

Part I

Hematology

Compound Microscope

Exp No:

Date:

Introduction

A microscope is an optical instrument which magnifies the image of an object. There are various types of microscope which use different types of lens and different principles of optics. Compound microscope is one of the most frequently used equipment in a medical laboratory.

Physical terms:

- Resolution

It is the ability to reveal closely adjacent structural details as separate and distinct. The limit of magnification of a microscope is set by its resolving power.

- Numerical Aperture

It is the ratio of the diameter of the lens to its focal length. Greater the numerical aperture greater the resolving power.

- Working Distance

It is the distance between the objective lens and the slide.

Parts Of The Microscope

Support System

1. Base

It supports the microscope on the working table.

2. Pillars

Two upright pillars project upwards from the base.

3. Handle

Handle is hinged to the pillars. It supports the magnifying and adjusting systems. It is the handle by which the microscope must be carried. It is curved and the microscope can be tilted at the hinged joint.

4. Body tube

The eyepiece fits into the top of the body tube. The nose piece with the objective lenses fits into its lower end. It is the part through which the light passes to the eyepiece. It actually conducts the image.



Compound Microscope

5. Stage

Fixed stage is the horizontal platform on which the object is placed. It has a central opening through which the illuminating system focuses the light on the object. Mechanical stage has a spring mounted clip to hold the slide or counting chamber in position. It has two screws to move the mounted object from side to side and forward and backwards.

6. Nose piece

Fixed nose piece is attached to lower end of body tube. Revolving nose piece carries objective lenses of different magnifying powers.

Adjusting System

It consists of the coarse and fine adjustment screws mounted in the handle by a double sided micrometer mechanism.

1. Coarse adjustment screws

It consists of rack and pinion which moves the tube rapidly through a large distance when the screw is rotated clockwise or anticlockwise. It is used to obtain an approximate focus of the object.

2. Fine adjustment screws

Similar to coarse adjustment screw, but several rotations will move the tube through a very small distance. It is used to obtain exact focus of the object.

Illumination System

1. Source of illumination

Light source may be internal or external.

Internal source – In modern microscopes, there is an in-built light source with an electrical tungsten lamp, which is placed directly under the stage.

External source – This can be from an electric lamp housed in a lamp box with a window or from the sun. The rays of light are reflected by a mirror towards the object. The mirror is located at the base of the microscope which is plain or concave.

2. Condenser

It focuses the rays of light reflected from the mirror onto the object under observation and helps in resolving the image. It is mounted below the stage of the microscope. Position of the condenser has to be adjusted according to the objective lens used.

3. Iris diaphragm

It is located at the bottom of the condenser. It has a central aperture. The size of the aperture can be altered to regulate the amount of light that passes through the condenser onto the object under observation.

Magnification System

1. Eye piece

This is a magnifying lens inserted into the upper end of the body tube. Each eyepiece has two lenses, an eye lens mounted at the top and a field lens at the bottom. It has a magnification power of 5 and 10. It magnifies the primary image to give a virtual image which is observed through the eye piece.

2. Objective lens

Three objective lenses are fitted to the lower end of the body tube in the revolving nose piece. They are the low power, high power and oil immersion objective lenses. The desired objective lens is placed close to object on the stage and it produces a real magnified and inverted primary image. When the oil immersion objective is used, the space between the object and the lens is filled with cedar wood oil which has the same refractive index as that of glass and hence prevents refraction of light.

Objective	Working Distance	Numerical Aperture	Magnification
Low Power	5 to 15 millm	0.3	10
High Power	0.5 to 4 millm	0.65	40/45
Oil immersion	0.15 to 1.5 millm	1.3	100

Adjustments for low power objective

- Concave mirror is used.
- Condenser is lowered.
- Iris diaphragm is slightly opened to decrease the intensity of illumination.

Adjustments for high power objective

- Concave mirror is used.
- Condenser is slightly raised.
- Iris diaphragm is partially opened to increase the intensity of illumination.

Adjustments for oil immersion objective (OPR)

- Open the Iris diaphragm fully to get maximum intensity of illumination
- Plane mirror is used.
- Raise the Condenser.

Precautions

- Objectives and eyepiece should be free from dust. item The mirror, the position of the condenser, and the aperture of the iris should be checked in order to get proper illumination.
- While changing the objective it should be noted that the objective clicks into its proper position.
- Do the necessary microscopic adjustments before using each objective.
- While focusing, lower the objective close to the slide and focus the object by slowly raising the objective.

- Never bring down the objective with the coarse adjustment screw while looking into the microscope.
- Examine the slide under low power and high power before examining it under oil immersion objective.
- After using oil immersion objective, clean the lens with filter paper and xylol.

Questions

1. Name the oils used for oil immersion objective.
2. How will you calculate the total magnification power of the microscope for each objective?
3. Name the other types of microscope.

Hemocytometer

Exp No:

Date:

Introduction

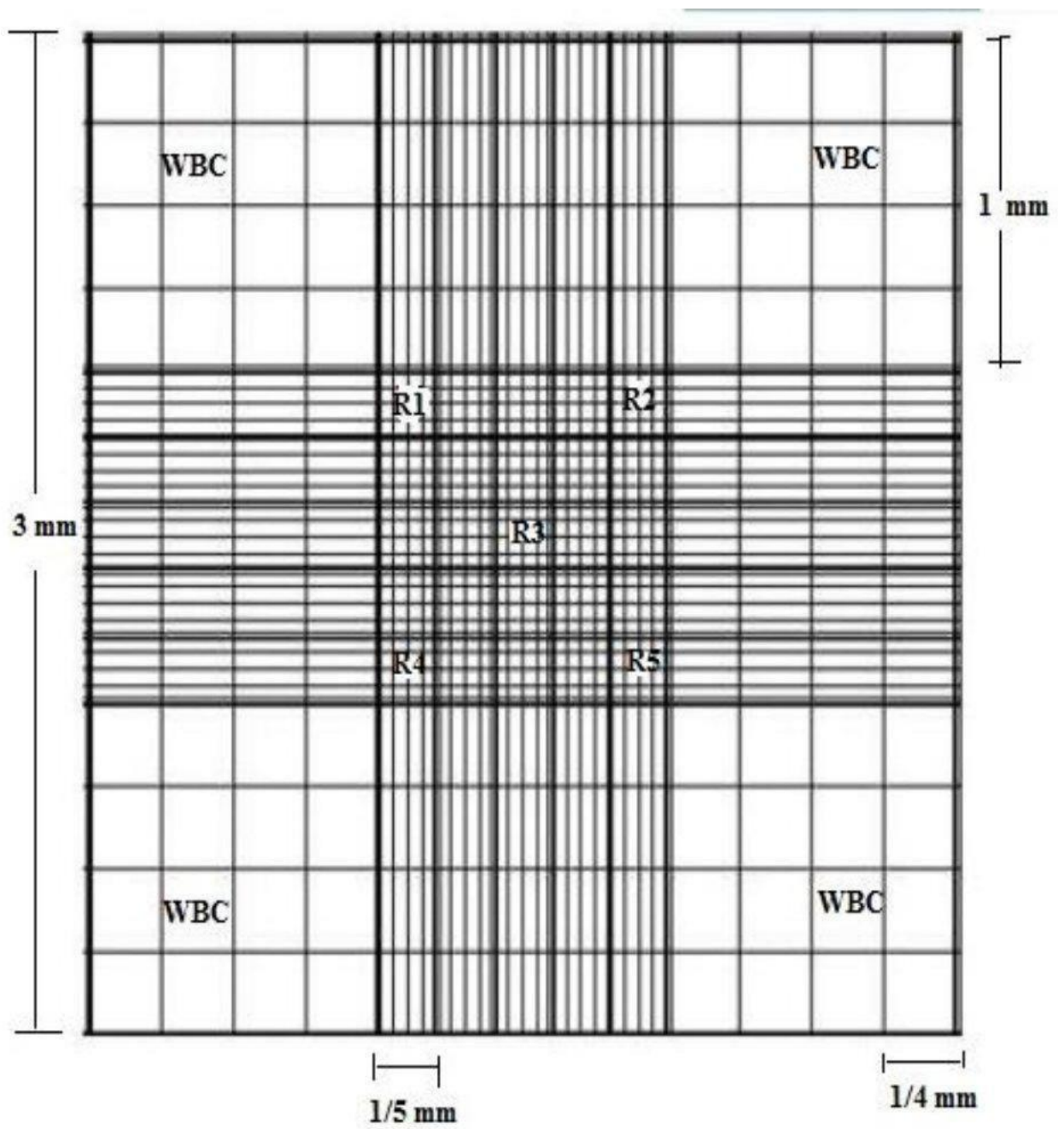
The formed elements of blood are counted by Hemocytometry. The apparatus is called as hemocytometer. It consists of diluting pipettes and counting chamber. The counting chamber in common use is the improved Neubauer's counting chamber. This is a thick glass slide divided into two central platforms by a 'H' shaped groove. The central platform is slightly lower than the sides. When a cover slip is placed over the central platforms, resting on the side platforms, a space of $\frac{1}{10}$ mm depth will be present between the cover slip and the central platform. This area is used for charging the chamber with the diluted blood for cell counting. The central platforms have ruled squares which are used for cell counting. The ruled area is a square measuring $3\text{ mm} \times 3\text{ mm}$. This area is divided into 9 large equal squares each having an area of 1 mm^2 . The four large corner squares are used for WBC count. The central square is used for RBC count. All nine squares are used for Absolute eosinophil count.

WBC counting squares

- The four large corner squares are used for the WBC count and each has 16 medium squares ($16 \times 4 = 64$ medium squares).
- Side of each large square is 1 mm .
- Area of each large square is $1 \times 1 = 1\text{ mm}^2$.
- Volume of each large square = area \times depth = $1 \times \frac{1}{10} = \frac{1}{10}\text{ mm}^3$.
- Volume of each medium square = $\frac{1}{4} \times \frac{1}{4} \times \frac{1}{10} = \frac{1}{160}\text{ mm}^3$.

