VetScan HM5

Operator's Manual

ABAXIS

VetScan HM5 Hematology System Original User's Manual

For Veterinary Use Only

Customer and Technical Support

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July 2018

PN: 790-7013 Rev. E Text

Union City, CA 94587

IMPORTANT: READ BEFORE USING THE VETSCAN® HM5 HEMATOLOGY ANALYZER FOR THE FIRST TIME

To get started quickly, please see the Quick Reference Guide in the pocket of this Operator's Manual.

Fill in this information for future reference.

Serial number (from the back of the unit): .....

Date of installation: .....

Distributor name and address: .....

.....

.....

Abaxis sales representative name: .....

Phone: .....

Email: .....

July 2018
PN: 790-7013 Rev. E

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Section 1 General Information

This section provides general information about the Abaxis VetScan HM5 Hematology System.

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1.1 Introduction

The VetScan HM5 hematology analyzer is a compact, fully automated cell counter for in-vitro diagnostic use in veterinary clinics, research laboratories, universities, and pharmaceutical/biotech companies.

The VetScan HM5 can process 16–20 samples per hour, and is designed to determine the following 24 hematology parameters from 50 µl (2 x 25 µl) of whole blood:

- WBC, LYM#, MON#, NEU#, EOS#, BAS#
  LYM%, MON%, NEU%, EOS%, BAS%
- HGB, RBC, HCT, MCV, RDWc, MCH, MCHC, RDWs
- PLT, MPV, PCT, PDWc, PDWs

The VetScan HM5 is calibrated to analyze multiple veterinary species. Further species may periodically be added through a free software upgrade.

The VetScan HM5 system features the following components:

- The HM5 hematology analyzer itself, with a touchscreen interface and optimized software
- A reagent pack, including five individually-bottled solutions: Diluent, Lyse, Lyse 2, Cleaner, and Rinse

The HM5 provides multiple user-friendly features:

- Rapid CBC analyses, with full five-part differentials
- A database for up to 5000 records, with USB drive backup capability
- Automated on-screen reminders, and illustrated instructions to simplify routine maintenance tasks
- Quick reagent pack change method

For added convenience, the VetScan HM5 can be connected to a VetScan VS2 Chemistry Analyzer and an external printer, so that results from both instruments can be consolidated and printed on a single, standard-size page.

The VetScan HM5 can also be connected to a compatible Veterinary Practice Management Software system. For a list of these systems, visit http://www.abaxis.com.

1.1.1 Customer and Technical Support

Abaxis Technical Support personnel can answer your questions regarding the VetScan HM5 Hematology Analyzer, or the combined VetScan HM5/VS2 system.

1.1.1.1 For USA:

- **Telephone:** 800-822-2947, 24 hours a day, seven days a week
- **Email:** vetsupport@abaxis.com
- **Web:** www.abaxis.com
- **Fax:** 877-900-9333

1.1.1.2 For Europe:

- **Telephone:** +49 (6151) 350 79 – 0
- **Email:** techsupport@abaxis.de

  Or for the U.K.
- **Telephone:** +44 (1904) 909 500
- **Email:** info@abaxis.co.uk

1.1.1.3 For Other Areas:

- Contact a local Abaxis distributor, or email **vetsupport@abaxis.com**

1.1.2 Safety Information

WARNING: ***THE PERIPHERAL CONNECTORS ON THE ABAXIS VETSCAN HM5 ARE SELV (SAFETY EXTRA LOW VOLTAGE) CONNECTORS. TO AVOID THE RISK OF ELECTRICAL SHOCK, CONNECT THE INSTRUMENT ONLY TO EXTERNAL DEVICES THAT ARE SELV RATED.***

Note: *This equipment has been designed and tested to CISPR 11 Class A. In a domestic environment it may cause radio interference, in which case, you may need to take measures to mitigate the interference.*

Note: ***For Canada:*** *This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard incorporating the same level of testing requirements.*

Note: *Abaxis recommends wearing protective eyewear and a lab coat when working directly with reagents (such as changing the reagent pack). In addition, users with sensitive skin should wear latex or nitrile gloves.*

1.2 HM5 System

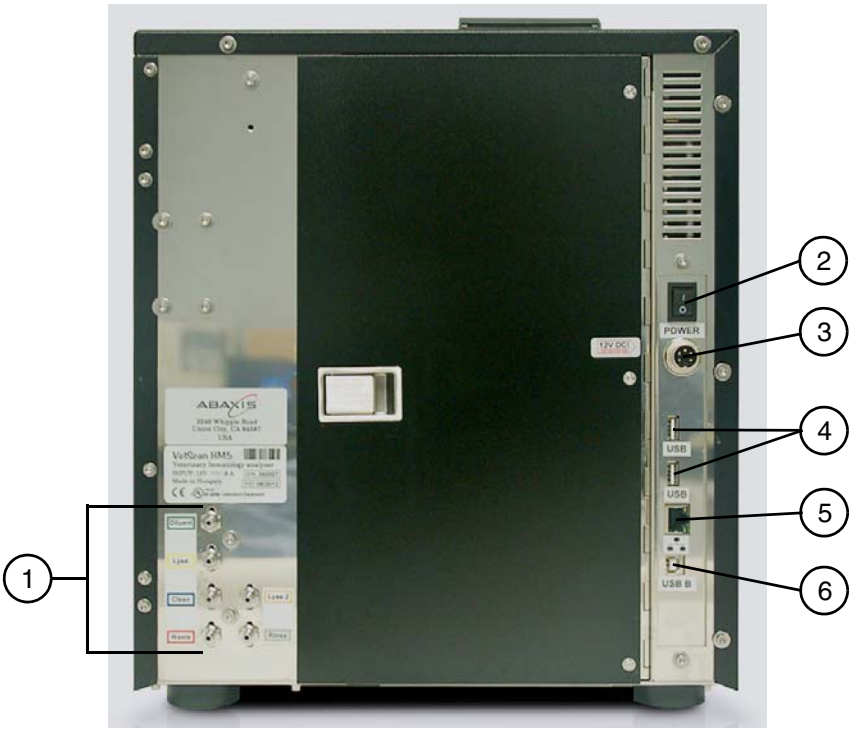
1.2.1 Main Components

1.2.1.1 Front View

1. Built-in thermal printer
2. LCD touchscreen
3. Sampling door and rotor
4. USB Type A ports (2)

1.2.1.2 Back View

1. Reagent ports/inlets
2. Power switch ON/OFF
3. Power supply connection
4. USB Type A ports (2)
5. Ethernet port
6. USB Type B port



1.2.2 Power Supply and Power Cord

The analyzer uses an external 12v DC power supply that can operate from a 220 or 110 volt main outlet. The power supply's input socket is a standard power cable connection, and its output is a special locking socket. The cord used will be designated by the region.

1.2.3 Reagents

The VetScan HM5 reagent pack (PN 770-9000) consists of five bottles containing Diluent, Cleaner, Lyse, Lyse 2, and Rinse solutions.

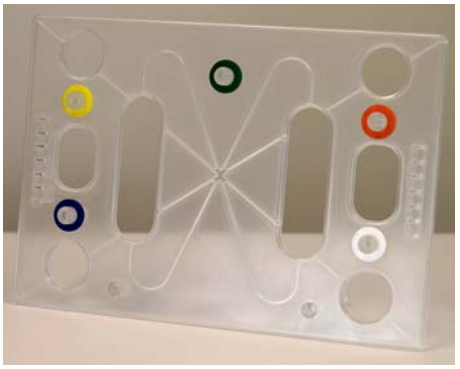
Table 1-1: Reagents and Containers

Reagents	Descriptions	Color	Volume
Diluent	Isotonic saline solution used to dilute whole blood specimens, and to rinse the analyzer's fluidic system between analyses.	Green	9 liters
Rinse	Used for certain species runs and for certain cleanings.	White	500 ml
Cleaner	Used in the fluidic system cleaning process.	Blue	300 ml
Lyse	Used to create hemolysate for three-part WBC differential, and for total WBC and HGB.	Yellow	300 ml
Lyse 2	Used to dilute whole blood and differentially hemolyse white blood cells to separate eosinophil granulocytes from other WBC by volume. Suitable for determining EOS, EOS%, BAS, and BAS% parameters.	Orange	800 ml

1.2.3.1 Reagent Connections

The VetScan HM5 draws in liquid reagents through a reagent tubing kit. This tubing can be configured in two ways, each of which connects to the analyzer's reagent inlets, but uses a different connection at the reagent pack.

- **Quick Change Apparatus (QCA):** The QCA (at right) allows a very rapid change to a new reagent pack, and can be used in setups where the reagent pack can be placed on a counter adjacent to the analyzer. The QCA includes a QCA frame, two kickstands (far right), and color-coded rigid dip tubes (below). In the QCA, the reagent tubing connects to the dip tubes in the reagent bottles.

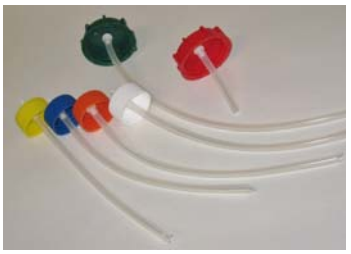


Note: *When using the QCA:*

- *To avoid contaminating the reagents, do not let the dip tubes rest on the counter. Instead, rest the frame on the kickstands.*
- *Do not use part of a QCA that is broken.*
- *Do not place anything on top of the assembled QCA. This helps avoid kinks in the reagent tubing.*

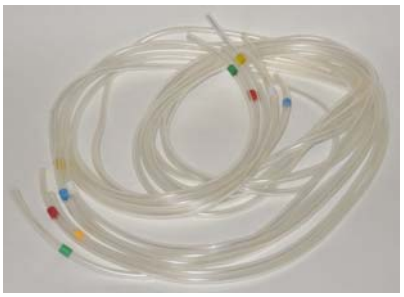
CAUTION: *The tips of the dip tubes may have a sharp edge.*

- **Bottle Caps:** The Bottle Caps setup includes color-coded caps with nozzles and attached flexible drop-down tubes. The bottle caps screw onto the appropriate reagent bottles and are intended for compact locations, such as under-counter installations. In the Bottle Caps setup, the reagent tubing connects to the bottle caps.



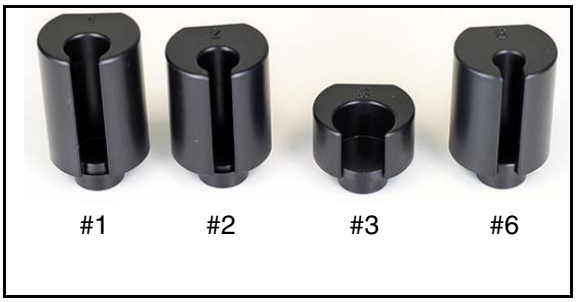
1.2.3.2 Reagent Tubing

The reagent tubing includes six color-coded tubes, all of which match the colors on the reagent and waste bottle caps.



1.2.4 Accessories

- **Keyboard:** A mini USB keyboard enables easier data input. Any USB keyboard can be used with the HM5.
- **Sample Tube Adaptors:**
  - **#1:** for 2-3 ml tubes and the Abaxis Control Tube
  - **#2:** for 1.3 ml tubes
  - **#3:** for 2 ml glass vials
  - **#6:** for microtainer tubes of 0.6 ml or less



- **Peristaltic Pump Tube:** In case this tube is damaged, a spare is provided. See "Peristaltic Pump Tubing Replacement" on page 6-13.

- **Thermal Paper Roll:** Two rolls are included with the analyzer package for use in the built-in printer. Each reagent pack also includes a new roll. Save the paper rolls, as printing to the built-in printer is often very useful for troubleshooting.

1.3 Touchscreen Icons

The following figures show the icons used in the HM5 touchscreen display.

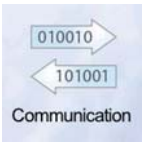
Measure: Analyze samples and run blanks

Database: Search, retrieve, view and manage up to 5,000 records

Maintenance: Clean, Calibrate, run Quality Control and manage Reagent Status

Settings: Manage printer, testing, date/time and other analyzer settings

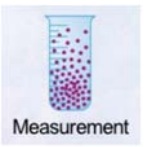
Exit: Select shut-down options and log in to user accounts



Communication: Manage VSx, serial USB communication and Device and Host Network Settings

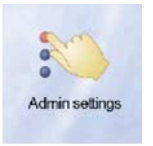
Printer: Manage printer settings and printout options

General Settings: Select analyzer options and language



Measurement Settings: Select units and set normal ranges for species

Date and Time: Change date and time options



Admin Settings: Allows Admin users to edit Reagent Replace settings, Schedule Maintenance and manage user accounts

Section 2

Installing the VetScan HM5

An Abaxis representative will normally install the VetScan HM5 analyzer. If this is not possible, however, follow the procedures in this section.

Section Contents

2.1 Choosing a Location

WARNING: ***MAKE SURE THE ANALYZER AND ALL ACCESSORIES ARE PROPERLY GROUNDED. IMPROPER GROUNDING CAN CAUSE INJURY, AND WILL VOID THE WARRANTY.***

The analyzer must be installed in a suitable location. To ensure accuracy and precision, and to maintain safety, the environmental and electrical requirements in this section must be met. Be sure to thoroughly consider all the following requirements in selecting a permanent location for the analyzer.

Note: *This analyzer is approved for use up to an altitude of 10,000 ft (3000 m).*

2.1.1 Environment Requirements

Choose a clean, dust-free, well-ventilated location, away from direct sunlight, and between 59–86 °F (15–30 °C). The location should also be level, sturdy, and as vibration-free as possible.

The HM5 works best if the analyzer and the reagent pack are on the same level. However, if this is not possible, place the reagent pack *below* the analyzer, so that the top of the reagent pack is *no more* than 18 in (45.7 cm) lower than the bottom of the analyzer.

WARNING: ***DO NOT PLACE THE REAGENT PACK ABOVE THE ANALYZER (SUCH AS ON A SHELF).***

DO NOT DROP THE REAGENT PACK, AS THIS CAN CAUSE MICRO-BUBBLES TO FORM, PREVENTING PROPER OPERATION.

IF THE PACK IS DROPPED, ALLOW IT TO SIT FOR 24 HOURS BEFORE INSTALLING IT ON AN ANALYZER.

Note: *To ensure accurate test results, use only reagents supplied by Abaxis.*

Avoid using equipment that can produce electromagnetic emissions nearby: refrigerators, freezers, centrifuges, fans, hair dryers, etc.

2.1.2 Electrical Requirements

- The VetScan HM5 is powered by a standard wall outlet, and requires a power supply of 100–240 VAC, 50–60 Hz, 1.5 A (this is provided with the analyzer).
- To avoid power surges and electrical noise, DO NOT plug the analyzer's power supply into a circuit that includes a centrifuge or other high-current device.

CAUTION: *Abaxis recommends using the analyzer with surge protection designed for a computer. In addition, a battery backup is strongly recommended if the VetScan HM5 will be used in an area prone to electrical surges or power outages.*

Use of an Abaxis provided power supply is required for system integrity and safety.

2.2 Installation

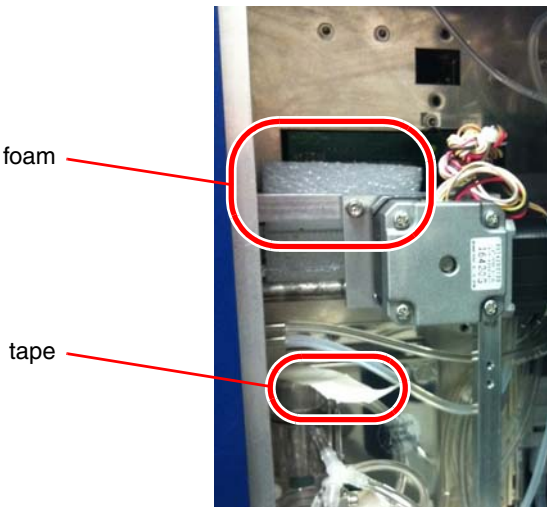
CAUTION: *Make sure the analyzer is powered* **OFF** *before connecting it to the power supply or any electrical device, such as an external printer, external keyboard, or computer.*

1. Open the shipping box, and lift the accessory box up and out of the shipping carton.
2. Remove the stabilizing foam from the top of the HM5.
3. Use both hands to carefully lift the HM5 out of the foam underneath it and out of the box.
4. Place the HM5 temporarily on a clean, stable counter.

