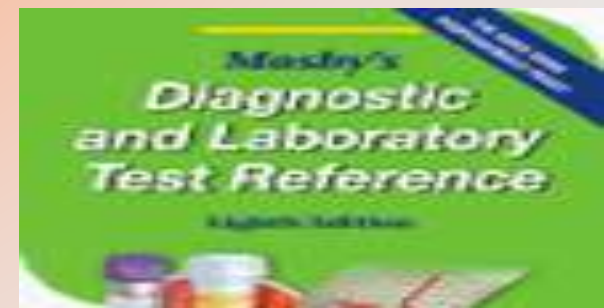


In the name of GOD

Interpretation of laboratory results

Dr Mehnoosh samady



مقدمه:

▶ ارزیابی وضع تغذیه به حل یک «پازل» می ماند که از چهار بخش اصلی داده های «بالینی»، «تن سنجی»، «رژیمی» و «آزمایشگاهی» تشکیل یافته و هر بخش نیز خود به مثابه یک «پازل» جداگانه است که از قطعات کوچکتری تشکیل یافته است. تنها با «درست» قرار دادن قطعات بخشهای مختلف این «پازل» است که «تصویر» صحیحی از «تابلوی بالینی» بیمار به دست می آید، «تابلویی» که از بیماری به بیمار دیگر متفاوت است و بر مبنای آن می توان مداخلات تغذیه ای را برای هر بیمار طراحی کرد **individualized nutritional intervention**

▶ به طور مثال، در بیمار بزرگسال مبتلا به ضربه مغزی head
intensive (neuro)trauma که در بخش مراقبتهای ویژه
care unit (ICU) از ۱۰ روز پیش بستری است و از ۳ روز پیش از
طریق لوله بینی-معدی تغذیه می شود (tube feeding):

۱- **رخداد اسهال** در ۱۲ ساعت پیش ضرورتاً به گلاوژ ربطی ندارد چه امکان دارد روز پیش به دلیل وقوع تب، پزشک معالج درخواست مشاوره با متخصص عفونی را داده و ایشان نیز نوعی آنتی بیوتیک وسیع الطیف را برای بیمار شروع کرده باشد و اسهال ناشی از واکنش بیمار به دارو باشد. از سویی دیگر، تا زمانی که بیمار از راه دهان غذایی دریافت نمی کند (NPO)، طبعاً تعداد دفعات دفع **defecation** نیز محدود خواهد بود ولی با شروع تغذیه روده ای، تعداد دفعات دفع افزایش می یابد که لزوماً «اسهال» نخواهد بود.

▶ کاهش وزن ظاهری بیمار (به ویژه در جایی که امکان توزین بیمار بر روی تخت وجود نداشته باشد) ضرورتاً به معنای شتاب یافتن دفع ازت (تعادل ازتی منفی) و به عبارتی کاتابولیسم نیست و امکان دارد ناشی از کاهش احتباس آب در بیمار به دنبال کنترل التهاب باشد.

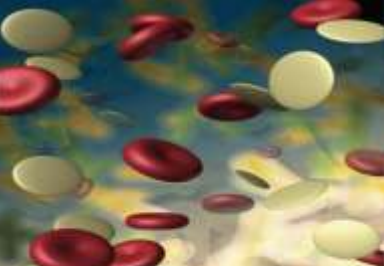
▶ اینکه همراه بیمار می گوید که بیمار پیش از این حادثه گاه و بیگاه شیر می نوشیده است و ظاهراً مشکلی هم با آن نداشته است ضرورتاً به این معنا نیست که اینک نیز به خوبی آن را تحمل می کند چه در بسیاری از آسیبها بیان ژن لاکتاز در روده ممکن است به نحو چشمگیری کاهش یابد.

▶ اندکی افزایش قند خون (مثلاً $\text{FBS: } 132\text{mg/dL}$) ضرورتاً به معنای ابتلای بیمار به دیابت و نیاز او به یک فرمول غذایی «دیابتی» نیست چه اولاً در چنین بیماری با وجود یک رگِ باز **IV line** که مستمراً از آن محلولهای وریدی تجویز می شود، بیمار به معنای واقعی کلمه «ناشتا» **fasting** نیست و ثانیاً در آسیبها به دلیل واکنش مرحله حاد **acute phase reaction (APR)** یک حالت مقاومت به انسولین **insulin resistance** پدید می آید که به تدریج با درمان بیمار و کنترل التهاب (عفونت) از میان می رود.

► پس در این حال می باید اطلاعات (بخشهای مختلف پازل) بالینی، تن سنجی، رژیم (که در بخشهای مراقبتهای ویژه خیلی به ندرت به آن دسترسی دارید) و آزمایشگاهی جداگانه و در کنار هم تحلیل شوند تا تصویر (پازل) نهایی به دست آید و سپس بر مبنای آن مداخلات تغذیه ای مناسب را انجام داد.

Component of the CBC:

- **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)**
 - **White blood cell types (WBC differential)**
- **Platelet**



Complete Blood Count (CBC)

- WBC: White Blood Cells: 4,000 - 10,000 / mm³
- RBC: Red Blood Cells: 4.2 - 5.9 million / mm³
- Hb.: Hemoglobin: Males: 14 - 18 g / dL
Females: 12 - 16 g / dL
- Hematocrit: Males: 40 - 54%
Females: 37 - 47%
- MCV: Mean Corpuscular Volume: 86 - 98 μm³ / cell
- MCH: Mean Corpuscular Hemoglobin: 27 - 32 μg / RBC
- RDW: Red Cell Distribution Width – 11.5-14.5
- Platelet Count: 150,000 - 400,000 / mm³
- WBC Differential:

Neutrophils:	40-75%
Lymphocytes:	15-45%
Monocytes:	1-10%
Eosinophils:	1-6%
Basophils:	0-2%

(c) 2006, Kanchan Ganda, M.D.

