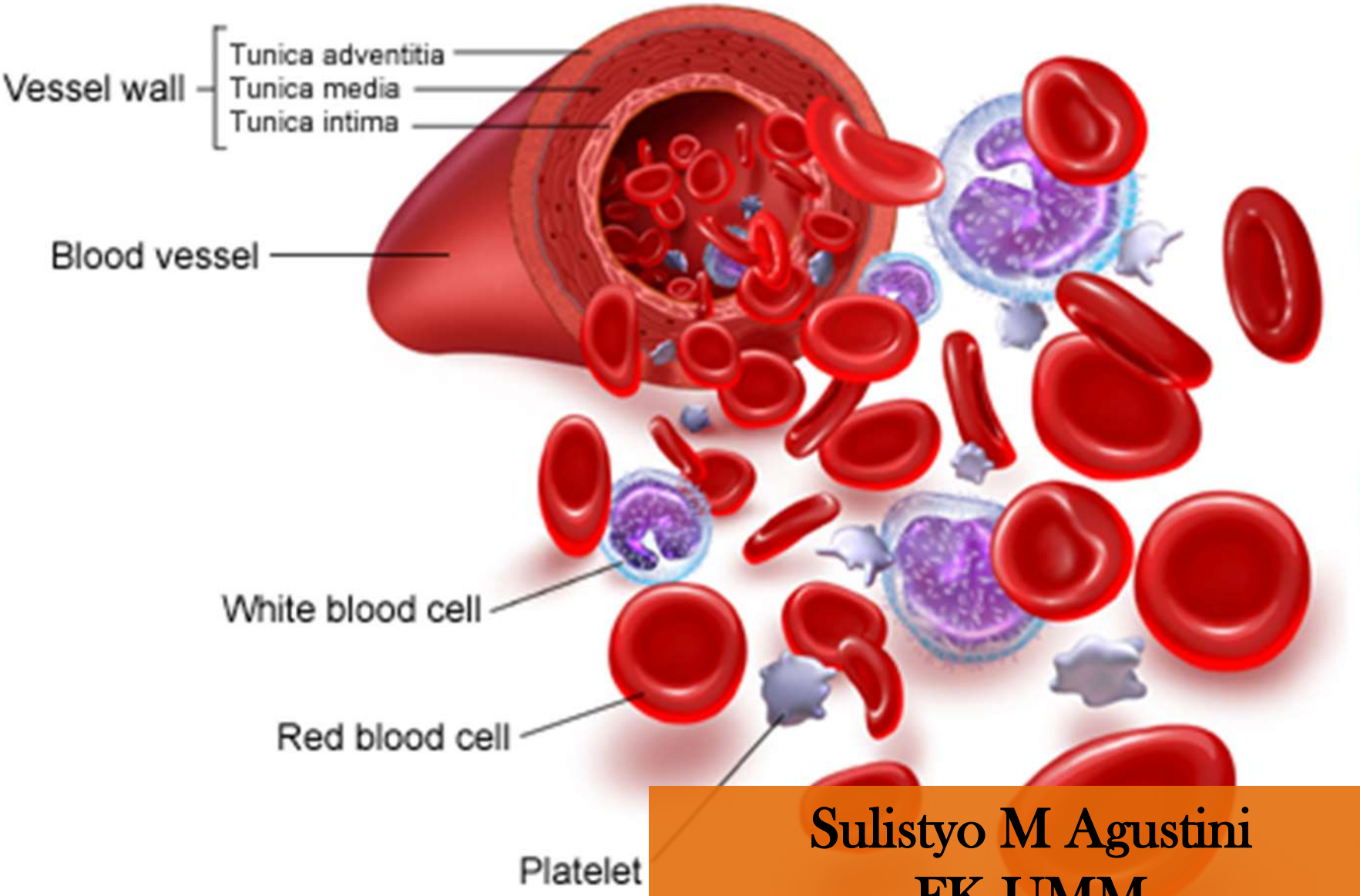
LABORATORIUM DARAH LENGKAP



Sulistyo M Agustini
FK-UMM
2024

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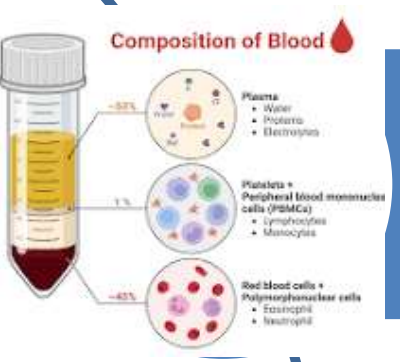
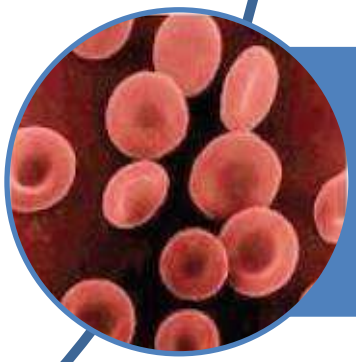
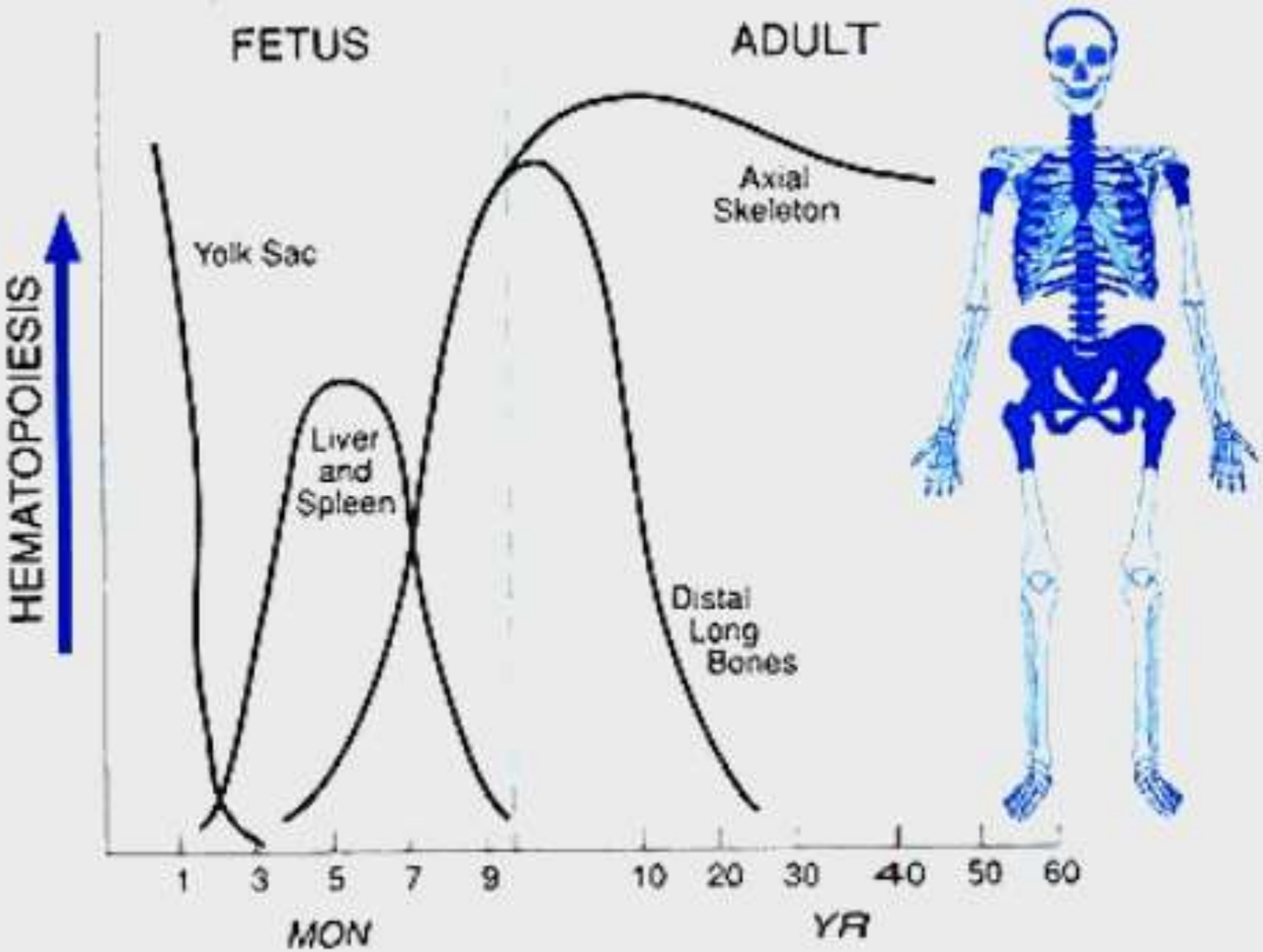


Hematopoiesis & components of blood (plasma, red blood cells, white blood cells, and platelets)