CAUTION: ***Place the analyzer in upright position only.*** *Do not place the unit on its back, side, or top, or you could cause severe damage.*

5. Remove the plastic wrap from the HM5.
6. Use the metal latch to open the door on the right side of the HM5.

7. Remove the foam and tape from inside the unit, as shown.



8. Open the Accessory and Initial Goods boxes, and make sure all the following are included:

- HM5 Operator's Manual CD
- Mini-keyboard
- Tubing kit (reagent tubing, bottle caps with drop down tubing)
- Quick Reference Guide
- Four sample tube adapters
- VetScan HemaClean Kit
- 1 liter polypropylene flask
- Power supply and cord
- Thermal paper rolls (2)
- Peristaltic pump tube
- Waste bottle and lid with nozzle

9. Plug the battery backup or surge protector into a standard outlet. Hold the power button down until it beeps.

WARNING: ***USE ONLY THE POWER SUPPLY PROVIDED WITH THE VETSCAN HM5. USING ANY OTHER POWER SUPPLY CAN DAMAGE THE INSTRUMENT AND WILL VOID THE WARRANTY.***

10. Screw the power supply onto the back of the HM5.

11. Plug the power cable into the power supply and the battery side of the battery backup or surge protection device once it has been turned on.

12. Attach the long reagent tubes to the back of the HM5. Match the colors of the reagent tubing with the colors on the rear of the analyzer.

CAUTION: *When working with the reagent tubing, make sure the tubing does not become pinched or kinked and is not trapped between or beneath objects.*

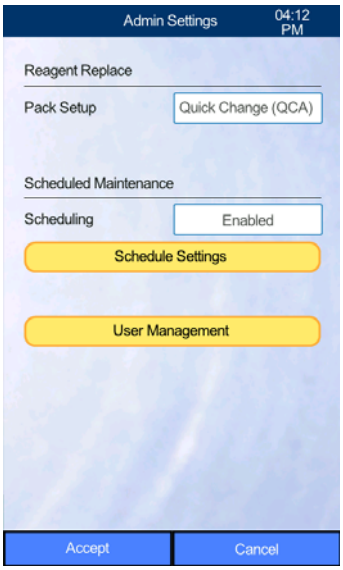
13. Attach the waste tube (red) to the top of the large white waste cap. Leave the other ends of the five reagent tubes free for now.
14. Place the white waste cap on the white waste bottle. This bottle can rest below the analyzer to provide more room on the counter.
15. If needed, attach the mini-keyboard to a USB Type A port on the back of the analyzer.

CAUTION: *If the analyzer has been kept at a temperature below 50 ºF (10 ºC), allow it to sit for* ***at least*** *an hour at the correct operating temperature (59–86 °F, 15–30 °C) before using it.*

16. Turn the analyzer on using the power switch on the back.
17. Allow the analyzer to boot up and initialize.

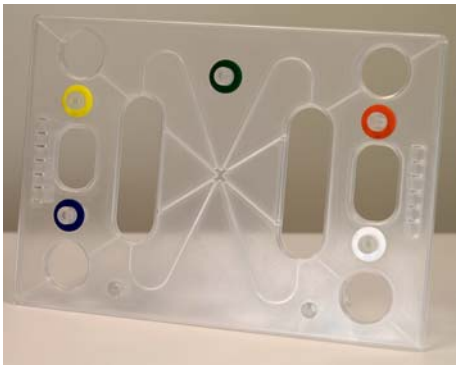
Note: *When the analyzer is turned on, it first performs a startup routine: all moving parts are tested, tubing is primed, sensors are calibrated, and automatic self-cleanings are performed. This process will take about 2 minutes.*

18. On the HM5's Home screen, select **Settings > Admin Settings**.

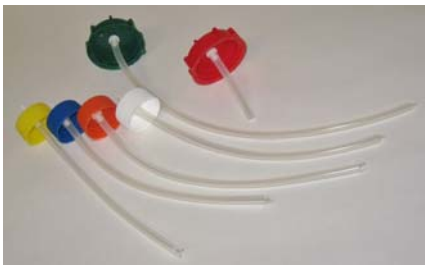


19. Select a **Pack Setup**:

- If the reagent pack will be *on the same level* as the HM5 (preferred) and you have the QCA (Quick Change Apparatus), select **Quick Change (QCA)** in **Reagent Replace.**



- If the reagent pack will be *on a lower level* than the HM5 and/or the Bottle Caps tubing set is being used, select **Bottle Caps**. Make sure the top of the reagent pack is no more than 18 in (45.7 cm) lower than the bottom of the analyzer.



20. Select **Schedule Settings > Reset > Accept** to restart maintenance timers from today.
21. Pour ~200 ml of distilled water into the Abaxis flask.
22. Submerge the free ends of the reagent tubes into the water.
23. Select **Maintenance > Reagent Status**, and then **Prime All**.
24. Run **Prime All** twice more (three times in all) until all water is gone from the flask and air is pumped into the tubing.

25. While the analyzer is priming, open the reagent pack. Remove the bottle caps from each of the five bottles. Save these lids for later disposal of the pack.

26. Make sure the foam liners stay in the bottle caps, and are not left on top of the bottles. See the photo.
27. Select **Exit > Change Reagent Pack**.
28. Follow the procedure below for the tubing set type being used: **QCA** or **Bottle Caps**.

CAUTION: *Use the color codes as guides when connecting tubing, dip tube heads, and reagent bottles. If the tubes are not connected correctly, the instrument will not produce accurate results.*

QCA Setup

a. Remove the QCA frame and both kickstands from the Initial Goods kit and unwrap them.

b. Insert the kickstands into the holes in the bottom of the frame and twist counterclockwise to lock them into place.

c. Place the QCA frame over the reagent pack so that the colors line up (green over green, yellow over yellow, etc.).

Note: *In the following steps, touch only the heads of the long dip tubes, or use clean gloves to prevent contamination of the dip tubes.*

d. Pull one of the five dip tubes (shown at right) out of the accessories kit.

Note: *To prevent contaminating the reagents, do not place the clean dip tubes on the counter.*

e. Insert the dip tube into the matching color-coded ring in the QCA frame.

f. When the dip tube touches the bottle seal, push the tube through the seal until the end of the tube contacts the bottom of the bottle.

Note: *The colored rings may not sit flush with the top of the frame.*

g. Connect the appropriately colored reagent tubes to the matching colored tops of the dip tubes.

h. Select **Next** through the steps of the pack change process until the analyzer primes.

Bottle Cap Setup

CAUTION: *In the following steps, do not touch the drop-down tubing with your bare hands, or you may contaminate the reagents. Wear latex or nitrile gloves.*

a. For each bottle in the reagent pack: cut an "X" in the heat seal and push down the 4 corners to open the bottle.

b. For each drop-down tube, one at a time:

i. Using a soft, lint-free cloth (such as a KimWipe®) moistened with distilled water (not tap water), wipe the drop-down tube to remove any lint or dust from the tube.

ii. Carefully place the drop-down tube into the appropriate color-matching bottle, then tighten the bottle cap.

Note: *Be sure to save the original reagent caps so you can re-cap the containers when the reagent pack is used up.*

CAUTION: *Make sure the small air vent on each cap is not blocked, so air can flow freely.*

c. Thread the long tubes from the back of the HM5 through the punched-out hole in the reagent pack lid.

d. Attach the long reagent tubes to the nozzles on the color-matching bottle caps.

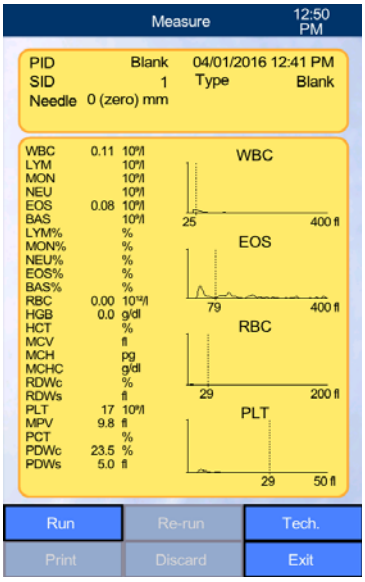
29. Select **Next** through the steps of the pack change process until the analyzer primes.

30. Select **Home** to return to the Home screen.

2.3 Initializing the VetScan HM5

1. Select **Measure > Run**. A Message that the blank has expired will appear.
2. Select **OK** to run a blank.

   The analyzer will run a blank measurement. When the process is complete, the instrument displays the result of the blank measurement. (Blank runs are described in more detail in "Running a Blank Measurement" on page 4-5.)
3. Select **Accept** if there are no flags and no values highlighted in red, indicating that the analyzer blank background level is within specifications.



   The analyzer then displays a sample measurement screen, as shown, and *is now ready to perform an analysis.*

Note: *You will be notified with a pop-up if the blank falls outside specifications. If this occurs, refer to "Blank Flags" on page 9-2. If the problem persists, call Abaxis Technical Support.*

4. Verify the analyzer's system settings, and make any needed changes: see "Settings" on page 3-1.

Section 3

Settings

This section describes how to configure the VetScan HM5's settings for optimal performance and to meet your particular lab requirements.

Section Contents

3.1 Settings Overview

The HM5 analyzer's Settings screen and icons are shown at right, and have these functions.

- **Printer**: sets printer type, paper size and margins, information included on printouts, and color options. See below.
- **General**: controls sounds, language, export format, and delays for screen saver and standby modes. See page 3-3.
- **Measurement**: sets units, normal ranges, and sampling needle depth. See page 3-4.
- **Date and time**: sets date, time, and format for each. See page 3-4.
- **Communications**: enables communication with a connected computer or VS2 analyzer. See page 3-5.
- **Admin Settings**: set the reagent tubing type, maintenance scheduling, and user management. See page 3-11.

3.2 Printer Settings

The Abaxis HM5 can print to its built-in printer or a connected external printer. (For a list of compatible printers, contact Abaxis Technical Support.)

The HM5's printer settings enable users to select specific information to print, manage print color and quality, modify margins, and add a personalized header.

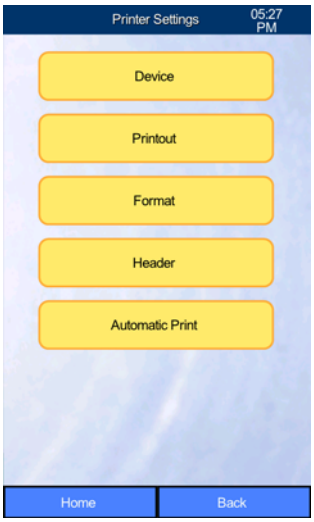
3.2.1 Connecting an External USB Printer

Follow these instructions to connect the HM5 to an external USB printer, and adjust the printer settings to fit the clinic's particular needs and setup.

You will need a USB A-B cable.

1. Plug the USB B (square) end of the cable into the printer, and the USB A (flat) end into a USB port on the back of the HM5.
2. From the HM5's Home screen, select **Settings > Printer**.

3. Adjust the printer settings as needed:



   - ❑ **Device**: selects printer, print mode, and paper type.
   - ❑ **Printout**: sets units and margins for printouts.
   - ❑ **Format:** selects the items included with printed results.
   - ❑ **Header:** sets up to 7 lines of customer information used at the top of the printout.
   - ❑ **Automatic Print:** enables automatic printing of results after CBC runs. (Disable if combining with VS2 results to avoid multiple printouts.)

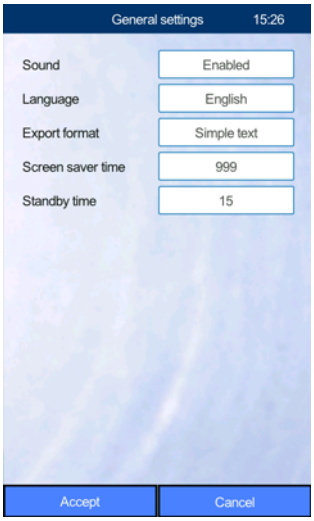
3.3 General Settings

Use **General Settings** to adjust sound, language, export format, screen saver time, and standby.

1. From the Home screen, select **Settings > General Settings**.
2. Select the settings to adjust:
   - ❑ **Sound**: enables/disables sound.
   - ❑ **Language:** selects the language used in analyzer displays.
   - ❑ **Data Export Format:** selects the format for exported data (**Advanced** is recommended).
   - ❑ **Screen Saver Time:** sets the delay time for screen saver activation, in minutes.
   - ❑ **Standby Time:** sets the delay time for standby activation, in minutes.

3.3.1 Screen Saver and Standby Time

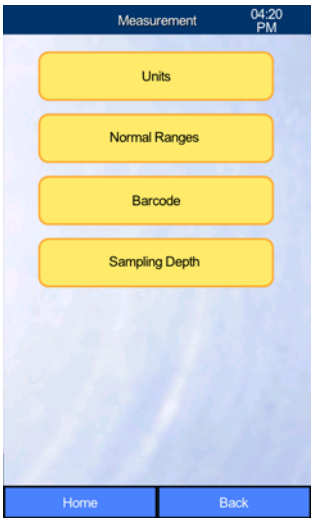
1. From the Home screen, select **Settings > General Settings**.
2. Select **Standby Time**, then enter the standby time in minutes.
3. Select **Screen Saver Time**, then enter the time before the screen saver activates, in minutes.
4. Select **Accept**.



3.4 Measurement Settings

Use **Measurement Settings** to set units, ranges, and sampling depth, or to enable scanning.

1. From the Home screen, select **Settings > Measurement**.
2. Select the settings to adjust:
   - ❑ **Units**: selects the units used for results.
   - ❑ **Normal Ranges**: sets default normal/reference ranges for each species.
   - ❑ **Barcode**: enables barcode scanning for patient ID numbers.
   - ❑ **Sampling Depth**: sets the default depth to which the needle descends into the sample tube to draw up blood.

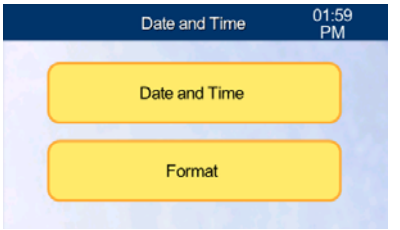


Note: *The HM5 software contains three duplicate software profiles called Dog2, Cat2 and Foal that measure with the same algorithms as Dog, Cat and Horse, respectively; users may edit these profiles with customized reference intervals for other species similar to dogs, cats or horses. They may also be used for younger pets, such as puppies, kittens or foals or geriatric populations. These customized reference ranges must be provided by the user.*

3.5 Date and Time Settings

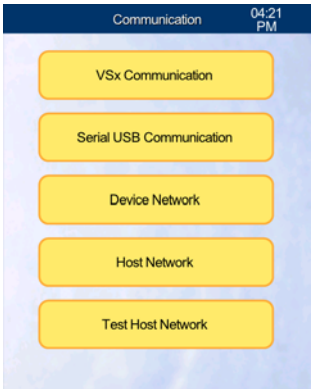
Use **Date and Time** to set the VetScan HM5's built-in clock and calendar, and the format used to display the date and time on results.

- ■ **Date and Time**: sets the displayed time and date on the analyzer clock.
- ■ **Format**: sets the date display format (Month/Day/Year, Year/Month/Day, or Day/Month/Year) and time display format (12- or 24-hour).



3.6 Communication Settings

This section provides information for network administrators to use in setting up the HM5 on a network.



The VetScan HM5 offers a variety of options for communicating with external systems such as practice management software, printers and selected Abaxis analyzers, using USB and/or network connections as described in this chapter.

The table below summarizes the USB and network data communication modes available to the HM5.

Table 3-1: VetScan HM5 USB/Network Communication Modes

Modes			
Target	**Name**	**Type**	**Purpose**
VetScan VS2 chemistry analyzers	VSx Communication	USB	Receives results from the VS2 analyzer and produces a formatted report that combines the VS2 and HM5 results when a Patient ID match is found in the HM5 database.
Computer (unidirectional)	Serial USB Cable Communication	USB	Sends results from the HM5 to a host (such as a computer with practice management software) through a USB serial COM port. See Table 3-2.
Computer (unidirectional)	Host PC (in Host Network)	Network	Sends results from the HM5 to a host computer via network-enabled software, such as a practice management system. See Table 3-3.
Computer (bidirectional)	Host EMR (in Host Network)	Network	Sends results from the HM5 to a host computer and receives work list orders from a host computer using network-enabled software, such as a practice management system or an electronic medical records (EMR) system. See Table 3-4.

These communication modes act independently and multiple modes can be enabled simultaneously though typical analyzer operation enables only one of the above modes at a time.