RBC counting squares

- The 1 mm^2 central RBC square is divided into 25 medium sized squares by triple lines. The four corner and central medium sized squares are used for RBC count.
- Each medium sized square is further divided into 16 small squares.
- ($5 \times 16 = 80$ small squares).
- Side of each medium sized square is $\frac{1}{5}\text{ mm}$.
- Area of each medium sized square is $\frac{1}{5} \times \frac{1}{5} = \frac{1}{25}\text{ mm}^2$.



Neubauer Chamber's Counting Region

- Volume of each medium sized square is $\frac{1}{250} \text{ mm}^3$.
- Volume of each smallest square = $\frac{1}{20} \times \frac{1}{20} \times \frac{1}{10} = \frac{1}{4000} \text{ mm}^3$.

Pipettes

The pipettes are used to dilute the blood to a known dilution. Two types of pipettes are used – RBC pipette, WBC pipette .

Parts of a pipette are:-

The Stem: The long narrow stem has a capillary bore and a well-grounded conical tip. It is divided into 10 equal parts with two numbers etched on it – 0.5 in the middle and 1.0 at the junction of stem and the bulb.

The bulb: The bulb contains a free-rolling bead. The bead helps in identifying the pipette and mixing the diluents with blood in the bulb. Free rolling of the bead in the bulb indicates whether the pipette is dry or not.

Rubber tube and mouthpiece: The narrow rubber tube attached to the bulb, facilitates filling of the pipette by gentle suction. There is a marking just above the bulb. This marking is 11 in WB C pipette and 101 in RBC pipette. The graduations do not indicate absolute or definite amounts in terms of cubic mm .They only indicate relative volumes in relation to each other. The markings indicate relative parts in the pipette

RBC pipette

- Markings are 0.5, 1.0 and 101
- The capillary bore is narrow
- Bulb is larger and has a red bead
- Volume of the bulb is 100 parts

WBC pipette:

- Markings are 0.5, 1.0 and 11
- The capillary bore is wider
- Bulb is smaller and has a white bead
- Volume of the bulb is 10 parts

Finger Prick

- Clean the tip of the finger with spirit and allow the area to dry.
- Prick the tip of finger with the lancet, deep enough to get a good drop of blood.
- Don't squeeze the finger pulp after pricking as this leads to the seepage of tissue fluid resulting in dilution of the blood.
- The prick is usually made on middle or ring finger.

Filling The Pipette

- Under aseptic precautions prick the finger and wipe away the first drop and allow the flowing blood to form a good sized drop.
- Hold the pipette horizontally and dip its end into the blood drop. Gently suck blood upto 0.5 or 1.0 mark depending on the dilution required.
- If the blood overshoots 0.5 or 1.0 mark, remove the excess blood by gently tapping the tip of the pipette on to the palm. Do not use cotton or any absorbent material as it might absorb water content of blood and concentrates blood.
- Place the tip of the pipette into the diluting fluid and suck upto the 11 mark in case of WBC pipette or 101 mark in case of RBC pipette without any air bubble.
- Place the pipette horizontally between the palms of both hands with the rubber tube folded parallel to it and roll the pipette for 1-2 minutes, for thorough mixing of blood with the fluid in the bulb.

Precautions

- The pipette must be dry and free from clotted blood and the bead must roll freely in the bulb.
- The tip must not press against the finger or be lifted out of the blood drop or else air will enter it.
- The blood must be diluted immediately, or else it may clot.
- Always hold the pipette horizontally to avoid leakage of fluid from the pipette while mixing.

Focussing The Counting Grid

- Focus the counting grid with low power and then high power objective.
- The lines of the squares must be seen clearly.

Charging The Chamber

- Place the coverslip on the central platform of the chamber covering the ruled squares.
- Discard the stem fluid before charging the chamber as it contains only the diluting fluid.
- Form a good drop of diluted blood at the tip of the pipette, by squeezing the rubber tube, while closing its mouthpiece or by gently blowing through the rubber tube.
- Hold the pipette at 45 degree inclination and touch the chamber with the tip of the pipette between the cover slip and the central platform.
- A thin layer of the fluid spreads under the coverslip on the central platform by capillary action.
- Avoid overcharging the chamber which is recognized by fluid in the trenches.

- Wait for 2 minutes for the cells to settle down.
- Focus the squares under the desired objective and start counting.

Precautions

- The chamber and the coverslip should be properly cleaned.
- The contents of the bulb must be thoroughly mixed before charging.
- 2-3 drops of fluid must be discarded from the pipette before charging as the stem contains only diluents.
- Air bubbles should not enter the platform of the chamber while charging.
- The chamber should not be overcharged (gives false low results) or undercharged (the cells may not be found in peripheral squares).

Cell Counting

- Count the cells in the respective squares.
- Care should be taken not to count the same cells again by following L rule. (Count the cells present inside the square and those on the left and lower lines. Ignore those on the right and upper lines).

Questions

1. What are the other types of cell counting chambers ?
2. What are the other cells that can be counted using Neubauer's chamber?
3. Mention the differences between RBC and WBC pipettes.

Estimation Of Total RBC Count

Exp No:

Date:

Aim

To enumerate the number of erythrocytes in 1 mm^3 of blood.

Apparatus Required

Microscope, Hemocytometer (RBC diluting pipette and counting chamber), RBC diluting fluid (Hayem's fluid), spirit, cotton and lancet.

Hayem's Fluid - composition

- Sodium chloride - 0.5 g - Maintains isotonicity
- Sodium bisulphate - 2.5 g - Prevents aggregation of RBCs (Rouleaux formation)
- Mercuric perchloride - 0.25 g - Acts as preservative, antifungal and antibacterial
- Distilled water - 100 ml - Acts as solvent

Procedure

Make a sterile finger prick and discard the first drop of blood. Draw blood upto 0.5 mark and Hayem's fluid upto 101 mark with the pipette. Mix the contents thoroughly. Discard the first few drops and then charge the Neubauer chamber. Allow the cells to settle for 3-4 minutes. Count the RBCs in the 4 medium sized corner squares and in the central medium sized square of the RBC counting area (total of $16 \times 5 = 80$ smallest squares) under high power objective.

Calcualtion

Number of RBCs in 5 medium sized RBC squares = n

Area of 1 medium sized RBC square = $\frac{1}{5} \times \frac{1}{5} = \frac{1}{25} \text{ mm}^2$

Volume of 1 medium sized RBC square = $\frac{1}{25} \times \frac{1}{10} = \frac{1}{250} \text{ mm}^3$

Volume of 5 medium sized RBC squares = $\frac{1}{250} \times 5 = \frac{1}{50} \text{ mm}^3$

Number of cells in $\frac{1}{50} \text{ mm}^3$ of diluted blood = n

Number of cells in 1 mm^3 of diluted blood = 50 n

Dilution factor = $1 : 200$

Number of cells in 1 mm^3 of un diluted blood = $\text{n} \times 50 \times 200$

Result

RBC count in the given blood sample is _____ cells / mm^3

Questions

1. Name the other diluting fluids used for red cell count.
2. How will you identify the RBC counting squares?
3. What is the normal RBC count in males and females?
4. Why is the RBC count high in males?
5. Mention the physiological and pathological causes for anemia and polycythemia?

Estimation Of Total WBC Count

Exp No:

Date:

Aim

To enumerate the number of leucocytes (white blood cells) in 1 mm^3 of blood.

Apparatus Required

Microscope, Hemocytometer, WBC pipette, Turk's fluid, Spirit, Cotton, Lancet

Turk's Fluid Composition

1% Glacial Acetic Acid	-	1.5 ml - Lyses RBCs without affecting WBCs
Gentian Violet	-	1.5 ml - Stains nuclei of WBCs
Distilled Water	-	100 ml - Acts as solvent

Procedure

Make a sterile finger prick and discard the 1st drop of blood. Draw blood upto 0.5 mark and Turk's fluid upto 11 mark in the WBC pipette. Mix the contents thoroughly. Discard the first few drops and charge the Neubauer chamber. Allow the cells to settle for 3 to 4 minutes. Count the WBCs in the 4 corner large squares (WBC counting area) under high power objective.

Calcualtion

Number of cells in 4 WBC squares = n

Area of 1 WBC square = $1 \times 1 = 1 \text{ mm}^2$

Volume of 1 WBC square = $1 \times \frac{1}{10} = \frac{1}{10} \text{ mm}^3$

Volume of 4 WBC squares = $4 \times \frac{1}{10} = \frac{4}{10} \text{ mm}^3$

Number of cells in $\frac{4}{10} \text{ mm}^3$ of Diluted blood = n

Therefore, Number of cells in 1 mm^3 of Diluted blood = $n \times \frac{10}{4}$

Dilution Factor = 1 : 20

Therefore, Number of cells in 1 mm^3 of Undiluted blood = $n \times \frac{10}{4} \times 20 = n \times 50$

Result

WBC count in the given blood sample is _____ cells / mm^3

Questions

1. What is the normal RBC : WBC ratio ?
2. In which condition is RBC pipette used for counting WBCs ?
3. Why is blood diluted only 20 times in WBC counting?
4. Mention the physiological and pathological causes of high and low WBC count.
5. What is Leucocytosis ?
6. What is Leukemia?

Absolute Eosinophil Count

Exp No:

Date:

Aim

To determine the number of eosinophils per cu mm of blood

Apparatus Required

Microscope, Hemocytometer, Dungen's fluid, spirit, cotton and lancet.

Dungen's Fluid Composition

1% of solution of eosin in water (5ml)- Eosin stains the eosinophilic granules.

Acetone (5ml) - Acetone lyses the cell membrane of all other cells.

Distilled water (90ml) - Distilled water to make up to 100ml. Acts as solvent.

