High-volume hematology analyzers

Getting better all the time

Raymond D. Aller, MD; Robert V. Pierre, MD

The capabilities and reliability of cell counting and differential instruments continue to evolve. We appreciate the investment and dedication of the manufacturers that develop, distribute, and support these valuable additions to our laboratories.

Now that five-part differential leukocyte counts have been available on automated instruments for more than 25 years, the reliability and accuracy of these counts have reached a high level. Therefore, it is *rarely* appropriate to replace an automated differential count with a manual count, based on a 100-cell slide examination. Each laboratory must establish criteria for reviewing smears, based on instrument flags, but these smear reviews are more often triggered by a need to look at erythrocyte morphology, or at platelets—not on recounting the differential. Reporting a manual differential would be appropriate only when the automated counter is unable to produce a differential.

There is still a need to examine blood films to determine the nature of abnormal leukocyte populations and abnormal red cell and platelet morphology. The CAP Hematology and Clinical Microscopy Resource Committee conducted a definitive study that showed that band and segmented neutrophils cannot be distinguished from each other accurately or reproducibly and recommended against measuring or reporting a band count (CAP TODAY, May 1994). Numerous studies have shown the superiority of the absolute neutrophil count over the band count in detecting infection. (Ardon MJ, Westengard JC, Dutcher TF. *Am J Clin Pathol.* 1994;102:646.) Two indications for the review of a blood film on a patient with a normal total leukocyte count are the febrile neonate and patients with suspected typhoid fever. The presence of bandemia with a normal WBC, in these isolated instances, provides significant clinical value.

Another consequence of the continual improvement of instrument flagging capabilities is that we have been able to widen our smear review criteria. For example, if there are no immature or blast flags, we no longer review smears for a neutrophil abnormality unless the neutrophil percentage exceeds 90 percent. Seven years ago in an acute care university hospital, a blood film review was performed on 100 percent of CBCs, whereas today only 13 percent of CBCs have a blood film prepared for review. This dramatic reduction is the result of review criteria and permitting requests of review differential counts no more frequently than every seven days in a single care period.

It has been several years since the automated reticulocyte count was added to the capabilities of automated counters. In addition to basic reticulocyte counts, many instruments provide estimates of reticulocyte immaturity. These parameters are frequently underused in evaluating anemias and bone marrow recovery from chemotherapy and bone marrow transplants.

Capabilities can be added to a cell counter, to the point of turning it into a stripped-down flow cytometer—capable of assessing differentiation antigens on cell surfaces or lymphocyte markers, or performing bone marrow differential counts. However, for these assays, many favor using a dedicated flow cytometer staffed by highly trained personnel, rather than trying to load low-volume specialized assays onto a hematology analyzer located in a high-volume, rapid-turnover environment and staffed by personnel who have been challenged already in today's core laboratories to be expert on hematology, chemistry, immunology, and urinalysis analyzers.

If reported with every CBC, a number of analytes would add to the medical value of the results the cell counters produce. However, instrument vendors have been unwilling to add them because the market hasn't demanded them.

Some argue that adding parameters to the routine CBC would confuse clinicians. In the mid-'80s, one of the authors (RDA) championed the clinical use of the hemoglobin distribution width parameter on his lab's Technicon H-1 instrument. It was reported with all CBCs, and the physician user population was educated about HDW's usefulness in the differential diagnosis of anemias. Unfortunately, few clinicians caught on to its use. Even today an alarming number of clinicians appear to be unfamiliar with the use of the MCV in evaluating anemias—though that has been well established for several decades.

The lineup of instruments on pages 27–34 profiles 14 instruments from five manufacturers. The data come from the vendors' responses to a CAP TODAY questionnaire. The reader is advised, therefore, for any instrument under consideration, to verify key characteristics and claims. The best way to evaluate products for use in the lab, of course, is to speak with present users of the instruments.   □

Dr. Aller is vice president for medical affairs and informatics at MDS Laboratory Services (U.S.). He is based in California and Nashville. Dr. Pierre is professor of clinical pathology at University of Southern California School of Medicine, Los Angeles.

Part 1 of 6	Abbott Diagnostics Greg O'Leary (gregory.oleary@abbott.com) 100 Abbott Park Rd., Bldg. AP6C-5, Dept. 02KL Abbott Park, IL 60064 800-323-9100 ext. 7-8134 www.abbott.com
Name of instrument	Cell-Dyn 3200
First year sold–installed in U.S./outside U.S.	1997/1997
No. units installed in U.S./outside U.S./list price	>700/>1,500/$165,000

Test menu: • Chartable	Standard menu (left) plus: RDW, MPV
All instruments have: WBC, RBC, Hb, Hct, MCV, MCH, MCHC, Plt, %&# neut, mono, lymph, eos, baso • Laboratory	Band #&%, IG #&%, variant lymph #&%, blast #&%, PCT, PDW, NRBC #&%
• Flags	Band, IG, variant lymph, blast, NRBC, NWBC, RRBC, FWBC, RBC morph., high/low interp. message, LRI, URI, LURI, WBC
FDA-cleared tests but not clinically released	None
Tests not avail. but submitted for clearance	None
Tests in development	Retic #&%, IRF to be submitted 12/00
For research-use-only	None
Tests unique to analyzer	3 dimensional optical RBC analysis with advanced MCV measurement

Differential method(s) used	M.A.P.S.S.™ (Multi-angle Polarized Scatter Separation)
Linearity: • WBC count (10^9/L)/RBC count (10^{12}/L)	0–250/0–8
• Hemoglobin (g/dL)/platelet (10^9/L)	0–25/0–1,750
• MCV (fL) or Hct (%)	35–180 (MCV)
Precision: • WBC count/RBC count	≤2.7%/≤1.5%
• Hb/platelet	≤1.0%/≤4.0%
• MCV or Hct	≤1.0% (MCV)
Accuracy of automated diff. compared with manual diff., per NCCLS H-20A	Neut #&%: ≥0.95, lymph #&%: ≥0.94, mono #&%: ≥0.86, eos #&%: ≥0.73
Interfering substances: • WBC	Lyse-resistant RBCs, Plt clumps, cryoglobulins
• RBC	Elevated WBC count
• MCV or Hct	MCV: elevated WBC count, hyperglycemia, in vitro hemolysis, micro RBCs
• Platelet	WBC frags., in vitro hemolysis, Plt clumps, increased no. giant Plts
• Hb	Elevated WBC count, increased plasma substances (triglycerides, bilirubin, in vivo hemolysis), lyse-resistant RBCs
Interfering substances: differential	n/a

