
BD Multitest™ IMK Kit

50 Tests per kit—Catalog No. 340503

50 Tests per kit with
BD Trucount™ Tubes—Catalog No. 340504

23-3602(18)
2023-07
English



1. INTENDED USE

The BD Multitest™ IMK Kit with optional BD Trucount™ Tubes is a 4-color direct immunofluorescence reagent kit for use in identifying and determining the percentages and absolute counts of T, B, and natural killer (NK) cells, as well as the CD4 and CD8 subpopulations of T cells, in peripheral blood on a BD flow cytometer equipped with the following:

- At least a 488-nm blue laser and a 640-nm red laser
- The ability to detect forward scatter (FSC) and side scatter (SSC)
- At least 4-color fluorescence
- Software to acquire and analyze the data

Clinical Applications

Determining percentages or absolute counts of CD3⁺CD4⁺ T lymphocytes is used in monitoring human immunodeficiency virus (HIV)-infected individuals. Individuals with HIV typically exhibit a steady decrease of CD3⁺CD4⁺ T-lymphocyte absolute counts as the infection progresses.¹

Determining percentages or absolute counts of CD3⁺, CD3⁺CD4⁺, or CD3⁺CD8⁺ T lymphocytes or CD19⁺ B lymphocytes is used to characterize or monitor some forms of immune deficiency and autoimmune diseases.^{1,2}

Determining percentages or absolute counts of CD3⁺ and CD16⁺ and/or CD56⁺ NK lymphocytes is used in immunological assessment of hematologically-normal subjects or patients having, or suspected of having, immune deficiency or other immune-mediated diseases.^{1,3}

2. SUMMARY OF THE TEST

Human peripheral blood contains three types of lymphocytes: T, B, and NK lymphocytes. They have distinct biologic functions and can be identified by differences in their cell-surface antigen expression.

Subsets of antigen-specific T and B lymphocytes have different roles in the adaptive immune response. Helper/inducer T lymphocytes secrete cytokines that help regulate the activity of other T lymphocytes as well as B lymphocytes. Suppressor/cytotoxic T lymphocytes suppress the activity of other T lymphocytes, or recognize and lyse infected or abnormal cells. Antigen-specific B lymphocytes produce and secrete immunoglobulins to regulate the humoral immune response. NK lymphocytes mediate antigen-nonspecific cytotoxicity against infected or abnormal cells.⁴

BD Multitest™ IMK Kit with or without BD Trucount™ Tubes is a quantitative assay intended for use by laboratory professionals to identify and enumerate the T-, B-, and NK-lymphocyte subset populations:

- CD3⁺ T lymphocytes
- CD3⁺CD4⁺ helper/inducer T lymphocytes
- CD3⁺CD8⁺ suppressor/cytotoxic T lymphocytes
- CD19⁺ B lymphocytes
- CD3⁻CD16⁺CD56⁺ NK lymphocytes

Automated sample preparation and acquisition can be achieved using the BD FACSDuet™ Sample Preparation System and BD loaders, respectively. Data analysis can be performed using a pre-defined template and automated gating, which can be manually adjusted by the user, if needed.

Principle of Operation

The BD Multitest™ IMK Kit includes two reagents, BD Multitest™ CD3/CD8/CD45/CD4 and BD Multitest™ CD3/CD16+CD56/CD45/CD19, each containing monoclonal antibodies conjugated to a specific fluorochrome. The reagent is added to peripheral blood and incubated, allowing each monoclonal antibody in the reagent to bind to a specific antigen on the surface of the cells. After incubation, BD Multitest™ IMK Lysing Solution is added to lyse the red blood cells in the sample. Cells are acquired on a BD flow cytometer using the appropriate software. During acquisition, the cells travel past the laser beam and scatter the laser light. The stained cells fluoresce. These scatter and fluorescence signals, detected by the instrument, provide information about the cell's size, internal complexity, and relative fluorescence intensity. BD Multitest™ reagents employ fluorescence triggering, allowing direct fluorescence gating of the lymphocyte population to reduce contamination of unlysed or nucleated red blood cells in the gate. The software and the BD Multitest™ 4-Color assay module are used to analyze the data and report the result.

When determining absolute cell counts, expressed as the number of cells/μL, a precise volume of specimen and the BD Multitest™ IMK Kit reagent are added to a BD Trucount™ Tube. The BD Trucount™ Tube contains a lyophilized pellet of fluorescent beads. During incubation of the reagent and the specimen, the bead pellet dissolves, releasing a known number of fluorescent beads, which are distinguished from cells by their fluorescence intensity. After lysing red blood cells, the sample is acquired on a BD flow cytometer. The software determines the absolute cell counts by comparing cellular events to bead events, and reports the absolute cell counts in the lab report.

For flow cytometer principles of operation, see the instructions for use (IFU) for your instrument.

3. REAGENT

Reagent Composition

The reagents contain the following conjugated antibodies:

Table 1 Composition of BD Multitest™ CD3/CD8/CD45/CD4

Antibody	Fluorochrome	Clone	Isotype	Concentration (μg/mL)
CD3	FITC	SK7 ^{5,6}	IgG ₁ ,κ	2.3
CD8	PE	SK1 ^{7,8}	IgG ₁ ,κ	1.75
CD45	PerCP	2D1 ⁹	IgG ₁ ,κ	7.50
CD4	APC	SK3 ^{7,8,10}	IgG ₁ ,κ	0.92

Table 2 Composition of BD Multitest™ CD3/CD16+CD56/CD45/CD19

Antibody	Fluorochrome	Clone	Isotype	Concentration (µg/mL)
CD3	FITC	SK7 ^{5,6}	IgG ₁ , κ	2.3
CD16	PE	B73.1 ¹¹	IgG ₁ , κ	1.65
CD56	PE	NCAM16.2 ¹²	IgG _{2b} , κ	1.1
CD45	PerCP	2D1 ⁹	IgG ₁ , κ	7.50
CD19	APC	SJ25C1 ¹³	IgG ₁ , κ	2.3

CD3 (SK7) recognizes the epsilon chain of the CD3 antigen/T-cell antigen receptor (TCR) complex.¹⁴ The CD3 antigen is present on T lymphocytes and is noncovalently associated with either α/β or γ/δ TCR.¹⁵ CD3 reacts minimally with other cell populations.¹⁶

CD16 and CD56 together facilitate identification of the NK-lymphocyte population.

CD16 (B73.1) recognizes a human NK-lymphocyte antigen that is an Fc receptor for IgG.^{17,18,19} CD16 also reacts with neutrophils²⁰ and with granulocytes to a variable extent.¹⁷

CD56 (NCAM16.2) recognizes an extracellular immunoglobulin-like domain of the neural cell adhesion molecule (NCAM).^{21,22,23} CD56 also reacts with approximately 5% of CD3⁺ peripheral blood lymphocytes.²⁰

CD45 (2D1) recognizes all isoforms of the leukocyte common antigen (LCA)/T200 family.²⁴ The CD45 antigen is present on all human leukocytes, including lymphocytes, monocytes, granulocytes, eosinophils, and basophils in peripheral blood.²⁴ CD45 has been reported to react weakly with mature circulating erythrocytes and platelets.^{24,25}

CD4 (SK3) recognizes an antigen that interacts with class II MHC molecules and is the primary receptor for HIV.^{26,27} The CD4 antigen is present on helper/inducer T lymphocytes and is present in low density on the cell surface of monocytes and in the cytoplasm of monocytes.⁸




CD19 (SJ25C1) recognizes an antigen that is present on human B lymphocytes at all stages of maturation,^{11,28,29} but is lost on plasma cells.²⁹ CD19 does not react with resting or activated T lymphocytes, granulocytes, or monocytes.³⁰

CD8 (SK1) recognizes an antigen that interacts with class I major histocompatibility complex (MHC) molecules, resulting in increased adhesion between the CD8⁺ T lymphocytes and the target cells and enhanced activation of resting T lymphocytes.^{31,32,33} The CD8 antigen is present on suppressor/cytotoxic T lymphocytes. CD8 also recognizes a subset of NK lymphocytes.³⁴

Precautions

- The reagent should be clear. Do not use the reagent if you observe any change in appearance. Precipitation, cloudiness, or change in color indicates instability or deterioration.
- The antibody reagent contains sodium azide as a preservative. However, take care to avoid microbial contamination, which can cause erroneous results.
- If using BD Trucount™ Tubes, calibrate pipets to deliver exactly 50 µL of sample or perform the reverse pipetting technique (see Reverse Pipetting on page 8). See the pipet manufacturer's instructions for more information.
- Bead count varies by lot of BD Trucount™ Tubes. It is critical to use the bead count shown on the current lot of BD Trucount™ Tubes when entering this value in the software or when manually calculating absolute counts. Do not mix multiple lots of BD Trucount™ Tubes in the same run.

- BD Trucount™ Tubes are designed for use with a specific lyse/no-wash procedure. Do not attempt to threshold on forward scatter (FSC) for data collection.
- BD Multitest™ IMK Lysing Solution contains 2,2'-oxybisethanol (31.3% diethylene glycol (CAS number 111-46-6, EC number 203-872-2); 9.77% formaldehyde (CAS number 50-00-0, EC number 200-001-8); and 3.4% methanol (CAS number 67-56-1, EC number 200-659-6). The lysing solution is classified as hazardous according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) and Regulation (EC) No 1272/2008. Go to regdocs.bd.com/regdocs/sdsSearch to download the Safety Data Sheet.

	Danger
  	<p>H302+H312+H332: Harmful if swallowed, in contact with skin or if inhaled.</p> <p>H314: Causes severe skin burns and eye damage.</p> <p>H317: May cause an allergic skin reaction.</p> <p>H335: May cause respiratory irritation.</p> <p>H341: Suspected of causing genetic defects.</p> <p>H350: May cause cancer.</p> <p>H370: Causes damage to organs.</p> <p>H373: May cause damage to organs through prolonged or repeated exposure.</p>
Prevention	<p>P201: Obtain special instructions before use.</p> <p>P202: Do not handle until all safety precautions have been read and understood.</p> <p>P260: Do not breathe dust/fume/gas/mist/vapors/spray.</p> <p>P264: Wash thoroughly after handling.</p> <p>P272: Contaminated work clothing should not be allowed out of the workplace.</p> <p>P273: Avoid release to the environment.</p> <p>P280: Wear protective gloves/protective clothing/eye protection/face protection.</p>
Response	<p>P301+P330+P331: IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.</p> <p>P303+P361+P353: IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water [or shower].</p> <p>P363: Wash contaminated clothing before reuse.</p> <p>P310: Immediately call a POISON CENTER/doctor.</p> <p>P305+P351+P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.</p> <p>P307+P311: IF exposed: Call a POISON CENTER or doctor/physician.</p> <p>P333+P313: If skin irritation or rash occurs: Get medical advice/attention.</p> <p>P304+P340: IF INHALED: Remove person to fresh air and keep comfortable for breathing.</p> <p>P312: Call a POISON CENTER/doctor if you feel unwell.</p> <p>P337+P313: If eye irritation persists: Get medical advice/attention.</p> <p>P308+P313: If exposed or concerned: Get medical advice/attention.</p>

Storage	P405: Store locked up.
Disposal	P501: Dispose of contents/container to an approved facility in accordance with local, regional, national and international regulations.