Procedure

Make a sterile finger prick and discard the first drop of blood. Draw blood upto 1 and the Dungen's fluid upto mark 11 in a WBC pipette. Mix the contents thoroughly. Cover the pipette with a petri dish lined by moistened filter paper. Wait for 15 minutes. Discard the first few drops and charge the Neubauer chamber. The eosinophils are identified by the pinkish orange stained coarse granules in the cytoplasm. Count the Eosinophils in all the 9 large squares of the Neubauer chamber. Count within 30 minutes of charging .

Calcualtion

Number of cells counted in 9 large squares = n

Area of 1 large square = $1 \times 1 = 1 \text{ mm}^2$

Volume of 1 large square = $1 \times \frac{1}{10} = \frac{1}{10} \text{ mm}^3$

Volume of 9 large square = $9 \times \frac{1}{10} = \frac{9}{10} \text{ mm}^3$

Number of cells in $\frac{9}{10} \text{ mm}^3$ of diluted blood = n

Number of cells in 1 mm^3 of diluted blood = $n \times \frac{10}{9}$

Dilution factor = 1:10

Therefore, number of cells in 1 mm^3 of undiluted blood = $n \times \frac{10}{9} \times 10 = n \times \frac{100}{9}$

Result

Absolute Eosinophil count in the given blood sample is _____ cells / mm^3

Questions

1. What is the normal value of Absolute Eosinophil Count ?
2. What is the difference between the Differential Count and the Absolute Eosinophil Count ?
3. What are the other diluting fluids used for Absolute Eosinophil Count?
4. What are the contents of eosinophilic granules ?
5. What are the functions of eosinophils?
6. What are eosinopenia and eosinophilia?

Differential Count

Exp No:

Date:

Aim

To determine the differential count of White Blood Cells.

Apparatus Required

Grease free and dry glass slides, Leishman's stain, distilled water, lancet, spirit, cotton.

Leishman's Stain Composition & Functions

Methylene blue (basic) - Stains acidic granules in cytoplasm especially granules of basophils and Nuclei of leucocytes.

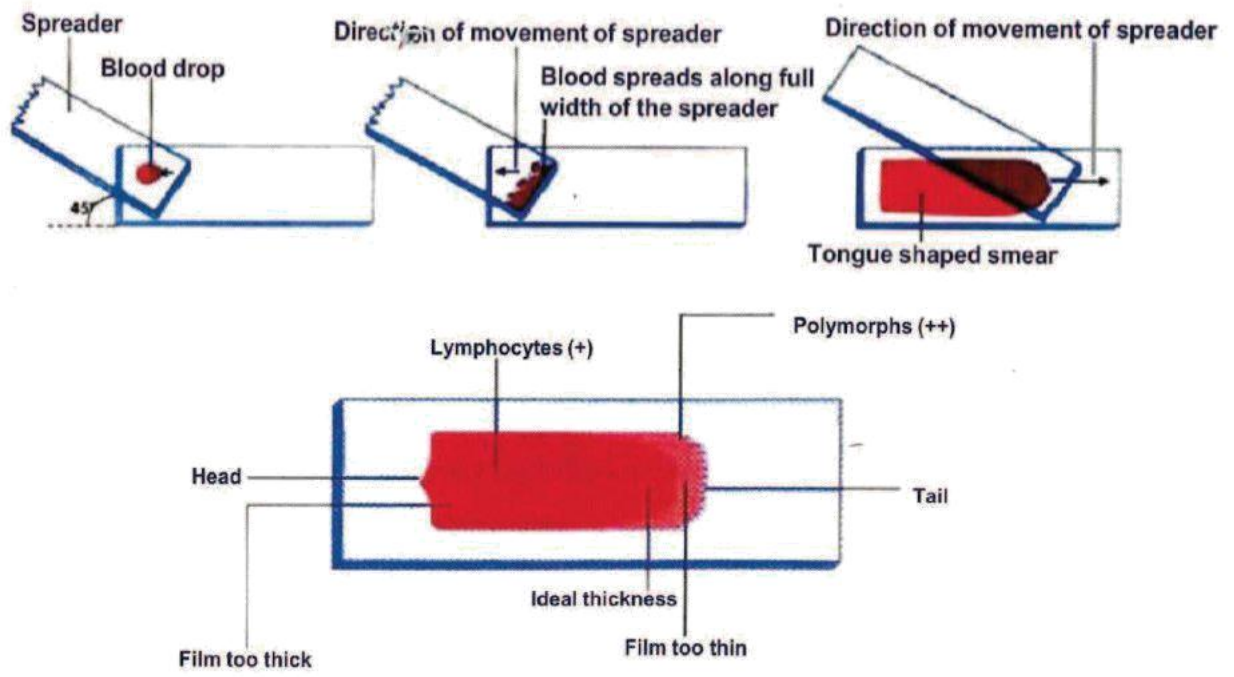
Eosin (acidic) - Stains cytoplasm, basic granules in cytoplasm, Hemoglobin of RBCs.

Acetone free methyl alcohol - Fixes the cells (Acetone free methyl alcohol is used as acetone is a lipid solvent that lyses cell membrane).

Procedure

Under aseptic precautions, prick the finger. Discard the first drop of blood. Place the slide on the table and support with left hand. Place the blood drop on the right end, one cm away from the edge. Place the spreader slide just in front of the blood drop. Draw the spreader slide backwards to touch the drop. The blood spreads across the edge of the spreader. Draw the spreader slide forward at an angle of 45° with a smooth, fast and firm movement to make a thin tongue shaped blood smear. Too thick, thin or a patchy smear is to be avoided. Air dry the smear quickly.

Place the glass slide with the smear on a tray and add Leishman's stain, drop by drop till the entire smear is covered with the stain. Count the number of drops added. Note the time and wait for 2 minutes (Fixation time). After 2 minutes, add double the quantity of distilled water over the film using a dropper. See to that the distilled water uniformly covers the entire surface of the slide and dilutes the stain homogeneously. Gently blow the stain and the distilled water from one end of the slide to the other for uniform mixing. Wait for about 8-10 minutes for the smear to take up the stain uniformly (Staining time). Flush the slide under a gentle stream of tap water to remove the excess stain. Dry the slide. Scan the film under low & high power objective. Make necessary microscopic adjustments for oil immersion objective (100X). Add a drop of cedar wood oil over the smear at the junction between the body and the tail, as the smear will be of one cell thickness with uniform staining here. Cedar wood oil has the same refractive



Making an ideal blood smear



index as that of glass and minimizes refraction. Examine in a zig-zag manner as shown in the figure.

Draw a table with 100 squares to count 100 WBCs and enter the type of cell as identified while examining the film.

Under aseptic precautions, prick the finger. Discard the first drop of blood. Place the slide on the table and support with left hand. Place the blood drop on the right end, one cm away from the edge. Place the spreader slide just in front of the blood drop. Draw the spreader slide backwards to touch the drop. The blood spreads across the edge of the spreader. Draw the spreader slide forward at an angle of 45° with a smooth, fast and firm movement to make a thin tongue shaped blood smear. Too thick, thin or a patchy smear is to be avoided. Air dry the smear quickly.

Result

The differential count of WBCs in the blood sample is as follows.

Neutrophil = _____ %

Eosinophil = _____ %

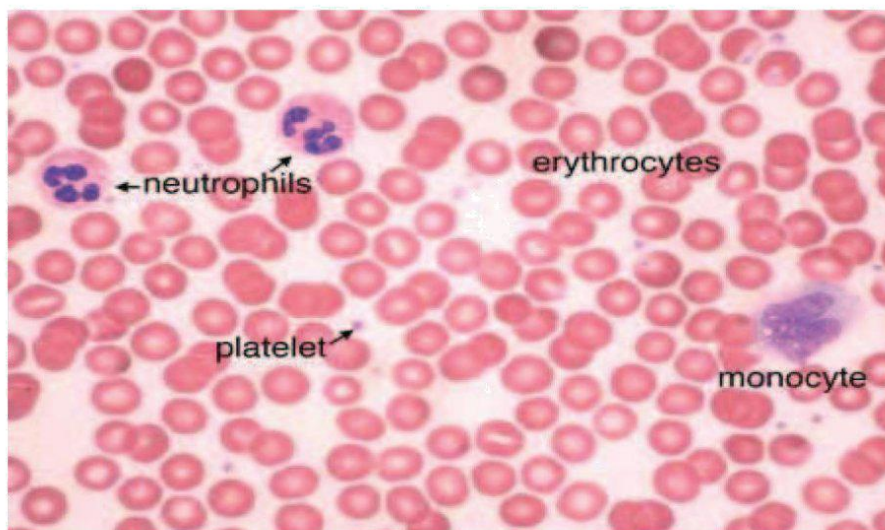
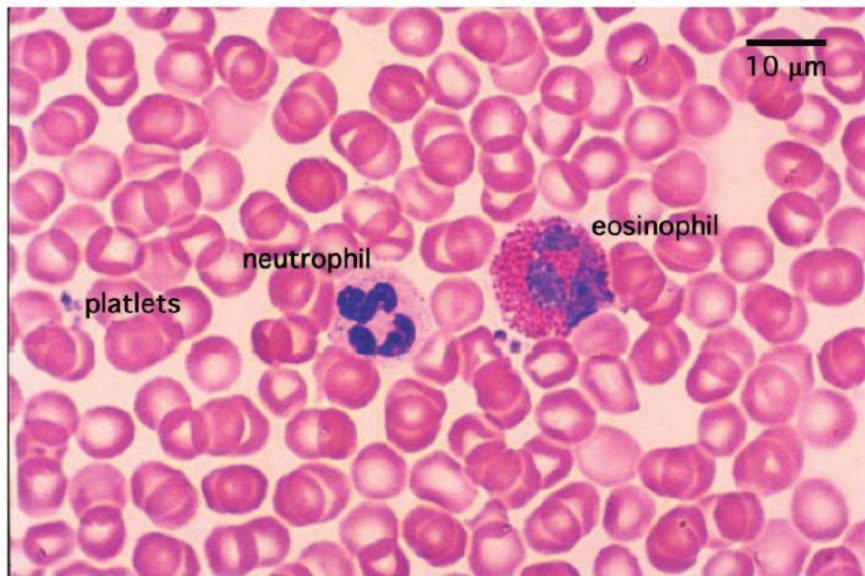
Basophil = _____ %

Lymphocyte = _____ %

Monocyte = _____ %

Questions

1. Draw the different WBCs using appropriate colours.
2. What other cells can you visualize in the smear?
3. Enumerate the criteria of a good blood smear.
4. Can tap water be used for dilution? why?
5. Mention the functions of various types of WBCs and their abnormalities in count.
6. Mention the clinical importance of peripheral blood smear.



