



Rajasthan

National Health Mission  
(NHM)

Staff Nurse

(Nursing)

Volume - 1



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# 1 CHAPTER

# Cell

The cell of the human body is Eukaryotic (Parenchyma) plant cell prokaryotic.

**Robert Hook (1665) :-**

- Father of cytology – Robert Hook
- Write about cells in a book – micrographic discover double dead cells and also discover double glass microscopes.
- Dead Cell is seen as a jail so called cell.

**Cell :-**

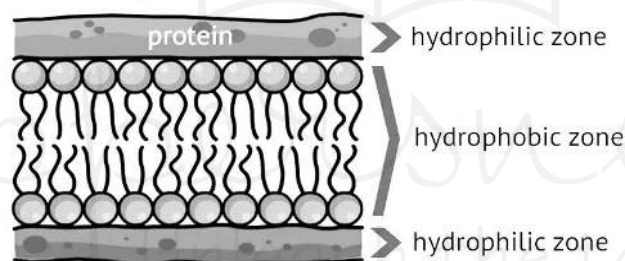
- Size : 10-20 U
- Cell Consist of 3 part
  - ✓ Cell membrane
  - ✓ Cytoplasm
  - ✓ Nucleolus

**Cell Membrane :-**

- Cell is Semipermeable / selective permeative membrane biologer Structure
- Thickness – 70-100 A<sup>o</sup> (A<sup>o</sup> = 10<sup>-10</sup>m) Armstrong
- Consist of Fat, Protein, Carbohydrate & PO<sub>4</sub> group

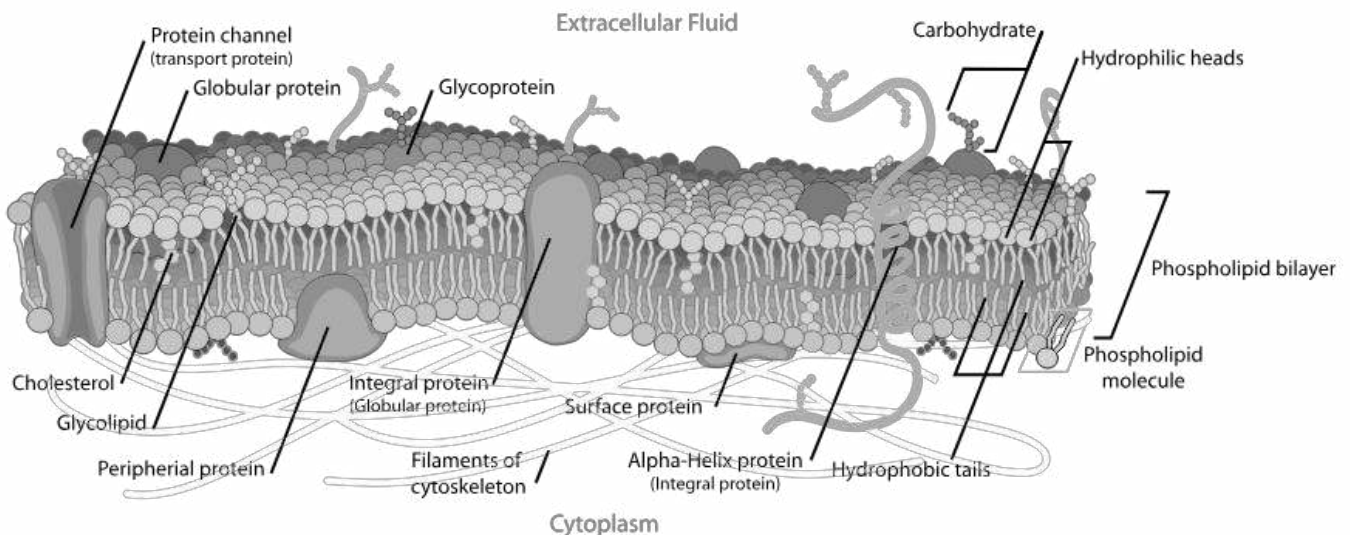
**1. Sandwich Model of Cell Membrane :-**

Sandwich (Davson-Danielli) model of cell membrane



1938 : Danniell and Davidson

**2. Fluid Mosaic Model :-**



Given by S.I. Singer and Nicolson

## 2. Cytoplasm / Biological Fluid of Body :-

**Assimilation :-** Formation process of cytoplasm

✓ Cytoplasm (90%) = Cytosol (70%) + Organelle

✓ Nucleoplasm : Fluid in Nucleolus

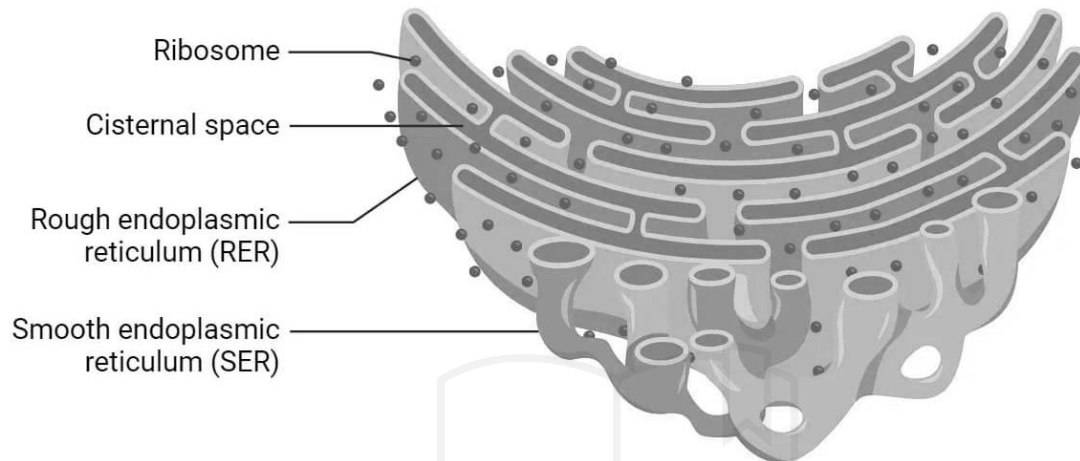
✓ Protoplasm : Nucleoplasm + Cytoplasm

Cytoplasm is discovered by Rudolf von Kolliker

### Cytoplasmic Organelles :-

#### 1) Endoplasmic Reticulum :-

## Endoplasmic Reticulum (ER) Structure



**This are found in cell cytoplasm**

#### **Function:-**

Protein synthesis

Fat synthesis

Steroid hormone synthesis (adrenal gland)

detoxification of drugs

- Normal Cell – ER
- Eye Cell – myeloid reticulum
- Skeletal muscle cell – Sarcoplasmic reticulum
- Neuron Nissel body / Nissel granules
- ER is discovered by porter