Tahapan pemeriksaan Laboratorium



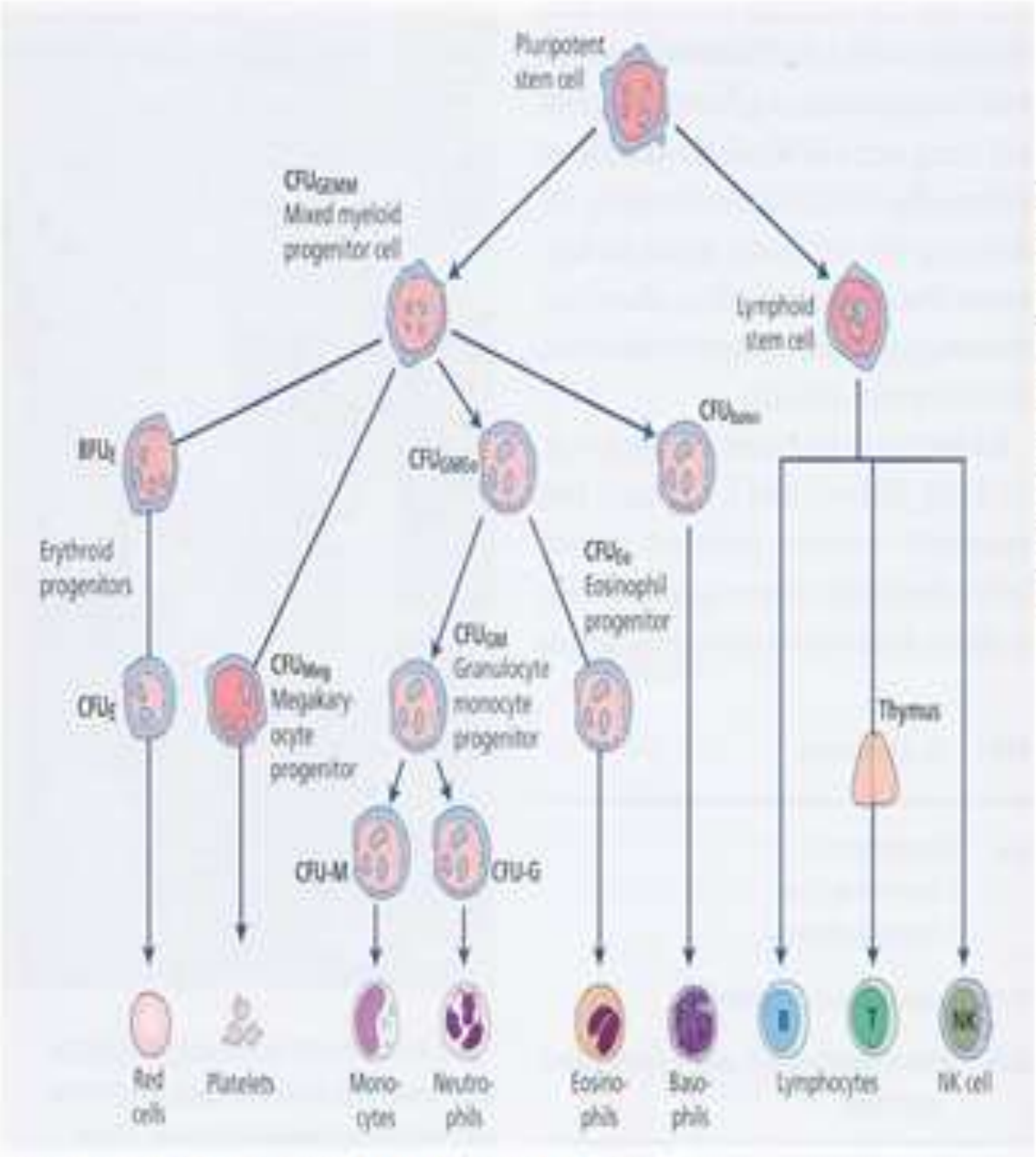
Complete blood count *(CBC)*


FETUS
ADULT
HEMATOPOIESIS
Yolk Sac
Liver and Spleen
Axial Skeleton
Distal Long Bones
1
3
5
7
9
10
20
30
40
50
60
MON
YR

Introduction

- ***Complete blood count*** *(CBC)→ tes yg darah yg umum diminta klinisi (dokter)* **mengevaluasi jumlah total dan karakteristik komponen sel dalam darah.**
- **Hematopoiesis** → produksi > 100 *billion cells*/hari *bone marrow* (dewasa: vertebrae, sternum & ribs; pada anak-2 di tulang panjang)
- Darah terdiri: bagian cairan (plasma), dan bagian seluler yang mengandung *Erythrocytes* (RBC), *White cells (WBC)*, dan trombosit/ *Platelet (PLT)*.
- ***Phlebotomy*** *→venipuncture*
- **Pemeriksaan Darah Lengkap (CBC)**
- **Hematology analyzer→Hitung darah lengkap (CBC) adalah salah satu tes darah paling umum yang diminta oleh dokter dan**

Haemopoiesis



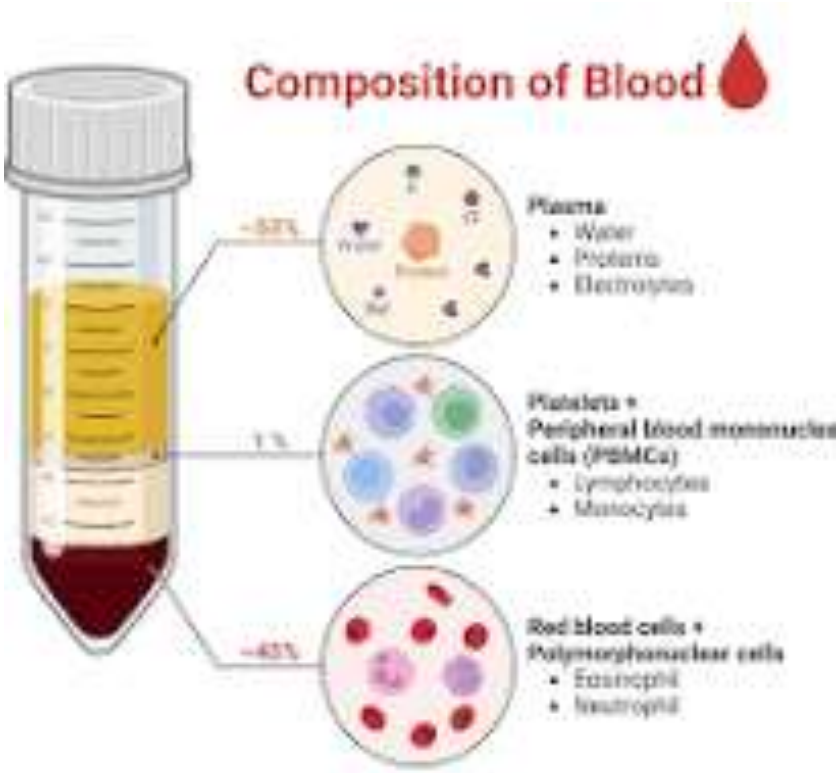
CFU: Colony-forming unit
BFU: Burst-forming unit
GEMM: (Granulocyte, Erytroid Monocyte, Megakaryocyte)
E : Erytroid:
Eo: Eosinophils
GM: Granulocyte, Monocyte
Meg: Megakaryocyte
NK: Natural Keiler

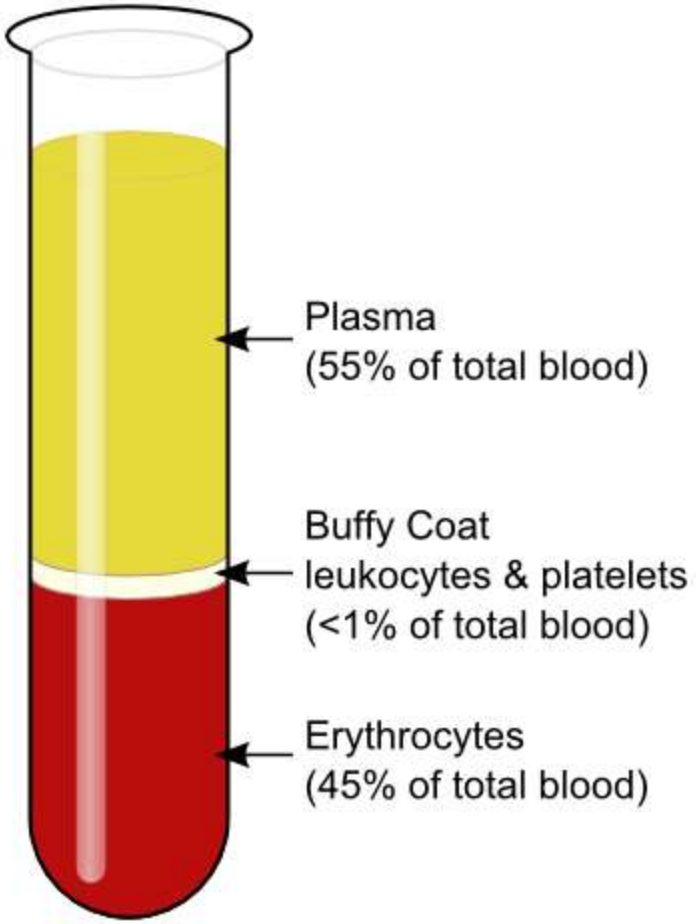
Hoffbrand AV, Essential Haematology, 2003

components of blood

- plasma
- red blood cells
- white blood cells
- platelets

The remaining 45% of blood mainly consists of red and white blood cells and platelets. Each of these has a vital role to play in keeping the blood functioning effectively


Composition of Blood
Plasma
Water
Proteins
Electrolytes
Platelets +
Peripheral blood mononuclear
cells (PBMCs)
Lymphocytes
Monocytes
Red blood cells +
Polymorphonuclear cells
Eosinophil
Neutrophil


Plasma
(55% of total blood)
Buffy Coat
leukocytes & platelets
(<1% of total blood)
Erythrocytes
(45% of total blood)

Functions

- Bone marrow produces red blood cells, white blood cells, and platelets, and from there they enter the bloodstream. Plasma is mostly water that is absorbed from ingested food and fluid by the intestines. The heart pumps them around the body as blood by way of the blood vessels

- Blood has various functions that are central to survival:
  - **supplying oxygen to cells and tissues**
  - providing essential nutrients to cells, such as amino acids, fatty acids, and glucose
  - removing waste materials, such as carbon dioxide, urea, and lactic acid
  - protecting the body from diseases, infections, and foreign bodies through the action of white blood cells
  - regulating body temperature

- The platelets in blood enable the clotting, or coagulation, of blood. When bleeding occurs, the platelets group together to create a clot. The clot forms a scab, which stops the bleeding and helps protect the wound from infection