Identifcation Of The Cells

A leukocyte is identified by its size, nucleus, cytoplasm and granules.

Cell type	Size	Nucleus	Cytoplasm	Normal Values
Neutrophil	10 – 14 μm	2-5 lobes connected by narrow strands of chromatin	Fine violet-pink granules	60-70%
Eosinophil	10 - 15 μm	Often bi-lobed connected by thick strands of chromatin (spectacle shaped nucleus)	Coarse brick-red to orange granules	2-8%
Basophil	10 - 15 μm	Irregularly shaped (S shaped) nucleus masked by the granules	Very coarse deep purple granules	0-1%
Small lymphocyte	7-9 μm	Single, round, almost fills the cell Thin crescent of clear, light blue cytoplasm.	No visible granules.	20-30%
Large lymphocyte	10 - 15 μm	Single, round, almost fills the cell. May be central or eccentric.	Large crescent of clear, light blue cytoplasm. No visible granules.	
Monocyte	12 - 20 μm	Horse-shoe shaped nucleus Indented	Abundant, muddy blue in appearance. No visible granules.	1-5%

Hemoglobin Estimation

Exp No:

Date:

Aim

To estimate the hemoglobin content of the blood by Sahli's acid hematin method.

Apparatus Required

Sahli's Hemoglobinometer, Hemoglobin pipette, $\frac{N}{10}$ HCl, Distilled water, Glass stirrer, Dropper, Lancet, Spirit and Cotton.

Principle

The amount of hemoglobin in the blood can be estimated by converting a known volume of blood into acid hematin solution and matching the color of the acid hematin solution with that of the standard colour.

Description Of The Apparatus

The hemoglobinometer is a rectangular cubic box consisting of a central compartment to accommodate the 'Hemoglobin tube' and two yellow brown coloured cylindrical rods on either side as comparators. The Hb tube is graduated in percentage on one side and in gram percentage on the other side.

The hemoglobin pipette has a single mark on the stem which corresponds to 0.02 ml or 20 cubic mm. A glass stirrer is provided for thorough mixing while diluting acid hematin solution.

Procedure

1. Fill the hemoglobin tube with $\frac{N}{10}$ HCl upto its lowest mark (2 g%).
2. Prick the finger under aseptic precautions to form an adequate drop of blood and suck blood into the hemoglobin pipette upto 20 mm^3 mark.
3. Gently wipe exterior of the tip of the pipette.
4. Insert the pipette into the hemoglobin tube containing $\frac{N}{10}$ HCl and blow out the blood. Rinse the pipette 2 or 3 times with the acid present in the tube.
5. Wait for 10 minutes for the formation of acid hematin.



Add drops of water until
colors matched



Record as $\frac{g \text{ Hb}}{100 \text{ mL blood}}$

Sahli's Hemoglobinometer

6. Then, dilute the acid hematin by adding distilled water drop by drop and mix with the stirrer.
7. Continue dilution till its color matches with that of the standards on either side.
8. While matching, always take care to raise the stirrer above the level of the solution. Never take the stirrer out of the tube.
9. Note down the final reading. (Lower meniscus).

Result

The Hb content of the given sample of blood is _____ g%

Questions

1. What are the other methods used to estimate Hb content of blood?
2. Which is the most reliable method for estimation of Hb?
3. What are the different types of normal Hb in adults?
4. Mention the names of abnormal hemoglobin.
5. What are the differences between adult Hb & fetal Hb?
6. What are the different RBC indices? What are their clinical significance?

Blood Grouping & Typing

Exp No:

Date:

Aim

To determine the ABO blood group and Rh type of the given blood sample.

Apparatus Required



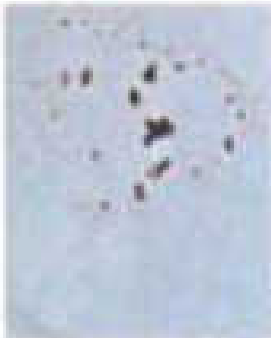

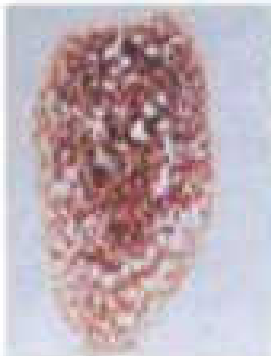
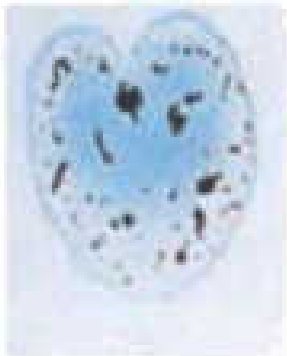
Lancet, spirit, cotton, normal saline, clean white porcelain tile, glass marking pencil, anti-A serum, anti-B serum, anti-D serum, small sticks for mixing, glass slides, microscope.

Principle

Determination of blood group is done by using specific agglutinins (antibodies), to confirm the presence or absence of corresponding agglutininogen (antigens) on the surface of the red blood cells.

Procedure

1. Divide the porcelain tile into four columns with a marking pencil.
2. Mark the columns as A, B, Rh and Control
3. Take 1ml of normal saline in a test tube.
4. Prick the finger with the lancet under aseptic conditions.
5. Mix 3-5 drops of blood with the saline to obtain a suspension of red blood cells.
6. Add a drop each of anti-A, anti-B, anti-D sera and saline to the respective columns.
7. Place a drop of the red cell suspension adjacent to the anti-sera in the respective columns.
8. Mix the anti-sera and red cell suspension by using separate sticks.
9. Wait for few minutes and observe the agglutination (clumping).
10. Compare it with the saline standard.
11. Record your findings.
12. If there is doubt regarding agglutination, confirm it under the microscope.

	Anti-B	Anti A	
Group A			Agglutination
Group B			No agglutination
Group AB			Agglutination

Blood Groups Showing Agglutination

Result

The blood group of the subject is _____

Questions

1. State Landsteiner's law.
2. What is cross-matching of blood?
3. What is the preservative used to store blood in the blood bank?
4. What are the clinical applications of blood grouping and Rh typing?
5. What are the minor blood groups?
6. What is the concept of universal donor/ universal recipient?
7. What are the indications and hazards of blood transfusion?
8. What are the differences between ABO system and Rh system?

Estimation Of Bleeding Time

Exp No:

Date:

Aim

To determine the bleeding time by Duke's method

Apparatus Required

Filter paper, lancet, spirit, cotton swabs & stop watch.

Principle

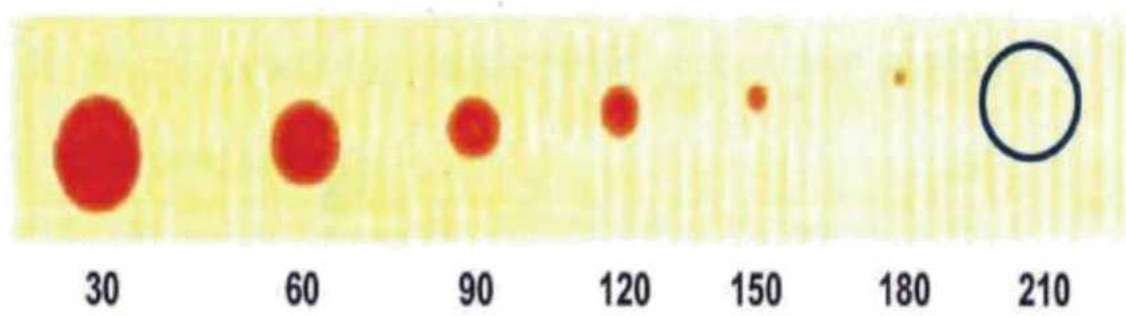
The time interval between skin puncture and spontaneous, unassisted stoppage of bleeding is called bleeding time. It is a test for assessing the function of platelets and integrity of capillaries.

Procedure

1. Clean the tip of the finger with spirit and cotton and allow the finger to dry.
2. Make a good deep finger prick with the lancet to get free flowing blood.
3. Do not squeeze the finger.
4. Immediately start the stopwatch.
5. Gently touch the puncture site with a clean filter paper every 15 seconds.
6. Repeat this step until no further blood spot appears on the filter paper.
7. Observe that successive spots are smaller in size.
8. Count the number of blood spots including the dry spot on the filter paper and divide it by 2 to get the bleeding time in minutes.
9. Normal bleeding time by Duke's method is 2-5minutes.

Result

The bleeding time determined by Duke's method is _____



Estimation Of Bleeding Time

Questions

1. Define bleeding time.
2. What are the other methods to determine the bleeding time?
3. What is hemostasis?
4. What is the role of platelets in hemostasis?
5. What is the normal platelet count? What do you mean by thrombocytosis?
6. Name few conditions where bleeding time is prolonged?
7. What is Thrombocytopenic purpura? Comment on the clotting time in this condition.

Estimation Of Clotting Time

Exp No:

Date:

Aim

To determine the clotting time of blood by Wright's capillary glass tube method.