ER is two types

#### 1) **Rough ER :-**

It contain ribosome in it surface so called rough ER

#### **Function :-**

Protein Synthesis

#### 2) **Smooth ER :-**

It not contain ribosome on it surface so called smooth ER

#### **Function :-**

Fat Synthesis

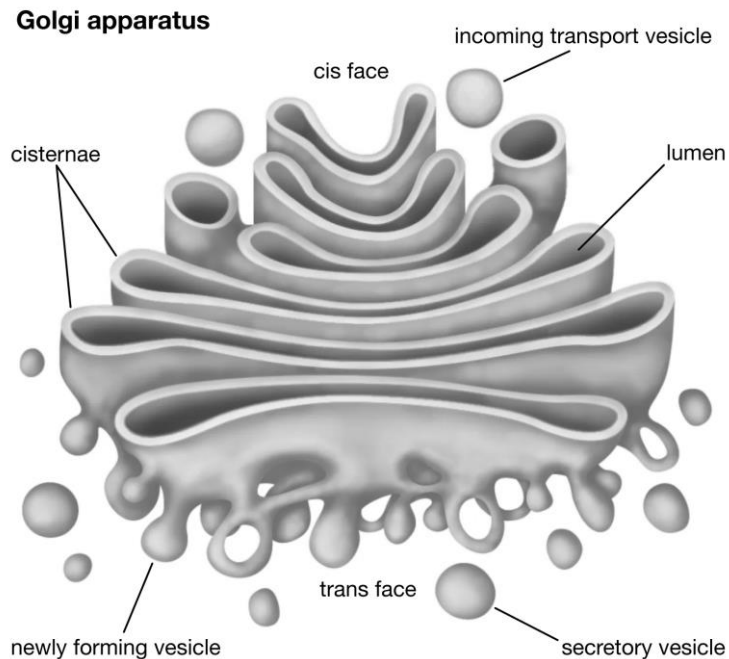
➤ **RBC and spermatid not contain ER**

➤ **Cell work on Basic medium ie PH = 7.2**

Steroid hormone synthesis (adrenal gland)

Detoxification of drugs

## 2) Golgi Body :- (Golgi apparatus/Postman of cell)



It is transporter, packager and delivered the protein within cell body  
It is also synthesis lysosome.

### 3) Lysosome :-

Suicidal bag of cell

It is synthesized by golgi body

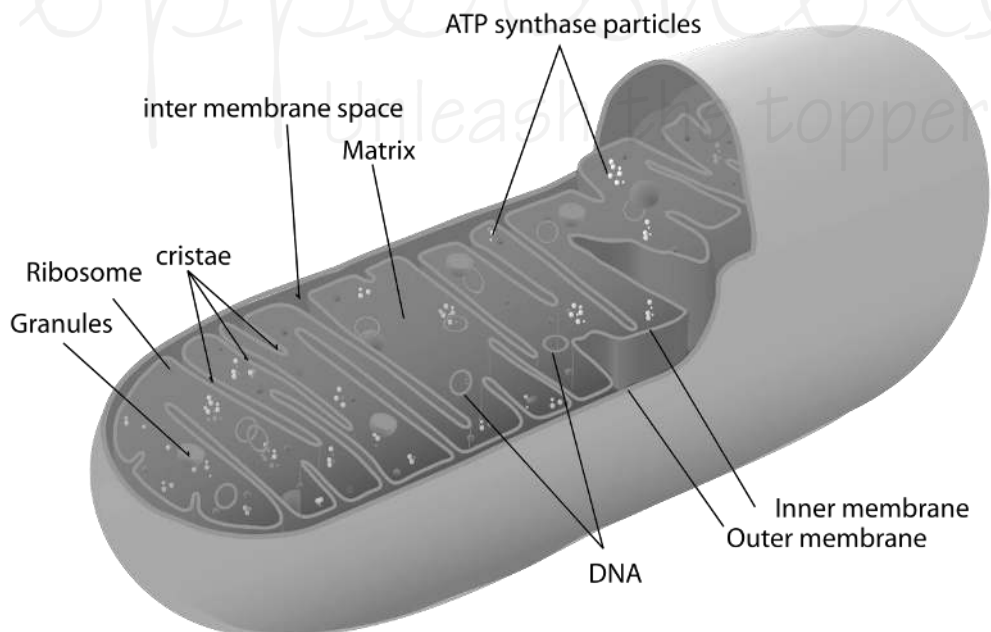
PH of Lysosome is – 5 acidic only

#### Function :-

Lysosome contain proteolytic enzyme called lysosome hydrolytic enzyme which killed infection agent like bacteria virus so called defender of cell or shoulder of cell

During massive inflammation lysosome district own cell so called suicidal bag cell

### 4) Mitochondria :-



(Power house of cell)

C. Benda Discover mitochondria

Diameter – 0.5-2 U

Highest Mitochondria – Sperm and SA Node

Bilateral structure

It contain fluid called – Matrix

Phosphorylation enzyme which is responsible for ATP generation

DNA also found in mitochondria also have regeneration power (but not role in genetic transmission)

Enzyme – Cellular respiration/glycolysis

- **Mitochondria 1st organelles destruct in response of hypoxia**
- **During glycolysis – 1 molecule of glycogen enter in pathways**

