بسم الله الرحمن الرحيم

Hematology Analyzer

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Electronic containg methods (Hematology Analyzer)

1: electrical Impedance

2: Light scattring

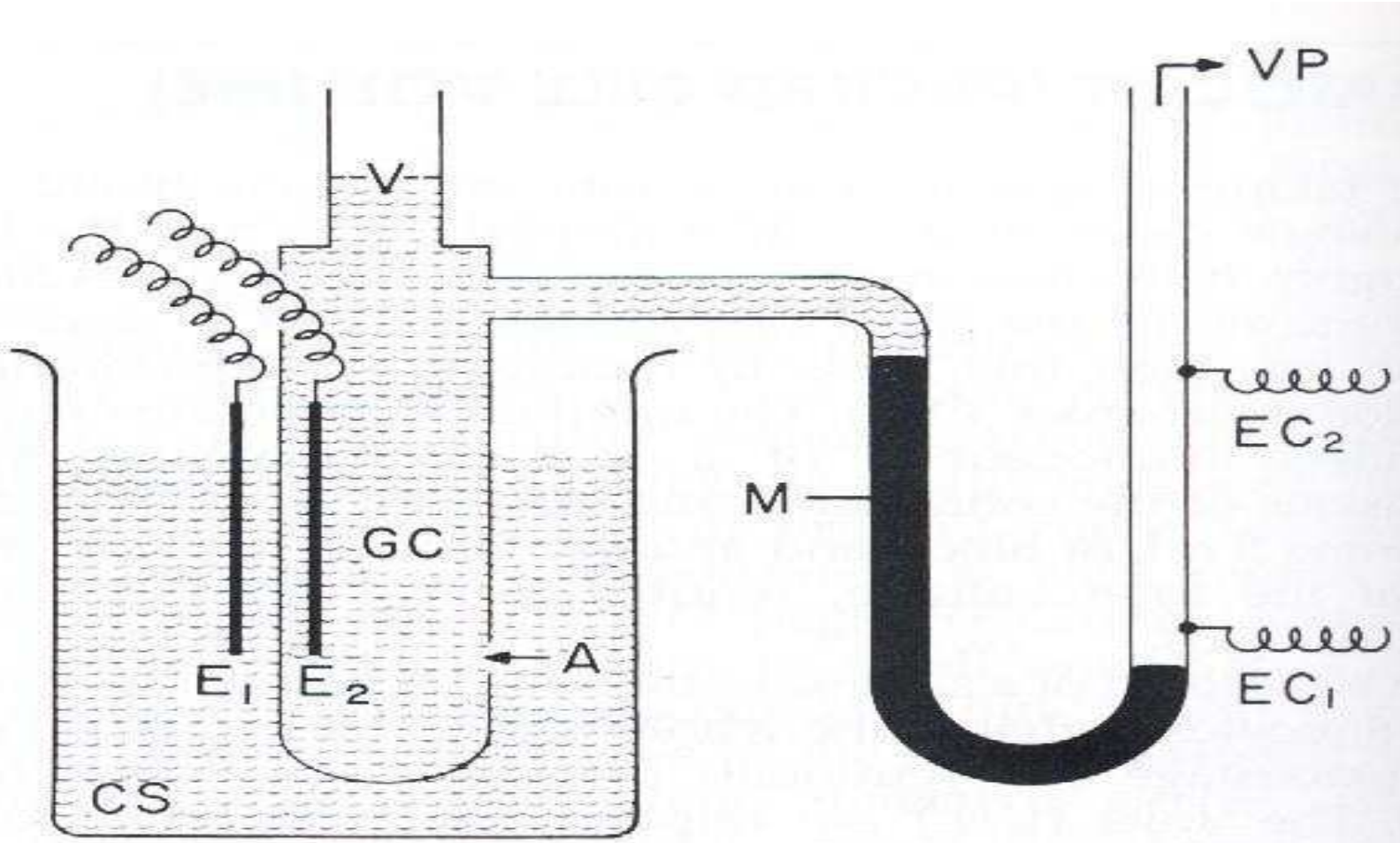
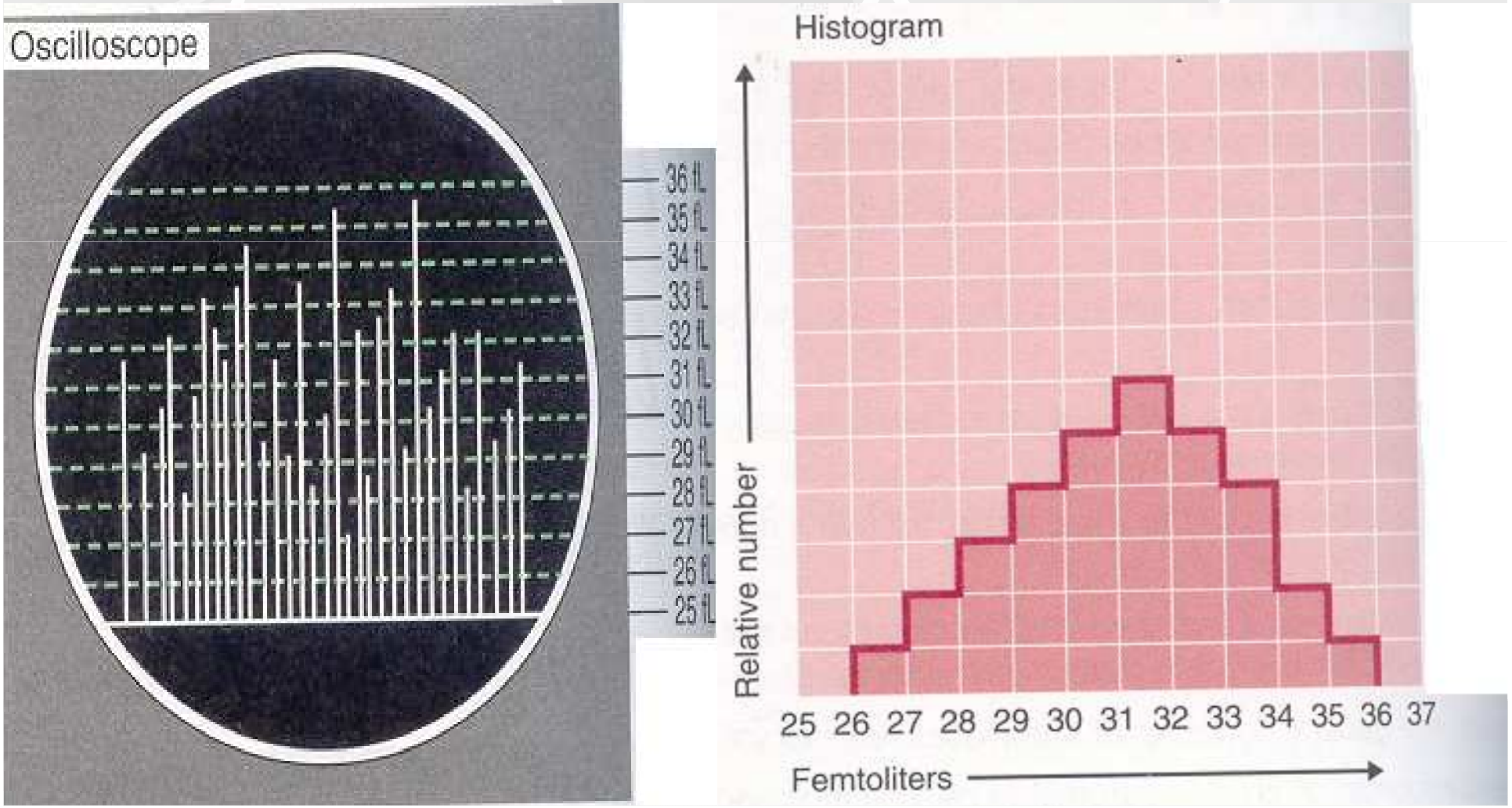


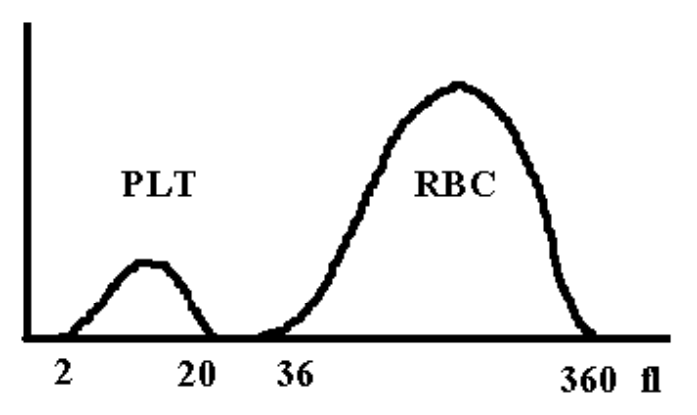
FIGURE 24–3 • Schematic diagram of particle counter in whi changes in electrical resistance are counted as voltage pulses. (CS = c suspension; GC = glass cylinder; A = aperture; E_1 and E_2 = platinu electrodes; V = value; M = mercury column; EC_1 and EC_2 = electric contacts; VP = vacuum pump.) (Diagram adapted from Ackerma 1972). (From Ackerman P: Electronic Instrumentation in the Clinic Laboratory. Boston. Little Brown and Co., 1972, p 140, with pe mission.)