Age- and sex-specific reference ranges	Yes
Max. CBCs per hr/max. CBCs & diffs. per hr	78/78
Recommended avg. frequency of calib.	6 mos verification
• Modes calibrated/parameters calibrated	Open &/or closed/WBC, RBC, Hb, MCV, Plt, MPV
Frequency of blood/latex controls	2 levels every 8 hrs/n/a
Min. specimen vol. open/closed/sample dead vol. closed	130 µL/250 µL/1 mL (sample loader)
Tube sampling supported	Yes
Veterinary capability	No
Microsample capability	Yes
Prepares microscopic slides automatically or flags problems for slide prep	Yes
If auto. slidemaker avail., no. installed/list price	80/$125,000

Archives patient data for later comparison	Yes
Patient-specific archiving	Yes
Max. archived data accessible when system online	10,000 results
Memory capacity—numeric results–no. specimens	10,000 results
Memory capacity—histo/cytograms–no. specimens	10,000 results
• Stored in conjunction with CBC data	Yes
• Histo/cytogram images & CBC data printed as 1 report	Yes
Saved results can be recalled and retransmitted	Yes
Saved data can be sorted for reprocessing or report transmission	Yes
Performs delta checks	No
Tags and holds results for followup, confirm. testing, or rerun	Yes
Parameters for flags for holding samples are defined by	User or vendor
Some results can be transmitted to LIS while others held	Yes
Scattergram display: cell-specific color	Yes
Histogram display: color with threshhold	Yes
Choice of desired specimen &/or result info. displayed	Yes

LIS interface formats supported	Proprietary
Information transferred on LIS interface	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast
LOINC codes transmitted with results	Yes
Optional data mgmt. or collation system	Yes, avail. in 2001. Price TBD. Proprietary.
• Software features	Enhanced QC, data archiving, data collation from multiple instruments
Interface avail. or planned to auto. specimen-handling system	Lab-Interlink, MDS/Autolab, Beckman Coulter (planned), Roche (planned), Labotix
Bar-code symbologies read on tube	Codabar, codes 39 & 128, interl. 2 of 5
Accommodates bar-code placement per NCCLS standard Auto2A	

Time required for maintenance by lab personnel	Daily: 30 sec., weekly: 5 min, monthly: 10 min
Onboard maintenance records	Yes
Time from communication of problem to engineer on site	Avg. <4 hrs
Onboard diagnostics/limited to software problems	Yes/no
Mftr. can perform diagnostics via modem	In development

Acquisition program based on cost-per-reportable result	Yes

Distinguishing features	M.A.P.S.S.™ cell-by-cell analysis provides a better diff; focused flow 2-dimensional optical RBC & Plt anal. provides better separation betw. microcytic RBCs & large Plts; uses only 3 reagents

Tabulation does not represent an endorsement   Survey editor: Raymond D. Aller, MD
by the College of American Pathologists