**Function :-**

It is responsible for ATP generation so called power house of cell

**Glycose / cellular respiration / Kreb's cycle critic acid cycle (CAC) :-**

**Check post of body – lymphatic system**

**Aerobic glycolysis first product is pyruvic acid**

**Aerobic glycolysis end product = 38 ATP + H<sub>2</sub>O + CO<sub>2</sub>**

**Anaerobic glycolysis end product = Lactic Acid + 2 ATP**

**Electron transport system (ETS) :-**

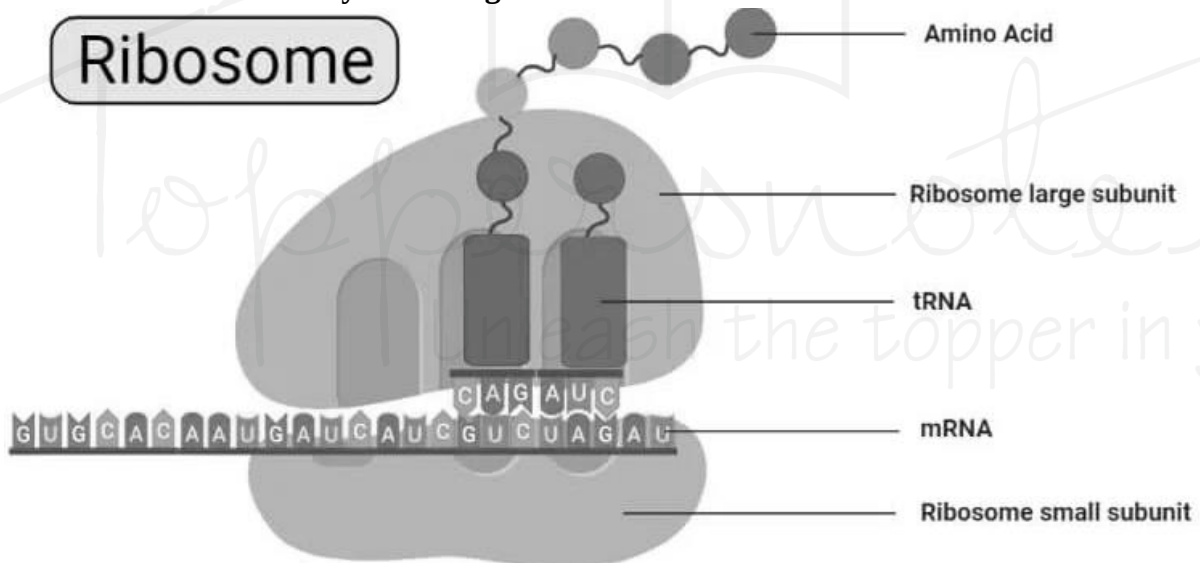
1) Embden Meyerhof pathway (EAP)

Nicotinamide adenine nucleotide Phosphate ETS 3 ATP  
(NADPH<sub>2</sub>)

2) FADHS<sub>2</sub> ETS 2 ATP

(Flavin adenine dinucleotide)

5) **Ribosome / Protein Factory / Cell Engine molecular machine :-**



This are consist of protein and RNA this

40% RNA

60% Protein

Eukaryotic

80s



60s 40s

Prokaryotic

70s



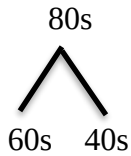
50s 30s

Ribosome are two type

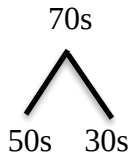
1) **Bind Ribosome :-**

Suspended in cytoplasm freely

Eukaryotic Cell contain 80s Ribosome



Prokaryotic Cell contain 70s ribosome



### Functions :-

1) **Translation** :- It Translate M-RNA to Protein so help in protein synthesis

R-RNA heterogeneity related disorder

eg. Hepatitis – C (Cricket associated paralysis)

6) **Centrosome** :-

**The centrosome is a crucial organelle found in animal cells, acting as the main microtubule-organizing center (MTOC) and a key regulator of cell division. It's a non-membranous structure located near the nucleus,**

### Function :-

It helps in cell division by mitigating chromosomes towards poles at anaphase of cell division.

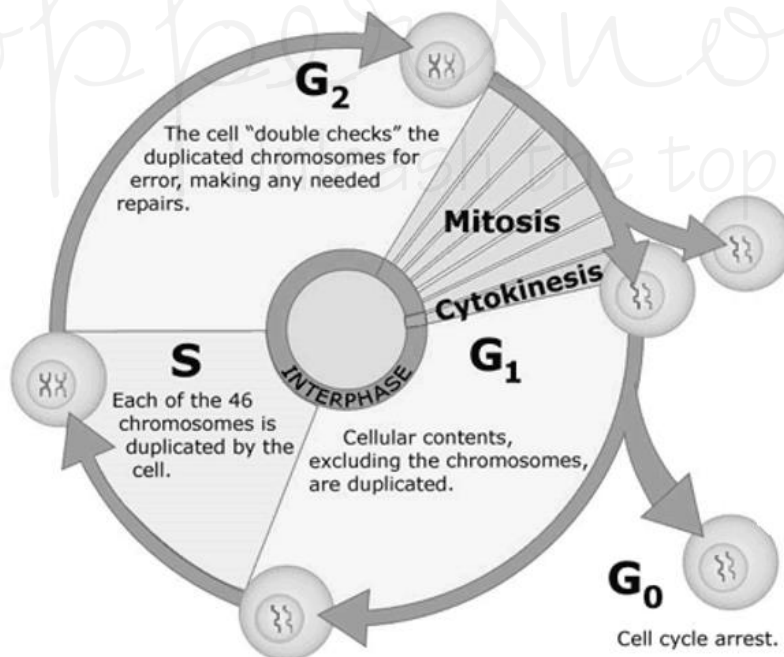
➤ **Most common cancer of brain in adult – Glioma (Headache)**

➤ **Glioma is malignant but not metastasis**

Centrosome contain two centromere

★ **Neurons do not contain centrosomes, so the neuron is the only cell of the body which is non mitotic.**

### Cell Cycle :-



The cell cycle is a series of events that take place in a cell leading to its division and duplication.

### Interphase (90%)

1) **G<sub>1</sub>** – (90%)

2) **S** – Phase

3) **G<sub>2</sub>** – Phase

---

## Mitosis – (10%)

1. Prophase (max)
2. Metaphase
3. Anaphase
4. Telophase

## Interphase :-

G – phase :- It is two types

1. G<sub>1</sub> Phase -
  2. G<sub>0</sub> Phase (Resting Phase)
- 1) G<sub>1</sub> Phase :- (Growth – 1)

❖ **Cell spend its maximum time in this phase (90%) in this phase cell size, cytoplasm, protein are increased up to double**

- 2) G<sub>0</sub> Phase :- (Resting Phase)

In this phase cell divided or in rest  
eg. Neurons

- 3) S-Phase (Synthesis Phase)

In this phase DNA is synthesis which is required for cell division DNA Replication occurs.

✓ **Most common brain cancer in children**– Medulloblastomas

✓ **Most common childhood brain tumour is**– ependymomas

**G<sub>2</sub> Phase :-** In this phase all substances increase DNA replication. Cell produce protein to be used in cell division.