Storage and Handling

- Store the reagent at 2–8 °C. Reagent in opened or unopened vials is stable until the expiration date shown on the vial label. Do not use after this expiration date.
- Do not freeze the reagent or expose it to direct light during storage or incubation with cells. Keep the reagent vial dry.
- The reagent is stable if kept in the BD FACSDuet™ instrument for 8 hours per day for 5 days. Do not store the reagent overnight in the instrument. Use of any reagent remaining after being kept in the BD FACSDuet™ instrument for 5 days must be validated by the user.
- Store BD Trucount™ Tubes in their original foil pouch at 2–25 °C. To avoid potential condensation, open the pouch only after it has reached room temperature and carefully reseal the pouch immediately after removing a tube. Do not remove the desiccant pack from the pouch. Use tubes within 1 hour after removal from the foil pouch.
- BD Trucount™ Tubes in an unopened pouch are stable until the expiration date shown on the packaging. Do not use tubes after the expiration date.
- Tubes in an opened pouch are stable for 1 month after the date of opening, when stored as directed. Write the date when you first open the pouch in the space provided on the label.

4. INSTRUMENT

The BD FACSLyric™ and BD FACSCanto™ II systems are outlined in the following table. See the corresponding reagent or instrument user documentation for details.

Table 3 BD FACSLyric™ and BD FACSCanto™ II systems

Flow cytometer	Setup beads	Setup software	Analysis software	Assay module
BD FACSLyric™	BD® CS&T Beads ^a BD® FC Beads 7-Color Kit ^b	BD FACSuite™ Clinical application	BD FACSuite™ Clinical application	BD Multitest™ 4-Color
BD FACSCanto™ II	BD FACS™ 7-Color Setup Beads ^c	BD FACSCanto™ Clinical Software v2.4 or later	BD FACSCanto™ Clinical Software v2.4 or later	BD Multitest™ 4-Color
a. To perform daily cytometer quality control. b. To calculate compensation. c. To set photomultiplier tube (PMT) voltages and fluorescence compensation, and check instrument sensitivity before use.				

The BD FACS™ Loader and BD FACS™ Universal Loader can be used with this product. See the IFU for the cytometer used with your Loader for more information.

The BD FACSDuet™ sample preparation system can be used with this product. See the *BD FACSDuet™ Sample Preparation System Instructions for Use* for more information.

5. SPECIMEN COLLECTION AND PREPARATION

- Collect blood specimens aseptically by venipuncture into a BD Vacutainer® EDTA blood collection tube, or equivalent.³⁵

BD Multitest™ IMK Kit with BD Trucount™ Tubes has been validated with both liquid and dry formulations of EDTA. The reagent has not been validated by BD Biosciences for use with heparin or acid citrate dextrose (ACD) liquid anticoagulants in determining absolute counts with BD Trucount™ Tubes.

The assay requires 50 µL of peripheral blood per test. We recommend starting with a minimum of 100 µL of blood to accommodate the excess volume needed to perform reverse pipetting.

- If using the dual platform method, obtain a white blood cell (WBC) count and a differential white cell count from the same whole blood sample before staining to calculate absolute counts from percentages. See Dual Platform Method on page 17.
- Store blood specimens at room temperature (20–25 °C).
- Stain specimens within 48 hours of draw.
- Acquire samples within 24 hours of staining.

WARNING All biological specimens and materials coming in contact with them are considered biohazards. Handle as if capable of transmitting infection^{36,37} and dispose of with proper precautions in accordance with federal, state, and local regulations. Never pipette by mouth. Wear suitable protective clothing, eyewear, and gloves. Fixation has been reported to inactivate HIV.³⁸

Interference

Substances present in the specimen might interfere with the assay:

- Specimens obtained from patients taking immunosuppressive drugs^{39,40,41} or undergoing monoclonal antibody treatment^{42,43,44,45,46,47} can yield erroneous results.
- Hemolyzed samples can interfere with the assay and should be rejected.⁴⁸ Do not use previously fixed and stored patient specimens. Whole blood samples refrigerated before staining can give aberrant results.
- Blast cells can interfere with test results.⁴⁹
- Lipemic specimens can interfere with the assay.^{50,51}
- Bilirubin interferes at an absorbance peak of 456 nm.⁵²

Interfering Conditions

The following table lists the substances that were tested for interference with a similar reagent, the BD Multitest™ 6-Color TBNK reagent, with optional BD Trucount™ Tubes.

Testing for interference was performed in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines⁵³. There was no detectable interference at the following concentrations.

Table 4 Non-interfering substances

Analyte	Concentration tested
Acetaminophen	156 µg/mL
Acetylsalicylic acid (Aspirin)	30 µg/mL
Albuterol	0.015 µg/mL
Atenolol	3 µg/mL
Atorvastatin	0.25 µg/mL
Azithromycin	3.7 µg/mL
Bilirubin, conjugated	2 mg/dL
Cobicistat	3.6 µg/mL
Efavirenz	12 µg/mL
Enoxaparin	2 µg/mL
Guaifenesin	1.5 µg/mL

Analyte	Concentration tested
Hydroxychloroquine	0.2 µg/mL
Ibuprofen	73 µg/mL
Insulin	37 µU/mL
Kaletra	15.5 µg/mL
Lisinopril	0.082 µg/mL
Maraviroc	0.888 µg/mL
Oseltamivir	0.133 µg/mL
Raltegravir	15 µg/mL
Remdesivir	16.32 µg/mL
Ritonavir	15 µg/mL
Tenofovir	0.978 µg/mL
Tocilizumab	149.4 µg/mL
Vancomycin	40 µg/mL

The following substances interfered with the assay at the indicated concentration:

Table 5 Interfering substances

Analyte	Concentration tested
Albumin ^{a,e}	6 g/dL
Bilirubin, unconjugated ^{b,e}	2 mg/dL
Erythrocytes ^{c,e}	6x10 ³ cells/µL
Hemoglobin ^{c,e}	1000 mg/dL
Triglycerides ^{d,e}	1500 mg/dL

a. Albumin interferes as a result of its comparatively large concentration in the peripheral blood and its ability to bind as well as to release large quantities of ligands.⁵⁴

b. Unconjugated Bilirubin may induce autofluorescence.⁵⁵

c. The presence of red blood cells (RBCs) in the sample preparation can cause light interference and nonspecific interactions leading to erroneous test results.⁵⁶ Hemolyzed samples should be rejected. The hemoglobin concentration refers to free hemoglobin.

d. Immunomodulatory drugs used for treatment of HIV infection may cause lipemia. Lipemia is known to interfere in assays that use the transmission of light and impact the scattering of light.^{57,58}

e. The listed endogenous substances interfere with the assay at higher than normal concentrations, i.e. hyperalbuminemia, unconjugated hyperbilirubinemia, erythrocytosis, hemoglobinemia, and hypertriglyceridemia. Interference caused by these endogenous substances is not uncommon and has been described in the literature (see references listed in notes a–d).

6. PROCEDURE

Reagents and Materials

Reagents and materials provided

The BD Multitest™ IMK Kit contains one vial of each reagent:

- BD Multitest™ CD3/CD8/CD45/CD4
- BD Multitest™ CD3/CD16+CD56/CD45/CD19

Each reagent is provided in 1 mL of buffered saline with <0.1% sodium azide. The reagents are sufficient for 50 tests each.

- BD Multitest™ IMK Lysing Solution

The lysing solution is provided as 10 mL of a 10X concentrate.

If calculating absolute counts, use BD Multitest™ IMK Kit with BD Trucount™ Tubes. In addition to the two vials of reagent and the lysing solution, the kit comes with four pouches of BD Trucount™ Tubes. Each pouch contains 25 tubes, sufficient for 25 tests. The tubes contain a freeze-dried pellet of fluorescent beads in a single-use tube.

Reagents and materials required but not provided

- Disposable 12 × 75-mm capped polystyrene test tubes, or equivalent (if not using BD Trucount™ Tubes)
- Vortex mixer
- Micropipettor with tips
- Bulk dispenser or pipettor (450 µL) for dispensing 1X BD Multitest™ IMK Lysing Solution
- BD Multi-Check™ Control (Catalog Nos. 340911, 340912, 340913)
- BD Multi-Check™ CD4 Low Control (Catalog Nos. 340914, 340915, 340916)
- (Optional) BD Trucount™ Controls (Catalog No. 340335)
- (Optional) BD FACS™ Universal Loader
- (Optional) BD FACS™ Loader (used on the BD FACSCanto™ II flow cytometer)

Diluting BD Multitest™ IMK Lysing Solution

Dilute the 10X concentrate 1:10 with room temperature (20–25 °C) deionized water. The prepared solution is stable for 1 month when stored in a glass or high density polyethylene (HDPE) container at room temperature.

Reverse Pipetting

Accurate pipetting is critical when using a BD Trucount™ Tube. Use the reverse pipetting technique to add the sample to the tube. For reverse pipetting, depress the button to the second stop. Release the button to draw excess sample into the tip. Press the button to the first stop to expel a precise volume of sample, leaving excess sample in the tip.

Performing Quality Control

Run two levels of process control material (for example, BD Multi-Check™ Control and BD Multi-Check™ CD4 Low Control) before acquiring patient specimens.⁵⁹ Control materials should provide established values for percent positive and absolute counts for the relevant cell populations. Process the controls like patient specimens to monitor the performance of the entire analytic process. This is done at least once each day when patient testing is performed.

NOTE BD Multi-Check™ Control and BD Multi-Check™ CD4 Low Control are validated as process controls on BD FACSLytic™ flow cytometers.

If needed, use BD Trucount™ Controls to verify pipetting accuracy and the bead count value of the BD Trucount™ Tubes.

Staining the Cells

If using the BD FACSDuet™ system to prepare the samples, see the *BD FACSDuet™ Sample Preparation System Instructions for Use*.

1. For each sample, remove a tube and label it with the appropriate reagent and sample identification.

For calculating absolute counts and lymphocyte subset percentages, label a BD Trucount™ Tube. For calculating lymphocyte subset percentages only, label a 12 × 75-mm tube.

NOTE For samples stained in BD Trucount™ Tubes, verify that the BD Trucount™ bead pellet is under the metal retainer at the bottom of the tube. If this is not the case, discard the BD Trucount™ Tube and replace it with another. Do not transfer beads to another tube.

2. Pipette 20 µL of the appropriate BD Multitest™ reagent into the bottom of the tube.

If using a BD Trucount™ Tube, pipette the reagent onto the side of the tube, just above the metal retainer, without touching the bead pellet.

3. Pipette 50 µL of well-mixed control material or anticoagulated peripheral blood onto the side of the tube.

If using a BD Trucount™ Tube, pipette the sample onto the side of the tube, just above the metal retainer, without touching the bead pellet.

NOTE Thoroughly mix the controls before pipetting them. See the *BD Multi-Check™ Control* or *BD Multi-Check™ CD4 Low Control* IFU for detailed instructions.

NOTE Use the reverse pipetting technique to pipette sample onto the side of the tube just above the retainer. See Reverse Pipetting on page 8. Avoid smearing sample down the side of the tube. If peripheral blood or control material remains on the side of the tube, it will not be stained with the reagent and can affect results.

4. Cap the tube and vortex gently to mix.
5. Incubate for 15–30 minutes in the dark at room temperature (20–25 °C).
6. Add 450 µL of 1X BD Multitest™ IMK Lysing Solution to the tube.
7. Cap the tube and vortex gently to mix.
8. Incubate for 15–30 minutes in the dark at room temperature (20–25 °C).

The sample is now ready to be analyzed on the flow cytometer. Acquire the sample within 24 hours of staining. Store the stained sample in the dark at room temperature (20–25 °C) until acquisition.

Running the Assay on BD FACSLyric™ Flow Cytometers

Before you begin:

1. Ensure that Characterization QC (CQC) and lyse/no wash reference settings have not expired.
2. Add reagent lots to library, if needed.

