct techniques for measuring oral and axillary temperature using a clinical thermometer or suitable digital thermometer.
- Record temperature accurately in degrees Celsius and document the measurement site and timing.
- Compare oral and axillary temperature readings and explain why they may differ.
- Measure temperature before and after a standardized bout of physical exercise, using safe and consistent procedures.
- Analyse the immediate effects of exercise on body temperature and relate the findings to heat production, heat loss, and thermoregulatory responses.
- Identify common sources of error and state the precautions required for reliable temperature measurement.

2. Principle & Normal Values

A clinical thermometer detects temperature at the site where it is placed. For a valid comparison, the same thermometer type, measurement site, posture, and recording procedure should be used at each time point. The resting temperature is measured after the subject has rested in a comfortable environment. The subject then performs a standardized, safe exercise bout, and temperature is recorded promptly after exercise and, if required, during recovery.

Expected physiological basis: exercise increases metabolic heat production. Thermoregulatory responses promote heat transfer to the skin and heat loss by evaporation of sweat. A small rise may be observed after exercise, but the recorded change can be modest or inconsistent with oral/axillary methods because these are not direct measures of core temperature.

Thermoregulation is controlled by the hypothalamic thermostat balancing heat production and heat loss.

- **Oral Site**: ≈ 37°C (98.6°F).
- **Axillary Site**: ≈ 36.5°C (97.7°F) (0.5°C lower than oral).
- **Rectal Site**: ≈ 37.5°C (99.5°F) (0.5°C higher than oral).

3. Apparatus and Materials

- Clinical digital thermometer or an approved clinical thermometer suitable for oral and axillary use.
- Disposable probe covers, if required by the device.
- Alcohol-based or manufacturer-recommended disinfectant wipes, where appropriate.
- Watch or stopwatch.
- Exercise step, stationary cycle, or open space for brisk walking, depending on the laboratory protocol.
- Recording sheet, pen, and access to drinking water.
- Hand hygiene supplies.

4. Part A: Measurement of Oral Temperature

(I) Principle

The thermometer probe is placed in a sublingual pocket at the side of the frenulum. The mouth is kept closed so that the probe is surrounded by oral tissues and is less affected by ambient air. The reading is recorded when the device signals completion or according to the manufacturer's instructions.

(II) Procedure

- Explain the procedure and obtain the subject's cooperation. Perform hand hygiene.
- Confirm that the subject has not recently consumed hot or cold drinks, eaten, smoked, chewed gum, or exercised vigorously. Follow the institution's recommended waiting period; commonly, allow about 15–30 minutes after food or drink and a longer period after vigorous exercise when obtaining a resting baseline.
- Check that the thermometer is clean, functional, and set to display degrees Celsius. Apply a disposable probe cover if indicated.
- Ask the subject to sit comfortably. Place the probe beneath the tongue in a posterior sublingual pocket, to either side of the frenulum.
- Ask the subject to close the lips gently around the thermometer without biting it. The mouth should remain closed during measurement.
- Wait until the digital thermometer signals completion, or for the time specified for the device being used. Do not remove the probe prematurely.
- Remove the thermometer, read and record the value in °C, and note the time and site as "oral."
- Dispose of the probe cover and clean the device according to the manufacturer's instructions. Perform hand hygiene.

(III) Expected Reading and Interpretation

- Oral temperature in a healthy adult commonly falls around 36.5–37.5°C, but normal values vary with the individual, time of day, and measurement method. Record the measured value rather than altering it to fit a reference range.

(IV) Limitations

- Recent food or drink, smoking, mouth breathing, and an incorrectly positioned probe can affect the reading.
- Oral measurement may be unsuitable for a confused or uncooperative subject, a person unable to keep the mouth closed, or someone at risk of biting the thermometer.
- Oral temperature may not track rapid changes in core temperature accurately during or immediately after exercise.

5. Part B: Measurement of Axillary Temperature

(I) Principle

The thermometer probe is placed high in the centre of a dry axilla, with close contact between the probe and skin. The upper arm is held firmly against the chest to reduce exposure to room air and improve contact.

