Basic Hematology

by

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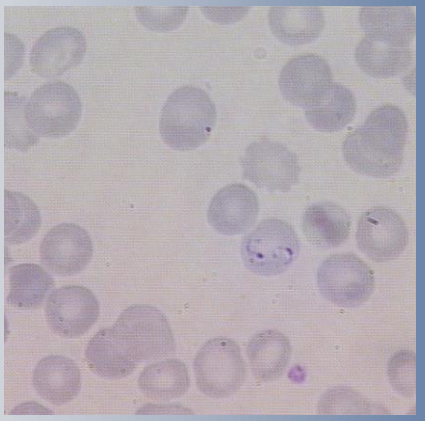
The function of blood

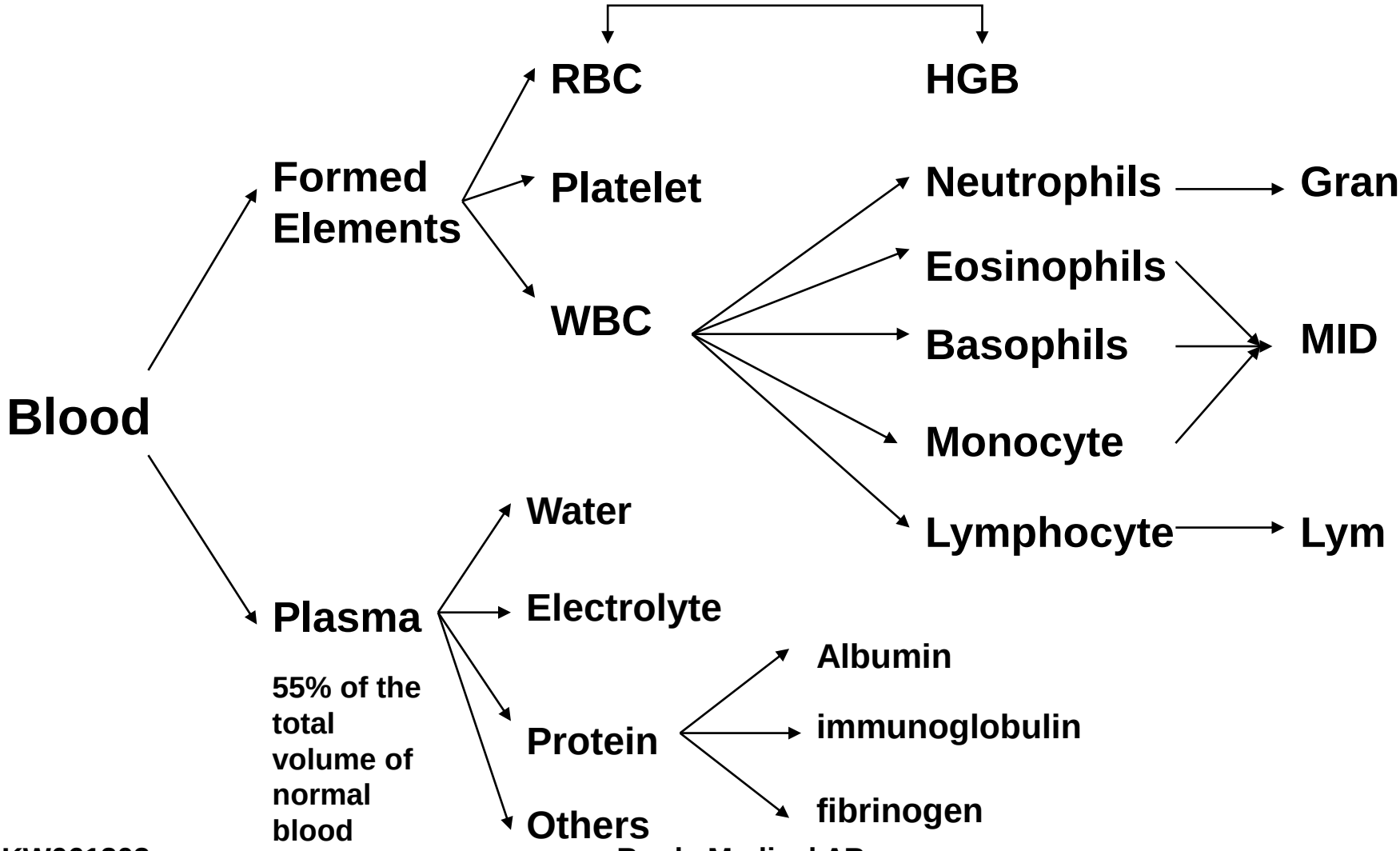
Blood is the ”spirit” that gives life to the body

Main functions:

- **Transportation of oxygen, nutrients and waste products**
- **Sealing after damages**
- **The body’s defence system**
- **Regulate temperature**
- **Control the liquid and the acid balance**



Blood Componets

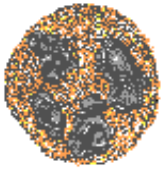


Basic Clinical Relevance of Blood Cells

Cellular component	Function	Clinical relevance
Red cells	Oxygen transport	Anemia Haemorrhage Diet Pregnancy
White cells	Bacterial and pathogen defenders	Bacterial infections Viral infections Parasite infections Allergies Leukaemia Immune deficiency
Platelets	Blood clotting stabilisers and vessel repairs	Coagulation Chemotherapy