See the *BD FACSLyric™ System Instructions For Use* for information.

3. Perform daily Performance QC (PQC) using BD® CS&T Beads.

See the *BD® CS&T Beads* IFU and the *BD FACSLyric™ System Instructions For Use* for information.

To run the assay:

1. Create a worklist.
 - Create a Multi-Check™ Control task for each process control you are running.
 - Create an appropriate assay task for each patient specimen you are running.
2. Enter information in the worklist table.
 - If not using BD Trucount™ Tubes, enter the WBC count and the percentage of lymphocytes (WBC (x1000) and Lymphs (%), respectively), or the lymphocyte count (Lymphs (x1000)) in the appropriate column.

NOTE Divide the WBC count or the lymphocyte count by 1,000 before entering it into the software.

- If using BD Trucount™ Tubes, enter the lot ID for the tubes and the bead count, found on the pouch label, in the appropriate column (Trucount Lot ID and Beads Per Pellet, respectively).
3. Run the control tasks on the worklist.
4. Vortex each tube thoroughly at low speed immediately before acquiring it.⁶⁰

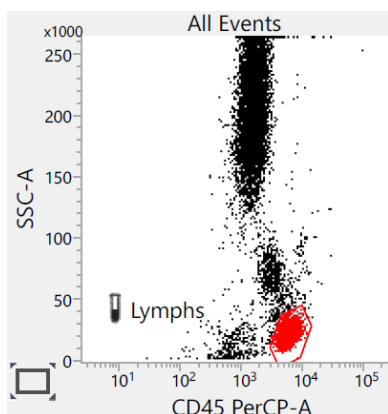
NOTE If you are using the BD FACS™ Universal Loader, vortex tubes immediately before placing them into the Loader racks.

5. After acquiring the control samples, click **Stop Tube**.

NOTE This assumes that process control passes. Stop it to verify, then continue with samples of interest. If process control fails, restrain samples and process controls because you cannot discriminate whether process control failure comes from staining or the instrument.

6. Review the lab report for the controls.
7. Visually inspect the CD45 PerCP-A vs SSC-A dot plot.

The lymphocyte population should appear as a bright, compact cluster with low SSC. Monocytes and granulocytes should also appear as distinct clusters. Do not proceed with analysis if populations are diffuse and there is little or no separation between clusters.



8. Verify that the results are within the values reported in the Assay Values sheet, provided with the controls.
9. Set the run pointer to the first patient specimen and select **Run from Pointer** from the **Run** menu.
Before acquiring samples, adjust the threshold to minimize debris and ensure populations of interest are included.
10. Review the assay lab report.
Page 1 of the lab report shows dot plots to identify the cell populations. The lab report shown is for BD Multitest™ IMK Kit without BD Trucount™ Tubes.

BD 4 Color TBNK: Lab Report

Sample ID: 313

Sample Name:

Acquired Using: Worklist.D3

Cytometer: BD FACScyte

Sample Preparer:

Operator Admin User

Approved: 10/03/2019 2:50:03 PM

Cytometer SN: 26545879021

Sample Preparer SN:

Director:

Department: None

Entry Status: Approved

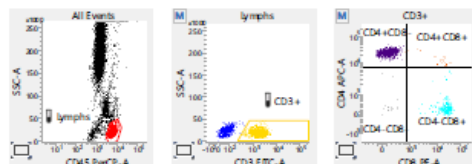
Software: BD FACSuite Clinical v1.4

Institution: None

Address:

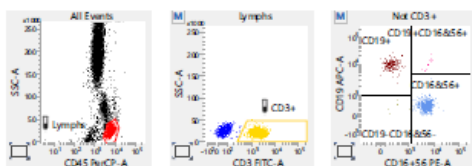
Tube Name: CD8/8/45/4

Events Acquired	11,389	Acquisition Date	10/03/2019
Reagent Lot ID	Multitest CD3/CD8/CD45/CD4 Lot ID: 910482	Acquisition Time	12:46:28 PM
Keyword 1	<no value>	Keyword 2	<no value>
WBC (x1000)	<no value>	Lymphs (%)	<no value>
Lymphs (x1000)	<no value>		



Tube Name: CD8/16+56/45/19

Events Acquired	11,272	Acquisition Date	10/23/2019
Reagent Lot ID	Multitest CD3/CD16+CD56/CD45/CD19 Lot ID: 79570	Acquisition Time	12:47:24 PM
Keyword 1	<no value>	Keyword 2	<no value>
WBC (x1000)	<no value>	Lymphs (%)	<no value>
Lymphs (x1000)	<no value>		



For In Vivo Diagnostic Lab

4 Color TBNK v1.1

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Page 2 of the lab report summarizes the results, presents QC and cross tube results for the assay, and presents any QC messages that were triggered.

Sample ID: 313
Sample Name:
Case Number:
Acquired Using: Worklist_003
Assay: 4 Color TBNK

Results Summary (Abs Cnt is in cells/μL)

Label	Tube 1	Tube 2	Average
Lymphs Events	2,499	2,499	
Lymphs Abs Cnt	No Value	No Value	
CD3+ %Lymphs	69.51	67.71	68.61
CD3+ Abs Cnt	No Value	No Value	No Value
CD3+CD4+ %Lymphs	52.46		
CD3+CD4+ Abs Cnt	No Value		
CD3+CD4+ %Lymphs (excl. dual pos.)	51.34		
CD3+CD4+ Abs Cnt (excl. dual pos.)	No Value		
CD3+CD8+ %Lymphs	17.53		
CD3+CD8+ Abs Cnt	No Value		
CD3+CD8+ %Lymphs (excl. dual pos.)	16.41		
CD3+CD8+ Abs Cnt (excl. dual pos.)	No Value		
CD3+CD4+CD8+ %Lymphs	1.12		
CD3+CD4+CD8+ Abs Cnt	No Value		
CD3+CD4-CD8- %Lymphs	0.64		
CD3+CD4-CD8- Abs Cnt	No Value		
CD19+ %Lymphs		7.84	
CD19+ Abs Cnt		No Value	
CD3-CD16+CD56+ %Lymphs		23.77	
CD3-CD16+CD56+ Abs Cnt		No Value	

QC and Cross Tube Results

Label	Results
4/8 Ratio	2.99
% T-Sum (<10%)	0.64
Lymphosum (95-105%)	100.22
CD3 %Lymphs Difference (<3)	1.80
CD3 Abs Cnt %Difference (<10%)	No Value

QC Messages

See the *BD FACSLyric™ System Instructions for Use* or the *BD FACSLyric™ Clinical Reference System* for more information.

Running the Panel on BD FACSCanto™ II Flow Cytometers

1. Run Setup using BD FACS™ 7-Color Setup Beads.
See the *BD FACSCanto™ II Instructions for Use* for more information.
2. Add a BD Multitest™ IMK Kit panel entry for each process control and patient sample.

NOTE The word "Control" must appear in the sample name of the process controls.

3. Acquire the process control samples.
4. Vortex each tube thoroughly at low speed immediately before acquiring it. It is important to reduce aggregation before running samples on the flow cytometer.

NOTE If you are using the BD FACS™ Loader, vortex tubes immediately before placing them into the Loader racks.

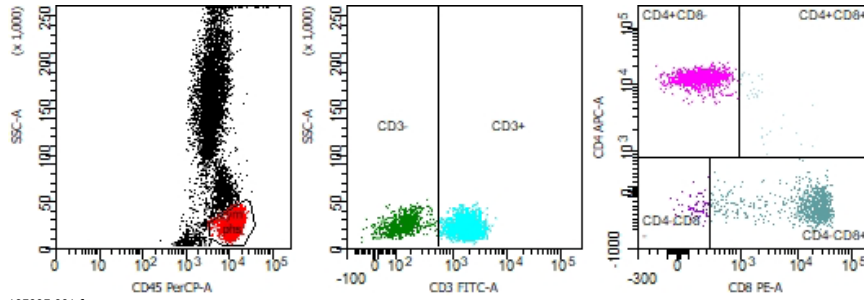
5. Verify that the process control values are within the manufacturer's expected ranges.
6. Acquire the patient samples.

7. Review the assay lab report.

105	
Director:	<div>Panel: 4 Color TBNK</div> <div>Acquired: 5/1/2013 3:34:31 PM</div> <div>Analyzed: 1/4/2018 2:40:31 PM</div> <div>Status: OK</div> <div>Operator: Lab Manager</div> <div>Reviewer:</div> <div>Results: 04012018.csv</div>
WBC Count (x1000):	<div>Lymphs (%):</div> <div>Lymphs (x1000):</div>
BD FACSCanto II V96100267	
BD FACSCanto v.3.5.6520.4317	

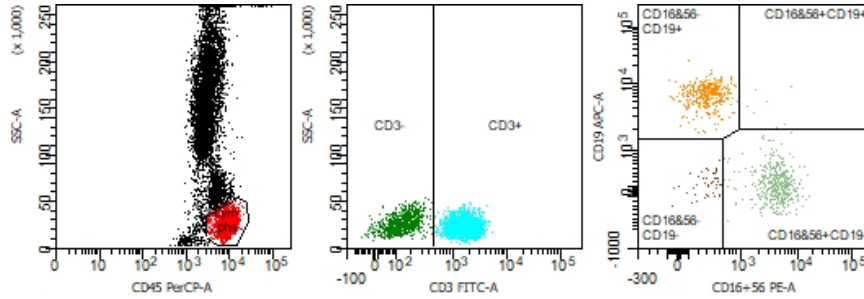
CD3/CD8/CD45/CD4

Total Events: 10058



CD3/CD16+56/CD45/CD19

Total Events: 10058



105			
Director:		Panel:	4 Color TBNK
		Acquired:	5/1/2013 3:34:31 PM
		Analyzed:	1/4/2018 2:40:31 PM
		Status:	OK
		Operator:	Lab Manager
		Reviewer:	
		Results:	04012018.csv
WBC Count (x1000):		Lymphs (%):	Lymphs (x1000):
BD FACSCanto II V96100267		BD FACSCanto v.3.5.6520.4317	

Parameter	Tube 1	Tube 2	Average
Lymph Events	3047	3213	3130
CD3+ %Lymphs	74.40	73.23	73.82
CD3+ Abs Cnt	0	0	0
CD3+CD8+ %Lymphs (Excl. dual pos.)	32.33		
CD3+CD8+ Abs Cnt (Excl. dual pos.)	0		
CD3+CD4+ %Lymphs (Excl. dual pos.)	38.73		
CD3+CD4+ Abs Cnt (Excl. dual pos.)	0		
CD3+CD4-CD8- %Lymphs	2.20		
CD3+CD4-CD8- Abs Cnt	0		
CD3+CD4+CD8+ %Lymphs	1.15		
CD3+CD4+CD8+ Abs Cnt	0		
CD3+CD8+ %Lymphs	33.48		
CD3+CD8+ Abs Cnt	0		
CD3+CD4+ %Lymphs	39.88		
CD3+CD4+ Abs Cnt	0		
CD45+ Abs Cnt	0	0	0
4/8 Ratio (Excl. dual pos.)	1.20		
4/8 Ratio	1.19		
CD16+CD56+ %Lymphs		13.69	
CD16+CD56+ Abs Cnt		0	
CD19+ %Lymphs		11.48	
CD19+ Abs Cnt		0	