Electrical Impedance



coulter

- Two chamber:
  - 1-RBC (x 3)
  - 2- WBC-Hb



- 1-RBC:
  - RBC
  - PLT
  - MCV
  - MPV
  - RDW

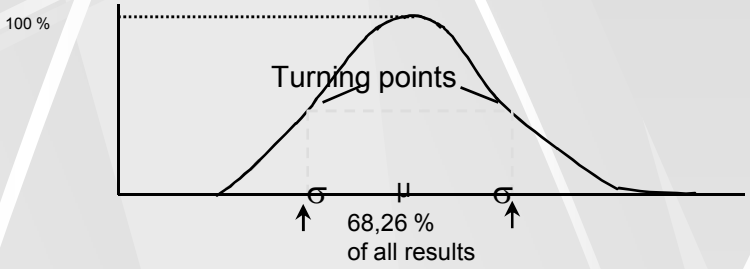
Precision : Parameter Whole Blood Mode

WBC	3.5% or lower
RBC	2.0% or lower
HGB	1.5% or lower
HCT	2.0% or lower
PLT	6.0% or lower

Erythrocyte-Histogram

Distribution width

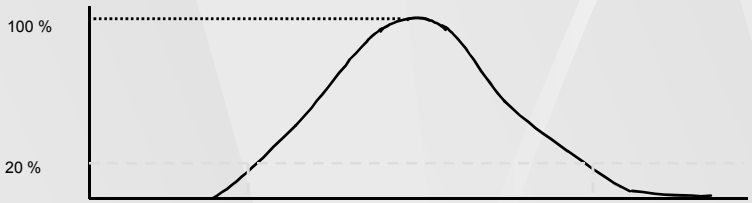
RDW-CV



RDW-CV (%) = 100 x σ/μ

RDW-CV
11 - 16 %

RDW-SD



RDW-SD
37 - 46 fl
Clinical relevant > 60 fl

RBC Distribution Curve as a parameter for anisocytosis

Erythrocyte-Histogram Flagging

Mark " *RL* ", abnormal height at lower discriminator

The curve does not start at the base line.

Possible causes (indeed noise):

- Giant Platelets
- Micro-Erythrocytes
- Platelet Clumps

Caution:

All results marked with " RL " should be controlled.

Mark " *RU* ", abnormal height at the upper discriminator.

The curve does not start at the base line.

Possible causes (indeed noise) :

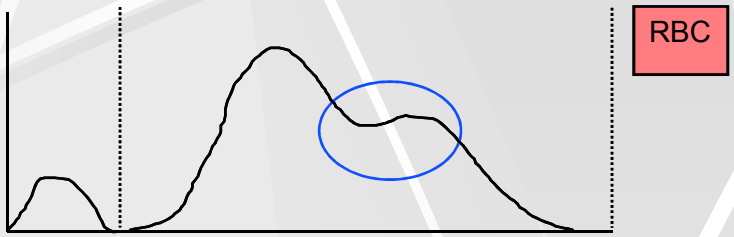
- Cold Agglutinins (check MCHC > 40 g/dl)
- Erythroblasts / Normoblasts

Caution :

RBC-result and all results marked with " RL " should be controlled.

Erythrocyte-Histogram Flagging

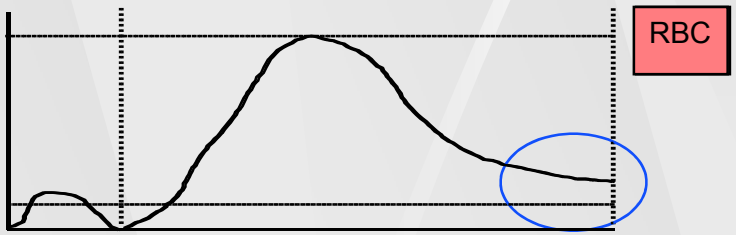
“ MP “, multiple peaks found



Possible causes:

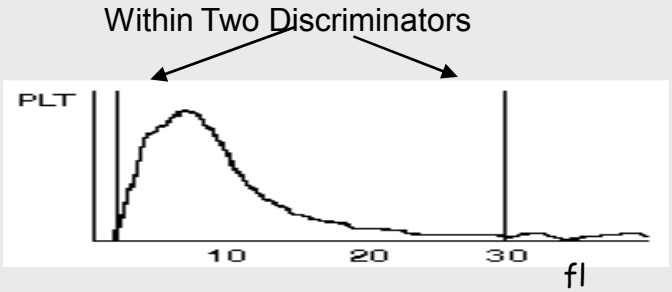
- Iron deficiency in therapie
- Infect- or Tumor Anämie (visceral iron deficiency)
- Transfusions

“DW “, abnormal histogram distribution



- Distribution curve does not cross 20% level twice.
- The overall height of the curve is always 100 %. The width is calculated on the 20 % height of the curve.
- **Hint for** extreme Aniso- or. Poikilocytosis.

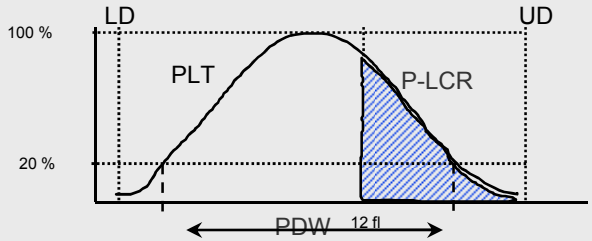
Thrombocyte-Histogram



- The histogram should lay within the two discriminators and start and end on the base line.
- PLT counted between 2 fl and 30 fl.
  1 flexible Diskriminator PL 2 to 6 fl.
  1 flexible Diskriminator PU 12-30 fl.
  1 fixed Diskriminator at 12 fl

Parameter of the Thrombocyte histogram

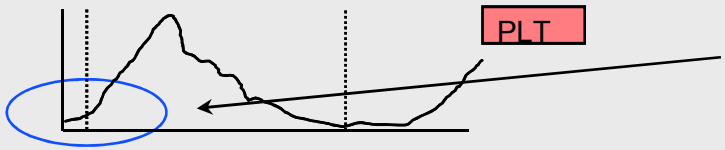
- MPV, mean PLT volume - reference range: 8 - 12 fl
- **P-LCR, ratio** of large platelets (% PLT>12 fl) - Reference range 15 - 35 %
- Increase could be a sign for:
  - PLT Clumps
  - Giant PLT
  - Microerythrocytes
- PDW, platelet distribution width at 20 % of peak height
  Reference range: 9 - 14 fl
  Increase could be a sign for:
  - PLT Clumps - Microerythrocytes - Fragments



$$\text{MPV (fl)} = \frac{\text{Pct (\%)}}{\text{PLT (x } 10^3/\mu\text{l)}}$$

Thrombocyte-Histogram Flagging

Mark " PL ", abnormal height at lower discriminator



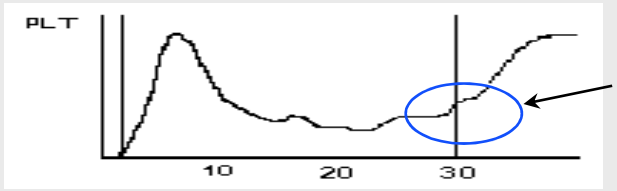
The curve does not start at the base line.

Possible cause:

- High blank value
- Cell fragments

Caution : Check Blank! Auto Rinse

Mark " PU ", abnormal height at upper discriminator



PLT

The curve does not end on the base line.

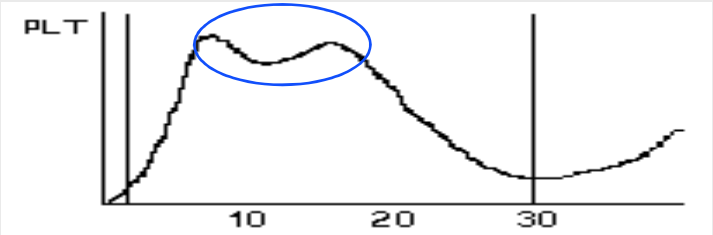
Possible Cause :

- PLT Clumps
  - EDTA-Incombatibility
  - Clotted sample
- Giant Platelets
- Microerythrocytes

Caution :Check PLT-Result (and all parameters marked with " PU "! In the event of perform the counting chamber or check PLT via Fonio!