The Blood Cells Concentration

- The white blood cell
  size: 35 - 420 fl number: **3.5 - 8 x** 10^9 / l

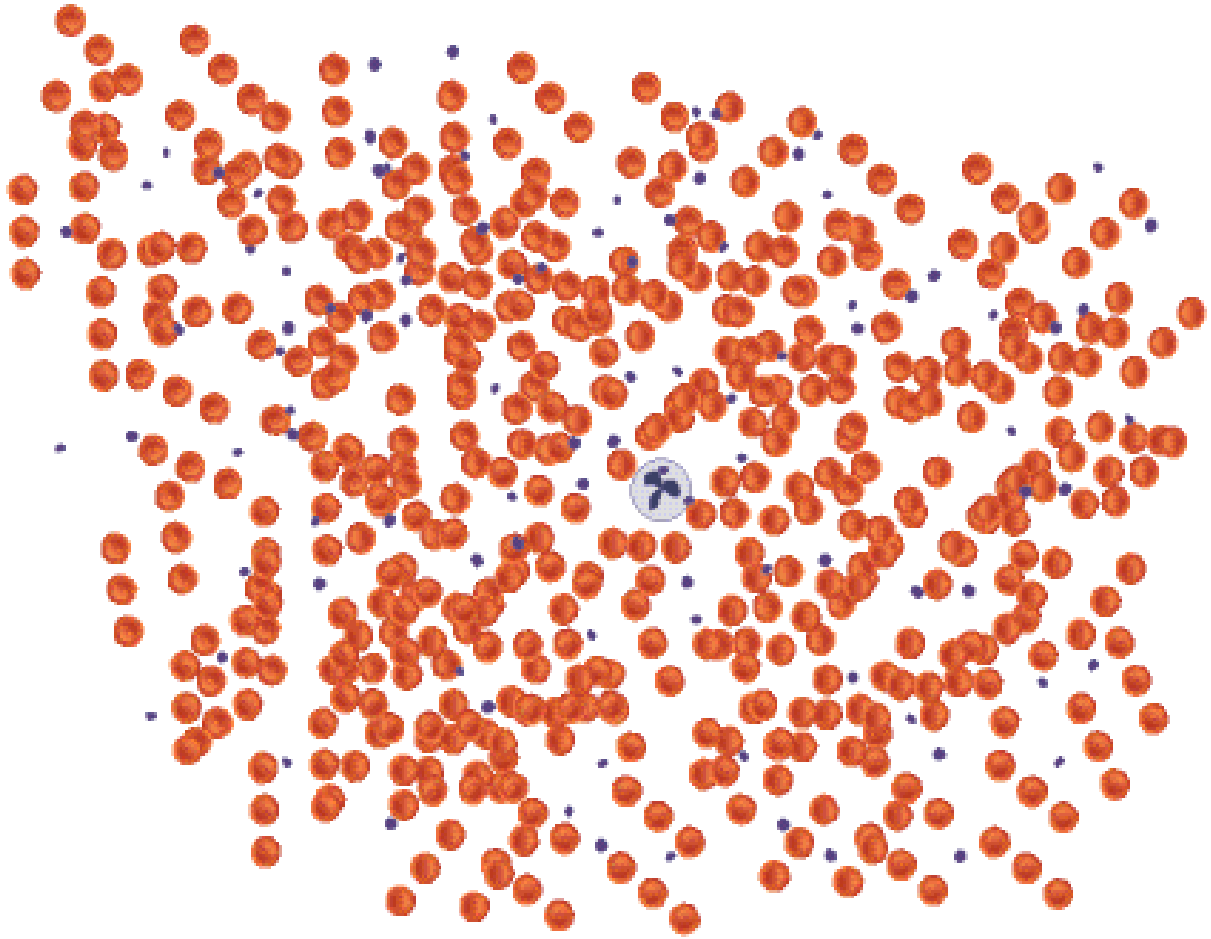


- The red blood cell
  size: 30 - 250 fl

  Number: **Females: 3.5 - 4.5 x 10^{12} / l**
  Males: 4.5 - 5 x 10^{12} / l

- The platelet
  size: 7 - 12 fl number: 150 - 350 x10^9 / l

Typical Blood Smear



The Red Blood Cell

- **Morphology:** No nucleus
Biconcave and elastic
- **Size:** 7 - 8 um
- **Lifetime:** 120 days
- **Function:** Transports oxygen and carbon dioxide

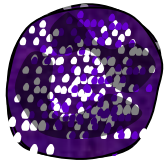
Hemoglobin

- **HGB**: concentration of hemoglobin in whole blood
- One of the most common parameter in clinical use
- A cyanid complex is still the reference method, but today most analysers use non-cyanid reagents due to the toxicity of cyanid.
- Concentration can be given in g/dl, mmol/l, or g/l
- Normal ranges
  Males: 13.5 - 16 g/dl
  Females: 11 - 15 g/dl

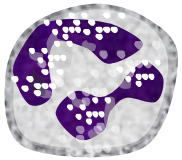
The Platelets

- Morphology: Small fragments (F) from the megacaryocyte (D)
- Size: 7 - 11 fl
- Lifetime: 8 days
- Function: Coagulate the blood

