INTERPRETATION OF HISTOGRAM

Dr. Behrooz Ghezelbash

Assistant Professor of Laboratory Hematology and Blood Banking

CBC (Complete blood count)

- همراه با داده های عددی، هیستوگرام و سیتوگرام ها پراکندگی آنالایزر خونی خودکار اطلاعات ارزشمندی را ارائه می دهد.
- این مهم است که اپراتورها ضمن تفسیر داده های عددی، درک اساسی از خروجی گرافیکی داشته باشند.
- این می تواند ابزار تشخیصی داده های خودکار را تقویت کند و در نهایت بیمار از تشخیص و نتیجه بهتر بهره مند شود.
- با این حال برخی اختلالات خون شناختی و غیرموفولوژیکی با استفاده از آنالیز خودکار CBC قابل تشخیص نیستند، لازم است علاوه بر اسمیر خون محیطی، تست های تکمیلی روی آنها انجام شود.

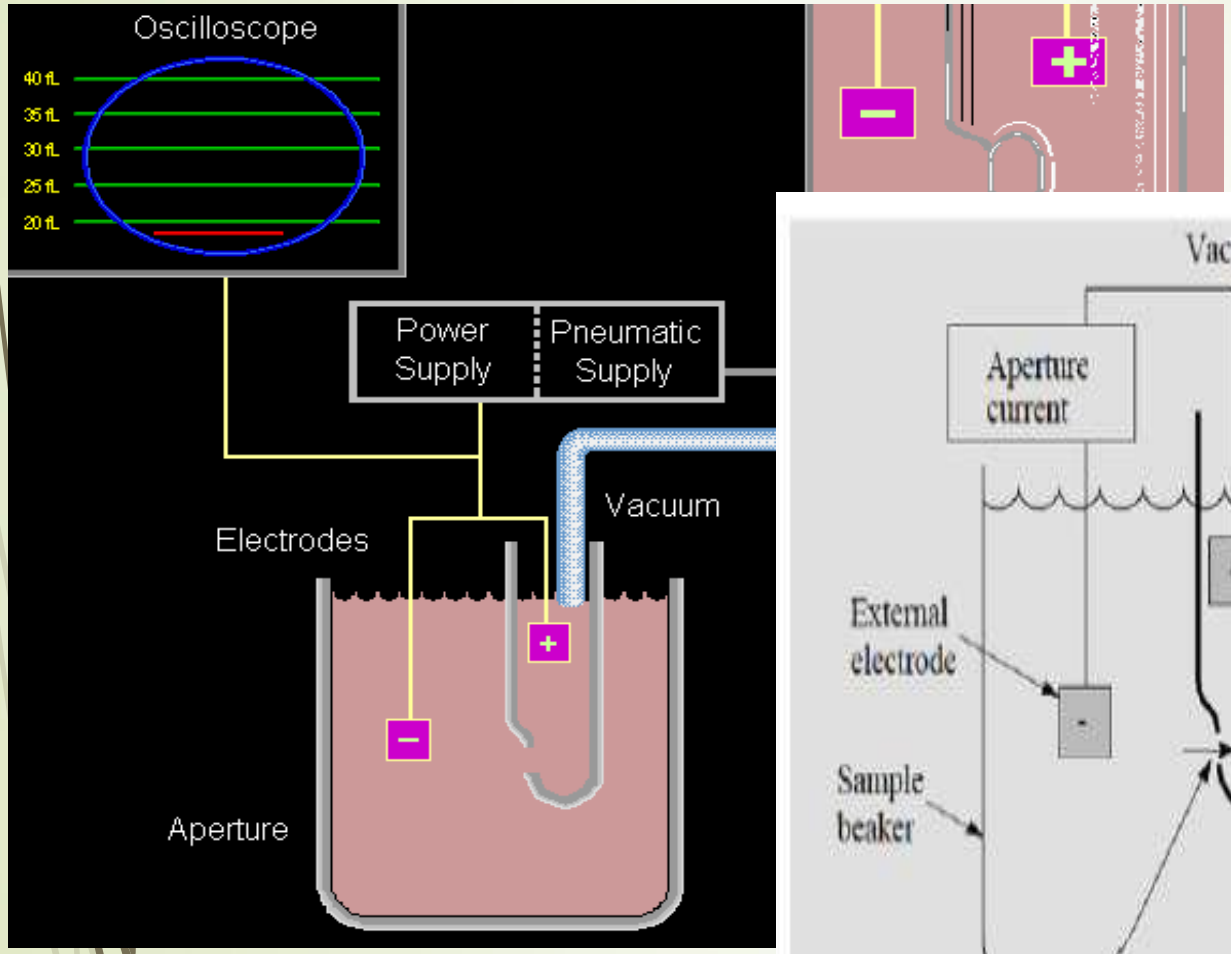
پارامترهای مختلف CBC

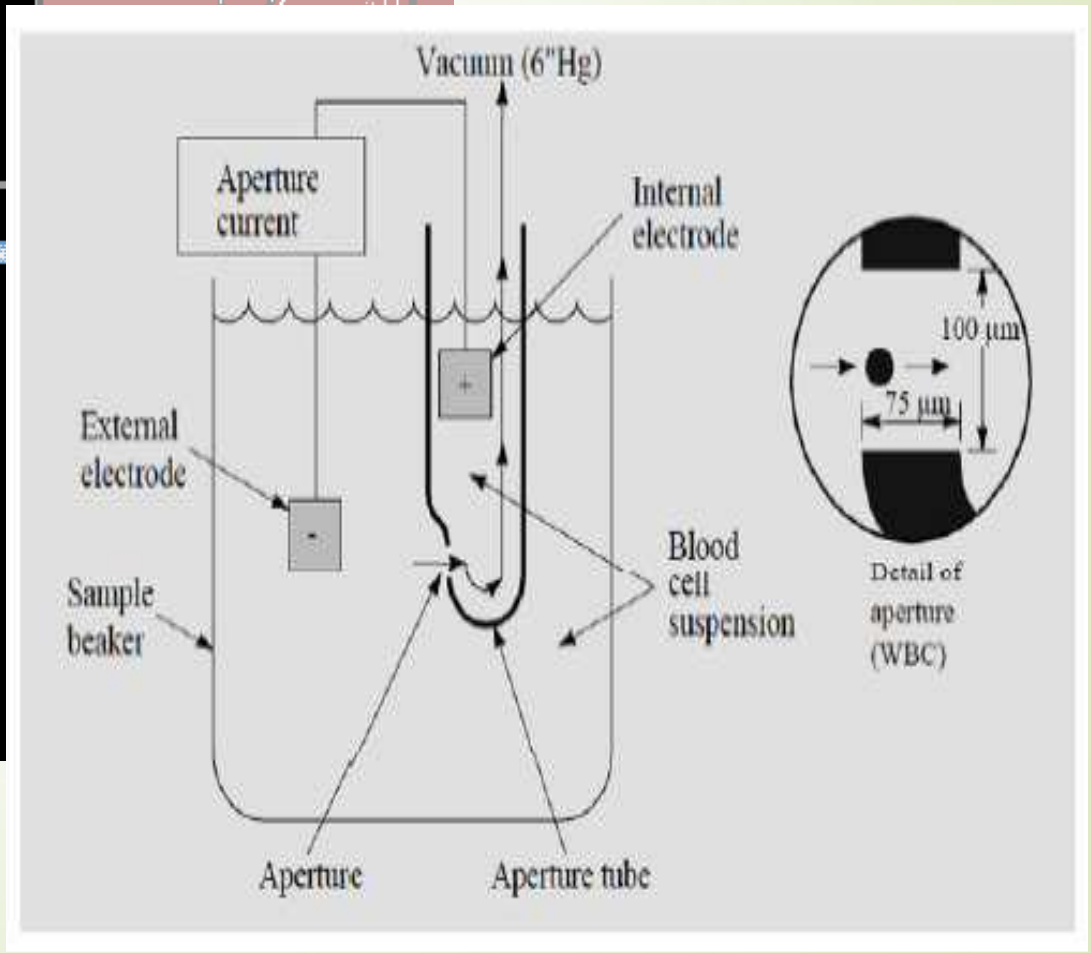
• RBC count • Hgb • Hct • MCV • MCH • MCHC • RDW-SD • RDW-CV • NRBC% • NRBC# • RET% • RET# • IRF-Immature Reticulocyte Fraction • RET-He	• WBC count • NEUT% • LYMPH% • MONO% • EO% • BASO% • NEUT# • LYMPH # • MONO# • EO# • BASO# • IG%—Immature Granulocyte Count • IG#—Immature Granulocyte Count	• PLATELET count • MPV • Pct • PDW • *IPF-Immature platelet fraction (measurement of reticulated platelets) to monitor thrombopoietic activity of the marrow* • *HPC-Quantitative hematopoietic progenitor cell count as a screen for the optimal presence of hematopoietic progenitor cells in peripheral blood and cord blood samples*
(#=Absolute count, % = percent count)		

اصول کار دستگاههاي سل کانتر

ابتدا با رقت 1 به 125 جهت سنجش هموگلوبین و شمارش WBC

نمونه 1/125 برای بار دوم 50 برابر رقیق شده جهت شمارش RBC/Plt



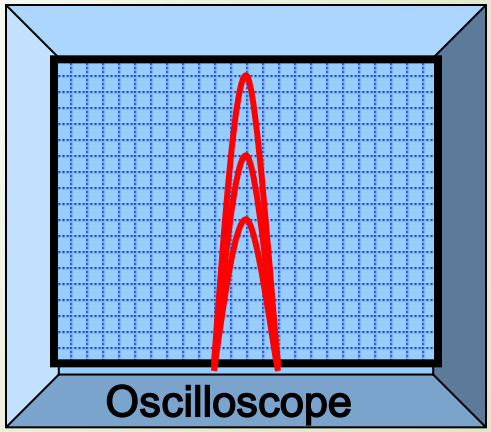


The Coulter Principle

Red Blood Cell

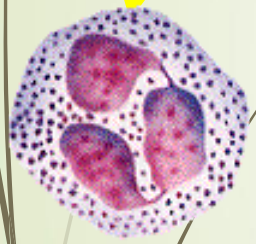
Sensing Zone

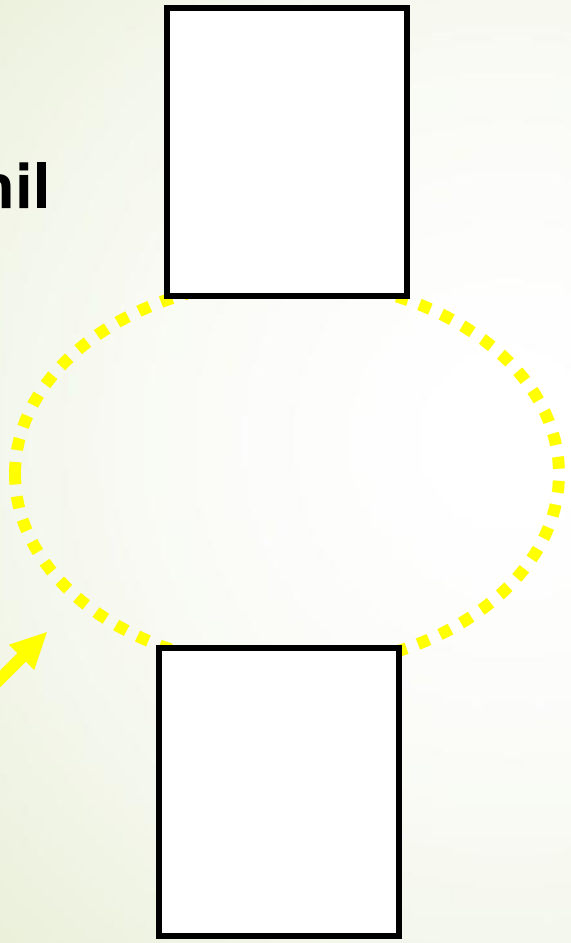
A red cell passes through RBC aperture



The Coulter Principle

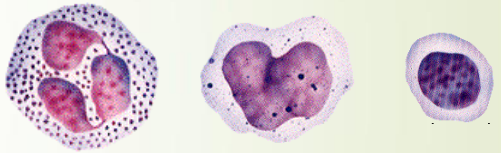
Neutrophil

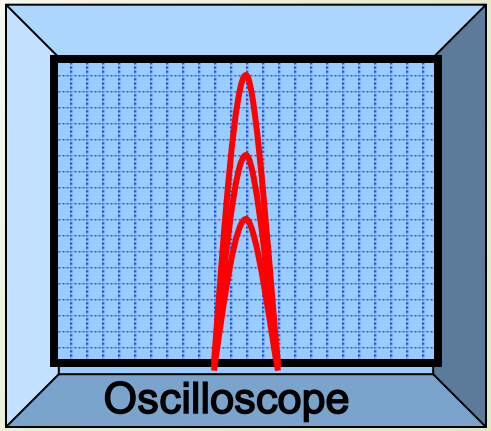




Sensing Zone

A white cell passes through WBC aperture





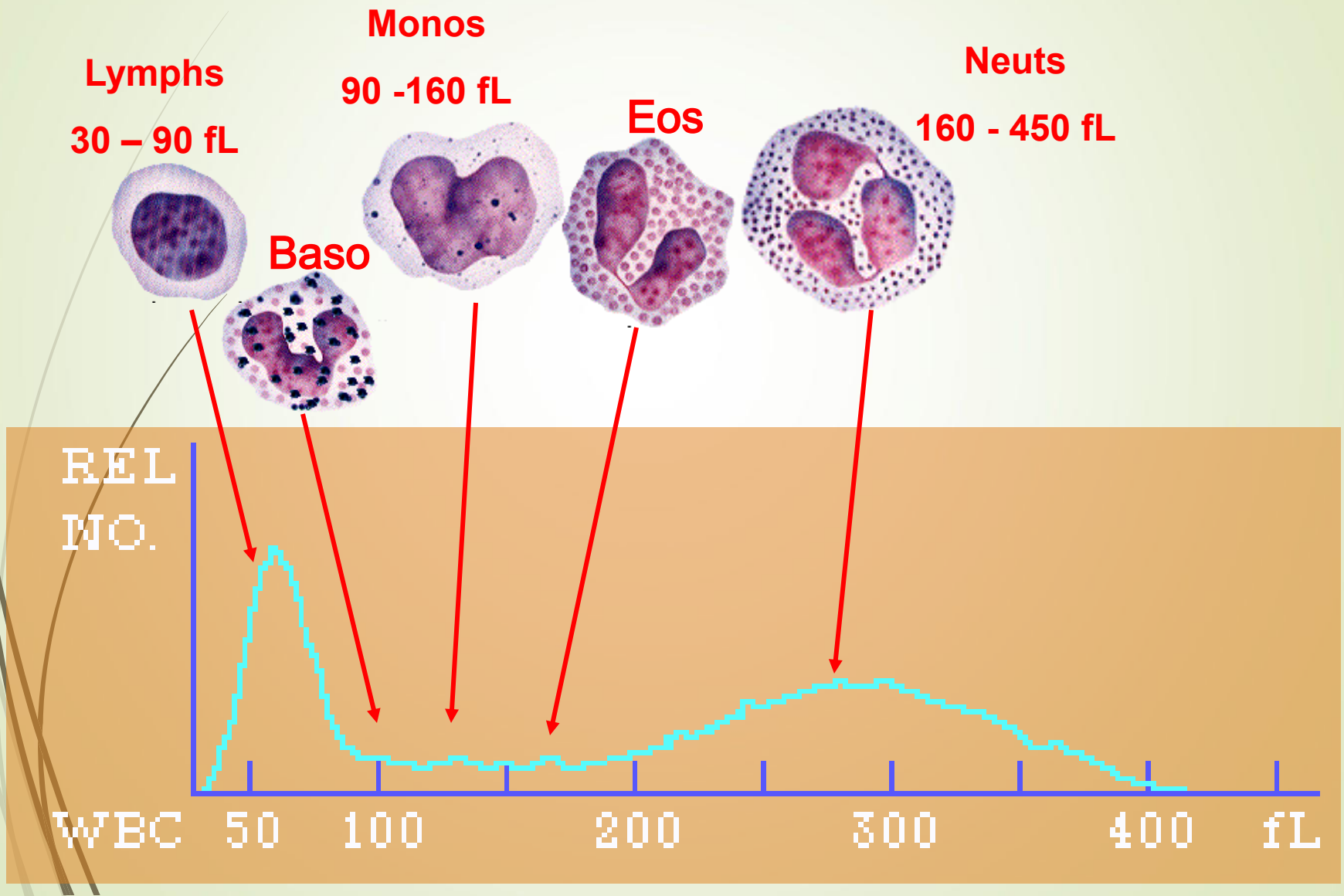
- **Discriminations thresholds**

- Platelet- with a volume of 8-12 fl are counted from 2-30 fl.
- RBC- with volume of 80-100 fl is detected from 30 -250 fl.
- WBC- RBC are lysed by lytic reagent .
- the different WBC discriminator set at different levels between the ranges of 30-450 fl.