Thrombocyte-Histogram
Flagging

Mark “ MP “, Multi Peaks found

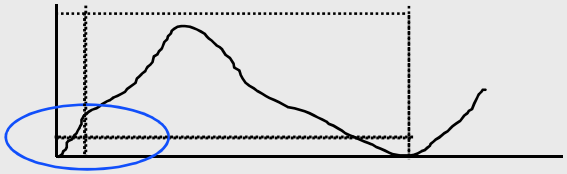


PLT

Possible Cause:

- Platelet transfusion

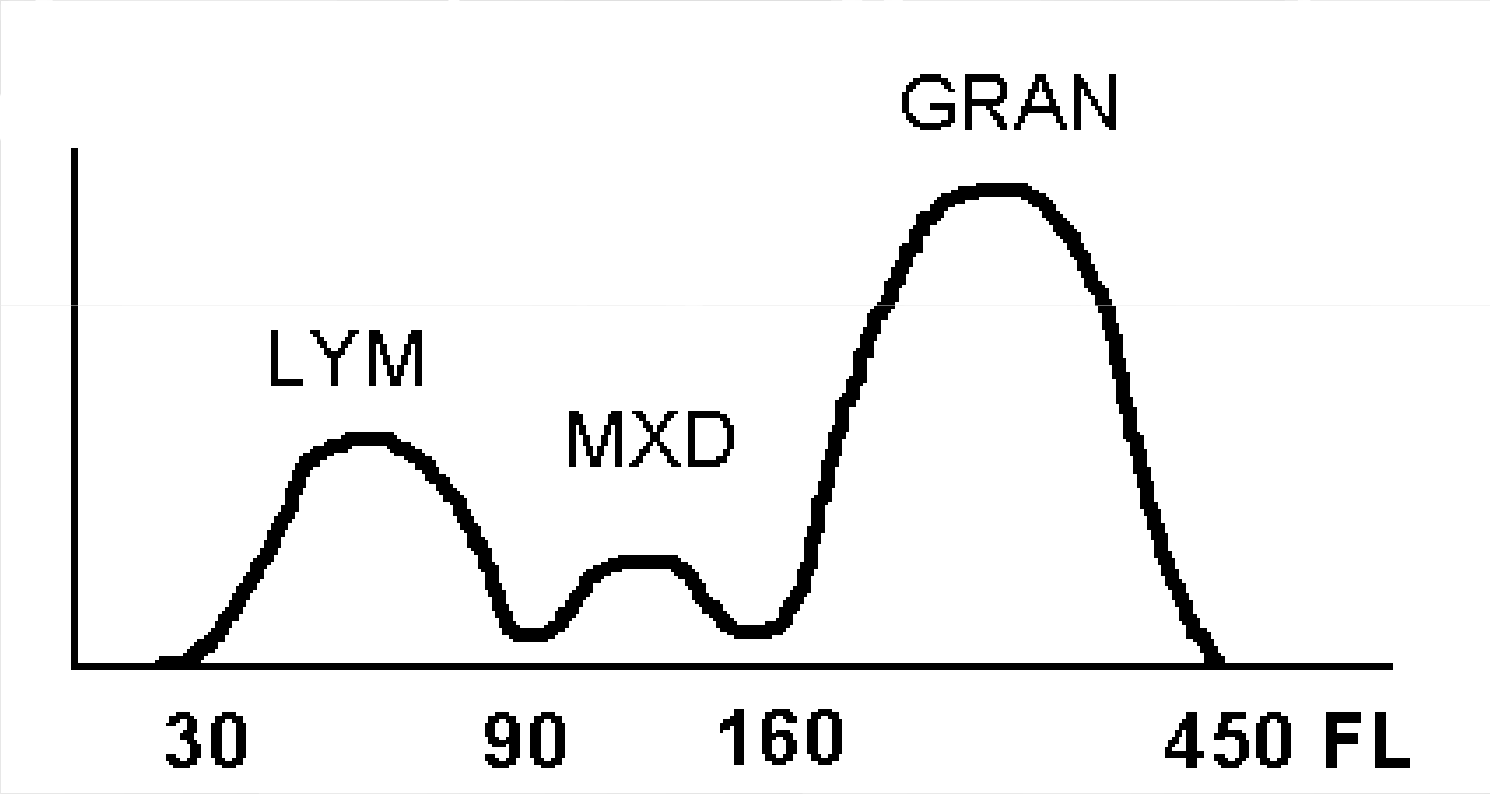
Mark “ DW “, Distribution With



PLT

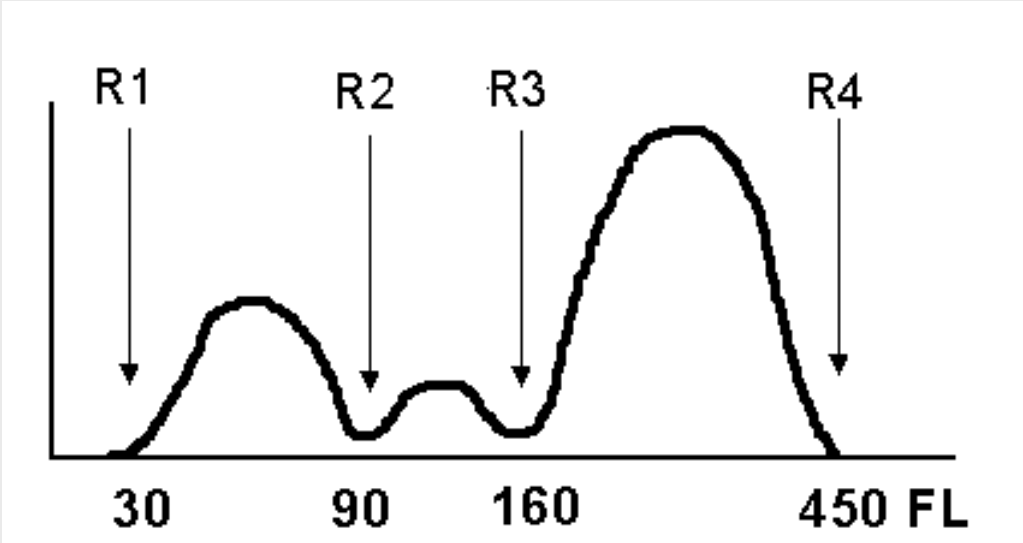
- The distribution can not be detected because the Histogram does not cross the 20 % limit twice.
- This curve in only an example but could also show another course.
- The overall height of the curve is always 100 %. The width is calculated on the 20 % height of the curve.

WBC

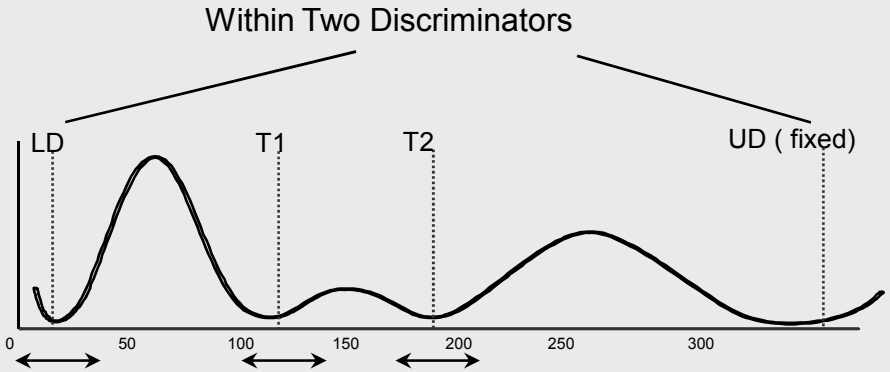


Region alarm(R flag)

- R1 <35
  - NRBC
  - PLT clamp
  - Fibrin
  - Cold agglutinin
  - Cryoglobin
  - Mallaria
  - heinz body
- R2 90
  - Atypical lym
  - Plasma cell
  - Blast
  - Hairy cell
  - Sezary cell
  - Increased mon ,eos,baso
- R3 160
  - Immature Gran
  - Increased mon ,eos,baso
- R4 450
  - Increased Gran



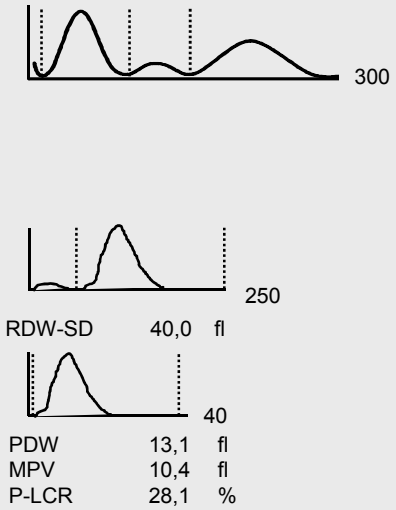
Leukocyte-Histogram



Important :

- The distribution curve should be within the discriminators. The curve should start and end at the basis line.
- The LD is flexible, but can not be lower than 30 fl.
- The WBC-channel shows Leukocytes and Thrombocytes (Erythrocytes are lysed).
- The volume of the Thrombocyts is usually between 8 - 12 fl, therefore the LD at the WBC-Histogramm seperates the Leukocytes from the Thrombocytes. (Thrombocytes were not counted).