Note: *When changing communication modes, be sure to verify the settings for all modes to ensure that only the desired mode is enabled. VSx Communication can be enabled or disabled independently of other settings with no unintended consequences.*

The following tables list the most commonly used settings.

Table 3-2: Unidirectional Transmission to a Host Through a USB Cable

Communication	Setting Name	Setting
Serial USB Communication	Serial USB Link	**Enabled**
	Serial Automatic Send	**Enabled**
Host Network	Personal Computer (PC)	Inactive
	PC Automatic Send	Disabled
	Electronic Medical Record (EMR)	Inactive
	EMR Automatic Send	Disabled

Table 3-3: Unidirectional Transmission to a Host Computer Through a Network Connection

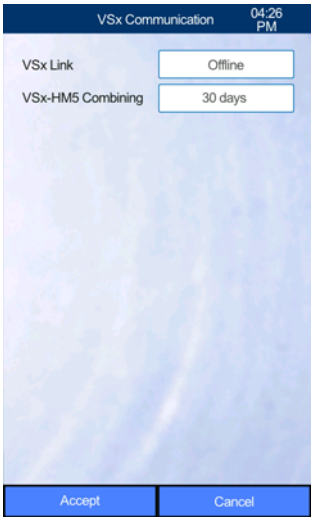
Communication	Setting Name	Setting
Serial USB Communication	Serial USB Link	Disabled
	Serial Automatic Send	Disabled
Host Network	Personal Computer (PC)	**Active**
	PC Automatic Send	**Enabled**
	Electronic Medical Record (EMR)	Inactive
	EMR Automatic Send	Disabled

Table 3-4: Bidirectional Transmission to a Host Computer Through a Network Connection

Communications	Setting Name	Setting
Serial USB Communication	Serial USB Link	Disabled
	Serial Automatic Send	Disabled
Host Network	Personal Computer (PC)	Inactive
	PC Automatic Send	Disabled
	Electronic Medical Record (EMR)	**Active**
	EMR Automatic Send	**Enabled**

3.6.1 VSx Communication

The HM5 can provide a formatted printout of results from an Abaxis VS2 analyzer and can produce a printout of VS2 results combined with HM5 results when a matching Patient ID is found in the HM5 result database.



1. On the Home screen, select **Settings > Communication > VSx Communication**.
2. Set **VSx Link** as needed:
   - ❑ **USB**: enables VSx communication and prints VS2 results.
   - ❑ **Offline**: VSx communication is disabled.
3. Set **VSx-HM5 Combining** to control the date range for the HM5 result lookup to match the VS2 patient result. Select **Same Day** to combine only HM5 results that were run on the same day as the VS2 result.
4. Connect the USB B (square) end of the USB cable to the USB B port on the back of the VS2.
5. Connect the USB A (flat) end of the cable to a USB A port on the HM5.
6. Press **Accept**.

3.6.2 Serial USB Connection to a Computer

The VetScan HM5 can connect to practice management software (PMS) on a computer using a USB A-B cable. For a list of compatible PMS software, visit the Abaxis website at www.abaxis.com.

3.6.2.1 USB A-B Cable Connection

1. Connect the B end of the cable into the USB B port on the back of the HM5.
2. Connect the A end of the cable into the PMS computer.
3. On the Home screen, select **Settings > Communication > Serial USB Communication**.
4. Enable **Serial USB Link** and **Serial Automatic Send**.
5. Set **Serial Link Baud Rate** to the rate recommended by the practice management software (typically 9600).
6. Using a computer connected to the internet, browse to www.abaxis.com.
7. Download and install the Color HM5 USB driver on the computer, following the instructions on the website. Contact the PMS company to complete the setup with the HM5.

3.6.3 Network Communication

The HM5 can connect to a computer network through the Ethernet port on the back of the analyzer (see “Back View” on page 1-4) using standard Cat5 networking cables:

- Unidirectional connections transmit results from the HM5 to a computer.
- Bidirectional communication transmits work orders to the HM5, from a software application such as practice management software, and results to the computer from the HM5. (For a list of compatible software, visit the Abaxis website at www.abaxis.com.)

When network communication is necessary, the HM5 must always be configured with a Device Network address assignment (see “Device Network,” below). This establishes the HM5 as a location on the network and enables the HM5 for subsequent use with the Host Network settings (see “Host Network” on page 3-9).

3.6.3.1 Device Network

The Device Network setting establishes the network address of the HM5 analyzer.

The network address may be assigned automatically via DHCP, or manually by making a static IP address assignment. The method to use depends on a number of factors, is best determined by the local network administrator.

DHCP address assignment is the easiest to configure and is the preferred method when Host EMR communication is not being used.

When using Host EMR communication, a fixed or static address is preferred. Contact your system administrator for details (see “Configure for Static Address Assignment” on page 3-9).

Note: *In some cases you may be directed to use the DHCP setting on the HM5, and the network administrator will configure the DCHP server to assign a fixed address to the HM5.*

In the Device Network screen, **Current Settings** shows the address assignment based on the most recent configuration: the information is automatically assigned if **DHCP Enabled** was used, or information entered manually for a static assignment.

Use **New Settings** to update the address assignment: see “Configure for DHCP Address Assignment,” or “Configure for Static Address Assignment,” below.

- Configure for DHCP Address Assignment
  1. Change the DHCP setting to **Enabled**. (You can ensure **Enabled** is set by selecting the setting value.)
  2. Press **Accept**.

- Configure for Static Address Assignment

  To use static address assignment for the HM5, your local network administrator must supply the necessary information.

  1. Change the DHCP setting to **Disabled**. (You can ensure **Disabled** is set by selecting the setting value.)
     The data entry fields in the New Settings area then become available.

  2. Enter the following settings using the values from your network administrator:
     - IP Address
     - Subnet Mask
     - Gateway
     - DNS

  3. Press **Accept**.

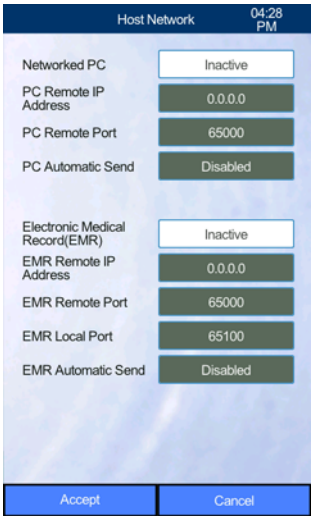
3.6.4 Host Network

When configured for Host Network communication, the HM5 can send results to another computer on the network (unidirectional mode), or accept work orders from and send results to a computer (bidirectional mode). The computer must be running compatible software to accept the result information and optionally send order information. For a list of compatible software, visit the Abaxis website at www.abaxis.com.

3.6.4.1 Personal Computer (PC)

The **Host Network > Personal Computer (PC)** settings enable the HM5 to send results one-way (unidirectional) to a network-enabled Personal Computer (PC) system or software such as a practice management system. In this mode, the HM5 cannot accept work list orders (bidirectional communication) from a PC system.

When sending results, the HM5 establishes an outbound connection to a specified IP address and port (see below). The receiving PC must be running a service that listens for incoming connections on the IP address and port. The local network administrator or software vendor can provide the necessary IP address and port values.



To configure the HM5 to send results to a PC system:

1. In the Host Network screen, set the Networked PC field to **Active**.
2. Enter the PC Remote IP Address and PC Remote Port number, as provided by your local network administrator or software vendor.

3. Set PC Automatic Send to **Enabled**.

Note: *Enabling PC Automatic Send is typical for this configuration, but may not be appropriate for your PMS or individual configuration. If you have questions about the correct setting for your clinic, contact Abaxis Technical Support or consult your PMS vendor.*

4. Select **Accept**.

3.6.4.2 Electronic Medical Record (EMR)

The **Host Network > Electronic Medical Record (EMR)** settings enable the HM5 to exchange work order and results (bidirectional) with a network-enabled PC or software such as a practice management system. Orders flow from the EMR host to the HM5, and results from the HM5 to the EMR host. The EMR host system software must be capable of bidirectional communication with the HM5.

When receiving orders, the HM5 establishes a listening service and waits for connections from the EMR host. The listening address is the HM5 analyzer IP address (see “Device Network” on page 3-8), and the listening port is determined by the EMR Local Port setting (see below).

When sending results, the HM5 establishes an outbound connection to the specified IP address and port (see below), and the receiving EMR system must be running a service listening for incoming connections on that IP address and port. The IP address and port values are provided by the local network administrator or software vendor.

To configure the HM5 to communicate with an EMR system:

1. In the Host Network screen, set Electronic Medical Record (EMR) to **Active.**
2. Enter the EMR Remote IP Address and EMR Remote Port number, as provided by your local network administrator or software vendor.
3. Enter the EMR Local Port number provided by, or determined in conjunction with, the EMR software vendor. (This is the port the HM5 listens on for incoming order connections.)
4. Set EMR Automatic Send to **Enabled**.

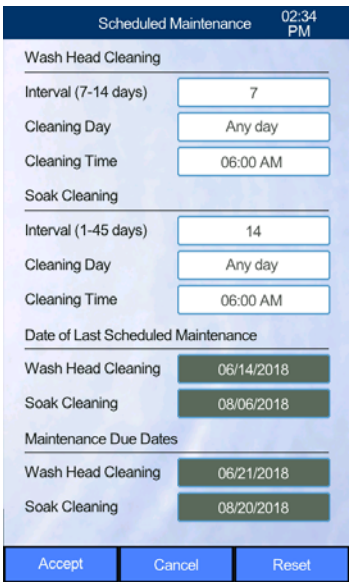
Note: *Enabling EMR Automatic Send is typical for this configuration, but may not be appropriate for your PMS or individual configuration. If you have questions about the correct setting for your clinic, contact Abaxis Technical Support or consult your PMS vendor.*

5. Press **Accept**.

3.7 Admin Settings

This menu is available to Admin-level users only (see Section 7). Use **Admin Settings** to adjust maintenance dates to fit the clinic's schedule, to tailor directions to the tubing set being used, and to set up user permissions.

1. On the HM5 Home screen, select **Settings > Admin Settings**.
2. The **Pack Setup** setting identifies the reagent pack tubing setup: select **QCA** or **Bottle Caps** (see "Installation" on page 2-3).
3. Select **Scheduling** and select the schedule for Wash Head Cleaning and Soak Cleaning:
   - ❑ To use the default maintenance schedule, select **Disable**.
   - ❑ To customize the maintenance schedule and enable full screen reminders for maintenance, select **Enable**.
4. Then select **Schedule Settings:**
   - ❑ The **Interval** fields can be used to set the number of days between cleanings. Abaxis recommends that **Intervals** be left at the default values of a 7 day Interval for Wash Head Cleaning and a 14 day Interval for Soak Cleaning. Use the **Cleaning Day/Time** fields to set the specific day and time that cleaning is due. Users who run fewer than 5 samples per day may set the Soak Cleaning Interval to 30 days.
   - ❑ Use **Last Date of Scheduled Maintenance** and **Maintenance Due Dates** to track the previous and the next scheduled cleanings.



Note: *The default interval settings are ideal for most clinics.*

Note: *Enabling Schedule Settings allows the user to set the preferred day and time for maintenance and will not allow samples to be run until maintenance procedures have been performed.*

Section 4

Running a Sample

Running a sample on the HM5 is a simple process that begins with good sample draws, proper mixing, and correct storage of the samples.

Section Contents

4.1 Collecting and Handling Samples

Because sample integrity is essential for accurate test results, always follow the guidelines in this section for sample handling.

CAUTION: *Use only tubes containing potassium EDTA (purple/lavender top) for CBC analysis.*

Note: *For multiple tube draws, always fill the tubes in this order:*
1) blue top
2) red top or tiger top
3) green top
4) lavender/purple top

- When collecting a sample, select the largest vein possible, and select the appropriate needle size for the vein.
- If blood stops flowing into the syringe before enough sample is acquired, dispose of that syringe and attempt a new draw with a new needle, new syringe, and new draw site.
- Avoid delays of more than 20 seconds between the venipuncture and the sample transfer to the EDTA tube, and between filling the tube and mixing. Delays can cause platelet clumping and clot formation.

Note: *For best results, fill the tube with blood to at least half its maximum fill volume (as marked on the tube).*

- To achieve proper mixing and prevent clotting, immediately mix samples by inverting the tubes 10-15 times (25-30 times with very small samples or in low volume microtubes) Inversion speed should be 2-3 inversions per second.

Note: ***Do not shake samples!*** *Doing so can damage the blood cells, and can form micro-bubbles that will cause inaccurate results.*

- Mix thoroughly by hand immediately before analysis by gently inverting the tube 10-15 times.

- When using a vacutainer system, allow the vacuum to pull the sample in. If the tube stops filling before enough sample is acquired, try to quickly redirect the needle.

  If this takes more than 5-10 seconds, remove the needle and dispose of the sample, and attempt a new draw at a new site, with a new needle and new tube. Once the tube is full, mix by inverting the tube 10-15 times (25-30 times in low volume microtubes).
- When using a butterfly with a vacutainer system, gently invert the tube while the tube is filling.
- IMMEDIATELY mix tubes after filling them to prevent the blood from clotting in the tube.

4.2 Storing Samples

- Samples may be put in a rack or on a counter until ready to run.
- Samples should be run within 4 hours if stored at room temperature, or 8 hours if refrigerated.
- If the samples were refrigerated, allow them to warm to room temperature before analysis by sitting on the counter for 10-15 minutes. Samples may also be warmed by slowly rolling the tube in the palms of the hands for 5-10 minutes.
- Do not use a rocker to mix samples smaller than 1.0 ml.

Note: *Rockers do not mix samples well. To mix properly, invert each sample by hand 10 to 15 times* ***immediately after*** *drawing, then invert 10 to 15 times again* ***immediately before*** *running the sample.*

4.2.1 Remixing Before Running

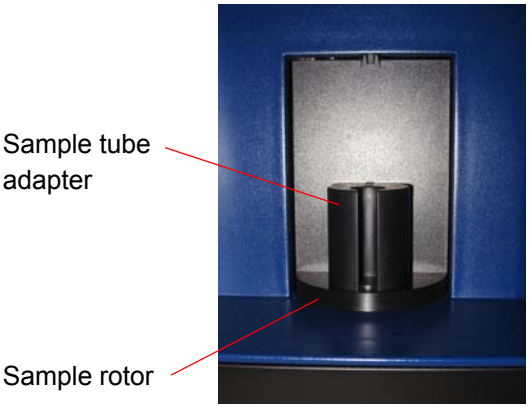
The HM5 software will display a reminder to mix samples before each sample run.

- Always mix the sample again with 10-15 inversions before analyzing the sample in the HM5. Over time, samples settle and start to separate so they must be mixed well again before being run.
- If any specks of solid blood (indicating clotting) are observed, or if there were any delays in filling the tube, discard the sample and redraw.

4.3 Before Performing an Analysis

4.3.1 Daily Cleaning

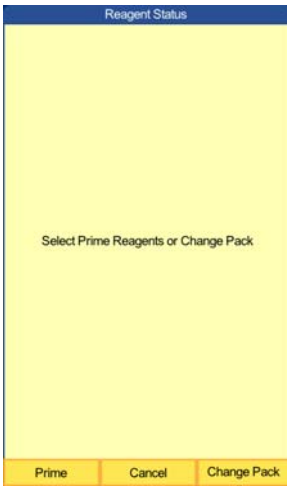
1. Wipe up any spills on the sample rotor.
2. Keep the instrument and immediate surroundings as clean as possible.



4.3.2 Check Tubing

1. Inspect the reagent tubes and connections to make sure the reagents can flow freely. Make sure the tubes are not pinched or kinked, or trapped between or beneath objects.
2. Check the reagent tubes (except the red waste tubing) for bubbles or air gaps. A few small, “soda-sized” bubbles are normal, but if any large bubbles (spanning the width of the tubing) or gaps exist, clear the affected tubes as follows.
   a. Make sure the affected tubes are securely attached at both ends.
   b. From the Home screen, select **Maintenance > Reagent Status**.

   c. Select **Prime All** to start priming the reagents. Confirmation will be required. Select **Change Pack** if you are currently changing the reagent pack, or **Prime** if you only need to clear bubbles in the tubes. For details on changing the reagent pack, see “Changing the Reagent Pack” on page 6-9.



   d. Repeat if needed to remove all air gaps and large bubbles from the reagent tubes.
   e. If priming is required more than two times or bubbles persist, call Abaxis Technical Support.