MCV: حجم متوسط گلبولهای قرمز: کاهش در فقر آهن ب ۱۲ و فولات- نخوردن گوشت قرمز و منابع حیوانی
MCH: غلظت خون یا متوسط هموگلوبین گلبول قرمز
MCHC میانگین وزن هموگلوبینی

objectives



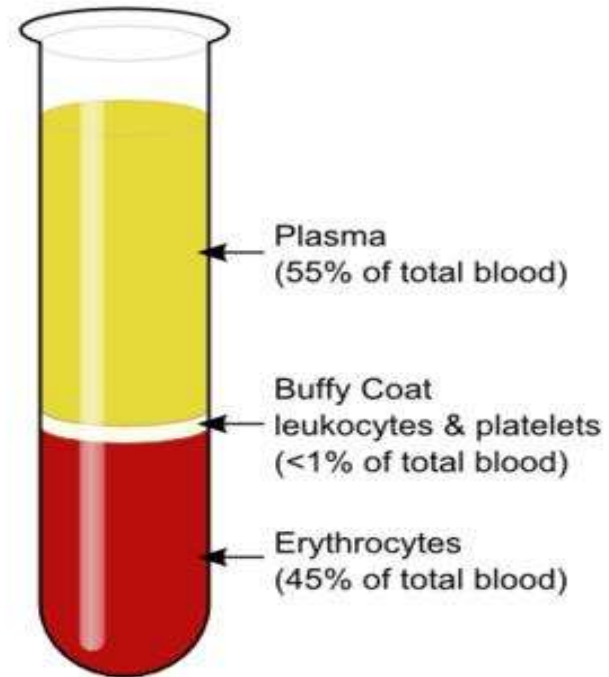
The CBC interpretation are useful in the diagnosis of **various types of anemia.**

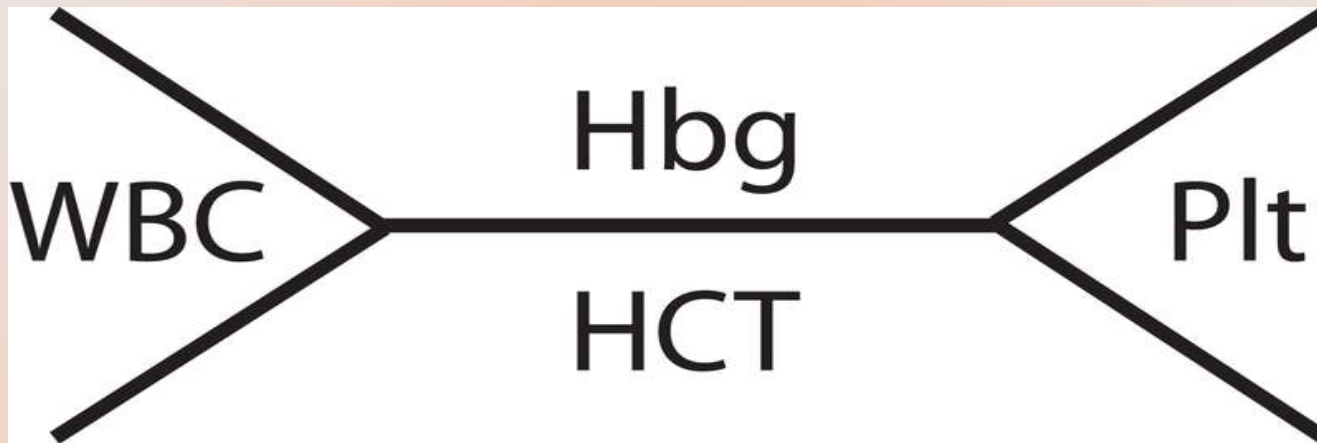


It can reflect acute or chronic **infection, allergies, inflammation, bleeding disorder, leukemia and problems with clotting.**

Many factors that may affect CBC parameters:

- Gender
- Ethnic differences
- Medication
- Alcohol
- Infections
- Pregnancy
- Iron deficiency
- Thalassemia





Schematics ("Fishbones")
shorthand for complete blood count commonly used by clinicians.

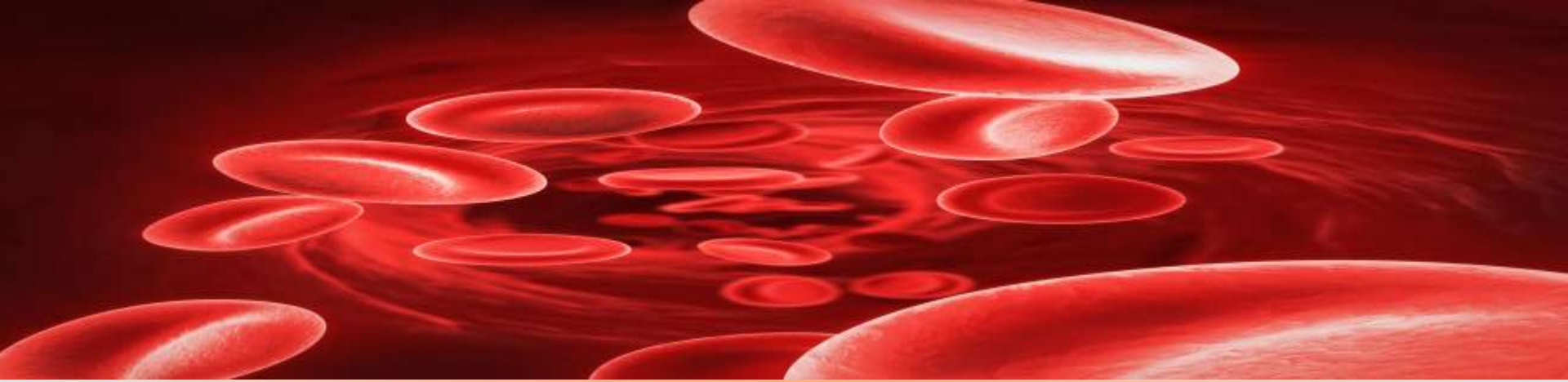
[Reference range](#)

WBC: $3.5-11 \times 10^9/L$

Hgb: 120-175 g/L

Hct: 31-53%

Plt: $140-450 \times 10^9/L$



RBC:

- Biconcave disc shape with diameter of about 8 μm
- Life span 100-120 days.