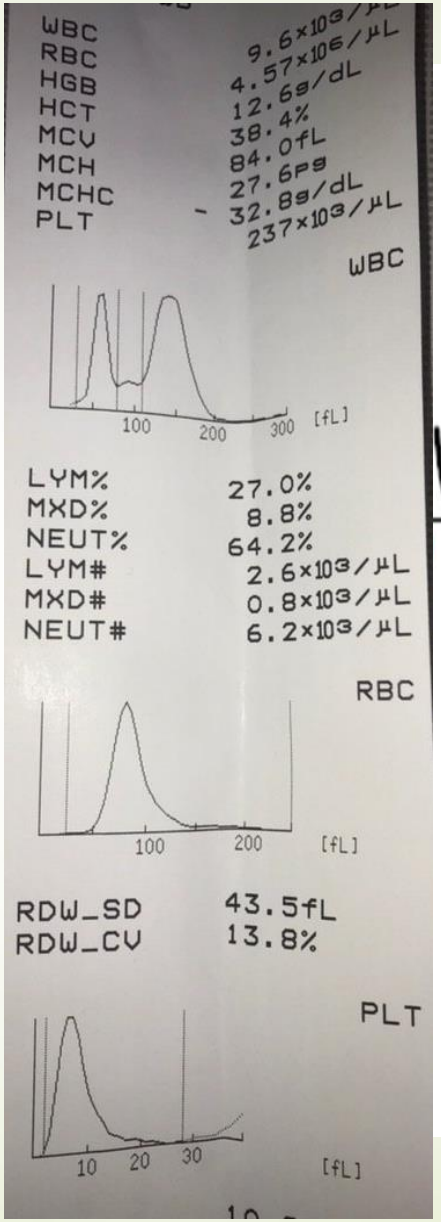
- Before adding lysing reagent — After
  - Cell diameter in µm — fl
- Neutrophils — 10 - 15 — **150 - 250**
- Basophils — 9 - 14 — 70 - 130
- Eosinophils — 11 - 16 — 90 - 140
- Monocytes — 12 - 20 — 90- 150
- Lymphocytes — 7 – 12 — 30 - 90

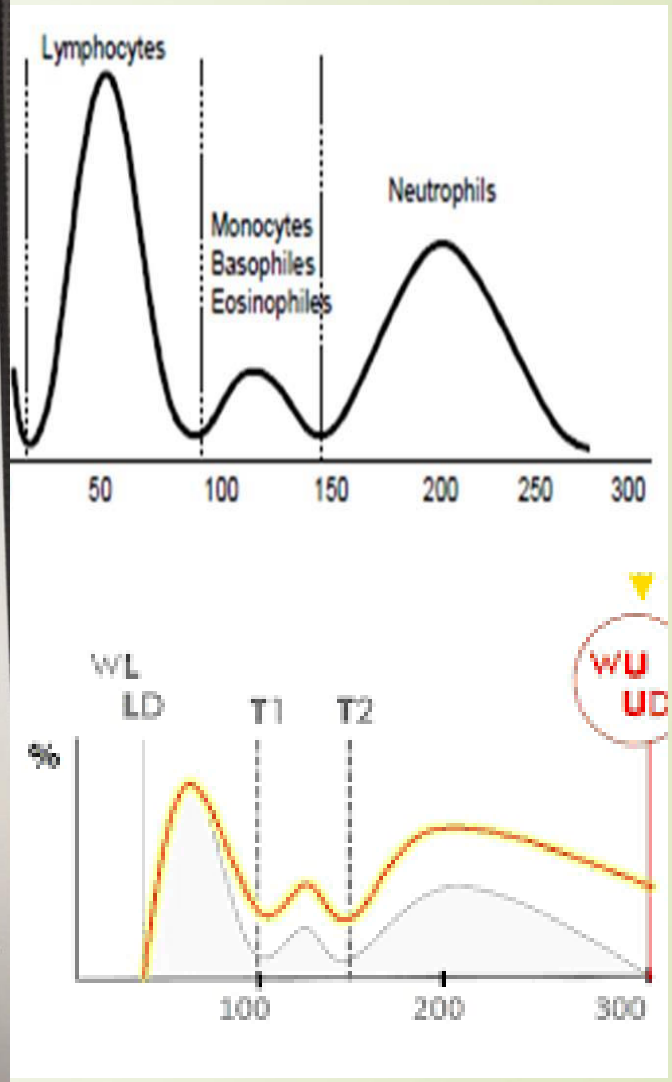
نوع سلول	اندازه واقعی در خون	اندازه در سیستم امپدانسی
لنفوسیت	کوچکترین، ۱۹۵fL-۱۴۰	کوچکترین، ۹۰fL-۳۵
منوسیت	بزرگترین، ۳۵۰fL-۳۰۰	متوسط، ۱۵۰fL-۹۰
نوتروفیل	متوسط، ۲۹۰fL-۲۴۵	بزرگترین، ۴۵۰fL-۱۵۰
ائوزینوفیل	متوسط، ۲۹۰fL-۲۴۰	متوسط، ۱۵۰fL-۹۰
بازوفیل	متوسط، ۲۹۰fL-۲۴۰	متوسط، ۱۵۰fL-۹۰
سلول‌های غیرطبیعی	متغیر	متغیر

Coulter WBC Histogram

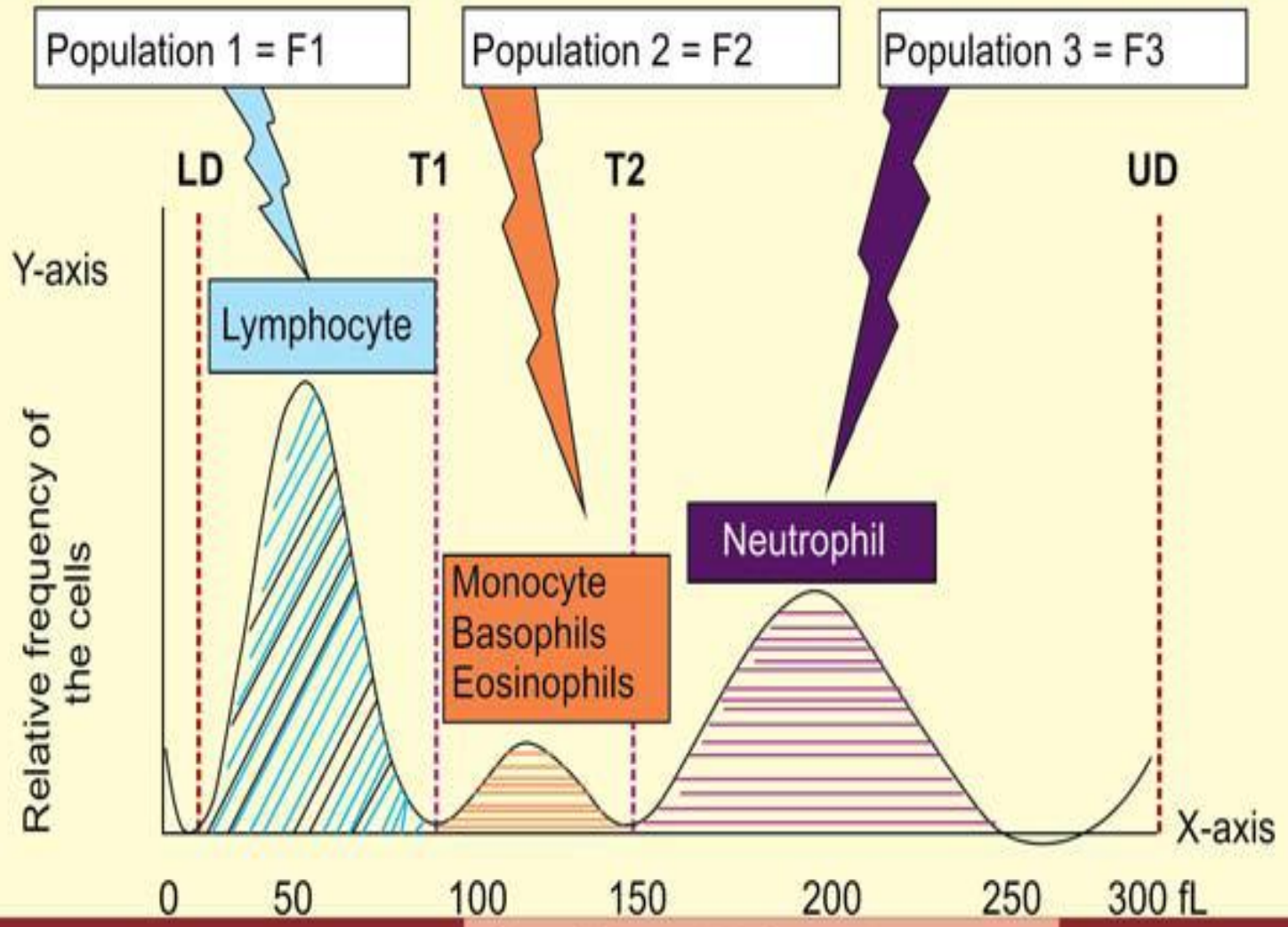


- **WL: Abnormal height at lower discriminator of WBC Histogram (LD)**
- **WU: Abnormal height at upper discriminator of WBC Histogram (UD)**
- **T1: Valley 1 not found**
- **T2: Valley 2 not found**
- **F1, F2, F3: Abnormal height at the points**

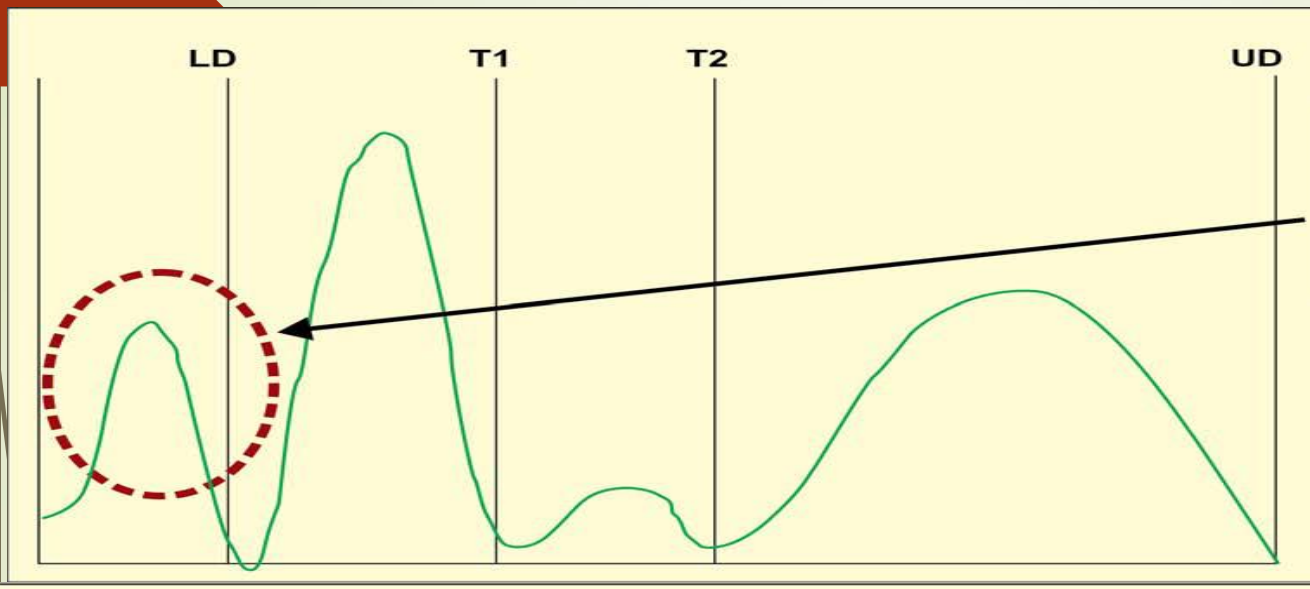




NORMAL WBC HISTOGRAM



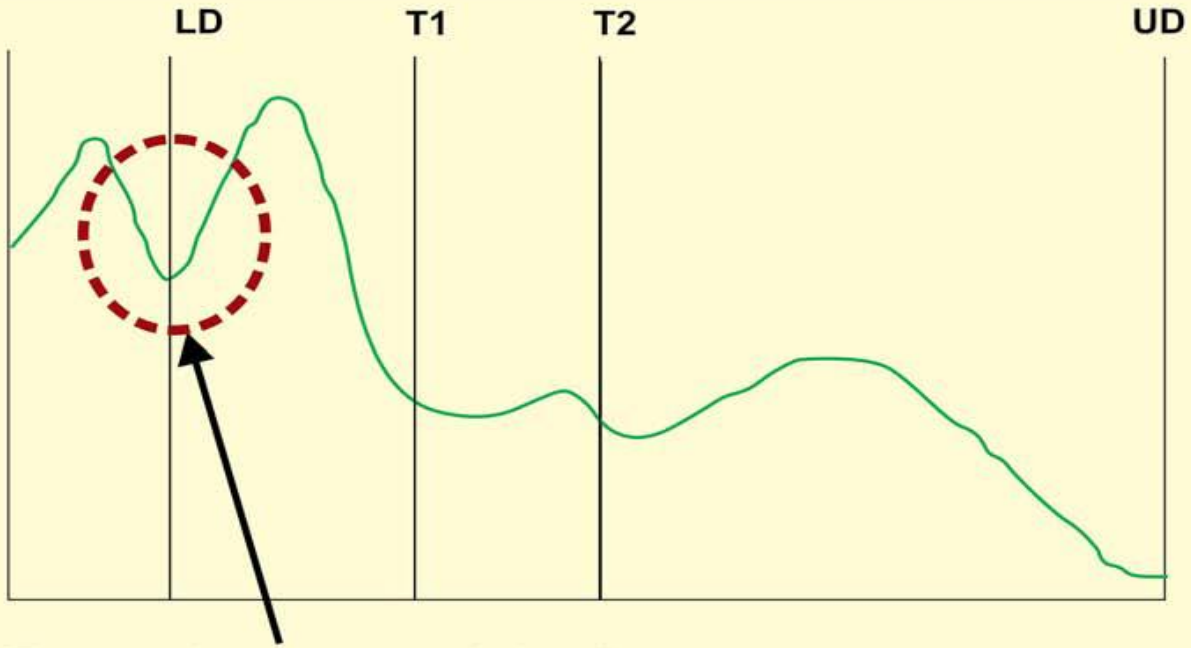
Flag " WL ", Curve does not begin at the basis line



Large numbers of particles are detected in front of lower WBC discriminator

Possible causes:

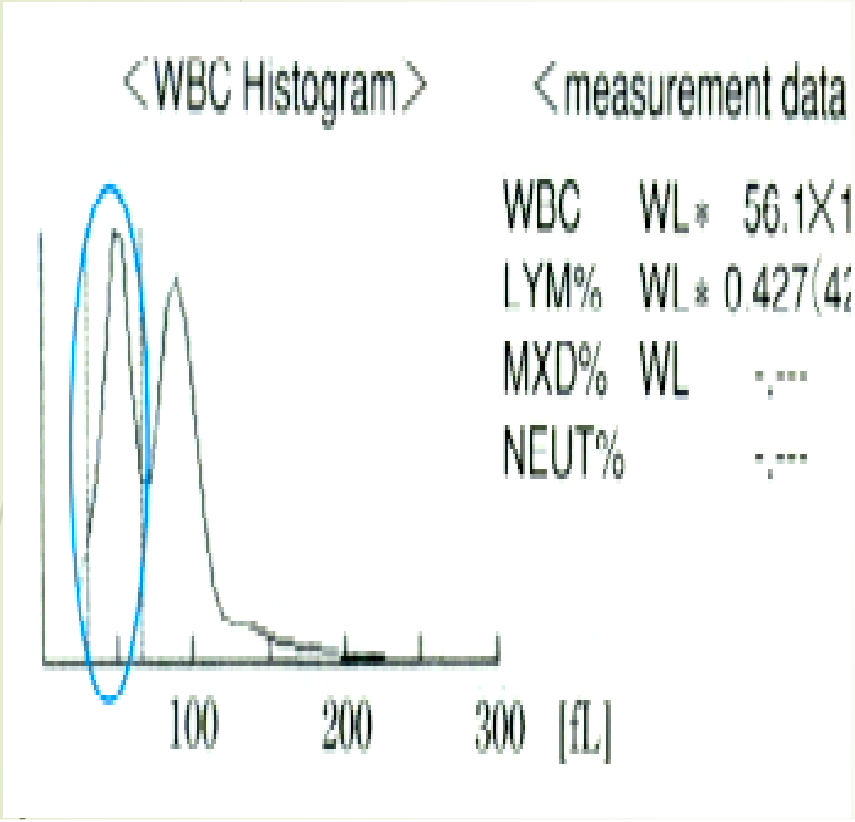
- Platelet aggregation as in EDTA incompatibility

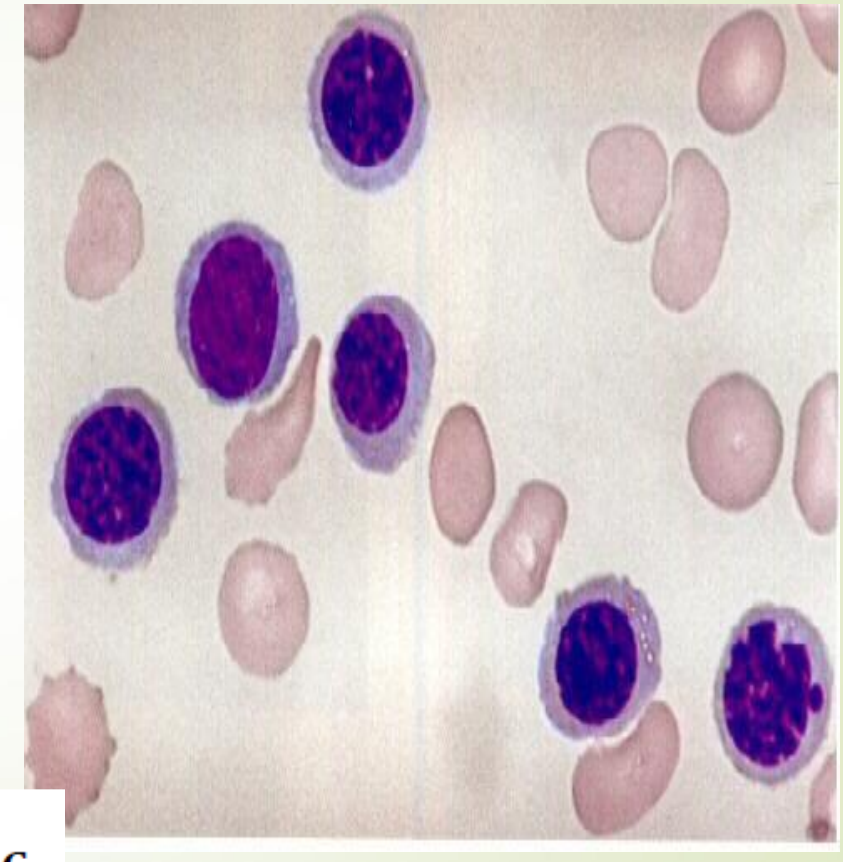


Possible causes :

