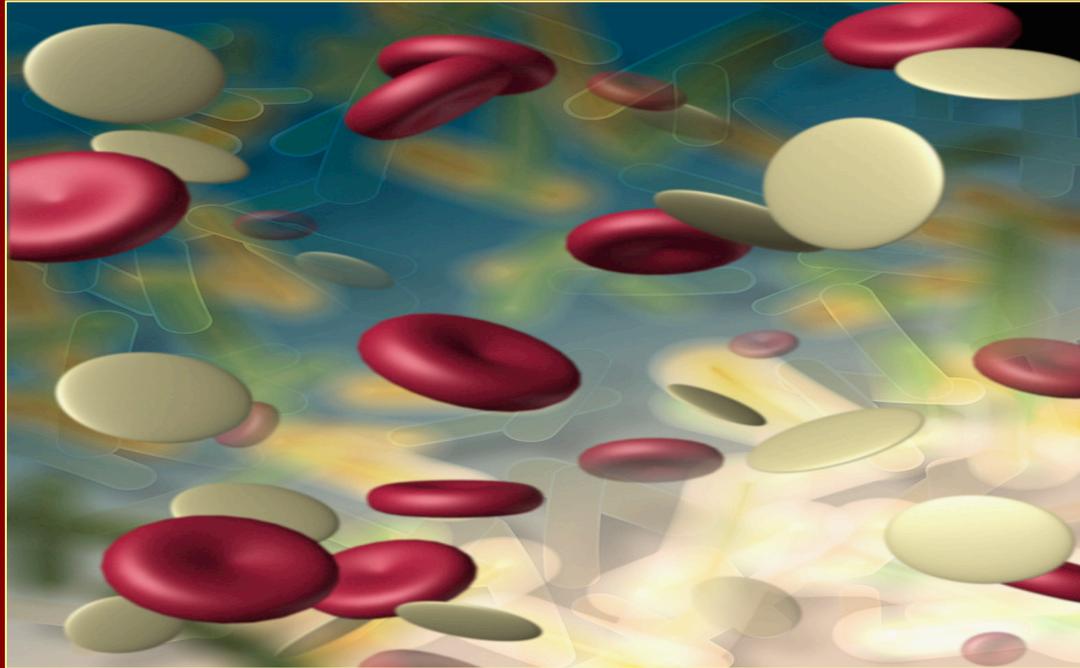


# CBC Interpretation



# CBC COMPONENTS

- Red Blood Cells (RBCs)
- Hematocrit (Hct)
- Hemoglobin (Hgb)
- Mean Corpuscular Volume (MCV)
- Mean Corpuscular Hemoglobin(MCH)
- Mean Corpuscular Hemoglobin Concentration (MCHC)
- Red cell distribution width (RDW)
- White Blood Cells (WBCs)
- Platelets
- Mean Platelet Volume (MPV)

# RBC

- Transport hemoglobin which carries oxygen from the lung to tissues throughout your body
- Produced in the bone marrow and stimulated by erythropoietin which is made in the kidneys