QC Messages

CD3% difference is: 1.17

% T-Sum is: 0.47

Lymphosum is: 99.00

4/8 ratio is: 1.19

CD3 Abs Cnt % difference is: 0

% T-Sum (Excl. dual pos.) is: 2.20

4/8 ratio (Excl. dual pos.) is: 1.20

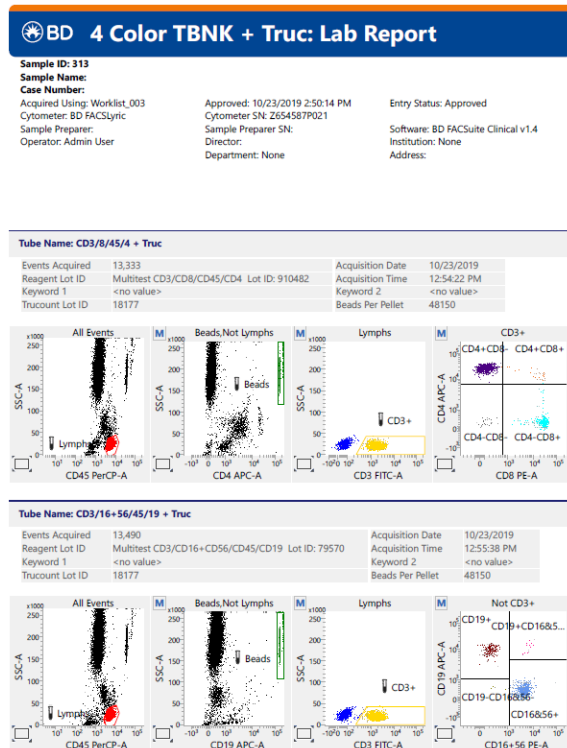
Comments

7. RESULTS

Representative Data

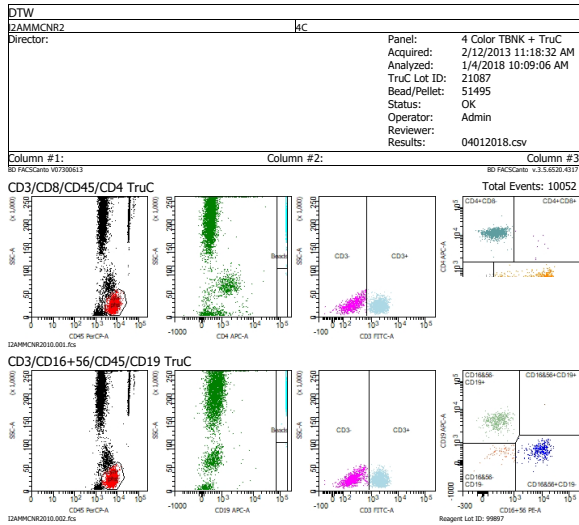
A hematologically normal adult sample stained with BD Multitest™ IMK Kit in a BD Trucount™ Tube was acquired on a BD FACSLytic™ flow cytometer. See Figure 1.

Figure 1 BD FACSLytic™ laboratory report showing data collected with BD Trucount™ Tubes.



A similar sample was obtained on a BD FACSCanto™ II flow cytometer.

Figure 2 BD FACSCanto™ II laboratory report showing data collected with BD Trucount™ Tubes.



The lymphocyte subsets are identified using the following gating strategies:

Table 6 Gating strategy for BD Multitest™ CD3/CD8/CD45/CD4

Dot plot	Parent population	Gate	Populations identified
CD45 PerCP-A vs SSC-A	All Events	Lymphs	Lymphocytes
CD4 APC-A vs SSC-A	Beads, Not Lymphs	Beads	Trucount beads
CD3 FITC-A vs SSC-A	Lymphs	CD3 ⁺	CD3 ⁺ T lymphocytes
CD8 PE-A vs CD4 APC-A	CD3 ⁺	Quadrant	CD4 ⁺ CD8 ⁻ CD4 ⁺ CD8 ⁺ CD4 ⁻ CD8 ⁺ CD4 ⁻ CD8 ⁻

Table 7 Gating strategy for BD Multitest™ CD3/CD16+CD56/CD45/CD19

Dot plot	Parent population	Gate	Populations identified
CD45 PerCP-A vs SSC-A	All Events	Lymphs	Lymphocytes
CD19 APC-A vs SSC-A	Beads, Not Lymphs	Beads	Trucount beads
CD3 FITC-A vs SSC-A	Lymphs	CD3 ⁺	CD3 ⁺ T lymphocytes
CD16+56 PE-A vs CD19 APC-A	Not CD3 ⁺ (CD3 ⁻)	Quadrant	CD19 ⁺ CD19 ⁺ CD16&56 ⁺ CD16&56 ⁺ CD19 ⁻ CD16&56 ⁻

The second dot plot for each tube, used to identify BD Trucount™ beads, is present in the 4-Color TBNK + Truc Lab Report only.

See the *BD FACSLyric™ Clinical Reference System*, which provides information on gating and troubleshooting.

Calculating Absolute Counts

When using cytometer-specific BD software, results show positive cells as a percentage of lymphocytes. In addition, the software uses one of two methods to calculate absolute counts of positive cells per microliter of blood (cells/μL).

Single Platform Method

When BD Trucount™ Tubes are used, the absolute number of positive cells in the sample can be determined by comparing cellular events to bead events. The software calculates absolute counts using the following formula:

$$\frac{\text{\# events in cell population}}{\text{\# events in absolute count bead region}} \times \frac{\text{\# beads/test}}{\text{test volume}} = \text{cell population absolute count}$$

The # beads/test is found on the BD Trucount™ Tubes foil pouch label and varies from lot to lot.

Dual Platform Method

This method is used when using 12 × 75-mm polystyrene tubes (or equivalent) instead of BD Trucount™ Tubes. When creating the worklist, enter values for either the lymphocyte count, or the WBC count and the percentage of lymphocytes, as determined by a hematology analyzer or another method. See the instructions for use for your instrument for more information. The software uses one of the following formulas to calculate absolute counts:

- User provides lymphocyte count per μL.

$$\frac{\text{\# events in cell population} \times \text{lymphocyte count per } \mu\text{L}}{\text{\# lymphocytes acquired}} = \text{cell population absolute count}$$

- User provides WBC count per μL and percentage of lymphocytes.

$$\frac{\text{\# events in cell population} \times \text{WBC count} \times (\% \text{lymphocytes}/100)}{\text{\# lymphocytes acquired}} = \text{cell population absolute count}$$

NOTE The accuracy of the absolute counts determined with the Dual Platform Method depends upon the accuracy of the values entered into the software.

8. LIMITATIONS

- Laboratories must establish their own normal reference intervals for the lymphocyte subsets identified using BD Multitest™ IMK Kit. Age, gender, clinical characteristics, and ethnicity of patients should be known when a reference interval is determined.⁶¹ The provided reference intervals are for information only.

- BD Multitest™ IMK Kit is not intended for screening samples for the presence of leukemic cells or for immunophenotyping samples from leukemia patients.
- Absolute counts are not comparable between laboratories using different manufacturers' equipment.
- BD Multitest™ IMK Kit with BD Trucount™ Tubes has not been validated by BD Biosciences for use with heparin or acid citrate dextrose (ACD) liquid anticoagulants to determine absolute counts.

9. REFERENCE INTERVALS

Reference intervals for the BD Multitest™ IMK Kit with and without BD Trucount™ Tubes were determined in a study using the BD FACSLytic™ flow cytometer.⁵⁵ The study objective was to establish device reference interval values in stained peripheral blood from a healthy cohort of male and female adults that are free of hematological abnormality. Device reference interval refers to a specified interval of the distribution of lymphocyte subset absolute count and percent values taken from a biological reference population. Blood from a population of healthy control subjects was stained with the BD Multitest™ IMK Kit with BD Trucount™ Tubes, and then acquired and analyzed on a BD FACSLytic™ flow cytometer using BD FACSuite™ Clinical application. See the first limitation (in the preceding section) for more information about reference intervals. The method conforms to CLSI guidelines.⁶¹

Table 8 Representative reference intervals for the BD Multitest™ IMK Kit reagents

Lymphocyte subset	N ^a	Units	Mean	95% range
Average CD3 ⁺	130	%	71.88	56.86–82.5
		cells/μL	1,555.87	827–2,547
CD3 ⁺ CD4 ⁺	130	%	46.51	32.42–63.19
		cells/μL	1,003.50	488–1,711
CD3 ⁺ CD8 ⁺	130	%	23.25	8.99–38.99
		cells/μL	514.19	154–1,097
CD19 ⁺	130	%	13.69	5.14–22.96
		cells/μL	292.73	60–551
CD3 ⁺ CD16 ⁺ CD56 ⁺	130	%	13.25	5.42–29.65
		cells/μL	281.04	102–617
a. N = number of samples				

10. PERFORMANCE CHARACTERISTICS

Specimen Handling and Collection (AOB/AOS)

A study was performed to assess the age of blood (AOB) and age of stain (AOS) using each of the BD Multitest™ IMK Kit reagents with BD Trucount™ Tubes. The stability of EDTA-anticoagulated blood was evaluated by assessing the combined effect of:

- AOB: Time duration between specimen draw and staining
- AOS: Time duration between staining specimen (end of lysis) and acquiring stained sample

Peripheral blood specimens were tested to at least 51 hours post draw and stained samples were tested to at least 26 hours post stain. All samples were maintained at room temperature (20–25 °C) before staining or acquisition.

Based on the results of this study, we recommend staining samples within 48 hours of draw and analyzing samples within 24 hours of staining.

Limit of blank and limit of detection

The detection capability of the BD Multitest™ IMK Kit reagents on the BD FACSLytic™ flow cytometer was assessed at one site. Samples were prepared manually or using the BD FACSDuet™ system. Limit of Blank (LOB) refers to the highest apparent absolute count values that can be detected in a stained sample containing no lymphocytes. Limit of Detection (LOD) refers to the lowest absolute count values that can be detected above zero in a stained sample containing a very low CD3⁺CD4⁺ lymphocyte concentration.

Cell-free plasma samples were used to estimate LOB. Plasma samples containing 10 ±5 CD3⁺CD4⁺ cells/μL were used to estimate LOD. Sixty replicates of each sample type were stained manually or using the BD FACSDuet™ system with each of three reagent lots.

Three BD FACSLytic™ flow cytometers were used to acquire the manually prepared samples. A minimum of one BD FACSDuet™ system integrated with a BD FACSLytic™ flow cytometer was used in the other study. Absolute count values for LOB and LOD are shown in the following table.

Table 9 Detection capability of the BD Multitest™ IMK Kit reagents (LOB and LOD)

	Manual sample preparation		Sample preparation with BD FACSDuet™ system	
Lymphocyte subset	LOB (cells/μL)	LOD (cells/μL)	LOB (cells/μL)	LOD (cells/μL)
Average CD3 ⁺	4	8	4	10
CD3 ⁺ CD4 ⁺	4	8	2	6
CD3 ⁺ CD8 ⁺	4	11	2	6
CD19 ⁺	2	5	0	4
CD3 ⁺ CD16 ⁺ CD56 ⁺	1	6	0	7

Limit of quantitation

The limit of quantitation (LOQ) of the BD Multitest™ IMK Kit reagents on the BD FACSLytic™ flow cytometer was assessed at one site. Samples were prepared manually or using the BD FACSDuet™ system. LOQ refers to the lowest lymphocyte absolute count values that can be quantitatively detected with stated accuracy in samples containing a range of very low CD3⁺CD4⁺ concentration. Plasma samples containing 10, 20, 30, or 50 CD3⁺CD4⁺ cells/μL were used to estimate LOQ.