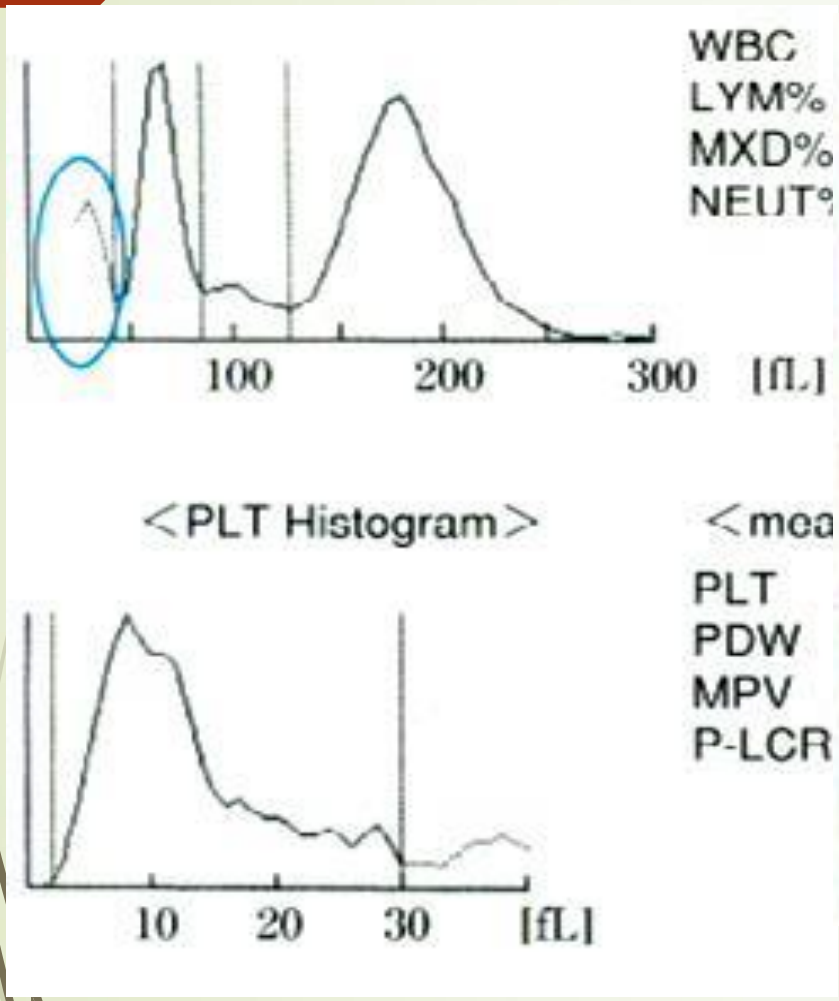
- Nucleated RBC
- Unlysed RBC
- Platelet clumps as in EDTA incompatibility and coagulated sample
- Cold agglutinins
- Impedance noise

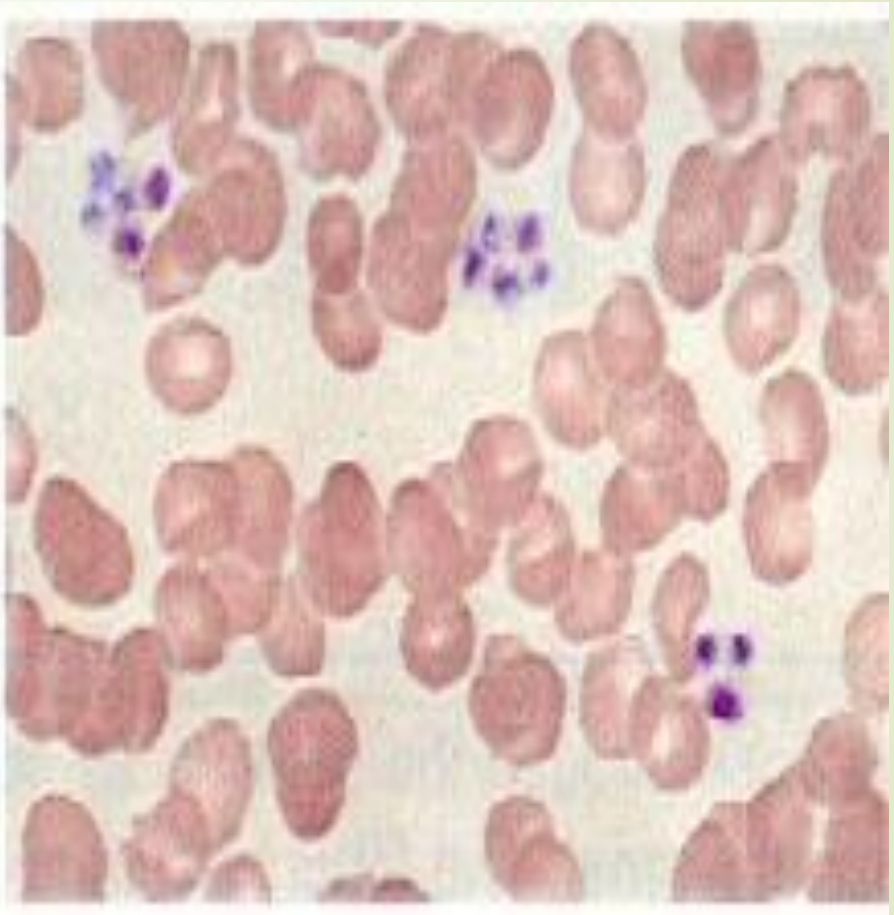
Case -





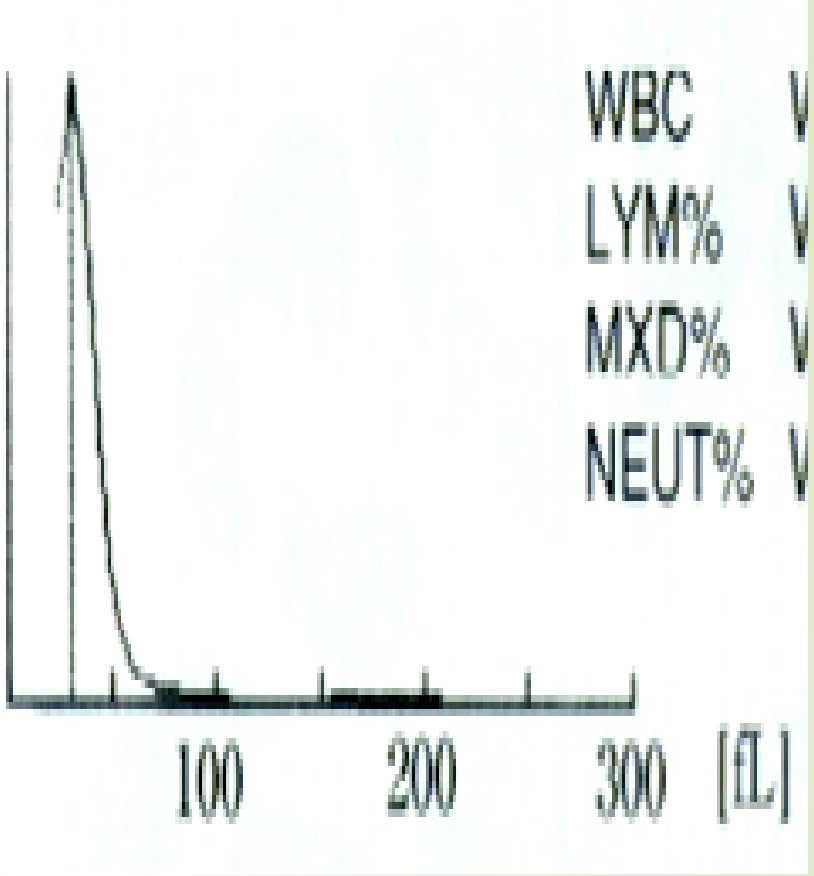
$$\text{Corrected WBC} = \frac{100 \times \text{Total WBC}}{100 + \text{NRBC}}$$

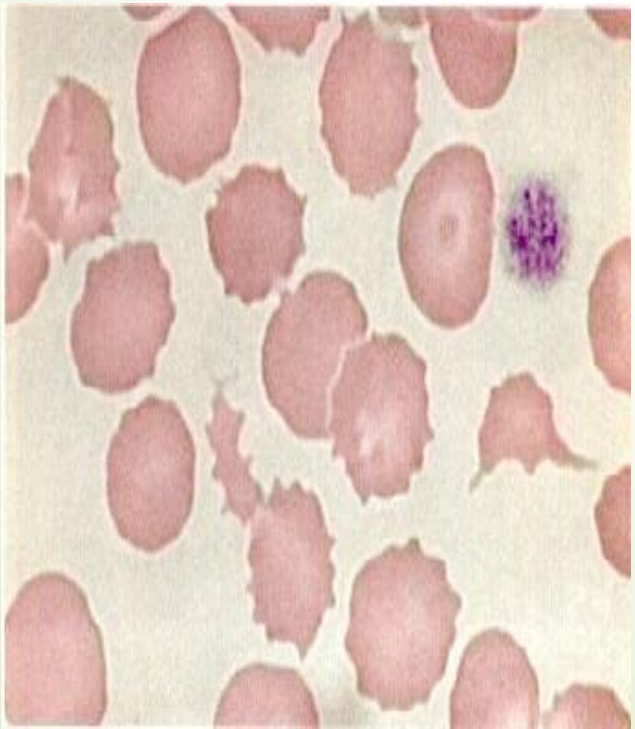

WBC
LYM%
MXD%
NEUT%
100
200
300
[fL]
<PLT Histogram>
<mea
PLT
PDW
MPV
P-LCR
10
20
30
[fL]



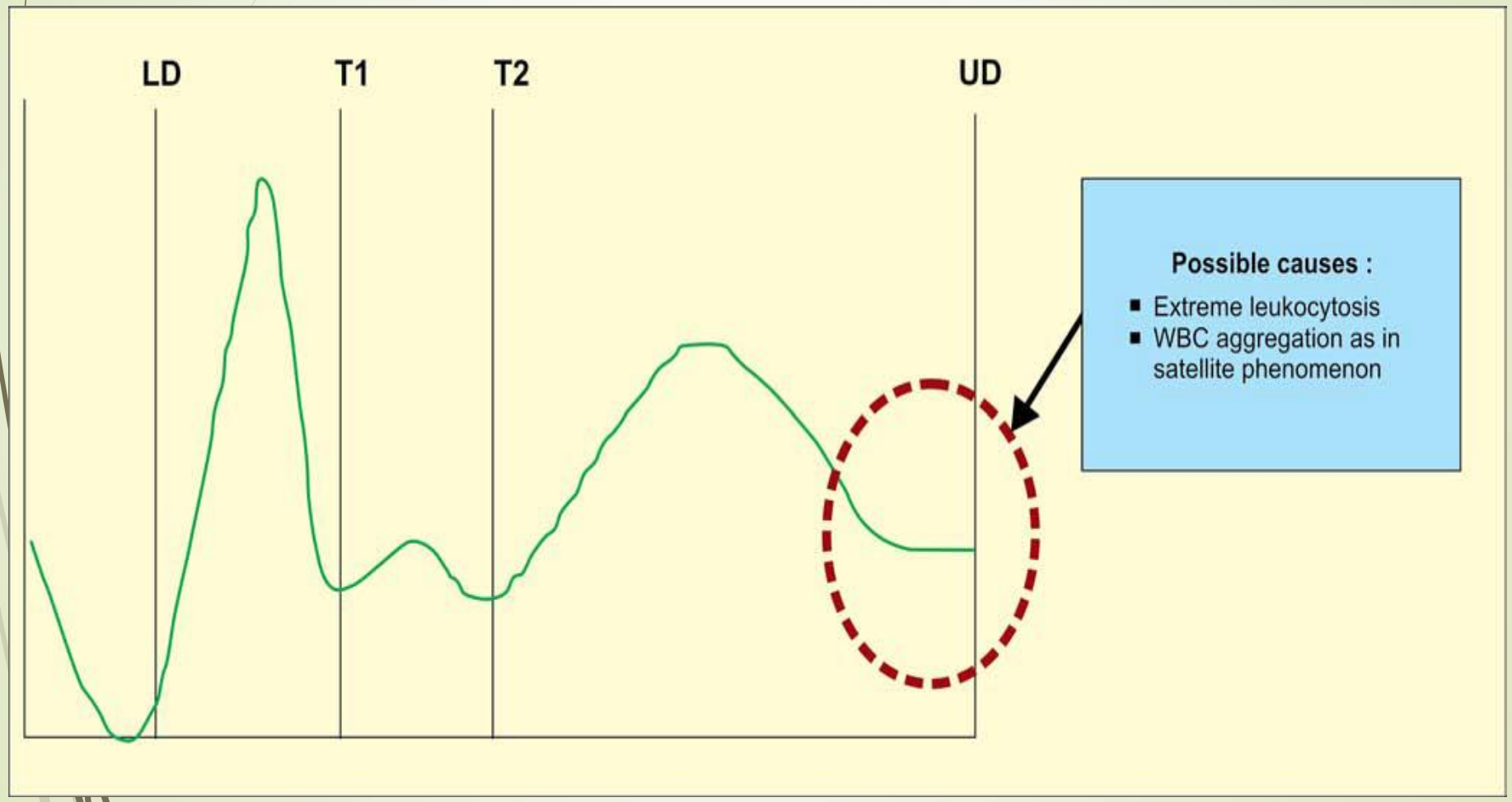
Case

- WBC — **49.4 x109/L**
- LYM% — -.---
- MXD% — -.---
- NEUT % — -.---



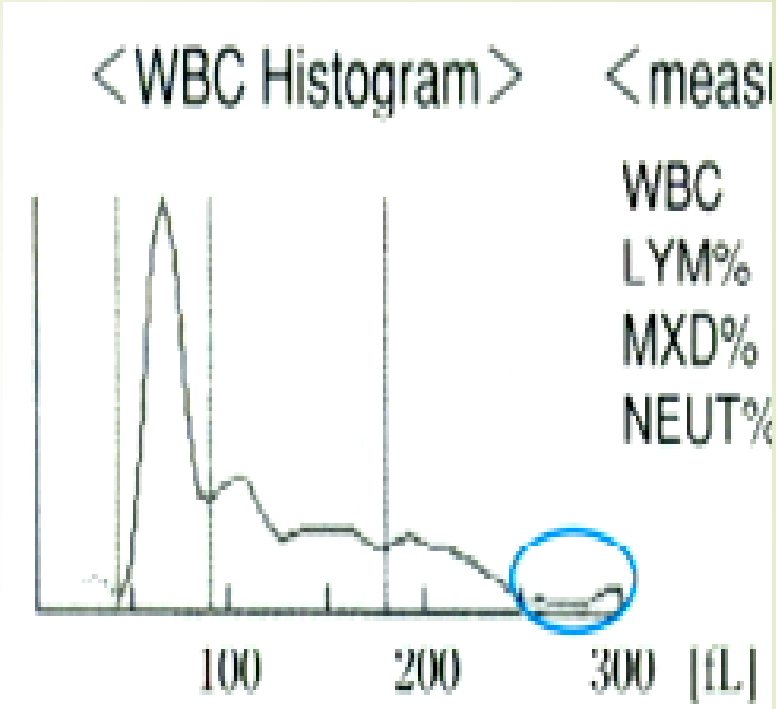


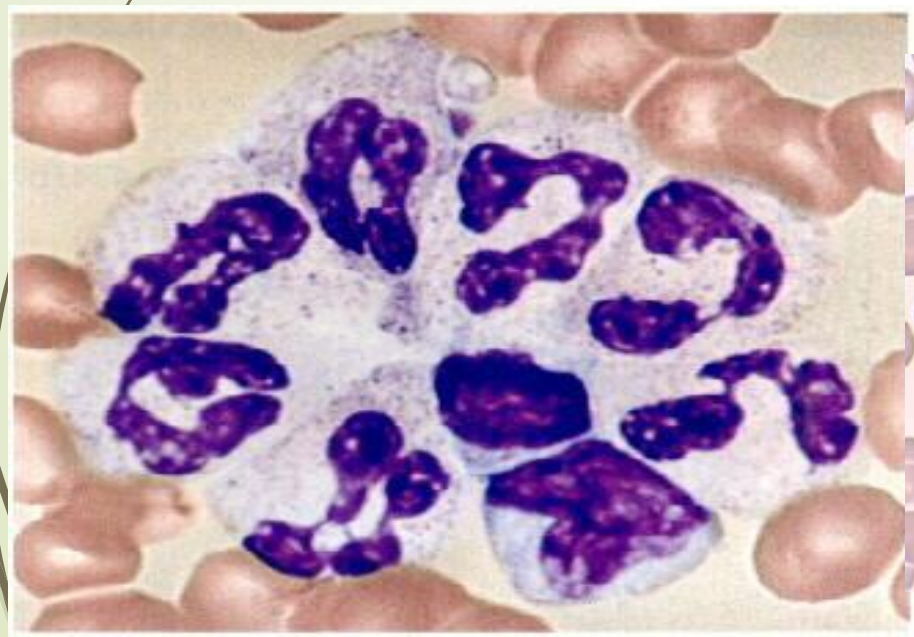
Insufficient Lysing of Erythrocytes

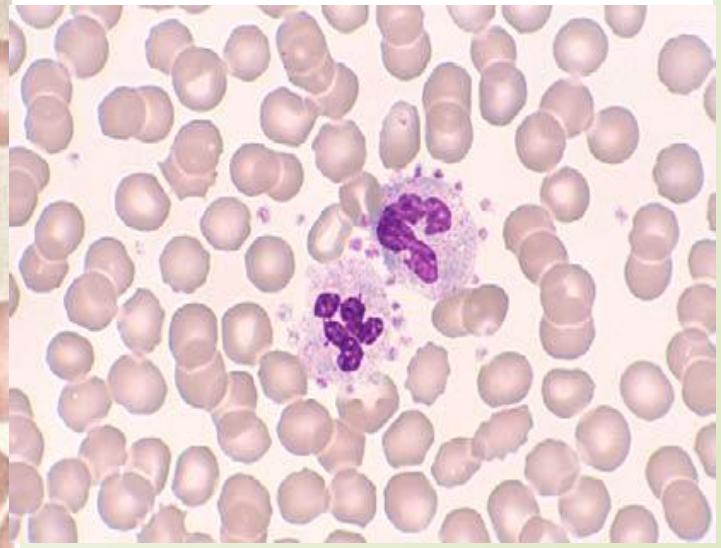

LD
T1
T2
UD
Possible causes :
Extreme leukocytosis
WBC aggregation as in satellite phenomenon

