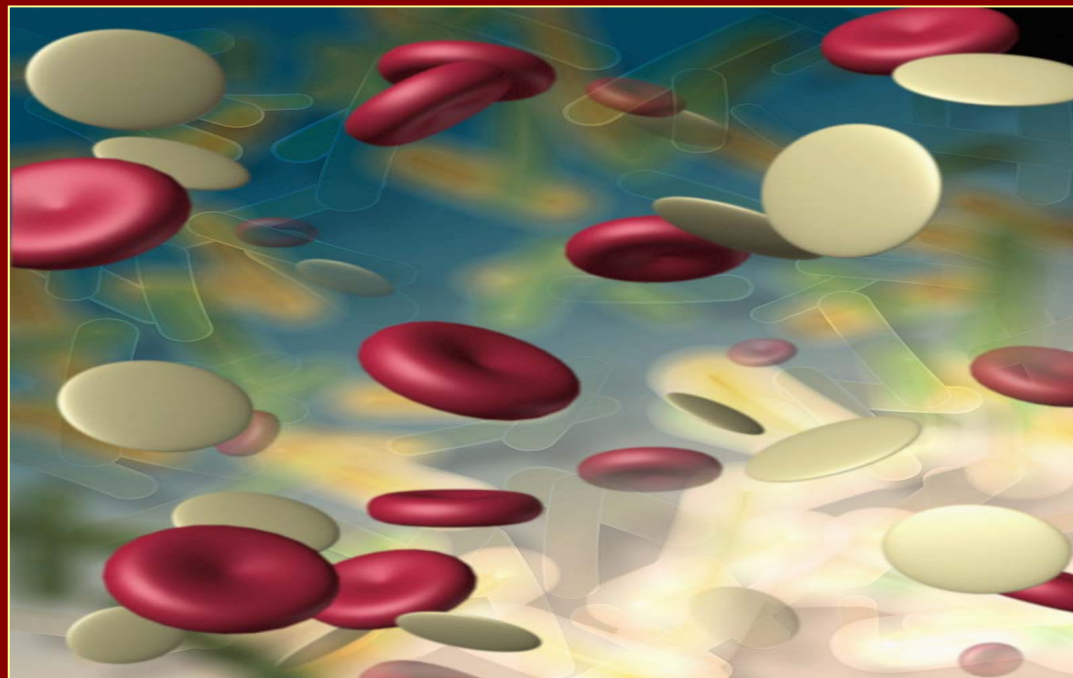


Complete Blood Count



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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 :

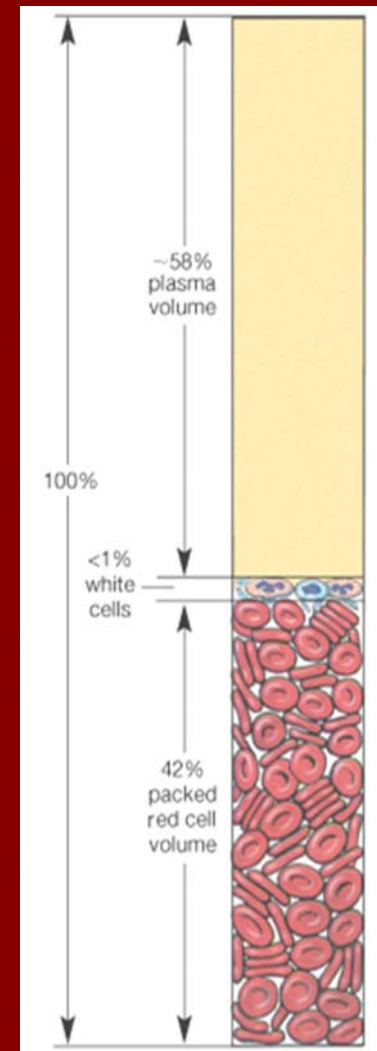
M: 13.0 to 17.5 gm/dL

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
HCT/RBC count = 80-100fL

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

➤ **MCH** = mean corpuscular hemoglobin
Hb/RBC count = 27-34 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 is 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