Apparatus Required

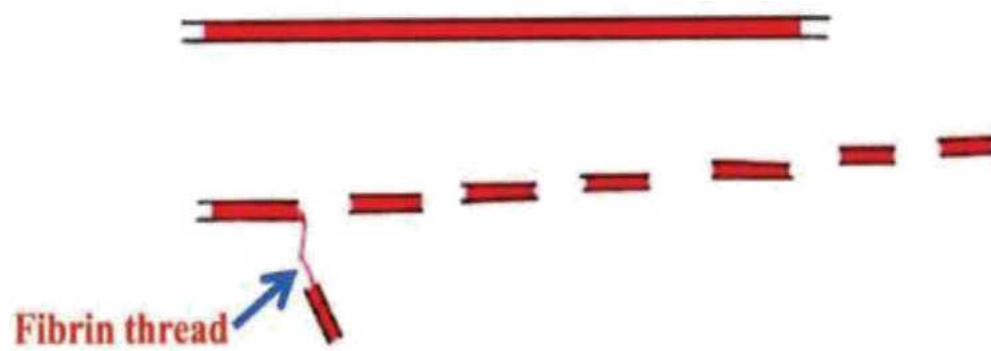
Capillary glass tube, lancet, spirit, cotton swabs & stop watch.

Principle

When blood comes in contact with glass surface, the coagulation pathway gets activated. The time taken for the formation of insoluble fibrin thread(blood clot) is called clotting time.

Procedure

1. Clean the tip of the ring finger with spirit and allow the finger to dry.
2. Make a good deep finger prick with the lancet to get free flowing blood.
3. Do not squeeze the finger.
4. When a blood drop of optimum size has formed, gently place the end of the capillary tube in the drop such that the other end of the tube is at a lower level.
5. Blood enters readily into the tube by capillary action.
6. Start the stop watch.
7. Hold the capillary tube with blood between the palms to maintain it at body temperature.
8. After 2 minutes, break a small bit of capillary tube at its end and check for the formation of fibrin thread.
9. Repeat it every 30 seconds until the appearance of insoluble fibrin thread between the broken ends of capillary tube and note the time.
10. The appearance of the fibrin thread indicates that the blood has clotted.



Estimation Of Clotting Time

11. The total time taken for the formation of fibrin thread is recorded as the clotting time.
12. Normal clotting time by this method is 2-8 minutes.

Result

The clotting time determined by Wright's capillary glass is _____

Questions

1. Define clotting time.
2. What are the other methods used to determine the clotting time?
3. Name the conditions in which clotting time is prolonged.
4. What is haemophilia? Comment on the clotting time in this condition.
5. What is clot retraction time?
6. Name the Vitamin K dependent coagulation factors.
7. What is an anticoagulant? Mention some invivo and invitro anticoagulants.
8. Name the proteins involved in fibrinolytic system.

Estimation Of Erythrocyte Sedimentation Rate

Exp No:

Date:

Aim

To determine the Erythrocyte Sedimentation Rate of the given blood sample.

Apparatus Required

Westergren's pipette and stand, syringe with needle and 3.8% sodium citrate solution (anticoagulant)

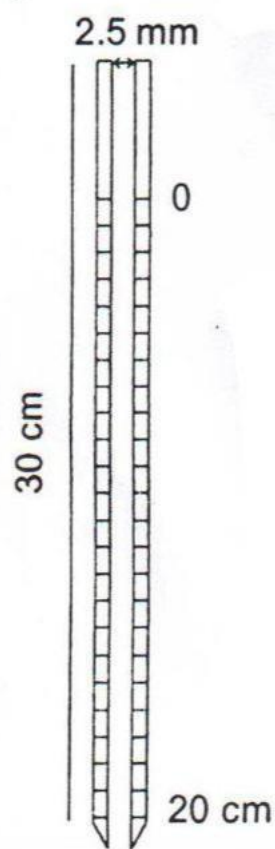
Principle

If blood treated with anticoagulant is allowed to stand in a tube placed vertically, the RBCs settle down gradually to the bottom since their specific gravity (1.093) is greater than that of the plasma (1.030). The rate at which the RBCs settle down is called as Erythrocyte Sedimentation Rate.

Procedure

Westergren's method:

1. Westergren's pipette (tube) which is used for this procedure is open at both ends and is graduated in *mm* from 0-200 with a bore diameter of 2.5*mm*.
2. A sterile solution of 3.8% sodium citrate is used as an anticoagulant.
3. In a clean dry syringe, draw 2ml of blood from the antecubital vein under aseptic precautions and mix with 0.4ml of 3.8% sodium citrate solution in a plastic container with its lid closed.
4. Fill the Westergren's pipette with blood by sucking, after placing the tip of the finger over the top of the pipette to control the flow of blood into and out of it, or with a rubber bulb.
5. Bring the blood column to exact zero mark.
6. Keeping the finger (or the rubber bulb) over the pipette, transfer it to the Westergren stand by firmly pressing its lower end into the rubber cushion. Now.



a) Westergren tube



b) Westergren tube on the rack

7. slip the upper end of the pipette under the screw cap.
8. After an hour, note the *mm* of clear plasma above the red cells.

Result

Erythrocyte Sedimentation Rate of the given blood sample is _____
mm in first hour.

Questions

1. What is ESR?
2. What are the 3 stages by which sedimentation of red cells occur?
3. What are the other methods of estimating ESR?
4. What are the advantages and disadvantages of Westergren method?
5. What are the advantages and disadvantages of Wintrobe method?
6. Can you use oxalate mixture in Westergren method and citrate in Wintrobe method?
7. What are the factors determining ESR?
8. What is rouleaux formation?
9. Why is ESR reading taken after one hour?
10. What is the normal ESR in males and females?
11. Why is the ESR higher in females than that of males?
12. What is the clinical significance of ESR?
13. Mention some physiological and pathological conditions in which ESR is increased / decreased?
14. What is zeta potential?

Packed Cell Volume

Exp No:

Date:

Aim

To determine the packed cell volume of the given blood sample.

Apparatus Required

Centrifuge, Hematocrit tube (Wintrobe tube), Pasteur pipette, syringe with needle and double oxalate or EDTA (anticoagulant).

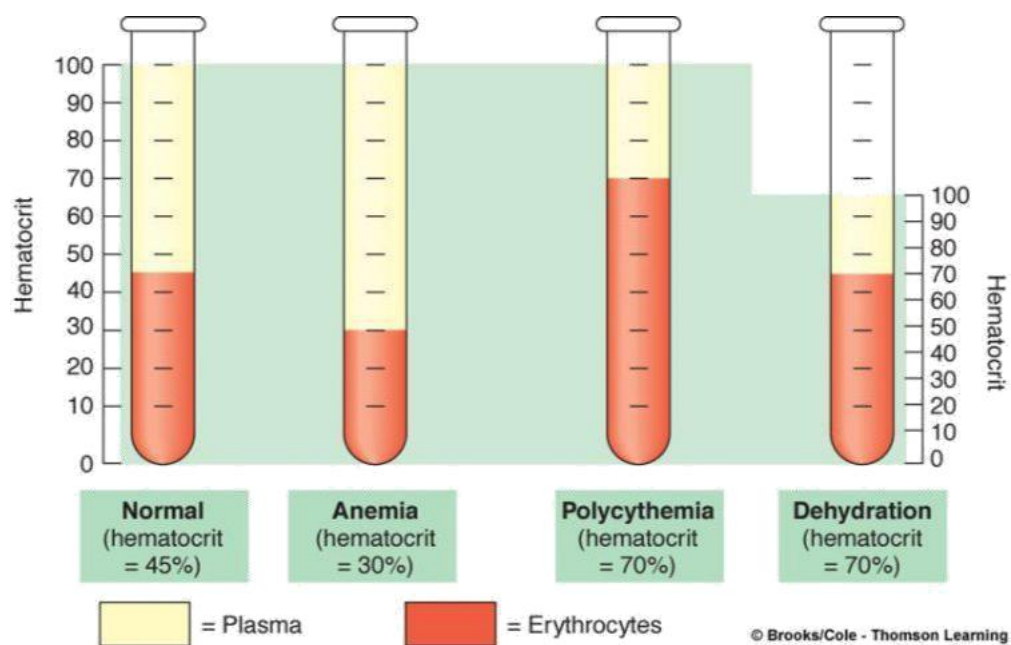
Principle

When the blood is mixed with an anticoagulant and centrifuged in a hematocrit tube, the red blood corpuscles settle down at the bottom. The ratio of the volume of the settled red blood cells to that of whole blood in the hematocrit tube is called the packed cell volume or the hematocrit. A thin grey-white layer of white cells at the top of the red blood cell column is called the buffy coat layer. Hematocrit measures the percentage of volume of the packed red cells. It is used to diagnose and classify the various types of anemia, along with other red blood cell indices.

Procedure

Wintrobe's Method:

1. Wintrobe's tube is a thick walled cylindrical tube, 11cm in length with an internal bore of 3mm. The tube is graduated from 0 to 10cm(100 mm) both in the ascending and descending order on either sides. The marking 0 – 10 from above downwards is used for ESR and the marking 0-10 from below upwards is used for reading PCV.
2. In a clean dry syringe, 2ml of blood is drawn from the antecubital vein under aseptic precautions and transferred to a container with anticoagulant.
3. The anticoagulated blood is then filled in the hematocrit tube from below upwards upto the mark 10 using the Pasteur pipette.
4. The tube is centrifuged at a rate of 3000 rpm for a period of 30 minutes.
5. At the end of 30 minutes, take the reading of upper level of packed red cell column.



Estimation Of Packed Cell Volume

Result

The packed cell volume or the hematocrit value of the given blood sample is _____%

Questions

1. Define PCV.
2. What is the clinical significance of PCV?
3. What is the normal range of PCV in males and females?
4. What is the ideal anti-coagulant used and why?
5. What is the difference between arterial and venous blood hematocrit?