Case

- WBC 2.3 x 109/L
- LYM% 39.7%
- MXD% 32.2%
- NEUT% 28.1%

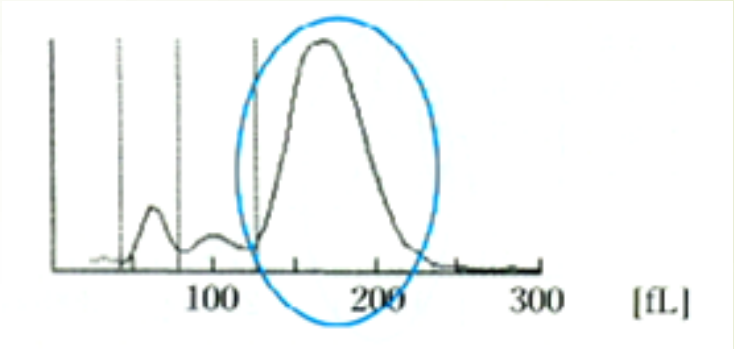


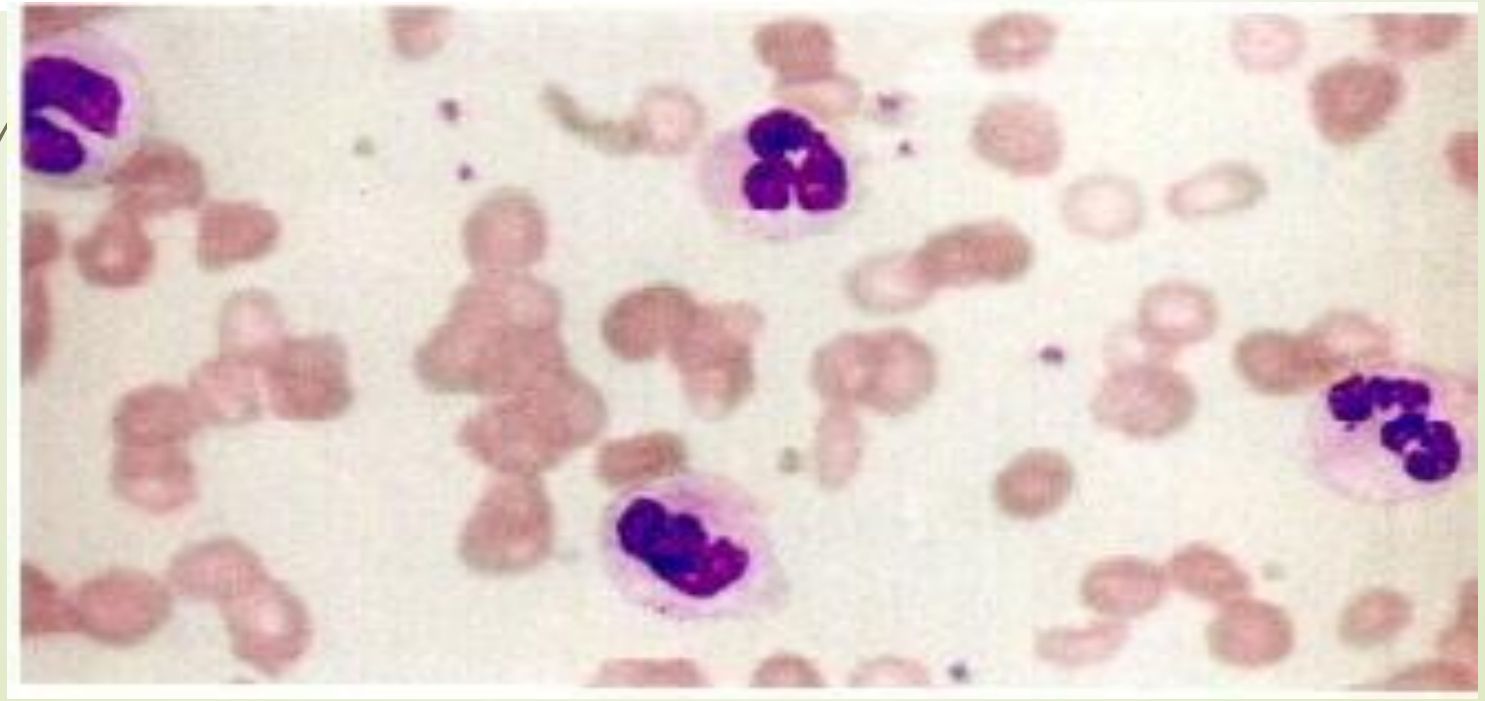


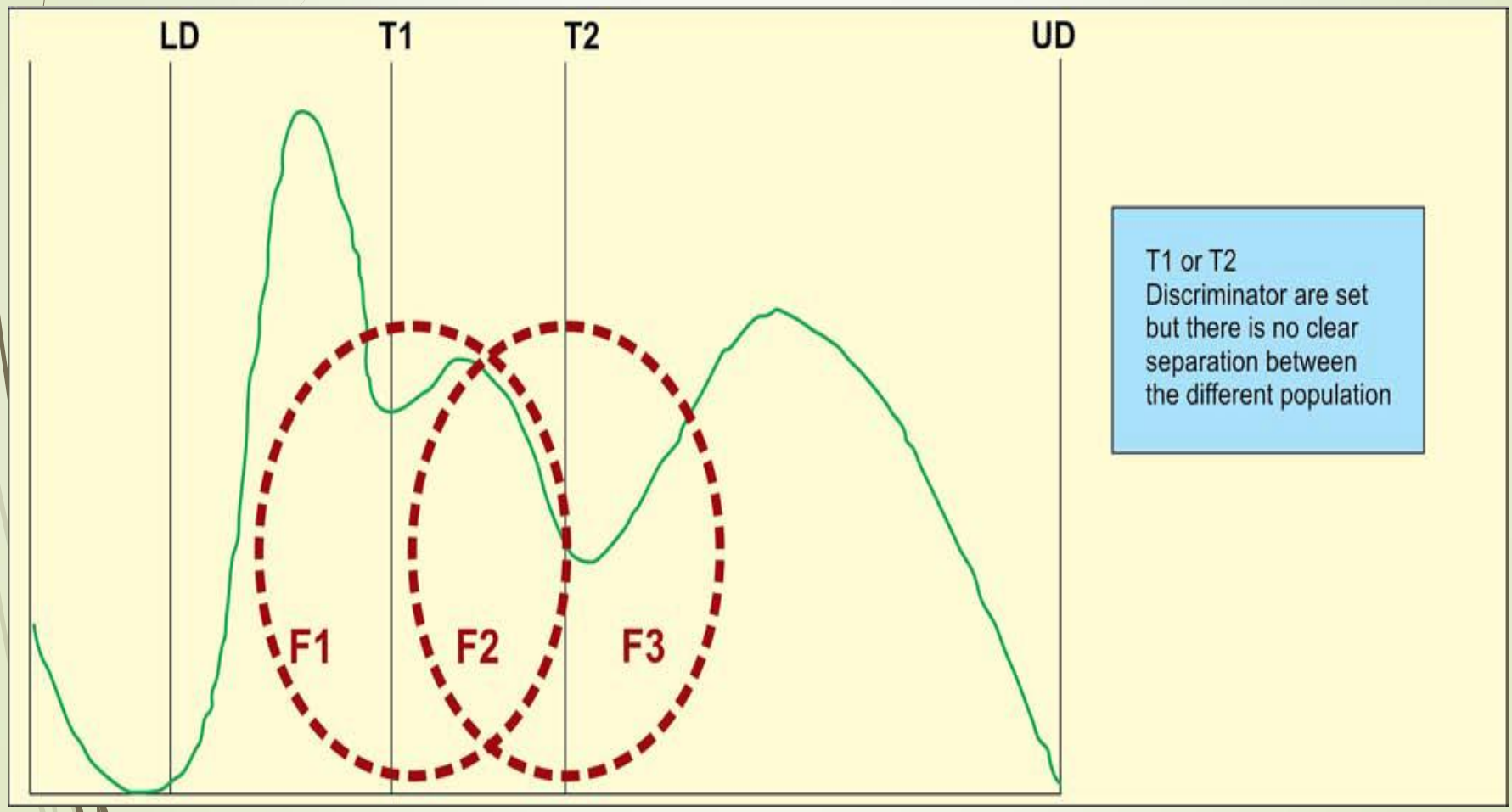


Case -

WBC	+ 23.8 x 109/L
LYM%	8.1%
MXD%	7.9%
NEUT%	**84.0%**

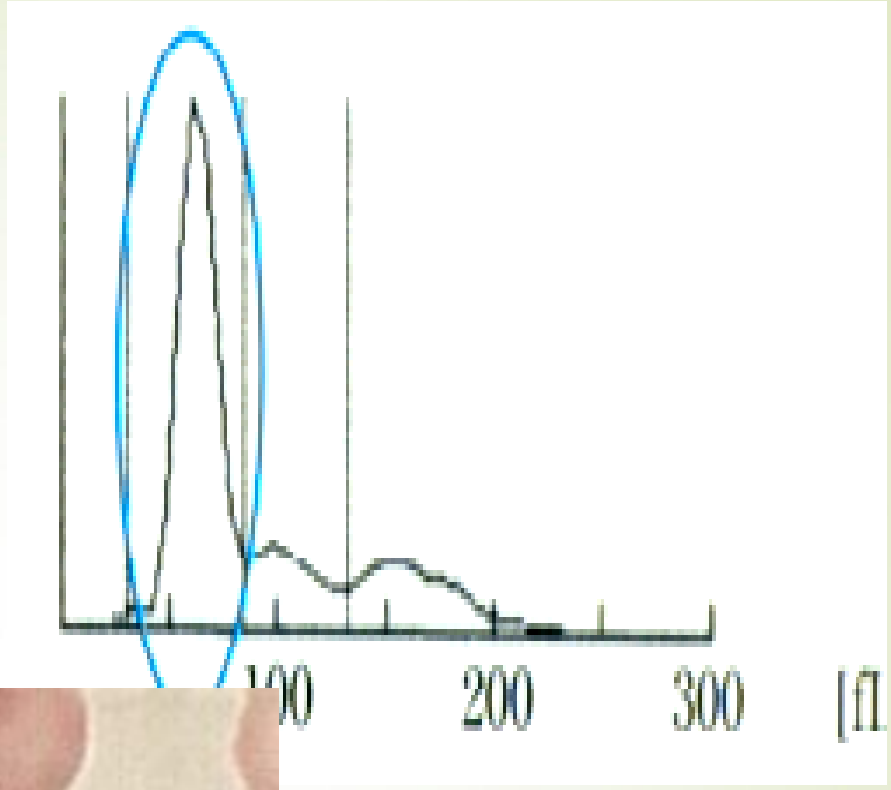


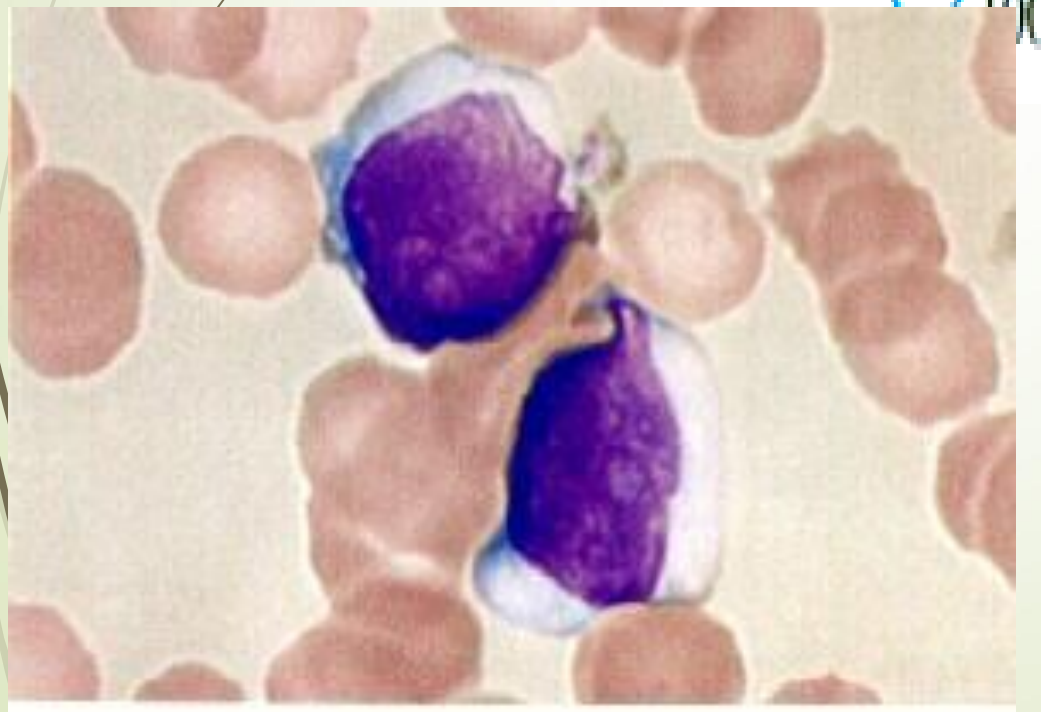



LD
T1
T2
UD
F1
F2
F3
T1 or T2
Discriminator are set
but there is no clear
separation between
the different population

Case -

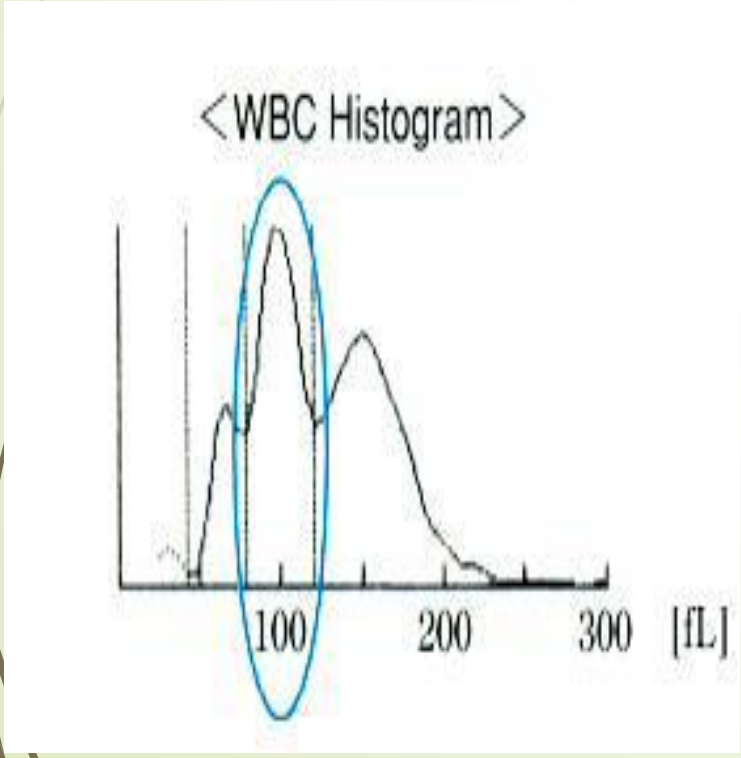
- WBC 7.9 x 109/L
- LYM% + 64.7%
- MXD% 15.8%
- NEUT% – 19.5%