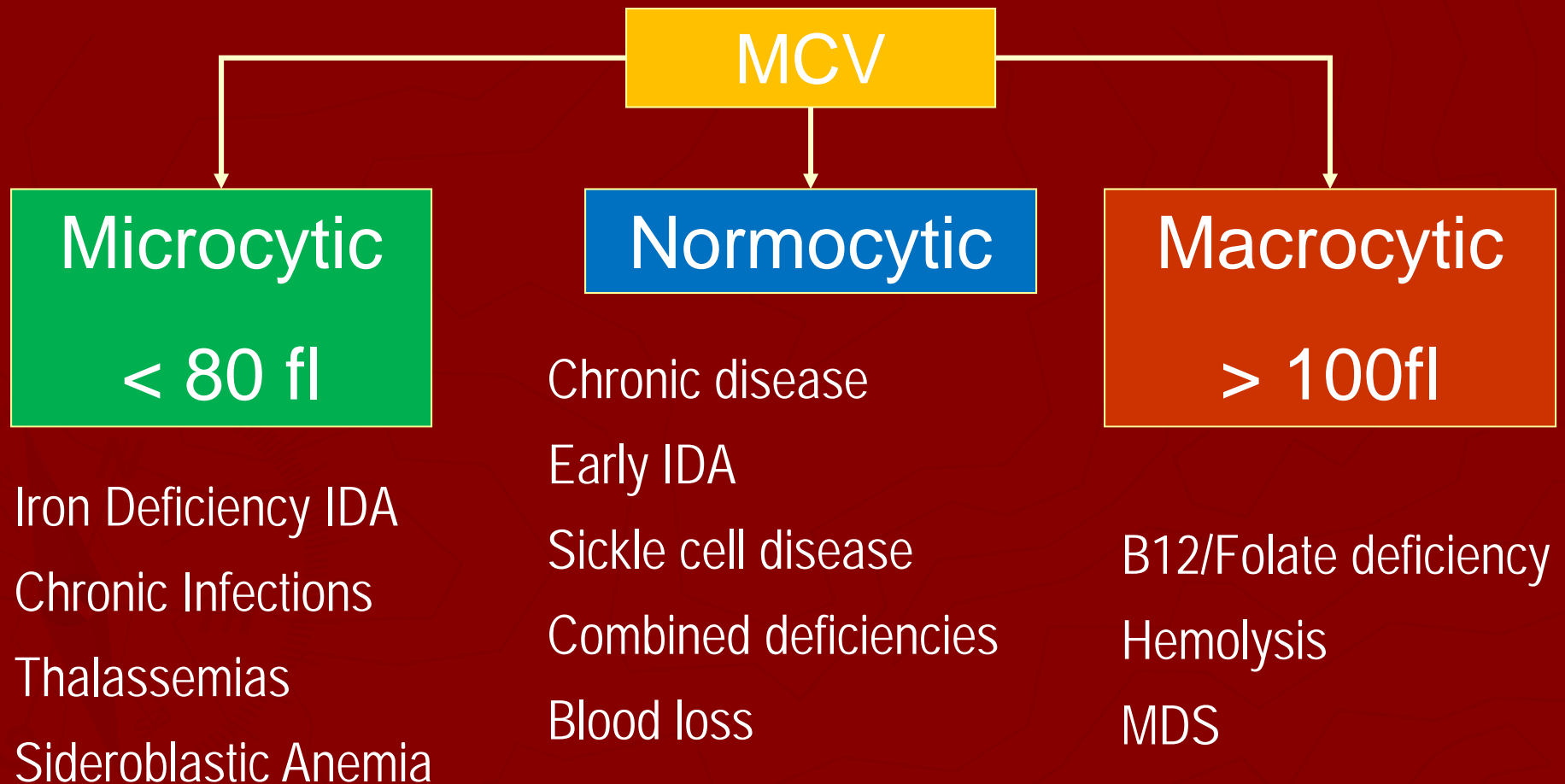
Low

- Anemia

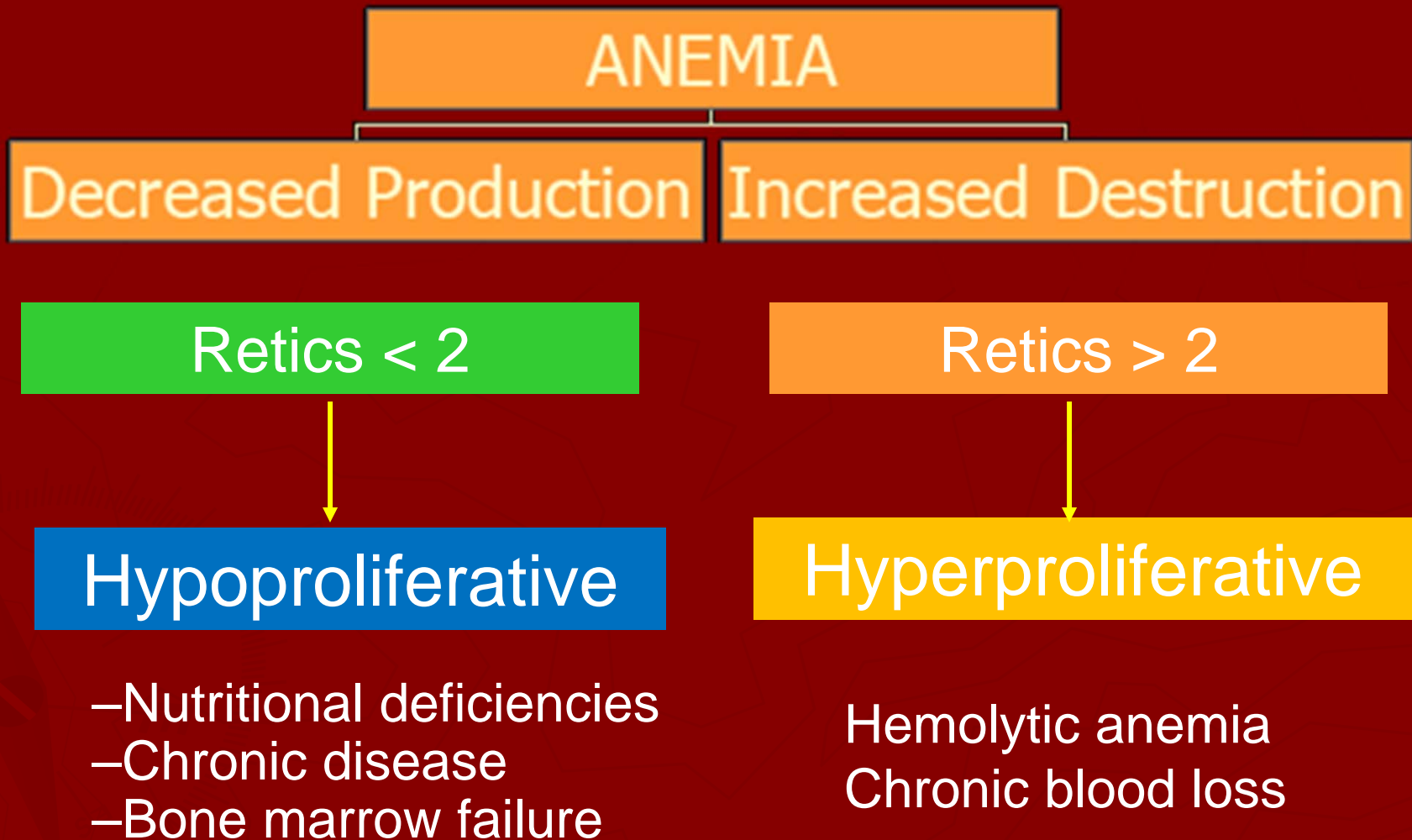
How to Approach Anemia

- Decreased production of RBC's
 - ex. bone marrow failure, nutritional deficiencies
- Increased destruction of RBC's
 - ex. hemolysis
- Loss of RBC's
 - ex. bleeding

MCV Differential



Retic Count Differential



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



Iron stores	Normal	Negative iron balance	Iron-deficient erythropoiesis	Iron-deficiency anemia
Iron stores	+++	None	None	None