(II) Procedure

- Explain the procedure, perform hand hygiene, and ensure the subject is seated or resting comfortably.
- Expose the axilla and gently dry it if perspiration is present. Moisture may affect the measurement.
- Check the thermometer and use a clean probe or disposable cover according to the device instructions.
- Place the probe tip high in the center of the axilla, ensuring direct contact with the skin rather than clothing.
- Ask the subject to bring the upper arm firmly against the chest and keep it in that position throughout the measurement.
- Wait for the completion signal or the manufacturer-recommended measurement time.
- Remove the thermometer and record the value in °C, clearly labelling it "axillary," with the time of measurement.
- Clean the thermometer according to the manufacturer's instructions and perform hand hygiene.

(III) Expected Reading and Interpretation

Axillary temperature is generally lower than oral temperature and may be less reliable as an estimate of core temperature. The difference varies between individuals and circumstances; do not add a fixed correction value to an axillary reading. Record the actual result and the site used.

(IV) Limitations

- Poor probe contact, a damp axilla, loose arm position, clothing between the probe and skin, or exposure to a cool environment can affect the reading.
- Axillary temperature may respond more slowly than core temperature to rapid physiological changes.
- Comparisons are most meaningful when the same site and technique are used consistently.

6. Part C: Effects of Exercise on Oral and Axillary Temperature

(I) Principle

Muscular work increases ATP turnover and metabolic heat production. Thermoregulatory responses, including cutaneous vasodilatation and sweating, increase heat transfer and evaporation. During exercise, heat production may temporarily exceed heat loss, causing temperature to rise. The size of the recorded change depends on the exercise protocol and environment, and oral/axillary measurements are imperfect indicators of core temperature.

(II) Procedure

- Screen for contraindications to exercise and follow the laboratory's safety instructions. Do not ask an unwell subject to exercise.
- Keep the subject in a comfortable room and allow a resting period, usually 10–15 minutes, before baseline measurements.
- Record baseline oral temperature and baseline axillary temperature. Use the same thermometer type and measurement technique throughout. If only one thermometer is available, clean it appropriately between sites and follow its instructions.
- Record baseline heart rate and any other variables required by the practical protocol. Note room conditions if available.
- Ask the subject to perform a standardized bout of moderate exercise, such as brisk walking or stepping, for a predetermined duration (for example, 3–5 minutes) under supervision. The intensity and duration must be the same for all subjects being compared.
- Stop the activity immediately if the subject develops chest pain, marked breathlessness, dizziness, faintness, unusual weakness, or other concerning symptoms.
- Immediately after exercise, record the time and measure oral temperature using the same technique. Minimize delay, but do not compromise safe and correct placement.
- Measure axillary temperature promptly after the oral reading, maintaining correct probe contact. Record the exact time after exercise for each measurement because sequential readings are not simultaneous.
- If instructed, repeat oral and axillary measurements after 5 minutes and 10 minutes of seated recovery to observe the trend toward baseline.
- Record all values in the observation table. Calculate the change from baseline for each site: post-exercise temperature − baseline temperature.
- Ensure the subject cools down comfortably and has access to water. Report any unexpected or concerning observations to the supervisor.

(III) Expected Changes

- Temperature may rise after exercise because of increased metabolic heat production.
- The rise may be small or not clearly detected by oral or axillary measurement, especially after brief or low-intensity activity.

- Temperature may remain elevated for a period during recovery and gradually move toward the resting value as heat loss catches up with heat production.
- Oral and axillary readings may show different changes because the sites differ in their relationship to core temperature and their sensitivity to technique and environmental conditions.

(IV) Calculation

- Change in temperature (°C) = post-exercise temperature (°C) − Resting temperature (°C).
- Example only: if oral temperature is 36.8°C at rest and 37.1°C after exercise, the recorded change is 37.1 − 36.8 = +0.3°C. This is an illustrative calculation, not a predicted or required result.

7. Observation Tables

Table 1. Resting Oral and Axillary Temperature

Subject/ID	Oral temperature (°C)	Axillary temperature (°C)	Time	Remarks

Table 2. Effect of Exercise on Temperature

Measurement site	Resting (°C)	Immediately after exercise (°C)	Change (°C)	5-min recovery (°C)	10-min recovery (°C)
Oral					
Axillary					

Table 3. Suggested Individual Record

Variable	Result/observation
Exercise type and duration	
Exercise intensity (as prescribed)	
Room/environmental conditions	
Resting oral temperature	
Resting axillary temperature	
Post-exercise oral temperature and time	
Post-exercise axillary temperature and time	
Symptoms or unusual observations	

8. Results and Interpretation

- Record the actual values obtained; do not substitute expected values for observations.
- Compare resting oral and axillary readings. State which was higher in the observed subject and the measured difference.
- Compare each site's post-exercise value with its own baseline value.
- Describe the direction and magnitude of any change and whether the readings moved toward baseline during recovery.
- Interpret the results in relation to increased metabolic heat production and thermoregulatory heat loss.