The White Blood Cells

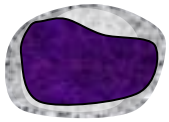


Neutrophils, 55 - 65% → **GRAN**



Eosinophils, 1 - 5%

Basophils, 0 - 1%

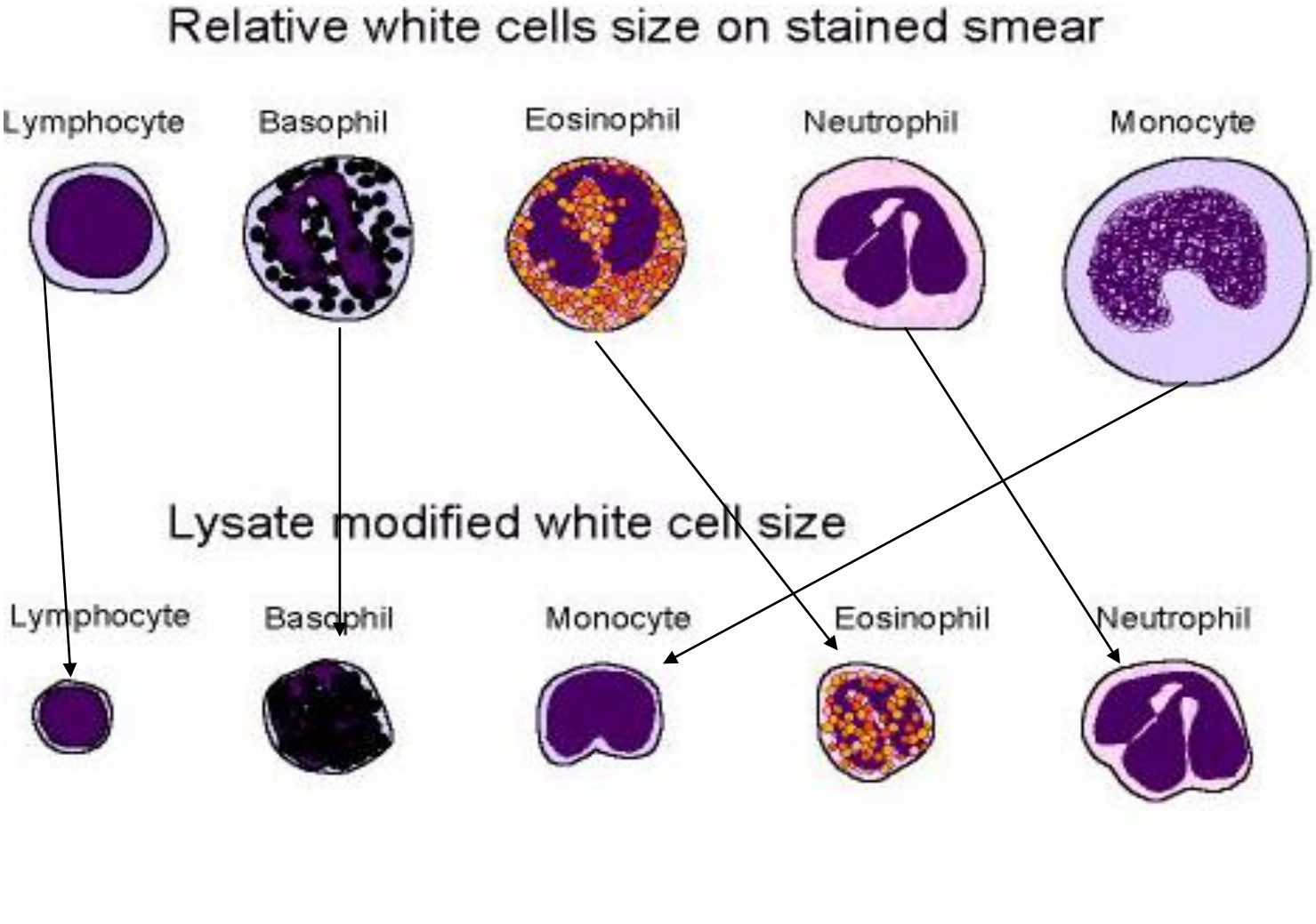


Monocyte, 3 - 8%

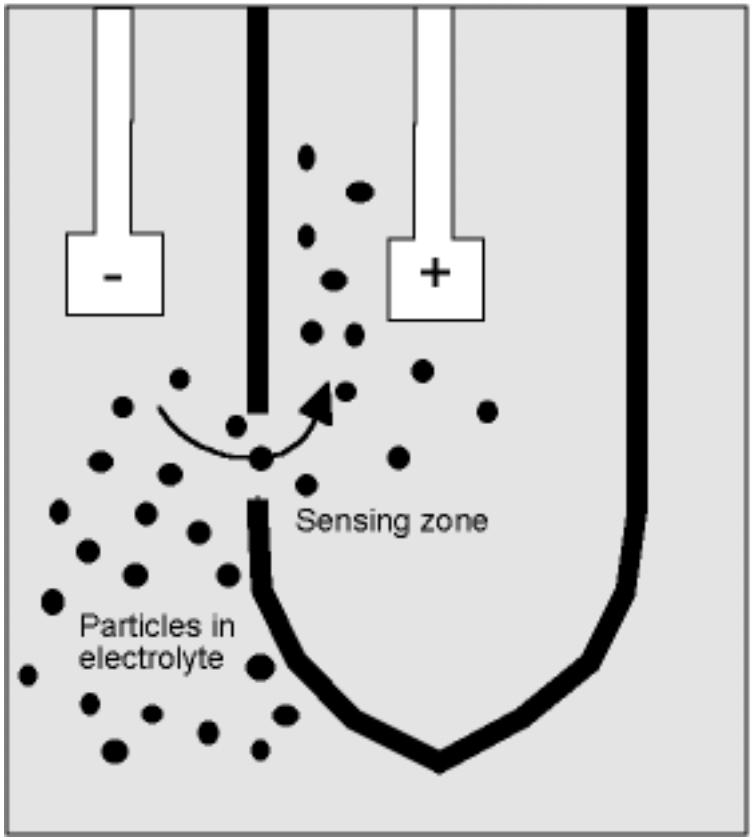
→ **MID**

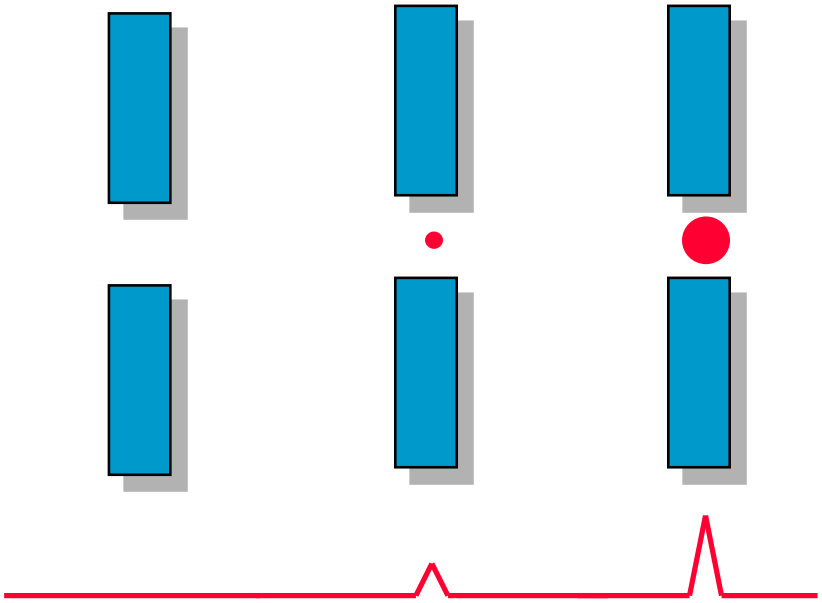