**M: 4.20 to 5.80 m/uL**

**F: 3.80 to 5.20 m/uL**



# HEMOGLOBIN AND HEMATOCRIT

**Hemoglobin :**

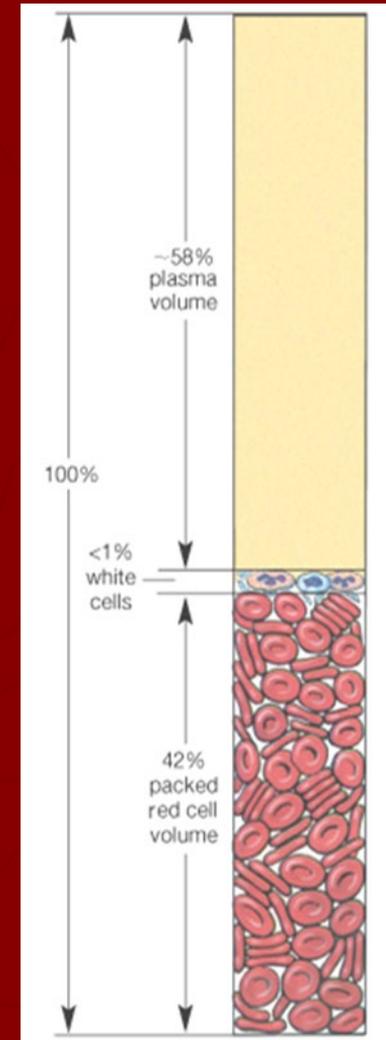
**M: 13.0 to 17.5 gm/dL**

**F: 11.5 to 15.5 gm/dL**

**Hematocrit :** Percentage of the volume of whole blood that is made up of red blood cells. (Hint: Hb x 3)

**M: 38 to 54 %**

**F: 34 to 46.5 %**



# MCV and MCHC

➤ **MCV** = mean corpuscular volume

➤  $\text{HCT/RBC count} = 80\text{-}100\text{fL}$

- small = microcytic
- normal = normocytic
- large = macrocytic

➤ **MCH** = mean corpuscular hemoglobin

$\text{Hb/RBC count} = 27\text{-}34 \text{ pg}$

- decreased = hypochromic
- normal = normochromic
- Increased = hyperchromic

# MCHC and RDW

- **MCHC = mean corpuscular hemoglobin concentration**

**Hb/HCT = 32- 36 gm/dl**

- **RDW = red cell distribution width**

*It correlates with the degree of anisocytosis or variation in red blood cell width*

**Normal range from 10-15%**

# Hemoglobin

## Elevated

- Primary erythrocytosis
  - Polycythemia Vera
- Secondary erythrocytosis
  - Chronic hypoxia(COPD, heart disease, high altitude)
  - Elevated erythropoietin due to malignancy