SURVEY OF INSTRUMENTS

High-volume hematology analyzers

Part 2 of 6 *See related article, page 27*	Abbott Diagnostics Rich Dalessio (rich.dalessio@abbott.com) 100 Abbott Park Rd., Bldg. AP6C-5, Dept. 02KL Abbott Park, IL 60064 800-323-9100 ext. 8-6033 www.abbott.com	Abbott Diagnostics Mark Musser (mark.musser@abbott.com) 100 Abbott Park Rd., Bldg. AP6C-5, Dept. 02KL Abbott Park, IL 60064 800-323-9100 ext. 8-3892 www.abbott.com	ABX Diagnostics Inc. Jim Mulry (jmulry@us.abx.fr) 34 Bunsen Irvine, CA 92618 888-903-5001 x 259 www.abx.fr
Name of instrument **First year sold–installed in U.S./outside U.S.** **No. units installed in U.S./outside U.S./list price**	Cell-Dyn 3700 1999/1999 >300/>500/$180,000 SL Model, $140,000 CS Model	Cell-Dyn 4000 1997/1997 >350/>500/$250,000	Pentra 60^{C+} Hematology Analyzer 2000/2000 0/0/$49,500
Test menu: •Chartable	Standard menu (left) plus: RDW, MPV, retic #&%, IRF	Standard menu (left) plus: RDW, MPV, NRBC #&%, retic #&%, IRF, CD61 (immuno-Plt)	Standard menu (left) plus: RDW, MPV
All instruments have: WBC, RBC, Hb, Hct, MCV, MCH, MCHC, Plt, %&# neut, mono, lymph, eos, baso •Laboratory	Band, IG, variant lymph, blast, PCT, PDW, NRBC #&% & retic scatter profile	#&% for segs, bands, IG, blasts, variant lymphs; PDW, PCT, white cell viability fraction (WVF)	Atyp. lymph, atyp. lymph %, LIC, LIC %
•Flags	Suspect populations, band, blast, variant lymph, IG, NRBC, RRBC, NWBC, LRI, URI, LURI, RBC morph., FWBC, high/low interp. message, WBC	Band, IG, blast, variant lymph, nvWBC, rstRBC, IR, Plt clump, ASYM, high/low interp. msg., PCT, PDW	Complete operator selectable flagging
FDA-cleared tests but not clinically released	None	None	None
Tests not avail. but submitted for clearance	None	None	None
Tests in development	None	CD3/4 & 3/8	None
For research-use-only	None	None	None
Tests unique to analyzer	IRF	Reportable NRBC #&%, CD61 for Plts, WVF	None
Differential method(s) used	M.A.P.S.S.™ (Multi-angle Pol. Scatter Sep.)	Optical scatter & fluorescence technology	DHSS technology combining cytochemistry, focused flow impedance, & light absorbance principles of measurement
Linearity: •WBC count (10^9/L)/RBC count (10^{12}/L)	0–250/0–8	0–250/0–7.5	0.1–90/0.5–8.1
•Hemoglobin (g/dL)/platelet (10^9/L)	0–24/0–2,000	1.0–25/0–2,000	2.5–23/10–1,000
•MCV (fL) or Hct (%)	50–200 (MCV)	37–197 (MCV)	10–70 (Hct)
Precision: •WBC count/RBC count	≤2.5%/≤1.5%	≤2.5%/≤1.5%	<2%/<2%
•Hb/platelet	≤1.2%/≤5.0%	≤1.0%/≤4.0%	<1%/<5%
•MCV or Hct	≤1.0% (MCV)	≤1.0% (MCV)	<1% (Hct)
Accuracy of automated diff. compared with manual diff., per NCCLS H-20A	Neut #&%: ≥0.95, lymph #&%: ≥0.94, mono #&%: ≥0.86, eos #&%: ≥0.84, baso #&%: ≥0.73	%neut 0.94, %lymph 0.93, %mono 0.84, %eos 0.91, %baso 0.40, NRBC/WBC 0.91, retic 0.95	Neut 0.9997, lymph 0.9897, mono 0.9645, eos 0.8910, baso 0.5490
Interfering substances: •WBC	Plt clumps, cryoglob. & cryofib.	Lyse-resistant RBCs, Plt clumps	NRBCs, Plt clumps, large Plts, lyse-resistant RBCs
•RBC	Increased no. giant Plts, auto-agglut, in vitro hemolysis	Auto- & cold agglut, in vitro hemolysis., sm. lymph (where lymph count [K>100] & MCV high)	Cold agglut, Plt clumps, WBC overlinearity
•MCV or Hct	MCV: elevated WBC count, increased no. giant Plts, hyperglycemia, in vitro hemolysis	MCV: in vitro hemolysis, auto- & cold agglut, hyperglycemia, leukocytosis with macrocy. anemia	Lipemic samples, high WBC, lipemic specimens, aggluts
•Platelet	WBC frags., in vitro hemolysis, microcytic RBCs, cryoglob., Plt clumps, increased no. giant Plts	Plt clumps, WBC & RBC frags., microcytic RBCs, auto- & cold agglut, Plt satellitosis	RBC & WBC frags
•Hb	Increased plasma substances (triglycerides, bilirubin, in vivo hemolysis), lytic-resistant RBCs	High lipids (>700 mg/dL), high WBCs (>250 K/µL), high bilirubin (>27 mg/dL), in vivo hemolysis, carboxyhemoglobin	Lipemia, high WBC
Interfering substances: differential	n/a	n/a	NRBC, resistant RBCs, lipemia
Age- and sex-specific reference ranges	Yes	Yes	Yes
Max. CBCs per hr/max. CBCs & diffs. per hr	90/90	106/106	60/60
Recommended avg. frequency of calib.	6 mos	6 mos verification	6 months
•Modes calibrated/parameters calibrated	Open & closed/WBC, RBC, Hb, MCV, Plt	Open-closed one proc./WBC, RBC, Hb, MCV, Plt, MPV	Open/WBC, RBC, Hb, MCV, PCT
Frequency of blood/latex controls	2 levels every 8 hrs/n/a	2 levels every 8 hrs/n/a	Daily/none
Min. specimen vol. open/closed/sample dead vol. closed	130 µL open/355 µL/1.0 mL	112.5 µL–aspir. vol./same/387 µL–dead vol.	53 µL/53 µL/0.5 mL
Tube sampling supported	Yes (13x75 mm)	Yes	Yes (multiple sizes)
Veterinary capability	Yes	No	Yes
Microsample capability	Yes	Yes (112 µL)	No
Prepares microscopic slides automatically or flags problems for slide prep	Yes	Yes	No
If auto. slidemaker avail., no. installed/list price	80/$125,000	80/$125,000	—
Archives patient data for later comparison	Yes	Yes	Yes
Patient-specific archiving	Yes	Yes	No
Max. archived data accessible when system online	10,000 results	10,000 results	—
Memory capacity—numeric results–no. specimens	10,000 results	10,000 results	10,000
Memory capacity—histo/cytograms–no. specimens	10,000 results	10,000 results	10,000
•Stored in conjunction with CBC data	Yes	Yes	Yes
•Histo/cytogram images & CBC data printed as 1 report	Yes	Yes	Yes
Saved results can be recalled and retransmitted	Yes	Yes	Yes
Saved data can be sorted for reprocessing or report transmission	Yes	Yes	Yes
Performs delta checks	No	Yes	Yes
Tags and holds results for followup, confirm. testing, or rerun	Yes	Yes	Yes
Parameters for flags for holding samples are defined by	User or vendor	User or vendor	User
Some results can be transmitted to LIS while others held	Yes	Yes	Yes
Scattergram display: cell-specific color	Yes	Yes	No
Histogram display: color with threshhold	Yes	Yes	Yes
Choice of desired specimen &/or result info. displayed	Yes	Yes	—
LIS interface formats supported	Proprietary	Proprietary	ASTM 1394 & 1238, HL7, IEEE MIB
Information transferred on LIS interface	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast	Num. & flag results, histograms & scatterplots, inst. to LIS; patient demographics, orders, LIS to inst.—broadcast; host query for demographics & orders	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, LIS to instrument—broadcast
LOINC codes transmitted with results	Yes	Yes	Yes
Optional data mgmt. or collation system	Yes, avail. in 2001. Price TBD. Proprietary.	Yes, avail. in 2001. Price TBD. Proprietary.	Avail. 2nd qtr. 2001
• Software features	Enhanced QC, data archiving, data collation from multiple instruments	Enhanced QC, data archiving, data collation from multiple instruments	Enhanced QC, data archiving
Interface avail. or planned to auto. specimen-handling system	Lab-Interlink, MDS/AutoLab, Beckman Coulter (planned), Roche (planned), Labotix	Lab-Interlink, MDS/AutoLab, Beckman Coulter (planned), Roche (planned), Labotix	No
Bar-code symbologies read on tube	Codabar, codes 39 & 128, interl. 2 of 5	Codabar, codes 39 & 128, interl. 2 of 5	Codabar, codes 39 & 128, ASTM, interl. 2 of 5
Accommodates bar-code placement per NCCLS standard Auto2A	Yes	Yes	Yes
Time required for maintenance by lab personnel	Daily: 30 sec, bi-weekly: 5 min, monthly: 10 min	Daily: 30 sec, weekly: 5 min, monthly: 10 min	Weekly: 15 min
Onboard maintenance records	Yes	Yes	Yes
Time from communication of problem to engineer on site	Avg. <4 hrs	Avg. <4 hrs	12 hrs
Onboard diagnostics/limited to software problems	Yes/no	Yes/no	Yes/no
Mftr. can perform diagnostics via modem	In development	In development	No
Acquisition program based on cost-per-reportable result	Yes	Yes	Yes
Distinguishing features	M.A.P.S.S.™ cell-by-cell analysis provides a better diff; retic with reportable IRF (immature retic. fraction); 60-species veterinary package	Reportable NRBC count, monoclonal antibody capability, fluoresc. random access retic w/ reportable IRF, WBC viability index, Argon laser	Reliable 5-part WBC diff technology—MTBF over 200 days; small footprint; small sample size of 53 µL

Tabulation does not represent an endorsement by the College of American Pathologists