Note: *Air gaps in the waste tubing (red) are normal.*

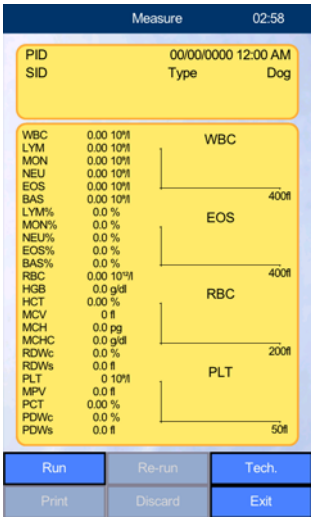
4.4 Running a Blank Measurement

A blank measurement must be run at the beginning of the day before any samples can be run, or every 12 hours for 24-hour clinics. Blanks must also be run after a reagent pack change. The blank checks the cleanliness of the VetScan HM5's fluidic system, and establishes a baseline for sample measurements. The results of a blank are used to determine if the background will affect the test results, and whether the analyzer needs cleaning or maintenance.

Note: *Each blank measurement is valid for 12 hours, after which the analyzer displays* **Blank results are expired!** *Accept the running of the blank then accept the blank to begin running samples again.*

In addition, a new blank must be run each time the analyzer is powered off and then powered on again.

1. From the Home screen, select **Measure > Run**.

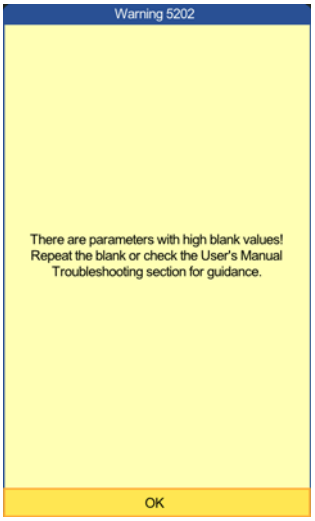


2. If the **Blank results are expired** screen appears, select **OK** to run a blank.

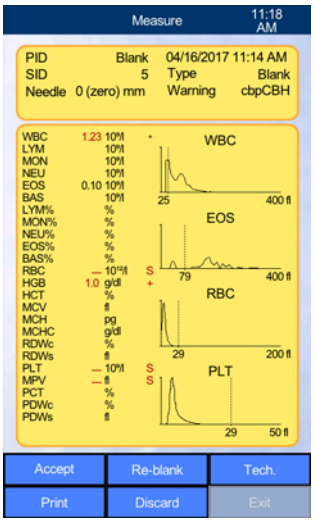
   (If a blank has already been run and accepted for the day, this message does not appear. To run a new blank, select **Run > Blank**.)

3. When the blank has run, if the blank is successful (meaning there are no values reported in red with **+** or ***** signs, and no warning message displayed) the results will appear on the screen.

4. If blank results are unacceptable for certain parameters, the analyzer will rerun the blank. If the results are still unacceptable, the message shown at right appears.



If this occurs, press **OK**, find the warning flag displayed at the upper right on the screen, then go to the section of "Troubleshooting" on page 9-1 for that flag.



CAUTION: *Do not accept an unacceptable blank (with high values).*

Note: *A new blank will be required after the following procedures:*

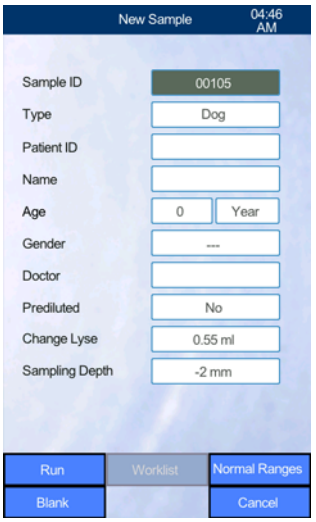
- ❑ Reagent Pack Change
- ❑ Soak Cleaning (see "Soak Cleaning" on page 6-6)
- ❑ Deep Cleaning (see "Deep Cleaning" on page 9-18)
- ❑ Self-test
- ❑ HM5 Reboot

4.5 Running a Sample

Use this general procedure to analyze samples with the VetScan HM5.

1. Prepare a well-mixed, potassium EDTA-preserved sample — see "Collecting and Handling Samples" on page 4-2.
2. Select the appropriate sample tube adapter for the tube size being used:
   - ❑ **#1:** for 2-3 ml tubes and the Abaxis Control tube.
   - ❑ **#2:** for 1.3 ml tubes.
   - ❑ **#3:** for 2 ml glass vials.
   - ❑ **#6:** for microtainer tubes of 0.6 ml or less
3. Place the adapter into the slot in the sample door.

4. From the Home screen, select **Measure > Run**.
5. Select the patient species under **Type**.
6. Enter patient information: select the needed fields, enter the information, then select **Enter**.



Note: *If combining with a VS2 or sending results to a PMS, be sure to enter the matching patient number into the Patient ID.*

7. Make sure the sample tube is at least half full. If the tube is not adequately filled (see "Collecting and Handling Samples" on page 4-2), results can be affected. *Good sample acquisition and sample handling are essential to prevent issues.*

8. Adjust the sampling depth if needed. If the sample fill is adequate, use the 0 mm sampling depth. However, if the sample tube is less than half full and a new draw cannot be performed, or the values resemble a blank and an E Warning is present, lower the sampling depth to -2 mm.

    a. Select the **Sampling Depth** field.

    b. Select the appropriate sampling depth (If using false-bottom tubes, **+5 mm** may be needed.)

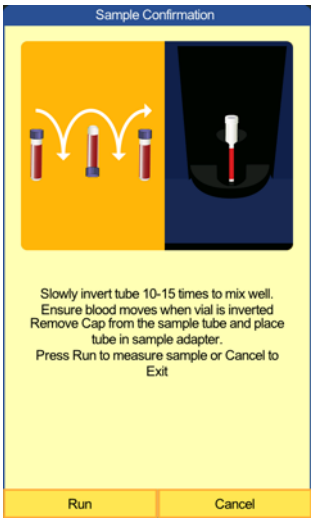
9. Select **Run**.

10. When prompted:

    a. Slowly invert the tube 10-15 times to mix well.

    b. Remove the cap from the sample tube, and place the tube in the appropriate sample adapter.

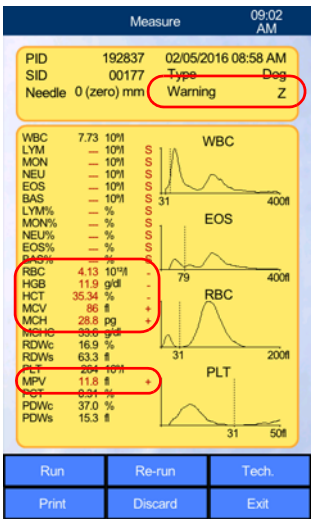
    c. Select **Run** as shown at right.



    The sample is taken into the HM5 and analysis begins. The CBC process takes approximately 4 minutes for a five-part differential, and 3 minutes for a three-part differential.

    When complete, results are displayed on the screen, and transmitted to a printer and/or the PMS, depending on configuration. (If the analyzer is not set to print results automatically, print them by selecting **Print**.)

If warning flags occur for the blanks or sample results, they will be indicated as shown in the example at right. See the Troubleshooting section for resolutions.



If results are out of range they will be indicated as follows:

1. Results *above* the species reference range are highlighted and marked with a plus sign (**+**).

2. Results *below* the species reference range are highlighted and marked with a minus sign (**–**).

4.6 Adjusting the Lyse Volume

The Lyse volume generally only needs adjustment on rare occasions if the patient has Lyse-resistant red blood cells, as indicated by an **L** warning on the results after other potential causes have been eliminated. For details on other potential causes and instructions, see "Result Warning Flags" on page 9-5.

If an L Warning occurs, proceed as follows:

1. If the sample was from a Cavalier King Charles Spaniel, or other breed with a known predisposition to macrothrombocytosis, perform a manual smear.
2. If the draw was difficult or the platelet value is low, redraw and rerun as this could be platelet clumping causing the L Warning.
3. Make sure the Lyse tube (yellow) has no kinks, or loose connections at the analyzer or bottle.
4. Make sure the tube is well attached to the connector on the dip tube or bottle cap.
5. Check for bubbles in the Lyse tube. If found, prime the Lyse and rerun the sample.
6. If the Lyse tube is in working order, from the Home screen, select **Measure > Run**.
7. Select the **Change Lyse** field, and increase the volume by 0.1 ml.
8. Rerun the sample.
9. If the **L Warning** persists, increase the Lyse by 0.2 ml, then rerun the sample.
10. If the L Warning still persists and there are no Lyse issues, perform a manual smear or send the sample out.

Note: *The new Lyse volume will be used for the current run only, then will revert to the default setting.*

4.7 Interpreting Results

The VetScan HM5 produces a printed report containing the patient ID, measurement data, numeric results with flags (if any), and histograms showing the different cell populations.

Note: *Always check whether the results include warning flags, at the top-right corner of the HM5 screen or the bottom of the HM5 printouts.*

Complete Blood Count (CBC) parameters are useful in assessing overall wellness of a patient, as well as identifying and monitoring certain disease states. See "CBC Parameters and Associated Indications" on page E-1 for information on the various CBC parameters and associated clinical indications.

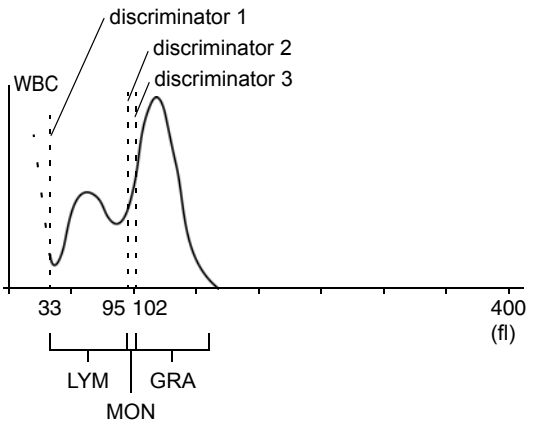
4.7.1 Histograms

In five-part differential mode, histograms display population distributions of each cell type: leukocytes (white blood cells — WBC), eosinophils (EOS), erythrocytes (red blood cells — RBC), and thrombocytes (platelets — PLT). The histograms show the relative frequency of cells on the vertical (Y) axis, and cell volume in femtoliters (fl) on the horizontal (X) axis.

Histograms enable you to quickly scan results for abnormalities, and also allow the versed practitioner to derive more information about the sample than is displayed by the values alone. The following pages describe each of the histograms (WBC, EOS, RBC, and PLT), and show a typical example of each with an explanation.

4.7.1.1 White Blood Cell Histogram (WBC)

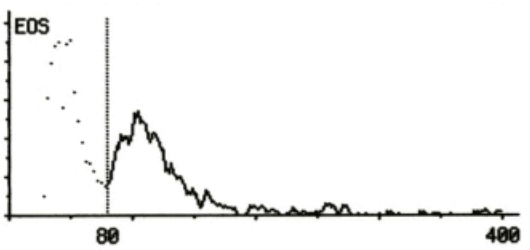
WBC histograms show white blood cell populations sorted by size. Cells larger than discriminator 1 are counted as WBCs. Blood includes three WBC populations:



- Lymphocytes (LYM), shown by the first peak in the histogram.
- Monocytes (MON), indicated by the area between the second and third discriminators (although the MON region does demonstrate a distinctive peak of its own, this peak is not always clear in histogram form).
- Granulocytes (GRA) are the neutrophils, eosinophils, and basophils, indicated by the peak to the right of the third discriminator.

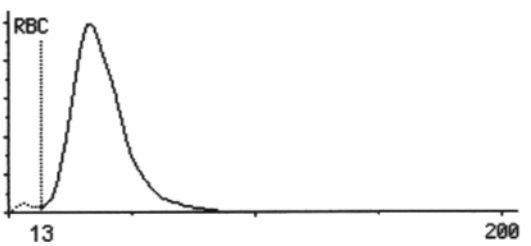
4.7.1.2 Eosinophil Histogram (EOS)

The distribution of eosinophils is shown by the second peak in the histogram. The first peak (dotted line) is the RBC "ghost" and other WBCs.

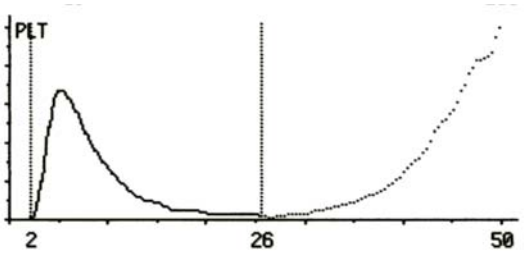


4.7.1.3 Red Blood Cell Histogram (RBC)

The distribution of red blood cells normally appears as a single, steep, bell-shaped curve. The presence of reticulocytes and nucleated red blood cells (nRBCs) cause this curve to widen.



4.7.1.4 Platelet Histogram (PLT)



The PLT histogram is a magnified portion of the beginning of the RBC histogram.

The example PLT histogram at right follows a log-normal distribution, with a good separation from RBCs.

The most commonly identified anomaly in platelet histograms results from aggregated (clumped) platelets. This appears as a flattened, lumpy histogram that increases towards the right side (see “Cat: Clumped PLT, Increased LYM” on page D-10).

Section 5

Quality Control and Calibration

This section describes the quality control and calibration procedures for the VetScan HM5.

Section Contents

5.1 Quality Control

The VetScan HM5 includes a quality control (QC) function that verifies the analyzer's accuracy. Performing QC checks regularly helps ensure optimal performance.

Note: *Quality control cannot be run if the blank results are elevated.*

Note: *Performing quality control does not change the HM5's settings or functions (unlike calibration).*

5.1.1 Required Quality Control Sample

The quality control procedure requires using VetScan HM5 Hematology control samples, which can be purchased from Abaxis or an authorized distributor. These control samples are available in low, normal, and high range. Abaxis recommends *only the normal control* for most veterinary facilities, though low and high controls can also be run in particularly stringent regulatory environments.

Note: *Use only Abaxis VetScan HM5 Hematology controls on the VetScan HM5.*

5.1.2 Handling Quality Controls

When opening new Abaxis HM5 controls, *always write the open date* onto the package insert and the control tube itself. Users can then monitor the open date of each tube and avoid using degraded control material. After the control is first opened, it will be good for up to 14 days if it is properly stored.

WARNING: ***THE CONTROL MATERIAL IS PARTIALLY DERIVED FROM HUMAN SOURCES. OBSERVE UNIVERSAL SAFETY PRECAUTIONS WHEN HANDLING THE CONTROL.***

CAUTION: *Abaxis recommends wearing latex or nitrile gloves for these procedures.*

5.1.3 Entering Quality Control Values

Each lot of quality control material has assigned target values that must be entered into the HM5. This can be done using any of three methods:

- Enter values manually through the HM5's touchscreen or a USB keyboard: see "Entering Values Manually" on page 5-3.
- Load USB control value files: see "Loading Values from a USB Drive" on page 5-5.
- Load values through a USB 2D barcode reader: see "Loading Control Values with a 2D Barcode Reader" on page 5-6.

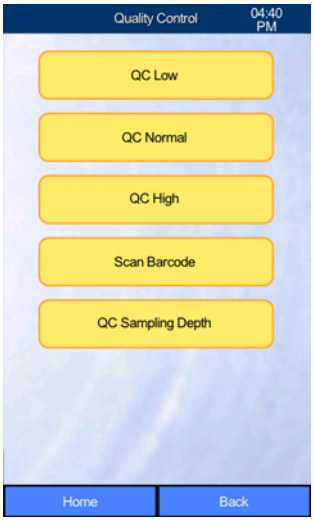
5.1.3.1 Entering Values Manually

Enter control values manually, for one level of control at a time, using the HM5's touchscreen or a USB keyboard.