Osmotic Fragility

Exp No:

Date:

Aim

To determine the osmotic fragility of red blood cells in the given sample of blood.

Apparatus Required

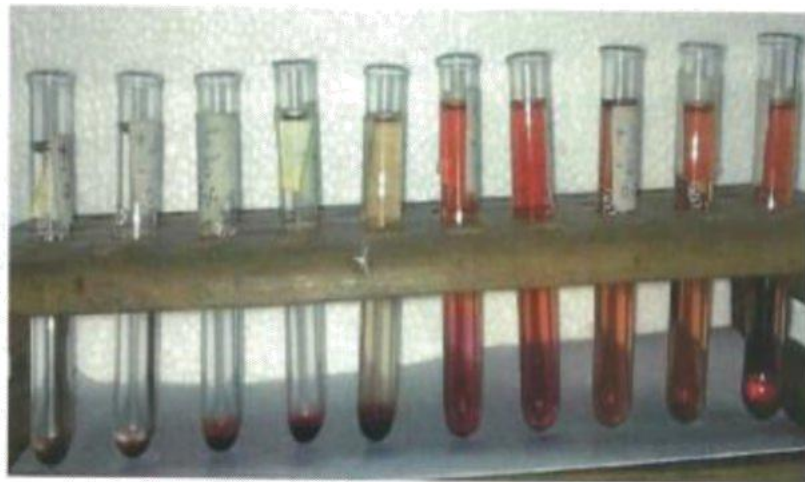
Test tubes with rack, anticoagulated blood, NaCl, distilled water.

Principle

The normal red blood cells can remain suspended in 0.9% sodium chloride solution (normal saline) for hours without any change in their size & shape. But when they are placed in decreasing strengths of hypotonic sodium chloride solutions they imbibe water due to osmosis and finally burst releasing the hemoglobin pigment in the medium.

Procedure

1. Sodium chloride solution of 1% tonicity is prepared by dissolving 1 gram of NaCl in 100ml of distilled water.
2. Arrange the test tubes in the rack and number them serially from 1 to 12.
3. Prepare solutions of increasing hypotonicity by mixing required number of drops of 1% NaCl solution and distilled water in the test tubes as given in the table.
4. Use separate droppers for saline solution and distilled water.
5. Note that the tube No.1 contains normal saline (0.9% approximately) – Isotonic with plasma while tube No.12 contains distilled water.
6. Draw 2ml of venous blood and treat it with anticoagulant in a test tube.
7. Add one drop of blood into each of the above 12 tubes.
8. Invert each tube gently once to mix blood with saline.
9. Leave the test tubes undisturbed for one hour. Then observe the extent of hemolysis in each tube by holding the rack at eye level, with a white paper sheet behind it.



Tonicity of NaCl in % 0.9 0.64 0.56 0.52 0.48 0.44 0.40 0.36 0.32 0.0

Start of hemolysis – 0.48
Complete hemolysis – 0.36

Findings of blood drop after one hour in increasing hypotonicity of NaCl solution and distilled water (only 10 tubes shown)

Estimation Of Osmotic Fragility

Test Tube No.	1	2	3	4	5	6	7	8	9	10	11	12
1% NaCl (drops)	22	16	15	14	13	12	11	10	9	8	7	0
Distilled water (drops)	3	9	10	11	12	13	14	15	16	17	18	25
Saline solution (%)”	0.9	0.64	0.6	0.56	0.52	0.48	0.44	0.4	0.36	0.32	0.28	0

Intpretation

- Test tube with partial hemolysis shows a supernatant fluid with pink colour proportionate to the degree of hemolysis and a lower layer of sedimented red cells at the bottom of the tube.
- Test tube with complete hemolysis shows a clear homogeneously pink solution with no cells at the bottom.
- Test tube with no hemolysis shows a clear colourless supernatant solution with a layer of sedimented red cells at the bottom of the tube

Result

Hemolysis begins in _____% of NaCl solution.

Hemolysis is complete in _____% of NaCl solution.

Questions

1. What is the normal range of osmotic fragility of red cells?
2. What is osmosis?
3. What do you mean by hypo/hyper tonicity?
4. Define fragility.
5. What happens to red cells when they are placed in isotonic, hypotonic and hypertonic solutions?
6. Name some conditions which increase / decrease the osmotic fragility of the RBC.
7. What are the advantages of the shape of red blood cells?

Specific Gravity

Exp No:

Date:

Aim

To determine the specific gravity of the given blood sample by using “Copper sulphate falling drop method”.

Apparatus Required

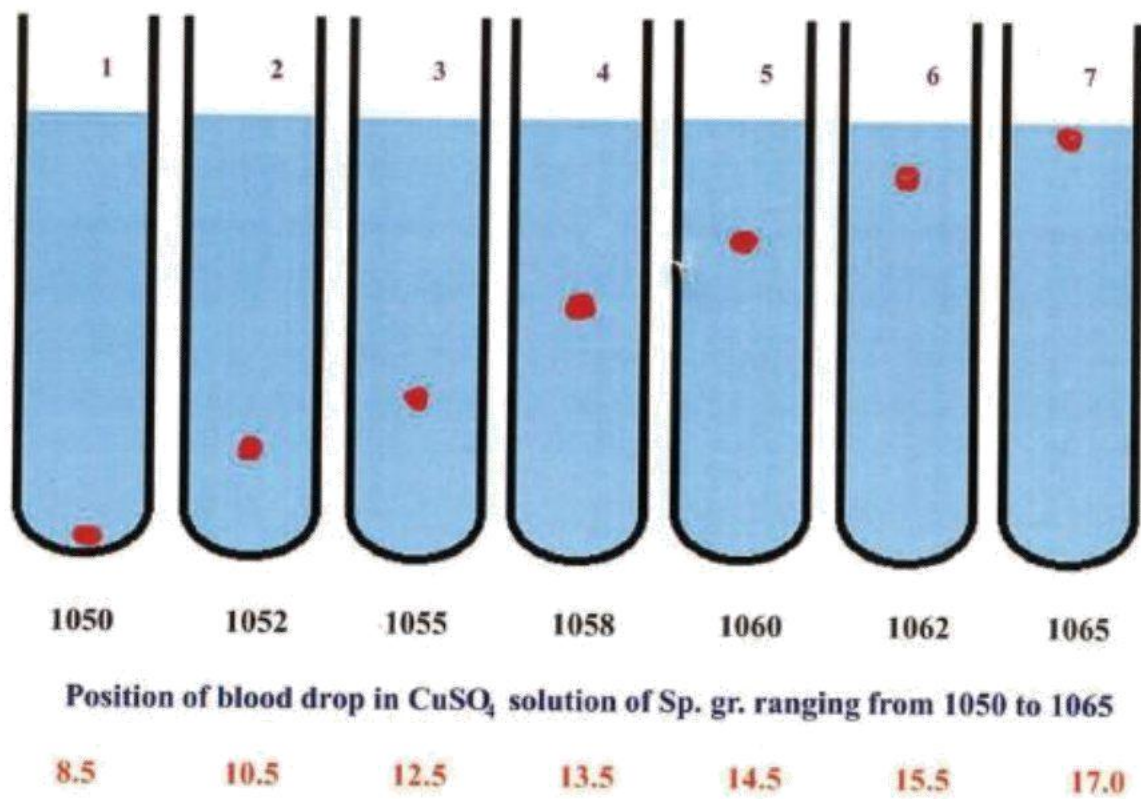
Test tubes with rack, distilled water, anticoagulated blood, copper sulphate crystals ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$), beaker, measuring jar, Pasteur pipette

Principle

The specific gravity of blood is determined by comparing the specific gravity of one drop of blood with that of copper sulphate solution of known specific gravity.

Procedure

1. Stock solution of copper sulphate is prepared by dissolving 159 g of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ in 1 liter of distilled water. The specific gravity of this stock solution is 1100.
2. Standard copper sulphate solutions of known specific gravity are prepared by mixing specific quantity of stock solution and distilled water as shown in table and label the test tubes.
3. Arrange the test tubes in rack in order of increasing specific gravity from left to right in test tube rack.
4. Draw 2ml of venous blood and treat it with the anticoagulant in a test tube.
5. Using Pasteur pipette a drop of blood is delivered into the middle test tube (no.4) from a height of about 1cm above the surface of the copper sulphate solution so that it doesn't touch the walls of the test tube.
6. The drop sinks to about 2-3cm, and loses its momentum in 3-4 seconds. The drop then behaves according to its specific gravity; observe its behaviour during the next 15 seconds.
7. If the specific gravity of blood drop is greater than that of the solution, the drop sinks to the bottom; if it is less than that of the solution, it rises to the surface



Position of blood drop in CuSO_4 solution of Sp. gr. ranging from 1050 to 1065

Specific gravity of blood and the corresponding hemoglobin content in g%

Determination Of Specific Gravity

and if it is the same as that of the solution, it becomes stationary and floats in the middle of the solution.

8. If the drop continues to sink in test tube no.4, try with higher specific gravity solution; if it begins to rise, try with the lower specific gravity solution till you come to a solution where the drop remains in the middle of the solution.
9. The whole observation has to be made in each step within 15 seconds.
10. The tube in which the blood drop remains suspended in the middle of the tube for at least 15 seconds is noted and the specific gravity mentioned on the tube is read and recorded.

Test Tube No.	1	2	3	4	5	6	7
Stock Solution (<i>ml</i>)	49	51	54	57	59	61	64
Distilled Water (<i>ml</i>)	51	49	46	43	41	39	36
Specific Gravity	1.05	1.052	1.055	1.058	1.06	1.062	1.065

Result

The specific gravity of the given blood sample is _____.

Questions

1. Define specific gravity.
2. What is the normal specific gravity of blood, plasma, serum and red blood cells?
3. Why is copper sulphate solution used in this experiment?
4. Why should the observation be made within 15 seconds?
5. Enlist the physiological and pathological conditions in which the specific gravity of blood is increased and decreased.
6. What are the clinical applications of this method?