## Low

- Anemia

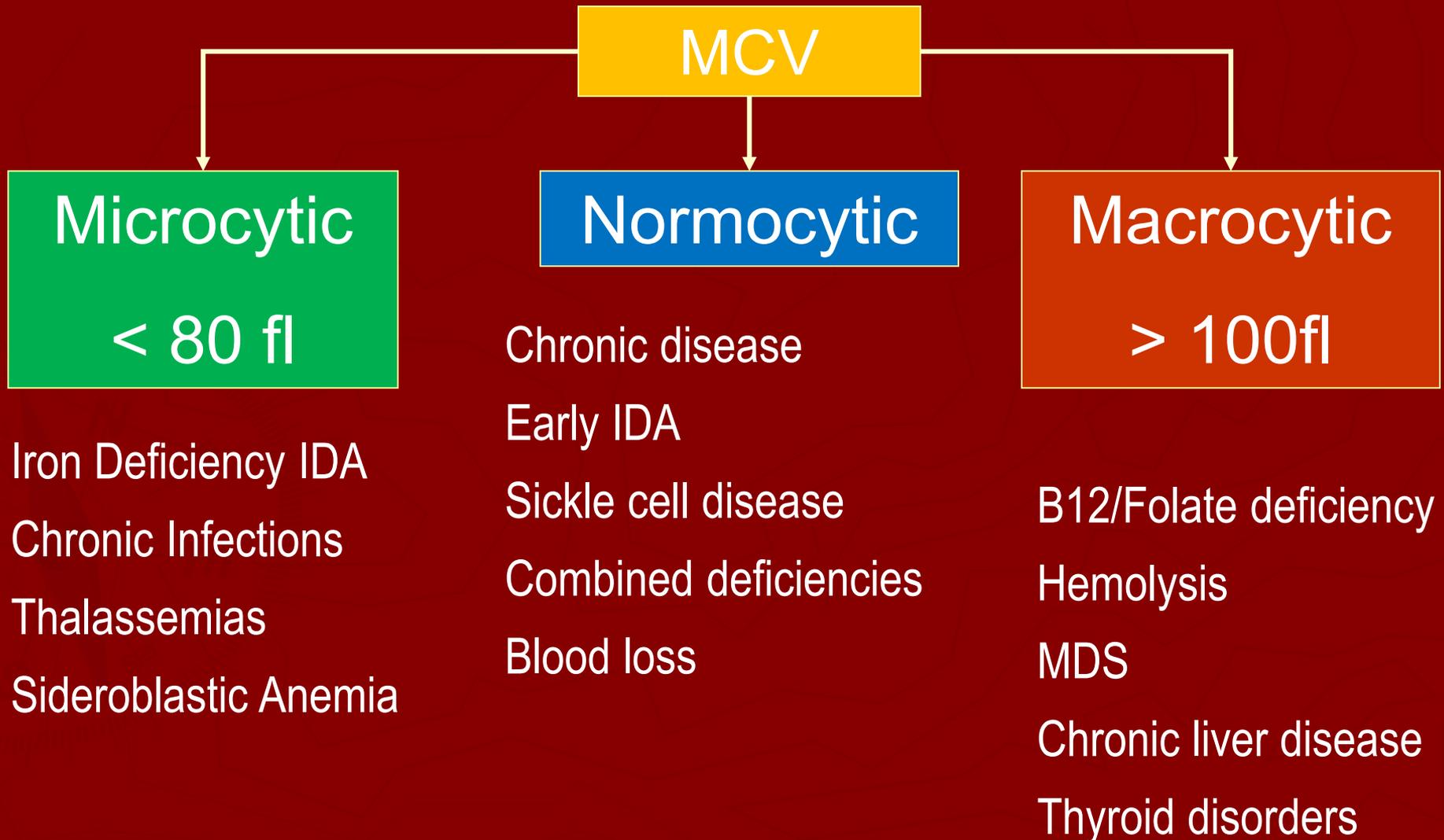
# How to Approach Anemia

- Characteristics and relevant ROS that maybe helpful
  - Fatigue, dyspnea, blood loss, etc
- Assess past medical history for ongoing risk factors such as chronic renal or liver disease, malignancies, and autoimmune disorders
- Any familial risk factors including heritable conditions like Sickle Cell Anemia
- Physical exam findings:
  - Icterus, jaundice, pallor?
  - Presence of flow murmur
  - Lymphadenopathy or organomegaly present?
  - Petechiae, gum bleeding, ecchymoses?

# How to Approach Anemia

- Decreased production of RBC's
  - ex. bone marrow failure, nutritional deficiencies
- Increased destruction of RBC's
  - ex. hemolysis
- Loss of RBC's
  - ex. Bleeding (GI vs GU vs ENT)

# MCV Differential



# Retic Count Differential

ANEMIA

Decreased Production

Increased Destruction

Retics < 2

Retics > 2

Hypoproliferative

Hyperproliferative

- Nutritional deficiencies
- Chronic disease
- Bone marrow failure

Hemolytic anemia  
Chronic blood loss

# Microcytic Anemia

# Iron Deficiency Anemia(IDA)

Iron related tests	Normal	IDA
Serum Ferritin (pmo/L)	33-270	< 33
TIBC ( $\mu\text{g/dL}$ )	300-340	> 400
Serum Iron ( $\mu\text{g/dL}$ )	50-150	< 30
Transferrin Saturation %	30-50	< 10
RDW	10-15%	> 15%
MCH	27-34	<27
Retic count	-	< 2

# STAGES OF IRON DEFICIENCY



<b>Marrow iron</b>	<b>+++</b>	<b>None</b>	<b>None</b>	<b>None</b>
<b>Ferritin</b>	<b>40- 200</b>	<b>20-30</b>	<b>10-15</b>	<b>&lt; 10</b>
<b>MCV</b>	<b>Normal</b>	<b>Normal</b>	<b>Slightly microcytic</b>	<b>Microcytosis</b>
<b>Anemia</b>	<b>Absent</b>	<b>Absent</b>	<b>Absent</b>	<b>Present</b>
<b>TIBC</b>	<b>Normal</b>	<b>Normal</b>	<b>Norma or Increased</b>	<b>Increased</b>
<b>Serum Iron</b>	<b>60- 150</b>	<b>&lt; 40</b>	<b>&lt; 20</b>	<b>&lt; 10</b>
<b>Transferrin Sat %</b>	<b>20-50</b>	<b>30</b>	<b>&lt;15</b>	<b>&lt; 15</b>

# Etiology of Iron Deficiency

- Blood loss
  - GI, menstruation, hemoptysis, dialysis
- Increased iron requirements
  - Pregnancy, erythropoietin therapy
- Inadequate iron supply
  - Poor dietary intake, vegan, malabsorption(IBD, celiac disease, gastric bypass)

# Treatment for IDA

- Oral iron is first line treatment (ferrous sulfate/gluconate)
  - A. Ca-tums, Phosphate, antacids ↓ **absorption**
  - B. Ascorbic acid (orange juice) ↑ **absorption**
- Reserve parenteral Rx. for oral intolerance
- Packed cell transfusion in emergency
- Continue Fe Rx at least 3 months after normal Hb

# Macrocytic Anemia

- - B12(Cobalamin) and Folate deficiency
  - Drugs (hydrea, 5-FU, MTX, HIV meds)
  - Liver disease/alcohol
  - Hypothyroidism
  - Myelodysplastic Syndrome
  - Hemolysis
    - Autoimmune hemolytic anemia
    - Drug induced hemolytic anemia
    - Sickle Cell Anemia

# Etiology of B12/Folate Deficiency

## B12

- Impaired absorption
  - Gastric atrophy, PPI,
    - \*Pernicious anemia, Gastric bypass, Crohn's disease, Celiac disease
- Poor dietary intake
  - Strict vegan
- Defect in transport

## Folate

- Impaired absorption
  - Crohn's disease, Celiac disease, decreased duodenal and ileal absorption
- Poor dietary intake
  - \*Tea and toast diet, Alcoholism
- Increased requirements
  - Pregnancy, hemolysis