1. From the Home screen, select **Maintenance > Quality Control**.

   The Quality control screen includes buttons for QC levels **QC Low**, **QC Normal**, and **QC High**:

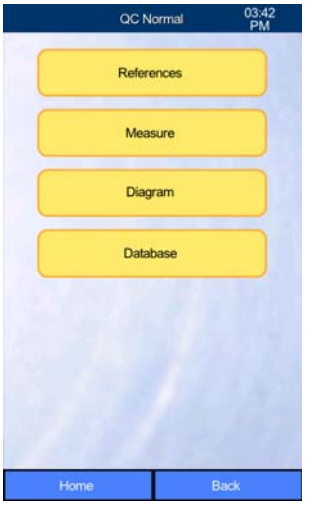
   - ❑ **QC Normal** for normal controls (required)
   - ❑ **QC Low** for low-level controls (optional)
   - ❑ **QC High** for high-level controls (optional)



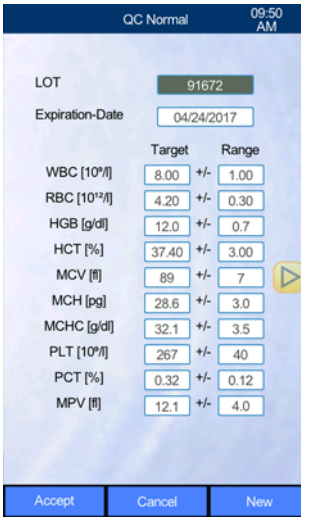
2. Select a QC level.

3. Select **Measure**.

4. Select **Run QC**.

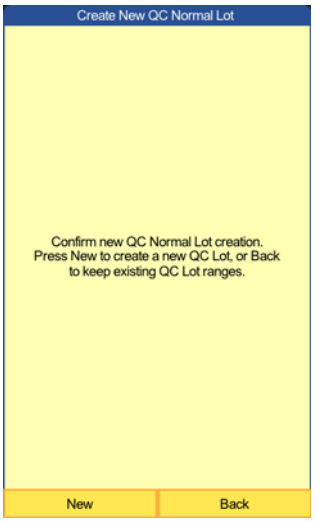


5. Compare the on-screen lot number, expiration date, and target values with those shown on the package insert.

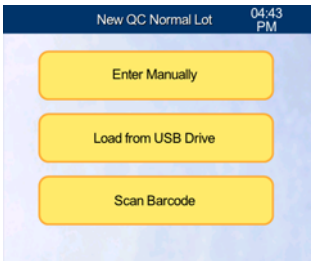


- ❑ If the lot number and expiration date of the current control tube in hand *are the same* as those displayed on-screen, verify that the on-screen target and range values match those on the control package insert, then select **Accept** and proceed to "Running a Quality Control Sample" on page 5-8.

- ❑ If the lot number and expiration date of the control tube *are different* than those on-screen, select **New**.



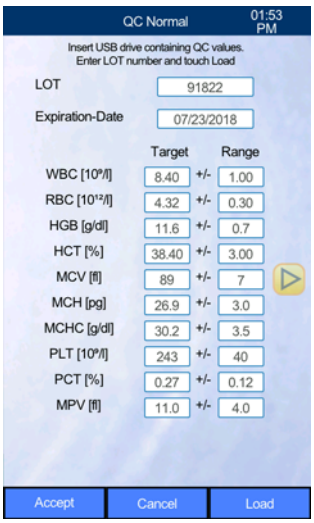
6. Select **Enter Manually** to enter values using the touchscreen and keyboard, **Load from USB Drive** for downloading the values from a USB Drive (with the values downloaded from www.abaxis.com) or **Scan Barcode** if a 2D barcode scanner from Abaxis is present.



7. When Manual is selected, enter the lot number, expiration date, Target (assay) values and Gap (ranges) from the pack.
8. Select **Accept**, followed by **Confirm**.
9. Go to "Running a Quality Control Sample" on page 5-8.

5.1.3.2 Loading Values from a USB Drive

1. Download the most recent control lot values files from www.abaxis.com onto a computer. Unzip the files then open it. Copy the files in the unzipped folder onto a USB drive. See the Abaxis website for more detailed instructions on extracting the files.
2. From the Home screen, select **Maintenance > Quality Control**.
3. Select **QC Normal** (or another level) **> Measure**.
4. Select **Run QC** then **New**.
5. Select **Load from USB Drive**.
6. Insert the USB drive containing the unzipped control values files downloaded from www.abaxis.com.
7. Enter the control lot number from the tube or control pack package insert into the LOT field on the screen, then select **Load**. The HM5 then loads the lot number file from the USB drive.



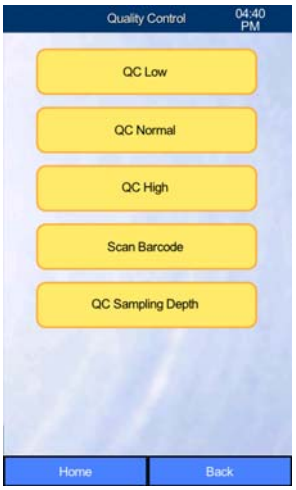
8. Verify that the loaded values are correct and match the package insert. Correct any incorrect values, then select **Accept**.
9. Verify that the lot number and expiration date match that on the tube to be measured, then select **Confirm**. Select **Accept** again then **Run QC**.
10. Go to "Running a Quality Control Sample" on page 5-8.

5.1.3.3 Loading Control Values with a 2D Barcode Reader

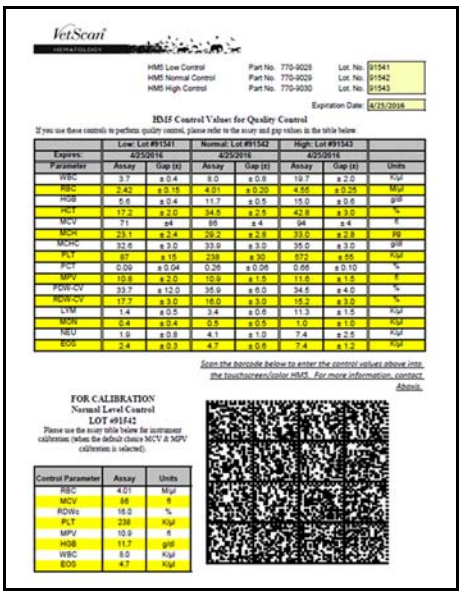
A 2D barcode reader can be used to quickly and accurately enter control values from an HM5 control values sheet.

1. Plug the 2D USB barcode reader into a USB port on the HM5.
2. From the Home screen, select **Maintenance > Quality Control**

.



3. Select **Scan Barcode**, then scan the 2D barcode on the HM5 value assignment sheet provided with the control tube.

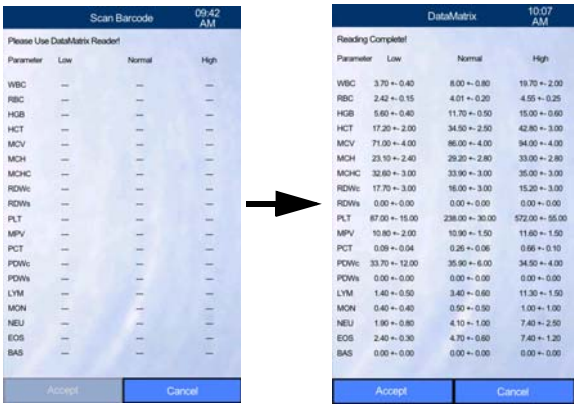


Note: *When scanning the barcode, make sure the control sheet is on a flat surface.*

Note: **Scan Barcode** *can also be selected after choosing the QC level and selecting* **New***.*

4. Verify that the loaded values are correct, then select **Accept**.

5. Select **OK** to delete previous QC results and save the new reference ranges.



6. If the 2D barcode reader will not scan the barcode, check the reader's brand and model:

   - **For a Motorola/Symbol reader:** Scan "Return to Factory Defaults" below.

Return to Factory Defaults

SET DEFAULTS

Then scan the three barcodes below: 1,2 then 3.

1

SCAN OPTIONS

2

<DATA><SUFFIX>

3

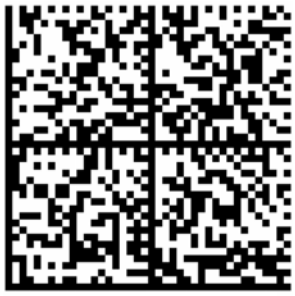
ENTER

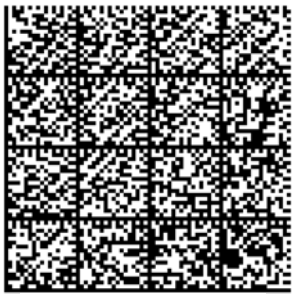
❑ **For a Code reader:**

a. Unplug the reader and plug it in again.

b. If the reader still doesn't scan correctly, scan the reset code at upper right, then scan the programming barcode at lower right.

1. Reset code





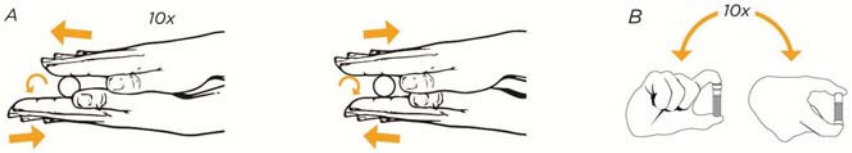
2. Programming code

7. Go to "Running a Quality Control Sample," below.

5.1.4 Running a Quality Control Sample

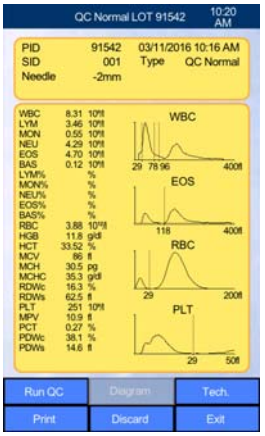
Note: *Before running a QC sample, make sure the control tubes have come to room temperature. Remove the controls from the refrigerator at least 15 minutes prior to use. Do not use a control that is expired or has been open for more than 14 days, as it may be degraded.*

1. Be sure that you have already entered control values: see "Entering Quality Control Values" on page 5-3.
2. After accepting the new control values, select **Run QC**.
3. Mix well by slowly rolling the tube flat between your hands (A), and then slowly inverting the tube 10-15 times (B).



4. Select **Run**.

5. When analysis is complete, the analyzer displays the results.



Note: *Any values out of range are highlighted in red, along with a plus or minus sign.*

6. Abaxis recommends performing at least two control runs:
   - ❑ If the values reported are in range, the analyzer is functioning properly and calibration is not necessary.
   - ❑ If any value is consistently out of range, refer to the next section, "What to Do If QC Values Are Out of Range," or contact Abaxis Technical Support.
   - ❑ A third QC run may be performed if the results of the first two QC runs are conflicting (meaning one is out of range while the other is not, or if the results are widely different from each other).

5.1.5 What to Do If QC Values Are Out of Range

Note: *There are many reasons why QC values may be out of range so stop to investigate the cause before calibrating the analyzer. Calibration is rarely needed. Most QC out of range issues are related to the cleanliness of the analyzer and/or the storage or shipping conditions of the control.*

Values to focus on during QC runs are RBC, MCV, RDWc, PLT, MPV, HGB, WBC and EOS. All other values are calculated using these eight parameters. Certain values such as PDWs and BAS do not have ranges so may always report as out of range because of the lack of target and range data.

- ■ If there are any Warning flags, refer to the "Troubleshooting," section of this manual to resolve the cause of the Warning.
- ■ If the RDWc value is two or more points above the target value, discard the control and order a new one as this indicates it has frozen or been exposed to too much heat.
- ■ If all values which are counted (RBC, WBC, PLT, HGB and EOS) are all low, run Soak Cleaning then rerun the QC sample.
- ■ If MCV is high or low, run a Soak Cleaning (see "Soak Cleaning" on page 6-6) then run the QC sample again.

- If the WBC and EOS values are low, mix the QC sample better and rerun.
- If the WBC, RBC and HGB are high, mix the QC sample better and rerun.
- If just the RBC value is low, make sure the control is at room temperature, mix well and rerun.
- If the RBC and/or PLT values are elevated, clean any visible debris from the Wash Head and dilution chamber below it and perform a Soak Cleaning before running an additional QC run.

5.2 Calibration

5.2.1 When to Calibrate

The VetScan HM5 is factory-calibrated for optimal performance. In certain situations, calibration is needed to fine-tune the analyzer:

- When quality control measurements show that one or more parameters are consistently out of range, and the analyzer has been determined to be clean and the control has been stored and shipped properly.
- After relocating the HM5.

Note: *Calibration cannot be performed if the blank is unsuccessful.*

5.2.2 Required Calibration Materials

The calibration procedure requires the VetScan HM5 Hematology Normal control (Abaxis part number 770-9029), which can be purchased through an authorized distributor or directly from Abaxis.

WARNING: ***THE CONTROL MATERIAL IS PARTIALLY DERIVED FROM HUMAN SOURCES. OBSERVE UNIVERSAL SAFETY PRECAUTIONS WHEN HANDLING THE CONTROL.***

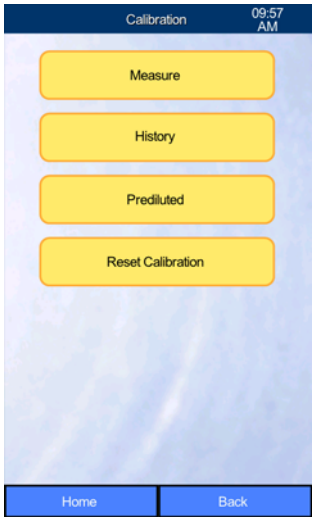
5.2.3 Calibration Procedure

Note: *Allow the normal control to reach room temperature before beginning. This takes about 15 minutes.*

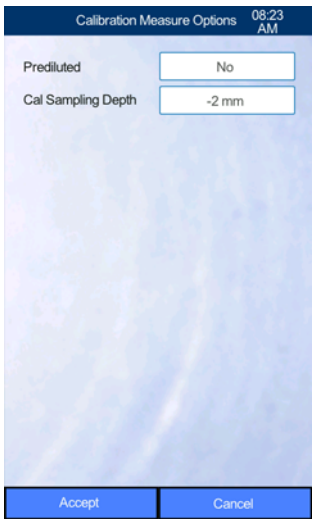
Once opened, the control has a shelf life of 14 days. Do not calibrate with an expired control or a tube that has been opened more than 14 days.

The calibration process requires at least three sample runs using the HM5 Normal control material.

1. From the Home screen, select **Maintenance > Calibration**.

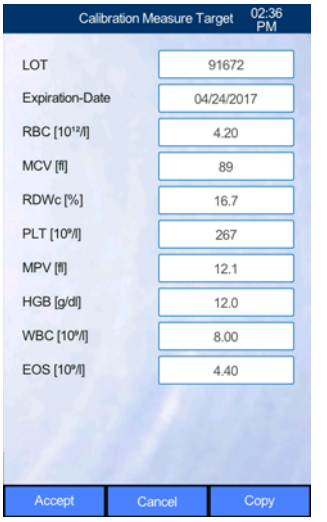


2. Select **Measure**.
3. Verify that **Prediluted** is set to **No** and that **Cal Sampling Depth** is set to **–2 mm**.
4. Select **Accept**.



5. If QC ranges are for the same control tube, select **Copy** to pull over the values from the QC menu. If QC values do not match the lot on the control tube being used for calibration, enter the lot number, expiration date in MM/DD/YYYY format, and target values from the HM5 control package insert.

6. Select **Accept**.



7. Select **Run Cal**.

   When prompted, mix the control, remove the cap, place the tube in the appropriate tube adapter.

8. Select **Run** to begin the first calibration run.

   When the analysis is complete, the results will appear on-screen.

9. Select **Run Cal** again. The analyzer will display a reminder to mix the sample. Mix control well by slowly rolling the tube flat between your hands 10 times, and then slowly inverting the tube 10-15 times.

10. Follow the on-screen directions, then select **Run**.

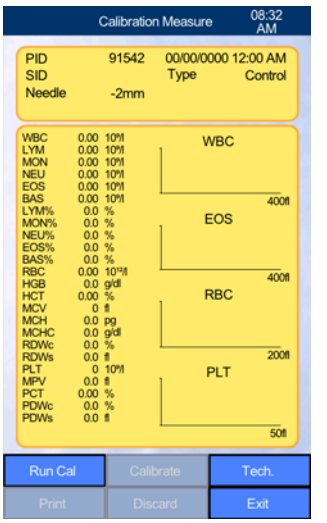
    When the second analysis is complete, the results will appear on-screen.

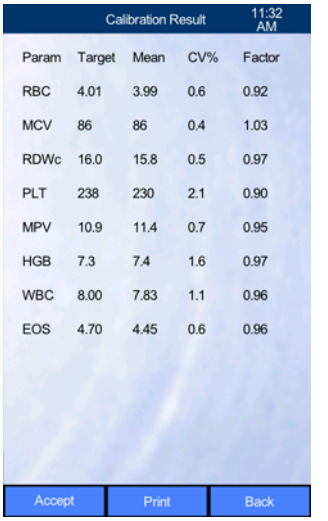
11. Select **Run Cal** for the third time. The analyzer will again display the mix reminder.