## Mitosis Phase (M-Phase) :-

- **Normal Cell spend it 10% time in M-Phase**
- **Cancerous cell spend it maximum time in M-Phases**

## M-Phase is 4 types :-

### A) Prophase :-

Largest phase of M-Phase

In this phase, increase chromatin and disappear nucleolus

### B) Metaphase :-

In this phase cell chromosome collect in center and divide by chromatid

### C) Anaphase :-

In this phase chromosome is migrate toward pole by help of centrosomes

### D) Telophase :-

In this phase cell division is completed

### 7) Microtubule and Microfilament :-

Cytoskeletal / Cell Scaffold

Microfilament – 3-4 mm

Microtubule and microfilament help in cell movement with the help of this

### 8) Vacuoles :-

Storage of nutrient

### 3) Nucleolus :-

(Controller of cell / Brain of Cell)

Discover by Robert Brown

Largest Organelle of cell

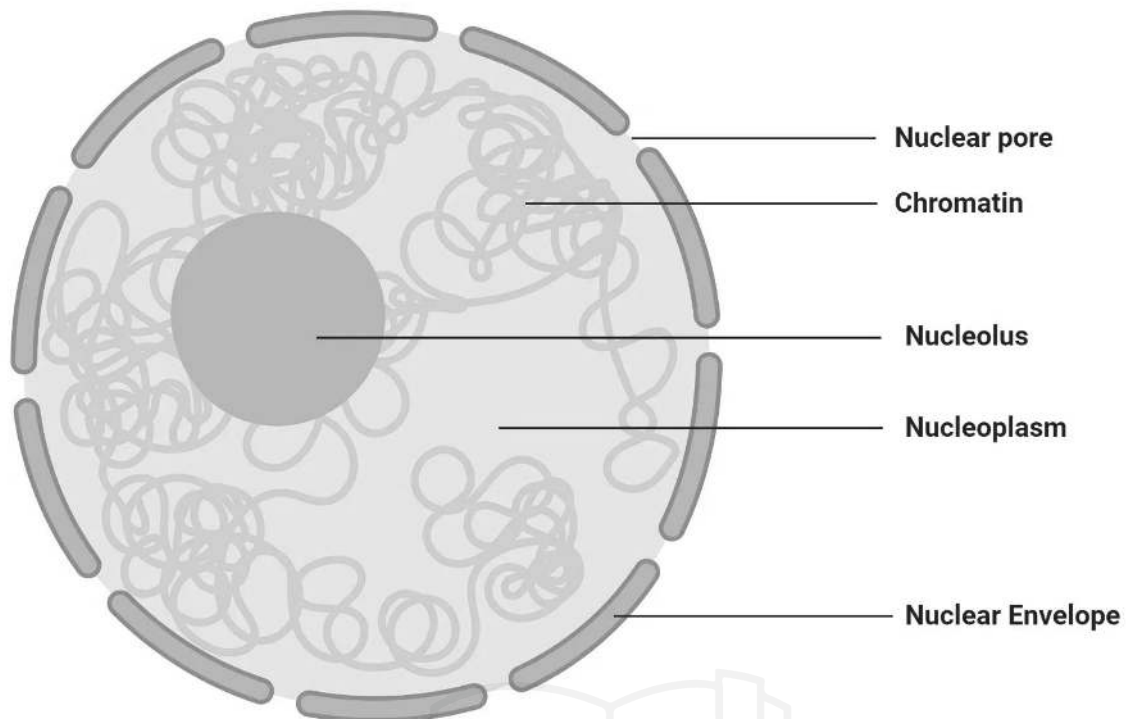
Eukaryotes Cell – Center

Control whole cell and help in cell division

Nucleolus contain nucleoplasm

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# Nucleus



## Protein Synthesis :-

When deficiency of protein in cell, Gene / codon give message to nucleus contain DNA and size of DNA is large, so it can not cross membrane.

- DNA double helix change into single chain RNA & give message to rough ER via M-RNA (Messenger RNA)
- This message read by T-RNA (translate / anticodon RNA)
- DNA to RNA = Transcription
- RNA to DNA = Reverse Transcription
- Rough ER make protein and Ribosome change into protein
- After that Golgi body receive this protein and pack deliver and transport the protein to definitive organics

# 2 CHAPTER

# Tissue

- Group of Cell is known as tissue  
Name given by – Grew  
Scientific study of tissue = Histology
- **Function :-** Secretion, absorption, excretion & protection of body

## 4 Type Of Tissue :-

1. Epithelial tissue
2. Connective tissue
3. Nervous tissue
4. Muscle tissue

### 1.) Epithelial tissue :-

↓                      ↓

Upon                  Membrane

These are group of cell lies on the basement membrane called epithelial tissue

#### Types :-

- A) Simple Epithelial tissue
- B) Stratified Epithelial tissue

#### A) Simple Epithelial tissue :-

- ✓ These are single layer of cell lies on the basement membrane

##### 1. Simple squamous epithelial tissue :-

- ✓ These are found in Alveoli of lung of nephron (ascending loop of Henle)
- ✓ Endocardium of heart
- ✓ Endothelial lining of capillary – Nephron LOH

##### 2. Simple cuboidal epithelial tissue :-

- ✓ Found in thyroid gland
- ✓ Prostate gland
- ✓ Nephron LOH, DCT, PCT

##### 3. Simple Columnar epithelial tissue :-

- ✓ intestinal mucosal
- ✓ Trachea
- ✓ Fallopian tube
- ✓ Uterus

#### B) Stratified Epithelial tissue :-

- ✓ These are multiple layer of cell which are lies on basement membrane

#### These are 2 types :-

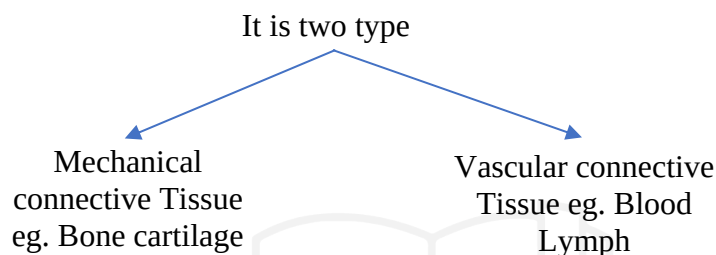
##### 1. Stratified squamous epithelial tissue :-

- ✓ Keratinizing stratified squamous epithelial tissue
  - Epidermis layer of skin
- ✓ Non keratinizing stratified squamous epithelial tissue
  - Female vagina
  - Conjunctiva
  - Pharynx
  - Esophagus

- ✓ **Hair, Nail cartilage connects epidermis lens are avascular structure of body**
- ✓ **Epidermis is developed from ectoderm**
- C) Transitional epithelial tissue :-**
  - Pear shape cell
  - Multiple layer
    - ☞ Urinary bladder mucosa stretching power & contract
    - ☞ New born baby vagina
- ✓ **Fallopian tube contain simple columnar epithelial tissue**
- ✓ **Adult female vagina contain stratified squamous epithelial tissue (Non keratinising)**
- ✓ **Urinary bladder contain transitional epithelial tissue called urothelium**

## 2.) **Connective Tissue :-**

- ✓ Tissue which connect the body
- ✓ Highly abundant amount of tissue in body
- ✓ Provide support to body



- **Connective tissues are made up of collagen fiber, elastic fiber and reticular fiber.**
  - ✓ **Skin and blood vessels contain collagen – 1<sup>st</sup> protein**
  - ✓ **Lens contain collagen – IV Protein**
  - ✓ **Vit C is required for collagen fiber synthesis**
  - ✓ **Vit C deficiency cause scurvy (gum bleeding)**
  - ✓ **Vit C help in wound healing by collagen protein synthesis**