# B12 (Cobalamin) Deficiency

- Symptoms : weakness, depression, memory loss, unsteady gait and clumsiness (posterior and later column degeneration)
- Diagnosed by B12 levels < 200 pg/ml
- Methylmalonic acid and homocysteine elevated in early deficiency
- Tx: oral B12 or B12 IM injections

# Folate Deficiency

- Symptoms: Similar to B12 deficiency, except no neurological symptoms
- Diagnosed by folate  $< 2$  ng
- Tx with folate 1-5mg/day

# Normocytic Anemia

1. Chronic disease
2. Early IDA
3. Hemoglobinopathies(SCD)
4. Primary marrow disorders
5. Combined deficiencies( ex: Iron+B12)

# Anemia of Chronic Disease (AOCD)

- Thyroid diseases
- Malignancy
- Collagen Vascular Disease
  - Rheumatoid Arthritis
  - SLE
  - Polymyositis
  - Polyarteritis Nodosa
- IBD
  - Ulcerative Colitis
  - Crohn's Disease
- Chronic Infections
  - HIV, Osteomyelitis
  - Tuberculosis
- Renal Failure

# Iron Deficiency Anemia vs AOCD

	<b>IDA</b>	<b>AOCD</b>
<b>Serum ferritin</b>	<b>Decreased</b>	<b>Normal or increased</b>
Serum Iron	Normal or decreased	Normal or decreased
<b>TIBC</b>	<b>Increased</b>	<b>Normal or decreased</b>
Iron saturation	Decreased	Normal or decreased
MCV	Decreased	Normal or decreased
<b>Bone marrow iron</b>	<b>Decreased</b>	<b>Normal or increased</b>

# White Blood Cells (WBC)

- **WBCs are involved in the immune response**
- The normal range:  $3.5 - 10.5 \times 10^9$  K/L
- **Two types of WBC:**
  - 1) Granulocytes consist of:**
    - Neutrophils: 50 - 70%
    - Eosinophils: 1 - 5%
    - Basophils: up to 1%
  - 2) Agranulocytes consist of:**
    - Lymphocytes: 20 - 40%
    - Monocytes: 1 - 6%

# Neutrophil

**Neutrophilia** – an increase in neutrophils

- **Bacterial infections**
- **Tissue destruction (burns)**
- **Inflammation (SLE, RA, UC)**
- **Thyrotoxicosis**
- **Cigarette smoking**
- **Corticosteroids**
- **B-agonist**
- **Leukemia**



# Neutrophil

**Neutropenia** – a decrease in neutrophils

- **Decreased bone marrow production**
- **Medications (ex. dapsone, cephalosporins)**
- **Immune related (ex. SLE, RA)**
- **Post acute infection (HSV, CMV, HIV, EBV)**

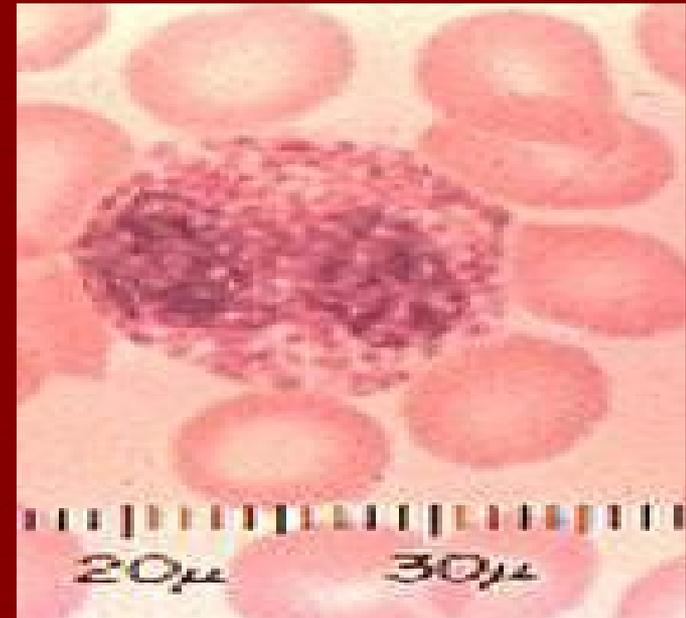
# Eosinophil

Eosinophilia: increased eosinophil count

- **Parasitic infections**
- **Allergic conditions and hypersensitivity reaction**
- **Aspergillosis**
- **Vasculitis**