High-volume hematology analyzers

Part 3 of 6 See related article, page 27	ABX Diagnostics Inc. **Jim Mulry** (jmulry@us.abx.fr) 34 Bunsen, Irvine, CA 92618 888-903-5001 x 259 www.abx.fr	Bayer Diagnostics **Nancy Lavon** (nancy.lavon.b@bayer.com) 511 Benedict Ave., Tarrytown, NY 10591 800-431-1970 www.bayer.diag.com	Beckman Coulter Inc. **Martha M. Diaz/Cellular Analysis Marketing** 200 S. Kraemer Blvd., Brea, CA 92822-8000 714-993-8847 www.beckmancoulter.com
Name of instrument	Pentra 120 Retic Hematology Analyzer	ADVIA 120 Hematology System	Coulter GEN•S Systems
First year sold–installed in U.S./outside U.S.	1999/1997	1998/1998	1996
No. units installed in U.S./outside U.S./list price	18/550/$125,000	500/2,000/$169,000–$189,000	>1,100/>2,000/$177,500; w/ SlideMaker-stainer, $327k
Test menu: •Chartable	Standard menu (left) plus: RDW, RTC, IRF, MPV	Standard menu (left) plus: CHCM, MPV, RDW, HDW, LUC %&#, retic %&#, CHr, CHCMr, MCVr	Standard menu (left) plus: RDW, MPV, retic #&%, graded RBC morph., MRV, IRF
•Laboratory	LIC, atyp. lymph, PCT, PDW, CRC%	%: hypo, hyper, macro, micro; calc. Hb, MPXI; %: blasts, PMN, MN; large Plt count; RBC frag. count; RBC ghost count	PCT, PDW
All instruments have: WBC, RBC, Hb, Hct, MCV, MCH, MCHC, Plt, %&# neut, mono, lymph, eos, baso •Flags	82 quantitative & qualitative flags	Left shift, atyp. lymph, blasts, immature grans, myeloperox. deficiency, aniso, micro, macro, Hb variation, hypo, hyper, NRBC, RBC frag., RBC ghost, large Plt, Plt clumps	User-definable age-, gender- &/or location-based ref. intervals, action & critical limits; user-def. definitive msgs. for quant. abnormality; user-def. RBC morph. gradient msgs. (+, ++, +++); user-selectable sensitivity for diff abnormal pop. suspect msgs.
FDA-cleared tests but not clinically released	None	None	None
Tests not avail. but submitted for clearance	None	None	—
Tests in development	None	IRF, MPC, MPM	None
For research-use-only	None	None	High light scatter retics, mean spherical cell vol.
Tests unique to analyzer	None	CHCM, HDW, CHr, CHCMr, MPC, MPM	Mean spherical cell vol.
Differential method(s) used	Cytochem., foc. flow impedance, light absorbence	Perox–Peroxidase cytochem. staining w/ light scatter & absorption; Baso–cytochem. stripping with 2-angle laser light scatter	Coulter's 3-D VCS technology, AccuFlex technology w/ IntelliKinetics & AccuGate
Linearity: •WBC count (10^9/L)/RBC count (10^{12}/L)	0.1–85/0.5–8.1	0.02-400/0-7.0	0–140/0–8.0
•Hemoglobin (g/dL)/platelet (10^9/L)	2–25/10–1,000	0-22.5 /5-3,500	0–25/0–1,500
•MCV (fL) or Hct (%)	10–70 (Hct)	30–180 (MCV)	50–200 (MCV)
Precision: •WBC count/RBC count	3%/2%	2.7%/1.2%	<1.7%/<0.8%
•Hb/platelet	2%/5%	0.93%/2.93%	<0.8%/<3.3%
•MCV or Hct	2% (Hct)	0.78% (MCV)	<0.8% (MCV)
Accuracy of automated diff. compared with manual diff., per NCCLS H-20A	Neut 0.99, lymph 0.99, mono 0.92, eos 0.97, baso 0.71	Neut 0.997r, lymph 0.997r, mono 0.943r, eos 0.979r, baso 0.772r, Luc 0.944r	Lymph%=+3.0%, mono%=+2.0%, neut%=+3.0%, eos%=+1.0%, baso%=+1.0%
Interfering substances:•WBC	Unlysed RBCs, NRBCs, cryoglob.	Incomplete RBC lysis (Perox only)	Unusual RBC abnormalities that resist lysing, NRBC, frag. WBC, unlysed particle >35 fL, large Plt
•RBC	Cold agglut, agglut RBCs	Cold agglut, extreme sickle cell	Very high WBC, high conc. large Plt, auto-agglut
•MCV or Hct	RBC agglut, large Plts	None	Very high WBC, high conc. large Plt, auto-agglut
•Platelet	Giant Plts, microcytes, Plt agglut	None	Very small eryth. or leuk., or cell frags. may cause no-fit. Chemotherapy may affect certain samples.
•Hb	Elevated WBC, elevated lipids	High WBC, lip., extremely high bili., interfere w/ cyanmethb only, none w/ direct cellular Hb (CHCM)	Very high WBC, severe lipemia, heparin, rare lyse-resistant RBCs
Interfering substances: differential	Lyse-resistant RBCs	Incomplete lysis of RBCs, complete myeloperox. def.	High triglycerides may affect lysing
Age- and sex-specific reference ranges	Yes	Yes	Yes
Max. CBCs per hr/max. CBCs & diffs. per hr	120/120	120/120	105/105
Recommended avg. frequency of calib.	With major PM or part replacement	6 mos	2 times/yr
•Modes calibrated/parameters calibrated	Open by cust., others by svc./WBC, RBC, Hb, Hct, Plt	Open, closed, autosampler/all measured params	Primary/RBC, WBC, Hb, MCV, Plt, MPV
Frequency of blood/latex controls	Per CLIA standards/not required	Once per shift/not required	Once per shift/once per day
Min. specimen vol. open/closed/sample dead vol. closed	130 µL/200 µL/1 mL	157 µL/157 µL/<300 µL (tube size dependent)	200 µL/300 µL/550 µL with SlideMaker/1.0 mL
Tube sampling supported	Yes	Yes (2, 3, 5, 7 mL—all sizes–open tube)	Yes (multiple sizes & styles)
Veterinary capability	Yes	Yes	No
Microsample capability	Yes	Yes	Yes
Prepares microscopic slides automatically or flags problems for slide prep	Yes	Yes	Yes, both
If auto. slidemaker avail., no. installed/list price	Avail. March 2000/list price $40,000	n/a	>100 U.S./$99,000
Archives patient data for later comparison	Yes	Yes	Yes
Patient-specific archiving	Yes	No	Yes
Max. archived data accessible when system online	90,000	10,000 samples	20,000 samples
Memory capacity—numeric results–no. specimens	90,000	10,000	20,000
Memory capacity—histo/cytograms–no. specimens	90,000	10,000	5,000
•Stored in conjunction with CBC data	—	Yes	Yes
•Histo/cytogram images & CBC data printed as 1 report	—	Yes	Yes
Saved results can be recalled and retransmitted	Yes	Yes	Yes
Saved data can be sorted for reprocessing or report transmission	Yes	Yes	Yes
Performs delta checks	Yes	Yes	Yes
Tags and holds results for followup, confirm. testing, or rerun	Yes	Yes	Yes
Parameters for flags for holding samples are defined by	User	User or vendor	User or vendor
Some results can be transmitted to LIS while others held	Yes (operator programmable)	Yes	Yes
Scattergram display: cell-specific color	No	Yes	Yes
Histogram display: color with threshhold	Yes	Yes	Yes
Choice of desired specimen &/or result info. displayed	Yes	Yes	Yes
LIS interface formats supported	Proprietary, ASTM 1394 & 1238, HL7, IEEE MIB	Proprietary (Spec 79)	Proprietary
Information transferred on LIS interface	Numeric & flag results, histograms & scatterplots, instr. to LIS; patient demographics, orders, LIS to instr.—broadcast; host query for demographics & orders	Numeric & flag results, histograms & scatterplots, instr. to LIS; patient demographics, orders, LIS to instr.—broadcast; host query for demographics & orders	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast
LOINC codes transmitted with results	No	No	No
Optional data mgmt. or collation system	Avail. 2nd qtr. 2001	In development	No
• Software features	Enhanced QC, data arch., collation from multiple instr.		
Interface avail. or planned to auto. specimen-handling system	No	MXS (Japan), LabCell (Bayer)	Beckman Coulter
Bar-code symbologies read on tube	Codabar, codes 39 & 128, ASTM, interl. 2 of 5	Codabar, codes 39 & 128, ASTM, interl. 2 of 5	Codabar, codes 39 & 128, interl. 2 of 5, NW-7
Accommodates bar-code placement per NCCLS standard Auto2A	Yes	Yes	Yes
Time required for maintenance by lab personnel	Weekly: 10 min, monthly: 10 min	Daily: 15 min, weekly: 15 min, monthly: 15 min	Monthly: 2 min
Onboard maintenance records	Yes	Yes	Yes
Time from communication of problem to engineer on site	4 hrs avg., 24 hrs guaranteed	Territory dependent	—
Onboard diagnostics/limited to software problems	Yes/no	Yes/no	Yes/no
Mftr. can perform diagnostics via modem	No	Yes	Yes
Acquisition program based on cost-per-reportable result	Yes, ABX prefers CPT acquisitions	Yes	Yes
Distinguishing features	Automatic repeats for sample verification, 48 hr WBC diff stability, random access retic enumeration	Unique laser technology provides cellular Hb for RBCs & retics; 2-dimensional Plt analysis which eliminates interference from RBC frags. & exclusion of large Plts; dual WBC counts w/ a linearity of up to 400,000	VCS technol., lowest review rate in class, zero daily maint., triplicate counting, aperture burn circuit, sweepflow, SmartStart, AccuGate, AccuFlex, IntelliKinetics application, WBC in near native state, 3-D diff. display, online training & help