Summery of all flags



WBC
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
T1 or T2; adjacent fractions are marked

RBC
RL: Abnormal height at lower discriminator of RBC Histogram (LD)
RU: Abnormal height at upper discriminator of RBC Histogram (UD)
MP: Multiple peaks: Distinguish ?? of two RBC Populations
DW:RDW can not be detected because the Histogram does not cross the 20 % limit twice.

PLT
PL: Abnormal height at lower discriminator of PLT Histogram (LD)
PU: Abnormal height at upper discriminator of PLT Histogram (UD)
MP: Multiple Peaks found
DW:PDW can not bedetected because the Histogram does not cross the 20 % limit twice.

Flow Cytometry

- A flow cytometer measures multiple properties of cells suspended in a moving fluid medium.
- As each particle passes single-file through a laser light source, it produces a characteristic light pattern that is measured by multiple detectors for scattered light (forward and 90 degrees) and fluorescent light (if the cell is stained with a fluorochrome).
- Flow cytometry is used to count and sort cells, as well as viral particles, DNA fragments, bacteria and latex beads.
- It is a core component of hematology cell counters and the technology used to differentiate white blood cells.

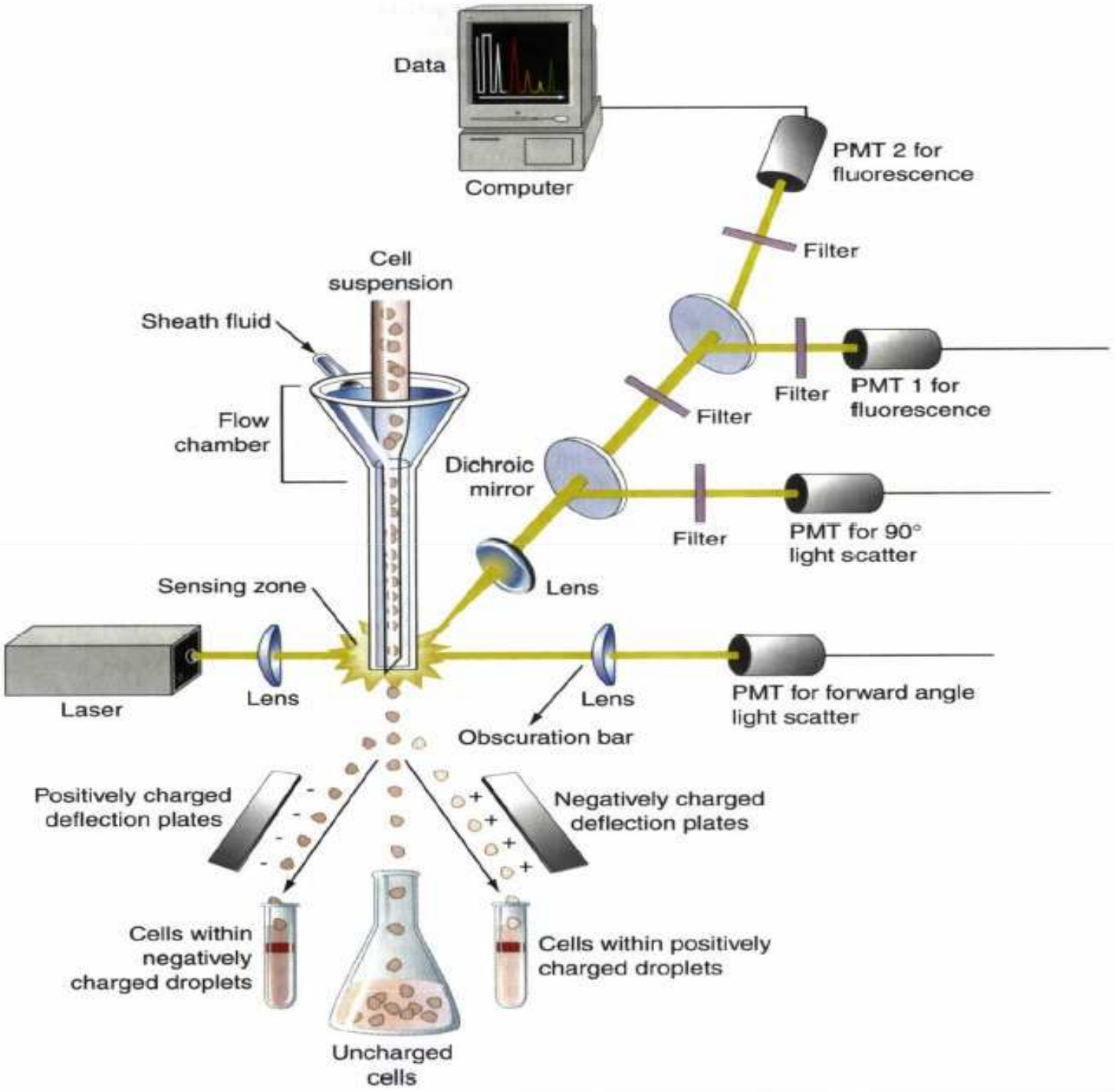


Figure 4–16 Components of a flow cytometer and a cell sorter. (Redrawn from Ward KM, Lehmann CA, Leiken AM: Clinical Laboratory Instrumentation and Automation; Principles, Applications, and Selection. Philadelphia, WB Saunders Company, 1994, with permission.)

- To be analyzed, particles must be in suspension as single cells.
- If not, they can be made suitable for flow cytometry by the use of mechanical disruption or enzymatic digestion.
- cells or particles must be 1-30 micron in diameter.

- Specialized flow cytometers are designed to handle smaller particles such as DNA fragments or bacteria.

Instrument Components

- The cell suspension aliquots are introduced into the flow chamber using air pressure.
- As the cells pass through the flow chamber, a low-pressure sheath fluid surrounds them.
- This outer fluid stream creates a laminar flow forcing the specimen to the center, and results in a single-file alignment of the individual cells.
- This process is called *hydrodynamic focusing*.

- A laser beam passes through each cell as it flows through the chamber.
- Forward light scatter is proportional to cell size,
- and 90-degree or right·angle scatter is related to cell granularity and nuclear irregularity.

- If the cells are labeled with appropriate fluorochromes, fluorescent signals proportional to the amount of bound label can be measured.
- Green fluorescence usually means that the dye fluorescein was used as a marker;
- red fluorescence usually means that a dye such as phycoerythrin was used.
- These *dyes* are usually attached to antibodies to specifically target selective antigens on cells or particles.

- Forward light scatter is directed to the forward scatter photodeteoor.
- At right angles to the laser beam are mirrors that divide the right-angle light scatter among the remaining photodeteclors. e.g., a right-angle scatter detector and two fluorescence detectors.
- Across the forward lens is an obscuration bar that blocks the laser beam after it passes through the stream.
- Only light from the laser that has been refracted or scattered as it strikes a particle in the stream is diverted enough from its original direction to avoid the obscuration bar and strike the forwardpositioned lens and the photodiode behind it.

- Granulocytes. monocytes. and lymphocytes are separated based on size and granularity patterns, determined by simultaneously analyzing forward and right-angle light scatter.
- For example, granulocytes with irregular nudei scatter more light to the side than do lymphocytes with their spherical nudei.
- Cell subpopulations can be identified by using electronic gating and analyzing fluorescence patterns (based on labels used for specific cells).

FACS

fluorescence-activated cell sorter

- describes a flow cytometer's ability to physically sort cells in a liquid suspension.
- To do so, the instrument design has to be modified to eleorically charge cells of interest.
- This is done by first vibrating the sheath stream to break it into drops.
- The stream of drops flows past two charge (high-voltage) plates where cells of interest are electrically charged with a voltage pulse.
- Then the flow stream enters an electrical field where charged cells are deflected into suitable collection containers.
- Unwanted cells are not charged and not deflected upon passing through the field.