In the study on the BD FACSLytic™ flow cytometer, 40 replicates of samples from each of the four concentration levels were stained using two lots of the BD Multitest™ IMK Kit reagents. For the comparator system, 10 of the 40 replicates from each concentration level were stained and acquired on a BD FACSCanto™ II flow cytometer. Three BD FACSLytic™ flow cytometers and one BD FACSCanto™ II flow cytometer were used in the study.

In the study using the BD FACSDuet™ system, 10 replicates from each concentration level were stained with three lots of the reagents using the BD FACSDuet™ system and acquired using an integrated BD FACSLyric™ flow cytometer. For the comparator system, five replicates from each concentration level were stained manually with three lots of the reagents and acquired on a BD FACSLyric™ flow cytometer. Three integrated BD FACSDuet™–BD FACSLyric™ systems and one standalone BD FACSLyric™ flow cytometer were used in the study. Absolute count values for LOQ are shown in the following table.

Table 10 Detection capability of the BD Multitest™ IMK Kit reagents (LOQ)

	Manual sample preparation (first study)	Sample preparation with BD FACSDuet™ system (second study)
Lymphocyte subset	LOQ (cells/μL)	LOQ (cells/μL)
Average CD3 ⁺	14	18
CD3 ⁺ CD4 ⁺	10	11
CD3 ⁺ CD8 ⁺	11	10
CD19 ⁺	14	15
CD3 [−] CD16 ⁺ CD56 ⁺	10	13

BD FACSLyric™ Flow Cytometer

Method comparison, BD FACSLyric™ vs BD FACSCanto™ II flow cytometer

A study was performed at five sites to demonstrate equivalency between acquisition using the BD FACSLyric™ flow cytometer and the BD FACSCanto™ II flow cytometer. Peripheral blood specimens were collected from normal donors and HIV-infected individuals using BD Vacutainer® EDTA blood collection tubes. Specimens were stained using BD Multitest™ IMK Kit in BD Trucount™ Tubes and acquired on a BD FACSLyric™ flow cytometer using the BD FACSuite™ Clinical application. Lymphocyte subset percentages and absolute counts were enumerated. The results were compared with results from the same samples acquired on a BD FACSCanto™ II flow cytometer using BD FACSCanto™ Clinical Software.

Method comparison statistics are reported for all cell subsets.⁶² See the following table.

Table 11 Method comparison statistics for lymphocyte subsets

Lymphocyte subset	N	Units	R ²	Slope	Intercept	Range
Average CD3 ⁺	362	%	1.00	1.00	0.60	1.34–98.01
		cells/μL	1.00	1.04	1.07	6–9,193
CD3 ⁺ CD4 ⁺	362	%	1.00	1.01	−0.22	0.12–97.72
		cells/μL	1.00	1.03	−0.05	1–7,739
CD3 ⁺ CD8 ⁺	362	%	1.00	1.00	−0.08	0.22–82.93
		cells/μL	0.99	1.02	−1.35	1–5,774

Lymphocyte subset	N	Units	R ²	Slope	Intercept	Range
CD19 ⁺	362	%	1.00	1.02	−0.18	0.00–92.43
		cells/μL	0.99	1.02	−0.05	0–4,252
CD3 ⁺ CD16 ⁺ CD56 ⁺	362	%	0.99	0.99	−0.81	1.09–87.67
		cells/μL	0.99	0.96	−3.79	14–2,151

Method comparison, BD FACS™ Universal Loader vs manual acquisition

A study was performed at one site to demonstrate equivalency between acquisition using the BD FACS™ Universal Loader and manual acquisition. Peripheral blood specimens were stained in duplicate using the BD Multitest™IMK Kit reagents with BD Trucount™ Tubes. Stained samples were acquired on one of three BD FACSLytic™ flow cytometers using either the BD FACS™ Universal Loader or manual acquisition.

The mean, difference, and relative difference for acquisition using the BD FACS™ Universal Loader vs manual acquisition were determined for lymphocyte subset percentages and absolute counts. See the following table.

Table 12 BD FACS™ Universal Loader vs manual acquisition

Lymphocyte subset	N	Units	Mean		Difference	Relative difference
			Loader	Manual		
Average CD3 ⁺	72	%	74.00	73.95	0.05	0.10
		cells/μL	1,495.26	1,506.07	−10.81	−0.46
CD3 ⁺ CD4 ⁺	72	%	28.46	28.55	−0.09	−0.78
		cells/μL	567.62	572.35	−4.72	−0.41
CD3 ⁺ CD8 ⁺	72	%	43.04	42.92	0.12	0.46
		cells/μL	887.74	882.47	5.26	0.60
CD19 ⁺	72	%	12.87	12.95	−0.08	−0.96
		cells/μL	250.65	255.93	−5.28	−1.83
CD3 ⁺ CD16 ⁺ CD56 ⁺	72	%	12.13	12.08	0.06	0.67
		cells/μL	215.79	220.47	−4.68	−0.42

Method comparison, BD FACSLytic™ with BD FACSDuet™ system vs standalone BD FACSLytic™

Peripheral blood specimens were collected at three clinical study sites. An aliquot of each specimen was stained with each of the BD Multitest™ IMK (CD3/CD8/CD45/CD4 and CD3/CD16+CD56/CD45/CD19) reagents in a BD Trucount™ Tube using the BD FACSDuet™ system. Stained samples were automatically transferred to an integrated BD FACSLytic™ flow cytometer and acquired using a BD FACS™ Universal Loader and BD FACSuite™ Clinical application. A second aliquot of each specimen was stained manually

with the reagents in a BD Trucount™ Tube. Stained samples were acquired on a standalone BD FACSLytic™ flow cytometer using a BD FACS™ Universal Loader and BD FACSuite™ Clinical application. Results were compared between samples prepared using the BD FACSDuet™ system and samples prepared manually. See the following table.

Table 13 Method comparison statistics for lymphocyte subsets (BD FACSLytic™ with BD FACSDuet™)

Lymphocyte subset	N	Units	R ²	Slope	Intercept	Range
Average CD3 ⁺	373	%	0.99	0.99	0.41	45.31–99.14
		cells/μL	0.99	1.00	0.85	89–11,376
CD3 ⁺ CD4 ⁺	373	%	0.99	1.00	–0.02	0.37–91.86
		cells/μL	0.99	1.00	–0.15	4–7,911
CD3 ⁺ CD8 ⁺	373	%	0.99	0.99	–0.01	2.52–86.68
		cells/μL	0.98	0.99	3.16	52–5,796
CD19 ⁺	373	%	0.97	1.00	–0.03	0.17–31.80
		cells/μL	0.98	0.99	–0.08	8–2,236
CD3 [–] CD16 ⁺ CD56 ⁺	373	%	0.98	1.00	0.23	0.52–44.27
		cells/μL	0.98	1.02	0.28	9–2,188

Precision (repeatability), control material (standalone BD FACSLytic™ flow cytometer)

A 21-day single-site precision study was performed to assess repeatability and within-site precision using control material.⁶³ Estimates of precision for the enumeration of lymphocyte subset percentages and absolute counts were determined across four BD FACSLytic™ flow cytometers and four operators by acquiring two concentrations of analyte, CD-Chex Plus® control (CDN) and CD-Chex Plus® CD4 Low control (CDL), stained in duplicate using four lots of the BD Multitest™ IMK Kit reagents. Two separate runs were analyzed during each of the 21 tested days.

The following tables present the standard deviation (SD) or coefficient of variation (%CV) for repeatability and within-site precision of lymphocyte subset percentages and absolute counts using control material, respectively.

Table 14 Repeatability and within-site precision of lymphocyte subset percentages in normal analyte concentration (CDN)

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	76.77	0.59	0.62
CD3 ⁺ CD4 ⁺	50.74	1.01	1.02
CD3 ⁺ CD8 ⁺	22.22	0.80	0.80
CD19 ⁺	12.09	0.55	0.55
CD3 [–] CD16 ⁺ CD56 ⁺	10.34	0.59	0.59

Table 15 Repeatability and within-site precision of lymphocyte subset percentages in low analyte concentration (CDL)

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	57.25	0.83	0.90
CD3 ⁺ CD4 ⁺	11.66	0.62	0.64
CD3 ⁺ CD8 ⁺	40.36	1.04	1.06
CD19 ⁺	21.70	0.79	0.82
CD3 ⁻ CD16 ⁺ CD56 ⁺	19.40	0.84	0.85

Table 16 Repeatability and within-site precision of lymphocyte subset absolute counts in normal analyte concentration (CDN)

Lymphocyte subset	Mean (cells/μL)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	1,733.81	3.05	3.21
CD3 ⁺ CD4 ⁺	1,142.52	4.04	4.18
CD3 ⁺ CD8 ⁺	500.42	5.56	5.67
CD19 ⁺	273.84	6.02	6.16
CD3 ⁻ CD16 ⁺ CD56 ⁺	234.38	7.41	7.52

Table 17 Repeatability and within-site precision of lymphocyte subset absolute counts in low analyte concentration (CDL)

Lymphocyte subset	Mean (cells/μL)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	870.51	3.15	3.29
CD3 ⁺ CD4 ⁺	176.91	6.59	6.67
CD3 ⁺ CD8 ⁺	612.12	4.55	4.65
CD19 ⁺	330.87	5.22	5.35
CD3 ⁻ CD16 ⁺ CD56 ⁺	295.88	6.03	6.21

Precision (repeatability), control material (BD FACSLyric™ flow cytometer with BD FACSDuet™ system)

A 21-day single-site precision study was performed to assess repeatability and within-site precision when samples were prepared and acquired on the BD FACSLyric™ flow cytometer with BD FACSDuet™ sample preparation system using control material. Estimates of precision for the enumeration of lymphocyte subset percentages and absolute counts were determined across three BD FACSDuet™ systems, each integrated with a BD FACSLyric™ flow cytometer, and at least three operators by acquiring two concentrations of analyte, CD-Chex Plus control (CDN) and CD-Chex Plus CD4 Low control (CDL), stained in duplicate using

three lots of the BD Multitest™ IMK (CD3/CD8/CD45/CD4 and CD3/ CD16+CD56/CD45/CD19) reagents. Two separate runs were analyzed during each of the 21 tested days for a total of 42 runs.

The following tables present standard deviations (SDs) and coefficients of variation (%CVs) for repeatability and within-site precision of lymphocyte subset percentages and absolute counts, respectively.

Table 18 Repeatability and within-site precision of lymphocyte subset percentages in normal analyte concentration (CDN)

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	77.45	0.64	0.64
CD3 ⁺ CD4 ⁺	48.79	0.96	0.96
CD3 ⁺ CD8 ⁺	26.77	0.91	0.91
CD19 ⁺	11.93	0.64	0.64
CD3 ⁻ CD16 ⁺ CD56 ⁺	9.98	0.55	0.55

Table 19 Repeatability and within-site precision of lymphocyte subset percentages in low analyte concentration (CDL)

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	63.67	0.81	0.82
CD3 ⁺ CD4 ⁺	14.94	0.68	0.70
CD3 ⁺ CD8 ⁺	44.04	1.11	1.12
CD19 ⁺	18.24	0.71	0.72
CD3 ⁻ CD16 ⁺ CD56 ⁺	16.87	0.72	0.74

Table 20 Repeatability and within-site precision of lymphocyte subset absolute counts in normal analyte concentration (CDN)

Lymphocyte subset	Mean (cells/μL)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	1,751.12	3.99	6.27
CD3 ⁺ CD4 ⁺	1,103.49	5.23	6.88
CD3 ⁺ CD8 ⁺	605.62	6.23	7.70
CD19 ⁺	269.47	6.93	8.53
CD3 ⁻ CD16 ⁺ CD56 ⁺	225.59	6.95	8.45

Table 21 Repeatability and within-site precision of lymphocyte subset absolute counts in low analyte concentration (CDL)

Lymphocyte subset	Mean (cells/ μ L)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	737.07	3.10	4.20
CD3 ⁺ CD4 ⁺	173.18	5.97	6.57
CD3 ⁺ CD8 ⁺	510.44	4.40	5.28
CD19 ⁺	210.89	5.69	6.37
CD3 ⁻ CD16 ⁺ CD56 ⁺	195.06	5.40	6.21

Precision (repeatability), peripheral blood (standalone BD FACSLytic™ flow cytometer)

A single-site precision study was performed to evaluate system repeatability and within-site precision using 44 donor samples. Each donor sample was stained in duplicate using the BD Multitest™ IMK (CD3/CD8/CD45/ CD4 and CD3/CD16+CD56/CD45/CD19) reagents in BD Trucount™ Tubes and run on 12 instruments for a total of 24 runs per sample for each reagent.