Function:

- Transport hemoglobin which carries oxygen from the lung to the tissues
- Acids-bases buffer

M: 4.7 to 6.1 $\times 10^{12}/\text{L}$

F: 4.2 to 5.4 $\times 10^{12}/\text{L}$

Hemoglobin & Hematocrit

The protein contained in red blood cells that is responsible for delivery of oxygen to the tissues

Measures the volume of red blood cells compared to the total blood volume

Normal ranges

Hemoglobin :

- Male: 14 to 18 gm/dL
- Female: 12 to 16 gm/dL
- Pregnancy: >11 gm/dl

Hematocrit :

- Male: 40.7 to 50.3 %
- Female: 36.1 to 44 %
- Pregnancy: >33 %

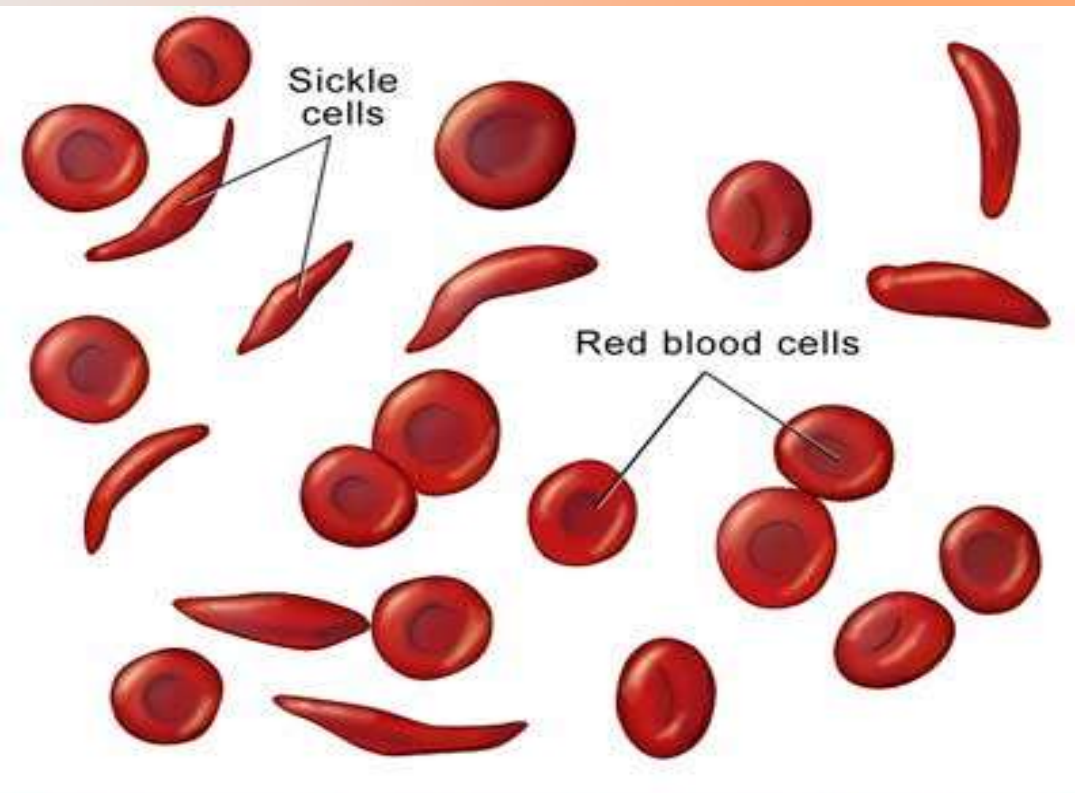
If the **RBC** and the **hemoglobin** are both normal, *the Hematocrit is approximately 3 times the Hemoglobin*

Increased Hgb

- ▶ High altitudes
- ▶ Smoking
- ▶ Dehydration
- ▶ Tumors

Decreased Hgb

- ▶ Loss of blood
- ▶ Nutritional deficiency
- ▶ Bone marrow problems
- ▶ Chemotherapy
- ▶ Kidney failure
- ▶ Abnormal hemoglobin
(such as that of sickle-cell
disease)



Increased Hct

- Erythrocytosis
- Polycythemia
 - Heart Disease
 - Chronic Hypoxia
- High Altitude
- Hemoconcentration
 - Surgery
 - Burns
 - Dehydration
- ▶ Congenital heart disease
- ▶ Pulmonary fibrosis

Decreased Hct

- ▶ Anemia
- ▶ Destruction of red blood cells
- ▶ Leukemia
- ▶ Overhydration
- ▶ Pregnancy
- ▶ Cirrhosis
- ▶ Bleeding
- ▶ Nutritional deficiencies of iron, folate, vit B12, vit B6
- ▶ Bone marrow failure
- ▶ Kidney disease

MCV&MCH

MCV

mean corpuscular volume

$\text{HCT} \times 10 / \text{RBC count} = 80-100\text{fL}$

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

MCH (mean corpuscular hemoglobin)

$\text{HB} \times 10 / \text{RBC} = 27-32 \text{ pg}$

MCHC & RDW

MCHC= mean corpuscular hemoglobin concentration

$HB \times 100 / HCT(\%) = 26-34\%$

- **decreased = hypochromic**
- **normal = normochromic**

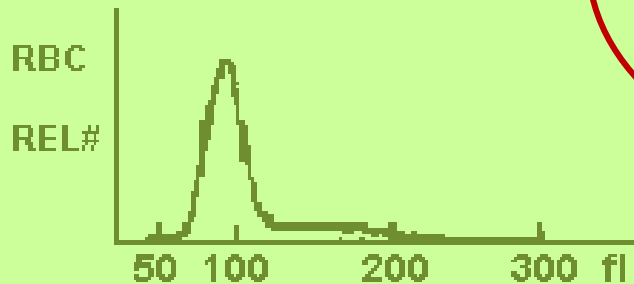
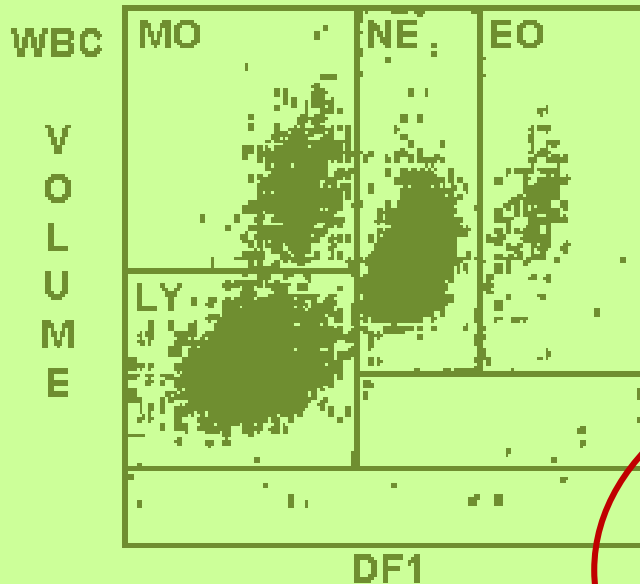
RDW (red cell distribution width)