Lymphocyte, 22 - 35% → **LYMPH**

How WBC looks like after Lyser is used



The Impedance Principle





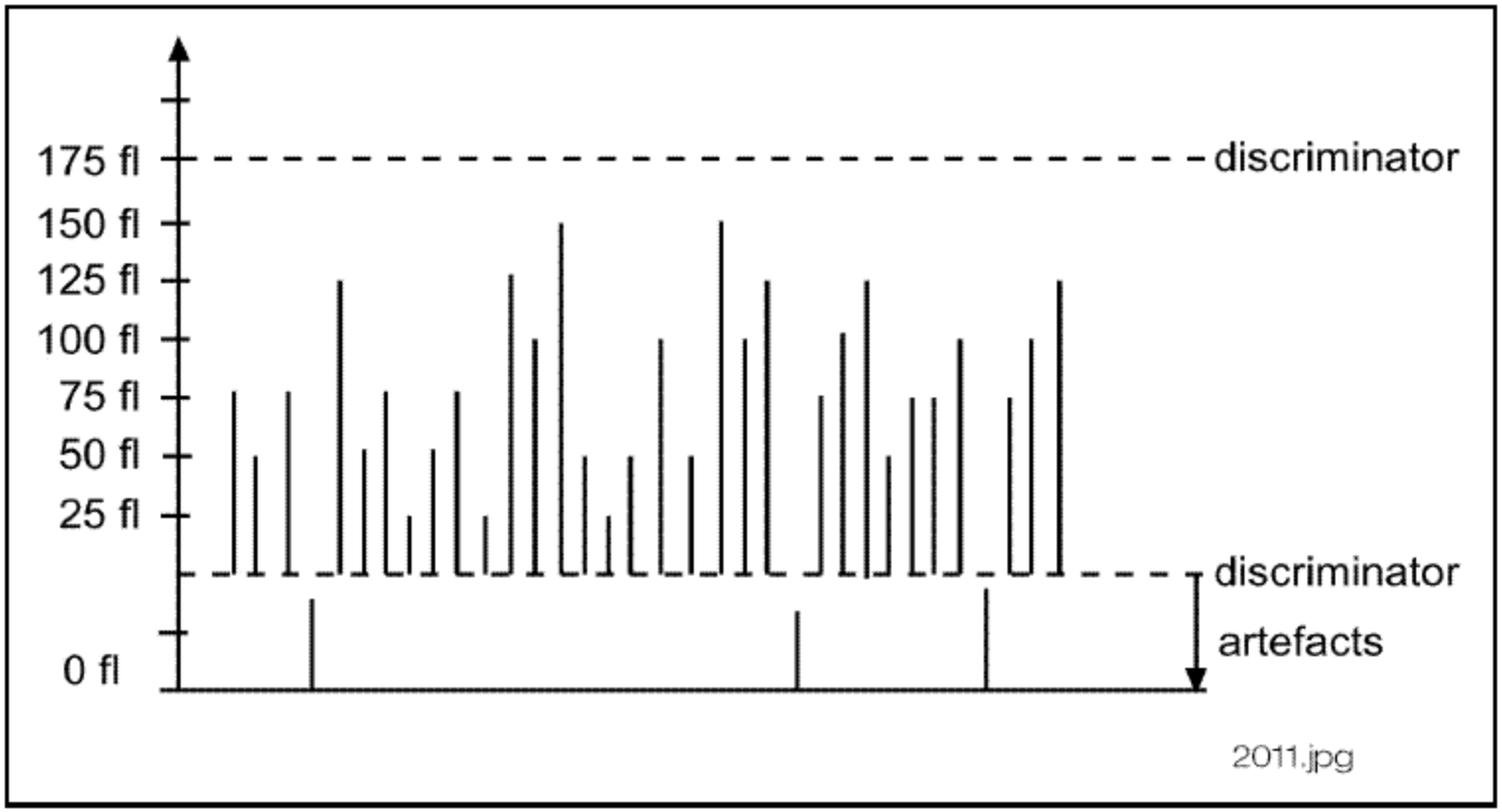
U = I x R

R = Resistance (Always changing)

I = Electric current (Stable)

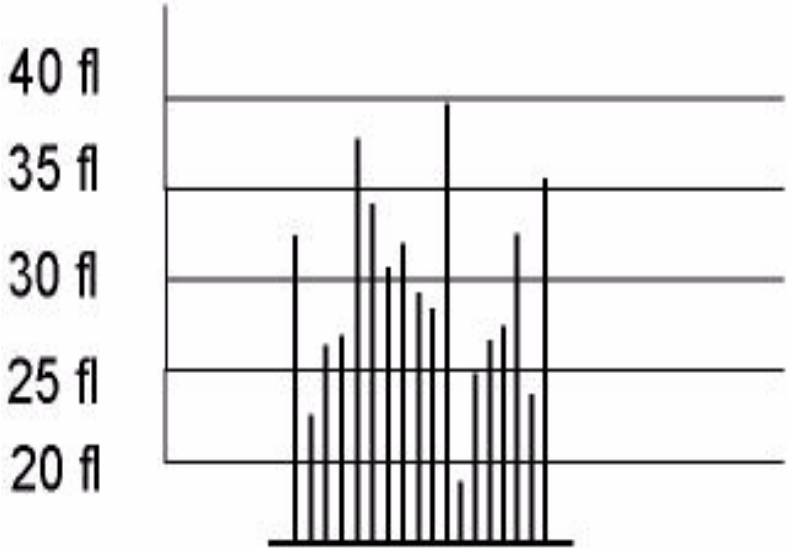
U = Electric Voltage (Change in accordance with change of R)