12. Select **Run**.

    The analyzer then displays the results of the third calibration.

13. Select **Calibrate**.





14. The analyzer then calculates and displays the new Calibration factors. Select **Accept** to complete the calibration.

Note: *If the analyzer displays the message* **1 or more of your factors are out of range**, *contact Abaxis Technical Support.*

15. Select **Exit**.
16. Perform a Quality Control run two or three times to verify that calibration was successful: see “Running a Quality Control Sample” on page 5-8.

5.2.4 View Calibration History

All calibration times and factors are saved, and can be viewed as follows:

1. From the Home screen, select **Maintenance > Calibration > History**.
2. Use the on-screen arrows to move through the history.

5.2.5 Resetting Calibration

If calibration fails repeatedly, call Abaxis Technical Support. If directed, use the Reset Calibration function as follows.

1. From the Home screen, select **Maintenance > Calibration > Reset Calibration**.
2. Select **OK**.
3. Calibrate the analyzer: see “Calibration Procedure” on page 5-11.

Section 6

Maintenance & Service

Section Contents

6.1 Preventive Maintenance

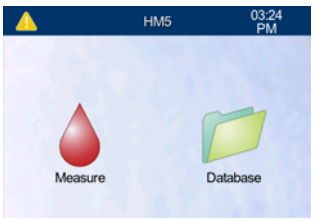
Always keep the analyzer and its immediate surroundings as clean as possible to help keep debris out of the system. Clean up any fluid spilled near the analyzer, and wipe up any spills on the sample rotor.

In addition, periodically performing certain preventive maintenance procedures will help keep the HM5 in optimal operating condition to ensure peak performance and high-quality results.

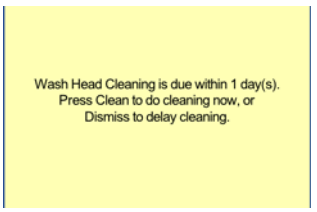
Preventive maintenance can be managed in two ways on the HM5: using the Scheduled Maintenance setting in the Admin Settings (accessible only to Admin users), or through default settings in the software.

The analyzer displays reminders when the two primary routine cleanings need to be performed:

- If Scheduling is disabled: a yellow triangle appears in the upper-left corner of the screen when cleaning is due. Select the triangle to see details.



- If Scheduling is enabled, you can adjust the cleaning frequency within allowed limits. Reminders appear three days, two days, and one day before cleaning is due. You can select **Next** in these messages to perform the cleaning, or **Dismiss** to postpone. Cleanings can also be performed by going to **Maintenance > Cleaning** and selecting the cleaning procedure desired from there.



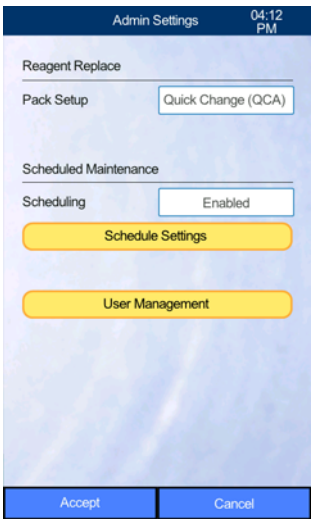
- On the date and time cleaning is due, the analyzer displays a cleaning due message.

Note: *Once the cleaning due message appears, cleaning **must** be performed before the next measurement is run. You will not be able to run samples until cleaning is performed.*

6.1.1 Scheduling Maintenance

The analyzer's maintenance reminder intervals are preset, but can be adjusted to best suit the particular needs of the clinic.

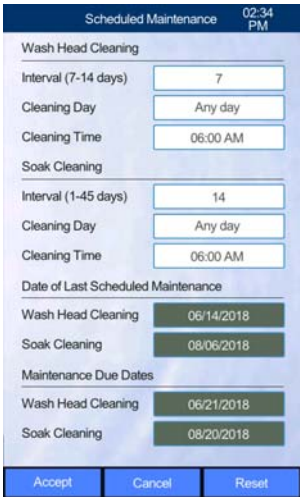
1. From the Home screen, select **Settings > Admin Settings**.
2. Selecting the **Scheduling** field changes the setting from **Enabled** to **Disabled** and vice versa. Set this to **Enabled**.



3. Select **Schedule Settings**.
4. As needed, select the appropriate fields to set the **Interval** and **Cleaning Day and Time** for the Wash Head and Soak Cleanings.

   Abaxis recommends these intervals:

   - Cleaning the Wash Head: 7 days
   - Soak Cleaning: 14 days



Note: *If your sample run rate will be less than 5 samples per day, you may set the Soak Cleaning Interval to 30 days.*

5. Select **Accept** for these settings then **Accept** again to confirm the Scheduling choice.

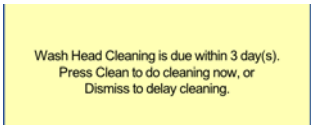
Note: *On installation, you can reset both timers to begin from the current date by pressing* **Reset**. *The next Scheduled Maintenance will then be a full interval away from the current date.*

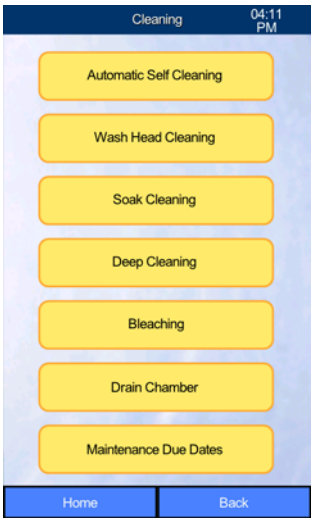
6.1.2 Cleaning the Wash Head

The Wash Head cleans the outer surface of the sample needle with a saline Diluent. If the Wash Head itself is not cleaned regularly, salt can accumulate on the bottom surface, leading to inaccurate test results, extra blanks being needed, and excess reagent use.

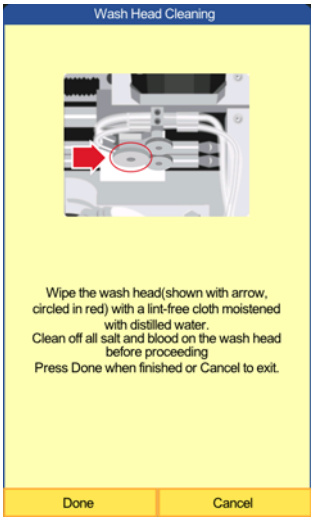
Note: *Do not clean the Wash Head without activating the HM5's software as described in this procedure. Otherwise, the needle assembly may not move correctly, and the analyzer will need to be restarted.*

1. If the analyzer displays a message that Wash Head cleaning is due, select **Clean** or **Next** to begin cleaning. If running this process manually (that is, without prompting by a pop-up), select **Maintenance** from the **Home screen > Cleaning > Clean the Wash Head.**





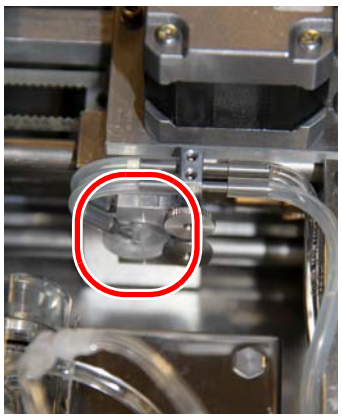
The analyzer then displays cleaning instructions, as detailed in the following steps.



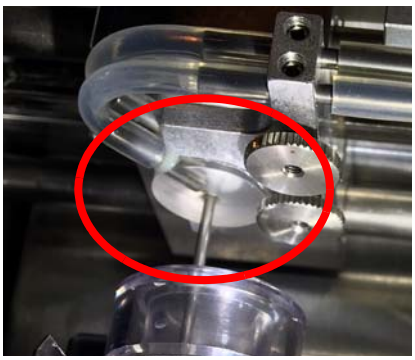
2. Open the door on the right side of the analyzer.

CAUTION: *Do not touch components inside the instrument except as specifically directed.*

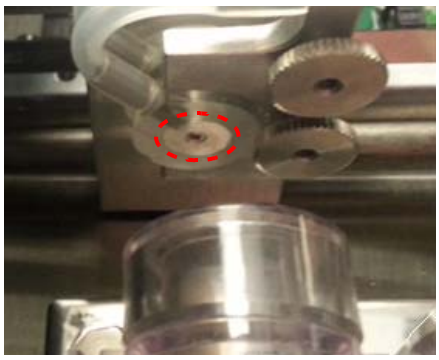
The Wash Head is located at the base of the needle, as shown at right.



3. Locate the Wash Head (Red Circle, see photo at right).
4. Visually inspect the Wash Head for any salt or blood build-up on its bottom surface. For best access, view from below. Refer to the following figures.



Clean Wash Head
No salt or blood build-up present on Wash Head's bottom surface



Wash Head with minor build-up

Wash Head with heavy build-up

- If minor salt or blood accumulation is visible on the Wash Head, clean the Wash Head: Use a soft, lint-free cloth and warm distilled water to gently wipe any build-up off the lower surface of the Wash Head.
- If the Wash Head has a great deal of accumulation on the bottom (as in the far right photo on previous page) or on the top (not shown), the Wash Head must first be removed for cleaning: see “Removing and Cleaning the Wash Head” on page 9-15.

  Upon removal, inspect the Wash Head for salt accumulation on the top *and* bottom surfaces.

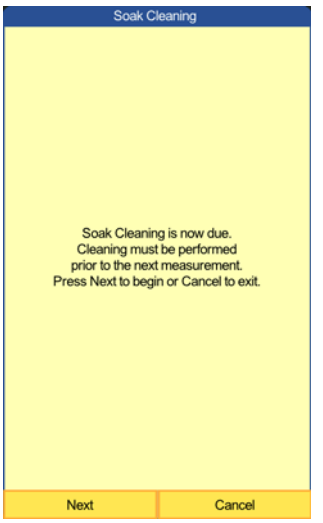
5. Inspect the Wash Head to be sure it is clean before proceeding.
6. When finished, close the side door, then select **Done**.

6.1.3 Soak Cleaning

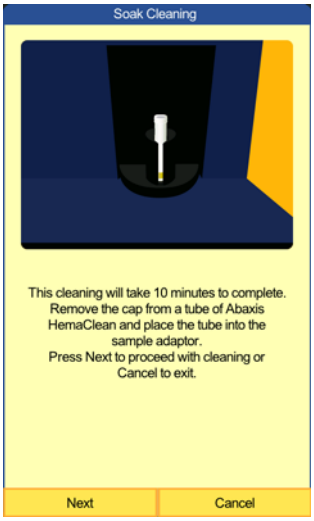
Soak Cleaning helps dissolve organic build-up from all surfaces that contact blood samples inside the analyzer and is the best way to clean the needle, the dilution chamber, and the aperture. The Soak Cleaning process will require a new, unused tube of VetScan HemaClean.

Abaxis recommends a Soak Cleaning every 14 days (the default setting). Users who run fewer than 5 samples per day may set the Soak Cleaning Interval to 30 days. The user may schedule a preferred day and time to perform this cleaning (see “Admin Settings” on page 3-11).

1. The analyzer displays reminders when a Soak Cleaning is needed. When this occurs, select **Next** to begin cleaning. An instruction screen is then displayed.



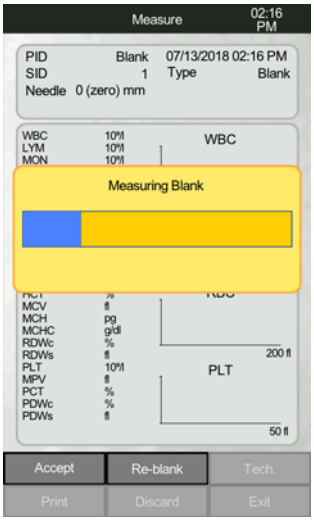
2. Remove the cap from a tube of HemaClean (Abaxis Part number: 790-1513) and place it on the HM5's holder.



3. Select **Next**. The cleaning cycle will last approximately 10 minutes.

Note: *If Soak Cleaning is needed for troubleshooting outside of scheduled maintenance, select* ***Maintenance > Cleaning > Soak Cleaning****, and follow the on-screen instructions, as above.*

4. After the Soak Cleaning, a blank is required to verify that the background counts are within specification. The software will automatically prompt the user to run a blank when a measurement is attempted after a Soak Cleaning. From the Home screen, select **Measure**, and then **Run**.



5. If the blank results are expired and this screen appears, select **OK** to run a blank. If the screen does not appear, you MUST run a new blank anyway. Select **Run**, and then **Blank**.

6. When the blank has run, verify that the results are acceptable (shown in black) or unacceptable (shown in red, with + or * signs, indicating too high).
7. If acceptable, select Accept. The analyzer is now ready to run Quality Control. If not, proceed to "Blank Flags" on page 9-2.
8. Run Quality Control using a new, unopened HM5 normal control. For detailed instructions go to "Quality Control" on page 5-2. If any warning message pops up, contact Abaxis Technical Support.
9. If two out of three Quality Control runs are within target range, the analyzer is ready to run blood work. If two out of three runs fall out of target range or have any error warnings, call Abaxis Technical Support at (844) 247-5271.

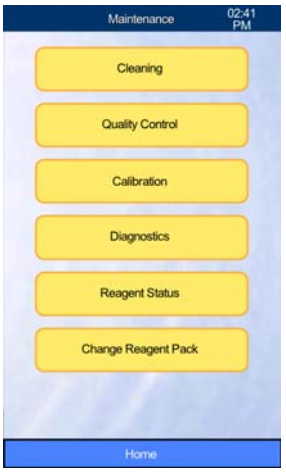
6.2 Automatic Self-Cleaning

After each measurement, the analyzer automatically cleans the measurement area. The software also provides a process to clear the measurement system of any debris when needed:

- when the blank is high for platelets or RBC
- to correct p, b, c, or C warnings after other cleaning procedures have failed
- following other cleaning procedures, such as Soak Cleaning, to ensure the aperture is clean

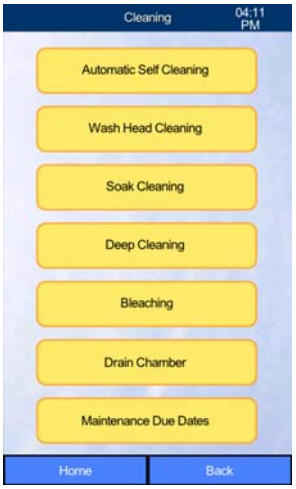
No additional cleaning solution is needed for this process: the HM5 uses the Cleaner and Rinse from the reagent pack.

1. From the Home screen, select **Maintenance**.
2. Select **Cleaning**.



3. Select **Automatic Self-Cleaning**.

   The analyzer then runs the cleaning process, and returns to the Maintenance menu when finished.



6.3 Changing the Reagent Pack

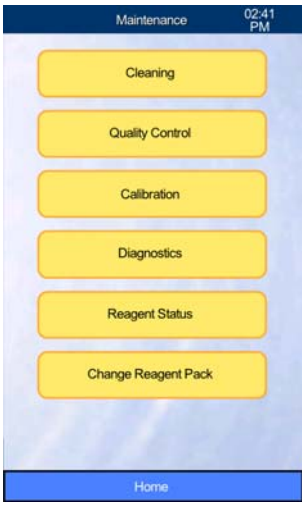
Note: *Abaxis recommends wearing protective eyewear and a lab coat when working directly with reagents (such as changing the reagent pack). In addition, users with sensitive skin should wear latex or nitrile gloves.*

The HM5 tracks the liquid levels in the reagent pack (Abaxis part no. 770-9000), and displays the message **The reagent volumes are running low** when one or more levels is low. When this occurs, change the reagent pack as follows.

1. Make sure you have the following:
   - ❑ New reagent pack
   - ❑ New HM5 Normal Quality Control
2. Remove the control from the refrigerator so it can warm to room temperature before use.
3. Select and follow the appropriate procedure below according to the reagent pack setup.

6.3.1 For QCA Tubing Setup

Use these instructions if the HM5 is set up with a QCA.