Colors and More Colors:
Applications of *Fluorochromes*

- Most laboratories are still using the most common fluorochromes,

- fluorescein isothiocyanate (FITC; 530 nm emission) and
- phycoerythrin (PE; 575 nm emission) for immunophenoryping

and

- propidium iodide (PI) (625 nm emission) in the measurement of DNA

- The use of multicolor fluorescence has allowed the concept of multiparameter analysis to become a reality in most laboratories.
- The parameters can evaluate:
- I. different functional subsets of a particular cell population using an intracellular fluorescent probes
- 2. use of several colors to identify small clusters of otherwise unidentifiable events (as in MRD)
- 3. activation status of cells in a particular disease stage (e.g., use of HLADR and CD38 on CD4 and CD8s in HIV staging using an anchor gate approach)
- 4. cell surface expression and the DI or S-phase of a particular cell population as in defining the CD 19 S-phase in an acute leukemia.

- H1 : 1985 - Diff : 60 sample/h-100µl
  - Hb
  - RBC/PLT
  - Perixidase canale
  - B/L (surfactant : lysis RBC & fetalic acid :shrinkage WBC)
- H2 : Diff : 80 sample/h
- H3 : Retic-colored picture

SEQ# 0000003
TIME 00:50 09/16/86
SYS# 529
ID

	CBC		
	7.53	x10³/µl	WBC
	4.27	x10⁶/µl	RBC
	13.3	g/dl	HGB
	38.5	%	HCT
	90.3	fl	MCV
H	31.1	pg	MCH
	34.4	g/dl	MCHC
	11.7	%	RDW
L	2.16	g/dl	HDW
	224	x10³/µl	PLT
	10.1	fl	MPV

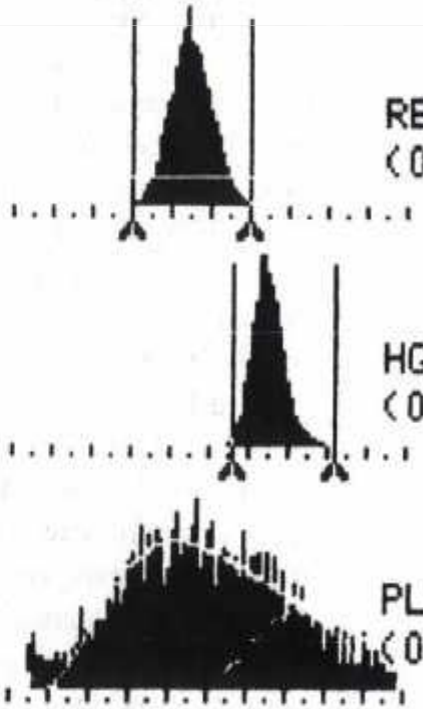
RBC FLAGS = 0000

%	DIFF	x10³/µl
56.0	NEUT	4.22
34.0	LYMP	2.56
5.4	MONO	.41
2.2	EOS	.16
.7	BASO	.05
1.8	LUC	.13
LI		2.70
MPXI		9.6

WBC FLAGS = 0100

MORPHOLOGY FLAGS

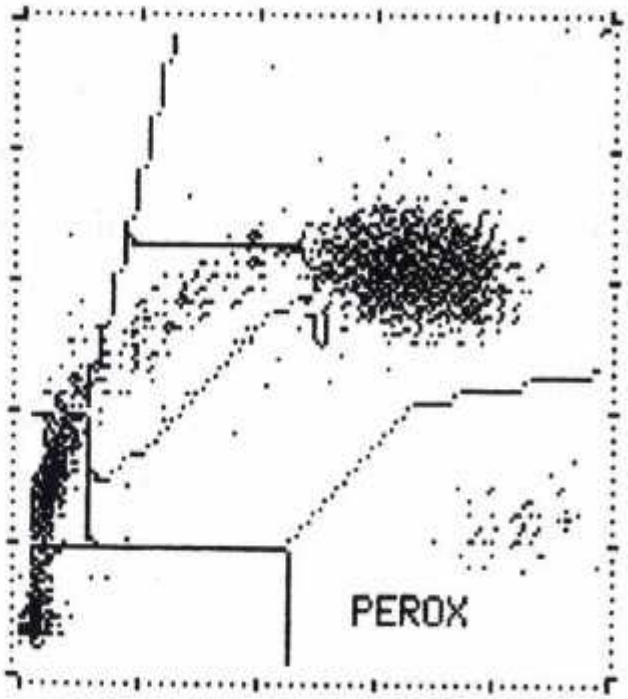
PARAMETER	SUSP	VERIFY
ANISO		
MICRO		
MACRO		
VAR		
HYPO		
HYPER		
L. SHIFT		
ATYP		
BLASTS		
OTHER		
OTHER		

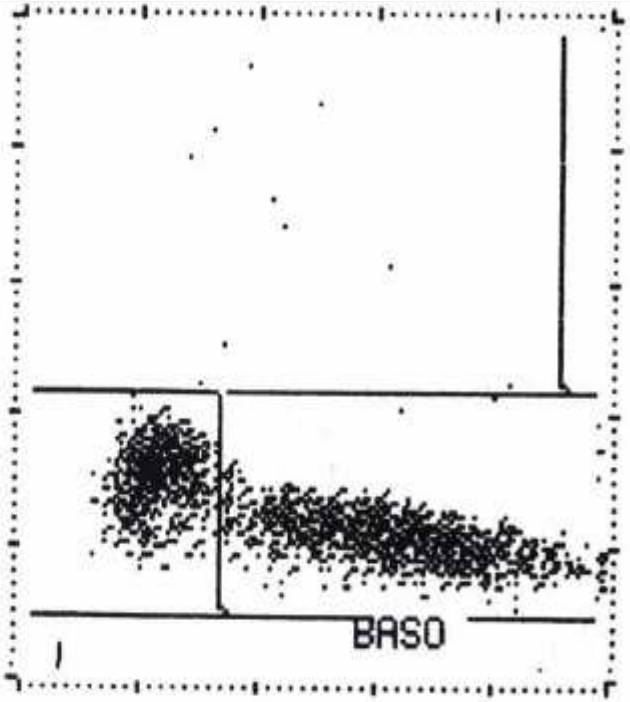


RBC VOLUME
(0-200 fl)

HGB CONC
(0-50 g/dl)

PLT VOLUME
(0-20 fl)





- MPXI (-10 , +10)
  - Increased : CML – MA- AIDS –TOXIC-infection- AML
  - Decreased : CLL- ALL- MPX drficiency
  - Mpx deficiency in 9%
  - Total Mpx deficiency in 0.04 %

Radiofrequency Conductivily

- Conductivity is determined using a high-frequency electromagnetic probe
- provides information on the cells internal constituents (chemical composition, nuclear characteristics, and granular constituents) by permeating the lipid layer of a cell's membrane.

- Conductivity is especially helpful in differentiating between cells of like size such as small lymphocytes and basophils

- This principle is utilized in instruments marketed by Coulter (LH 700, GENI.S, HmX, A.T, ete.; Beckman Coulter, Ine., Brea, GA) and Sysmex (XE-2100, XT 2000i, HST-N,ete.; Sysmex America, Ine., Mundelein, IL).