Size Distribution Graphs

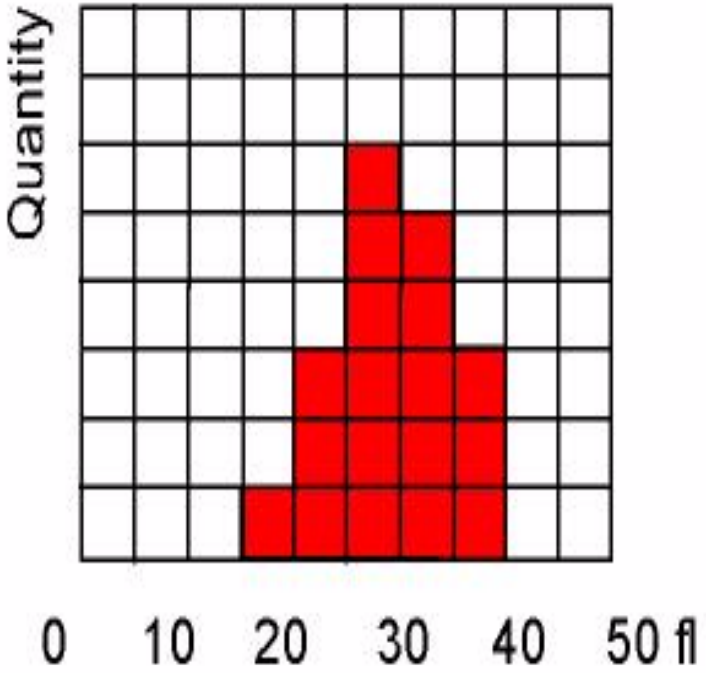


Size Distribution Graphs

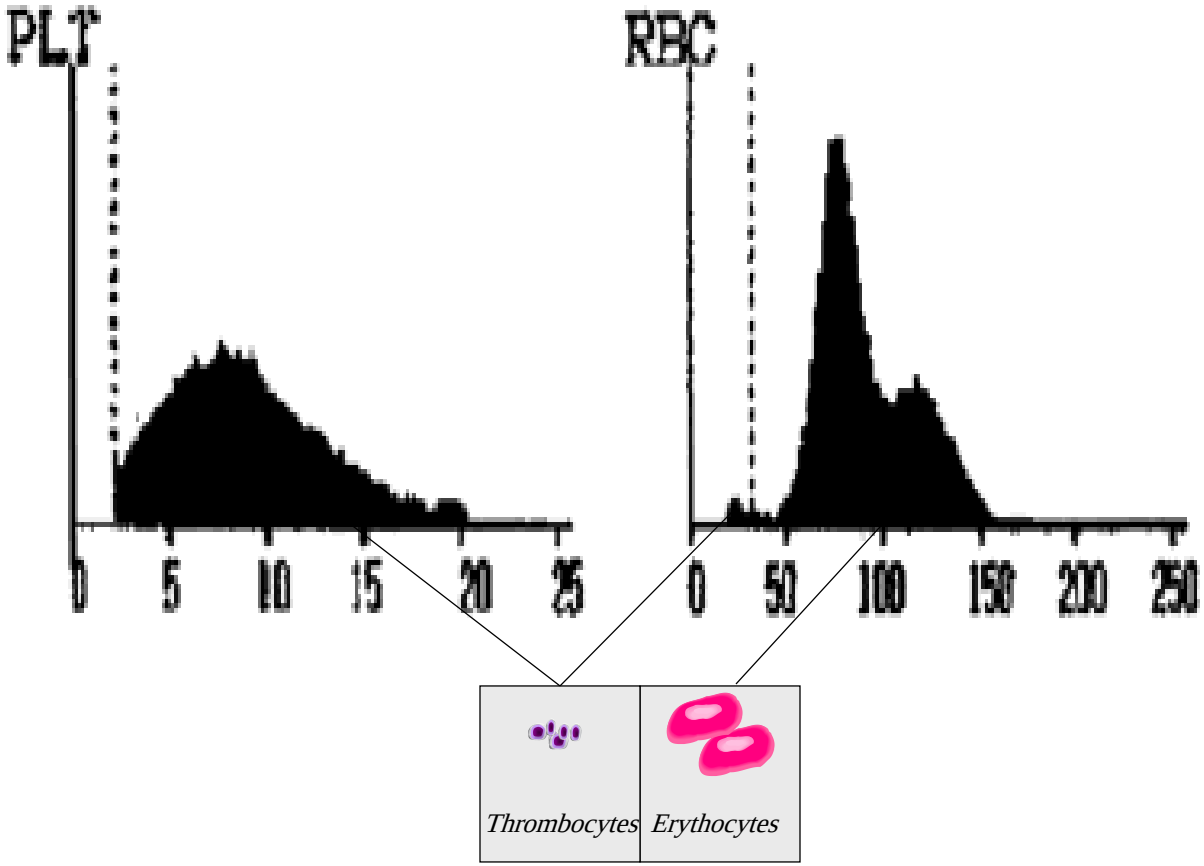
Pulses



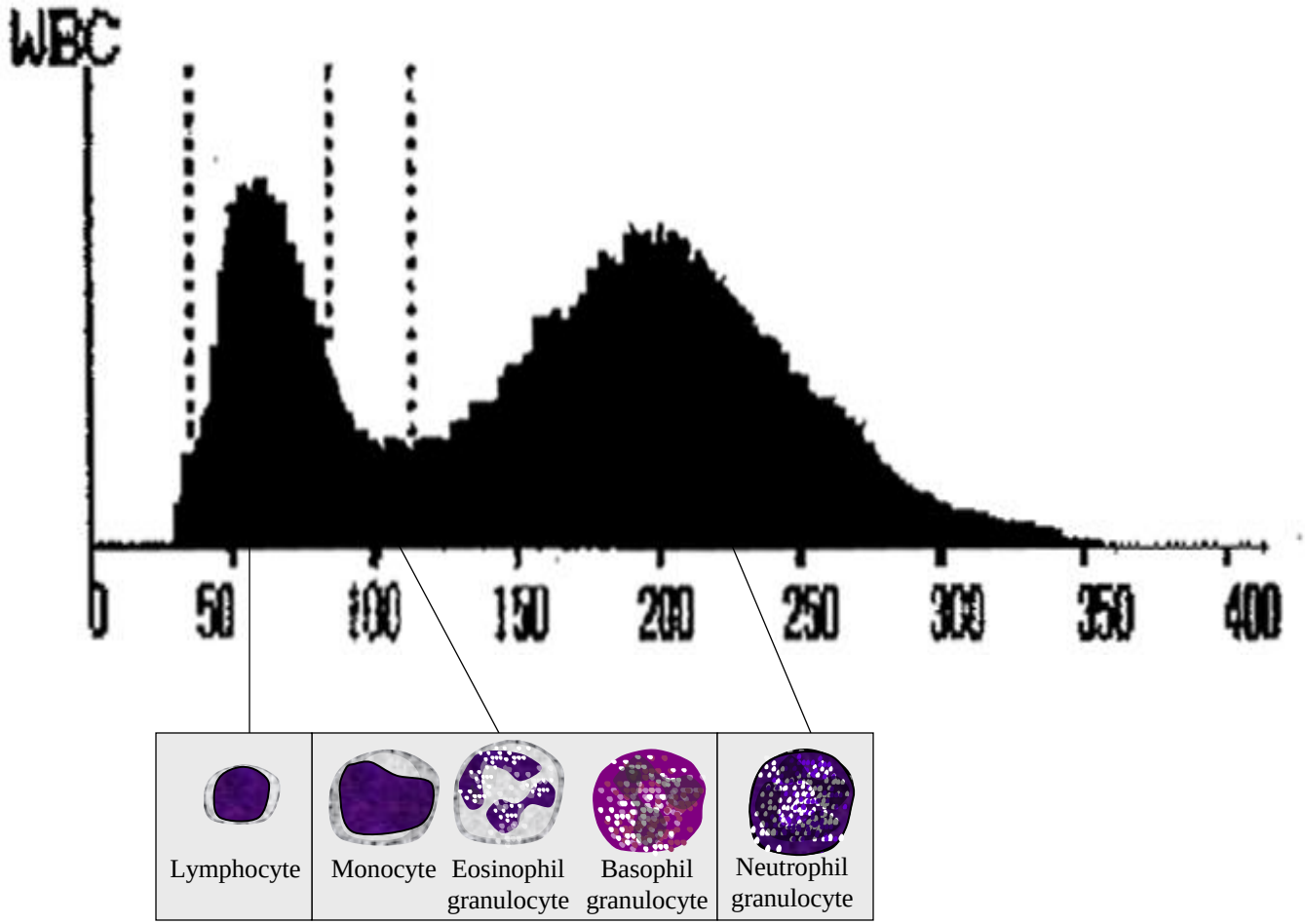
Histogram



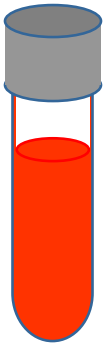
Histogram RBC&PLT



Histogram WBC

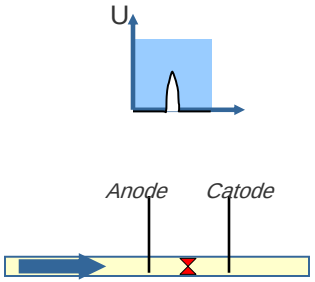


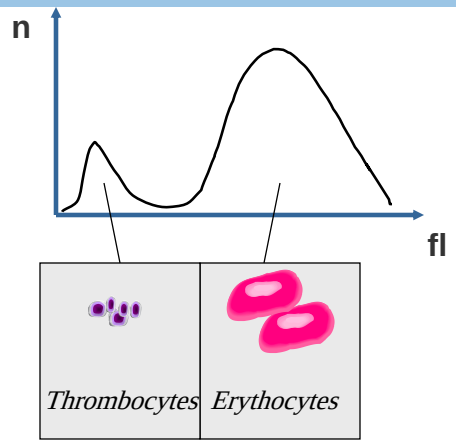
3-part — Analyzing Principle