1. From the Home screen, select **Maintenance > Change Reagent Pack.**
2. Follow the displayed instructions and prompts.
3. Place the new reagent pack next to the current pack, then select **Next**.
4. Remove the new reagent pack from its shipping box, open the pack lid, then select **Next**.
5. Remove the foam from the pack, unscrew the bottle caps, remove any white foam liners from the bottle caps, and save the bottle caps.
6. Select **Next**.
7. Lift the QCA by the frame, and place it over the new pack. Align the kickstand posts next to the Diluent bottle. Select **Next**.
8. Make sure the frame is centered on each of the bottle seals, then select **Next**.
9. Verify that the colors on the reagent tubes, dip tube heads, QCA frame, and reagent pack all match.
10. One at a time, grasp each dip tube head, and push the tube through its white heat seal and into the same-colored bottle. Repeat until all dip tubes are through the bottle seals and touching the bottom of the bottles.
11. Select **Next**.
12. Dispose of the waste per local regulations. The original white waste bottle or the emptied Diluent bottle with the red cap that came with the initial shipment may be used as the waste container.
13. Select **Next**.
14. Make sure all reagent lines are securely connected to the back of the analyzer and the dip tube heads, and that the reagent tubes are not kinked.
15. Select **Next**. The HM5 will prime all of the reagent tubes.
16. Run a QC sample to make sure the new reagent pack is properly installed and the analyzer is in calibration. The system will prompt you to run a blank before running the control. Confirm that the blank results are within range before running the control: see “Running a Quality Control Sample” on page 5-8.
17. Select **Next**.

6.3.2 For Bottle Caps Tubing

This procedure requires a new reagent pack and a control.

1. From the Home screen, select **Maintenance > Change Reagent Pack**.
2. Follow the on-screen instructions.

Note: *In the following steps, do not touch the tubing with your bare hands, or you may contaminate the reagents. Wear latex or nitrile gloves.*

3. Place the new reagent pack next to the current pack, then select **Next**.
4. Remove the foam from the pack, unscrew and save the bottle caps, then select **Next**.
5. With a clean blade, cut an **X** into the heat seal, then fold down the four flaps to open the bottle.
6. Select **Next**.
7. One by one, remove the reagent caps with the drip-down tubing from the old reagent bottles, and place them on their color-matching bottles in the new reagent pack.

CAUTION: *To avoid contamination, avoid touching the flexible drop down tubes with bare hands.*

8. Make sure the small air vent on each cap is not blocked, so air can flow freely.
9. Empty the waste container, or set up the empty Diluent container from the old reagent pack as the new waste container.
10. Reconfirm that the colors on the reagent tubes, the back of the analyzer, the bottle caps, and the reagent pack all match. Make sure all reagent tubes are firmly attached to the bottle tops and the back of the analyzer, and that there are no kinks in the tubing.
11. Press **Next** to prime the reagents.
12. Press **Next** to proceed the Quality Control menu.
13. Run a QC sample to make sure the new reagent pack is properly installed: see "Running a Quality Control Sample" on page 5-8.

6.3.3 Disposing of Reagent

When it is time to change the reagent pack, there will always be reagent left in the bottles in the old reagent pack. Dispose of this remaining reagent as follows.

CAUTION: *Never pour reagent from a bottle in the old reagent pack into any bottle in the new pack. Doing so could drastically reduce the effectiveness of the new reagents, and could contaminate the new reagents.*

- Dispose of unused reagents and waste in an environmentally friendly manner. Check the local county regulations for proper disposal requirements.
- MSDS are available at in the Resource Center at www.abaxis.com/reference-center.

6.4 Software Upgrades

Abaxis will periodically provide a software upgrade for the HM5. Abaxis can send these upgrades preloaded on a USB drive, and they can be downloaded from www.abaxis.com and copied to a USB drive. Follow the instructions on the Abaxis website.

Upgrade from the USB drive as follows:

1. Power off the analyzer.
2. Plug the USB drive containing the software into a USB port on the analyzer.
3. Power on the analyzer and select **Upgrade**.

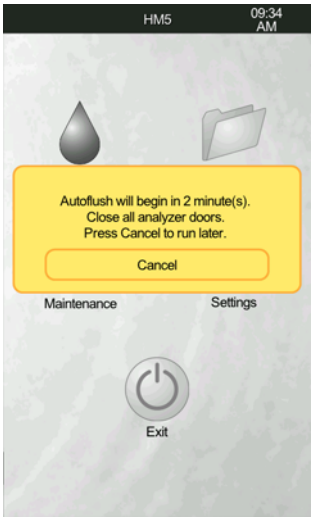
Note: *Do not select* **Erase/Format** *unless directed by Abaxis Technical Support. Doing so will erase all settings, patient data, and control data from the analyzer, and require it to be recalibrated.*

4. When prompted, unplug the USB drive and select **OK**.

The analyzer then automatically reboots to complete the software upgrade.

6.5 Auto Maintenance Flush

If the HM5 has been powered on but not used for 4 days, it will perform an Auto Maintenance routine to flush itself out to prevent salt build-up within its internal tubing. If the notification appears, select **OK** to begin maintenance immediately. Otherwise, the flush begins automatically within 2 minutes.



6.6 Peristaltic Pump Tubing Replacement

The analyzer's peristaltic pump is designed to be maintenance-free. However, after long periods of non-use, the pump tubing can become flattened and eventually needs to be "massaged" back into shape, or replaced. A spare tube is included in the accessories kit.

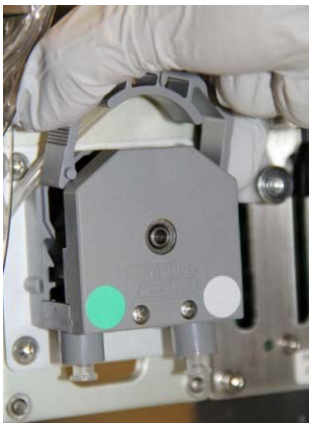
Although replacement is a simple process, Abaxis strongly recommends contacting Abaxis Technical Support before beginning. They will verify the need for pump tube replacement, and provide guidance through the process if necessary.

Note: *Wear latex or nitrile gloves during this procedure.*

Replace the peristaltic pump tube assembly as follows.

1. Open the analyzer's back door, and locate the peristaltic pump at the lower left of the rear compartment.
2. Disconnect the green and white color-coded tubes attached to the base of the pump housing, by twisting the luer connectors as shown.

3. Use your thumb and forefinger to grasp the middle of the serrated band, then squeeze and lift the band straight up.



4. Grasp the bottom left tube connector (green band) and push it to the left. The connector slides out, freeing the left end of the tube.

5. Grasp the bottom right tube connector (white band) and push it to the right. The connector slides out, freeing the right end of the tube.

6. Slide the gray attachments toward the center of the yellow pump tube.

7. Disconnect the tube from the clear tube connectors.

8. Place the two gray attachments onto the new pump tube. Connect either end of the new yellow pump tube to the clear connectors.
9. Slide the gray attachments down onto the clear connectors so that the connectors fit snugly into the gray pieces.

10. Using one hand to guide the tubing, slide one of the gray pieces on the pump tube into the right side of the pump. Stretch the yellow pump tube over the top of the pump, then slide the remaining gray piece into the left side of the pump until it snaps into place.

11. Reconnect the appropriate color tubes to the bottom of the pump.
12. Grasp the gray cover and slide it down over the pump.
13. Once the notches on the side are in place, push down on the top of the cover until it snaps into place.
14. Wipe up any spilled fluids from the base of the instrument.

Section 7

User Permissions

This section describes how to provide three different levels of user access to the VetScan HM5.

Section Contents

7.1 User Permission Levels

The HM5 software provides for three levels of users: Basic, Advanced, and Admin.

7.1.1 Basic Level

Basic users can perform the following:

- Measure blanks and run CBCs
- Perform scheduled maintenance
- Change reagent packs
- Run QC control on previously entered QC lots
- View, print, and save CBC results

7.1.2 Advanced Level

Advanced users can perform all functions available to Basic Users, as well as the following:

- Load new QC lot values
- Calibrate the analyzer
- Adjust all settings other than Admin settings (schedule maintenance)

7.1.3 Admin Level (Default)

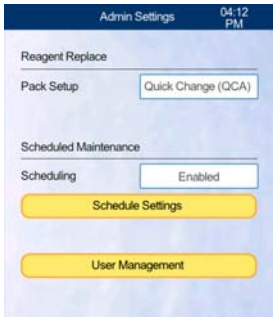
Admin users can view and operate all functions in the analyzer, and have access to all settings. The default user level is Admin.

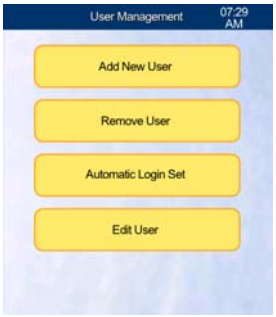
7.2 Adding Users and Passwords

Each user may have a unique login and password or multiple users of a given level may also share a login and password.

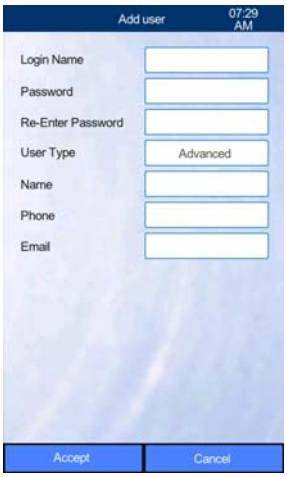
Add new users and their passwords as follows.

1. From the Home screen, select **Settings > Admin Settings > User Management > Add New User**.





2. Select fields and enter the **Login Name** and **Password**, then **Re-Enter Password**.

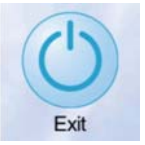


3. Select **User Type** until the desired permission level is displayed.
4. If desired, enter **Name**, **Phone**, and **Email**.
5. Select **Accept**.

7.3 Logging In

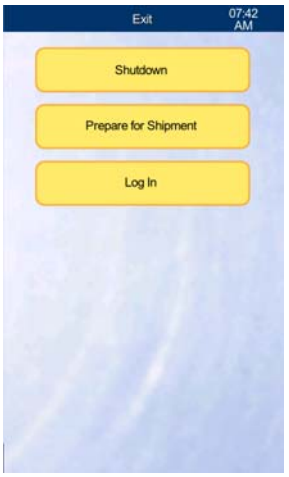
Log into the HM5 as follows.

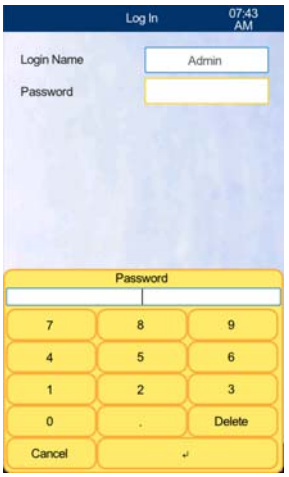
1. From the Home screen, select **Exit.**



2. Select **Log Out Admin**.

3. Select **Log In**, then enter your login name and password.





4. When the advanced or admin-level maintenance is complete, be sure to **Exit** and **Log Out** again to return the analyzer to its basic mode.

7.4 Automatic Login Set

Automatic login set allows the VetScan HM5 to revert to a specific user whenever rebooted.

1. Select **Settings > Admin Setting > User Management**.
2. Select **Automatic Login Set** and select the default user.

Section 8 Shutdown

This section describes how to shut down the VetScan HM5 analyzer.

Section Contents

8.1 Shutting Down the Analyzer

The HM5 is designed to be left on at all times, except when it will not be used for long periods. During such periods, shutdown functions are used to properly maintain the analyzer

- If the analyzer will be unused or powered off for more than a week, use the **Temporary Shutdown** option: see below.
- If the analyzer will be unused or turned off for more than two weeks, or will be shipped, use the **Prepare for Shipment** option: see "Longer Term Shutdown or Storage" on page 8-3.

CAUTION: ***Always*** *follow the instructions in this section when turning off the analyzer.*

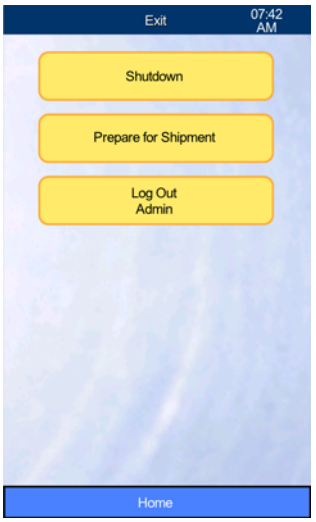
The analyzer uses an isotonic saline solution in its fluidic system. When the analyzer is shut down properly, as described below, it rinses its fluidic system to remove this solution. Simply turning off power does not allow it to perform this rinse, which can lead to salt build-up in the system.

CAUTION: *If an emergency occurs, turn off the analyzer using the power switch on the back of the instrument, and unplug the power cord from its outlet.*

8.1.1 Temporary Shutdown

If the analyzer will not be used for 7-14 days, shut it down as follows:

1. On the Home screen, select **Exit > Shutdown**.
2. Select **OK** to confirm.
3. When the analyzer displays a message and sounds a tone, power it off using the power switch on the rear panel. The off position is marked by the **O** symbol.



8.1.2 Longer Term Shutdown or Storage

If the analyzer will be unused for more than two weeks, or will be shipped, use the **Prepare for Shipment** option as follows.

CAUTION: *If this is not done before the analyzer is powered off for long periods, salt crystals can form blockages in the tubing.*

Required materials:

- Distilled water, 200 ml
- 1-liter flask, polypropylene (from Abaxis) or an equivalent container

1. From the Home screen, select **Exit**.
2. Select **Prepare for Shipment**.
3. Follow the instructions that appear on the display.

   The procedure drains the reagents from the analyzer, and flushes the Diluent from the internal tubing. An alarm sounds when it is safe to turn off the analyzer using the power switch on the back panel.

8.1.3 Powering Off for Troubleshooting

On occasion, the analyzer may freeze or require a reboot for troubleshooting. In these situations, proceed as follows:

1. Turn the analyzer off using the power switch on its back panel.
2. Turn the analyzer on.

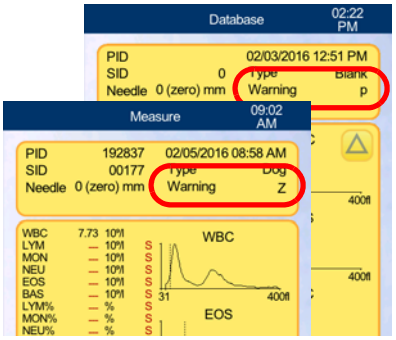
Section 9 Troubleshooting

Use the information in this section to help diagnose and solve problems with the VetScan HM5.

Section Contents

9.1 Warning Indicators

This section lists warning indicators (flags) that can appear in test results, along with possible solutions for each.



Capital-letter warning flags (**B**, **C, Z**, etc.) indicate WBC-related parameters, while lower-case flags (**b**, **c**, **p**, etc.) indicate RBC- or PLT-related parameters. This is true for *all* measurement cycles.

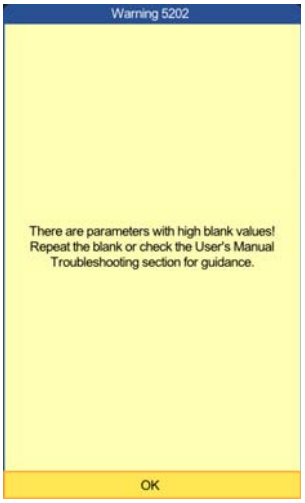
Warning flags appear at the top right of the blank or sample results screen.

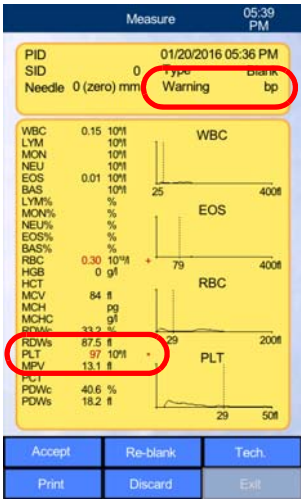
9.1.1 Blank Flags

A blank must be run at the beginning of each day before running samples, controls, or calibrations, or every 12 hours for 24-hour clinics. The blank measures the cleanliness of the analyzer and the purity of the reagents.

- If there are no warning flags and no values highlighted in red (accompanied by **+** or ***** **)**, accept the blank. The analyzer is then ready to run patient samples.
- If there are issues with the blank, the warning shown at right appears. Click **OK** to view the actual blank results on the blank results screen.

  Elevated values are shown in red.