InfoLabmed
PRE ANALITIK, ANALITIK, DAN PASKA ANALITIK
PEMERIKSAAN DI LABORATORIUM MEDIS

Proses Pemeriksaan Laboratorium

MRK Diagnostics

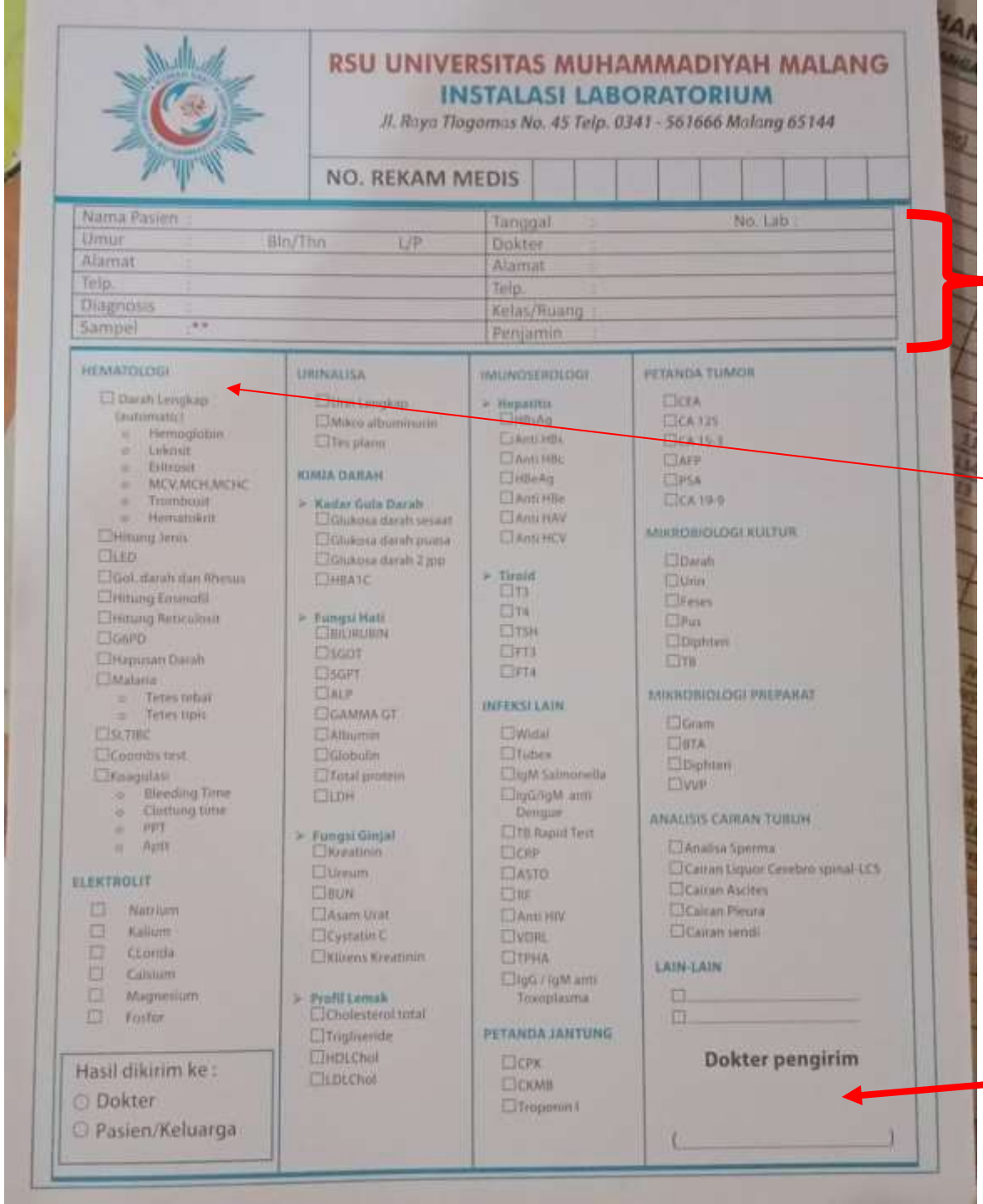
- Kesalahan Sampel
- Hemokonsentrasi
- Antikoagulan (jenis & kadar tidak tepat)
- Homogenisasi tidak bagus
- Kesalahan administrasi
- dll

- Kelainan pada komponen darah
  - Eritrosit
  - Lekosit
  - Trombosit
- Hiperbilirubin
- Hiperlipidemia

- Transfer Hasil
- Historycal
- Validasi
- Reporting

Hematology analyser beyond compromise

Boule



RSU UNIVERSITAS MUHAMMADIYAH MALANG
INSTALASI LABORATORIUM
Jl. Raya Tlogomas No. 45 Telp. 0341 - 561666 Malang 65144

NO. REKAM MEDIS

Nama Pasien :		Tanggal :	No. Lab :
Umur :	Bln/Thn L/P	Dokter :	
Alamat :		Alamat :	
Telp. :		Telp. :	
Diagnosis :		Kelas/Ruang :	
Sampel : **		Penjamin :	

HEMATOLOGI
- ☐ Darah Lengkap (automatic)
  - Hemoglobin
  - Leukosit
  - Eritrosit
  - MCV,MCH,MCHC
  - Trombosit
  - Hematokrit
- ☐ Hitung Jenis
- ☐ LED
- ☐ Gol. darah dan Rhesus
- ☐ Hitung Eosinofil
- ☐ Hitung Reticulosit
- ☐ G6PD
- ☐ Hapusan Darah
- ☐ Malaria
  - Tetes tebal
  - Tetes tipis
- ☐ SI,TIBC
- ☐ Coombs test
- ☐ Koagulasi
  - Bleeding Time
  - Clotting time
  - PPT
  - APTT

ELEKTROLIT
- ☐ Natrium
- ☐ Kalium
- ☐ Clorida
- ☐ Calsium
- ☐ Magnesium
- ☐ Fosfor

Hasil dikirim ke :
- ○ Dokter
- ○ Pasien/Keluarga

URINALISA
- ☐ Urine Lengkap
- ☐ Mikro albuminuria
- ☐ Tes plano

KIMIA DARAH

➢ Kadar Gula Darah
- ☐ Glukosa darah sesaat
- ☐ Glukosa darah puasa
- ☐ Glukosa darah 2 jpp
- ☐ HBA1C

➢ Fungsi Hati
- ☐ BILIRUBIN
- ☐ SGOT
- ☐ SGPT
- ☐ ALP
- ☐ GAMMA GT
- ☐ Albumin
- ☐ Globulin
- ☐ Total protein
- ☐ LDH

➢ Fungsi Ginjal
- ☐ Kreatinin
- ☐ Ureum
- ☐ BUN
- ☐ Asam Urat
- ☐ Cystatin C
- ☐ Klirens Kreatinin

➢ Profil Lemak
- ☐ Cholesterol total
- ☐ Trigliseride
- ☐ HDLChol
- ☐ LDLChol

IMUNOSEROLOGI

➢ Hepatitis
- ☐ HBsAg
- ☐ Anti HBs
- ☐ Anti HBc
- ☐ HBeAg
- ☐ Anti HBe
- ☐ Anti HAV
- ☐ Anti HCV

➢ Tiroid
- ☐ T3
- ☐ T4
- ☐ TSH
- ☐ FT3
- ☐ FT4

INFEKSI LAIN
- ☐ Widal
- ☐ Tubex
- ☐ IgM Salmonella
- ☐ IgG/IgM anti Dengue
- ☐ TB Rapid Test
- ☐ CRP
- ☐ ASTO
- ☐ RF
- ☐ Anti HIV
- ☐ VDRL
- ☐ TPHA
- ☐ IgG / IgM anti Toxoplasma

PETANDA JANTUNG
- ☐ CPK
- ☐ CKMB
- ☐ Troponin I

PETANDA TUMOR
- ☐ CEA
- ☐ CA 125
- ☐ CA 15-3
- ☐ AFP
- ☐ PSA
- ☐ CA 19-9

MIKROBIOLOGI KULTUR
- ☐ Darah
- ☐ Urin
- ☐ Feses
- ☐ Pus
- ☐ Diphteri
- ☐ TB

MIKROBIOLOGI PREPARAT
- ☐ Gram
- ☐ BTA
- ☐ Diphteri
- ☐ VVP

ANALISIS CAIRAN TUBUH
- ☐ Analisa Sperma
- ☐ Cairan Liquor Cerebro spinal-LCS
- ☐ Cairan Ascites
- ☐ Cairan Pleura
- ☐ Cairan sendi

LAIN-LAIN
- ☐ _____
- ☐ _____

Dokter pengirim

(_____)

Identitas

Hematologi

Ttd dpjp (dokter)

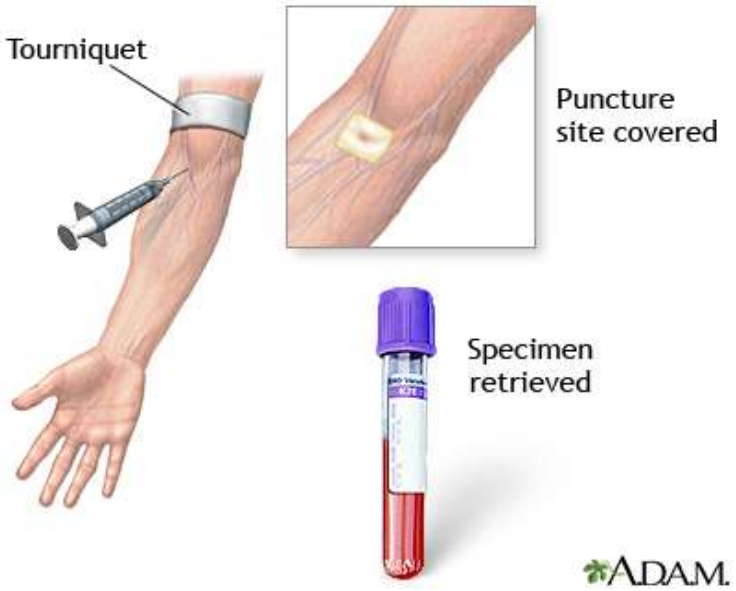
- *Phlebotomy* → prosedur invasif terhadap tubuh melalui dengan tusukan, dan dilakukan oleh para profesional yang dikenal sebagai: *Phlebotomists*
- Melakukan secara profesional sikap →•komunikasi efektif• Mengetahui kebijakan dan prosedur fasilitas • Identifikasi pasien dgn benar • Pengambilan secara benar darah vena & kapiler • Pilih tabung yg sesuai dan akurat untuk Pemeriksaan yang ditentukan