## **Connective tissue disorder :-**

- MARFAN Syndrome
- Sjogern Syndrome
- Rheumatic arthritis
- Rheumatic Fever
- Systemic Lupus erythematosus (SLE)
- Scleroderma – Hardening of Skin

### **1. MARFAN Syndrome :-**

Connective tissue disorder in which abnormal synthesis of fibrillin 1<sup>st</sup> protein

It is genetic disease

S/S :-

M – Mitral Valve Stenosis

A – Aortic Aneurism

R – Retinal Deattachment (myopia)

F – Failure of heart

A – Aractodacty (long finger – Spider like finger)

N – Nine feet height

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## 2. Sjogern Syndrome :-

It is a autoimmune disorder of connective tissue which affect moisture producing gland

**S/S :-**

Dry mouth

Dry Eye

## 3. Systemic lupus Erythematous (SLE)

It is Autoimmune disease

Connective tissue multisystem disorder

Type – III hypersensitivity reaction / Immune complex

**C/S/S :-**

**Butter Fly rashes on face / malar rash**

**D/E :-**

ANA Titer (Anti-Nuclear Antibody)– IOC (1:40)

RFT, CRP (0-3mg/l)

RBC become lupus cause anomies

Erythema of palm (red)

**CRP :-**

It is protein released by liver

**Absent CRP level indicate – liver failure**

**Rx :-**

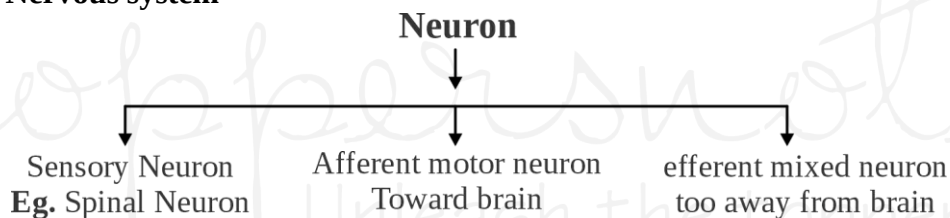
→ Steroid immunosuppressant – cyclophosphamide

→ Plasmapheresis, Vit C Diet rich

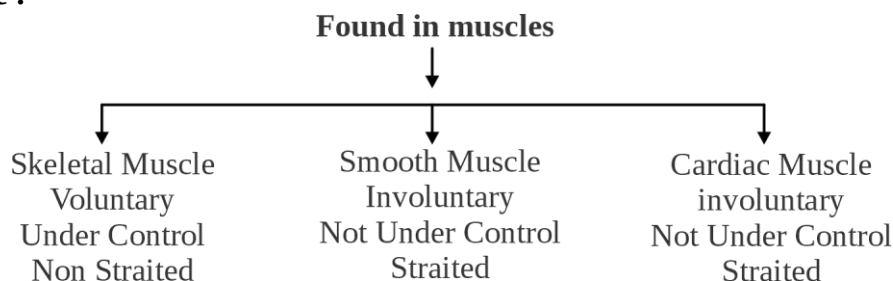
→ Scmcuccu transplant in life threatening SLE

## 3) Nervous tissue :-

**Found only in Nervous system**



## 4.)Muscle Tissue :-



# 3

## CHAPTER

# Blood

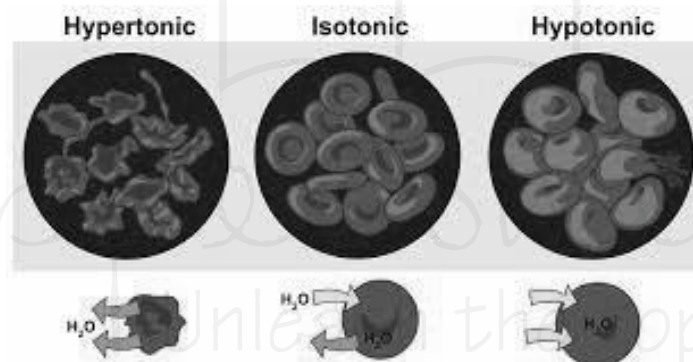
### General Properties of Blood

Property	Value / Fact
Color	<b>Red</b> (due to Hemoglobin, respiratory pigment)
Nature	Vascular connective tissue
Total Volume	<b>5–6 liters</b> ( $\approx$ 7–8% of body weight, or 80 ml/kg)
pH	<b>7.35–7.45</b> → Slightly alkaline
Specific Gravity	<b>1.050–1.069</b>
Viscosity	<b>5× thicker than water</b>
Origin	Derived from <b>mesoderm</b>

#### Nursing Booster:

- Blood is slightly alkaline → essential for cell function.
- Most exams ask: **Normal blood volume = 5–6 L ( $\approx$  7–8% of body weight).**

#### Behavior in Solution



- **Hypotonic solution:** RBC absorbs water → swells → ruptures → **Hemolysis**
- **Isotonic solution (0.9% NaCl):** No change
- **Hypertonic solution:** RBC shrinks (crenation)

#### Exam Booster:

- Question often asked: “RBC in hypotonic solution undergoes → Hemolysis.”

#### Body Fluids Distribution

Age Group	% of Body Weight as Fluid
Adult	<b>60%</b>
Old age	<b>55%</b>
Newborn	<b>80%</b>

#### Nursing Booster:

- Body water % **decreases with age.**

#### Compartmental Distribution of Body Fluid

For an **adult male, 70 kg** body weight:

- **Total Body Fluid = 60% of 70 = 42 liters**

Fluid Compartment	% of Total	Volume (Liters)
Intracellular Fluid (ICF)	70%	28 L
Extracellular Fluid (ECF)	30%	14 L

**Mnemonic:** "I (ICF) hold more, E (ECF) holds less."

## Composition of Blood

### **Cellular Ratios**

Ratio	Value
Platelets : WBC	40 : 1
RBC : WBC	600 : 1
RBC : Platelets	10 : 1

### **Nursing Booster:**

- WBC count ↑ in newborns (11,000–17,000/cumm)
- WBC count ↑ in pregnancy (up to 20,000/cumm)

### **Plasma Proteins**

Plasma = blood matrix, contains **3 major proteins**:

#### **(a) Albumin**

- **Normal:** 3–5 g% (≈ 54% of total plasma proteins)
- **Synthesis:** Liver (Hepatocyte ER)
- **Types:**
  - ✓ Pre-albumin (0.03 g/dl) → transports **T<sub>3</sub>, T<sub>4</sub>, Hb**
  - ✓ Albumin → transports **Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup>, bilirubin**
- **Functions:**
  - ✓ Maintains **osmotic pressure** at capillary end
  - ✓ Transports hormones & minerals

#### **Exam Booster:**

- ↓ Albumin → edema, jaundice (bilirubin transport failure).
- Most abundant plasma protein = **Albumin**.