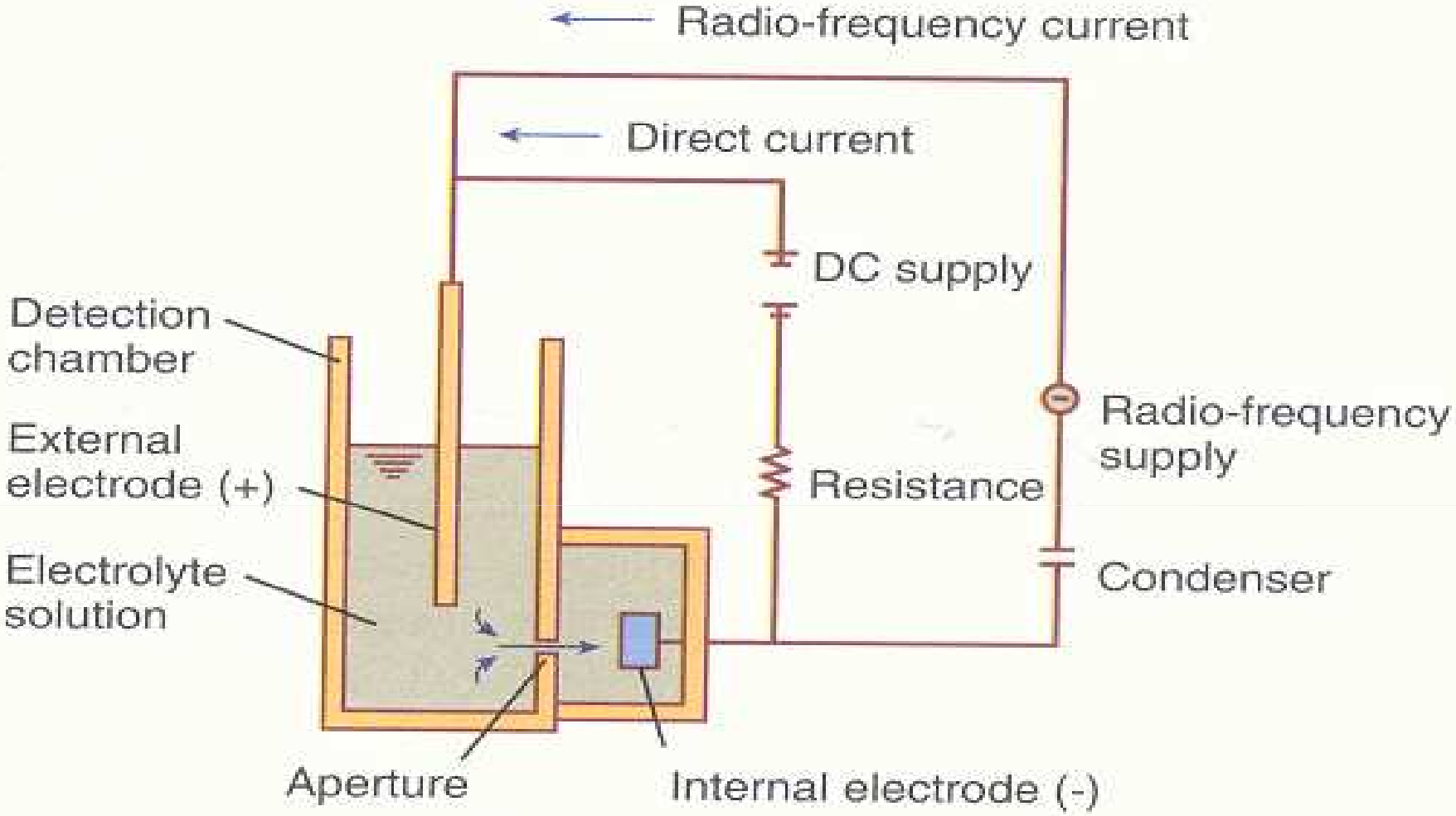


FIGURE 40-3 RF/DC detection method, showing simultaneous use of direct current (DC) and radiofrequency (RF) in one measurement system on the Sysmex SE-9500. (From Toa Medical Electronics Co., Ltd.: Sysmex™ SE-9500 Operator's Manual (CN 461-2464-2). Kobe, Japan: Toa Medical Electronics Co., Ltd., 1997; reprinted with permission.)

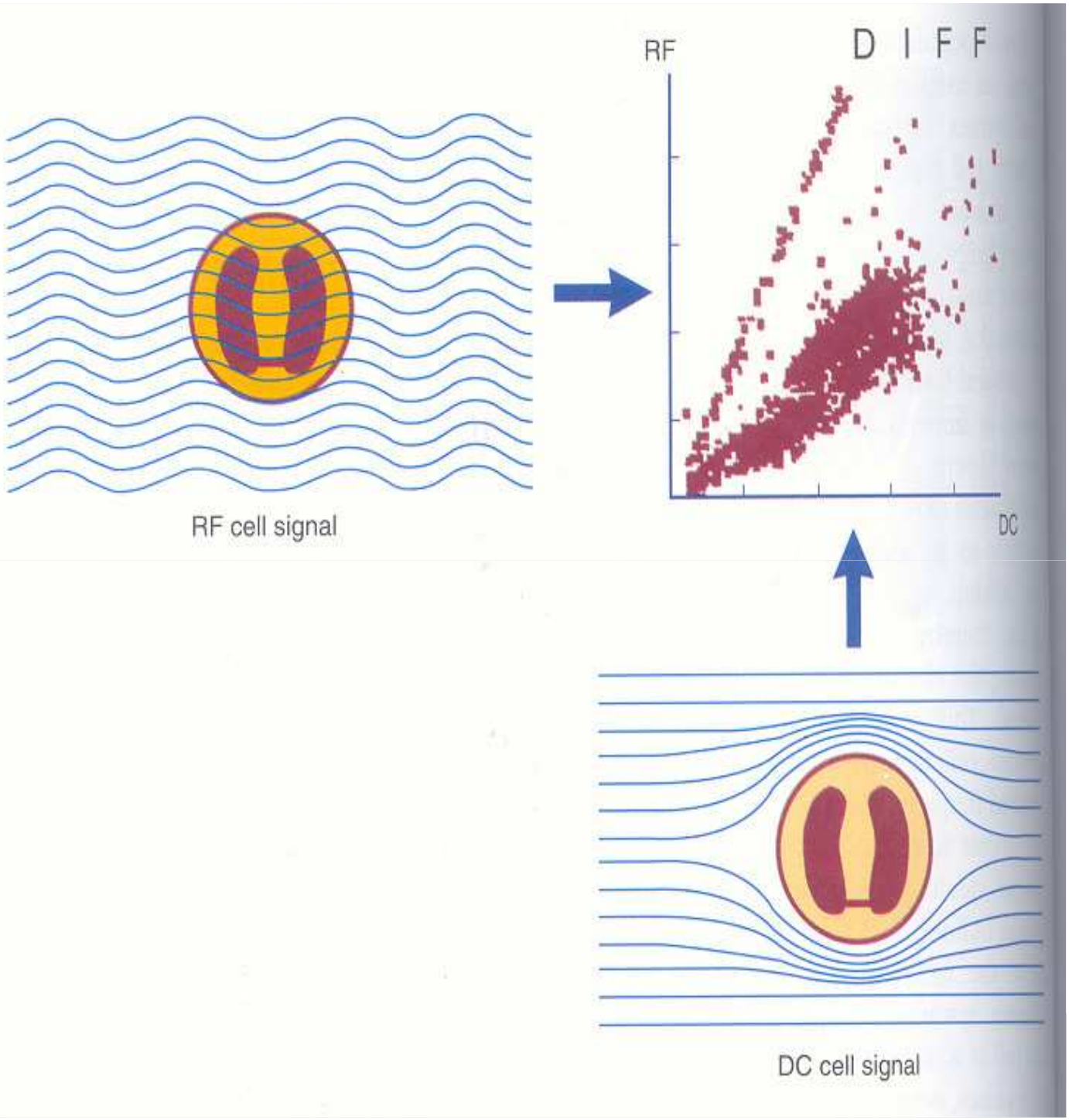


FIGURE 40-4 Illustration of cell size/volume measurement with DC voltage change versus the measure of cell nuclear volume/complexity with change in the RF signal. The two measurements can be plotted against each other for the formation of a two-dimensional distribution scatterplot. (From Toa Medical Electronics Co., Ltd.: Sysmex™ SE-9500 Operator's Manual (CN 461-2464-2). Kobe, Japan: Toa Medical Electronics Co., Ltd., 1997; reprinted with permission.)

Coulter Gen-S & Coulter STKS Hematology Analyzer

- capable of providing a CBC
  - five-part differential leukocyte count,
  - reticulocyte count.
  - automated CD4/CD8 count.

- The Gen-S analyzer uses the Coulter Volume, Conductivity, Scatter (VCS) technology to probe hydrodynamically focused cells.
  - Volume measurement is performed using the Coulter principle of electrical impedance.
  - The high frequency conductivity provides information about cell size, internal structure, and density.
  - A helium-neon laser and a multiple-angle light scatter provide information about a cell's internal structure, granularity, and surface morphology.

