Complete Blood Count

Purpose and Principle of Test

The Beckman Coulter method of sizing and counting particles uses measurable changes in electrical resistance produced by nonconductive particles suspended in an electrolyte.

A suspension of blood cells passes through a small orifice simultaneously with an electric current. A small opening (aperture) between electrodes is the sensing zone through which suspended particles pass. In the sensing zone, each particle displaces its volume of electrolyte. Beckman Coulter measures the displaced volume as a voltage pulse, the height of each pulse being proportional to the volume of the particle.

The quantity of suspension drawn through the aperture is for an exact reproducible volume. Beckman Coulter counts and sizes individual particles at a rate of several thousand per second. This method is independent of particle shape, color, and density.
The MAXM is a quantitative, automated, differential cell counter for in vitro diagnostic use.

The MAXM measures these parameters in whole blood:

Cell	Parameter	Measured	Pulse size wavelength calculation	Reported units
WBC	white blood cell count	WBC bath	≥35 fL	$n \times 10^3$ cells/µL
RBC	red blood cell count	RBC bath	36–360 fL	$n \times 10^6$ cells/µL
Hgb	hemoglobin concentration	WBC bath	525 nm	g/dL
Hct	hematocrit	computed	RBC x MCV/10	%
MCV	mean cell volume	derived from RBC histogram	# × size of RBC/total RBC	fL
MCH	mean cell hemoglobin	computer	Hgb/RBC × 10	pg
MCHC	mean cell hemoglobin concentration	computed	Hgb/Hct × 100	g/dL
RDW	red cell distribution width	derived from RBC histogram	CV expressed in % of the RBC size distribution	%
Plt	platelet count	RBC bath	2 to 20 fL	$n \times 10^3$ cells/µL
MPV	mean platelet volume	derived from Plt histogram	Mean volume of Plt population under the fitted curve × constant	fL
NE%	neutrophil percent	derived from scatterplot	# cells inside NE area/# cells inside total cell area × 100	%
NE #	neutrophil number	absolute number	NE%/100 × WBC count	10^3 cells/µL
LY%	lymphocyte percent	derived from scatterplot	# cells inside LY area/# cells inside total cell area × 100	%
LY#	lymphocyte number	absolute number	Ly%/100 × WBC count	103 cells/µL

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MO%	monocyte percent	derived from scatterplot	# cells inside MO area/# cells inside total cell area × 100	%
MO#	monocyte number	absolute number	MO%/100 × WBC count	103 cells/µL
EO%	eosinophil percent	derived from scatterplot	# cells inside EO area/# cells inside total cell area × 100	%
EO#	eosinophil number	absolute number	EO%/100 × WBC count	103 cells/µL
BA%	basophil percent	derived from scatterplot	# cells inside BA area/# cells inside total cell area × 100	%
BA#	basophil number	absolute number	BA%/100 × WBC count	103 cells/µL

*PDW – platelet distribution width and percent – platelet crit are NOT for diagnostic use and do not print. Coulter uses the value for PDW as an internal check on the reported platelet parameters, Pct and MPV.

Methodology: The methods used to derive CBC parameters are based on the Beckman Coulter method of counting and sizing, in combination with an automatic diluting and mixing device for sample processing, and a single beam photometer for hemoglobinometry. The WBC differential uses VCS technology. Analysis and classification of WBCs use three simultaneous measurements of individual cell volume (V), high frequency conductivity (C), and laser light scatter (S). The scattergram plots the cells based upon the measurements of these three parameters.

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Reference Ranges (Normal Values)

Males

Test Type	Ages 1-5	Ages 6-18	Ages 19-65	Ages 66+
WBC (x 10^3 µL)	4.3-14.1	3.7-11.9	3.9-12.1	3.9-12.3
RBC (x 10^6 µL)	4.00 - 5.30	4.10-5.60	4.10-5.80	4.00-5.60
Hgb (g/dL)	10.5-13.7	11.5-16.3	12.7-17.1	11.0-16.8
HCT (%)	31.8-40.8	34.4-48.3	38.0-50.3	33.1-50.2
MCV (fL)	67.6-88.2	74.3-93.0	78.1-99.2	78.9-101.4
MCH (pg)	21.7-29.8	24.3-31.7	25.7-33.8	25.6-34.4
MCHC (g/dL)	31.5-35.0	31.9-35.1	32.0-35.3	31.8-35.1
RDW (%)	11.7-16.5	11.7-14.3	11.8-15.3	12.1-16.6
Plt (x 10^3 µL)	224-568	194-477	157-414	138-407
MPV (fL)	6.3-9.3	6.6-9.9	6.8-10.4	6.7-10.6
LY (%)	24.5-70.0	20.0-56.6	17.8-51.8	13.0-48.3
MONO (%)	0-12	0-12	0-12	0-13
NE (%)	21.4-70.5	33.2-74.7	39.7-77.3	44.7-81.9
EO (%)	0-10	0-11	0-8	0-8
BA (%)	0-2	0-2	0-2	0-2

Females

Test Type	Ages 1-5	Ages 6-18	Ages 19-65	Ages 66+
WBC (x 10^3 µL)	4.2-13.6	4.0-12.4	3.9-12.5	4.0-12.3
RBC (x 10^6 µL)	3.90 - 5.20	3.90-5.20	3.70-5.20	3.50-5.20
Hgb (g/dL)	10.5-13.7	11.1-14.7	10.4-15.2	10.5-15.5
HCT (%)	32.0-40.6	33.4-43.4	32.0-45.0	32.0-46.0
MCV (fL)	69.0-88.6	74.5-93.9	73.4-98.3	79.7-100.2
MCH (pg)	22.3-30.1	24.2-31.8	23.2-33.3	25.9-33.8
MCHC (g/dL)	31.8-35.1	31.7-35.0	31.4-35.1	31.6-35.0
RDW (%)	11.4-15.4	11.6-14.8	11.8-16.6	12.0-16.1
Plt (x 10^3 µL)	229-581	202-476	172-453	147-440
MPV (fL)	6.3-9.2	6.7-10.0	6.9-10.7	6.8-10.8
LY (%)	24.9-70.5	18.7-58.5	17.8-52.8	15.7-51.1
MONO (%)	0-12	0-12	0-12	0-13
NE (%)	21.3-69.3	32.9-77.2	39.6-77.8	42.0-79.8
EO (%)	0-10	0-11	0-8	0-8
BA (%)	0-2	0-2	0-2	0-2

C. Reference ranges for normal values were calculated from NHANES III data set using 95% reference interval(s) determined nonparametrically, through ranking the observations and determining the lower (2.5th percentile) and the upper (97.5th percentile) reference limits. The nonparametric (ranking) method was used because most measured hematology parameters have a skewed, non-Gaussian distribution.

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