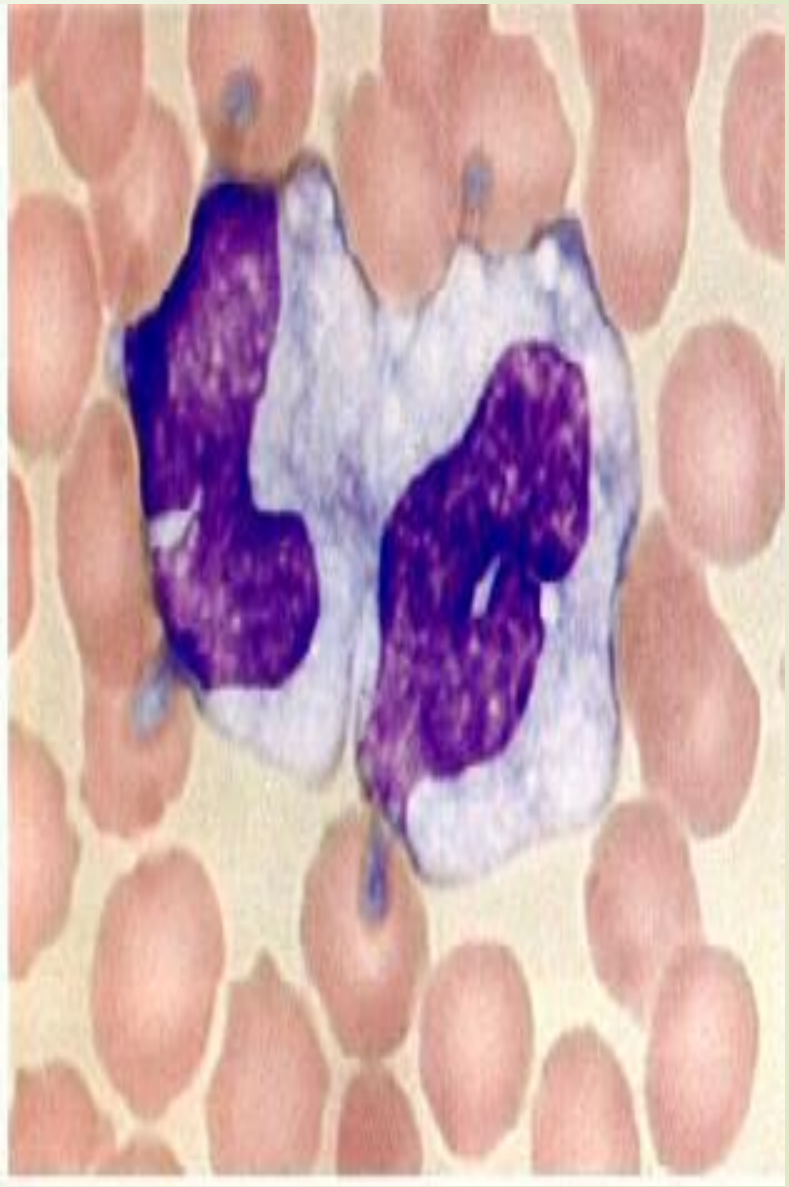




Case

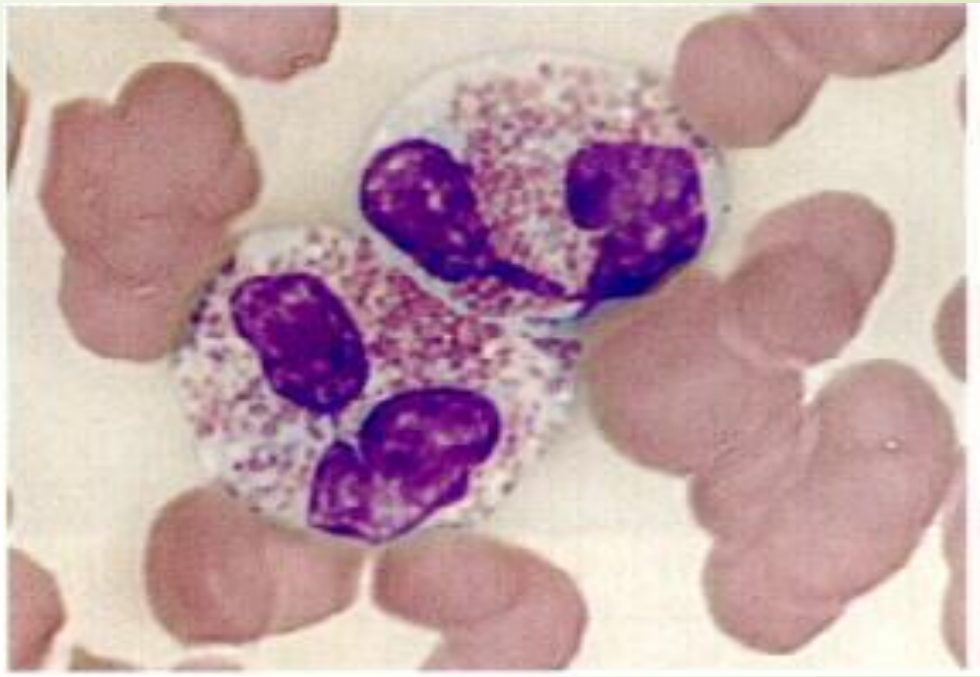
- WBC 7.7 x 109/L
- LYM% F1 * 13.2%
- MXD% F2 * **37.7%**
- NEUT% 49.1%

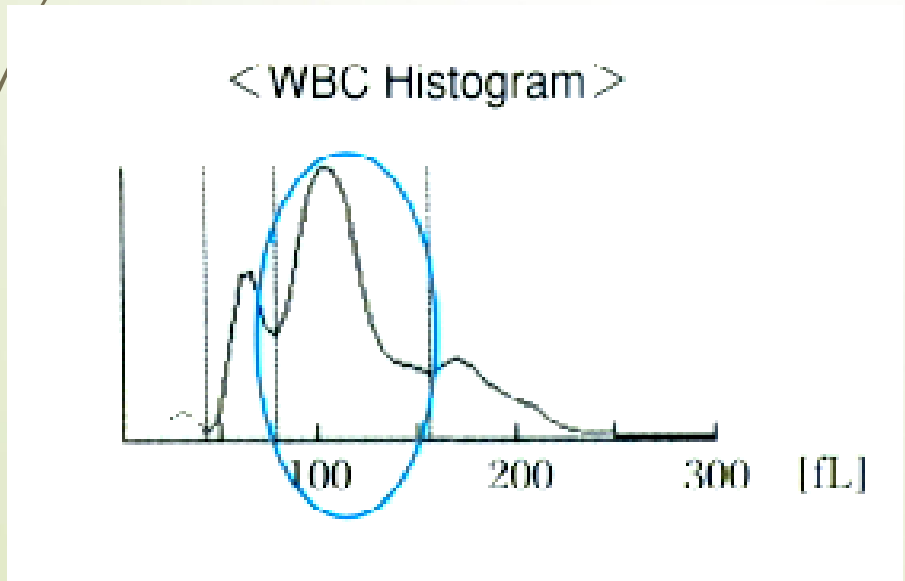




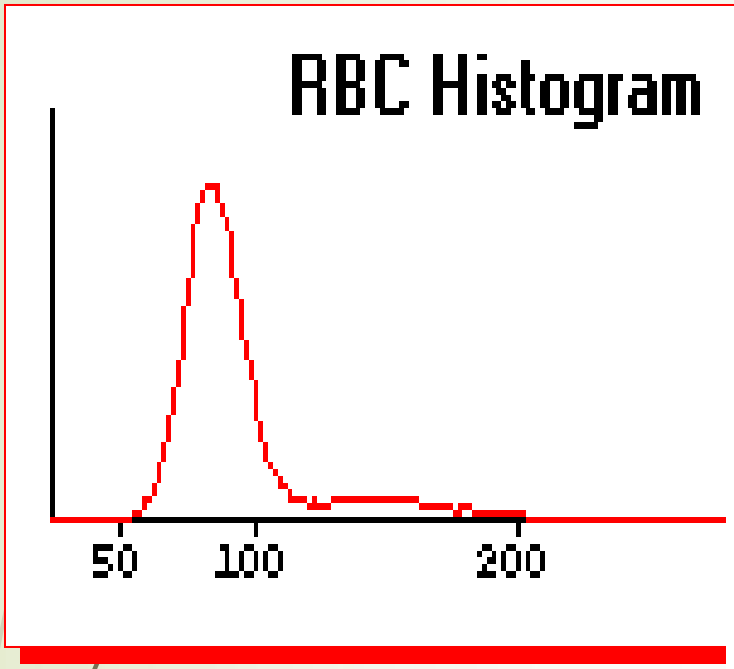
Case

WBC	4.3 x 109/L
LYM%	18,3%
MXD%	+ 62,2%
NEUT%	19.5%

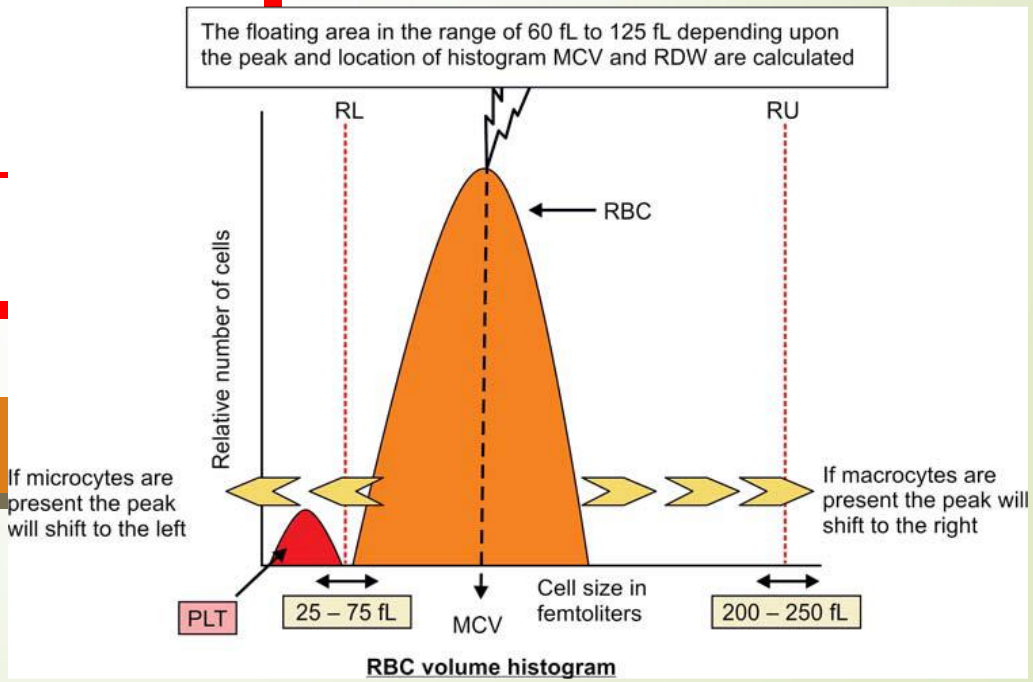




RBC HISTOGRAM



NORMAL



Index	male	Female
Red cell count	4.5-6.5	3.9-5.6
Hb (gr/dl)	13.5-17.5	11.5-15.5
Hct (%)	40-52	36-48
MCV (fl)	80-96	78-96
MCH (pg)	27-34	27-34
MCHC (%)	32-36	32-36

Box 2.1 Grading of anaemia

- Mild: Haemoglobin from lower limit of normal to 10.0 g/dl
- Moderate: 10.0–7.0 g/dl
- Severe: < 7.0 g/dl

Box 2.2 "Rule of 3"

- Red cell count in millions/cmm x 3= Haemoglobin in g/dl
- Haemoglobin in g/dl x 3 = PCV in %

Rule of 3 is used as a mathematical check by clinicians and technologists

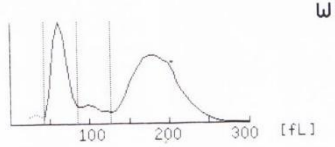
Rule of 3 applies mainly to normocytic normochromic specimens

Question 1: Does my patient have anemia?	**RBC-Hb- HCT**
Question 2: What type of anemia is there if there is anemia?	**MCV-MCH-RDW**
Question 3: Does my patient with anemia have other cellular disorders such as white blood cells and platelets?	**WBC and PLT count**

No. 22
Date 11/30/2023
Time 13:33
Mode WB

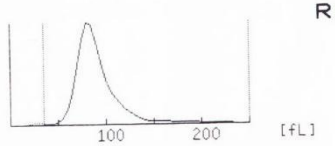
WBC		8.2×10³/μL
RBC		4.69×10⁶/μL
HGB		14.0g/dL
HCT		40.7%
MCV		86.8fL
MCH		29.9pg
MCHC		34.4g/dL
PLT	AG	276×10³/μL

WBC



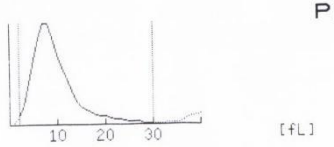
LYM%	29.4%
MXD%	8.3%
NEUT%	62.3%
LYM#	2.4×10³/μL
MXD#	0.7×10³/μL
NEUT#	5.1×10³/μL

RBC



RDW_SD	43.8fL
RDW_CV	13.1%

PLT

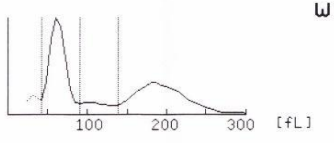


PDW	11.8fL
MPV	9.5fL
P_LCR	21.7%

No. 469
Date 20/07/2024
Time 03:20
Mode WB

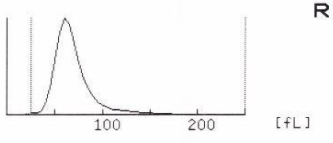
WBC		6.4×10³/μL
RBC		5.33×10⁶/μL
HGB		10.7g/dL
HCT		35.2%
MCV	-	66.0fL
MCH	-	20.1pg
MCHC	-	30.4g/dL
PLT	PL*	209×10³/μL

WBC



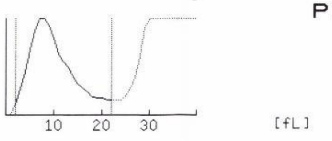
LYM%	44.3%
MXD%	9.0%
NEUT%	46.7%
LYM#	2.8×10³/μL
MXD#	0.6×10³/μL
NEUT#	3.0×10³/μL

RBC



RDW_SD	38.8fL
RDW_CV	15.7%

PLT

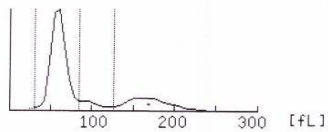


PDW	PL*	15.5fL
MPV	PL*	10.0fL
P_LCR	PL*	28.7%

No. 1534623
Date 20/07/2024
Time 01:40
Mode WB

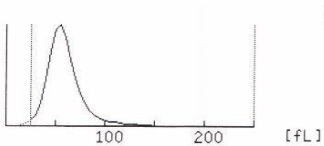
WBC		9.3×10³/μL
RBC		4.34×10⁶/μL
HGB	-	6.1g/dL
HCT	-	25.1%
MCV	-	57.8fL
MCH	-	14.1pg
MCHC	-	24.3g/dL
PLT	+	704×10³/μL

WBC



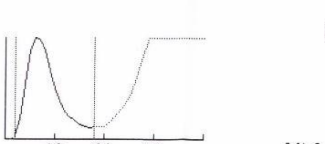
LYM%	+	67.4%
MXD%		8.0%
NEUT%	-	24.6%
LYM#		6.3×10³/μL
MXD#		0.7×10³/μL
NEUT#		2.3×10³/μL

RBC



RDW_SD		41.6fL
RDW_CV	+	19.6%

PLT

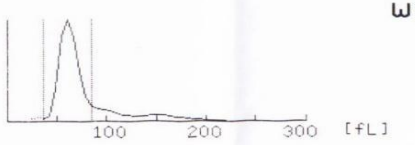


PDW		10.9fL
MPV	-	8.1fL
P_LCR		13.8%

No. 1394999
Date 12/06/2023
Time 10:50
Mode WB

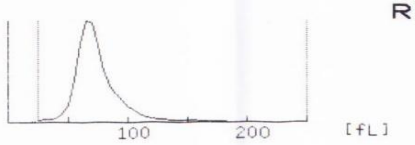
WBC		7.7	×10³/μL
RBC		3.69	×10⁶/μL
HGB	-	7.8	g/dL
HCT		26.6	%
MCV	-	72.1	fL
MCH	-	21.1	pg
MCHC	-	29.3	g/dL
PLT	PL*	71	×10³/μL

WBC



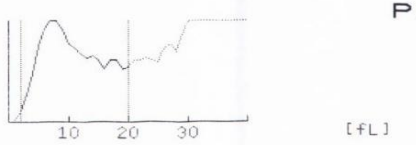
LYM%	+	76.0	%
MXD%	T2	---.-	%
NEUT%	T2	---.-	%
LYM#		5.9	×10³/μL
MXD#	T2	---.-	×10³/μL
NEUT#	T2	---.-	×10³/μL

RBC



RDW_SD	38.5	fL
RDW_CV	14.0	%

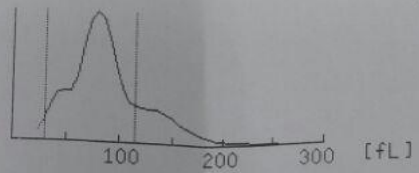
PLT



PDW	DW	---.-	fL
MPV	PL	---.-	fL
P_LCR	PL	---.-	%

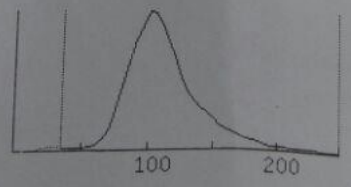
WBC	+	49.6	×10³/μL
RBC	-	2.25	×10⁶/μL
HGB		8.2	g/dL
HCT	-	24.5	%
MCV		108.9	fL
MCH		36.4	pg
MCHC		33.5	g/dL
PLT	PL*	64	×10³/μL

WBC



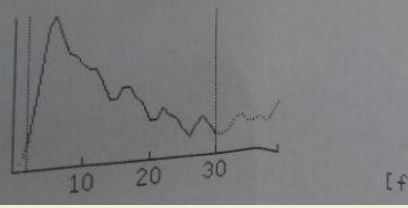
W_SCR	+	77.0	%
W_MCR	T2	---.-	%
W_LCR	T2	---.-	%
W_SCC		38.2	×10³/μL
W_MCC	T2	---.-	×10³/μL
W_LCC	T2	---.-	×10³/μL

RBC



RDW_SD	+	67.3	fL
RDW_CV	+	17.5	%

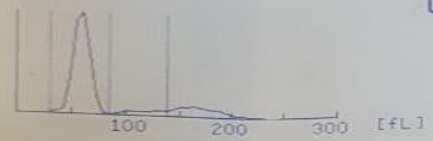
PLT



No. 2-335
Date 1998/02/19
Time 14:25
Mode WB

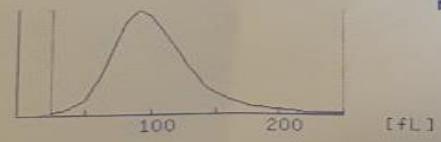
WBC		7.5	×10³/μL
RBC	-	1.85	×10⁶/μL
HGB	-	5.5	g/dL
HCT	-	18.7	%
MCV		101.1	fL
MCH		29.7	pg
MCHC	-	29.4	g/dL
PLT	-	37	×10³/μL