Method				
Instrument	**Impedance**	**Conductivity**	**Light Scatter**	**Cytochemistry**
Abbott	X	X	X	
ABX	X		X	X
Bayer			X	X
Coulter	X	X	X	
Sysmex	X	X	X	

sourecs of error

- WBC>30000
  - Increased Hb, HCT, MCV
- Glucose >400 & hyperosmolarity
  - High MCV-HCT
  - Low MCHC
  - 44.7 µ blood + 10 cc isoton solution (1:224) for 10 min
- Cold agglutinin
  - High MCV-MCHC
  - Low RBC
- Hyperlipemia
  - High Hb- MCH- MCHC
  - Hb=total Hb – plasmacrit x plasma Hb
  - N=5/1-HCT
- Osmotic resistance

Osmotic resistance

- MDS
- Post splenectomy
- Hemoglobinopathy
- MA
- Neonate

PARAMETER	CAUSES OF SPURIOUS INCREASE	CAUSES OF SPURIOUS DECREASE
WBC	Cryoglobulin, cryofibrinogen Heparin Monoclonal proteins Nucleated red cells Platelet clumping Unlysed red cells	Clotting Smudge cells Uremia plus immunosuppressants
RBC	Cryoglobulin, cryofibrinogen Giant platelets High WBC (>50,000/μL)	Autoagglutination Clotting Hemolysis (*in vitro*) Microcytic red cells
Hemoglobin	Carboxyhemoglobin (>10%) Cryoglobulin, cryofibrinogen Hemolysis (*in vitro*) Heparin High WBC (>50,000/μL) Hyperbilirubinemia Lipemia Monoclonal proteins	Clotting Sulfhemoglobin (?)
Hematocrit (automated)	Cryoglobulin, cryofibrinogen Giant platelets High WBC (>50,000/μL) Hyperglycemia (>600 mg/dL) Hyponatremia Plasma trapping	Autoagglutination Clotting Hemolysis (*in vitro*) Microcytic red cells
Hematocrit (microhematocrit)		Excess EDTA Hemolysis (*in vitro*) Hypernatremia
MCV	Autoagglutination High WBC (>50,000/μL) Hyperglycemia Reduced red cell deformability	Cryoglobulin, cryofibrinogen Giant platelets Hemolysis (*in vitro*) Microcytic red cells Swollen red cells
MCH	High WBC (>50,000/μL) Spuriously high Hb Spuriously low RBC	Spuriously low Hb Spuriously high RBC
MCHC	Autoagglutination Clotting Hemolysis (*in vitro*) Hemolysis (*in vivo*) Spuriously high Hb Spuriously low Hct	High WBC (>50,000/μL) Spuriously low Hb Spuriously high Hct
Platelets	Cryoglobulin, cryofibrinogen Hemolysis (*in vitro* and *in vivo*) Microcytic red cells Red cell inclusions White cell fragments	Clotting Giant platelets Heparin Platelet clumping Platelet satellitosis

Quality control

- Brittin-index are stable at 24h in 4 C
  - **T student**

$$t_n = \frac{\bar{d}}{SD}\sqrt{n}$$

$$SD = \sqrt{\frac{\sum[d^2] - \frac{\sum(d)^2}{n}}{n-1}}$$

- **Moving average-change >3%**
- **Delta checks**
- **Cyto check- 31 day**

نمونه	MCV روز اول	MCV	d روز دوم	d^2
۱	۷۸	۸۰	-۲	۴
۲	۹۸	۹۴	۴	۱۶
۳	۷۲	۷۰	۲	۴
۴	۶۰	۶۱	۱	۱
۵	۸۹	۸۶	۳	۹
			$\Sigma d = ۸$	$\Sigma d^2 = ۳۴$

$$\bar{d} = \frac{\Sigma d}{n}$$

$$\bar{d} = \frac{۸}{۵} = ۱/۶$$

$$SD = \sqrt{\frac{\Sigma[d^2] - \frac{\Sigma(d)^2}{n}}{n-1}}$$

$$S_d = \sqrt{\frac{۳۴ - \frac{(۸)^۲}{۵}}{۴}} = ۲/۳$$

$$t_n = \frac{\bar{d}}{SD}\sqrt{n}$$

$$t_n = \frac{۱/۶}{۲/۳}\sqrt{۵} = ۱/۵۴$$

$۱/۵۴ < ۲/۷۸ \Rightarrow H_۰$ → قبول

Percentage points of the t distribution (this table gives the values of t for differing df that cut off specified proportions of the area in one and in two tails of the t distribution)

	Area in Two Tails				
	.10	.05	.02	.01	.001
	Area in One Tail				
df	.05	.025	.01	.005	.0005
1	6.314	12.706	31.821	63.657	636.619
2	2.920	4.303	6.965	9.925	31.598
3	2.353	3.182	4.541	5.841	12.941
4	2.132	2.776	3.747	4.604	8.610
5	2.015	2.571	3.365	4.032	6.859
6	1.943	2.447	3.143	3.707	5.959
7	1.895	2.365	2.998	3.499	5.405
8	1.860	2.306	2.896	3.355	5.041
9	1.833	2.262	2.821	3.250	4.781
10	1.812	2.228	2.764	3.169	4.587
11	1.796	2.201	2.718	3.106	4.437
12	1.782	2.179	2.681	3.055	4.318
13	1.771	2.160	2.650	3.012	4 221
14	1.761	2.145	2.624	2.977	4.140
15	1.753	2.131	2.602	2.947	4.073
16	1.746	2.120	2.583	2.921	4.015
17	1.740	2.110	2.567	2.898	3.965
18	1.734	2.101	2.552	2.878	3.922
19	1.729	2.093	2.539	2.861	3.883
20	1.725	2.086	2.528	2.845	3.850
21	1.721	2.080	2.518	2.831	3.819
22	1.717	2.074	2.508	2.819	3.792
23	1.714	2.069	2.500	2.807	3.767
24	1.711	2.064	2.492	2.797	3.745
25	1.708	2.060	2.485	2.787	3.725
26	1.706	2.056	2.479	2.779	3.707
27	1.703	2.052	2.473	2.771	3.690
28	1.701	2.048	2.467	2.763	3.674
29	1.699	2.045	2.462	2.756	3.659
30	1.697	2.042	2.457	2.750	3.646
40	1.684	2.021	2.423	2.704	3.551
60	1.671	2.000	2.390	2.660	3.460
120	1.658	1.980	2.358	2.617	3.373
∞	1.645	1.960	2.326	2.576	3.291

Adapted from Table 12: Percentage points of the t-distribution, p. 146 in Biometrika Tables for Statisticians, Vol. 1, 3rd ed. 1966 by E.S. Pearson and H.O. Hartley with permission of the Biometrika Trustees.

calibration

- Calibrant
- Whole blood- 10-20 sample per day
  - HB- HICN
  - HCT- microhct-with 1-3% correction
  - RBC- WBC
- If correction factor equll 5% then sample x 1.05

calibration

- **Calibrant (كاليبره كننده هاي تجارتي)**
- **Whole blood (با استفاده از خون كامل)**

10-20 sample per day

- HB- HICN
- HCT- microhct-with 1-3% correction
- RBC(single chanel analyzer)
- WBC (single chanel analuzer or hemocytometer)

- هریک ازمراحل ذکر شده ۳ باراروی این اشخاص انجام شده و هر رقت دو بار خوانده شده و متوسط هر یک تعیین می گردد.
- تفاوت بین مقادیر بدست آمده از روشهای مرجع و دستگاه هماتولوژی برای هر نمونه تعیین و ازاین طریق درصد اختلاف و در نهایت فاکتور تصحیح محاسبه می گزدد.

Example: If correction factor equal 5% then sample × 1.05

مقادیر جدید کالیبراسیون = مقدارکالیبراسیون قبلي × متوسط مقدار به دست آمده به روش مرجع / مقدار به دست آمده با دستگاه

$$\text{مقادیر جدید کالیبراسیون} = \text{مقدارکالیبراسیون قبلي} \times \frac{\text{متوسط مقدار به دست آمده به روش مرجع}}{\text{مقدار به دست آمده با دستگاه}}$$

اندازه گیری هموگلوبین روی پنج نمونه ابتدا به روش مرجع و سپس توسط دستگاه سل کانتر هماتولوژی انجام، و نتایج زیر حاصل گردید.

۱ـ **به روش مرجع :** ۱۴/۷ gr/dl، ۱۵/۵ gr/dl ، ۱۴/۵ gr/dl، ۱۵ gr/dl، ۱۵/۳ gr/dl

۲ـ **توسط دستگاه :** ۱۴/۶gr/dl، ۱۴/۴ gr/dl، ۱۴/۷gr/dl، ۱۴/۳ gr/dl، ۱۴/۵ gr/dl

چنانچه فاکتور قبلی کالیبراسیون سل کانتر ۹۸/ ۰باشد، فاکتور جدید را محاسبه نماید.

کالیبراسیون در سیسمکس

- نیاز به کالیبراسیون دوره ای ندارد.
- اجازه کالیبراسیون فقط هموگلوبین و هماتوکریت را می دهد.
- به دو روش دستی و اتوماتیک انجام می گیرد.