**It is correlates with the degree of anisocytosis (غیر ہم
اندازگی)**

Normal range from 10-15%

Analytes	Reference Range*	Significance
Red blood cells	4.7-6.1 $\times 10^6/\mu\text{L}$ (males); 4.7-6.1 $10^{12}/\text{L}$ 4.2-5.4 $\times 10^6/\mu\text{L}$ (females); 4.2-5.4 $10^{12}/\text{L}$	In addition to nutritional deficits, may be decreased in those with hemorrhage, hemolysis, genetic aberrations, marrow failure, or renal disease or who are taking certain drugs; not sensitive for iron, vitamin B ₁₂ , or folate deficiencies
Hemoglobin concentration	14-18 g/dL; 8.7-11.2 mmol/L (males) 12-16 g/dL; 7.4-9.9 mmol/L (females) >11 g/dL; >6.8 mmol/L (pregnant females) 14-24 g/dL; 8.7-14.9 mmol/L (newborns)	In addition to nutritional deficits, may be decreased in those with hemorrhage, hemolysis, genetic aberrations, marrow failure, or renal disease or who are taking certain drugs; not sensitive for iron, vitamin B ₁₂ , or folate deficiencies
Hematocrit	42%-52% (males) 35%-47% (females) 33% (pregnant females) 44%-64% (newborns)	In addition to nutritional deficits, may be decreased in those with hemorrhage, hemolysis, genetic aberrations, marrow failure, or renal disease or who are taking certain drugs; not sensitive for iron, vitamin B ₁₂ , or folate deficiencies
MCV	80-99 fL 96-108 fL (newborns)	Decreased (microcytic) in presence of iron deficiency, thalassemia trait and chronic renal failure, anemia of chronic disease; increased (macrocytic) in presence of vitamin B ₁₂ or folate deficiency and genetic defects in DNA synthesis; neither microcytosis nor macrocytosis sensitive to marginal nutrient deficiencies

Normal CBC



WBC	6.8	
	%	#
NE	52.6	3.6
LY	36.7	2.5
MO	7.8	0.5
EO	2.5	0.2
BA	0.4	0.0
RBC	5.29	
HGB	16.2	
HCT	47.0	
MCV	88.8	
MCH	30.7	
MCHC	34.5	
RDW	12.5	
PLT	179	
MPV	8.4	

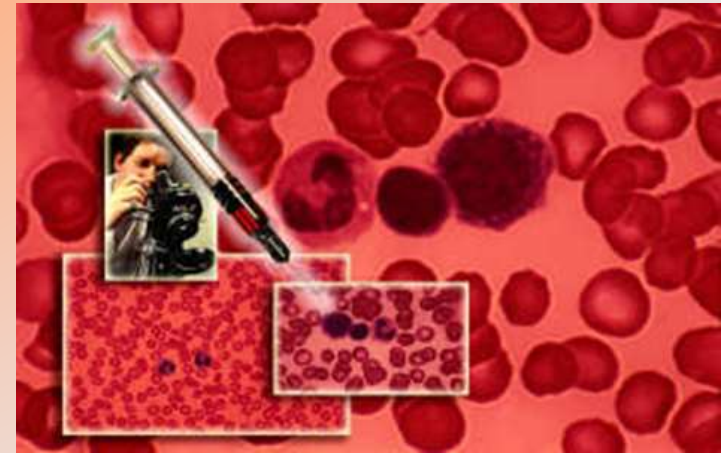
Anemia

Reduction in the number of circulating red blood cell mass and there by O₂ carrying capacity

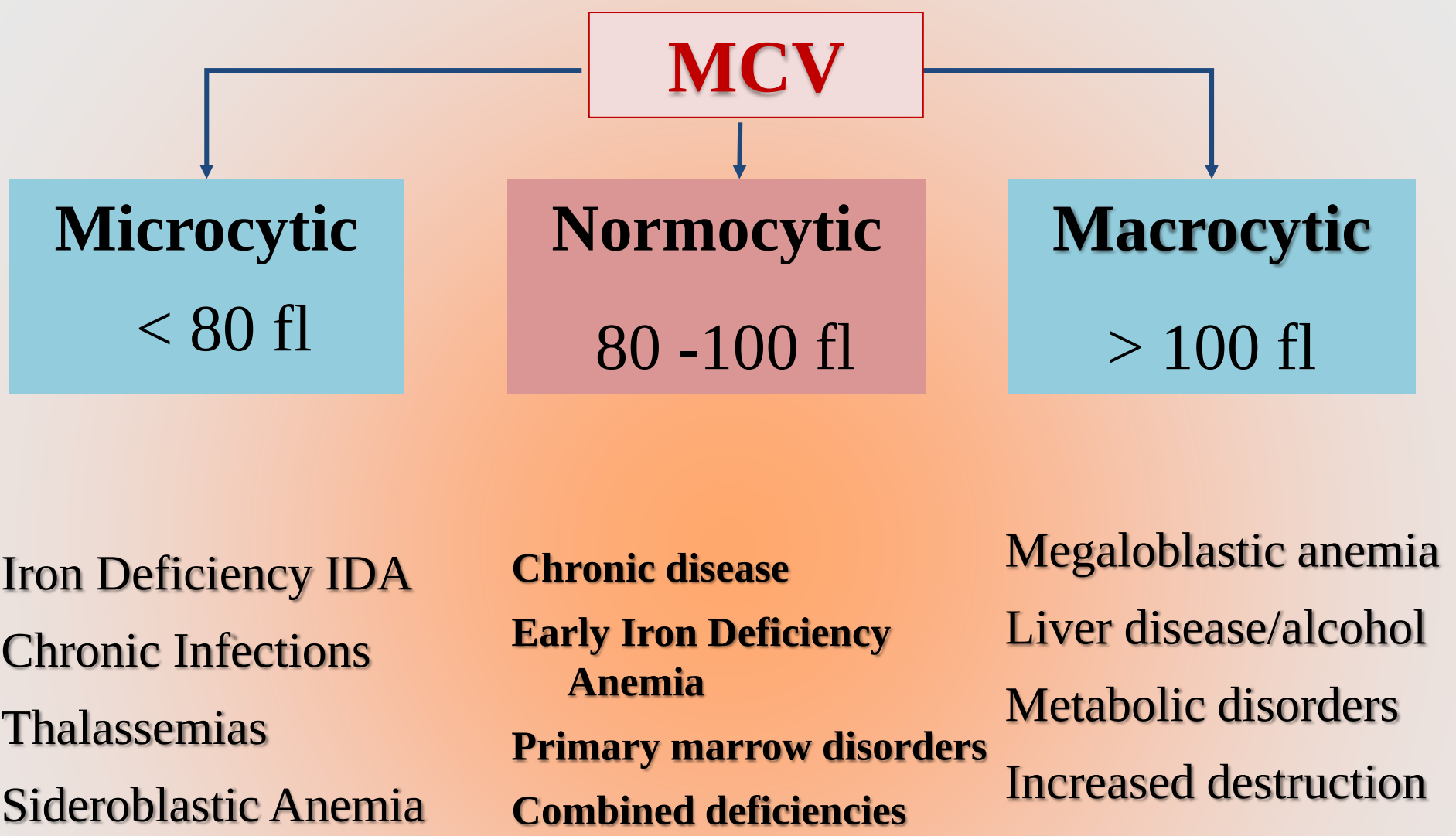
Hgb concentration below the 95th percentile for healthy reference.