WBC



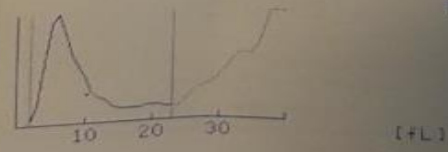
LYM%	+	72.4	%
MXD%		7.8	%
NEUT%	-	19.8	%
LYM#		5.4	×10³/μL
MXD#		0.6	×10³/μL
NEUT#		1.5	×10³/μL

RBC



RDW_SD	+	85.9	fL
RDW_CV	+	25.1	%

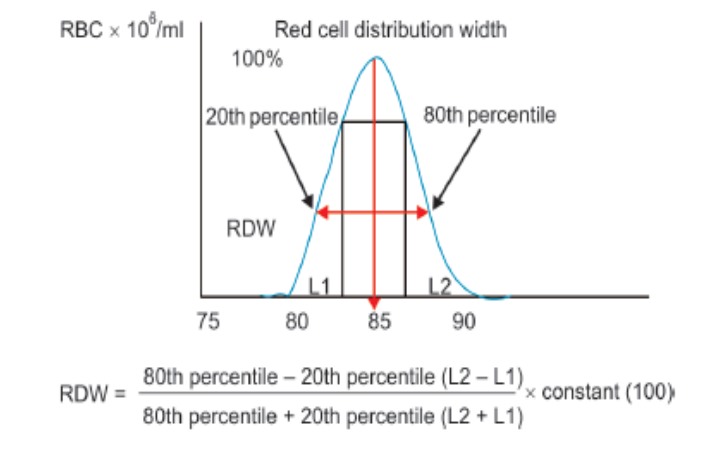
PLT

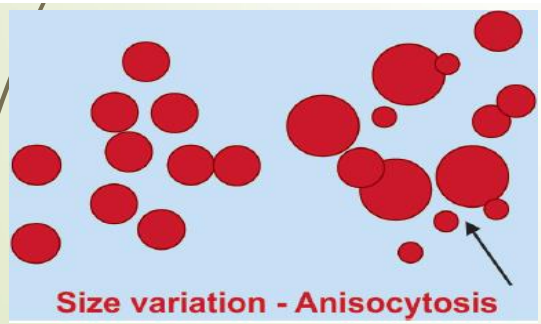


PDW	10.4	fL
MPV	9.2	fL
P_LCR	22.8	%

RED CELL DISTRIBUTION WIDTH (RDW)

میزان توزیع گلبول های قرمز





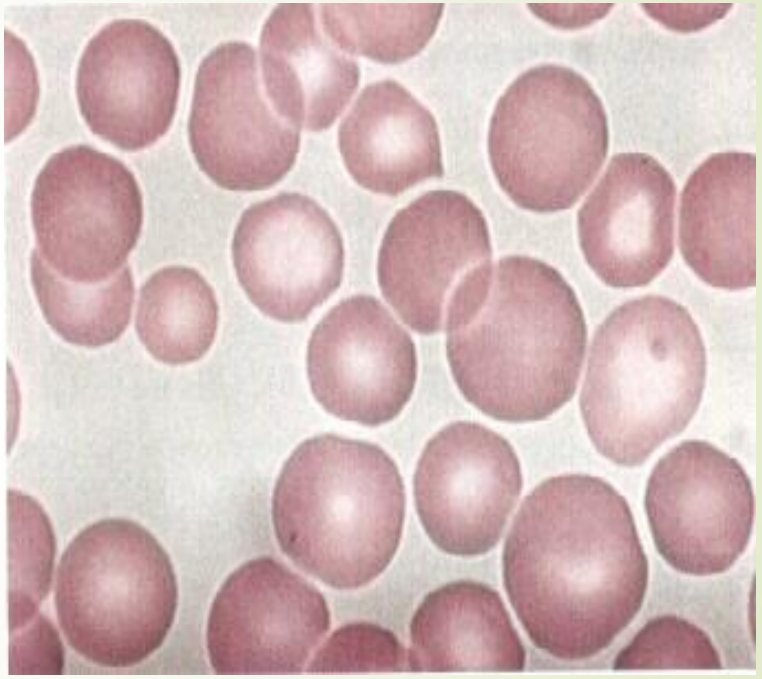
- آنیزوسایتوز در RBC ها، تنوع اندازه ی سلول ها در یک جمعیت سلولی، یا هتروژنیتی گسترده در لام محیطی، بر اساس CV(ضریب تنوع و تغییرات) می باشد.
- CV(ضریب تغییرات) به این معناست که اندازه گیری تکرار شونده چقدر است.
- ضریب تغییرات (CV) اندازه گلبول قرمز تحت عنوان RDW گزارش می شود.
- شاخص ناهمگونی سلول های قرمز نباید فقط عرض هیستوگرام باشد، زیرا این تنها SD را اندازه می گیرد.

RED CELL DISTRIBUTION WIDTH (RDW)

- **RDW-CV:**
- RDW-CV از فرمول زیر محاسبه می شود:
- RDW-CV =(RBC انحراف استاندارد / MCV میانگین)×100
- SD نشان می دهد که تنوع سایز اریتروسیت ها در حدود میانگین است. از آن جهت که SD بر MCV تقسیم شده می فهمیم که RDW-CV به میانگین مقدار MCV اریتروسیت ها نیز بستگی دارد.
- شاخص مرجع: 11.5 – 14.5 %
- **RDW-SD:**
- تعیین RDW-SD یک اندازه گیری واقعی از منحنی توزیع عرض اریتروسیت هاست. این اندازه گیری در ارتفاع نسبی 20درصدی بالاتر از خط مبنا انجام می شود. هر چه منحنی عریض تر باشد اریتروسیت ها گستره ی بزرگ تری از اندازه های مختلف را دارند و شاخص RDW-SD بالاتر خواهد بود.
- شاخص مرجع: 35-45fl
- بدین ترتیب SD داده شده می تواند بسته به MCV، طبیعی یا غیرطبیعی باشد.
- پس محاسبه ی RDW-SD مهم تر می باشد. برخلاف بیشتر متغیر ها که می توانند بصورت غیرطبیعی بالا و پایین باشند ، هیچ اختلالی با RDW پایین تر از حد طبیعی وجود ندارد.

Case

RBC	4.15 x1012/L
HGB	14.0g/dl
HCT	40.8%
MCV	98.3fl
MCH	33.7pg
MCHC	34.3g/dl
RDW	**22.7%**

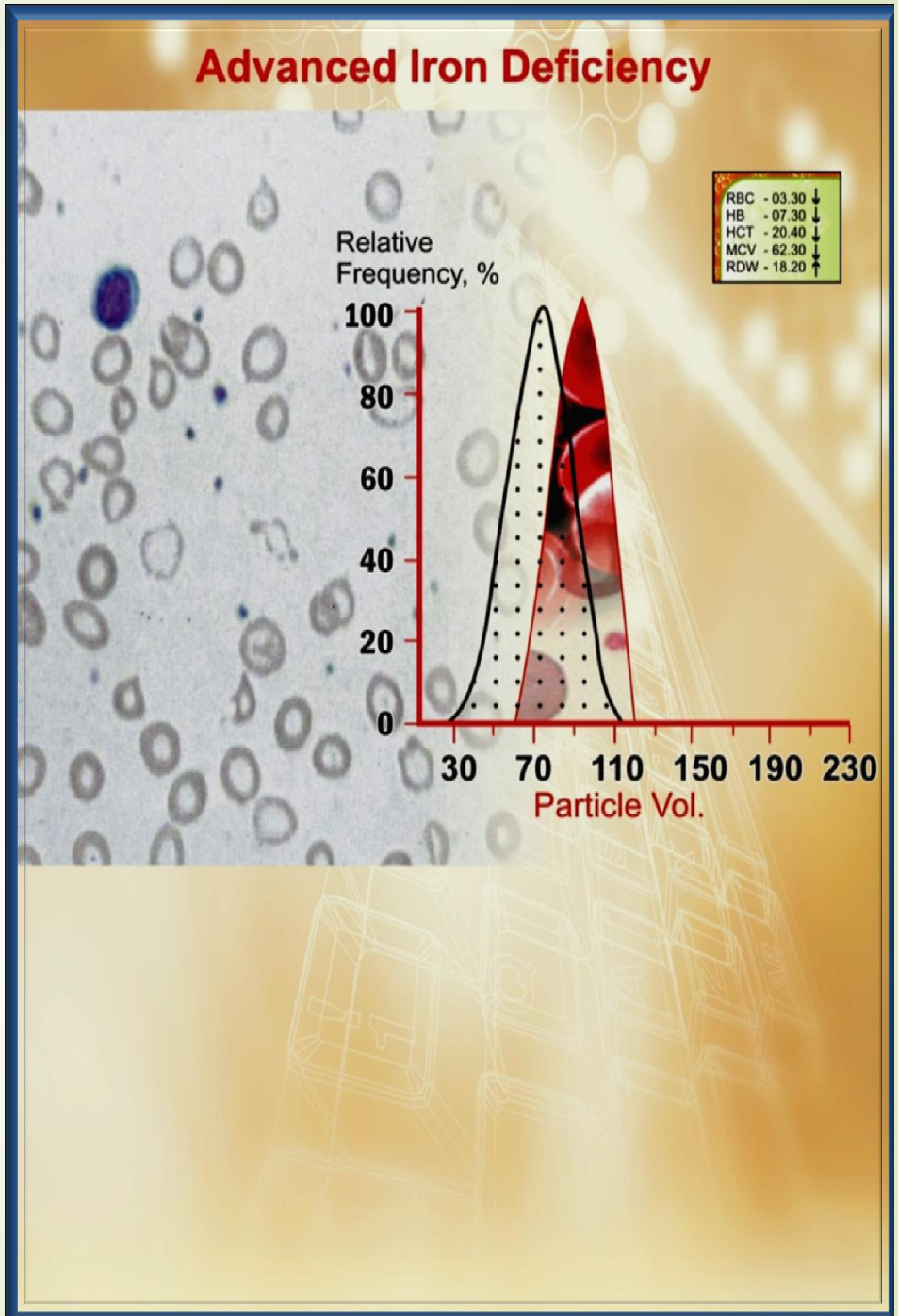


Anemia is present, MCV is very low, and the smear is very abnormal

RDW is abnormally high;

Histogram remains abnormal.

The diagnosis is easily



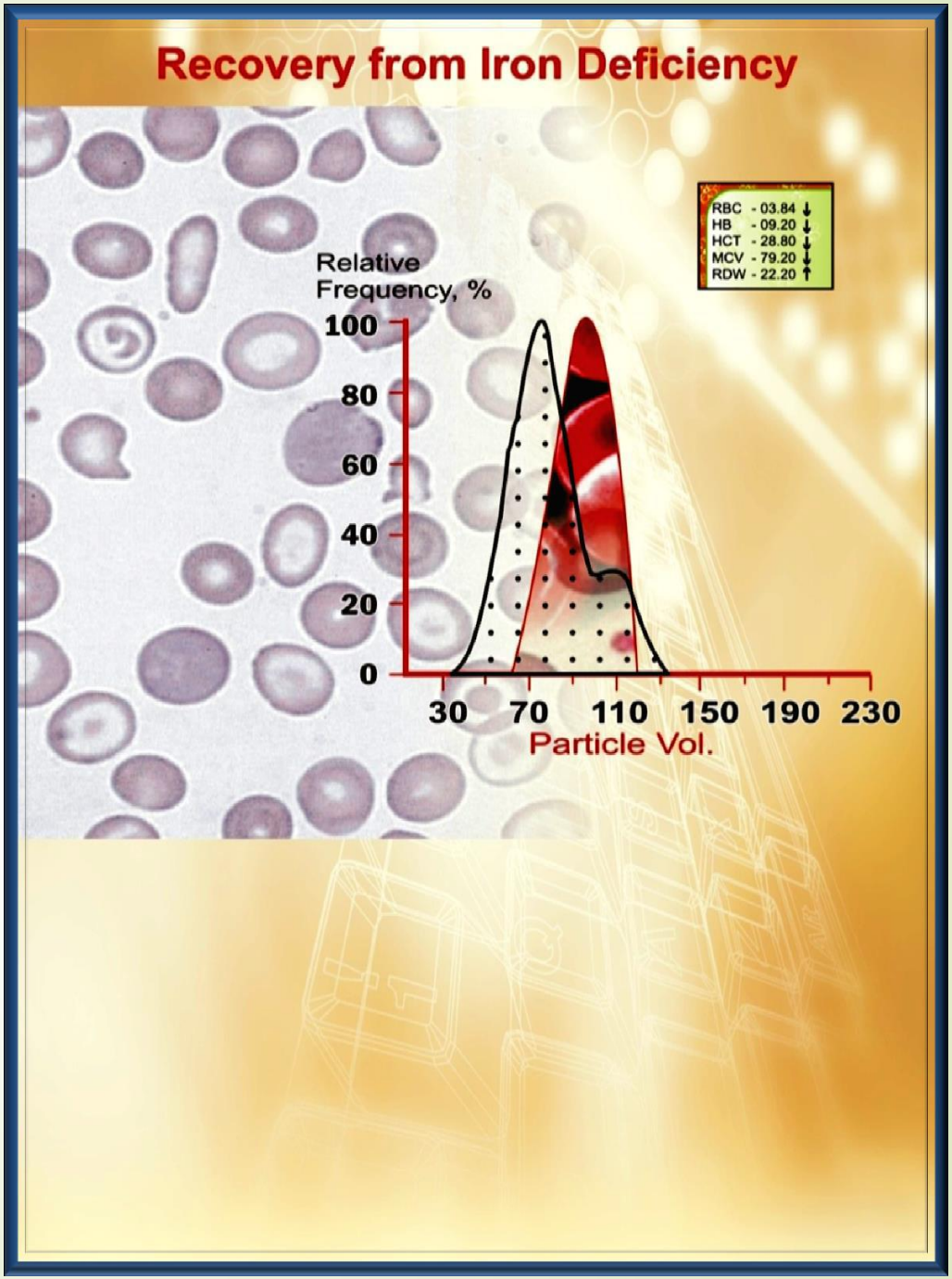
The red cell count is increasing,

MCV is not yet normal, and

Two populations of red cells are

microcytes, and newly formed normocytes.

The two populations are distinguished easily on the red cell histogram but not so easily on the peripheral blood smear.



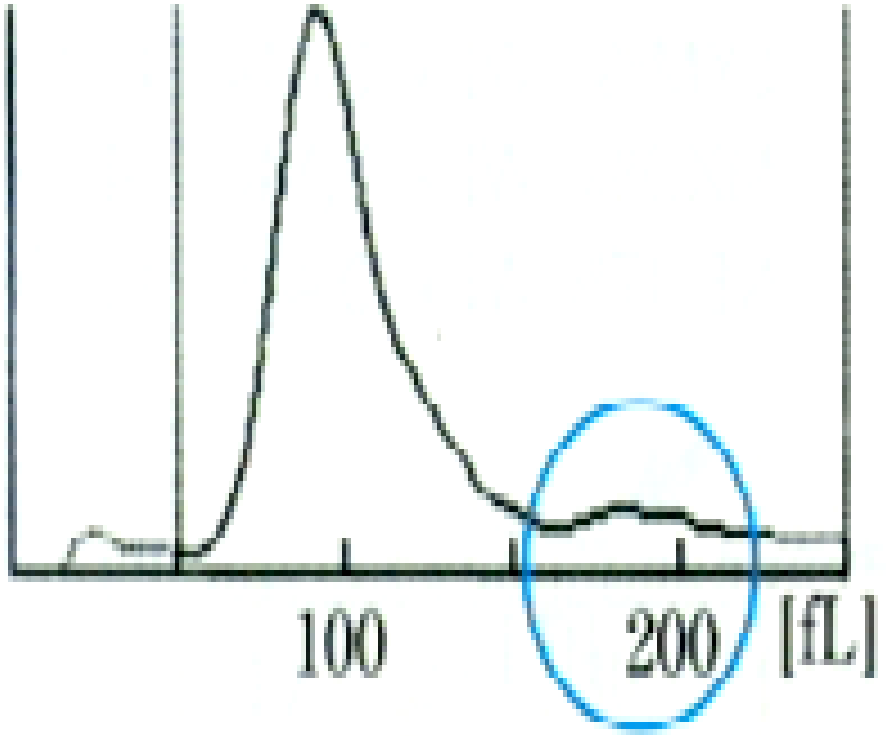
- **RL: (LD)**
  - Giant Platelets
  - Micro-Erythrocytes
  - Platelet Clumps

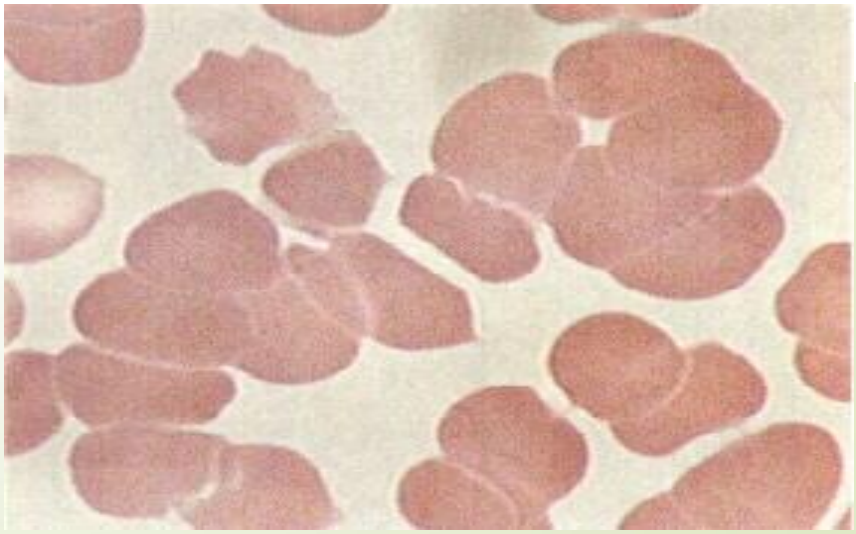
- **RU: (UD)**
  - Cold Agglutinins(check MCHC > 40 g/dl)
  - Erythroblasts / Normoblasts