Tabulation does not represent an endorsement by the College of American Pathologists

High-volume hematology analyzers

Part 4 of 6 See related article, page 27	Beckman Coulter Inc. Martha M. Diaz/Cellular Analysis Marketing 200 S. Kraemer Blvd., Brea, CA 92822-8000 714-993-8847 www.beckmancoulter.com	Beckman Coulter Inc. Martha M. Diaz/Cellular Analysis Marketing 200 S. Kraemer Blvd., Brea, CA 92822-8000 714-993-8847 www.beckmancoulter.com	Beckman Coulter Inc. Martha M. Diaz/Cellular Analysis Marketing 200 S. Kraemer Blvd., Brea, CA 92822-8000 714-993-8847 www.beckmancoulter.com
Name of instrument	Coulter HmX	Coulter STKS with Reticulocytes	Coulter MAXM with Reticulocytes
First year sold–installed in U.S./outside U.S.	1999 HmX A/L, 1999 HmX CP	1989	1991 MAXM, 1992 MAXM AL
No. units installed in U.S./outside U.S./list price	>100/>250/$135,000 A/L/$120,000 CP	>2,600/2,600/$162,000	>2,100/2,400/MAXM with retics $90,000; MAXM AL with retics $105,000
Test menu: •Chartable All instruments have: WBC, RBC, Hb, Hct, MCV, MCH, MCHC, Plt, %&# neut, mono, lymph, eos, baso •Laboratory •Flags	Standard menu (left) plus: RDW, MPV, retic #&%, graded RBC morph. PCT, PDW Comprehensive high/low, definitive & suspect messages	Standard menu (left) plus: RDW, MPV, retic #&%, graded RBC morph. PCT, PDW Comprehensive high/low, definitive & suspect messages	Standard menu (left) plus: RDW, MPV, retic #&%, graded RBC morph. PCT, PDW Comprehensive high/low, definitive & suspect messages
FDA-cleared tests but not clinically released	None	CD4 #&%, CD8 #&%, CD4/CD8 ratio	None
Tests not avail. but submitted for clearance	MRV, IRF	None	None
Tests in development	None	None	None
For research-use-only	None	Mean retic vol., maturation index	Mean retic vol., maturation index
Tests unique to analyzer	None	None	None
Differential method(s) used	Coulter's 3-D VCS technology	Coulter's 3-D VCS technology	Coulter's 3-D VCS technology
Linearity: •WBC count (10^9/L)/RBC count (10^{12}/L)	0–99.9/0–7.0	0–99.9/0–7.0	0–99.9/0–7.0
•Hemoglobin (g/dL)/platelet (10^9/L)	0–25/0–999	0–25/0–999	0–25/0–999
•MCV (fL) or Hct (%)	50–150 (MCV)	50–200 (MCV)	50–150 (MCV)
Precision: •WBC count/RBC count	<2.5%/<2.0%	<1.7%/<0.8%	<2.5%/<2.0%
•Hb/platelet	<1.5%/<5.0%	<0.8%/<3.3%	<1.5%/<5.0%
•MCV or Hct	<2.0% (MCV)	<0.8% (MCV)	<2.0% (MCV)
Accuracy of automated diff. compared with manual diff., per NCCLS H-20A	Lymph%=+3.0%, mono%=+2.0%;,neut%=+3.0%, eos%=+1.0%, baso%=+1.0%	Lymph%=+3.0%, mono%=+2.0%, neut%=+3.0%, eos%=+1.0%, baso%=+1.0%	Lymph%=+3.0%, mono%=+2.0%, neut%=+3.0%, eos%=+1.0%, baso%=+1.0%
Interfering substances:•WBC	Unusual RBC abnormalities that resist lysing, NRBC, frag. WBC, any unlysed particle >35 fL, large Plt	Unusual RBC abnormalities that resist lysing, NRBC, frag. WBC, any unlysed particle >35 fL, large Plt	Unusual RBC abnormalities that resist lysing, NRBC, frag. WBC, any unlysed particle >35 fL, large Plt
•RBC	Very high WBC, high conc. of very large Plt, auto-agglut	Very high WBC, high conc. of very large Plt, auto-agglut	Very high WBC, high conc. of very large Plt, auto-agglut
•MCV or Hct	Very high WBC, high conc. of large Plt, auto-agglut	Very high WBC, high conc. of large Plt, auto-agglut	Very high WBC, high conc. of large Plt, auto-agglut
•Platelet	Very small eryth. or leuk., or cell frags. may cause no-fit. Chemotherapy may affect certain samples.	Very small eryth. or leuk., or cell frags. may cause no-fit. Chemotherapy may affect certain samples.	Very small eryth. or leuk., or cell frags. may cause no-fit. Chemotherapy may affect certain samples.
•Hb	Very high WBC, severe lipemia, heparin, rare lyse-resistant RBCs	Very high WBC, severe lipemia, heparin, rare lyse-resistant RBCs	Very high WBC, severe lipemia, heparin, rare lyse-resistant RBCs
Interfering substances: differential	High triglycerides may affect lysing	High triglycerides may affect lysing	High triglycerides may affect lysing
Age- and sex-specific reference ranges	Gender-specific printout	No	Gender-specific printout
Max. CBCs per hr/max. CBCs & diffs. per hr	75/75	120/110	75/75
Recommended avg. frequency of calib.	2 times/yr	4 times/yr	4 times/yr
•Modes calibrated/parameters calibrated	Primary/RBC, WBC, Hb, MCV, Plt, MPV	Primary/RBC, WBC, Hb, MCV, Plt, MPV	Primary/RBC, WBC, Hb, MCV, Plt, MPV
Frequency of blood/latex controls	Once per shift/once per day	Once per shift/once per day	Once per shift/once per day
Min. specimen vol. open/closed/sample dead vol. closed	125 µL/185 µL/50 µL predilute/0.5 mL	150 µL/250 µL/0.5 mL	125 µL/185 µL/0.5 mL
Tube sampling supported	Yes (multiple sizes & styles)	Yes (multiple sizes & styles)	Yes (multiple sizes & styles)
Veterinary capability	No	No	No
Microsample capability	Yes	Yes	Yes