- Comment on limitations, including sequential rather than simultaneous measurements and the limited ability of oral/axillary sites to represent rapidly changing core temperature.

9. Expected Result

- At rest, the oral reading is commonly higher than the axillary reading, although individual results vary.
- Following moderate exercise, temperature may increase slightly, and it may gradually return toward the resting value during recovery. The size and even the detectability of the change depend on the exercise protocol, environment, timing, and measurement technique.
- The student should report the actual observations rather than assuming that every measurement must show a rise.

10. Precautions

- Use a thermometer suitable for the intended measurement site and follow the manufacturer's instructions.
- Use the same measurement site and technique when comparing resting and post-exercise values.
- Allow an appropriate resting period before baseline measurements and avoid recent hot/cold drinks or food before oral measurement.
- For oral measurement, place the probe in a sublingual pocket and keep the lips closed throughout the measurement.
- Do not use oral measurement when it is unsafe or impractical, including in a subject who cannot cooperate or may bite the thermometer.
- For axillary measurement, ensure the axilla is dry, the probe is in direct skin contact, and the arm is held firmly against the chest.
- Clean the thermometer between measurements and between subjects according to infection-control guidance and manufacturer instructions.
- Record the site, time, device type if relevant, and exact reading. Do not apply a fixed correction to convert axillary to oral temperature.
- Standardize exercise type, duration, and intensity as far as practical; record the time elapsed before each post-exercise reading.
- Exercise must be supervised. Stop if the subject develops concerning symptoms, and do not exercise anyone who is unwell or has a contraindication.
- Do not interpret a small oral or axillary change as proof that core temperature has not changed; these sites may not track rapid core-temperature shifts accurately.

11. Viva Questions

1. What is body temperature?
2. What is the usual range of normal adult temperature?
3. Which part of the brain is primarily responsible for thermoregulation?
4. Where is oral temperature measured?
5. Why should the mouth remain closed during oral measurement?
6. Where should the probe be placed for axillary temperature?
7. Is axillary temperature usually higher or lower than oral temperature?
8. Should a fixed correction be added to axillary temperature to estimate oral temperature?
9. Why can hot or cold drinks affect oral temperature?
10. Why does body temperature tend to rise during exercise?
11. Name two mechanisms that increase heat loss during exercise.
12. Why should the same site be used for serial measurements?
13. How is the change in temperature calculated?
14. Why may oral or axillary readings fail to show a clear rise immediately after exercise?
15. What information should accompany a temperature reading?
16. What should be done if the subject becomes dizzy or develops chest pain during exercise?

17. Why should the axilla be dry before measurement?
18. What is the difference between heat production and heat loss?
19. What is the main limitation of using oral and axillary temperature during exercise?

12. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 12.3: Observation of Light Reflexes and Analysis of Results

1. Learning Objectives

- Explain the physiological basis and reflex pathway of the pupillary light reflex.

<!– –> - Demonstrate the correct technique for observing direct and consensual light reflexes. - Identify the normal pupillary response to illumination of either eye. - Compare pupillary responses in the two eyes and record the findings systematically. - Analyse abnormal or unequal responses and relate them cautiously to possible defects in the afferent or efferent limbs of the reflex arc. - State the precautions required for safe and reliable examination of the pupillary light reflex.

2. Principle

Light falling on the retina activates retinal pathways. Signals pass through the optic nerve, optic chiasm and optic tract to the pretectal nuclei of the midbrain. Interneuronal connections activate both Edinger–Westphal nuclei. Preganglionic parasympathetic fibres pass in the oculomotor nerves to the ciliary ganglia; postganglionic fibres travel in the short ciliary nerves to the sphincter pupillae. Contraction of this muscle produces pupillary constriction (miosis).

Reflex pathway: Retina → optic nerve → optic chiasm/optic tract → pretectal nuclei of midbrain → bilateral Edinger–Westphal nuclei → oculomotor nerves (CN III) → ciliary ganglia → short ciliary nerves → sphincter pupillae → constriction of both pupils.

Direct light reflex: constriction of the pupil in the eye receiving light. Consensual light reflex: constriction of the pupil in the opposite eye when light is shone into one eye.