- **MP: Multiple peaks:**
  - Iron deficiency in therapy
  - Infection or Tumor Anemia
  - Transfusions

Case

RBC	**2.23 x1012/L**
HGB	14.4g/dl
HCT	24.9%
MCV	**111.7fl**
MCH	64.6pg
MCHC	**57.8g/dl**
RDW	25.4fl

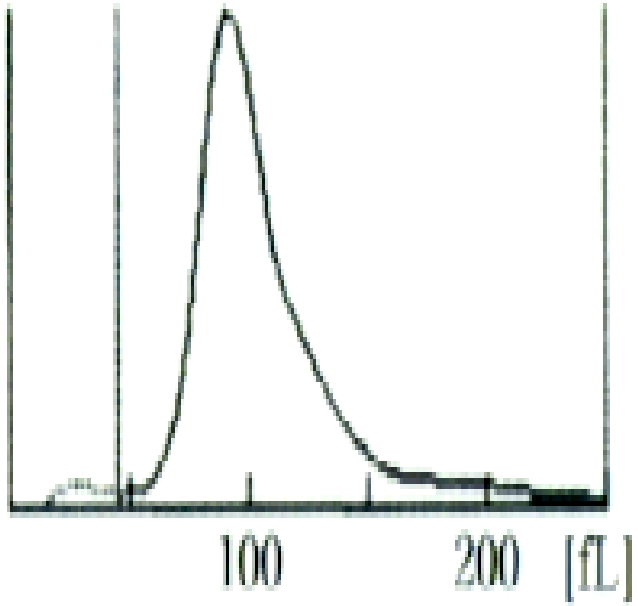


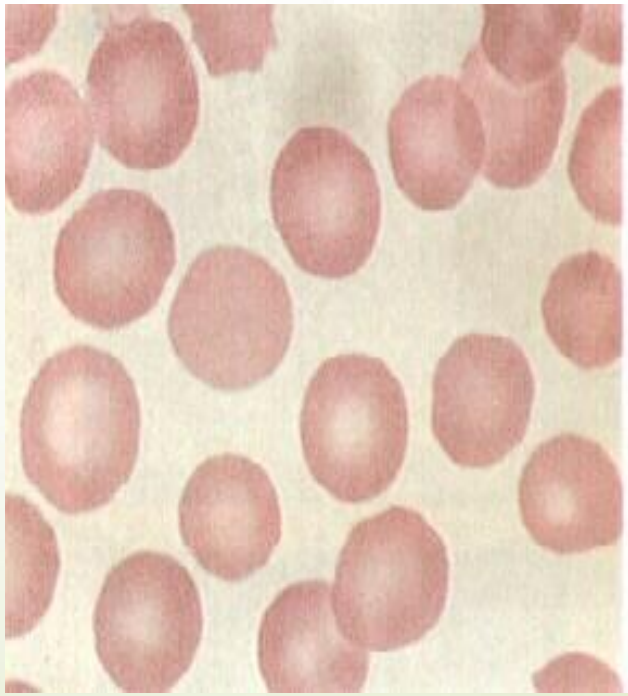


Cold Agglutinins

Incubation 30 min

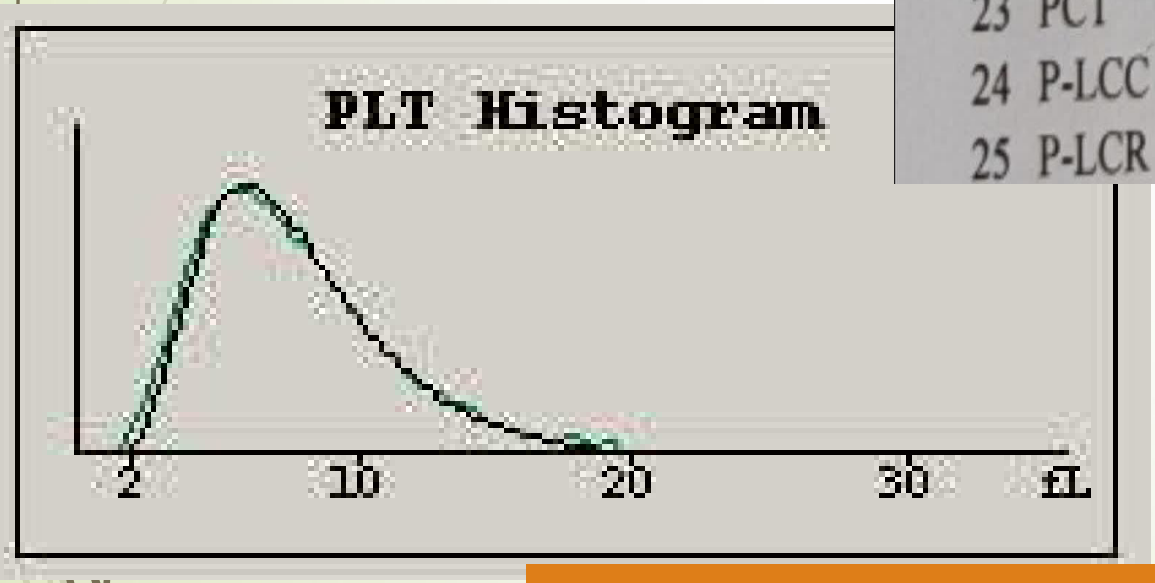
RBC	**4.35 x1012/L**
HGB	14.5g/dl
HCT	43.5%
MCV	**100.0fl**
MCH	33.3pg
MCHC	**33.3g/dl**
RDW	14.7fl





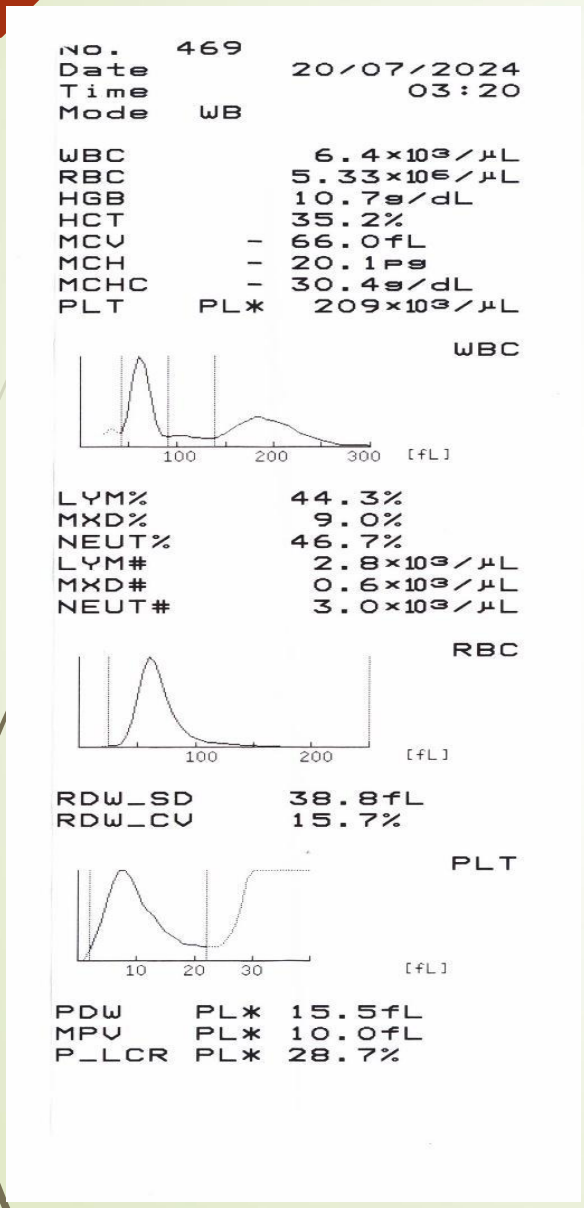
PLT HISTOGRAMS

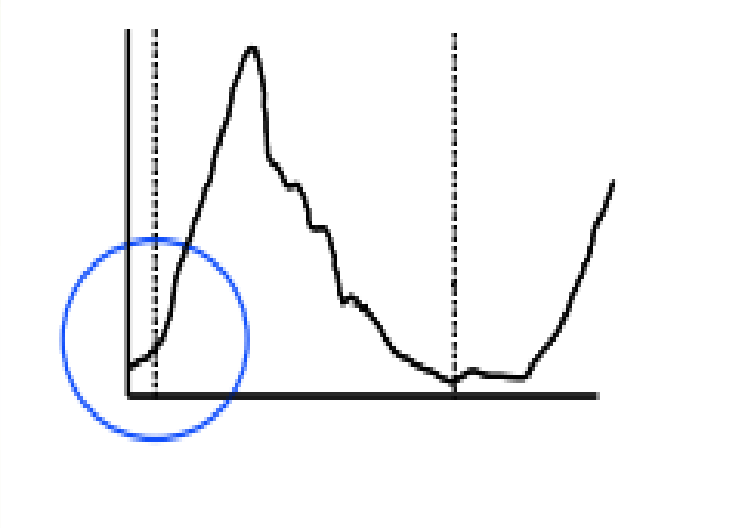
20	PLT	61	L	10^3/uL	117 - 420
21	MPV	10.6		fL	6.5 - 12.0
22	PDW	17.6	H		15.0 - 17.0
23	PCT	0.065	L	%	0.108 - 0.282
24	P-LCC	19	L	10^3/uL	30 - 90
25	P-LCR	30.6		%	11.0 - 45.0



NORMAL

PL: Abnormal height at lower discriminator



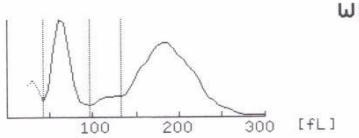


- High blank value
- Cell fragments

PU

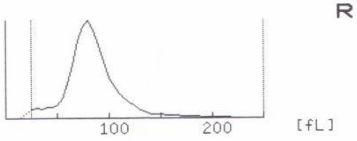
No.		521
Date		2024/08/27
Time		10:46
Mode		WB
WBC		8.5×10³/μL
RBC		3.75×10⁶/μL
HGB		10.9g/dL
HCT		30.5%
MCV	-	81.3fL
MCH		29.1pg
MCHC		35.7g/dL
PLT	PU*	336×10³/μL

WBC



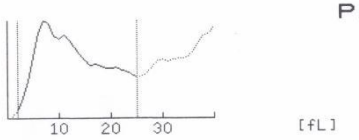
LYM%	28.9%
MXD%	7.5%
NEUT%	63.6%
LYM#	2.5×10³/μL
MXD#	0.6×10³/μL
NEUT#	5.4×10³/μL

RBC

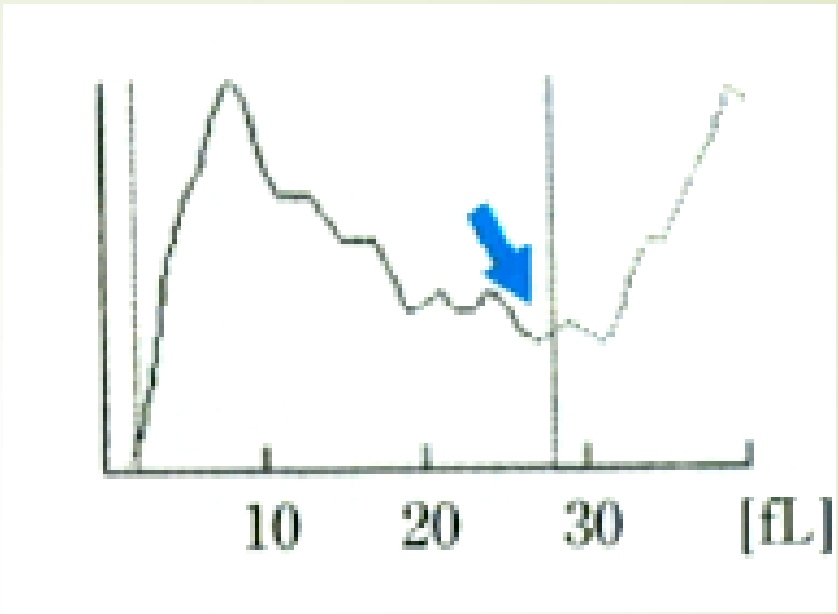


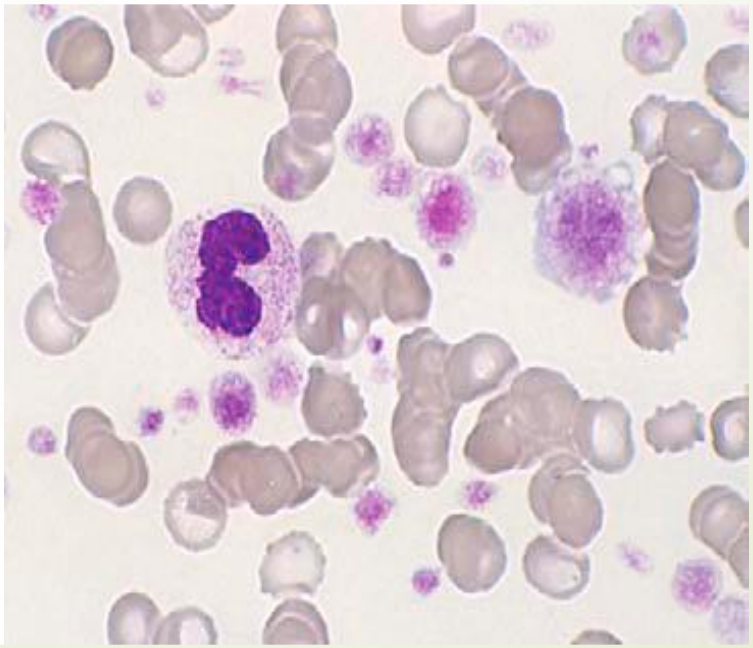
RDW_SD		50.6fL
RDW_CV	+	19.2%

PLT



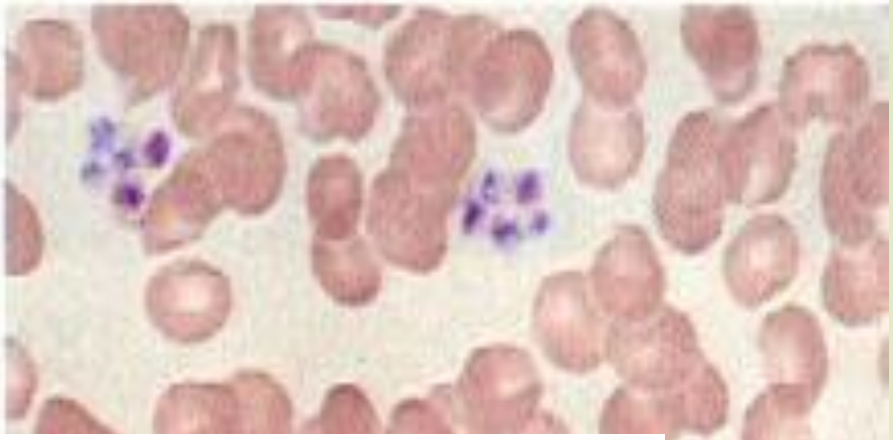
PDW	DW	---.-fL
MPV	PU	---.-fL
P_LCR	PU	---.-%



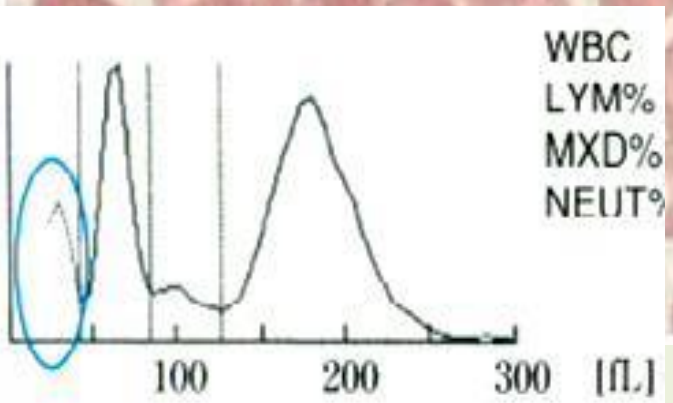


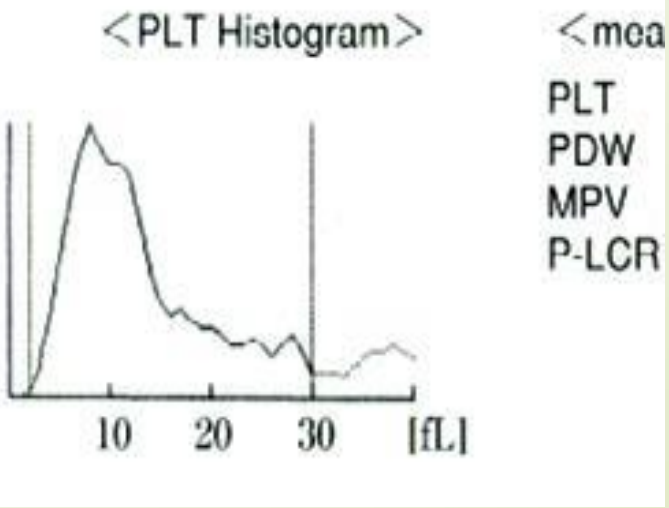
- PLT Clumps
- Giant Platelets
- Microerythrocytes