Nutritionists must distinguish between anemia caused by:

**nutritional inadequacies
that caused by other factors.**



MCV



```
graph TD; MCV[MCV] --> Microcytic[Microcytic<br/>< 80 fl]; MCV --> Normocytic[Normocytic<br/>80 -100 fl]; MCV --> Macrocytic[Macrocytic<br/>> 100 fl];
```

Microcytic

< 80 fl

Iron Deficiency IDA

Chronic Infections

Thalassemias

Sideroblastic Anemia

Normocytic

80 -100 fl

Chronic disease

**Early Iron Deficiency
Anemia**

Primary marrow disorders

Combined deficiencies

Macrocytic

> 100 fl

Megaloblastic anemia

Liver disease/alcohol

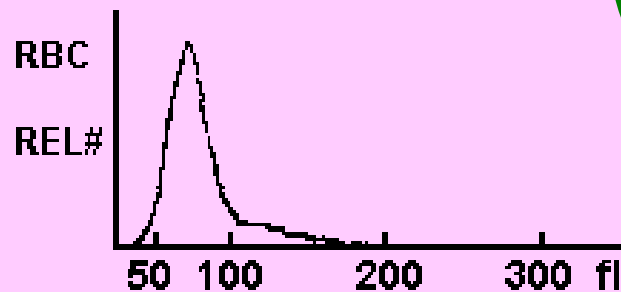
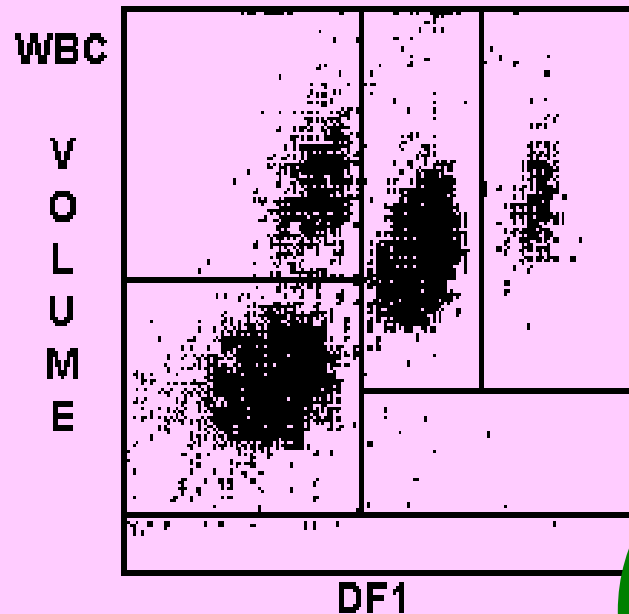
Metabolic disorders

Increased destruction

Tests for Iron Deficiency Anemias

- Hemoglobin (Hgb)
- Hematocrit (Hct)
- MCV
- MCH
- MCHC
- RDW

Iron Deficiency Anemia -CBC



WBC	5.5	
	%	#
NE	54.7	3.0
LY	34.1	1.9
MO	7.5	0.4
EO	3.0	0.2
BA	0.7	0.0

RBC	4.28	L
HGB	9.7	L
HCT	29.9	L
MCV	69.7	L
MCH	22.6	L
MCHC	32.4	L
RDW	18.4	H

PLT	331
MPV	8.8

Serum Ferritin

- Direct measure of all **proteins available to bind mobile iron**
- **depends on the number of free binding sites on the plasma iron-transport protein (transferrin).**

Serum Iron

- Serum iron measures the amount of circulating iron that is bound to transferrin.
- it is a **relatively poor index** of iron status because of large **day-to-day changes**, even in healthy individuals. (highest concentrations occurring from 6 to 10AM)
- Averaging 30% less than the morning level, occurring midafternoon.