3. Apparatus and Materials

- A penlight or small torch with a focused, non-intense beam.
- A dim or moderately darkened room, where practical.
- Chair for the subject and examiner.
- Observation sheet and pen.

4. Procedure

(I) Preparation

- Explain the procedure to the subject and obtain cooperation.
- Ask the subject to sit comfortably and look at a distant target to minimize accommodation-related pupillary constriction.

- Allow the eyes to adapt to the room lighting for a short period. Observe both pupils at rest, noting their approximate size, shape, and symmetry.
- Position yourself so that both pupils can be observed. Avoid shining the light directly into the eye for longer than necessary.

(II) Observation of the Direct Light Reflex

- Ask the subject to continue looking at a distant target.
- Illuminate one eye from the side, directing the beam briefly toward the pupil without obscuring your view.
- Observe the pupil of the illuminated eye for prompt constriction.
- Remove the light and allow the pupil to return toward its baseline size.
- Repeat on the other eye, using a similar light intensity and duration.

(III) Observation of the Consensual Light Reflex

- Ask the subject to look at the distant target and keep the head still.
- Illuminate one eye while keeping the pupil of the opposite eye visible to the examiner.
- Observe whether the pupil of the non-illuminated eye constricts at the same time as the illuminated pupil.
- Remove the light and observe recovery toward baseline.
- Repeat by illuminating the opposite eye and observing the other pupil.

(IV) Comparative Testing

- Compare the direct and consensual responses when the right eye is illuminated and when the left eye is illuminated.
- Record whether each response is present, brisk, sluggish, or absent. Note any clear asymmetry.
- Repeat a questionable observation once, ensuring that the subject is looking at a distant target and that the light is adequate but not uncomfortable.
- Do not make a diagnosis from this practical test alone; an abnormal finding requires clinical assessment and, where indicated, further examination.

5. Normal Response

- When the right eye is illuminated, the right pupil constricts (right direct response) and the left pupil also constricts (left consensual response).
- When the left eye is illuminated, the left pupil constricts (left direct response) and the right pupil also constricts (right consensual response).
- The responses are usually prompt and broadly symmetrical, although pupil size and response speed may vary with age, ambient light, medications, and other factors.

6. Observation Table

Eye illuminated	Pupil observed	Response assessed	Expected normal response	Actual observation
Right eye	Right pupil	Direct	Constriction	
Right eye	Left pupil	Consensual	Constriction	
Left eye	Left pupil	Direct	Constriction	
Left eye	Right pupil	Consensual	Constriction	

7. Analysis of Results

- Analyse the observations by identifying which pupil was illuminated and which pupil was observed. Record direct and consensual responses separately for each eye.
- The following patterns provide a basic physiological framework; they are not a substitute for a full clinical examination.

Observed pattern	Possible physiological interpretation
Both pupils constrict when either eye is illuminated	Consistent with intact afferent and efferent pathways for the tested light reflex.
Neither pupil constricts when light is directed into one eye, but both constrict when the other eye is illuminated	May suggest an afferent defect in the eye receiving light; clinical confirmation is needed.
One pupil fails to constrict regardless of which eye is illuminated, while the other pupil constricts	May suggest an efferent parasympathetic pathway or iris sphincter problem in the non-responsive eye.
Responses are present but slow or reduced	May reflect physiological variation, medication effects, ocular disease, or neurological dysfunction; interpret with other findings.
Pupils are unequal at rest	Anisocoria may be physiological or pathological; compare responses in bright and dim light and seek clinical assessment if new or symptomatic.

8. Expected Result

- Normally, illumination of either eye produces constriction of both pupils: a direct response in the illuminated eye and a consensual response in the opposite eye.
- The responses should generally be prompt and similar on the two sides. Record actual findings and mention any absent, sluggish, unequal, or otherwise unusual response.

9. Precautions

- Explain the procedure and obtain the subject's cooperation before starting.
- Use a penlight with a comfortable intensity; do not use an excessively bright light or prolong illumination unnecessarily.
- Ask the subject to fix their gaze on a distant target to minimize accommodation-associated pupillary constriction.
- Observe both pupils clearly, particularly the non-illuminated pupil during testing of the consensual response.
- Use similar light intensity, angle, and duration for both eyes.
- Allow the pupils to return toward baseline before repeating the test.
- Avoid pressing on the eyeball or touching the cornea.
- Consider room illumination, medications, age, previous eye surgery, and ocular conditions when interpreting findings.
- Do not diagnose a neurological lesion from this observation alone. A new abnormal pupil, sudden visual change, severe headache, drooping eyelid, double vision, or other acute neurological symptom requires urgent clinical evaluation.