#### **(b) Globulin**

- **Normal:** 2.3 g/dl (2nd most abundant protein)
- **Synthesis:** Plasma cells
- **A:G ratio:** Normal = 1.7:1 | Pregnancy = 1:1 (due to ↓ Albumin)
- **Functions:**
  - ✓ Forms **glycoproteins** (e.g., erythropoietin)
  - ✓ Forms **lipoproteins**

### **Lipoproteins:**

Type	Normal	Function
<b>HDL</b> (Good cholesterol)	30–70 mg/dl	Transports fat <b>from blood</b> → <b>tissues</b>
<b>LDL</b> (Bad cholesterol)	≤130 mg/dl	Transports fat <b>from tissues</b> → <b>blood vessels</b>
<b>VLDL</b>	<200 mg/dl	Internal fat transport (liver → adipose tissue)
<b>Chylomicrons</b>	<200 mg/dl	External fat transport (intestine → blood)

### **Exam Booster:**

- Estrogen & exercise ↑ HDL; smoking ↓ HDL → ↑ cardiac risk.
- Fat intake = triglycerides; stored as **triacylglycerol (TAG)**.

**(c) Special Plasma Proteins**

Protein	Function	Normal	Clinical Note
<b>Transferrin</b>	Iron transport	3–4.5 mg/dl	Helps iron absorption in GIT
<b>Ferritin</b>	Iron storage (mainly in liver, 2–4 g)	F: 12–300 ng/ml, M: 150–300 ng/ml	Best test for <b>community anemia</b>
<b>Ceruloplasmin</b>	Cu <sup>2+</sup> transport	–	Deficiency → <b>Wilson’s disease</b> (Cu <sup>2+</sup> deposits in liver, kidney, brain → failure + Kayser–Fleischer ring in eye)
<b>Haptoglobin</b>	Binds free Hb → prevents kidney loss	–	Low in <b>hemolysis</b>
<b>Fibrinogen</b>	Clotting factor I	0.3 g% (300 mg/dl)	1st clotting factor, prevents <b>rouleaux</b> formation

**Exam Booster:**

- Wilson’s disease → **Kayser–Fleischer ring** (brown ring at corneal limbus).
- Serum ferritin = **best test for detecting anemia** at community level.

**Fat Metabolism**

- Dietary fat intake = **triglycerides**
- Stored in adipose tissue as **TAC (Triacylglycerol)**
- **Bile salts** emulsify fat → water soluble → absorption

**Newborn vs Adult Fat:**

- **Newborn:** Brown fat (thermogenesis)
- **Adult:** Yellow fat (energy storage)

**Blood Donation & Transfusion**

Process	Safe Volume
Blood Donation	7 ml/kg body weight
Blood Transfusion	10 ml/kg body weight

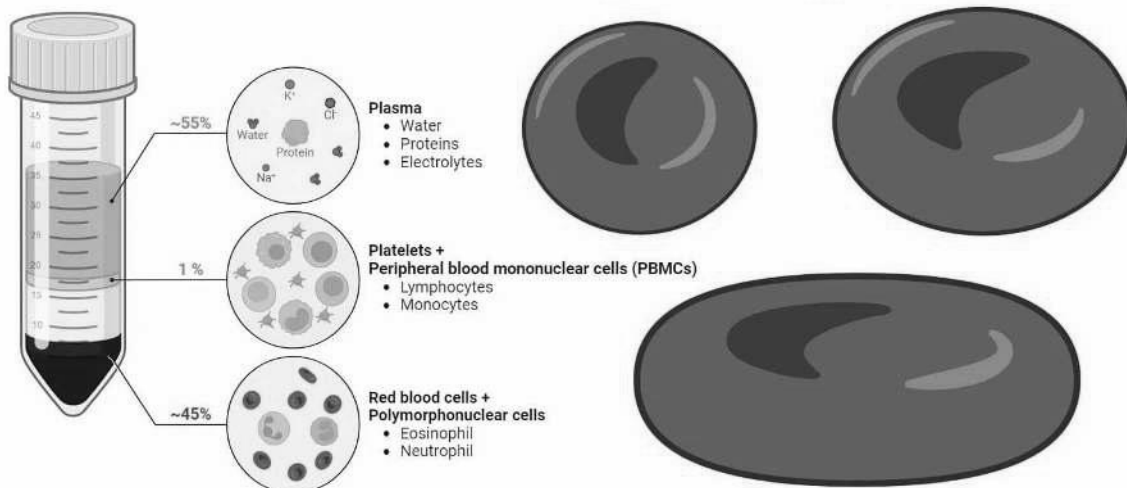
**Exam Booster:**

- Donor: Max **350–450 ml** in one sitting.
- Frequent exam Q: “Safe limit for transfusion = **10 ml/kg.**”

**Blood Cells**

**RBC (Erythrocytes)**

# Red Blood Cells (RBCs)



Feature	Normal Value / Fact
Count (Female)	4.5–5.5 million/cumm
Count (Male)	5.5–6.5 million/cumm
Newborn	6.8 million/cumm
Lifespan	120 days (adult), 60–80 days (newborn)
Size	7.2 $\mu$ (normocytic)
Shape	Biconcave, disc-shaped
Erythropoiesis Time	7 days
Nucleus	Absent (limits lifespan)

#### Booster:

- Newborn → ↑ RBC count, ↓ lifespan, immature liver → **risk of physiological jaundice.**

#### Abnormalities

- **Anisocytosis** → abnormal size
- **Poikilocytosis** → abnormal shape
- **Spherocytosis** → spherical RBC

#### RBC Membrane Special Features

- **Proteins:** Spectrin, Ankyrin (maintain shape)
- **Antigens:** ABO & Rh blood group determinants
- **Enzyme:** G6PD (metabolizes drugs like aspirin, quinine, gentamicin, amikacin)
  - ✓ Deficiency → **drug-induced hemolysis**
  - ✓ Also associated with **Von Gierke's disease** (glycogen metabolism defect).

#### Booster:

- Hemoglobin = **best buffer in blood.**
- Glutathione protein maintains normal Hb ( $35 \pm 2\%$  inside RBC).

#### Erythropoiesis

**Definition:** Formation & maturation of RBC.

- **Hormone:** Erythropoietin (from kidney, afferent arteriole → in response to hypoxia).
- **Time:** 7 days.