Total Iron-Binding Capacity

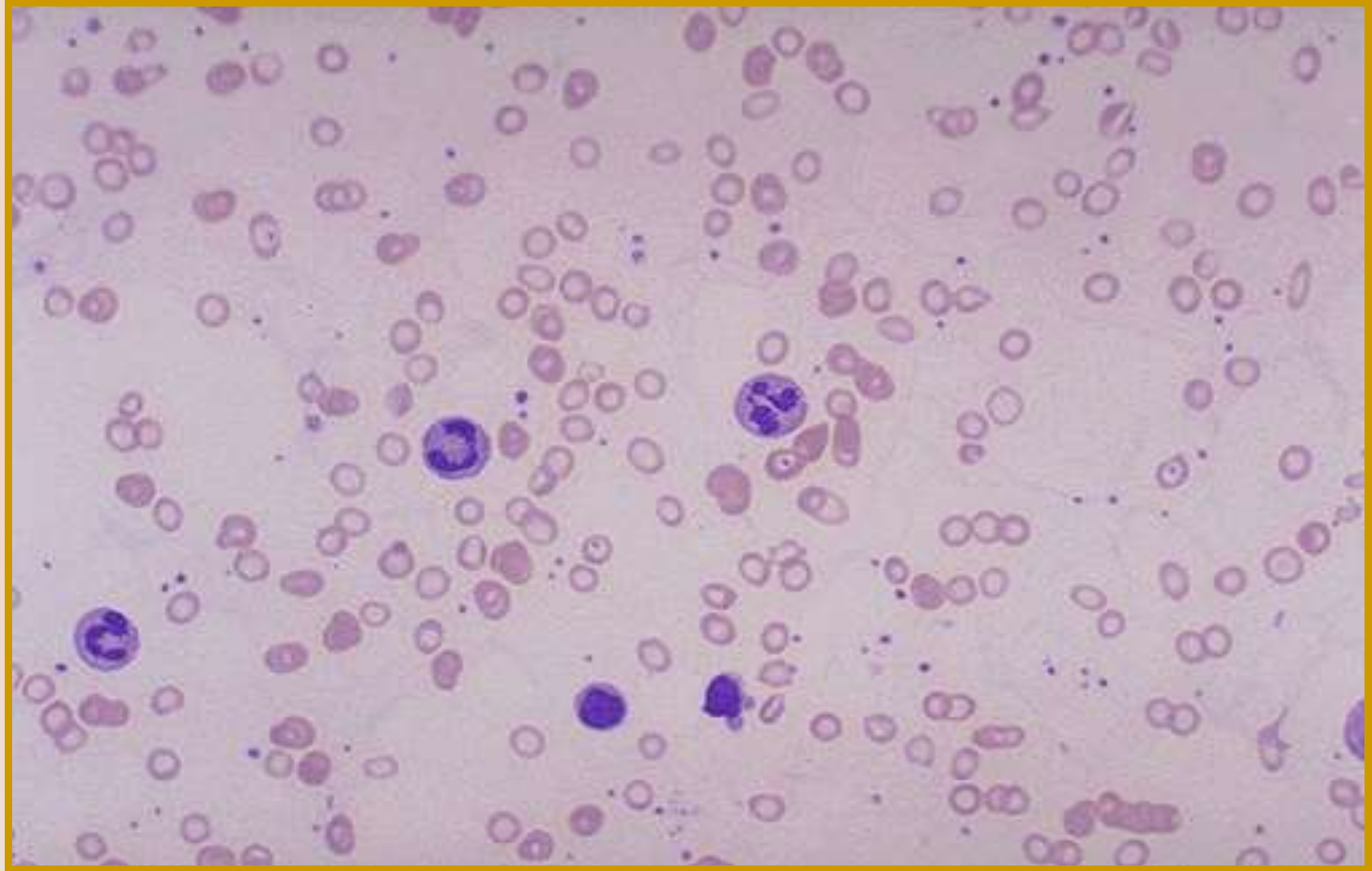
- Direct measure of all proteins available to bind mobile iron
- Depends on the number of free binding sites on the plasma transferrin.

Iron Deficiency Anemia – Special Tests



Iron related tests	Normal	IDA
Serum Ferritin (pmo/L)	33-270	< 33
TIBC (µg/dL)	300-340	> 400
Serum Iron (µg/dL)	50-150	< 30
Saturation %	30-50	< 10
Bone marrow Iron	++	Absent

Microcytic Hypochromic - IDA



Microcytic Anaemias

MCV < 80 fl	Serum Iron	TIBC
Iron Def. Anemia	↓↓	↑↑
Chronic Infection	↓↓	↓↓
Thalassemia	↑↑	N
Hemoglobinopathy	N	N
Lead poisoning مسمومیت سرب	N	N
Sideroblastic	↑↑	N

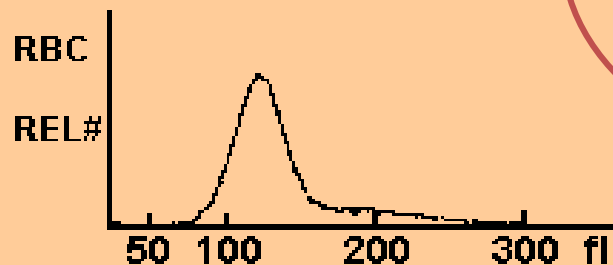
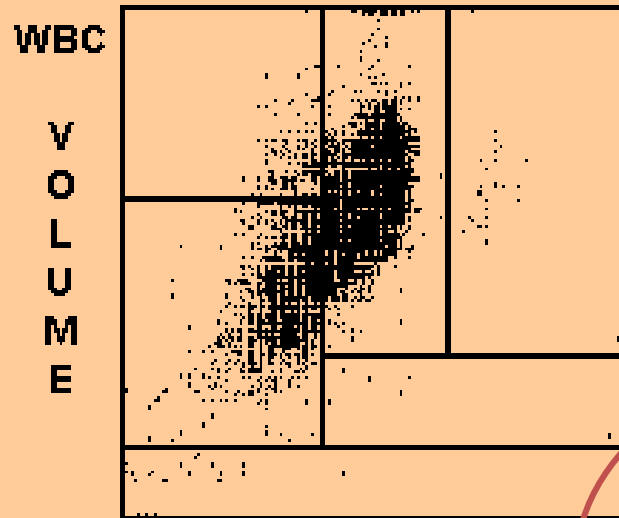
Macrocytic Anaemias