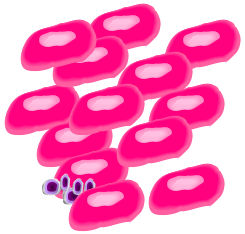


Red blood cells & Thrombocytes

+ *Diluent*
1:40 000



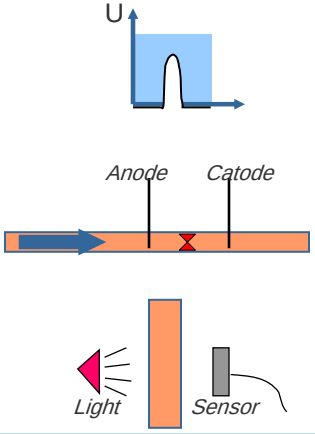


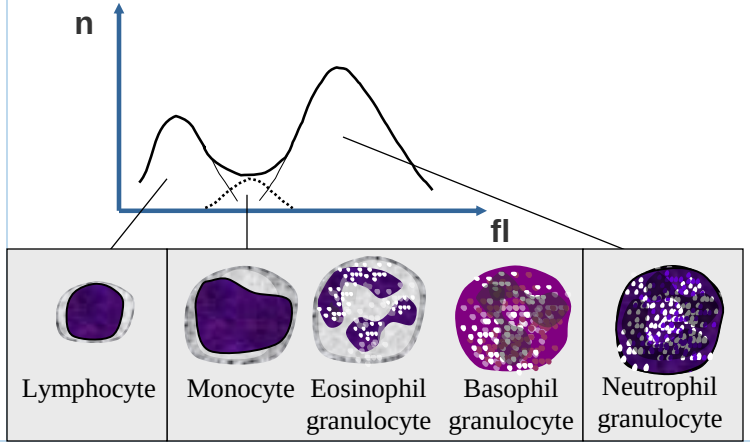


White blood cells & Hemoglobin

+ *Diluent*
1:400

+ *Lyzer*





Reqirement of Impedance Method

Correct cell dilution

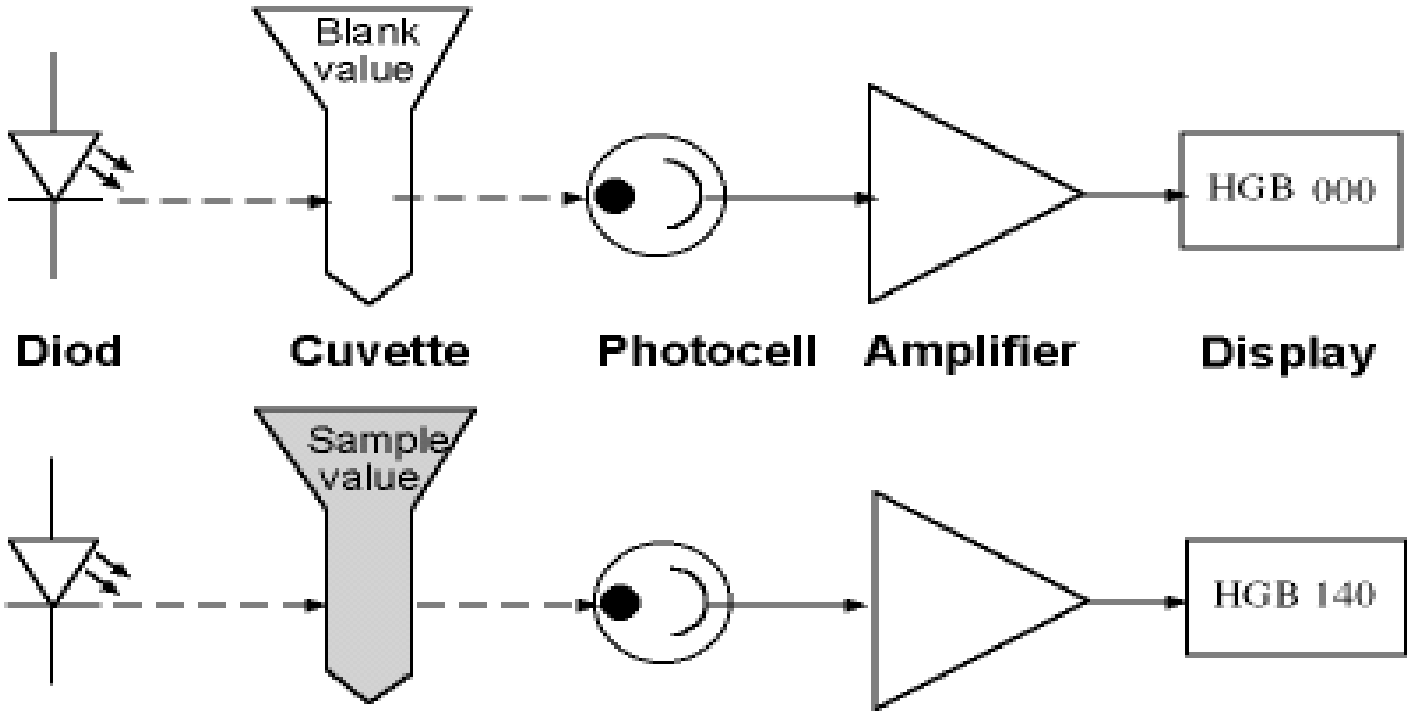
Sufficient and proper mixing of the cell dilution