Table 22 Repeatability and within-site precision of lymphocyte subset percentages

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
CD3 ⁺	73.59	0.69	0.69
CD3 ⁺ CD4 ⁺	33.46	0.83	0.83
CD3 ⁺ CD8 ⁺	37.93	0.93	0.93
CD19 ⁺	13.02	0.67	0.67
CD3 ⁻ CD16 ⁺ CD56 ⁺	12.37	0.71	0.71

Table 23 Repeatability and within-site precision of lymphocyte subset absolute counts

Lymphocyte subset	Mean (cells/ μ L)	Repeatability (%CV)	Within-site precision (%CV)
CD3 ⁺	1,398.45	3.21	3.35
CD3 ⁺ CD4 ⁺	633.59	5.32	5.40
CD3 ⁺ CD8 ⁺	726.59	5.42	5.53
CD19 ⁺	229.21	7.32	7.47
CD3 ⁻ CD16 ⁺ CD56 ⁺	215.01	7.84	7.94

Precision (repeatability), peripheral blood (BD FACSLytic™ with BD FACSDuet™ system)

A single-site precision study was performed to evaluate system repeatability and within-site precision using 27 donor specimens. Each donor specimen was stained in duplicate using three lots of the BD Multitest™ IMK (CD3/CD8/CD45/CD4 and CD3/CD16+CD56/CD45/CD19) reagents in BD Trucount™ Tubes and run on

three BD FACSDuet™ instruments, each integrated with a BD FACSLytic™ flow cytometer, for a total of 18 runs per sample.

Table 24 Repeatability and within-site precision of lymphocyte subset percentages

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	76.67	0.74	0.75
CD3 ⁺ CD4 ⁺	31.18	0.89	0.89
CD3 ⁺ CD8 ⁺	44.04	1.01	1.05
CD19 ⁺	11.97	0.67	0.67
CD3 ⁻ CD16 ⁺ CD56 ⁺	10.66	0.81	0.83

Table 25 Repeatability and within-site precision of lymphocyte subset absolute counts

Lymphocyte subset	Mean (cells/μL)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	1,575.57	3.45	3.85
CD3 ⁺ CD4 ⁺	636.55	5.12	5.38
CD3 ⁺ CD8 ⁺	905.37	5.17	5.65
CD19 ⁺	246.37	7.55	7.80
CD3 ⁻ CD16 ⁺ CD56 ⁺	217.20	10.46	11.02

Precision (reproducibility), control material (standalone BD FACSLytic™ flow cytometer)

A study was performed at four sites to assess reproducibility of the BD Multitest™ IMK Kit reagents. A single lot of each control material, CD-Chex Plus® control (CDN) and CD-Chex Plus® CD4 Low control (CDL), was provided to each of the sites. For each type of control material, three replicates were stained using each of the BD Multitest™ IMK Kit reagents. Two separate runs were analyzed during each of 5 nonconsecutive tested days.

The following tables present the standard deviation (SD) or coefficient of variation (%CV) for reproducibility of lymphocyte subset percentages and absolute counts, respectively.

Table 26 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset percentages in normal analyte concentration (CDN)

Lymphocyte subset	Mean (%)	SD
Average CD3 ⁺	76.74	0.77
CD3 ⁺ CD4 ⁺	51.67	1.58
CD3 ⁺ CD8 ⁺	23.23	0.85
CD19 ⁺	12.02	0.66
CD3 ⁻ CD16 ⁺ CD56 ⁺	10.30	0.62

Table 27 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset percentages in low analyte concentration (CDL)

Lymphocyte subset	Mean (%)	SD
Average CD3 ⁺	57.12	1.00
CD3 ⁺ CD4 ⁺	12.12	0.61
CD3 ⁺ CD8 ⁺	40.74	1.12
CD19 ⁺	21.74	0.83
CD3 ⁻ CD16 ⁺ CD56 ⁺	19.44	1.06

Table 28 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset absolute counts in normal analyte concentration (CDN)

Lymphocyte subset	Mean (cells/μL)	%CV
Average CD3 ⁺	1,747.70	3.98
CD3 ⁺ CD4 ⁺	1,177.59	5.17
CD3 ⁺ CD8 ⁺	529.63	6.05
CD19 ⁺	273.58	7.23
CD3 ⁻ CD16 ⁺ CD56 ⁺	234.28	7.50

Table 29 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset absolute counts in low analyte concentration (CDL)

Lymphocyte subset	Mean (cells/μL)	%CV
Average CD3 ⁺	883.06	4.18
CD3 ⁺ CD4 ⁺	187.01	7.30
CD3 ⁺ CD8 ⁺	628.51	5.23
CD19 ⁺	336.79	5.71
CD3 ⁻ CD16 ⁺ CD56 ⁺	301.25	7.40

Precision (reproducibility), control material (BD FACSLytic™ flow cytometer with BD FACSDuet™ system)

A study was performed at three clinical sites to assess reproducibility of BD Multitest™ IMK Kit. A single lot of each process control, CD-Chex Plus control (CDN) and CD-Chex Plus CD4 Low control (CDL), was provided to each site. The control samples were stained using three lots of the BD Multitest™ IMK (CD3/CD8/CD45/CD4 and CD3/CD16+CD56/CD45/CD19) reagents with one lot of BD Trucount™ Tubes using the BD FACSDuet™ sample preparation system and automatically transferred to an integrated

BD FACSLytic™ flow cytometer and acquired using the BD FACS™ Universal Loader. Two separate runs were performed each day. Results obtained over 15 non-consecutive test days were analyzed.

The following tables present standard deviations (SDs) and coefficients of variation (%CVs) for reproducibility (total precision) of lymphocyte subset percentages and absolute counts, respectively.

Table 30 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset percentages in normal analyte concentration (CDN)

Lymphocyte subset	Mean (%)	SD
Average CD3 ⁺	75.97	0.60
CD3 ⁺ CD4 ⁺	49.83	0.91
CD3 ⁺ CD8 ⁺	24.60	0.73
CD19 ⁺	12.19	0.57
CD3 ⁻ CD16 ⁺ CD56 ⁺	11.17	0.58

Table 31 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset percentages in low analyte concentration (CDL)

Lymphocyte subset	Mean (%)	SD
Average CD3 ⁺	57.11	0.77
CD3 ⁺ CD4 ⁺	9.97	0.61
CD3 ⁺ CD8 ⁺	42.94	1.05
CD19 ⁺	21.46	0.84
CD3 ⁻ CD16 ⁺ CD56 ⁺	20.16	0.85

Table 32 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset absolute counts in normal analyte concentration (CDN)

Lymphocyte subset	Mean (cells/μL)	%CV
Average CD3 ⁺	1,980.54	5.64
CD3 ⁺ CD4 ⁺	1,303.23	6.62
CD3 ⁺ CD8 ⁺	643.31	7.28
CD19 ⁺	317.00	8.36
CD3 ⁻ CD16 ⁺ CD56 ⁺	290.39	8.15

Table 33 Reproducibility of BD Multitest™ IMK Kit reagents for lymphocyte subset absolute counts in low analyte concentration (CDL)

Lymphocyte subset	Mean (cells/μL)	%CV
Average CD3 ⁺	958.18	5.68
CD3 ⁺ CD4 ⁺	167.16	8.47
CD3 ⁺ CD8 ⁺	719.77	6.68
CD19 ⁺	360.46	7.21
CD3 ⁻ CD16 ⁺ CD56 ⁺	338.44	7.53

Linearity (BD FACSLyric™ flow cytometer with and without BD FACSDuet™ system)

Linearity of the BD Multitest™ IMK Kit was assessed for the BD FACSLyric™ flow cytometer, with and without an integrated BD FACSDuet™ system, using triplicate measurements of 11 equally spaced concentrations of WBCs. Lymphocyte subsets were observed to be linear across the following ranges. See the following table.

Table 34 Linear ranges of lymphocyte subsets (BD FACSLyric™ flow cytometer with and without BD FACSDuet™)

Lymphocyte subset	Range (cells/μL)	
	Standalone BD FACSLyric™	BD FACSLyric™ with BD FACSDuet™
CD3 ⁺	5–5,181	4–5,310
CD3 ⁺ CD4 ⁺	1–3,184	3–3,016
CD3 ⁺ CD8 ⁺	7–3,480	2–3,130
CD19 ⁺	0–2,601	0–2,237
CD3 ⁻ CD16 ⁺ CD56 ⁺	2–1,396	1–1,419

Measuring Range (BD FACSLyric™ flow cytometer with and without BD FACSDuet™ system)

The analytical measurement range (AMR) for BD Multitest™IMK Kit on the BD FACSLyric™ flow cytometer was determined. To establish the measuring range of the BD Multitest™IMK Kit, data was taken from the following:

- The LOQ studies using the BD FACSLyric™ flow cytometer with and without the BD FACSDuet™ system.
- The method comparison study between the BD FACSLyric™ and the BD FACSCanto™ II flow cytometers.
- The method comparison study between the standalone BD FACSLyric™ flow cytometer and the BD FACSLyric™ with BD FACSDuet™ system.

The lower end of the AMR was determined based on results from the limit of quantitation (LoQ) studies and the upper end of the AMR was determined based on results from the method comparison studies.

Table 35 AMR of lymphocyte subsets (BD FACSLytic™ flow cytometer with and without BD FACSDuet™ system)

Lymphocyte subset	Analytical measuring range (cells/μL)
Average CD3 ⁺	18–5,000
CD3 ⁺ CD4 ⁺	11–3,000
CD3 ⁺ CD8 ⁺	11–3,000
CD19 ⁺	15–2,000
CD3 ⁺ CD16 ⁺ CD56 ⁺	13–1,200

BD FACSCanto™ II Flow Cytometer

Method comparison, BD FACSCanto™ II vs BD FACSCanto™ flow cytometer

Lymphocyte subset percentage and absolute counts were enumerated with the BD Multitest™ IMK (CD3/CD8/CD45/CD4 and CD3/CD16+CD56/CD45/CD19) reagents in BD Trucount™ Tubes and analyzed on the BD FACSCanto™ II flow cytometer using BD FACSCanto™ Clinical Software version 2.1. The results were compared with results from the same samples analyzed on the BD FACSCanto™ flow cytometer using BD FACSCanto™ Clinical Software version 2.0. Peripheral blood samples were collected at random at one clinical laboratory. Regression statistics are reported in the following table.