کنترل کیفی

- استفاده از نمونه های کنترل تجاری وتجزیه تحلیل آنها به روشهای:
  - محاسبه SD نمونه کنترل
  - رسم نمودارهای کنترل کیفی از جمله نمودار Levey- Jenning

- انجام دو بار آزمایش روی نمونه های بیماران وبررسی تغییرات ایجاد شده با استفاده از آزمون استودنت t

- میانگین متحرک
- دلتا چک
- استفاده از نتایج دیگر آزمایشگاهها

standard deviation

انحراف معیار استاندارد

تعریف انحراف معیار:معدل فاصله از نقطه میانگین یک مجموعه داده.

$$SD = \sqrt{\frac{\sum (x_i - \overline{x})^2}{n-1}}$$

$$Mean = \overline{x} = (x_1 + x_2 + \ldots x_n) + n$$

X	$(X - \bar{X})$	$(X - \bar{X})^2$
0	-10	100
8	-2	4
12	2	4
20	10	100
Total		208
Divided by (n-1)		69.333
Square Root		8.3266

X_i	$(X_i - \bar{X})$	$(X_i - \bar{X})^2$
8	-2	4
9	-1	1
11	1	1
12	2	4
Total		10
Divided by (n-1)		3.333
Square Root		1.8257

coefficient of variation

ضريب تغييرات

- CV= SD / mean
- The CV is often expressed as a percentage, although it can also be expressed as a decimal fraction less than 1.
- If mean = 25 and the SD = 5,
  - the CV = 20%, or 0.20.

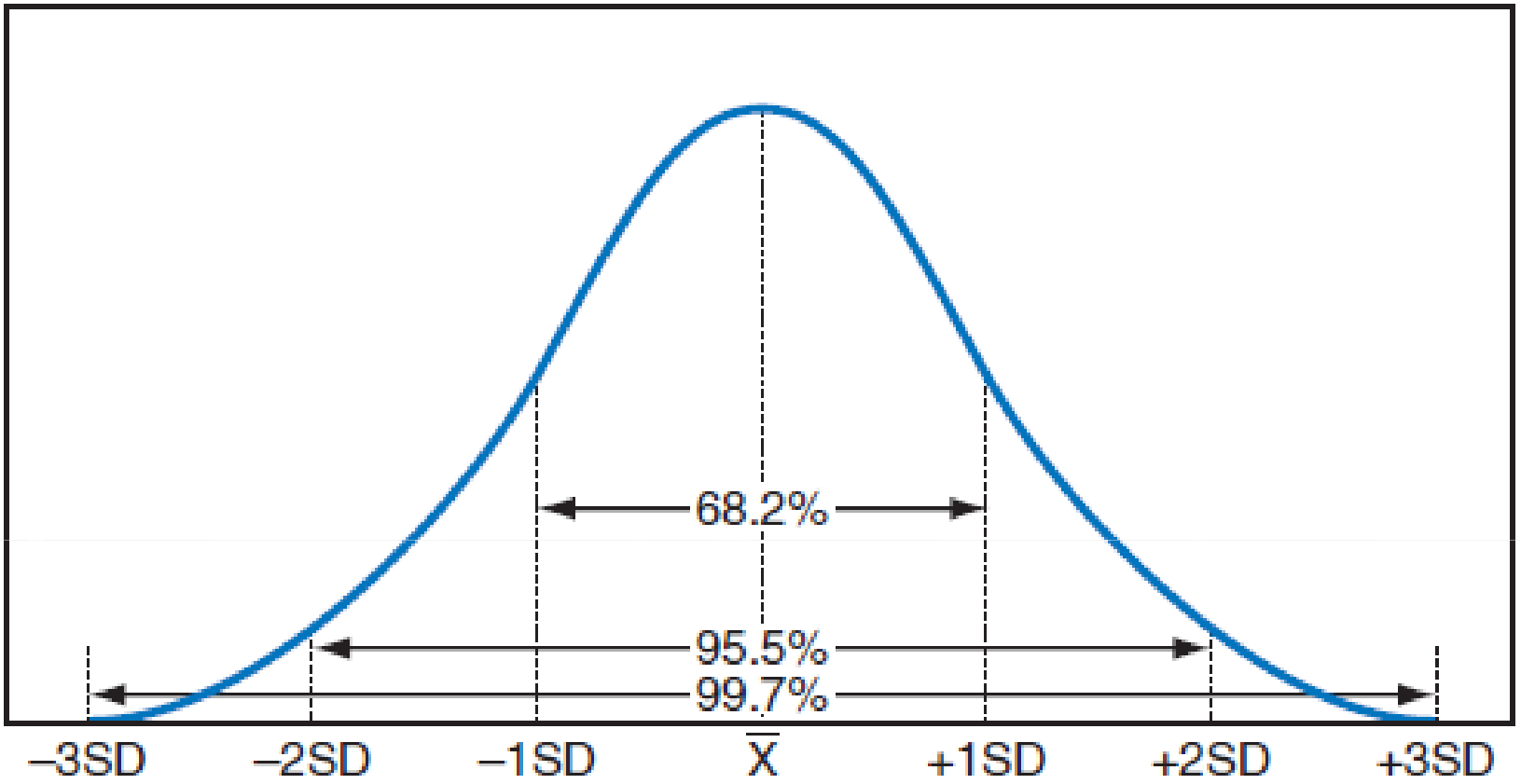


Figure 9-1 Idealized Gaussian (normal) distribution showing areas under the curve corresponding to mean ± 1, 2, and 3 standard deviations (SD).

معایب Student t test

- ـاشکالات ناگهاني ممکن است تا روز بعد کشف نگردند.
- ـ کالیبراسیون هاي نادرست را تشخیص نمي دهد .
- ـبه Gradual drift حساس نیست.

کنترل کیفی در سیسمکس

—

- X control
- Levy-Jennings

متغیر	علل افزایش کاذب	علل کاهش کاذب
WBC	کرایوگلوبولین, کرایوفیبرینوژن هپارین پروتئینهای منوکلونال، گلبولهای قرمز هسته دار، تجمع های پلاکتی ،گلبولهای قرمز لیز نشده	لخته خون, سلولهای له شده اورمی همراه با سرکوب کننده های ایمنی و بعضی از لوسمیها
RBC	کرایوگلوبولین, کرایوفیبرینوژن پلاکتهای غول پیکر WBC بالا (بیش از µl / ۵۰۰۰۰)	اتوآگلوتیناسیون لخته خون همولیز (در آزمایشگاه) گلبولهای قرمز میکروسیت
Hemoglobin	کربوکسی هموگلوبین (< ۱۰%) کرایوگلوبولین, کرایوفیبرینوژن همولیز(در آزمایشگاه)، لوکوسیت بالا،لیپمی، هیپربیلیروبینمی، پروتئینهای مونوکلونال	لخته خون سولفهموگلوبین(؟)
هماتوکریت (اتوماتیک)	کرایوگلوبولین, کرایوفیبرینوژن پلاکتهای غول پیکر WBC بالا(بالاتر از µl/۵۰۰۰۰) هیپرگلیسمی(<۶۰۰ mg/dl)	اتوآگلوتیناسیون لخته خون همولیز (در آزمایشگاه) گلبولهای قرمز میکروسیت، EDTA اضافی
هماتوکریت (میکروهماتوکریت)	هیپوناترمی به دام افتادن پلاسما	همولیز(در آزمایشگاه) هیپرناترمی

متغیر	علل افزایش کاذب	علل کاهش کاذب
MCV	اتوآگلوتیناسیون WBC بالا(بیش از ۵۰۰۰۰ / µl) هیپرگلیسمی کاهش شکل پذیری گلبولهای قرمز	کرایوگلوبولین, کرایوفیبرینوژن پلاکتهای غول پیکر همولیز(در آزمایشگاه) گلبولهای قرمز میکروسیت گلبولهای قرمز متورم
MCH	WBC بالا (بیش از ۵۰۰۰۰/µl) Hb بالای کاذب RBC پایین کاذب	Hb پایین کاذب RBC بالای کاذب
MCHC	اتو آگلوتیناسیون لخته خون همولیز(در آزمایشگاه) همولیز(در بدن) هموگلوبین بالای کاذب Hct پایین کاذب	WBC بالا(بیش از۵۰۰۰۰ / µl) Hb پایین کاذب Hct بالای کاذب
پلاکتها	کرایوگلوبولین، کرایوفیبرینوژن همولیز(در آزمایشگاه و در بدن) گلبولهای قرمز میکروسیت ذرات داخل گلبول قرمز ذرات گلبول سفید	لخته خون پلاکتهای غول پیکر هپارین تجمع های پلاکتی اقماری قرار گرفتن پلاکتها