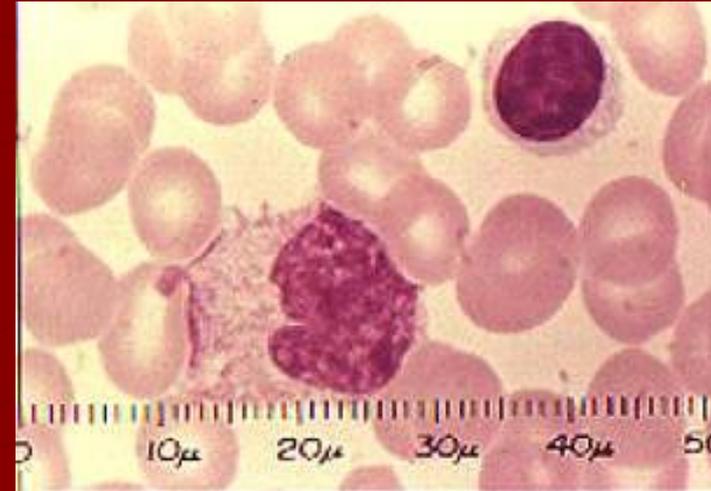
Eosinopenia

- **Sepsis**



# Lymphocyte

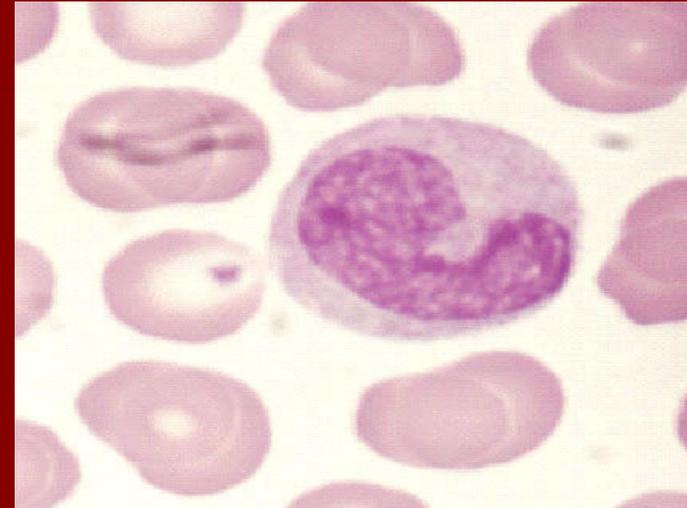
- Lymphocytosis – increased lymphocyte count
  - \_ Viral infection( EBV, CMV, Infectious mononucleosis)
  - Leukemia/Lymphoma (CLL, MCL)
- Lymphopenia – decreased lymphocyte count
  - \_ Medication induced
  - \_ Autoimmune disorder
  - \_ Viral infections



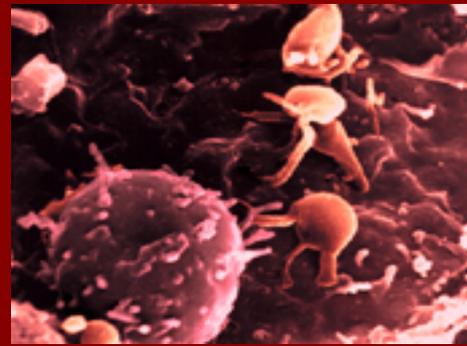
# Monocytes

- Monocytosis
  - Pregnancy
  - TB
  - Syphilis
  - Sarcoid

- Monocytopenia
  - Acute infection
  - Steroids
  - Leukemia (HCL)

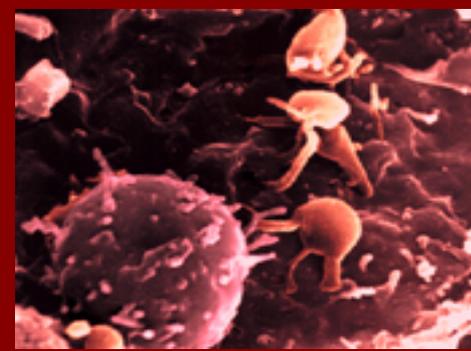


# Platelets



- Platelets/thrombocytes:
  - principal function is to prevent bleeding
- The normal range is 150-400 K/UL

# Platelets



- **Numbers of platelets**
  - **Increased (Thrombocytosis)**
    - Splenectomy
    - Inflammation (Reactive)
    - Myeloproliferative disease (ET)
    - Iron deficiency anemia
  - **Decreased (Thrombocytopenia)**
    - TTP, DIC, ITP, HIT\*\*\*\*\*
    - Blood loss
    - Splenomegaly
    - Medications ( antibiotics)
    - Viral Infections
    - ETOH abuse
    - Chronic liver disease
    - Bone marrow disorder (leukemia)