Phlebotomy → venipuncture

PENGAMBILAN BAHAN & ANTIKOAGULAN

Pengambilan darah

- Darah vena
- Darah kapiler
- *Arterial capillary blood*
- Vena pungsi



Anti-koagulan

- EDTA (Ethylene diamine tetra acetic acid)
- Natrium sitrat dalam larutan 3,8 %→ Faal hemostasis
- Heparin → analisa gas darah

BLOOD TEST (Darah Lengkap)

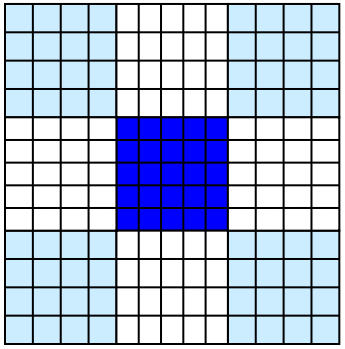
Dasar Skrening test : yg di periksa

- Kelainan hemoglobin (Hb)& sel2 hematopoiesis
- Synthesis dan Fungsi

- Kelaian Darah (Anemia, Leukemia, abnormal Perdarahan & Pembekuan)
- Inflammation
- Infection
- Inherited disorders→ Red blood cells (RBC); White blood cells (WBC); Platelets (Plt)

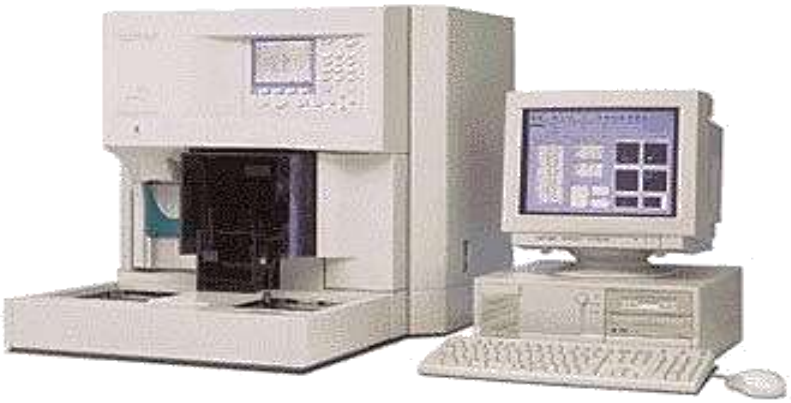
History of Hematology Cell Counting

Manual
WBC, RBC PLT



Semi Automatis
WBC RBC, PLT

Otomatis
WBC RBC, PLT




A hematology analyzer used to perform complete blood counts (CBC)
mindray
BC-5800

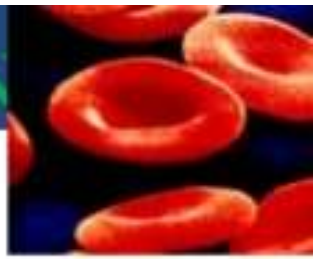
hematology analyzer

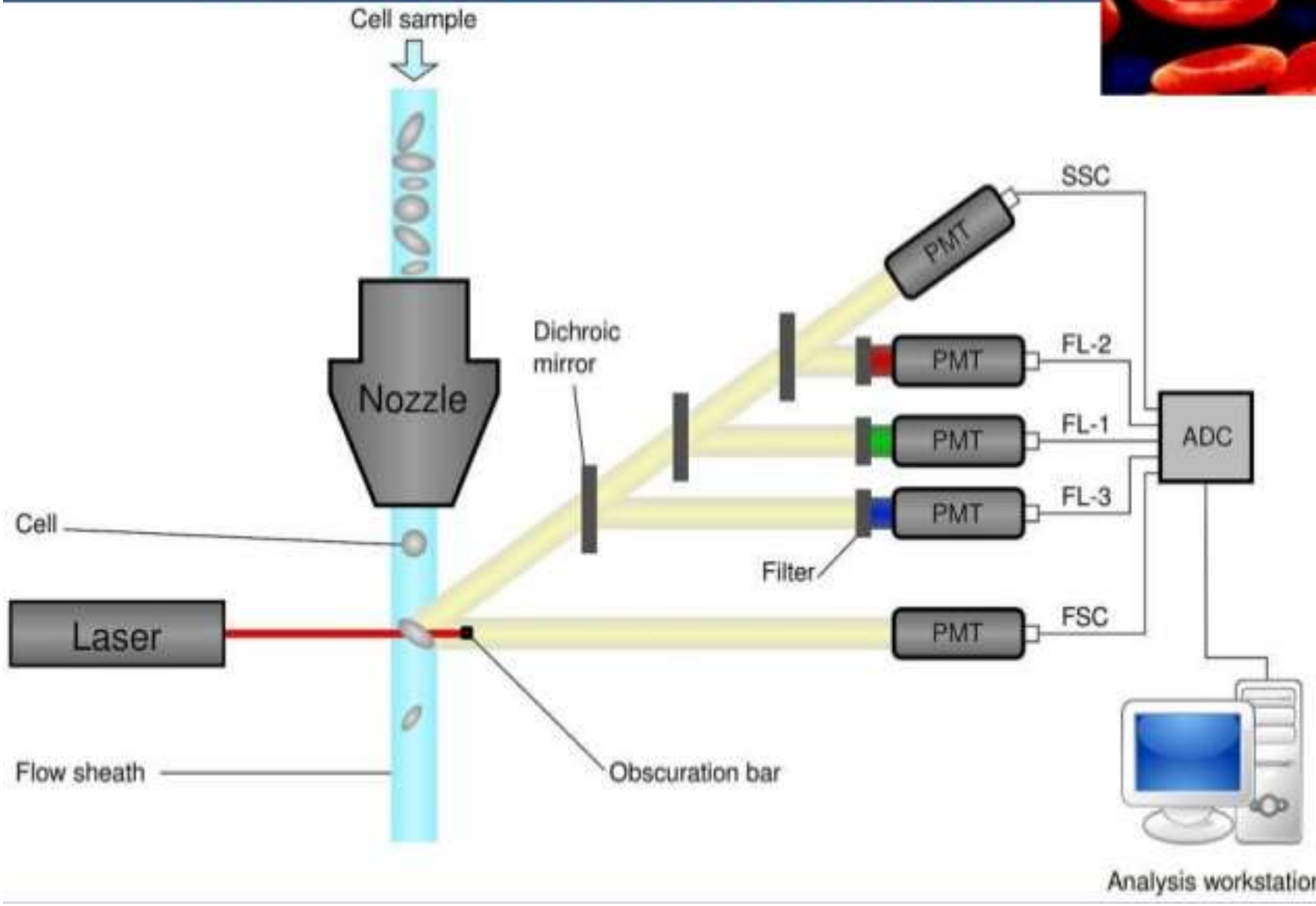
Instrumen *automated hematology*:

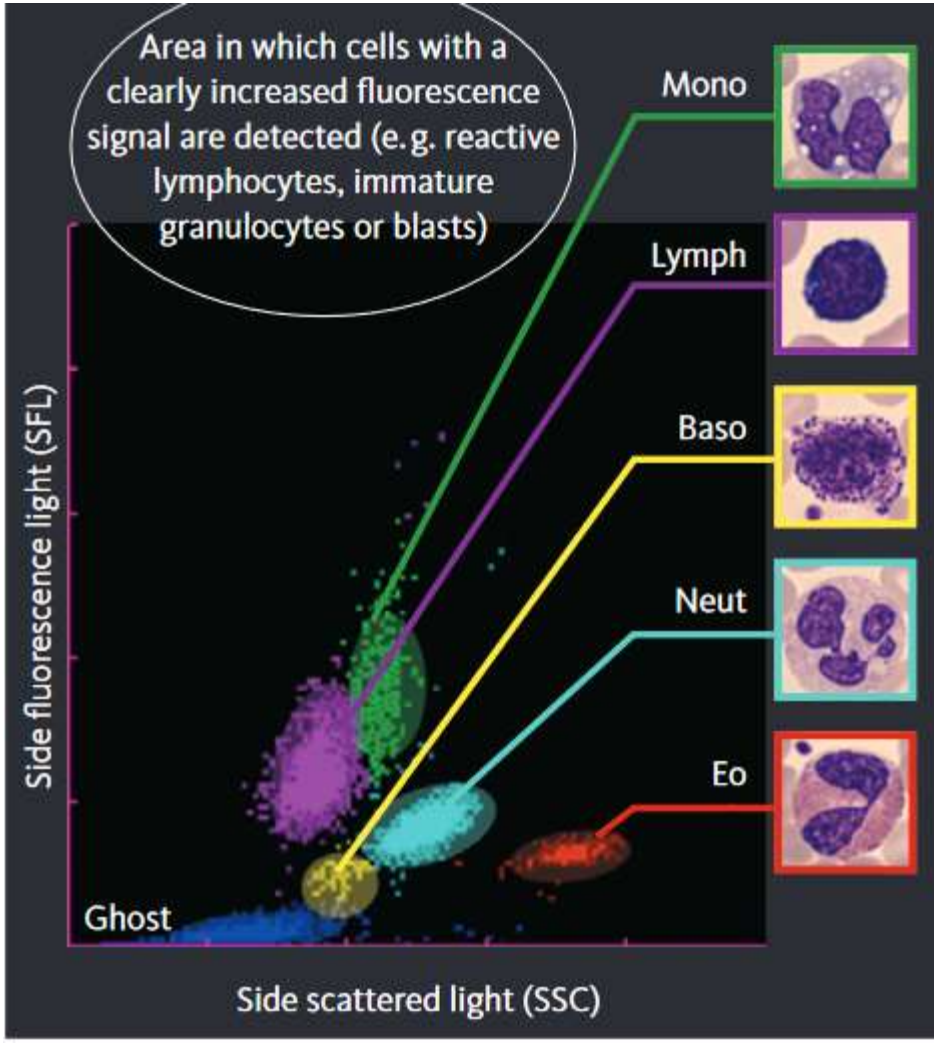
- *optical methods (light scatter)*
- *impedance-based methods based on the Coulter principle* (changes in electrical current induced by blood cells flowing through an electrically charged opening)