A. Megaloblastic Macrocytic – B12 and Folate↓

B. Non Megaloblastic Anaemias

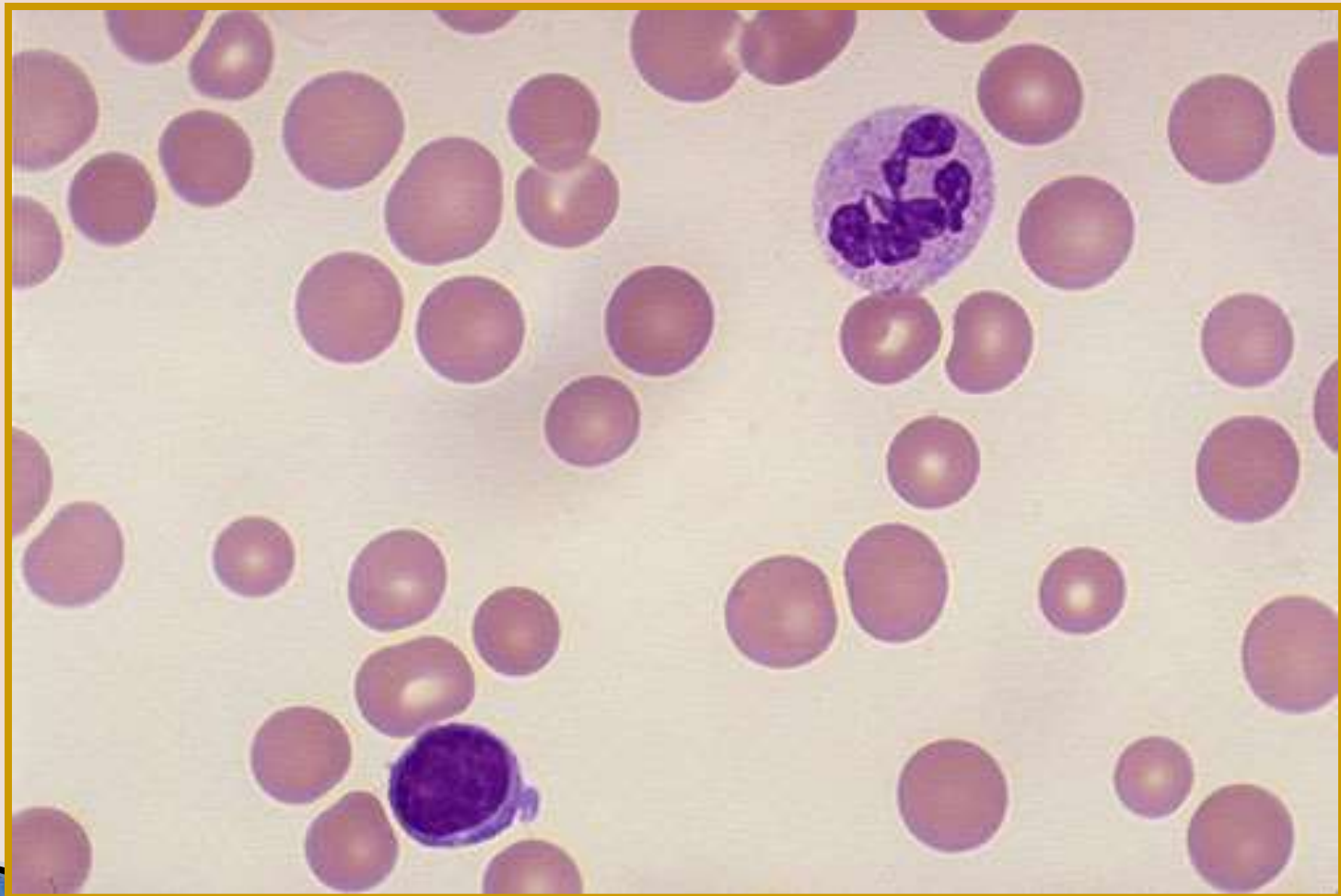
- i. Liver disease/alcohol**
- ii. Hemoglobinopathies**
- iii. Metabolic disorders, Hypothyroidism**
- iv. Myelodystrophy, BM infiltration**
- v. Drugs (cytotoxics, immunosuppressants ,...)**

Megaloblastic Anemia



WBC	12.1	H		
	%		#	
NE	71.1	H	8.5	H
LY	15.9	L	1.9	
MO	3.3		0.5	
EO	0.5	L	0.1	
BA	8.7	H	1.1	H
RBC	2.69	L		
HGB	10.6	L		
HCT	31.6	L		
MCV	117.6	H		
MCH	39.6	H		
MCHC	33.7			
RDW	14.1			
PLT	578	H		
MPV	7.2	L		

Macrocytosis –Megaloblastic A



Normocytic Anaemias

- I. Chronic disease**
- II. Early Iron Deficiency Anemia**
- III. Hemoglobinopathies**
- IV. Primary marrow disorders**
- V. Combined deficiencies**
- VI. Increased destruction**
- VII. Anaemia of investigations -ICU**

White Blood Cells

- **WBCs are involved in the immune response.**
- **The normal range: $4 - 11 \times 10^9 /L$**

Two types of WBC:

Granulocytes consist of:

- **Neutrophils: 50 - 70%**
- **Eosinophils: 1 - 5%**
- **Basophils: up to 1%**

Agranulocytes consist of:

- **Lymphocytes: 20 - 40%**
 - **Monocytes: 1 - 6%**

White Blood Cells

The type of cell affected depends upon its primary function:

In **bacterial infections**, **neutrophils** are most commonly affected

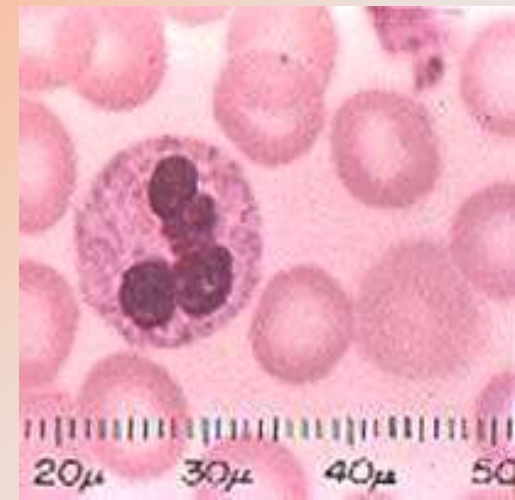
In **viral infections**, **lymphocytes** are most commonly affected

In **parasitic infections**, **eosinophils** are most commonly affected.