10. Viva Questions

1. What is the pupillary light reflex?
2. What is the direct light reflex?
3. What is the consensual light reflex?
4. What is the receptor for the pupillary light reflex?
5. What is the afferent nerve of the reflex?
6. Which part of the brain integrates the pupillary light reflex?
7. What is the efferent cranial nerve?
8. Where do the preganglionic parasympathetic fibres synapse?

9. Which muscle constricts the pupil?
10. Which nerves carry postganglionic fibres to the sphincter pupillae?
11. Why do both pupils constrict when only one eye is illuminated?
12. Why should the subject look at a distant object?
13. What might failure of one pupil to constrict regardless of which eye is illuminated suggest?
14. Name two factors other than neurological lesions that may influence pupil size or response.

11. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 12.4: Determination of Visual Acuity by Snellen's Chart

1. Learning Objectives

- Explain the concept of visual acuity and the principle of the Snellen chart.
- Demonstrate the correct procedure for testing distance visual acuity using a Snellen chart.
- Measure and record visual acuity separately for the right and left eyes.
- Interpret the Snellen fraction and identify reduced visual acuity.
- State the precautions and common sources of error during visual acuity testing.

2. Introduction

Visual acuity is the ability of the visual system to distinguish fine details and to recognize two closely spaced points as separate. It depends on the optical quality of the eye, retinal function—particularly the fovea—and the integrity of the visual pathways. Distance visual acuity is commonly assessed using a Snellen chart.

3. Principle

Each line of a Snellen chart is designed so that the optotypes subtend a standardized visual angle when viewed from the chart's specified distance. The subject reads the smallest line that can be identified according to the chart's scoring instructions.

Snellen fraction = Testing distance / distance at which the line is designed to be read by a person with standard acuity.

A result of 6/6 means that the subject can read at 6 metres what a person with standard acuity is expected to read at 6 metres. A result of 6/12 means that the subject can read at 6 metres what a person with standard acuity can read at 12 metres. A larger denominator generally indicates poorer distance visual acuity.

4. Apparatus and Materials

- Snellen distance visual acuity chart with adequate, even illumination.
- Measuring tape to mark the standard testing distance.
- Ocular occluder or clean opaque card to cover one eye without pressing on it.
- Pointer, if required by the chart protocol.
- Record sheet and pen.

- Usual distance spectacles or contact lenses, if testing corrected visual acuity; note whether the test is unaided or corrected.

5. Procedure

(I) Preparation

- Explain the test to the subject and ensure that they are comfortable and cooperative.
- Place the Snellen chart at the recommended height, in a well-lit area, avoiding glare, reflections, and shadows.
- Measure and mark the specified testing distance, commonly 6 metres, from the chart to the subject's eye position.
- Ask whether the subject normally uses spectacles or contact lenses. Record whether testing is unaided or with the usual distance correction.
- Ask the subject to stand or sit upright at the marked distance, facing the chart.

(II) Testing the Right Eye

- Cover the left eye with an occluder or opaque card. Do not apply pressure to the covered eye.
- Ask the subject to read the letters on the chart, starting from the larger optotypes and proceeding to smaller lines.
- Encourage the subject to attempt each line without squinting, leaning forward, or tilting the head.
- Follow the chart's scoring rule to determine the smallest line read correctly. Some charts permit a specified number of errors; use the rule supplied with the chart.
- Record the visual acuity for the right eye as a Snellen fraction, along with whether it was unaided or corrected.

(III) Testing the Left Eye

- Cover the right eye without pressing on it.
- Repeat the same procedure using the same chart, illumination, and testing distance.
- Record the visual acuity for the left eye as a Snellen fraction.

(IV) Binocular Testing and Repeat Measurement

- If required by the practical protocol, test both eyes together and record binocular visual acuity separately.
- If a result seems inconsistent, repeat the test after checking chart distance, lighting, occlusion, and the subject's understanding of the task.
- Do not allow the subject to memorize or receive cues about the letters. Use a different chart or alternate optotypes when indicated by the protocol.

6. Normal Result and Interpretation

- A commonly accepted normal distance visual acuity is 6/6 in each eye when tested with an appropriate chart under standard conditions.
- Results should be interpreted according to the chart used, testing distance, subject's age and cooperation, and whether refractive correction was worn.