Part II

Clinical Physiology

General Examination

Exp No:

Date:

A thorough general examination is done before any systemic examination. Vital information such as name, age, sex, height, weight, occupation and address of the individual are recorded. The subject is comfortably seated. The room is well illuminated. It is always preferable to examine under good day light. The examiner should always be on the right side of the subject while examining.

The following observations are recorded:

Level Of Consciousness

The level of consciousness can be clear sensorium, drowsiness, stupor, semicoma and coma.

Orientation To Time, Place And Person

Ask about the day, date, month, year and time of day. Subject should know where they are (e.g. home or hospital) Similarly test his orientation towards person.

Body Build And Nourishment

Build refers to skeletal frame work and nourishment refers to muscular bulk. It should be observed whether he is well / moderately / thin built and nourished.

Temperature

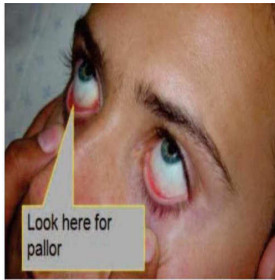
Recorded by a clinical thermometer.

- **Method of recording temperature:**

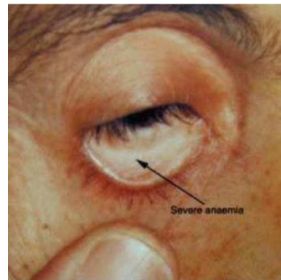
Do not touch the bulb of the thermometer. Shake down the mercury column into the bulb. Keep it under the tongue with the mouth closed for one minute before reading the temperature.

- **Sites of recording temperature:**

- Mouth (36.6°C to 37.2°C)
- Axilla (0.5 °C lower than oral temperature)
- Rectum (0.5 °C higher than oral temperature – Closer to core temperature)



(a) Site Of Examination of Pallor



(b) Lower Palpabral Conjunctiva In Severe Anemia



(c) Koilonychia



(d) Icterus

Low oxygen levels in the blood cause the lips, fingers, and toes to look blue (cyanotic)



(e) Cyanosis

Children with Tetralogy of Fallot exhibit bluish skin during episodes of crying or feeding.



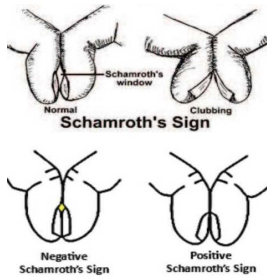
(f) Cyanosis



(g) Cyanosis



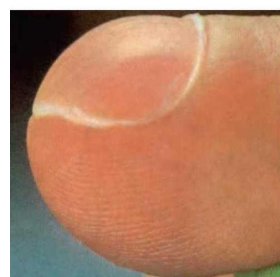
(h) Cyanosis



(i) Clubbing



(j) Clubbing



(k) Clubbing



(l) Pedal Edema

General Examination

Pallor

Pallor of the skin and mucous membrane.

- **Areas to look for pallor**

- Lower palpebral conjunctiva
- Instruct the subject to look up and retract the lower lid to see the palpebral conjunctiva
- Dorsum of tongue
- Mucous membrane of oral cavity
- Nail bed
- Skin over palm and sole

- **Conditions where pallor is seen**

- Anemia – Reduced count of RBCs / Hb content in blood
- Shock

Jaundice (Icterus)

Yellowish discoloration of the sclera, skin and the mucous membrane due to presence of excess bilirubin in blood of more than 2 *mg%*

- **Areas to look for jaundice**

- Bulbar conjunctiva of both eyes – Upper sclera (Instruct the subject to look down and retract the upper lid to view the sclera)
- Mucus membrane of oral cavity (especially the undersurface of tongue and floor of mouth)
- Nail bed
- Skin

- **Causes of yellowish discoloration of skin**

- Jaundice, Carotenemia, Hemochromatosis

- **Hypercarotenemia occurs in**

- People who eat large quantity of raw carrots and tomatoes
- Hypothyroidism.

Cyanosis

It is the bluish discoloration of the skin and mucous membrane due to an increased quantity of reduced hemoglobin concentration of more than 5 gm in 100 ml of blood.

- **Areas to look for cyanosis:**

- Lips
- Tongue
- Mucous membrane over the Palate

- Conjunctiva
- Tip of the nose and ear lobules
- Extremities (fingers, toes and nail beds)
- **Types of Cyanosis:**
 - Central cyanosis
 - Peripheral cyanosis
 - Differential cyanosis

Clubbing

Bulbous enlargement of soft parts of the terminal phalanges with over curving of the nails both longitudinally and transversely.

- **Schamroth's sign:**
 - When two fingers of both hands are held together with their nails facing each other, a diamond shaped space is seen. This space is lost in clubbing (Positive Schamroth's sign).
- **Clubbing is seen in**
 - Bronchopulmonary diseases like bronchiectasis, lung abscess, empyema, chronic bronchitis and bronchogenic carcinoma
 - Cardiac diseases like congenital cyanotic heart disease and bacterial endocarditis
 - Gastro intestinal diseases like ulcerative colitis and liver cirrhosis
 - Endocrine disorders like acromegaly, thyrotoxicosis
 - Hereditary

Oedema

It is the condition where there is accumulation of free fluid in the interstitial space. Pedal oedema is examined by pressing the skin and the tissue against the tibial bone just above the medial malleolus, sustaining the pressure for at least 15 seconds and releasing the pressure to look for pitting, if any. In bed ridden subjects oedema is examined by pressing over the presacral region.

- **Types of oedema:**
 - Pitting oedema – Heart failure, renal disease, hypoproteinemia
 - Non-pitting oedema – Myxoedema, filariasis

Lymphadenopathy

- **Group of nodes to be examined:**
 - Submental, submandibular, cervical, posterior auricular, occipital, supraclavicular, axillary, inguinal and popliteal nodes.
- **Points to be noted while examining lymph nodes:**

- Site, size, number, consistency (soft, firm or hard), tenderness, mobility, matted or discrete, fixity to skin, generalized or localized.
- **Examination of lymph nodes:**
 - Examiner should stand behind the sitting subject- Submental, submandibular, deep cervical nodes in the anterior triangle of neck
 - Examiner should stand in front of the sitting subject – deep cervical nodes in the posterior triangle of neck, posterior auricular and occipital nodes
 - Axillary nodes – sitting posture with abducted arm
 - Inguinal nodes – supine position with thigh flexed to 10°
 - Popliteal nodes – Flex the knees and palpate deep into popliteal fossa

Questions

1. Where will you look for pallor?
2. What is cyanosis?
3. What are the types of Jaundice?
4. How do you detect clubbing?
5. What are the types of oedema and what are their causes?
6. What are the vital signs?

Case Sheet - General Examination Of The Subject

Name:

Age:

Sex:

Occupation:

Consciousness and orientation

Build and nourishment

Afebrile / Febrile

Pallor

Jaundice

Cyanosis

Clubbing

Pedal edema

Lymphadenopathy

Vital Signs:

Temperature

Pulse rate

Respiratory rate

Blood pressure

Inference:

Examination Of Respiratory System

Exp No:

Date:

Introduction

Important Anatomical Landmarks:

- Midclavicular line – a vertical line that extends downwards from the midpoint between the middle of the suprasternal notch and the tip of the acromion.
- Anterior axillary line – a vertical line extending downwards from the anterior axillary fold.
- Posterior axillary line – a vertical line extending downwards from the posterior axillary fold.
- Midaxillary line – a vertical line originating at a point midway between the anterior and posterior axillary line.

Examination of the respiratory system consists of Inspection, Palpation, Percussion & Auscultation.

Inspection

Ask the subject to sit on a stool with the chest and upper abdomen fully exposed.

1. Shape and symmetry of the chest

- Examine both the front and back of the chest.
- Look for any skeletal deformities and drooping of shoulder.
- Normal chest is bilaterally symmetrical and elliptical in cross section.
- The transverse diameter is greater than the anteroposterior diameter with a ratio of 7:5 (Hutchinson's index).

Abnormal Findings:

- Barrel shaped chest - anteroposterior diameter is more than the transverse diameter. It is seen in patients with severe COPD.
- Pectus carinatum (pigeon chest) is a localized prominence of the sternum and adjacent costal cartilages. Occurs in rickets.
- Pectus excavatum (funnel chest) is a developmental deformity with a localized depression of the lower end of sternum
- Kyphosis is forward bending of the spine and Scoliosis is lateral bending. Kyphoscoliosis involves both deformities.

2. Position of Trachea



Hyperinflated chest



Kyphoscoliosis



Pectus carinatum



Pectus excavatum

Abnormal Chest Shapes

- Stand in front of the subject. Ask the subject to look straight. Observe for any deviation of trachea. Normally, it is in the midline or slightly deviated to the right.
- Look for any prominence of the sternocleidomastoid muscle. If it is prominent on one side, it indicates tracheal deviation to that side. This is TRIAL'S sign.

3. Apical impulse

Look for apical impulse over the precordium. (Refer CVS Examination)

4. Movement of the chest

The subject is instructed to take deep breaths. Observe, if the respiratory movements are equal on both sides.

5. Respiratory Rate

Count the respiratory rate (breaths/min) for one minute, while you divert his attention by palpating the radial pulse. Normal rate ranges from 12-16 breaths / min. Increased rate of respiration is known as Tachypnoea and decreased rate is known as bradypnoea.

6. Respiratory Movement

The subject is instructed to take deep breaths. Observe, if the respiratory movements are equal on both sides.

Type of Respiratory movements:

Observe, if the respiration is predominantly thoracic or abdominal. During normal respiration, women use the intercostal muscles more than the diaphragm, and their respiratory movements are predominantly thoracic. Men rely more on the diaphragm and their respiratory movements are predominantly abdominal.