Prepares microscopic slides automatically or flags problems for slide prep	Yes	No	No
If auto. slidemaker avail., no. installed/list price	n/a	n/a	n/a
Archives patient data for later comparison	Yes	Yes	No
Patient-specific archiving	Yes	Yes	Yes
Max. archived data accessible when system online	5,000 samples	5,000 samples	5,000 samples
Memory capacity—numeric results–no. specimens	5,000	5,000	5,000
Memory capacity—histo/cytograms–no. specimens	5,000	5,000	5,000
•Stored in conjunction with CBC data	Yes	Yes	Yes
•Histo/cytogram images & CBC data printed as 1 report	Yes	Yes	Yes
Saved results can be recalled and retransmitted	Yes	Yes	Yes
Saved data can be sorted for reprocessing or report transmission	Yes	Yes	Yes
Performs delta checks	No	No	No
Tags and holds results for followup, confirm. testing, or rerun	Yes	Yes	Yes
Parameters for flags for holding samples are defined by	User or vendor	User or vendor	User or vendor
Some results can be transmitted to LIS while others held	Yes, through a selective batch process	Yes, through a selective batch process	No (all held)
Scattergram display: cell-specific color	4 colors/cell types	4 colors/cell types	4 colors/cell types
Histogram display: color with threshhold	Colors without thresholds	Colors without thresholds	Colors without thresholds
Choice of desired specimen &/or result info. displayed	No	No	No
LIS interface formats supported	Proprietary	Proprietary	Proprietary
Information transferred on LIS interface	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast	Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast
LOINC codes transmitted with results	No	No	No
Optional data mgmt. or collation system	No	No	No
•Software features			
Interface avail. or planned to auto. specimen-handling system	Beckman Coulter	Beckman Coulter	Beckman Coulter
Bar-code symbologies read on tube	Codabar, codes 39 & 128, interl. 2 of 5, NW-7	Codabar, code 39, interl. 2 of 5	Codabar, codes 39 & 128, interl. 2 of 5, NW-7
Accommodates bar-code placement per NCCLS standard Auto2A	No	No	No
Time required for maintenance by lab personnel	Monthly: 2 min	Monthly: 5 min	Monthly: 2 min
Onboard maintenance records	No	No	No
Time from communication of problem to engineer on site	—	—	—
Onboard diagnostics/limited to software problems	Yes/no	Yes/no	Yes/no
Mftr. can perform diagnostics via modem	No	No	No
Acquisition program based on cost-per-reportable result	Yes	Yes	Yes
Distinguishing features	VCS technology, lowest review rate in class, zero routine daily maint., triplicate counting, aperture burn circuit, sweepflow, SmartStart system, autoloader & single sample models	VCS technology, lowest review rate in class, zero routine daily maint., triplicate counting, aperture burn circuit, sweepflow	VCS technology, lowest review rate in class, zero routine daily maint., triplicate counting, aperture burn circuit, sweepflow, autoloader & single sample models

Tabulation does not represent an endorsement by the College of American Pathologists

High-volume hematology analyzers

Part 5 of 6 *See related article, page 27*	Roche Diagnostics Corp. Lisa Davis or Mike Clark 9115 Hague Rd., Indianapolis, IN 46250-0475 800-428-5074 (www.roche.com)	Roche Diagnostics Corp. Lisa Davis or Mike Clark 9115 Hague Rd., Indianapolis, IN 46250-0475 800-428-5074 (www.roche.com)
Name of instrument **First year sold–installed in U.S./outside U.S.** **No. units installed in U.S./outside U.S./list price**	Sysmex SF-3000/SF-Alpha 3000: 1996/—, Alpha: 1997/— 3000: 100/2,300/$120,000, Alpha: —/—/$211,850	Sysmex SE-9500/SE-Alpha II 9500: 1994/—, Alpha II: —/— 9500: 350/2,100/$197,500, Alpha II: —/—/$349,580
Test menu: •**Chartable** All instruments have: •**Laboratory** WBC, RBC, Hb, Hct, MCV, •**Flags** MCH, MCHC, Plt, %&# neut, mono, lymph, eos, baso	Standard menu (left) plus: RDW-SD, RDW-CV, MPV None RBC agglut, turbidity/Hb interference, WBC abn scattergram, RBC abn distrib, Plt abn distrib, NRBC/Plt clumps, blasts, immature grans, left shift, atyp./abn lymph	Standard menu (left) plus: RDW-SD, RDW-CV, MPV None Plt clumps, RBC agglut, turbidity, WBC abn scattergram, RBC abn distrib, Plt abn distrib, RBC lyse resistance, NRBC/Plt clumps, blasts, immature grans, atyp./abn lymphs, abn lymph/aged sample
FDA-cleared tests but not clinically released **Tests not avail. but submitted for clearance** **Tests in development** **For research-use-only** **Tests unique to analyzer**	PDW, P-LCR None None None None	PDW, P-LCR None Peripheral blood stem cell counting (HPC) None IMI channel
Differential method(s) used	Flow cyto with semiconductor laser for lymph, mono, neut, eos, baso	DC detection with cell specific lyse (eos, baso, IMI), RF/DC detection (lymph, mono, gran, IMI)