Snellen result	Interpretation
6/6	Standard distance visual acuity at the testing distance.
6/9	Mild reduction compared with 6/6; interpret in context.
6/12	At 6 m, the subject reads what a person with standard acuity reads at 12 m.
6/18	Reduced distance visual acuity compared with 6/6.
6/60	At 6 m, the subject reads what a person with standard acuity reads at 60 m.

7. Observation Table

Eye tested	Testing condition	Testing distance	Smallest line read	Visual acuity
Right eye	Unaided / Corrected	6 m		
Left eye	Unaided / Corrected	6 m		
Both eyes (if required)	Unaided / Corrected	6 m		

8. Analysis of Results

- Compare the right-eye and left-eye Snellen fractions.
- If both eyes record 6/6, the measured distance visual acuity is within the commonly accepted normal range under the conditions of the test.
- If one or both eyes have a larger denominator than 6/6, visual acuity is reduced relative to the standard chart reference and may require further assessment.
- Compare unaided and corrected results when both are tested. Improvement with distance correction may indicate a refractive component, but the Snellen test alone does not establish a diagnosis.
- Consider possible sources of error such as poor illumination, incorrect testing distance, failure to cover the opposite eye, unfamiliarity with letters, squinting, or inaccurate recording.
- Reduced acuity, a new difference between eyes, or a sudden change in vision should be referred for appropriate clinical/eye assessment.

9. Expected Result

- The visual acuity of each eye is determined separately and recorded as a Snellen fraction. In a healthy subject with normal distance visual acuity, the result is commonly 6/6 in each eye.

10. Precautions

- Ensure that the chart is correctly positioned, clearly visible, and adequately illuminated.
- Maintain the exact testing distance specified for the chart.
- Test each eye separately and cover the other eye completely without applying pressure.
- Do not allow the subject to squint, lean forward, or tilt the head to improve performance.
- Use the same chart conditions for both eyes and document whether the test is unaided or corrected.
- Follow the scoring instructions supplied with the particular chart; do not guess or alter the recorded fraction.
- Clean reusable occluders between subjects and maintain appropriate hygiene.

11. Viva Questions

1. What is visual acuity?
2. Which chart is commonly used to measure distance visual acuity?
3. What is the usual testing distance for a standard Snellen chart?
4. What does the numerator in the Snellen fraction represent?
5. What does the denominator represent?
6. What does 6/6 visual acuity mean?
7. What does 6/12 mean?
8. Why is each eye tested separately?
9. Why should the occluder not press on the eye?
10. Why must the chart be properly illuminated?
11. What is the difference between unaided and corrected visual acuity?
12. Which retinal region is most important for high-resolution visual acuity?
13. Name one common cause of reduced visual acuity.

14. Does a reduced Snellen fraction alone establish the cause of visual impairment?
15. What should be recorded with the Snellen result?

12. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

Experiment 12.5: Hearing Tests: Rinne and Weber Tests with Interpretation and Analysis of Results

1. Learning Objectives

- Explain the physiological basis of air conduction and bone conduction of sound.
- Demonstrate the correct technique for performing the Rinne and Weber tests with a tuning fork.
- Identify the normal response to both tests.
- Compare air and bone conduction in each ear and record the findings systematically.
- Interpret abnormal results cautiously to distinguish conductive from sensorineural hearing loss.
- State the precautions required for reliable tuning fork testing.

2. Principle

Sound reaches the inner ear by two routes. In air conduction (AC), sound waves pass through the external auditory canal to the tympanic membrane, are transmitted by the ossicles (malleus, incus, stapes) to the oval window, and set the cochlear fluids in motion. In bone conduction (BC), vibrations applied to the skull travel directly through bone to the cochlea, bypassing the outer and middle ear. In a healthy ear, air conduction is more efficient than bone conduction because the middle ear amplifies sound.

Conductive hearing loss arises from disease of the external or middle ear; BC is preserved or relatively better than AC. Sensorineural hearing loss arises from disease of the cochlea, cochlear nerve or central auditory pathway; both AC and BC are reduced.

Rinne test: compares AC and BC in the same ear. A vibrating fork is placed on the mastoid process (BC) and then in front of the ear canal (AC).

Weber test: compares BC between the two ears. A vibrating fork is placed on the midline of the skull and the subject reports where the sound is heard louder.