Neutrophils

Function: Phagocytosis of bacteria and cell debris

- Numbers rise with all manner of stress, especially bacterial infections
- Conditions associated with neutrophilia (افزایش نوتروفیل) are:
 - ❑ Bacterial infections (most common cause)
 - ❑ Tissue destruction
 - ❑ leukemoid reaction
 - ❑ Leukemia



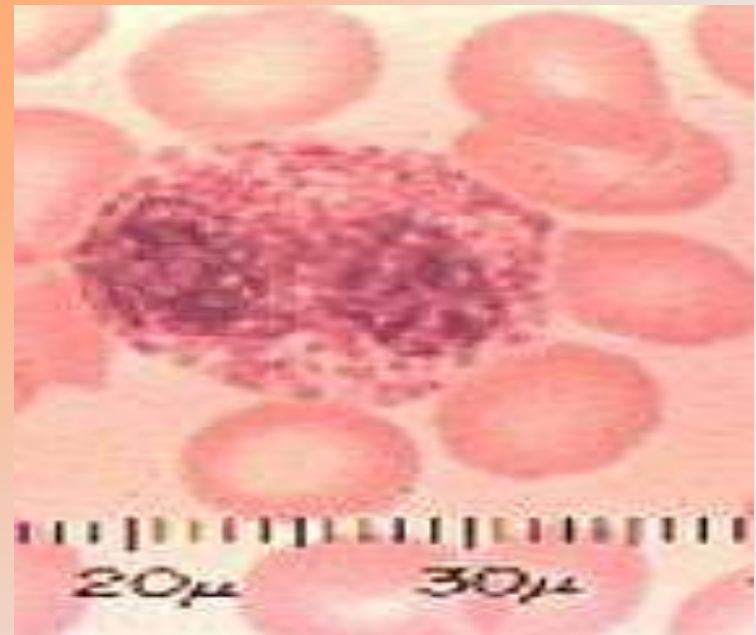
Neutropenia(کاهش نوتروفیل)

- ❑ Decreased bone marrow production, BM hypoplasia.**
- ❑ In effective bone marrow production**
- ❑ megaloblastic anemias**
- ❑ typhoid fever(تب تیفوئید)**
- ❑ brucellosis(تب مالت).**

Eosinophil

Function: Parasitic infections

- Allergic conditions
- hypersensitivity reaction

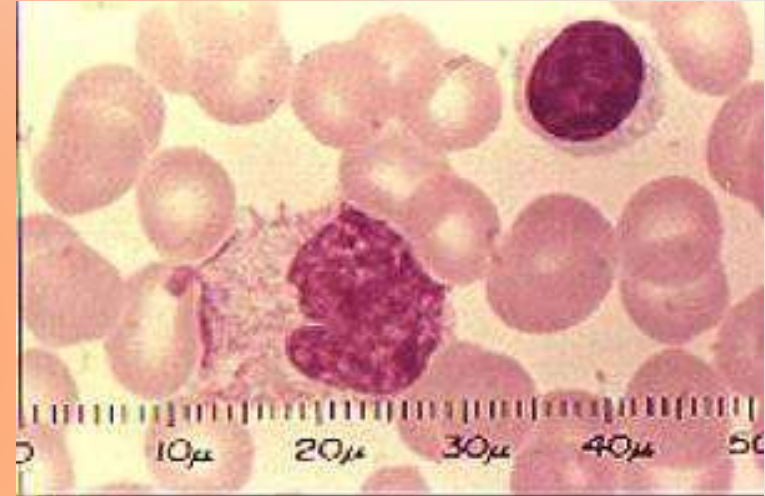


Lymphocyte

I. T cells: cellular (for viral infections)

II. B cells: humeral (antibody)

III. Natural Killer Cells



Lymphocytosis: Viral infection, Bacterial infection

Lymphopenia : Stress, Steroid therapy , Irradiation

Abnormal result of WBC

Leukocytosis:

- ❑ Infectious diseases
- ❑ Inflammatory disease (rheumatoid arthritis or allergy)

Leukemia

- ❖ Severe emotional or physical stress
- ❖ Tissue damage (e.g. necrosis, or burns)

Leukopenia:

- Decreased WBC production from Bone Marrow.
- Irradiation.
- Exposure to chemical or drugs.

Causes for abnormalities in the white blood cell (WBC) differential count

Type of WBC and normal differential count	Elevated	Decreased
Neutrophils 55-70%	Neutrophilia Physical or emotional stress Acute suppurative infection Myelocytic leukemia Trauma Cushing's syndrome Inflammatory disorders Metabolic disorders	Neutropenia Aplastic anemia Dietary deficiency Overwhelming bacterial infection Viral infections Radiation therapy Addison's disease Drug therapy: myelotoxic drugs (as in chemotherapy)
Lymphocytes 20-40%	Lymphocytosis Chronic bacterial infection Viral infection Lymphocytic leukemia Multiple myeloma Infectious mononucleosis Radiation Infectious hepatitis	Lymphocytopenia Leukemia Sepsis Immunodeficiency diseases Lupus erythematosus Later stages of HIV infection Drug therapy: adrenocorticosteroids, antineoplastic Radiation therapy
Monocytes 2-8%	Monocytosis Chronic inflammatory disorders Viral infections Tuberculosis Chronic ulcerative colitis Parasites	Monocytopenia Drug therapy: prednisone
Eosinophils 1-4%	Eosinophilia Parasitic infections Allergic reactions Eczema Leukemia Autoimmune diseases	Eosinopenia Increased adrenosteroid production
Basophils 0.5-1.0%	Basophilia Myeloproliferative disease (e.g., myelofibrosis, polycythemia rubra vera) Leukemia	Basopenia Acute allergic reactions Hyperthyroidism Stress reactions

SOURCE: Pagana, K.D. and T.J. Pagana. *Mosby's Diagnostic and Laboratory Test Reference*. 3rd ed. St. Louis: Mosby, 1997.

Platelets



- ▶ **Small granular non-nucleated discs.**
- ▶ **Diameter about 2-4 μm**
- ▶ **Normal range; $150-300 \times 10^9 / \text{L}$**
- ▶ **Destroyed by macrophage cells in the spleen.**

Function:

- ▶ **coagulation and blood haemostasis.**
- ▶ **Life span 7-10 days**

Numbers of platelets

Increased (Thrombocythemia)

- **Pregnancy.**
- **Exercise.**
- **splenectomy**

Decreased (Thrombocytopenia)

- **Mens : (Menstruation)**
- **Haemorrhage.**
- **Bone marrow destruction or suppression e.g. leukemia**

Manifestations of thrombocytopenia

- Petechial hemorrhage (پتشی).
- Easy bruising (کبودی).
- Mucosal bleeding
- Gum bleeding (لثه)



مراجع برای مطالعه بیشتر:

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