Case

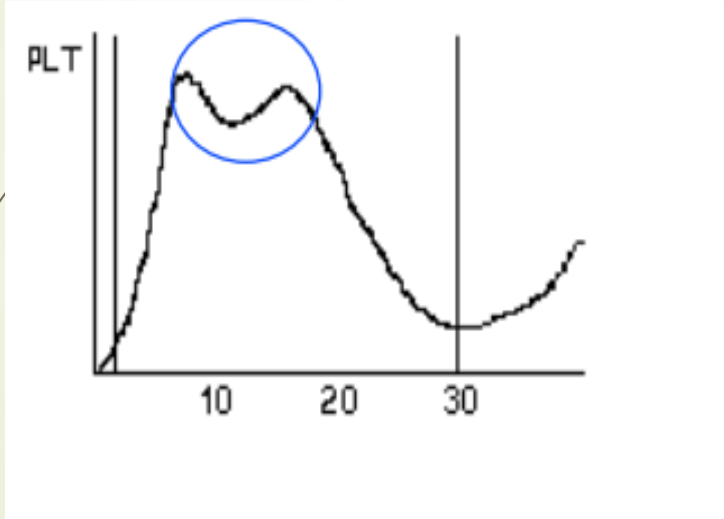


WBC	6.0 x109/L
LYM%	27.5%
MXD%	7.9%
NEUT %	64.4%
PLT	86 x109/L
PDW	18.6fl
MPV	12.8fl
P-LCR	43.7%

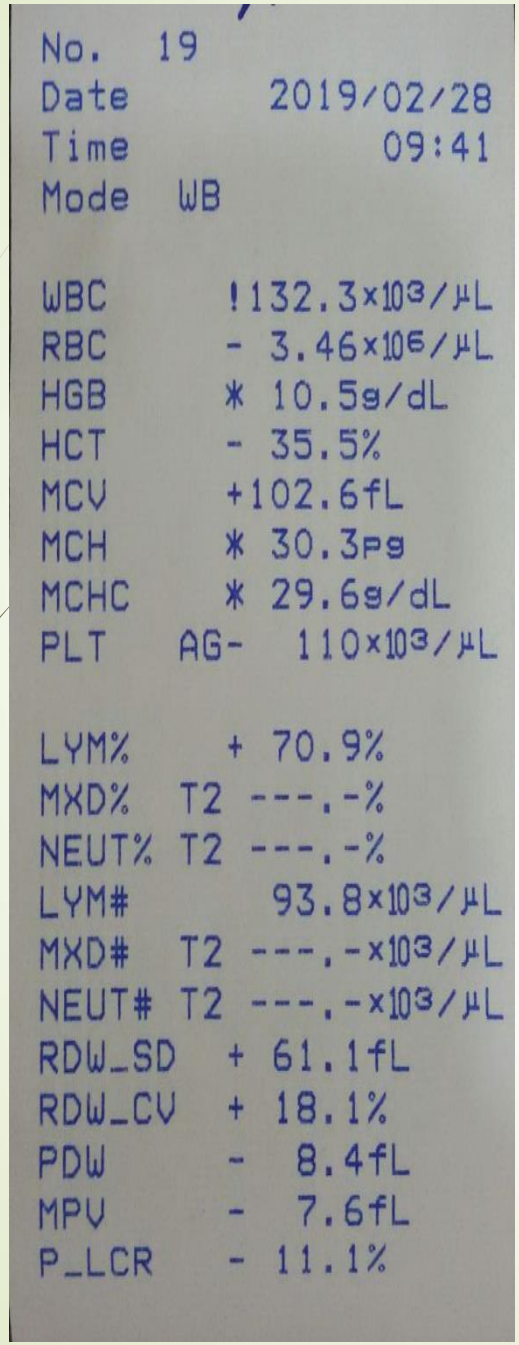




MP

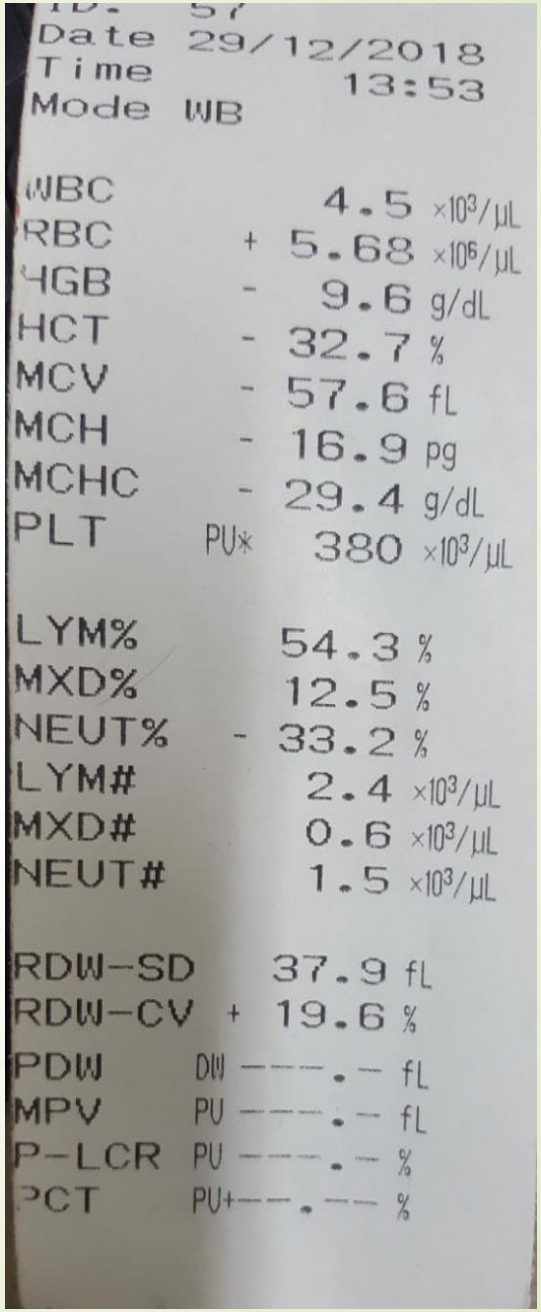


- Platelet Transfusions
- Platelet Aggregation
- Chemotherapy



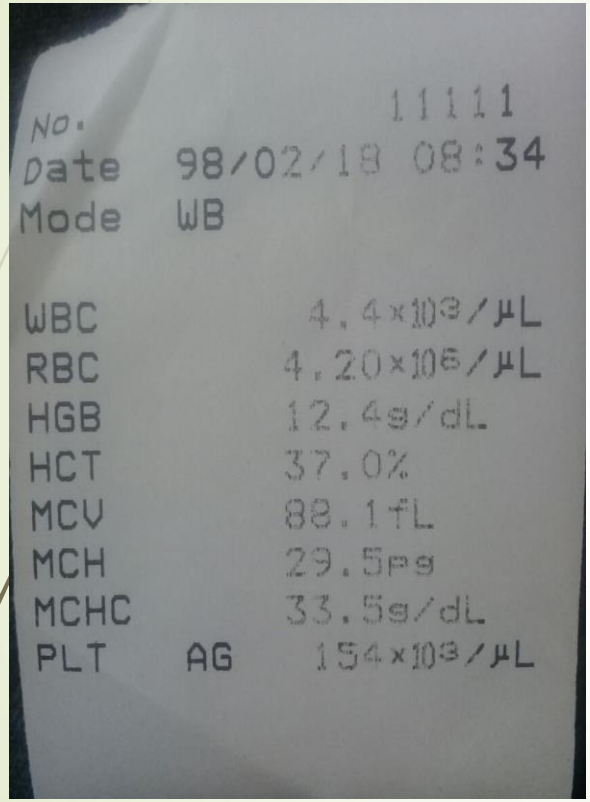
No. 19
Date 2019/02/28
Time 09:41
Mode WB

WBC	!	132.3×10³/μL
RBC	-	3.46×10⁶/μL
HGB	*	10.5g/dL
HCT	-	35.5%
MCV	+	102.6fL
MCH	*	30.3pg
MCHC	*	29.6g/dL
PLT	AG-	110×10³/μL
LYM%	+	70.9%
MXD%	T2	---.-%
NEUT%	T2	---.-%
LYM#		93.8×10³/μL
MXD#	T2	---.-×10³/μL
NEUT#	T2	---.-×10³/μL
RDW_SD	+	61.1fL
RDW_CV	+	18.1%
PDW	-	8.4fL
MPV	-	7.6fL
P_LCR	-	11.1%



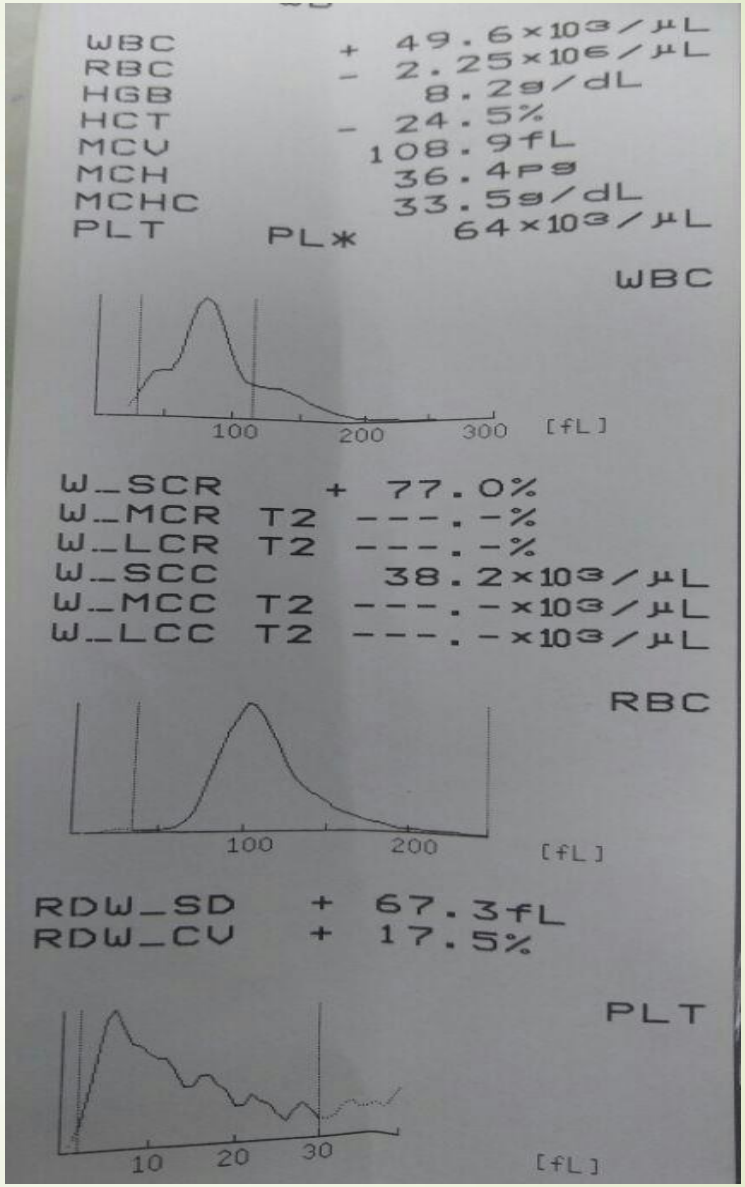
Date 29/12/2018
Time 13:53
Mode WB

WBC		4.5 ×10³/μL
RBC	+	5.68 ×10⁶/μL
HGB	-	9.6 g/dL
HCT	-	32.7 %
MCV	-	57.6 fL
MCH	-	16.9 pg
MCHC	-	29.4 g/dL
PLT	PU*	380 ×10³/μL
LYM%		54.3 %
MXD%		12.5 %
NEUT%	-	33.2 %
LYM#		2.4 ×10³/μL
MXD#		0.6 ×10³/μL
NEUT#		1.5 ×10³/μL
RDW-SD		37.9 fL
RDW-CV	+	19.6 %
PDW	DW	---.- fL
MPV	PU	---.- fL
P-LCR	PU	---.- %
PCT	PU	---.-- %



NO. 11111
Date 98/02/18 08:34
Mode WB

WBC		4.4×10³/μL
RBC		4.20×10⁶/μL
HGB		12.4g/dL
HCT		37.0%
MCV		88.1fL
MCH		29.5pg
MCHC		33.5g/dL
PLT	AG	154×10³/μL



WBC	+	49.6×10³/μL
RBC	−	2.25×10⁶/μL
HGB		8.2g/dL
HCT	−	24.5%
MCV		108.9fL
MCH		36.4pg
MCHC		33.5g/dL
PLT	PL*	64×10³/μL

WBC

100 200 300 [fL]

W_SCR	+	77.0%
W_MCR	T2	---.-%
W_LCR	T2	---.-%
W_SCC		38.2×10³/μL
W_MCC	T2	---.-×10³/μL
W_LCC	T2	---.-×10³/μL

RBC

100 200 [fL]

RDW_SD	+	67.3fL
RDW_CV	+	17.5%

PLT

10 20 30 [fL]

Cell Name Grading System: minimum of **1000 RBC should be evaluated** to provide a precise percentage of the cells having a particular morphological abnormality.

	Few/1+	Mod/2+ ,%	Many/3+, %
Anisocytosis	N/A	% 11–20	>20
Macrocytes	N/A	11–20	>20
Microcytes	N/A	11–20	>20
Hypochromic	N/A	11–20	>20
Polychromasia	N/A	5–20	>20
Acanthocytes	N/A	5–20	>20
Echinocytes	N/A	5–20	>20
Elliptocytes	N/A	5–20	>20
Ovalocytes	N/A	5–20	>20
Spherocytes	N/A	5–20	>20
Stomatocytes	N/A	5–20	>20
Target cells	N/A	5–20	>20
Teardrop cells	N/A	5–20	>20
Basophilic stippling	N/A	5–20	>20

	Few/1+	Mod/2+ ,%	Many/3+, %
Oval macrocytes	N/A	2–5	>5
Bite cells	N/A	1–2	>2
Blister cells	N/A	1–2	>2
Schistocytes	<1%	1–2	>2
Sickle cells	N/A	1–2	>2
Howell-Jolly bodies	N/A	2–3	>3
Pappenheimer bodies	N/A	2–3	>3

RBC Histogram

ABN / INDICATOR	PROBABLE CAUSE	COMMENT
Left of curve does not touch baseline	Schistocytes and extremely small red cells	Review smear CBC and Platelet histogram
Bimodal peak	Transfused cells, therapeutic response	Review Smear
Right portion of curve extended	Red cell autoagglutination	Review CBC & Smear
Left shift of curve	Microcytes	Review smear & CBC
Right shift of curve	Macrocytes	Review smear & CBC

WBC Histogram

ABN / INDICATOR	PROBABLE CAUSE	COMMENT
Trail extending downward at extreme left, or lymph peak not starting at baseline	NRBC, Plt clumping, unlysed RBC, cryoproteins, parasites	Review smear and correct WBC for NRBC
Peak to the left of lymph peak or widening of lymph peak towards left	NRBC	Review smear & correct WBC for NRBC
Widening of lymph peak to right	Atypical lymphs, blasts, plasma cells, hairy cells, eosinophilia, basophilia	Review smear
Wider mono peak	Monocytosis, plasma cells, eosinophilia, basophilia, blasts	Review smear

WBC Histogram

ABN / INDICATOR	PROBABLE CAUSE	COMMENT
WBC histogram (lymph peak) does not start at baseline	Giant platelets, NRBC, Plt clumping	Review smear, correct WBC for NRBC
Elevation of left portion of granulocyte	Left Shift	Review smear
Elevation of right portion of granulocyte peak	Neutrophilia, Hyperseg,	Review smear

Platelet Histogram

ABN / INDICATOR	PROBABLE CAUSE	COMMENT
Peak or spike at left end of histogram (2-8 fl)	Cytoplasmic fragments	Review smear
Spike towards right end of histogram	Schistocytes, microcytes, giant platelets	Review smear + CBC (↓ MCV & ↑ RDW) (↑ MPV & ↑ PDW)
Bimodal peak	Cytoplasmic fragments	Review smear

Known interfering substance

RBCs

- High WBCs esp if RBCs is low → ↑RBCs
- Agglutinated RBCs → ↓ RBCs

Hb

Turbidity of the blood sample → ↑ Hb

- Elevated WBCs
- Elevated lipids
- Fetal bloods

MCV

- **Red cell agglutination**
- **↑ number of large platelets**

HT

- **Red cell agglutination**

RDW

- **Agglutination of RBCs**
- **Nutritional deficiency**
- **Blood transfusion**

WBCs interferring subs.

- Normoblasts → ↑ WBCs
- Unlysed RBCs → ↑ WBCs
- MM → ↑ WBCs (ppt protein)
- Hemolysis → ↑ WBCs (red cell stroma)
- Leukemia → ↓ WBCs (↑ cell fragility)

  → In CLL small lymph not counted
- Cryoglobulin → ↑ all parameters of blood

Platelets

- RBCs fragments → ↑ plat (microcytes)
- WBCs fragments → ↑ plat (microcytes)
- Chemotherapy → ↓ plat (↑ plat. fragments)
- Hemolysis → ↑ Plat (red cell strom)
- ACD blood → ↓ plat (plat. Aggregation)
- RBCs inclusion → ↑ plat. (Malaria, H.j bodies)
- Plat. agglutination → ↓ plat

Lymphocytes

- **Nucleated RBCs → ↑ lymph**
- **Parasites → ↑ lymph**
- **Resistent RBCs → ↑ lymph**

Monocytes

- **↑ in large lymphocytes, atypical lymph, blasts and basophils**

Granulocytes

- **↑ in eosinophilia, blasts, promyelo, myelo, metameyl and plasma cell**

CONCLUSION

Histogram in conjunction with absolute counts give valuable information about the abnormality of the sample & the need for follow up peripheral blood examination.Histogram should be used as quality check **but not diagnostic** for any pathological condition.***The manual blood film remains the definitive tool for complete haematological analysis.***


Thank you for your attention