#### Sites of RBC Formation

Stage	Site
Fetus (0–3 months)	Yolk sac (mesoderm)
Fetus (4–6 months)	Liver & spleen
Fetus (7 months–birth)	Red bone marrow of long bones (tibia, femur, radius, ulna)
Birth–18 years	Red bone marrow of long bones
>18 years	Red marrow of flat bones (sternum, vertebrae, ribs)

#### Booster:

- If bone marrow destroyed → **liver & spleen re-activate** as erythropoietic organs.

#### Spleen

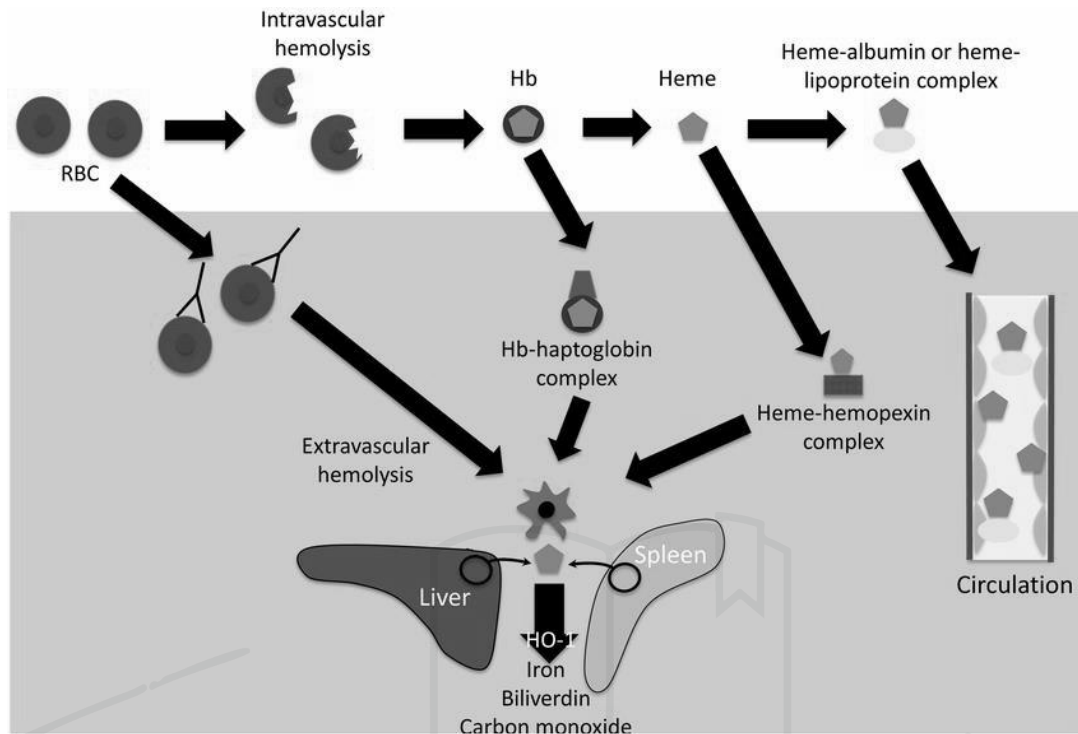
- Largest **lymphatic organ**
- Location: Below **9th–11th ribs**
- Stores ~**240 ml RBC** (“blood bank of body”)

- **Red pulp:** venous sinuses (RBC destruction)
- **White pulp:** WBCs (immune function)
- Removes old (>120 days) or fragile RBC → “**Graveyard of RBCs**”

**Booster:**

- Contains **reticuloendothelial cells** → phagocytose abnormal RBCs.

**Hemolysis & Jaundice**



**Types of Jaundice**

Type	Cause	Key Lab Finding
<b>Pre-hepatic</b>	Hemolysis (Rh/ABO incompatibility, sickle cell anemia)	↑ Indirect (unconjugated) bilirubin
<b>Hepatic</b>	Hepatitis, cirrhosis, ↓ UDPGT enzyme	↑ Indirect bilirubin
<b>Post-hepatic</b>	Obstruction (stone in bile duct, tumor)	↑ Conjugated bilirubin

**Syndromes**

- **Crigler–Najjar Syndrome:** Complete absence of UDPGT → ↑ unconjugated bilirubin → needs **liver transplant**.
- **Gilbert’s Syndrome:** Partial deficiency of UDPGT → mild unconjugated hyperbilirubinemia.
- **Dubin–Johnson Syndrome:** Autosomal recessive, obstruction in bile excretion → ↑ conjugated bilirubin (liver black).
- **Rotor Syndrome:** Similar to Dubin–Johnson but without liver pigmentation.

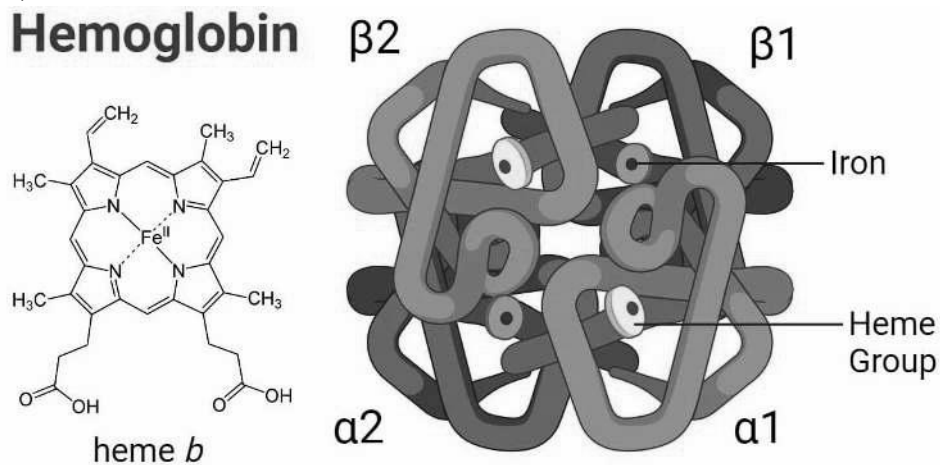
**Normal Values:**

- Indirect bilirubin = 0.3–1 mg/dl
- Conjugated bilirubin = 0.1–0.2 mg/dl

**Diagnostic Tests**

- **Bilirubin (urine):** Fouchet’s test, Ehrlich’s test, Smith’s test
- **Bile salt:** Hay’s test
- **Ketone in urine:** Rothera’s test
- **Phenylketonuria:** Guthrie test (blood)

## Hemoglobin (Hb)



- Hemoglobin = **respiratory pigment** in RBC.
- Each RBC contains Hb = **35 ± 3% of weight**.
- **Iron form in Hb:** Ferrous ( $\text{Fe}^{2+}$ )
- **Dietary iron:** Ferric ( $\text{Fe}^{3+}$ ) → reduced to  $\text{Fe}^{2+}$  by **HCl + Vitamin C** (acidic medium).