Linearity: •**WBC count (10^9/L)/RBC count (10^{12}/L)**
  •**Hemoglobin (g/dL)/platelet (10^9/L)**
  •**MCV (fL) or Hct (%)**
Precision: •**WBC count/RBC count**
  •**Hb/platelet**
  •**MCV or Hct**
Accuracy of automated diff. compared with manual diff., per NCCLS H-20A
Interfering substances:•**WBC**
  •**RBC**
 	
  •**MCV or Hct**
 	
  •**Platelet**
 	
  •**Hb**
Interfering substances: differential
	1–99.99/1–9.99
	2–25/10–999
	10–60 (Hct)
	3% (WBC>4)/1.5% (RBC>4)
	1.5%/5% (Plt>100)
	1.5% (Hct)
	Neut% R>0.90, lymph% R>0.90, mono% R>0.75, eos% R>0.80, baso% R>0.50
	Cold agglut, Plt clumps, NRBCs, cryoglobulins
	Cold agglut, severe microcytosis, frag. RBCs, WBC > 100,000/μL
	Cold agglut, WBC>100,000/μL, abn RBC fragility
	Plt satellitism, Plt clumps, increased microcytosis, giant Plts
	WBC>100,000/μL, lipemia, abn proteins
	Lyse-resistant RBCs
		0–99.9 /0–9.99
		0–25/0–999
		0–60 (Hct)
		3% (WBC>4)/1.5% (RBC>4)
		1%/4% (Plt>100)
		1.5% (Hct)
		Neut% R>0.90, lymph% R>0.90, mono% R>0.75, eos% R>0.80, baso% R>0.50
		Cold agglut, Plt clumps, NRBCs, cryoglobulins
		Cold agglut, severe microcytosis, frag. RBCs, WBC > 100,000/μL
		Cold agglut, WBC>100,000/μL, abn RBC fragility, abn proteins
		Plt satellitism, Plt clumps, increased microcytosis, giant Plts
		WBC>100,000/μL, lipemia, abn proteins, sulfhemoglobin
		Lyse-resistant RBCs

Age- and sex-specific reference ranges **Max. CBCs per hr/max. CBCs & diffs. per hr** **Recommended avg. frequency of calib.** •**Modes calibrated/parameters calibrated** **Frequency of blood/latex controls** **Min. specimen vol. open/closed/sample dead vol. closed** **Tube sampling supported** **Veterinary capability** **Microsample capability** **Prepares microscopic slides automatically or flags problems for slide prep** **If auto. slidemaker avail., no. installed/list price**	No 80/80 With major PM or parts replacement Open by customer, others by svc./WBC, RBC, Hb, Hct, Plt 2 levels per 8 hrs operation/service calibration only 170 μL/270 μL/1 mL Yes (3 mL, 5 mL, 7 mL) No Yes Yes w/ Alpha upgrade >100/—	Yes 120/120 With major PM or parts replacement Open by customer, others by svc./WBC, RBC, Hb, Hct, Plt 2 levels per 8 hrs operation/service calibration only 100 μL/250 μL/1 mL Yes (3 mL, 5 mL, 7 mL) — Yes Yes w/ Alpha upgrade >100/—

Archives patient data for later comparison
Patient-specific archiving
Max. archived data accessible when system online
Memory capacity—numeric results–no. specimens
Memory capacity—histo/cytograms–no. specimens
  •**Stored in conjunction with CBC data**
  •**Histo/cytogram images & CBC data printed as 1 report**
Saved results can be recalled and retransmitted
Saved data can be sorted for reprocessing or report transmission
Performs delta checks
Tags and holds results for followup, confirm. testing, or rerun
Parameters for flags for holding samples are defined by
Some results can be transmitted to LIS while others held
Scattergram display: cell-specific color
Histogram display: color with threshhold
Choice of desired specimen &/or result info. displayed
	Yes
	No
	1,000 samples (additional on disk)
	1,000
	1,000
	Yes
	Yes
	Yes
	Yes
	Yes
	Yes
	User or vendor
	Yes
	Yes
	Yes
	Yes
		Yes
		Yes
		10,000 samples
		10,000
		10,000
		Yes
		Yes
		Yes
		Yes
		Yes
		Yes
		User or vendor
		Yes
		Yes
		Yes
		Yes

LIS interface formats supported **Information transferred on LIS interface** **LOINC codes transmitted with results** **Optional data mgmt. or collation system** •**Software features** **Interface avail. or planned to auto. specimen-handling system** **Bar-code symbologies read on tube** **Accommodates bar-code placement per NCCLS standard Auto2A**	RS-232C Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast; host query for patient demographics & orders — Yes, proprietary Enhanced QC, data archiving, data collation from multiple instruments No — Yes	RS-232C Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast; host query for patient demographics & orders — Yes, proprietary Enhanced QC, data archiving, data collation from multiple instruments Roche, Labotix, IDS, A&T Codabar, codes 39 & 128, interl. 2 of 5, JAN 8, JAN 13 Yes
Time required for maintenance by lab personnel **Onboard maintenance records** **Time from communication of problem to engineer on site** **Onboard diagnostics/limited to software problems** **Mftr. can perform diagnostics via modem**	Daily: 15 min, weekly: 20 min, monthly: 15 min Yes Territory dependent No/no No	Daily: 15 min, weekly: 30 min, monthly: 15 min Yes Territory dependent Yes/no No
Acquisition program based on cost-per-reportable result	Yes	Yes
Distinguishing features	Adaptive Cluster Anal. System (ACAS), semiconductive diode laser, bidirec. commun.	Adaptive Cluster Anal. System, random access, discrete testing, immature info channel

Tabulation does not represent an endorsement by the College of American Pathologists