Constant flow rate through the orifice

A constant radius of the orifice

A constant measuring volume

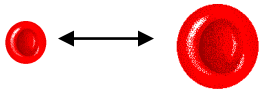
Photometry for HGB



RBC Parameters (1)-From Measuring

- **RBC: red blood cell concentration**
  Females: 3.5 - 4.5 x 10^{12} / l
  Males: 4.5 - 5 x 10^{12} / l

- **MCV: mean cell volume of red blood cells**
  80-90 fl



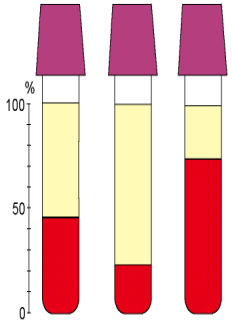
RBC Parameters (2)-From Calculation

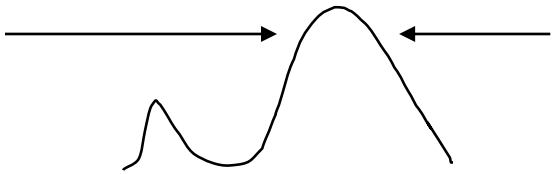
- **HCT: hematocrit = proportion of total packed**

  red cell mass to whole blood.
  HCT = RBC x MCV

  Males: 40 - 54%
  Females: 36 - 47%
  Children, 1 - 10 years: 35 – 37%

- **RDW: red cell distribution width**





Parameters Generated from RBC and HGB

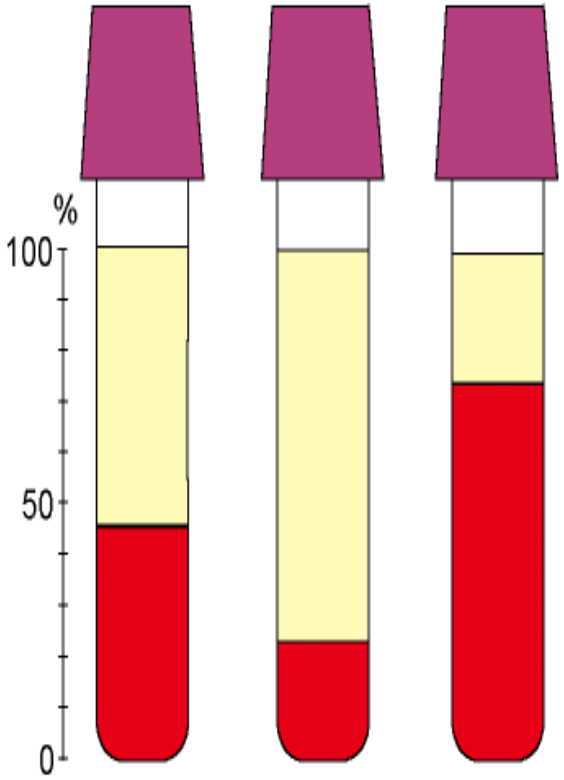
MCH: mean cell hemoglobin = HGB / RBC

clinical use is limited.

MCHC: mean HGB concentration of the clinical value can be given together with MCV and RDW.

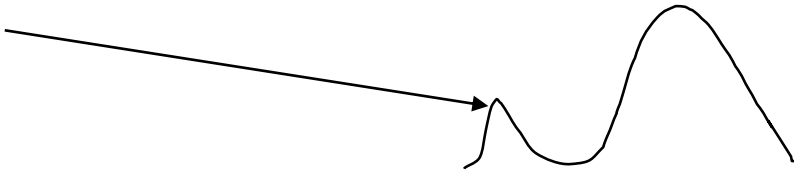
RBC = HGB / (MCV x RBC)

- limited clinical use
- the best parameter for quality control
- normal range: 32 - 36 g/dl



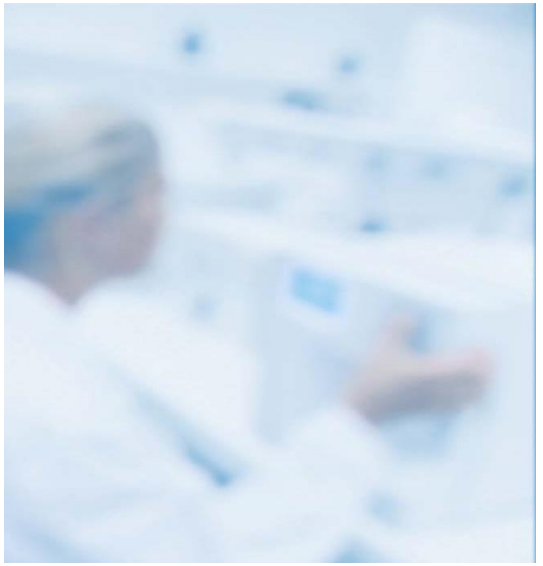
Platelet Parameters

- **PLT**: platelet concentration
  150 - 350 x 10^9 / l



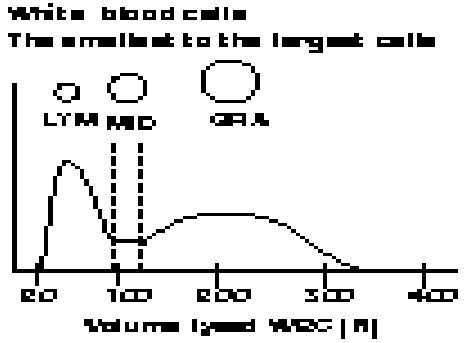
- **MPV**: mean platelet volume
  7-11 fl
- **PDW**: platelet distribution width
  SD/MCVx100

  not FDA approved, little clinical use
- **PCT**: platocrit = PLT x MPV
  not FDA approved, little clinical use
- **LPCR**: large platelet concentration ratio
  not FDA approved, little clinical use