Table 36 Regression analysis for subset absolute counts and percentages (BD FACSCanto™ II flow cytometer)

Lymphocyte subset	N	Units	R ²	Slope	Intercept	Range
Average CD3 ⁺	104	%	0.984	0.97	2.72	51–92
		cells/μL	0.991	0.97	27.59	221–3,872
CD3 ⁺ CD4 ⁺	104	%	0.994	1.01	0.20	1–57
		cells/μL	0.986	0.95	18.25	11–1,905
CD3 ⁺ CD8 ⁺	104	%	0.993	1.00	0.34	11–81
		cells/μL	0.988	0.95	28.36	68–3,577
CD19 ⁺	104	%	0.986	0.97	0.32	0–39
		cells/μL	0.979	0.97	2.37	0–834
CD3 ⁺ CD16 ⁺ CD56 ⁺	104	%	0.957	0.93	0.19	1–32
		cells/μL	0.961	0.88	10.56	20–606

Precision (repeatability), control material (BD FACSCanto™ II flow cytometer)

A 21-day single-site study was conducted to assess repeatability precision. Estimates of precision for the enumeration of lymphocyte subset percentages and absolute counts were determined across three instruments and at least three operators by acquiring two concentrations of analyte, CD-Chex Plus control

(CDN) and CD-Chex Plus CD4 Low (CDL) control, stained in duplicate using one lot of BD Multitest™ IMK Kit. Two separate runs were analyzed during each of the 21 tested days for a total of 42 runs.

The following tables present SDs and CVs for within-device precision and repeatability of lymphocyte subset percentages and absolute counts, respectively.

Table 37 Repeatability and within-site precision of lymphocyte subset percentages in normal analyte concentration (CDN)

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	73.0	0.63	0.67
CD3 ⁺ CD4 ⁺	46.8	0.81	0.82
CD3 ⁺ CD8 ⁺	25.4	0.78	0.80
CD19 ⁺	15.4	0.54	0.56
CD3 ⁻ CD16 ⁺ CD56 ⁺	10.6	0.51	0.52

Table 38 Repeatability and within-site precision of lymphocyte subset percentages in low analyte concentration (CDL)

Lymphocyte subset	Mean (%)	Repeatability (SD)	Within-site precision (SD)
Average CD3 ⁺	54.1	0.96	0.98
CD3 ⁺ CD4 ⁺	10.3	0.53	0.53
CD3 ⁺ CD8 ⁺	43.2	1.33	1.34
CD19 ⁺	26.1	0.86	0.86
CD3 ⁻ CD16 ⁺ CD56 ⁺	18.2	0.87	0.87

Table 39 Repeatability and within-site precision of lymphocyte subset absolute counts in normal analyte concentration (CDN)

Lymphocyte subset	Mean (cells/μL)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	2,105.4	2.7	2.9
CD3 ⁺ CD4 ⁺	1,347.1	3.6	3.8
CD3 ⁺ CD8 ⁺	731.4	4.7	4.7
CD19 ⁺	443.5	5.5	5.6
CD3 ⁻ CD16 ⁺ CD56 ⁺	306.3	6.0	6.0

Table 40 Repeatability and within-site precision of lymphocyte subset absolute counts in low analyte concentration (CDL)

Lymphocyte subset	Mean (cells/ μ L)	Repeatability (%CV)	Within-site precision (%CV)
Average CD3 ⁺	1,086.0	3.5	3.6
CD3 ⁺ CD4 ⁺	205.6	5.9	5.9
CD3 ⁺ CD8 ⁺	866.0	3.8	3.9
CD19 ⁺	526.1	6.2	6.4
CD3 ⁻ CD16 ⁺ CD56 ⁺	367.1	5.9	6.1

Linearity (BD FACSCanto™ II flow cytometer)

Linearity of the BD Multitest™ IMK Kit was assessed for the BD FACSCanto™ II system within a WBC range of 0 to 3.8×10^4 cells/ μ L. Results were observed to be linear across the following ranges.

Table 41 Linear ranges of lymphocyte subsets

Lymphocyte subset	Range (cells/ μ L)
Average CD3 ⁺	4–5,998
CD3 ⁺ CD4 ⁺	1–3,669
CD3 ⁺ CD8 ⁺	2–2,324
CD19 ⁺	0–857
CD3 ⁻ CD16 ⁺ CD56 ⁺	0–447

11. TROUBLESHOOTING

Problem	Possible Cause	Solution
Poor resolution between debris and lymphocytes.	Cell interaction with other cells and platelets.	Prepare and stain another sample.
	Rough handling during cell preparation.	Check cell viability. Centrifuge cells at lower speed.
	Inappropriate instrument settings.	Follow proper instrument setup procedures. Optimize instrument settings as required.

Problem	Possible Cause	Solution
Staining dim or fading.	Cell concentration too high at staining step.	Check and adjust cell concentration or sample volume. Stain with fresh sample.
	Insufficient reagent.	Repeat staining with increased amount of antibody.
	Cells not analyzed within 24 hours of staining.	Repeat staining with fresh sample. Analyze promptly.
Few or no cells.	Cell concentration too low.	Resuspend fresh sample at a higher concentration. Repeat staining and analysis.
	Cytometer malfunctioning.	Troubleshoot instrument.

REFERENCES

1. Cossarizza A, De Biasi S, Gibellini L, et al. Cytometry, immunology, and HIV infection: three decades of strong interactions. *Cytometry. Part A: the Journal of the International Society for Analytical Cytology*. 2013;83(8):680-691.
2. Hanson IC, Shearer WT. Ruling out HIV infection when testing for severe combined immunodeficiency and other T-cell deficiencies. *J Allergy Clin Immunol*. 2012;129(3):875-876.e875.
3. Oliveira JB, Fleischer TA. Molecular- and flow cytometry-based diagnosis of primary immunodeficiency disorders. *Current Allergy and Asthma Reports*. 2010;10(6):460-467.
4. Rich RR, Chaplin DD. The Human Immune Response. In: Rich RR, Fleischer TA, Shearer WT, Schroeder HW, Frew AJ, Weyand CM, eds. *Clinical Immunology (Fifth Edition)*. London: Content Repository Only; 2019:3-17.e11.
5. Haynes BF. Summary of T-cell studies performed during the Second International Workshop and Conference on Human Leukocyte Differentiation Antigens. In: Reinherz EL, Haynes BF, Nadler LM, Bernstein ID, eds. *Leukocyte Typing II: Human T Lymphocytes*. Vol 1. New York, NY: Springer-Verlag; 1986:3-30.
6. Knowles RW. Immunochemical analysis of the T-cell-specific antigens. In: Reinherz EL, Haynes BF, Nadler LM, Bernstein ID, eds. *Leukocyte Typing II: Human T Lymphocytes*. Vol 1. New York, NY: Springer-Verlag; 1986:259-288.
7. Bernard A, Bousmell L, Hill C. Joint report of the First International Workshop on Human Leucocyte Differentiation Antigens by the investigators of the participating laboratories: T2 protocol. In: Bernard A, Bousmell L, Dausset J, Milstein C, Schlossman SF, eds. *Leucocyte Typing*. New York, NY: Springer-Verlag; 1984:25-60.
8. Evans RL, Wall DW, Platsoucas CD, et al. Thymus-dependent membrane antigens in man: inhibition of cell-mediated lympholysis by monoclonal antibodies to T_{H2} antigen. *Proc Natl Acad Sci USA*. 1981;78:544-548.
9. Cobbold SP, Hale G, Waldmann H. Non-lineage, LFA-1 family, and leucocyte common antigens: new and previously defined clusters. In: McMichael AJ, Beverley PC, Cobbold S, et al, eds. *Leucocyte Typing III: White Cell Differentiation Antigens*. New York, NY: Oxford University Press; 1987:788-803.
10. Wood GS, Warner NL, Warnke RA. Anti-Leu-3/T4 antibodies react with cells of monocyte/macrophage and Langerhans lineage. *J Immunol*. 1983;131:212-216.
11. Schmidt RE. Non-lineage/natural killer section report: new and previously defined clusters. In: Knapp W, Dörken B, Gilks WR, et al, eds. *Leucocyte Typing IV: White Cell Differentiation Antigens*. New York, NY: Oxford University Press; 1989:517-542.

12. Ritz J, Trinchieri G, Lanier LL. NK-cell antigens: section report. In: Schlossman SF, Boumsell L, Gilks W, et al, eds. *Leucocyte Typing V: White Cell Differentiation Antigens*. Vol 2. New York, NY: Oxford University Press; 1995:1367-1372.
13. Nadler LM. B Cell/Leukemia Panel Workshop: Summary and Comments. In: Reinherz EL, Haynes BF, Nadler LM, Bernstein ID, eds. *Leukocyte Typing II: Human B Lymphocytes*. Vol 2. New York, NY: Springer-Verlag; 1986:3-43.
14. van Dongen JJM, Krissansen GW, Wolvers-Tettero ILM, et al. Cytoplasmic expression of the CD3 antigen as a diagnostic marker for immature T-cell malignancies. *Blood*. 1988;71:603-612.
15. Clevers H, Alarcón B, Wileman T, Terhorst C. The T cell receptor/CD3 complex: a dynamic protein ensemble. *Annu Rev Immunol*. 1988;6:629-662.
16. Reichert T, DeBruyère M, Deney V, et al. Lymphocyte subset reference ranges in adult Caucasians. *Clin Immunol Immunopath*. 1991;60:190-208.
17. Perussia B, Starr S, Abraham S, Fanning V, Trinchieri G. Human natural killer cells analyzed by B73.1, a monoclonal antibody blocking Fc receptor functions. I. Characterization of the lymphocyte subset reactive with B73.1. *J Immunol*. 1983;130:2133-2141.
18. Perussia B, Acuto O, Terhorst C, et al. Human natural killer cells analyzed by B73.1, a monoclonal antibody blocking Fc receptor functions. II. Studies of B73.1 antibody-antigen interaction on the lymphocyte membrane. *J Immunol*. 1983;130:2142-2148.
19. Perussia B, Trinchieri G, Jackson A, et al. The Fc receptor for IgG on human natural killer cells: phenotypic, functional, and comparative studies with monoclonal antibodies. *J Immunol*. 1984;133:180-189.
20. Lanier LL, Le AM, Civin CI, Loken MR, Phillips JH. The relationship of CD16 (Leu-11) and Leu-19 (NKH-1) antigen expression on human peripheral blood NK cells and cytotoxic T lymphocytes. *J Immunol*. 1986;136:4480-4486.
21. Lanier LL, Chang C, Azuma M, Ruitenberg JJ, Hemperly JJ, Phillips JH. Molecular and functional analysis of human natural killer cell-associated neural cell adhesion molecule (N-CAM/CD56). *J Immunol*. 1991;146:4421-4426.
22. Schubert J, Lanier LL, Schmidt RE. Cluster report: CD56. In: Knapp W, Dörken B, Gilks WR, et al, eds. *Leucocyte Typing IV: White Cell Differentiation Antigens*. New York, NY: Oxford University Press; 1989:699-702.
23. Cunningham BA, Hemperly JJ, Murray BA, Prediger EA, Brackenbury R, Edelman GM. Neural cell adhesion molecule: structure, immunoglobulin-like domains, cell surface modulation, and alternative RNA splicing. *Science*. 1987;236:799-806.
24. Schwinzer R. Cluster report: CD45/CD45R. In: Knapp W, Dörken B, Gilks WR, et al, eds. *Leucocyte Typing IV: White Cell Differentiation Antigens*. New York, NY: Oxford University Press; 1989:628-634.
25. Jackson A. Basic phenotyping of lymphocytes: selection and testing of reagents and interpretation of data. *Clin Immunol Newslett*. 1990;10:43-55.
26. Dalgleish AG, Beverley PCL, Clapham PR, Crawford DH, Greaves MF, Weiss RA. The CD4 (T4) antigen is an essential component of the receptor for the AIDS retrovirus. *Nature*. 1984;312:763-767.
27. Maddon PJ, Dalgleish AG, McDougal JS, Clapham PR, Weiss RA, Axel R. The T4 gene encodes the AIDS virus receptor and is expressed in the immune system and the brain. *Cell*. 1986;47:333-348.
28. Moldenhauer G, Dörken B, Schwartz R, Pezzutto A, Knops J, Hammerling GJ. Analysis of ten B lymphocyte-specific workshop monoclonal antibodies. In: Reinherz EL, Haynes BF, Nadler LM, Bernstein ID, eds. *Leukocyte Typing II: Human B Lymphocytes*. New York, NY: Springer-Verlag; 1986:2:61-67.
29. Dörken B, Möller P, Pezzutto A, Schwartz-Albiez R, Moldenhauer G. B-cell antigens: CD19. In: Knapp W, Dörken B, Gilks WR, et al, eds. *Leucocyte Typing IV: White Cell Differentiation Antigens*. New York, NY: Oxford University Press; 1989:34-36.
30. Loken MR, Shah VO, Dattilio KL, Civin CI. Flow cytometric analysis of human bone marrow. II. Normal B-lymphocyte development. *Blood*. 1987;70:1316-1324.
31. Gallagher PF, Fazekas de St. Groth B, Miller JFAP. CD4 and CD8 molecules can physically associate with the same T-cell receptor. *Proc Natl Acad Sci, USA*. 1989;86:10044-10048.