Ferritin	40- 200	20-30	10-15	< 10
MCV	Normal	Normal	Slightly microcytic	Microcytosis
Anemia	Absent	Absent	Absent	Present
TIBC	Normal	Normal	Normal or Increased	Increased
Serum Iron	60- 150	< 40	< 20	< 10
Transferrin Sat %	20-50	30	<15	< 15

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

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 lateral columns 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

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

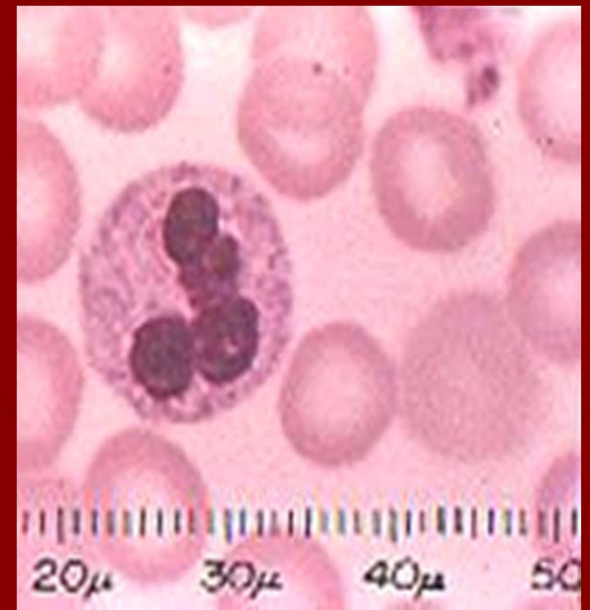
White Blood Cells (WBC)