Pathway: Sound → external auditory canal → tympanic membrane → ossicles → oval window → cochlea (organ of Corti) → cochlear nerve (CN VIII) → cochlear nuclei → superior olivary complex → inferior colliculus → medial geniculate body → auditory cortex (temporal lobe).

3. Apparatus and Materials

- A 512 Hz tuning fork (256 Hz may be used if unavailable).
- A quiet room, free from ambient noise.
- Rubber pad or the examiner's knee/elbow for striking the fork.
- Chair for the subject and examiner; otoscope, if available, to inspect the ear canals.
- Observation sheet and pen.

4. Procedure

(I) Preparation

- Explain the procedure to the subject and obtain cooperation.
- Seat the subject comfortably in a quiet room. Inspect both external ear canals and remove or note any visible wax or discharge.
- Ask the subject to respond clearly (for example, “yes” or “no”, or “right”, “left” or “middle”) and to keep the eyes closed during testing.
- Strike the tuning fork gently on the knee, elbow or rubber pad. Hold it by the stem and avoid touching the prongs.

(II) Rinne Test

- Place the base of the vibrating fork firmly on the mastoid process behind the ear being tested (bone conduction). Ask the subject to say when the sound is no longer heard.
- Immediately move the fork, with the prongs facing forward and in line with the ear canal, about 2.5 cm from the external auditory meatus (air conduction), without touching the ear.
- Ask whether the sound can still be heard. If yes, AC > BC (Rinne positive). If no, BC > AC (Rinne negative).
- Repeat on the other ear, using similar force and the same fork.

Alternative method: Hold the fork alternately on the mastoid and in front of the meatus for equal periods and ask the subject which position sounds louder.

(III) Weber Test

- Strike the fork and place the base firmly on the midline of the forehead, vertex or glabella (or on the upper central incisors).
- Ask the subject whether the sound is heard in the middle of the head, in the right ear or in the left ear, or whether it is louder on one side.
- Repeat once to confirm the answer. To check reliability, gently occlude one ear with a finger and ask whether the sound shifts to that ear.

(IV) Comparative Testing

- Record the Rinne result separately for the right and left ears and the Weber result (central, right or left).
- Combine the findings and compare them with the interpretation table in section 7.
- Repeat a questionable observation once, ensuring a quiet environment and correct fork placement.
- Do not diagnose hearing loss from this practical test alone; an abnormal finding requires audiometry and clinical assessment.

5. Normal Response

- Rinne test: In both ears, the sound is heard longer or louder by air conduction than by bone conduction (Rinne positive, AC > BC).
- Weber test: The sound is heard in the midline or equally in both ears (Weber central, not lateralised).
- Pitch, loudness and duration of response may vary with age, ambient noise, fork frequency and the force with which the fork is struck.

6. Observation Table

Test	Ear tested	Expected normal response	Actual observation
Rinne	Right	Positive (AC > BC)	
Rinne	Left	Positive (AC > BC)	
Weber	Both (midline)	Heard centrally / equally in both ears	

7. Analysis of Results

- Record the Rinne result for each ear and the Weber result separately, then interpret them together.
- The following patterns provide a basic physiological framework; they are not a substitute for audiometry or full clinical examination.

Condition	Rinne test	Weber test	Possible physiological interpretation
Normal hearing	Positive in both ears	Central	Consistent with normal air and bone conduction.
Conductive loss, one ear	Negative in the affected ear; positive in the normal ear	Lateralised to the affected ear	Suggests a defect in the external or middle ear on that side; clinical confirmation is needed.
Sensorineural loss, one ear	Positive in both ears (reduced in the affected ear)	Lateralised to the normal (better) ear	Suggests a cochlear or neural defect in the affected ear; clinical confirmation is needed.
Bilateral conductive loss	Negative in both ears	Central, or toward the worse ear	Suggests bilateral outer or middle ear disease.
Bilateral sensorineural loss (symmetrical)	Positive in both ears	Central	Suggests symmetrical cochlear or neural impairment, such as presbycusis; Weber cannot lateralise.
Severe unilateral sensorineural loss	May appear falsely negative in the deaf ear	Lateralised to the normal ear	Sound crosses the skull to the better cochlea; masking the better ear is required to confirm.

Reasoning: In conductive loss, the cochlea is normal and BC is intact, so a vibrating fork on the skull is heard louder in the affected ear, partly because it is shielded from environmental noise. In sensorineural loss, the damaged cochlea or nerve responds poorly to bone-conducted sound, so the better ear hears it louder. The Rinne test remains positive because both AC and BC are reduced proportionately.