High-volume hematology analyzers

Part 6 of 6 *See related article, page 27*	Roche Diagnostics Corp. Lisa Davis or Mike Clark 9115 Hague Rd., Indianapolis, IN 46250-0475 800-428-5074 (www.roche.com)	Roche Diagnostics Corp. Lisa Davis or Mike Clark 9115 Hague Rd., Indianapolis, IN 46250-0475 800-428-5074 (www.roche.com)
Name of instrument First year sold–installed in U.S./outside U.S. No. units installed in U.S./outside U.S./list price	Sysmex SE-9500R/SE-Alpha IIR/HST 1997/— 350/2,100/9500R: $306,500, Alpha IIR: $426,350	Sysmex XE 2100/XE Alpha II/HST 2000 n/a/100/TBD
Test menu: •Chartable All instruments have: WBC, RBC, Hb, Hct, MCV, MCH, MCHC, Plt, %&# neut, •Laboratory mono, lymph, eos, baso •Flags FDA-cleared tests but not clinically released Tests not avail. but submitted for clearance	Standard menu (left) plus: RDW-SD, RDW-CV, MPV, retic #&%, RMI/IRF, low-middle-high-fluorescent ratios None Plt clumps, RBC agglut, turbidity, WBC abn scattergram, RBC abn distrib, Plt abn distrib, RBC lyse resistance, NRBC/Plt clumps, blasts, immature grans, atyp./abn lymphs, abn lymph/aged sample PDW, P-LCR, reticulated Plt None	Standard menu (left) plus: NRBC %&#, retic %&#, RDW-SD, RDW-CV, IRF None Plt clumps, RBC agglut, turbidity, WBC abn scattergram, RBC abn distrib, Plt abn distrib, RBC lyse resistance, NRBC/Plt clumps, blasts, immature grans, atyp./abn lymphs, abn lymph/aged sample None None
Tests in development For research-use-only Tests unique to analyzer	Peripheral blood stem cell counting (HPC) None IMI channel	HPC %&#, IG %&# MPV, P-LCR, PCT, PDW NRBC, IMI channel
Differential method(s) used Linearity: •WBC count (10^9/L)/RBC count (10^{12}/L) •Hemoglobin (g/dL)/platelet (10^9/L) •MCV (fL) or Hct (%) Precision: •WBC count/RBC count •Hb/platelet •MCV or Hct Accuracy of automated diff. compared with manual diff., per NCCLS H-20A Interfering substances: •WBC •RBC •MCV or Hct •Platelet •Hb Interfering substances: differential	DC detection with cell specific lyse (eos, baso, IMI), RF/DC detection (lymph, mono, gran, IMI) 0–99.9/0–9.99 0–25/0–999 0–60 (Hct) 3% (WBC>4)/1.5% (RBC>4) 1%/4% (Plt>100) 1.5% (Hct) Neut% R>0.90, lymph% R>0.90, mono% R>0.75, eos% R>0.80, baso% R>0.50 Cold agglut, Plt clumps, NRBCs, cryoglobulins Cold agglut, severe microcytosis, frag. RBCs, WBC >100,000/μL Cold agglut, WBC>100,000/μL, abn RBC fragility, abn proteins Plt satellitism, Plt clumps, increased microcytosis, giant Plts WBC>100,000/μL, lipemia, abn proteins, sulfhemoglobin Lyse-resistant RBCs	Flow cytometry using semiconductor laser RF/DC detecting method 0–170/0–8 0–25/0–5,000 0–60 (Hct) <3%/<1.5% <1.0%/<4.0% <1.0% (Hct) Neut% R=0.95, lymph% R=0.95, mono% R=0.79, eos% R=0.92, baso% R=0.82, NRBC% R=0.96 Cold agglut, Plt aggreg, nucl. RBCs, cryoglob., lyse-resistant RBCs in patients w/hemoglobinopathies, severe liver disease or neonates Cold agglut, severe microcytosis, frag. RBCs, large no. giant Plts, in vitro hemolysis Hct: cold agglut, leukocytosis (>100,000/μL), abn red cell fragility, spherocytosis Pseudothrombocytopenia, Plt aggreg, incr. microcytosis, megalocytic Plts Lipema, abn proteins in blood plasma, severe leukocytosis (>100,000/μL) Lyse-resistant RBCs
Age- and sex-specific reference ranges Max. CBCs per hr/max. CBCs & diffs. per hr Recommended avg. frequency of calib. •Modes calibrated/parameters calibrated Frequency of blood/latex controls Min. specimen vol. open/closed/sample dead vol. closed Tube sampling supported Veterinary capability Microsample capability Prepares microscopic slides automatically or flags problems for slide prep If auto. slidemaker avail., no. installed/list price	Yes 120/70–120 (depends on no. retics/hr) With major PM or parts replacement Open by customer, others by svc./WBC, RBC, Hb, Hct, Plt 2 levels per 8 hrs operation/service calibration only 100 μL/250 μL/1 mL Yes (3 mL, 5 mL, 7 mL) No Yes Yes w/ Alpha or HST upgrade >100/—	Yes 150/150 Annually Open, closed, capillary/WBC, RBC, Hb, Hct, Plt Per CLIA requirements/not required 130 μL/200 μL/1 mL Yes No Yes Yes w/ Alpha or HST upgrade >100/TBD
Archives patient data for later comparison Patient-specific archiving Max. archived data accessible when system online Memory capacity—numeric results–no. specimens Memory capacity—histo/cytograms–no. specimens •Stored in conjunction with CBC data •Histo/cytogram images & CBC data printed as 1 report Saved results can be recalled and retransmitted Saved data can be sorted for reprocessing or report transmission Performs delta checks Tags and holds results for followup, confirm. testing, or rerun Parameters for flags for holding samples are defined by Some results can be transmitted to LIS while others held Scattergram display: cell-specific color Histogram display: color with threshhold Choice of desired specimen &/or result info. displayed	Yes Yes 10,000 samples 10,000 10,000 Yes Yes Yes Yes Yes Yes User or vendor Yes Yes Yes Yes	Yes Yes 10,000 samples 10,000 10,000 Yes Yes Yes Yes Yes Yes User or vendor Yes Yes Yes Yes
LIS interface formats supported Information transferred on LIS interface LOINC codes transmitted with results Optional data mgmt. or collation system • Software features Interface avail. or planned to auto. specimen-handling system Bar-code symbologies read on tube Accommodates bar-code placement per NCCLS standard Auto2A	RS-232C Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast; host query for patient demographics & orders — Yes, proprietary Enhanced QC, data archiving, data collation from multiple instruments Roche, Labotix, IDS, A&T Codabar, codes 39 & 128, interl. 2 of 5, ITF, NW-7, JAN 8, JAN 13 Yes	RS-232C/TCP IP Numeric & flag results, histograms & scatterplots, instrument to LIS; patient demographics, orders, LIS to instrument—broadcast; host query for patient demographics & orders — Yes, proprietary Enhanced QC, data archiving, data collation from multiple instruments Roche, Labotix, IDS, A&T Codabar, codes 39 & 128, interl. 2 of 5, ITF, NW-7, JAN 8, JAN 13 Yes
Time required for maintenance by lab personnel Onboard maintenance records Time from communication of problem to engineer on site Onboard diagnostics/limited to software problems Mftr. can perform diagnostics via modem	Daily: 15 min, weekly: 30 min, monthly: 15 min Yes Territory dependent Yes/no No	Daily: 15 min Yes Territory dependent Yes/no In development
Acquisition program based on cost-per-reportable result	Yes	Yes
Distinguishing features	Adaptive Cluster Anal. System, random access, discrete testing, immature information channel, integrated retic	Enumeration of NRBCs, throughput of 150 CBCs/hr, random access, discrete testing, network capability and extended linearities

Tabulation does not represent an endorsement by the College of American Pathologists