Progressive improvement in *automated hematology* → penghitungan dan evaluasi sel darah dengan akurasi, presisi, dan kecepatan yang tinggi dengan biaya yang sangat rendah (tgt parameter yg digunakan)

PRINCIPLE OF OPERATION






Area in which cells with a clearly increased fluorescence signal are detected (e.g. reactive lymphocytes, immature granulocytes or blasts)
Mono
Lymph
Baso
Neut
Eo
Ghost
Side fluorescence light (SFL)
Side scattered light (SSC)

Automated hematology analyzers

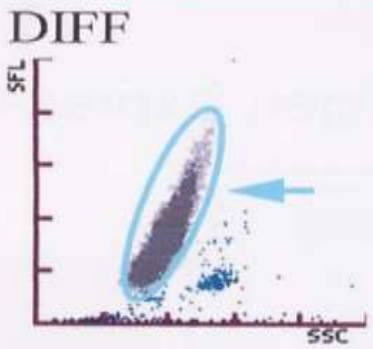
- can rapidly analyze whole blood specimens for the complete blood count (CBC). Results include red blood cell (RBC) count, white blood cell (WBC) count, platelet count, hemoglobin concentration, hematocrit, RBC indices, and a leukocyte differential

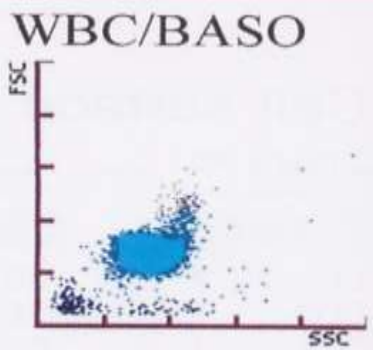
Complete blood count (CBC)

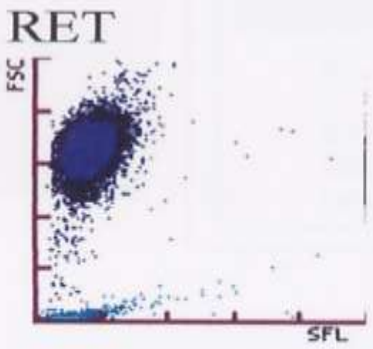
- Darah : cairan yg komplek, terdiri dari elemen (*red cells, white cells, platelets) dan plasma*
- ***Red blood cells (RBCs),*** erythrogram (RBC count, determination of hemoglobin (Hb) and hematocrit, and indices calculation (mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and red cell distribution width (RDW)
- ***Hb*** → fs utama membawa O2 ke jaringan seluruh tubuh. Namun, Hb dapat berinteraksi dengan berbagai gas serta O2, dan juga berinteraksi dengan karbon dioksida dan karbon monoksida
- RDW → untuk membedakan berbagai jenis anemia, factor: jenis kelamin, usia, genetic
- ***White blood cells (WBCs),*** → *immune system* dan petanda penyakit lain (↑ atau↓): inflamasi, cancer, efek samping Tx cancer
- ***Neutrophil-to-Lymphocyte Ratio (NLR)*** →*Neutrophil: primary immune cells & Lymphocyte:* berperan dlm *innate and adaptive immunity*
- ***Platelet (PLT)***→ peran dalam koagulasi: *platelet count indices calculation* (*mean platelet volume (MPV)*
- *Plasma*→ air (>>), elektrolit, & protein plasma

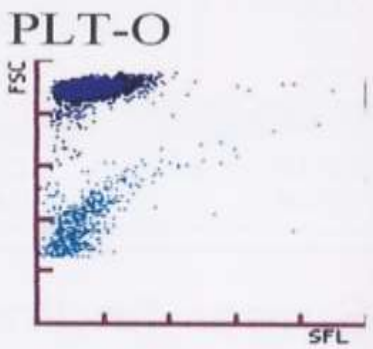
CARA MEMBACA
AUTOMATED HEMATOLOGY ANALYZER

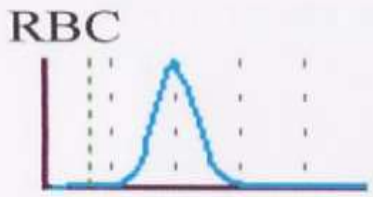
WBC	52.39 *	[10^9/L]		
RBC	1.44 -	[10^{12}/L]		
HGB	47 -	[g/L]		
HCT	14.4 -	[%]		
MCV	100.0	[fL]		
MCH	32.6	[pg]		
MCHC	326	[g/L]		
PLT	55 *	[10^9/L]		
RDW-SD	51.5	[fL]		
RDW-CV	15.2	[%]		
PDW	9.6 *	[fL]		
MPV	9.0 *	[fL]		
P-LCR	17.3 *	[%]		
PCT	0.05 *	[%]		
NEUT	----	[10^9/L]	----	[%]
LYMPH	----	[10^9/L]	----	[%]
MONO	----	[10^9/L]	----	[%]
EO	0.01 *	[10^9/L]	0.0 *	[%]
BASO	0.08 *	[10^9/L]	0.2 *	[%]
RET	0.14	[%]	2.0	[10^9/L]
IRF	17.7	[%]		
LFR	82.3	[%]		
MFR	11.8	[%]		
HFR	5.9	[%]		

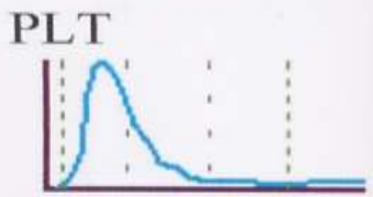












WBC IP Messages

WBC Abn Scattergram
Leukocytosis

Blasts?

RBC/RET IP Messages

Anemia

PLT IP Messages

Thrombocytopenia

PLT Clumps?

Visual count data

Stab	0 [%]
Seg	2 [%]
Lymph	4 [%]
Mono	0 [%]
Eo	0 [%]

Plasma

Plasma accounts for around 55% of blood fluid in humans. Plasma is 92% water, and the contents of the remaining 8% include

- glucose
- hormones
- proteins
- mineral salts
- fats
- Vitamins

The remaining 45% of blood mainly consists of red and white blood cells and platelets. Each of these has a vital role to play in keeping the blood functioning effectively

Red blood cells, hemoglobin, and hematocrit

- RBC→membawa oksigen dari paru-paru ke jaringan dan kembali membawa karbon dioksida kembali ke paru-paru utk dikeluarkan (Hb).
- Nilainya 10^6 cells per microlitre of blood ($\times 10^6/\mu L$)
- **mean corpuscular volume** (MCV)→ ukuran rata2 eritrosit
- **mean corpuscular hemoglobin** (**MCH**)→ massa rata-rata hemoglobin (Hb) per sel darah merah (RBC)
- MCHC → rata-2 hemoglobin.

Red blood cells, or erythrocytes

- Red blood cells have a slightly indented, flattened disk shape. They transport oxygen to and from the lungs. Hemoglobin is a protein that contains iron and carries oxygen to its destination. The life span of a red blood cell is 4 months, and the body replaces them regularly. The human body produces around 2 million, blood cells every second

White blood cells

- WBC→ defend against infections and are involved in the inflammatory response
- Five types of white blood cells→neutrophils, lymphocytes, monocytes, eosinophils, and basophils
- elevated neutrophil count (neutrophilia) is associated with bacterial infection, inflammation, and myeloproliferative disorders
- increased number neutrophils→ (lymphocytosis, granulositosis. Monocytosis dst)

White blood cells, or leukocytes

- White blood cells make up less than 1% of blood content, forming vital defenses against disease and infection. The number of white blood cells in a microliter of blood usually ranges from 3,700–10,500. Higher or lower levels of white blood cells can indicate disease