8. Expected Result

- Normally, the Rinne test is positive in both ears (AC > BC) and the Weber test is central.
- Record the actual findings and mention any negative Rinne, lateralised Weber, or otherwise unusual response, along with the likely type of hearing loss.

9. Precautions

- Explain the procedure and obtain the subject's cooperation before starting.
- Perform the test in a quiet room, as ambient noise can mask the sound and cause errors.
- Strike the fork gently on the knee, elbow or rubber pad; do not strike it on a hard surface.
- Do not touch the prongs after striking, as this damps the vibration.
- Place the base of the fork firmly and flat on bone, avoiding hair, and use the same pressure on both sides.
- For air conduction, hold the prongs about 2.5 cm from the meatus, in line with the canal and without touching the pinna.
- Do not give verbal or visual cues; ask neutral questions and ask the subject to keep the eyes closed.
- Examine the ear canals first, since wax, a foreign body or discharge can cause a conductive loss.
- Use the same tuning fork frequency (preferably 512 Hz) for both ears.
- Avoid causing discomfort; do not press the fork on the skull excessively.
- Remember that tuning fork tests are screening tests. Sudden hearing loss, ear discharge, vertigo, tinnitus, ear pain or facial weakness requires urgent clinical evaluation.

10. Viva Questions

1. What is the Rinne test?
2. What is the Weber test?
3. Which tuning fork is preferred, and why?
4. How should the tuning fork be activated?
5. What is a positive Rinne test?
6. What is a negative Rinne test?
7. What does the Weber test show in conductive deafness?
8. What does the Weber test show in sensorineural deafness?
9. Why is Weber heard louder in the ear with conductive loss?
10. What is the usual Rinne result in sensorineural deafness?
11. What is a false negative Rinne test?
12. How much air-bone gap is needed before Rinne becomes negative?
13. Name the pathway of air conduction.
14. Name two common causes of conductive hearing loss.
15. Name two causes of sensorineural hearing loss.
16. Is a tuning fork test a substitute for audiometry?

11. Practical Record Sheet

Date	Observation	Result	Interpretation	Teacher's Signature

CHAPTER 13: PRACTICAL EXAMINATION PROTOCOLS

13.1 Traditional Practical Examination

The traditional practical examination evaluates performance of experiments, accuracy of data recording, interpretation of results, and viva voce knowledge.

13.2 Objective Structured Practical Examination (OSPE)

Station Type	Competency Assessed	Allocated Time
Procedure Station	Execution of practical skill according to checklist	5 minutes
Spotter Station	Identification of instrument / slide / graph	2 minutes
Data Interpretation	Analysis of lab report / blood values / ECG	3 minutes
Communication Station	Patient instruction / ethical interaction	2 minutes

13.3 Assessment and Marks Distribution

The practical component of the 1st Professional MBBS Examination carries 100 marks: OSPE (40), Traditional Practical Methods and Experiments (40), Practical Notebook (10), and Assignment on Integrated Teaching (10). The detailed distribution is given in Section 4.6.

13.4 Reference Table of Normal Physiological Values

Parameter	Normal Reference Range
Haemoglobin	Male: 13–17 g/dL; Female: 12–15 g/dL
Total RBC count	Male: 4.5–5.9 × 10^6/µL; Female: 4.1–5.1 × 10^6/µL
Total WBC count	4,000–11,000/µL
Differential WBC count	Neutrophils 40–75%; Lymphocytes 20–45%; Monocytes 2–10%; Eosinophils 1–6%; Basophils 0–1%
ESR (Westergren)	Male: 0–15 mm/1st hour; Female: 0–20 mm/1st hour
Packed cell volume (PCV)	Male: 40–54%; Female: 36–48%
Bleeding time (BT)	2–7 minutes
Clotting time (CT)	5–11 minutes
Radial pulse rate	60–100 beats/min
Arterial blood pressure	90–120 / 60–80 mmHg (average 120/80 mmHg)
Resting respiratory rate (adult)	12–20 breaths/min
Oral body temperature	≈ 37 °C (98.6 °F)

Parameter	Normal Reference Range
Urine specific gravity	1.003–1.030
FEV_1/FVC ratio (adult)	≥ 70% (typically 75–85%)
ECG intervals	PR 0.12–0.20 s; QRS 0.06–0.10 s; QT 0.35–0.44 s

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