-
32. Anderson P, Blue M-L, Morimoto C, Schlossman SF. Cross-linking of T3 (CD3) with T4 (CD4) enhances the proliferation of resting T lymphocytes. *J Immunol.* 1987;139:678-682.
 33. Eichmann K, Jönsson J-I, Falk I, Emmrich F. Effective activation of resting mouse T lymphocytes by cross-linking submitogenic concentrations of the T cell antigen receptor with either Lyt-2 or L3T4. *Eur J Immunol.* 1987;17:643-650.
 34. Lanier LL, Le AM, Phillips JH, Warner NL, Babcock GF. Subpopulations of human natural killer cells defined by expression of the Leu-7 (HNK-1) and Leu-11 (NK-15) antigens. *J Immunol.* 1983;131:1789-1796.
 35. *Collection of Diagnostic Venous Blood Specimens, 7th ed.* Wayne, PA: Clinical and Laboratory Standards Institute; 2017. CLSI document GP41.
 36. *Protection of Laboratory Workers from Occupationally Acquired Infections; Approved Guideline—Fourth Edition.* Wayne, PA: Clinical and Laboratory Standards Institute; 2014. CLSI document M29-A4.
 37. Centers for Disease Control and Prevention. 2007 Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings. <https://www.cdc.gov/infectioncontrol/guidelines/isolation/index.html>. Accessed March 12, 2019.
 38. Nicholson JK, Browning SW, Orloff SL, McDougal JS. Inactivation of HIV-infected H9 cells in whole blood preparations by lysing/fixing reagents used in flow cytometry. *J Immunol Methods.* 1993;160:215-218.
 39. Giorgi JV. Lymphocyte subset measurements: significance in clinical medicine. In: Rose NR, Friedman H, Fahey JL, eds. *Manual of Clinical Laboratory Immunology.* 3rd ed. Washington, DC: American Society for Microbiology; 1986:236-246.
 40. Neves I Jr, Morgado MG. Immunological evaluation of human immunodeficiency virus infected individuals by flow cytometry. *Mem Inst Oswaldo Cruz Rio de Janeiro.* 2000;95(3):393-400.
 41. Giacoia-Gripp CBW, Sales AM, Nery JA, et al. Evaluation of cellular phenotypes implicated in immunopathogenesis and monitoring immune reconstitution inflammatory syndrome in HIV/leprosy cases. *PLoS One.* 2011;6(12):e28735.
 42. Ostrov BE, Amsterdam D. The interference of monoclonal antibodies with laboratory diagnosis: clinical and diagnostic implications. *Immunol Invest.* 2013;42(8):673-690.
 43. Book BK, Agarwal A, Milgrom et al. New crossmatch technique eliminates interference by humanized and chimeric monoclonal antibodies. *Transplant Proc.* 2005;37(2):640-642.
 44. Kaufman A, Herold KC. Anti-CD3 mAbs for treatment of type 1 diabetes. *Diabetes Metab Res Rev.* 2009;25(4):302-306.
 45. Frankel AE, Zuckero SL, Mankin AA, et al. Anti-CD3 recombinant diphtheria immunotoxin therapy of cutaneous T cell lymphoma. *Curr Drug Targets.* 2009; 10(2):104-109.
 46. Kochenderfer JN, Dudley ME, Feldman SA, Rosenberg SA. B-cell depletion and remissions of malignancy along with cytokine-associated toxicity in a clinical trial of anti-CD19 chimeric antigen-receptor-transduced T cells. *Blood.* 2012;119(12):2709-2720.
 47. Mendez LM, Cascino MD, Garg J, Brunetta P. Peripheral blood B cell depletion after Rituximab and complete response in lupus nephritis. *Clin J Amer Soc Neph.* 2018;13(10):1502-1509.
 48. Centers for Disease Control. Guidelines for Performing Single-Platform Absolute CD4+ T-Cell Determinations with CD45 Gating for Persons Infected with Human Immunodeficiency Virus. *MMWR.* 2003;52:3.
 49. Craig FE, Foon MA. Flow cytometric immunophenotyping for hematologic neoplasms. *Blood.* 2008;111:3941-3967.
 50. Kroll MH. Evaluating interference caused by lipemia. *Clin Chemistry.* 2004;50.
 51. Nikolac N. Lipemia: causes, interference mechanisms, detection and management. *Biochem Med (Zagreb).* 2014;24(1):57-67.
 52. Dimeski G. Interference testing. *Clin Biochem Rev.* 2008;29:S43-48.
 53. *Interference Testing in Clinical Chemistry; Approved Guideline—Third Edition.* Wayne, PA: Clinical and Laboratory Standards Institute; 2018. CLSI document EP07-A3.
 54. Selby C. Interference in immunoassay. *Ann Clin Biochem.* 1999;36 (Pt 6):704-721.
doi:10.1177/000456329903600603

-
55. Htun NM, Chen YC, Lim B, et al. Near-infrared autofluorescence induced by intraplaque hemorrhage and heme degradation as marker for high-risk atherosclerotic plaques. *Nat Commun*. 2017;8(1):75. Published 2017 Jul 13. doi:10.1038/s41467-017-00138-x
 56. Mandy FF, Nicholson JK, McDougal JS; CDC. Guidelines for performing single-platform absolute CD4+ T-cell determinations with CD45 gating for persons infected with human immunodeficiency virus. Centers for Disease Control and Prevention. *MMWR Recomm Rep*. 2003;52(RR-2):1-13.
 57. Kroll MH. Evaluating interference caused by lipemia. *Clin Chemistry*. 2004;50.
 58. Nikolac N. Lipemia: causes, interference mechanisms, detection and management. *Biochem Med (Zagreb)*. 2014;24(1):57-67.
 59. *Enumeration of Immunologically Defined Cell Populations by Flow Cytometry—Second Edition*. Wayne, PA: Clinical and Laboratory Standards Institute; 2007. CLSI document H42-A2.
 60. Jackson AL, Warner NL. Preparation, staining, and analysis by flow cytometry of peripheral blood leukocytes. In: Rose NR, Friedman H, Fahey JL, eds. *Manual of Clinical Laboratory Immunology*. 3rd ed. Washington, DC: American Society for Microbiology; 1986:226-235.
 61. *Defining, Establishing, and Verifying Reference Intervals in the Clinical Laboratory; Approved Guideline—Third Edition*. Wayne, PA: Clinical and Laboratory Standards Institute; 2010. CLSI document EP28-A3c.
 62. *Measurement Procedure Comparison and Bias Estimation Using Patient Samples; Approved Guideline—Third Edition*. Wayne, PA: Clinical and Laboratory Standards Institute; 2013. CLSI document EP09-A3.
 63. *Evaluation of Precision of Quantitative Measurements Procedures; Approved Guideline—Third Edition*. Wayne, PA: Clinical and Laboratory Standards Institute; 2014. CLSI document EP05-A3.

NOTICE

EU Only: Users shall report any serious incident related to the device to the Manufacturer and National Competent Authority.

Outside EU: Contact your local BD representative for any incident or inquiry related to this device.

Refer to the Eudamed website: <https://ec.europa.eu/tools/eudamed> for Summary of Safety and Performance.

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Unless otherwise indicated in any applicable BD general conditions of sale for non-US customers, the following warranty applies to the purchase of these products.

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PATENTS AND TRADEMARKS

For US patents that may apply, see bd.com/patents.

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HISTORY

Revision	Date	Changes made
23-3602(17)	2022-12	Updated to meet requirements of Regulation (EU) 2017/746.
23-3602(18)	2023-07	Updated legal manufacturer address. Added EU and Swiss importer addresses and importer symbol. Updated hazard and precautionary statements. Updated symbols glossary.

Symbols Glossary

Please refer to product labeling for applicable symbols.

Symbol	Meaning
	Manufacturer
	Authorized representative in the European Community
	Authorised representative in Switzerland
	Date of manufacture
	Use-by date
	Batch code
	Catalogue number
	Serial number
	Sterile
	Sterilized using aseptic processing techniques
	Sterilized using ethylene oxide
	Sterilized using irradiation
	Sterilized using steam or dry heat
	Do not resterilize
	Non-sterile
	Do not use if package is damaged and consult <i>instructions for use</i>
	Sterile fluid path
	Sterile fluid path (ethylene oxide)
	Sterile fluid path (irradiation)
	Fragile, handle with care
	Keep away from sunlight
	Keep dry
	Lower limit of temperature
	Upper limit of temperature
	Temperature limit
	Humidity limitation
	Biological risks
	Do not re-use
	Consult <i>instructions for use</i> or consult <i>electronic instructions for use</i>
	Caution
	Contains or presence of natural rubber latex
	In vitro diagnostic medical device
	Negative control
	Positive control
	Contains sufficient for <n> tests
	For IVD performance evaluation only
	Non-pyrogenic
	Patient number
	This way up
	Do not stack

Symbol	Meaning
	Single sterile barrier system
	Contains or presence of phthalate: combination of bis(2-ethylhexyl) phthalate (DEHP) and benzyl butyl phthalate (BBP)
	Collect separately Indicates separate collection for waste of electrical and electronic equipment required.
	CE marking; Signifies European technical conformity
	Device for near-patient testing
	Device for self-testing
	This only applies to US: "Caution: Federal Law restricts this device to sale by or on the order of a licensed practitioner."
	Country of manufacture "CC" shall be replaced by either the two letter or the three letter country code.
	Collection time
	Cut
	Peel here
	Collection date
	Keep away from light
	Hydrogen gas is generated
	Perforation
	Start panel sequence number
	End panel sequence number
	Internal sequence number
	<Box #> / <Total Boxes>
	Medical device
	Contains hazardous substances
	Ukrainian conformity mark
	Meets FCC requirements per 21 CFR Part 15
	UL product certification for US and Canada
	Unique device identifier
	Importer
	Place patient label in framed area only
	Magnetic resonance (MR) safe
	Magnetic resonance (MR) conditional
	Magnetic resonance (MR) unsafe
	For use with
	This Product Contains Dry Natural Rubber
	For Export Only
	Instruments

Note: Text layout in symbols is determined by label design.

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