7. Respiratory Rhythm

Observe, if the rhythm of respiration is regular or irregular.

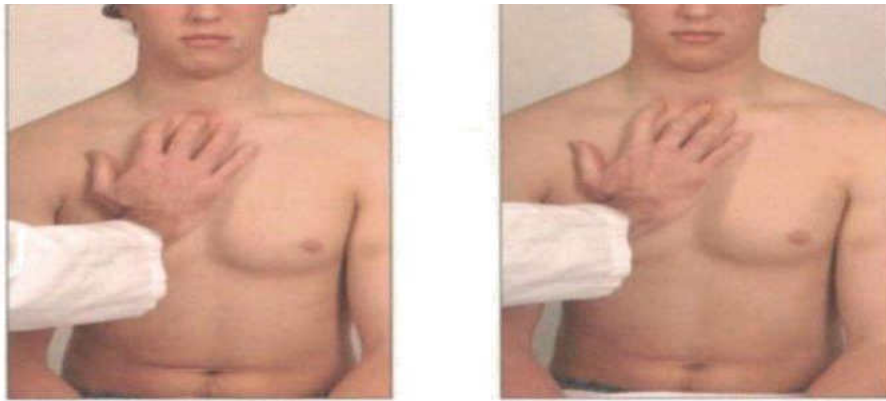
8. Abnormal pulsations, dilated veins, scars and sinuses over the chest wall:

Palpation

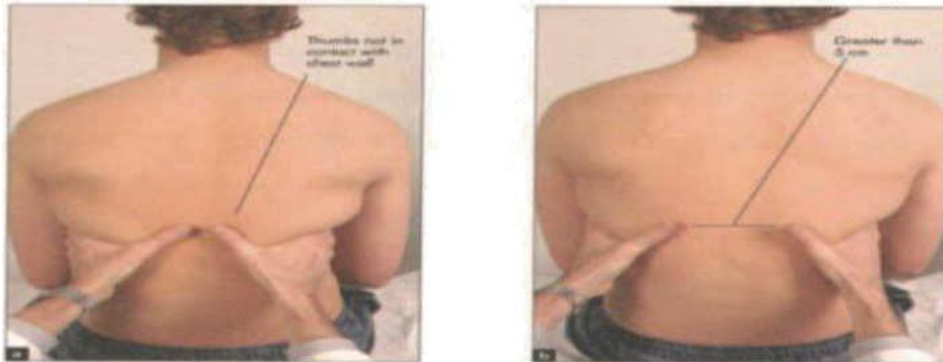
1. Determine the position of mediastinum by examining the tracheal position and apical impulse.

Tracheal Position:

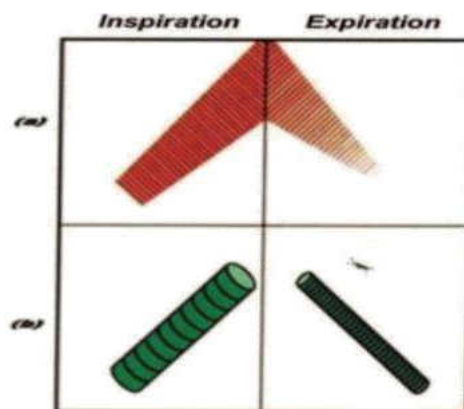
- Ask the subject to sit erect. Keep your index and ring finger of the right hand on medial ends of clavicle. Using the middle finger, gently feel for the trachea and assess whether it is in midline or deviated to one side.
- Then, insinuate your middle finger into the space between the trachea and the sternocleidomastoid muscle on either side to assess the degree of yielding or resistance.
- Common causes of Tracheal deviation
- Towards the side of the lung lesion (pull) - Upper lobe collapse, Upper lobe fibrosis, Pneumonectomy



(a) Examination Of Tracheal Position



(b) Examination of chest expansion



(c) Breath Sounds

- Away from the side of the lung lesion (push) - Tension pneumothorax, Massive pleural effusion

Apical impulse / Apex beat:

- Palpate the precordium first with palm and then with ulnar border of hand to locate the apical impulse.
- Place the index finger on the apical impulse and using the other hand, count the intercostal spaces with reference to sternal angle.
- The normal apical impulse is felt at the left 5th intercostal space, half an inch medial to the left mid clavicular line.

Shift of mediastinum:

Shift of the upper mediastinum causes tracheal deviation. Displacement of apical impulse may indicate shift of lower mediastinum. Displacement of the cardiac impulse without tracheal deviation is usually due to left ventricular enlargement but can occur in scoliosis, kyphoscoliosis or severe pectus excavatum.

2. Respiratory Movements:

- Assess expansion of the lower lobes by placing your hands firmly on the anterior chest wall. Extend your fingers around the sides of the subject's chest.
- Your thumbs should almost meet in the midline and hover just off the chest so that they can move freely with respiration.
- Ask the subject to take deep breaths. Observe, whether your thumbs move equally on both sides.
- To examine the movement of apical lobes, place the hands over the shoulders on both sides from behind. The degree of lift of the fingers indicates the degree of expansion of the apical lobes.
- Examine the lower lobes of the lungs as explained before by placing the hands in the infrascapular area.
- Reduced expansion on one side indicates abnormality on that side such as pleural effusion, lung collapse, pneumothorax and fibrosis

3. Chest Expansion:

- The chest expansion is measured quantitatively by using a measuring tape.
- Hold the measuring tape around the chest wall just below the level of nipples.
- The difference in expansion after a full expiration and a deep inspiration is the total chest expansion.
- The normal expansion ranges from 5 to 8 *cm*.
- It is decreased in restrictive lung diseases.

4. Vocal fremitus / Tactile vocal fremitus:

- Ask the subject to repeat the word "ONE" or "NINETY NINE" in a clear voice.
- Feel the vibrations using ulnar border of the hand in each intercostal space and compare it with the other side consecutively.
- VF is increased in consolidation of lungs.
- VF is decreased in pleural effusion and empyema.

Percussion

Percussion allows you to hear the pitch and loudness of the percussed note. Percussion is done in sequence over corresponding areas on both sides of the chest.

Rules of percussion

- Place the middle finger of the left hand (Pleximeter finger) firmly against the chest,
- aligned in the intercostal space.
- Strike the centre of the middle phalanx of Pleximeter finger with the tip of your right middle finger (Percussing finger). Use a loose swinging movement of the wrist and not the forearm.
- The long axis of the pleximeter finger should be parallel to the border of the organ being percussed.
- Percussion is performed from a more resonant to less resonant area

Methods of Percussion:

- Direct percussion - Percuss directly over the medial third of clavicles without an intervening finger.
- Percuss the lung apices by placing the finger in the supraclavicular fossa.
- Continue the percussion downwards on the anterior chest wall, axillae and posterior chest wall covering all the lung areas.
- Always compare the percussion note on the two sides of the chest systematically, moving from one side to the other side. Do not percuss all the way down one side and then down the other.
- Normal lung produces a resonant note.

Percussion Notes

- Resonant - Normal lung
- Hyperresonant - Pneumothorax
- Dull - Lung Consolidation, lung collapse, severe pulmonary fibrosis
- Stony dull - Pleural effusion

Positioning Of Subject For Percussion: **To Percuss Lateral chest wall:** Ask the subject to keep the hands over the head. **To Percuss Posterior chest wall:** Ask the subject to fold the arms across the front of the chest which will move the scapulae laterally.

Auscultation:

- The stethoscope is used to auscultate the breath sounds, added sounds and vocal resonance.
- Instruct the subject to take deep breaths with open mouth.
- With the diaphragm of the stethoscope, auscultate all areas of the lung.
- As with percussion, listen to the sounds in comparable positions on either side alternately, switching back and forth from one side to the other side.
- Normal breath sounds auscultated are known as Vesicular breath sounds. They are low pitched and have a rustling quality. There is no distinct pause between the end of inspiration and the beginning of expiration. Sound is heard throughout inspiration and only during one third of expiration.
- Abnormal breath sounds are known as bronchial breath sounds.

Bronchial Breath Sounds:

- It is a high-pitched breath sound with a hollow or blowing quality. The breath sounds are heard throughout inspiration and expiration. There is a distinct pause between the inspiration and expiration.
- Bronchial breath sounds are heard in pulmonary consolidation (pneumonia) and in fibrosis.

Causes for absence of breath sounds

Pleural effusion, Pneumothorax.

Vocal Resonance:

- It is the auscultatory component of vocal fremitus.
- Ask the subject to repeat "ONE" and auscultate in all the lung areas consecutively on both sides to assess the quality and amplitude of vocal resonance.
- Vocal resonance is increased in consolidation and decreased in pleural effusion, pneumothorax and fibrosis.

Adventitious or Added Sounds There are abnormal sounds that arise in the lung or in the pleura.

- **Wheeze / Rhonchi:**

Wheeze is a continuous musical sound, heard due to narrowing of airways. It is heard in bronchial asthma.

- **Crackles/ Rales/ Crepitations:**

Crackles are short, explosive sounds often described as bubbling sounds. Crackles may result from sudden opening of previously closed small airways. It may also be heard when air bubbles through secretions in major bronchi. It is heard in bronchiectasis and pulmonary edema.

- **Pleural rub:**

It is a creaking sound produced when inflamed parietal and visceral pleurae slide over one another. It is heard in pleuritis.

Note: Examination of respiratory system is carried out in the following lung areas.

- Supraclavicular
- Infraclavicular
- Mammary
- Inframammary
- Axillary
- Infraaxillary
- Suprascapular
- Interscapular
- Infrascapular

Questions:

1. What is the normal Respiratory rate?
2. What is Tachypnoea?
3. What is dyspnoea?
4. Name the muscles of inspiration and expiration.
5. Name one condition in which vocal fremitus is increased and decreased.
6. What are the normal breath sounds?
7. What are Wheezes and Crackles?