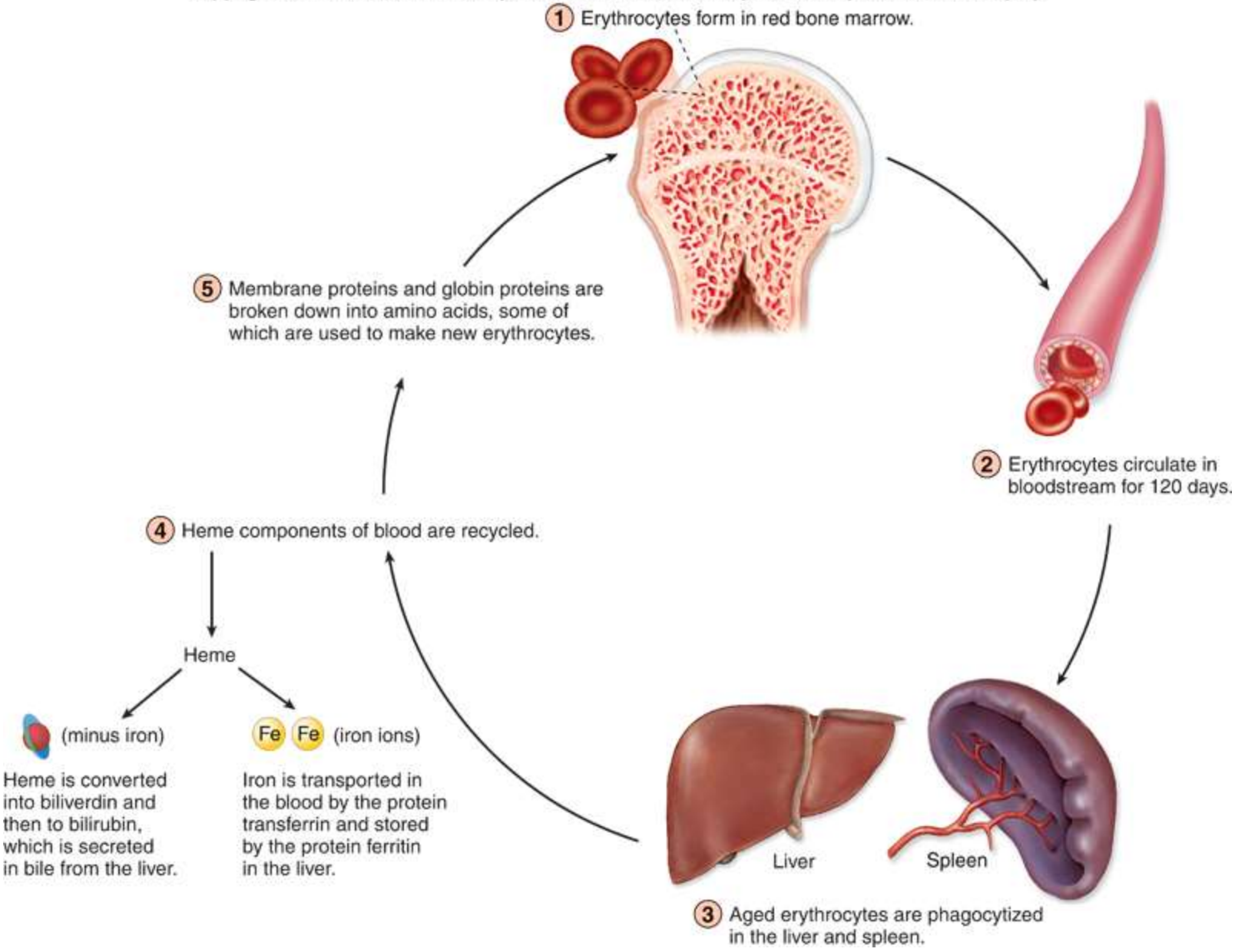
Trombosit= **Platelets**

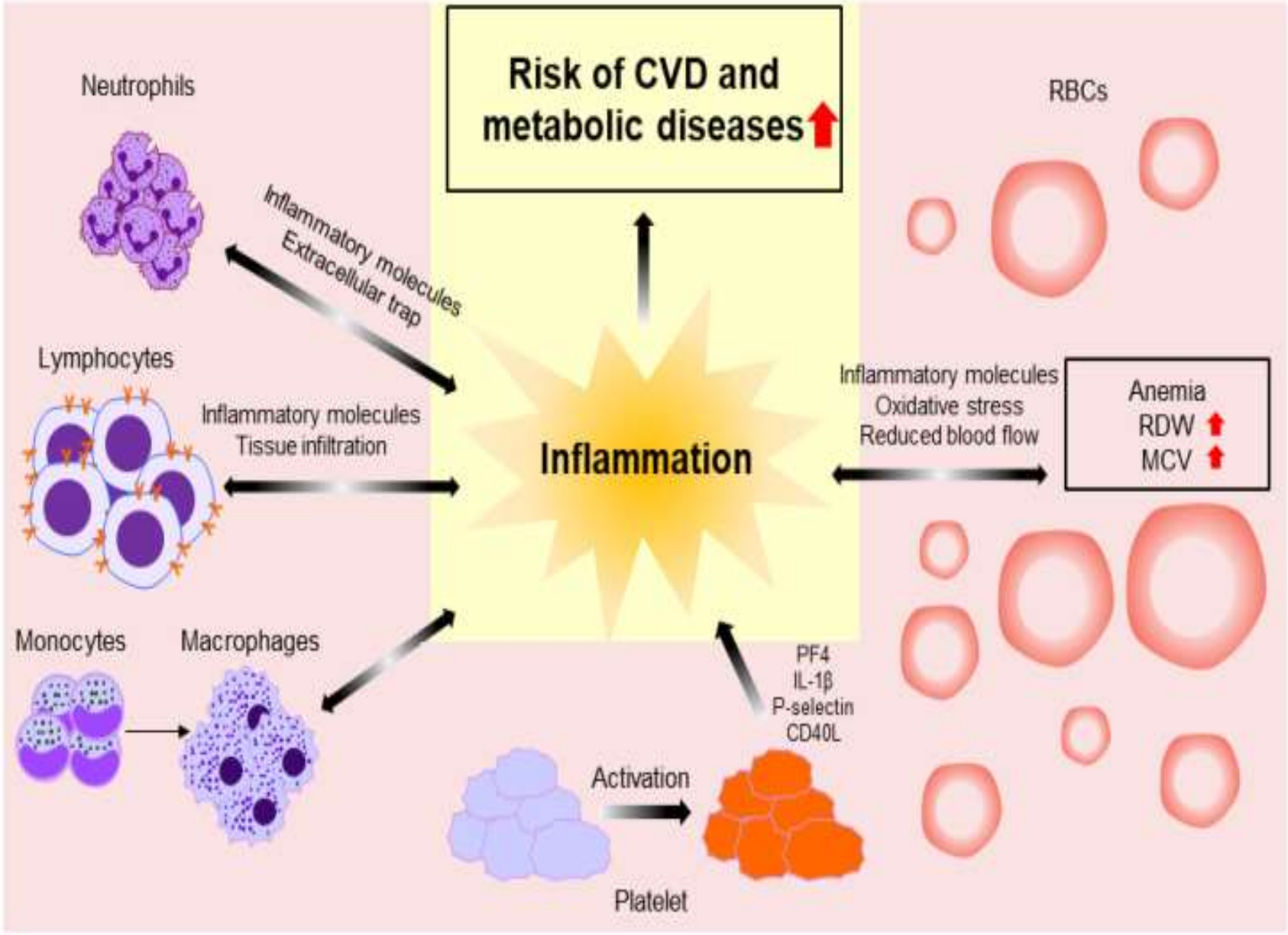
- Platelets play an essential role in clotting
- Thrombocytopenia→ may cause bleeding if severe
- Thrombocytosis→ a high platelet count, may occur in states of inflammation or trauma

Platelets, or thrombocytes

- Platelets interact with clotting proteins to prevent or stop bleeding. There should be between 150,000 and 400,000 platelets per microliter of blood.
- Bone marrow produces red blood cells, white blood cells, and platelets, and from there they enter the bloodstream. Plasma is mostly water that is absorbed from ingested food and fluid by the intestines. The heart pumps them around the body as blood by way of the blood vessels

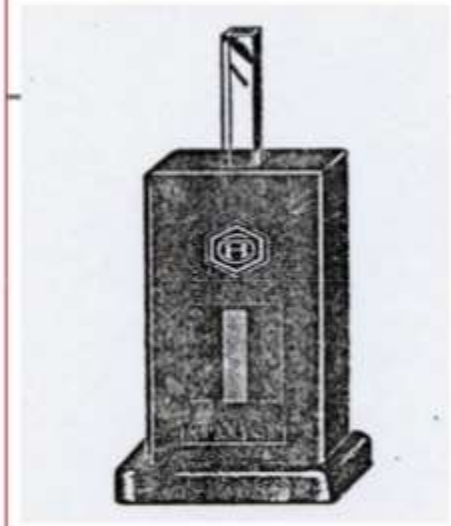
Complete Blood Count with Differential (CBC with diff)		
Test	**Conventional**	**SI Units**
Red Blood Cell (RBC)	Male: 4.6–6.2 $\times$ 10^6 cells /μL	4.6–6.2 $\times$ 10^{12} cells /L
	Female: 4.2–5.9 $\times$ 10^6 cells / μL	4.2–5.9 $\times$ 10^{12} cells /L
Hemoglobin (Hgb)	Male: 13–18 g/dL	Male: 130–180 g/L
	Female: 12–16 g/dL	Female: 120–160 g/L
Hematocrit (Hct)	Male: 45–52%	Male: 0.45–0.52
	Female: 37–48%	Female: 0.37–0.48
MCV	80 to 100 μm^3	80 to 100 μm^3
MCH	27 to 31 pg/cell	27 to 31 pg/cell
MCHC	32 to 36 g/dL	32 to 36 g/dL
White Blood Cells (WBC)	4,300–10,800 cells/mm^3	4.3–10.8 $\times$ 10^9/L
WBC Differential		
◆ Neutrophils, bands	0–5%	0.03–0.08
◆ Neutrophils, segmented	54–65%	0.54–0.65
◆ Lymphocytes	25–40%	0.25–0.40
◆ Monocytes	2–8%	0.02–0.08
◆ Eosinophils	1–4%	0.010.04
◆ Basophils	0–1%	0–0.01
Platelets	150,00–450,000/ mm^3	150–450 x 10^9/L




Risk of CVD and metabolic diseases
Neutrophils
Inflammatory molecules
Extracellular trap
RBCs
Lymphocytes
Inflammatory molecules
Tissue infiltration
Inflammation
Inflammatory molecules
Oxidative stress
Reduced blood flow
Anemia
RDW
MCV
Monocytes
Macrophages
PF4
IL-1β
P-selectin
CD40L
Activation
Platelet


SELAMAT BELAJAR & SUKSES

HEMOGLOBINOMETER
(METODE ASAM
HEMATIN/SAHLI)



HEMOGLOBIN

Normal : Laki : 13-18 g/dl
Wnt : 12-16 g/dl

Pemeriksaan standard : cyanmeth-Hb
Pemeriksaan praktikum : sahli

Tujuan :

1. **pemeriksaan penyaring**
2. **penderita anemia**
   (perlu dicari penyebabnya)

PENGUKURAN HEMATOKRIT (PCV) CARA WINTROBE

Prinsip :

mengukur prosentase pengendapan eritrosit terhadap darah penuh dalam tabung wintrobe,dg waktu & kecepatan tertentu

- **ALAT YANG DIBUTUHKAN**
  - **TABUNG WINTROBE**
  - **SPUIT / SEMPRIT UNTUK MEMASUKKAN DARAH KE DALAM TABUNG**
  - **SENTRIFUS**

LED

Prinsip : mengukur kecepatan pengendapan eritrosit /jam dalam tabung tertentu (pengaruh gravitasi)

Dipengaruhi oleh :