### Nursing Booster:

- Give oral iron **before meals**, with lemon/orange juice (Vitamin C).
- **Contraindicated with milk.**
- Iron syrup → give slowly → prevents **green/black teeth discoloration**.
- Best Vitamin C source = **Amla (Indian gooseberry)**.

### Normal Hemoglobin Levels

Group	Hb Value
Male	14–16 g/dl
Female	12–14 g/dl
Newborn	18–20 g/dl
4-month-old baby	~10 g/dl

### Iron & Oxygen Transport

- **1 g Hb = 3.34 mg iron**
- **50% of body iron** is in blood
- **1  $\text{Fe}^{2+}$  ion = carries 4  $\text{O}_2$  molecules**
- **1 g Hb = carries 1.34–1.36 ml  $\text{O}_2$**
- **100 ml blood = 19–21 ml  $\text{O}_2$  capacity**
- **Saturation ( $\text{SpO}_2$ ):** Oxygen carrying capacity of Hb
- **$\text{SpO}_2 = 6\text{th}$  vital sign**

### Binding Affinity of Hemoglobin

Gas	Compound	Affinity vs $\text{O}_2$
$\text{O}_2$	Oxyhemoglobin ( $\text{HbO}_2$ )	1×
$\text{CO}_2$	Carbaminohemoglobin ( $\text{Hb-NHCOOH}$ )	20×
CO	Carboxyhemoglobin ( $\text{HbCO}$ )	<b>200× stronger than <math>\text{O}_2</math></b>
Reduced Hb	Hb without $\text{O}_2$	–

### Nursing Booster:

- CO poisoning → **HbCO** (deadly, binds 200× stronger than  $\text{O}_2$ ).

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## **Abnormal Hemoglobin**

### **Methemoglobin (HbOH)**

- Fe<sup>2+</sup> oxidized → Fe<sup>3+</sup>
  - Cause: **cyanide poisoning, ionized drugs**
  - Antidote: **Amyl nitrite**
  - Result: Hb cannot carry O<sub>2</sub> → hypoxia
- Note:** Hb also transports **T<sub>3</sub>, T<sub>4</sub>, glucose, nitric oxide (NO)**.
- NO acts as **vasodilator** → aids pulmonary gas exchange.

### **Types of Hemoglobin**

Type	Description
<b>HbF (Fetal)</b>	↑ O <sub>2</sub> affinity, present till ~4 months age
<b>HbA (Adult)</b>	Normal adult hemoglobin
<b>HbS (Sickle Hb)</b>	Mutation: Glutamic acid → Valine (6th position, β-chain) → Sickle Cell Anemia
<b>HbC</b>	Variant, may cause hemolytic anemia
<b>HbE</b>	Mutation: Glutamic acid → Lysine (25th position, β-chain)

### **Exam Booster:**

- HbF > HbA in O<sub>2</sub> affinity.
- HbS = **Sickle cell anemia** → Hemolytic anemia.
- Best buffer in blood = **Hemoglobin**.

## **RBC Indices & Related Tests**

### **RBC Indices**

- **MCV (Mean Cell Volume):** 84–94 fL → Avg. size of RBC
- **MCH (Mean Corpuscular Hb):** 27–32 pg → Hb per RBC
- **MCHC (Mean Corpuscular Hb Conc.):** 35 ± 3% → % of Hb in RBC
- **Color Index (CI):** 0.85–1.15 (≈ 1:1) → Hb level vs RBC count
  - ✓ **Low CI** = Hypochromic anemia
  - ✓ **High CI** = Hyperchromic anemia

### **Hematocrit (PCV)**

- **High PCV (↑):**
  - ✓ Dehydration
  - ✓ Diabetes insipidus
  - ✓ Dengue, Burns
  - ✓ Polycythemia vera
  - ✓ COPD / Kidney hypoxia
  - ✓ High altitude
- **Low PCV (↓):**
  - ✓ Pregnancy (normal >30%)
  - ✓ Anemia
  - ✓ Malnutrition
  - ✓ Acute Myeloid Leukemia

### **Polycythemia Vera**

- Bone marrow cancer → ↑ RBC
- PCV >70%
- Thick blood → clot risk

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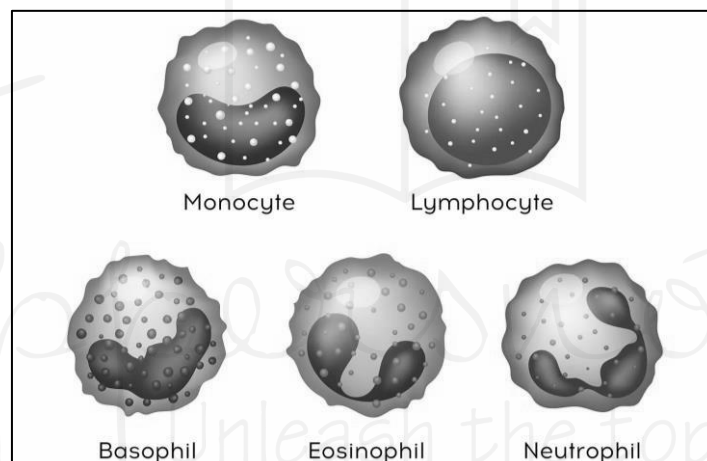
## ESR (Erythrocyte Sedimentation Rate)

- **Normal:**
  - ✓ Male → 10–15 mm/hr
  - ✓ Female → 10–30 mm/hr
  - ✓ Newborn → 0–2 mm/hr
- ↑ **ESR:** Pregnancy, Anemia, TB, RA, SLE, Asthma, Multiple myeloma
- ↓ **ESR:** Polycythemia vera, Sickle cell, Leukemia, CHF
  - ✓ **Zeta potential** ↓ → **ESR** ↑
  - ✓ **Fibrinogen** ↑ → **ESR** ↑
  - ✓ Test discovered by **Edmund Biernacki**

## Nursing Booster Points

- **MCV:** 84–94 fL
- **MCHC:** 35 ± 3%
- **CI normal:** ≈ 1
- **PCV >70% = Polycythemia vera**
- **ESR ↑ = Inflammation**
- **ESR ↓ = Polycythemia / Sickle c**

## WBC / Leukocytes



- Leuko = **colourless**
- **Nucleated blood cells**
- **Largest blood cells**
- **Least numerous blood cells**
- Function → **Body defenders (immunity)**

## Normal Count

- Adult: **4,000 – 11,000 / cumm**
- Newborn: **11,000 – 17,000 / cumm**
- Pregnancy: **up to 20,000 / cumm**

## WBC Disorders

### Leukopenia (WBC < 4,000 /cumm)

#### Causes:

- Starvation
- Typhoid fever
- Viral infections
- Protozoal infections