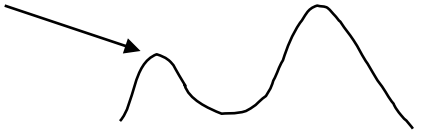


White Blood Cell Parameters

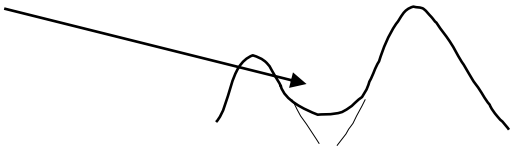
WBC: **white blood cell concentration 3.5 - 8 x 10^9 /l**



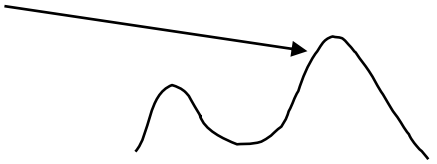
LYMPH and LYMPH%: **number and proportion of lymphycytes of all WBC 20 - 48%**



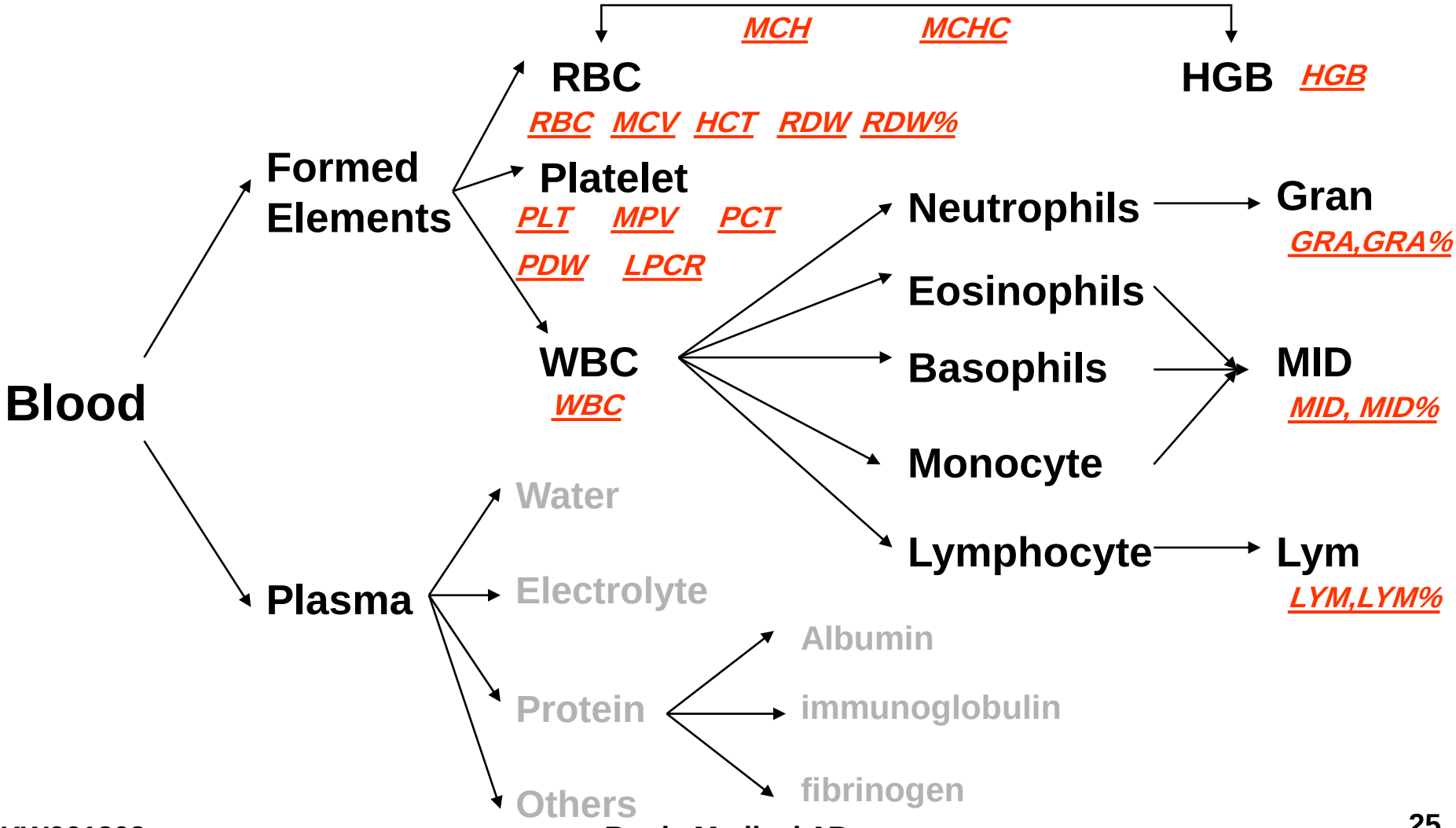
MID and MID%: Number and proportion of monocytes, basophils and eosinophils of all WBC 2 - 10%



GRAN and Gran%: **number and proportion of neutrophils of all WBC 42 - 80%**



Review of Parameters



Most Crucial Parameters

1. HGB: Hemoglobin
   - low value means anaemia

2. WBC: White blood cell count
   - high number indicates infection

3. MCV: Mean cell volume of red blood cells
   - for investigation of anaemia together with RDW
   - high value can indicate high alcohol consumption

4. PLT: Platelet count
   reduced number due to anaemia, leukaemia, drugs, Malignancy or infection

5. 3-part differentiation of WBC
   - high LYMH indicates viral infection
   - high GRAN indicates bacterial infection

Handling of Samples

- K2 EDTA shall be used as anticoagulant
- 15 minutes ”rest” after drawing, after that gentle mixing
- WBC differential - sample not older than 8 hours
- PLT count - sample not older than 24 hours
- Pre-diluted capillary samples - measure as soon as possible