*** anemia * fibrinogen**

*** α_2 globulin * γ globulin**

Normal : laki : < 10 mm/jam

wnt : < 15 mm/jam

LED ↓ : Polisitemia vera

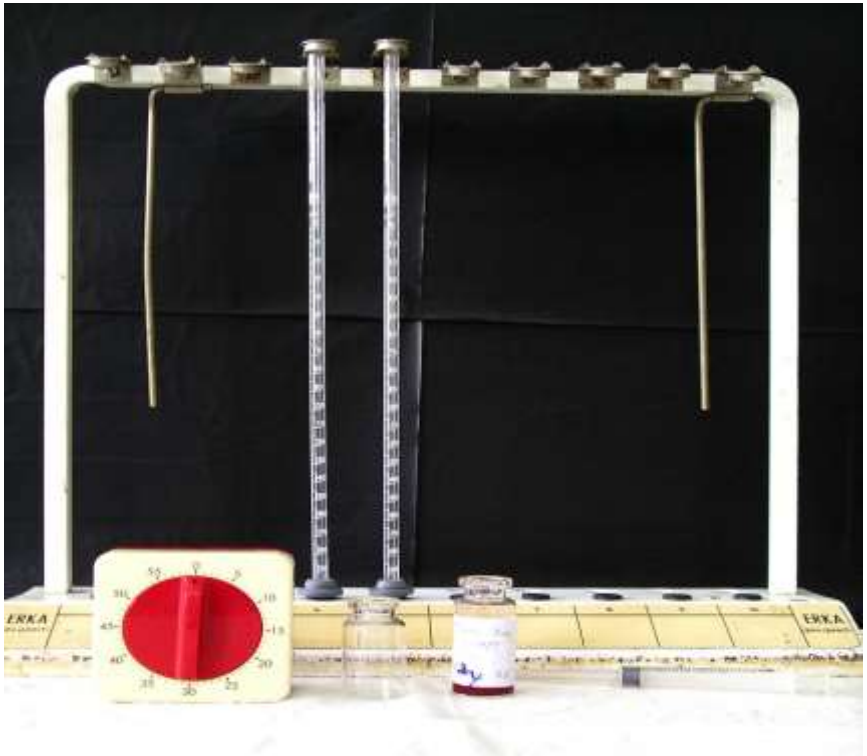
LED ↑ : Infeksi bakteri (TBC, pneumonia)

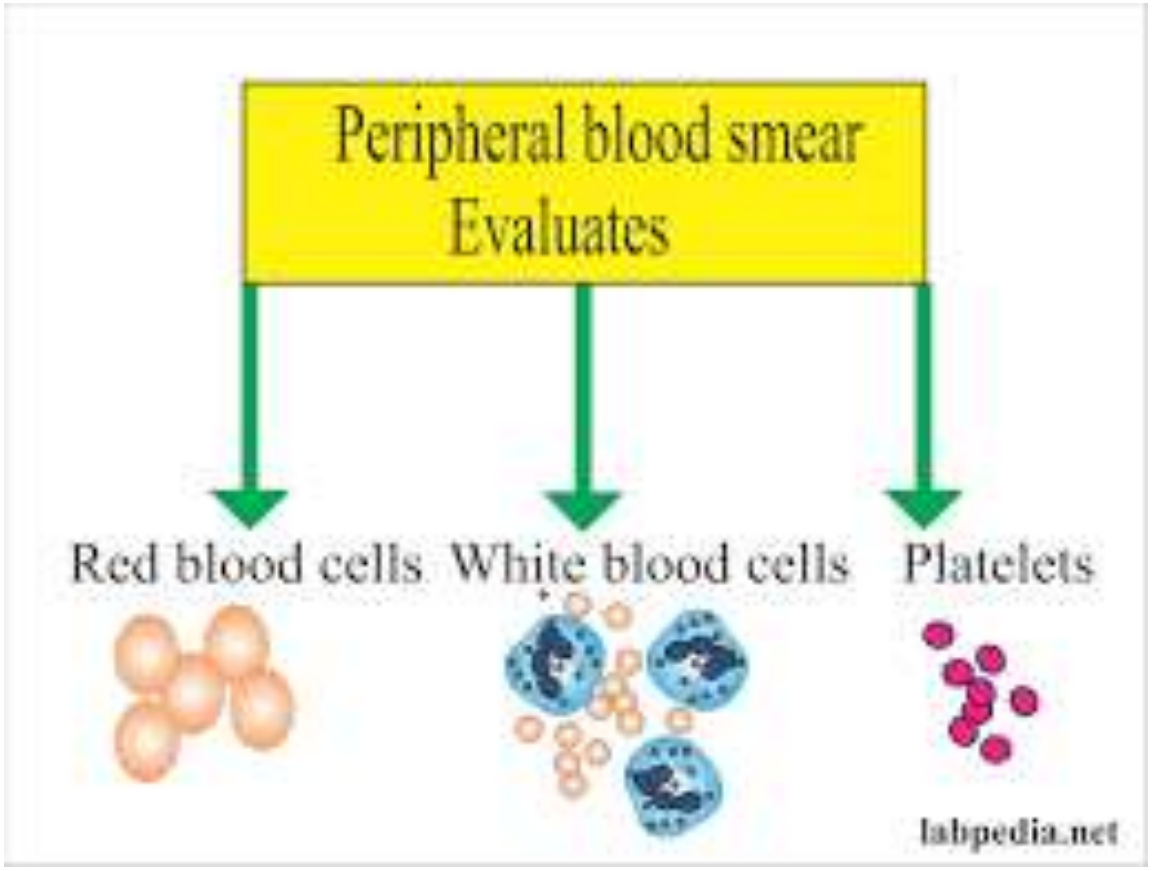
rhematoid arthritis

anemia

LAJU ENDAP DARAH / LED (Westergren)

Prinsip : **mengukur kecepatan pengendapan eritrosit/jam dalam tabung westergren**




Peripheral blood smear
Evaluates
Red blood cells
White blood cells
Platelets
labpedia.net

- **Jumlah eritrosit :**
  - **±5 juta sel/mm³ → laki-laki**
  - **±4 juta sel/mm³ →perempuan**

- **Tidak dapat menembus dinding kapiler**

- **Usia 120 hari**

eritrosit

↓ **120 hari**

mati

↓ **diubah**

bilirubin (zat warna empedu)

HEMATOKRIT

Definisi : prosentase eritrosit terhadap darah penuh (*whole blood*) dalam tabung wintrobe dg kecepatan & waktu ttn

Normal : laki : 40-48 %
wnt : 37-43 %

Hct ↓ : anemia

Hct ↑ : polisitemia vera
hemokonsentrasi (ct : DHF)
dehidrasi

LEKOSIT

- **Fungsi :**
  melawan berbagai penyakit infeksis
  (sistem kekebalan tubuh)
- **Sifat :**
  Tidak berwarna
  bentuknya tidak tetap
  Memiliki inti
  Dapat menembus dinding kapiler /diapedesis

- **Jumlah :**
  $4x10^9$ - $11x10^9$ /L darah manusia dewasa yang sehat
  (4.000 – 11.000 sel /mm^3)
- **Jenis :**
  LIMFOSIT, MONOSIT, NETROFIL, EOSINOFIL, BASOFIL

Definis Neutrophilia;
Absolute neutrophil count >10 - 11 x 109/L

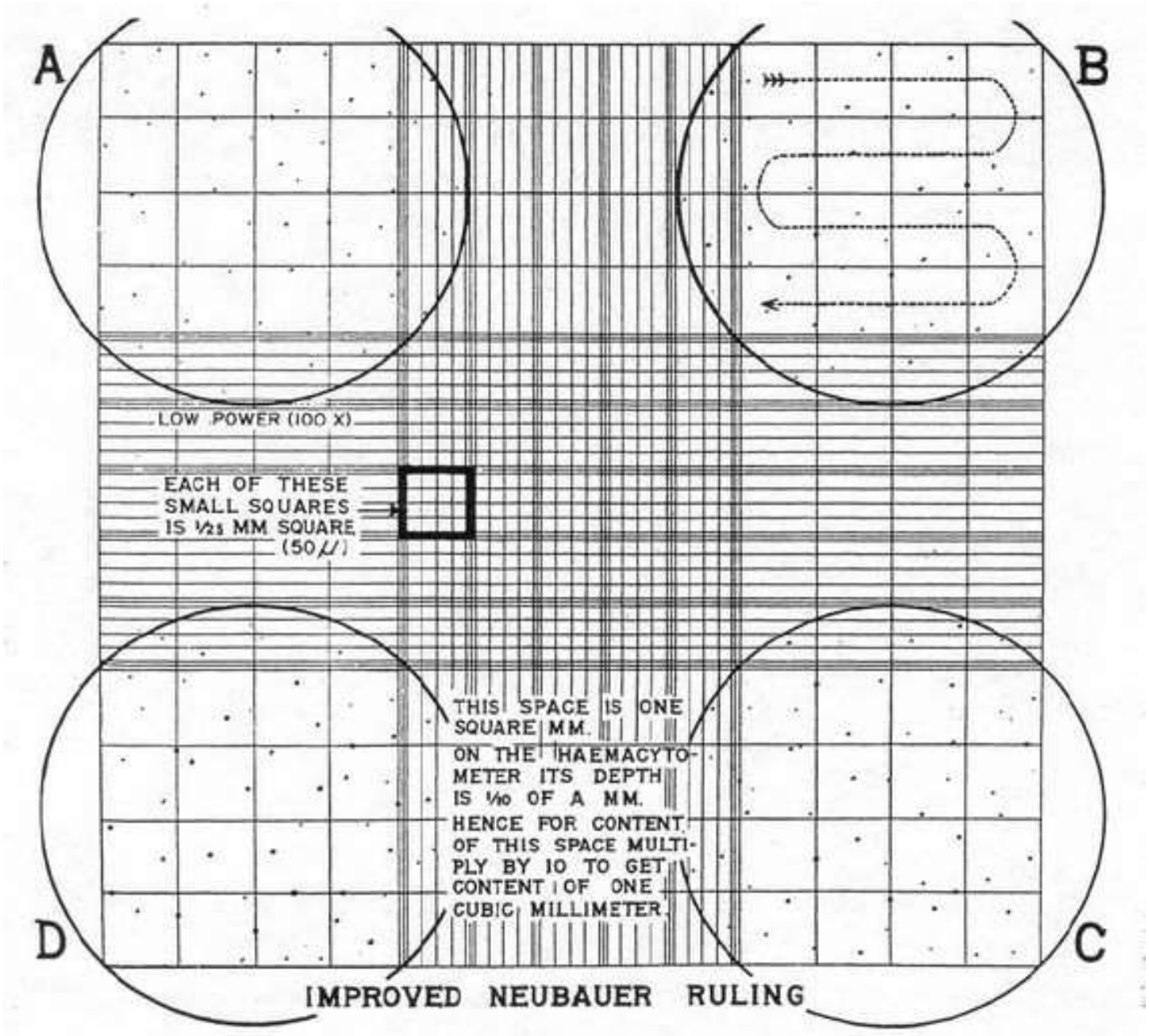
Components of elevated WBC count
(masing2 sel memepunyai fungsi)