- **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)**

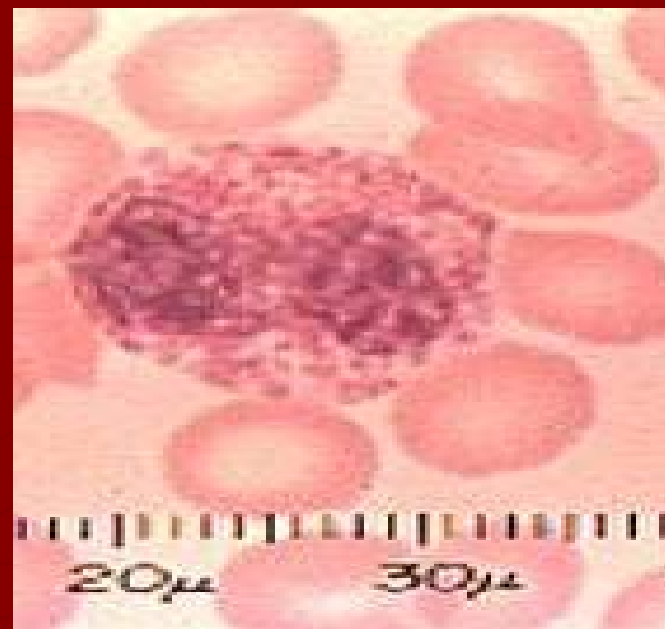
Eosinophil

Eosinophilia: increased eosinophil count

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

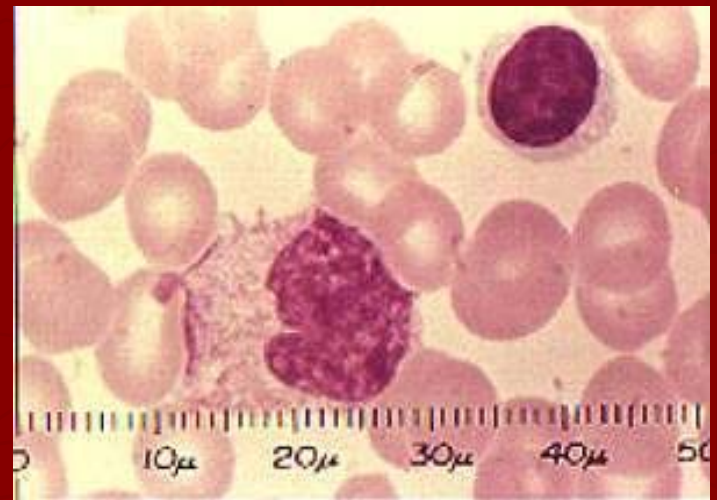
Eosinopenia

- **Sepsis**



Lymphocyte

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

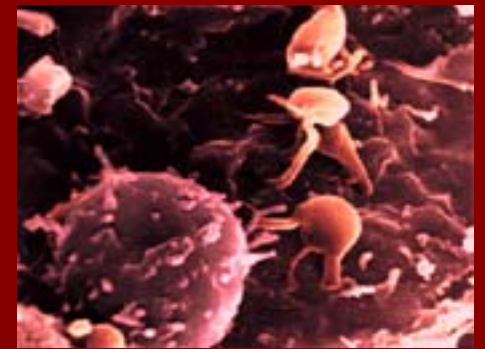


Monocytes

- Monocytosis
 - Pregnancy
 - TB
 - Syphilis
 - Sarcoid
- Monocytopenia
 - Acute infection
 - Steroids
 - Leukemia

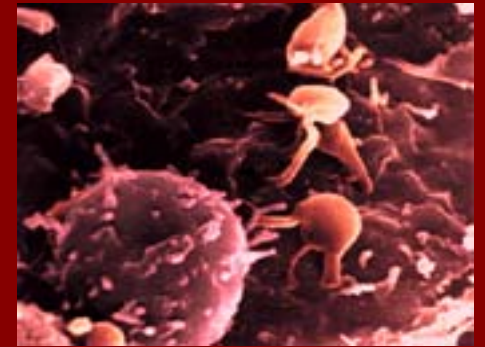


Platelets



- 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
 - Bone marrow disorder (leukemia)