- Neutrophilic leukocytosis/ Neutrophilia→ pyogenic infection (bacterial)
- Lymphocytic leukocytosis/ Lymphocytosis→ Viral infections (measles, rubella, chickenpox, infectious mononucleosis)
- Monocytic leukocytosis/ monocytosis→ severe infections, by phagocytosis
- Basophilic leukocytosis/basophilia→ Parasitic infections, some allergic disorders
- Eosinophilic leukocytosis/ eosinophilia→ Allergic disordes and parasitic infectations

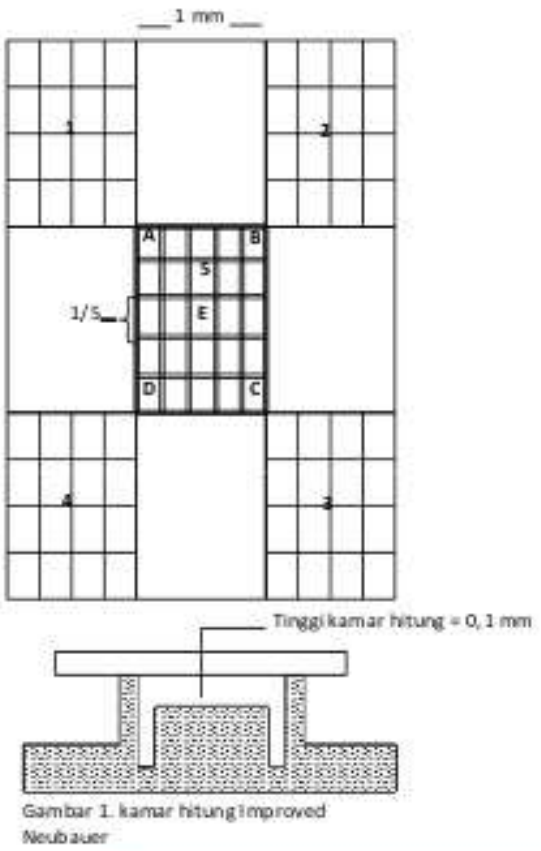
Leukocytosis/ Neutrophilia

Clinical Implication: leukocytosis: WBC > 11.000/mm3 atau 11.0 X 10.3/mm3 :

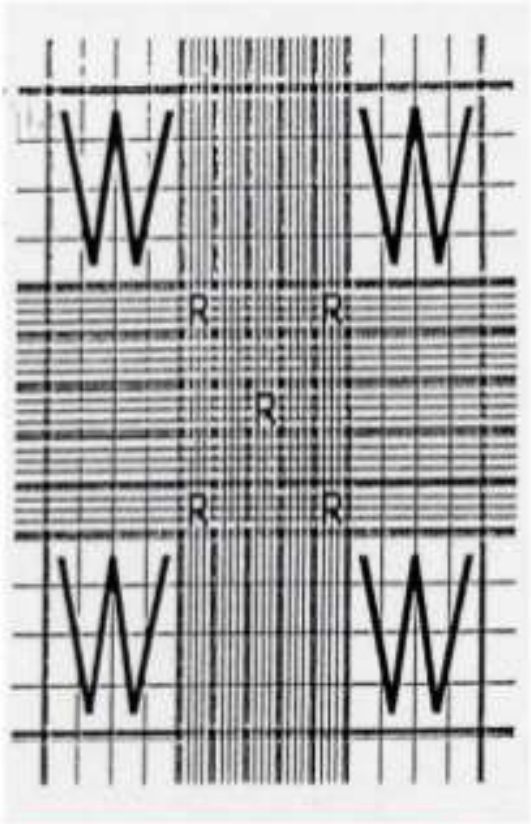
- Infection→ bacterial; fungal; Rickettsial; viral; parasitic
- Connective Tissue Disease→ vasculitis; Rhematoid arthritis
- Malignancy→ Renal; Pancreatic; Hodgin's disease; stomach dll
- Medications→ corticosteroid; epinephrine; Lithium; growth factor
- Tissue Necrosis→ myocardial infarction; gangrene
- Metabolic conditions→ Lactic acidosis; thyrotoxicosis; Uremia; diabetic ketoacidosis; Gout
- Physiologic Neutrophilia (pseudoneutrophilia)→ exercise; pain; stress; hypoxia; trauma; dll
- Trauma→ crush injuries; electric shock



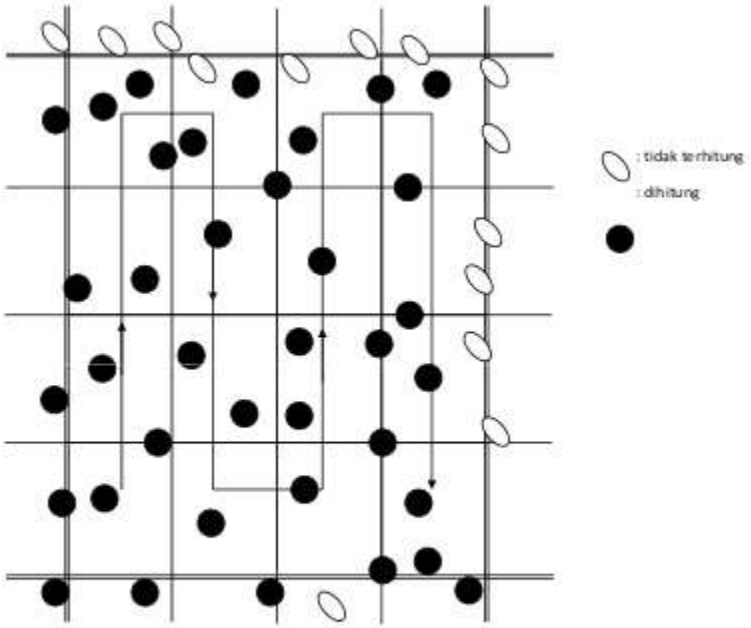
IMPROVED NEUBAUER RULING



Gambar 1. kamar hitung Improved Neubauer



TAMPILAN KAMAR HITUNG DI LIHAT DI MIKROSKOP



Gambar 2. Cara menghitung leukosit di dalam kamar hitung

TROMBOSIT

- **Keping darah / lempeng darah / trombosit / platelet**
  - ✓ **fragmen sel yang tersirkulasi dalam darah**
  - ✓ **terlibat dalam mekanisme hemostatis (pembekuan darah/trombus)**
  - ✓ **disfungsi atau jumlah keping darah <<< menyebabkan pendarahan**
    jumlah >>> meningkatkan risiko trombosis

- **Sifat :**
  Bentuk : tidak teratur,
  tidak berwarna
  tidak berinti
  berukuran lebih kecil dari eritrosit dan leukosit
  mudah pecah bila tersentuh benda kasar

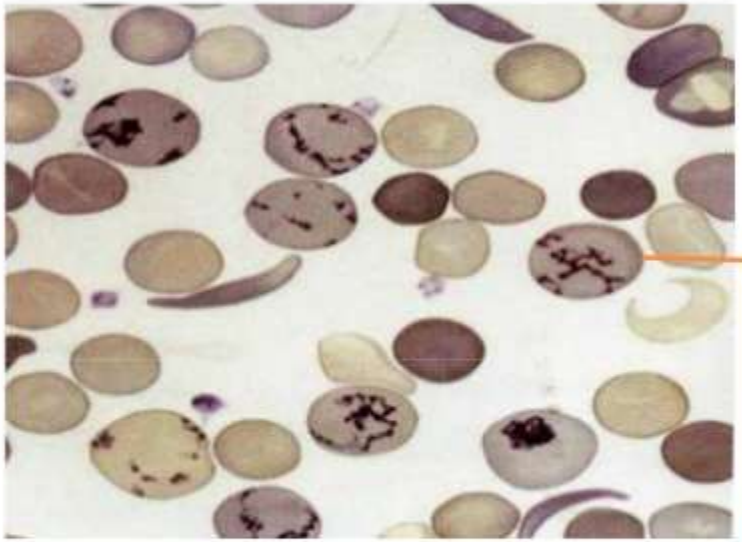
- **Jumlah trombosit : 150.000-450.000 keping/mm^3 darah.**

RETIKULOSIT

- Sel darah merah muda.
- Mengandung sisa ribosom dan sisa asam ribonukleat dan dapat bereaksi dengan BCB (Briliant Cresent Blue) atau new Metilen Blue membentuk granul atau filamen.
- Ukuran lebih besar dari SDM.
- Dijumpai pada sum tul ataupun darah tepi.

PERHITUNGAN RETIKULOSIT

- Dilakukan dengan menghitung retikulosit dalam 1000 eritrosit, dinyatakan dalam % .
- Retikulosit dijumpai dalam sumsum tulang, setelah mengalami maturasi selama 2 hari → dilepaskan kedarah tepi, beredar selama 1 hari untuk kemudian menjadi eritrosit matur .
- Hitung retikulosit yg tepat dapat mencerminkan aktivitas eritropoisis .



GAMBAR RETIKULOSIT PADA SEDIAAN DARAH