High values for the following parameters cause the blank to fail and display these warning flags:

Parameter	High Blank Warning Flag	Blank Value Limit
WBC	B	0.50 x 10^9/l
EOS	X	0.20 x 10^9/l
RBC	b	0.05 x 10^12/l
HGB	H	10 g/dl
PLT	p	27 x 10^9/l

Other warning flags may be seen on a blank, such as c, C, and S.

9.1.1.1 High Blanks

CAUTION: *If the high blank value warning appears, accept or discard the blank and rerun it, but* ***do not begin running samples****. Instead, follow the troubleshooting procedures below according to the flags that appear in the results.*

There are parameters with high blank values! Repeat the blank or check the User's Manual Troubleshooting section for guidance.

If any high blanks are accepted without correcting causes, the blank flags will appear in the sample results, and the results for that parameter will not be reported, until the next acceptable blank is run and accepted. The analyzer will not allow QC or Calibration runs to be performed until the blank is acceptable.

A red **S** in the results indicates that a result was not displayed since an error occurred (such as a blank flag).

9.1.1.2 p, b Warning Flags

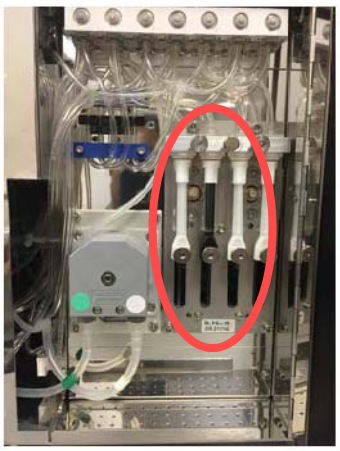
p and **b** flags can indicate salt and/or blood build-up. If either of these appears, do the following:

1. Visually inspect the Wash Head and dilution chamber below to make sure there is no salt or build-up. For the best view, examine from below. For details, see "Cleaning the Wash Head" on page 6-4.
   - ❑ If the Wash Head has significant accumulation, the Wash Head must be removed for cleaning: see "Removing and Cleaning the Wash Head" on page 9-15. While the Wash Head is removed, clean the area around the Wash Head mounting point if there is salt build-up there.
   - ❑ If the Wash Head is clean, perform a Soak Cleaning: see "Soak Cleaning" on page 6-6 then repeat the blank.
2. Check for blood debris in the dilution chamber. If debris is found, manually clean this area while performing Deep Cleaning (see "Deep Cleaning" on page 9-18) then rerun a blank.
3. If the **p** or **b** flags persist, perform a Soak Cleaning: see "Soak Cleaning" on page 6-6. Then repeat the blank.
4. If the **p** or **b** flags remain, contact Abaxis Technical Support.

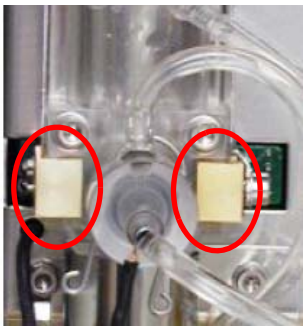
9.1.1.3 X Warning Flags

X warning flags can indicate severe salt or blood build-up, or possible leaks in the Lyse 2 and/or Diluent reagent tubing. If an X flag appears, do the following:

1. Visually inspect the Wash Head and the dilution chamber below for salt or blood debris. For best access, view from below. See “Cleaning the Wash Head” on page 6-4. If debris is found, follow the directions for cleaning the Wash Head. Rerun the blank.
2. If the X flag persists, perform an Soak Cleaning: see “Soak Cleaning” on page 6-6, then rerun the blank.
3. If the issue has not been resolved, perform “Deep Cleaning” on page 9-18, then rerun the blank.
4. If the blank is still high for EOS, perform “Removing and Cleaning the Wash Head” on page 9-15. Remove blood debris from the dilution chamber while the Wash Head is pulled to the right during the cleaning process. Rerun the blank.
5. For continued X flags, check the Lyse 2 (orange) and Diluent (green) reagent tubing for bubbles or leaks. If either are found, attach the tubing more firmly to the analyzer, dip head or bottle cap. If the attachment is loose, cut 3-5 mm off the end of the tube and reattach. Then prime: **Maintenance > Reagent Status > Prime** and select Lyse 2 and/or Diluent.
6. If the flag persists, Remove the Lyse 2 (orange) and Diluent (green) reagent tubes from the back of the analyzer and hold them up so all of the fluids drain back into the bottles. Reattach the reagent tubes and prime them once: from the Home screen, select **Maintenance > Reagent Status > Prime** for Lyse 2 and/or Diluent. Run the blank.
7. If the EOS value is still high, open the analyzer’s back door, and examine the black syringe for any signs of salt residue on or near it. If salt or leaking fluid is present, contact Abaxis Technical Support.
8. If the **X** flag persists, contact Abaxis Technical Support.



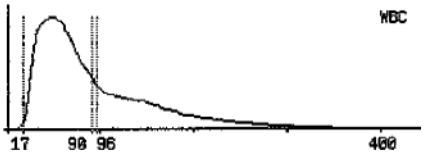
9.1.1.4 B, H Warning Flags

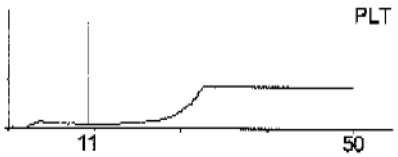
Warning Flag	Meaning	Solution
B	WBC blank is high	• **If B is the only flag:** check the Lyse (yellow) reagent tube for loose connections on the back of the analyzer and where the tubing connects to the bottle cap or dip head. If the tubing has stretched out at either location, cut the bulge off the tubing and reattach, then prime the Lyse. (From the Home screen, select **Maintenance > Reagent Status > Prime** for the Lyse.) • If **B** is accompanied by other flags (such as p, X or b), follow the troubleshooting process for those flags.
H	HGB blank is high	• Check for moisture, salt or blood debris on the HGB head (in the side door area, circled in red) and dry/clean if any is found. Reboot the HM5 then rerun the blank.  • Run Soak Cleaning or Deep Cleaning, then rerun the blank. • Run a self-test: from the Home screen, select **Maintenance > Diagnostics > Self-Test > Start**. If the self-test fails, call Abaxis Technical Support.

9.1.2 Result Warning Flags

Warning flags can appear in sample results as well as blanks. See the following chart to troubleshoot these flags.

Flag	Meaning	Description / Recommended action
E	No sample detected.	• If no values are shown (the results resemble blank results), verify that the sample tube is filled at least halfway. • If needed, lower the needle to -2 mm to reach the sample, and/or insert a sponge disk to raise the tube. See “Measurement Settings” on page 3-4. • Make sure the correct tube holder is being used for that size tube. • Run Soak Cleaning. • If the error persists, redraw the sample, making sure to fill the tube at least halfway, then rerun. If the error persists further, contact Abaxis Technical Support.

Flag	Meaning	Description / Recommended action
S	Particular value is too high or low to be measured.	• Check for other warnings, such as **X**, **p**, **m**, **M**, **c**, or **C**, and troubleshoot those to resolve the **S** flag.
M, **N**	WBC values are too high.	• This can occur with inadequate Lyse (yellow bottle) delivery. Make sure the Lyse tube (yellow) connects securely to the Lyse bottle and the reagent port on the back of the analyzer (if the connection is too loose, cut the bulge from the ends of the tube and reattach), then prime the Lyse and rerun the sample: from the Home screen, select **Maintenance > Reagent Status > Prime** for Lyse. • If the **M** flag persists, verify that the Lyse reagent tube is connected to the correct port on the back of the analyzer and to the correct bottle within the reagent pack. If bottles have been swapped, remove the reagent tubes from the back of the analyzer and hold the tubing up so all of the fluids drain back into the bottles then attach the tubing correctly and prime the tubes affected. • The **M** flag can also occur with legitimate very high WBC counts, as with leukemias: see the figure at right. Check the Lyse delivery system, and if no problems exist, perform a manual smear to verify the WBC count.  • If the **M** flag persists and the manual smear does not indicate a high WBC count, call Abaxis Technical Support.
c, **C**, **q**	Analyzer's aperture is clogged.	• Run 2-3 automatic self-cleanings (see "Automatic Self-Cleaning" on page 6-8). • Redraw a sample, making sure to transfer the sample into the tube immediately and mix well, then rerun. • If visible clots are seen in the original sample, perform a Deep Cleaning. If no visible clots, run a Soak Cleaning and rerun a new, well-mixed sample • Verify the software version is 2.3 or higher. • If the problem persists, call Abaxis Technical Support.
m	• RBC and/or PLT measurement exceeds the linearity limit. • A very dirty analyzer, contaminated reagent pack, or severely dehydrated patient.	• Make sure the sample is properly mixed, to prevent settling. • Visually inspect the Wash Head. If very dirty, remove and clean the Wash Head (see "Removing and Cleaning the Wash Head" on page 9-15), then rerun the sample. • If sample is hemolyzed, redraw and rerun. • Perform Soak Cleaning. If the warning persists, repeat the Soak Cleaning. • If the patient is severely dehydrated and fluid administration is indicated, discard the run and redraw after fluids have been absorbed. • If the **m** flag persists, call Abaxis Technical Support.

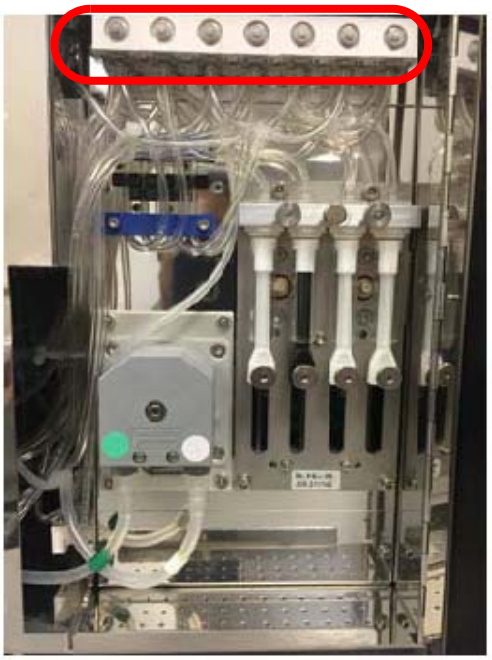
Flag	Meaning	Description / Recommended action
L	Insufficient Lyse reagent delivered to burst all RBCs (or lyse-resistant RBCs), platelet clumping or large platelets for a Cavalier King Charles Spaniel.	• If patient is a Cavalier King Charles Spaniel or other breed with known predisposition to macro-platelets, perform a manual smear. • If the draw was difficult, the platelets are low, or there were delays in filling the tube, redraw and rerun. • Make sure the Lyse tube (yellow) has no kinks, or bends and that nothing is compressing the tubing. • Check for bubbles in the Lyse tube. If found, prime the Lyse: see "Check Tubing" on page 4-4. • If no Lyse issues are found, rerun the sample with increased Lyse +0.1 ml, then if needed with +0.2 ml: see "Adjusting the Lyse Volume" on page 4-9. • If the L Flag still persists, draw a new sample, aiming for a clean needle puncture and fast transfer to the EDTA tube. • If the **L** flag still persists, call Abaxis Technical Support.
W	Severe platelet clumping or very large WBCs.	• If the cat platelet histogram resembles the diagram at right, redraw the sample, reduce delays in filling the tube, and mix well with at least 10-15 inversions immediately.  • If the **W** flag persists, call Abaxis Technical Support.
Y	• Reagent tubing connected to incorrect port or bottle, clogging, or insufficient Lyse 2 delivered. • If the **Y** flag is accompanied by many other warnings (**c**, **C**, **E**, **B**, **Y**), call Abaxis Technical Support.	• Make sure the Lyse 2 tube (orange) is connected to the Lyse 2 bottle. If not, disconnect the incorrectly connected tubes from the analyzer, and hold them up so the liquid in them flows back into the bottles. Connect tubes to the correct connections on the analyzer, bottle caps or dip tubes by color-matching the tubes, analyzer port, and bottle caps or dip tube heads, then prime Lyse 2. • If the tubing is already correctly connected, check the Lyse 2 tubing connections at the analyzer and the bottle cap/dip head. Make sure the tube is securely connected to the connector. If this reagent pack was newly installed, prime the Lyse 2 twice, then rerun the sample. • If the Lyse 2 tube is securely connected, run 1-3 automatic self-cleanings (see "Automatic Self-Cleaning" on page 6-8), then rerun the sample or blank that gave the **Y** warning. • If the **Y** flag persists, call Abaxis Technical Support.
Z	Lyse 2 delivery issues, or a dirty Wash Head or aperture.	• Check the Lyse 2 tube as described above for the **Y** flag. • If the Lyse 2 tube connected correctly, inspect the Wash Head and clean as needed (see "Cleaning the Wash Head" on page 6-4), then run 1-3 automatic self-cleanings (see "Automatic Self-Cleaning" on page 6-8). Rerun the sample. • If the **Z** flag persists, call Abaxis Technical Support.

9.2 Error Messages

9.2.1 Reagent Supply Errors

If a first Reagent Supply Error is displayed, proceed as follows before pressing **Prime**:

1. Check reagent tubing for loose connections for the reagent mentioned, in particular:
   - ❑ Where the tubing attaches to the rear of the analyzer.
   - ❑ Where the tubing attaches to the bottle cap or dip tube head (top of QCA).
2. If any connections are loose, attach more firmly by pushing the tubing further onto the hose barbs, bottle cap or dip tube head.
3. If tugging lightly on the affected clear tubes causes it to pop off of the attachment point, cut 3-5 mm off of the tip of the tubing, and reattach it to make a better seal.
4. Straighten the tubing if kinked or severely bent or being compressed by anything such as the foot of the analyzer.
5. Make sure the reagent bottle is not empty.
6. Prime the reagent tube by pressing the **Prime** button on the pop-up.
7. If a second Reagent Supply Error is displayed, open the door on the back of the analyzer, and check for any loose or disconnected tubes. Examine the seven white valves (circled in red) closely to see if any tubes have detached from them. Touch the tubes to help determine if they are tightly attached. Reconnect any tubes that are detached or loose, then select **Re-prime.**



8. If a third Reagent Supply Error appears, select **Abort** and contact Abaxis Technical Support.
9. If the reagent priming is successful, select **Back** and repeat the step before the Reagent Error appeared. If the reagent sensor was turned off during the error process, from the Home screen, select **Maintenance > Reagent Status**, and turn the sensor back **ON**.
10. Select **Calibrate Sensors**.
11. If the issue persists, call Abaxis Technical Support.

9.2.2 Fluid Sensor Error

If a screen shows a sensor calibration error, the system has turned off that reagent sensor.

1. Go through troubleshooting for "Reagent Supply Errors," on the previous page.
2. From the Home screen, select **Maintenance > Reagent Status**, and turn the sensor back **ON**.
3. Select **Calibrate Sensors** to recalibrate the failed sensor.
4. If the issue persists, call Abaxis Technical Support

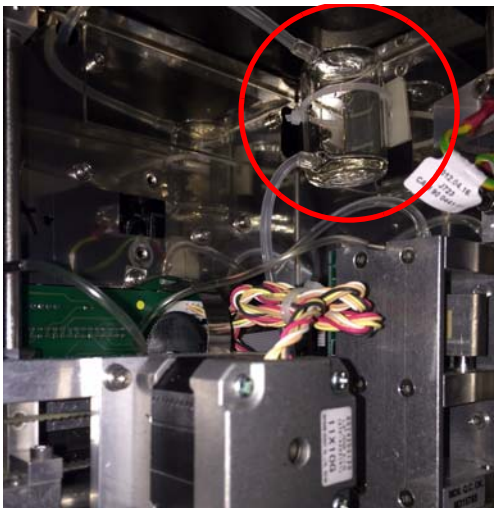
9.2.3 Drain Pressure Error

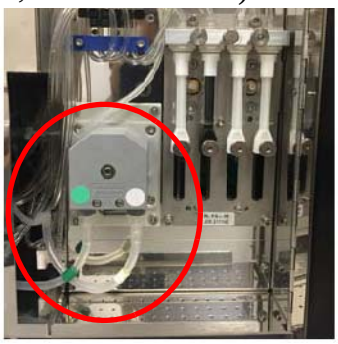
Pressure errors occur when the analyzer is unable to empty its waste. This error can result from a kink in the waste tube, a full waste bottle, a salt or blood clot, or disconnected tubing in the analyzer.

1. Check the waste tube (red band) for pinching or kinks and straighten if necessary. Empty the waste bottle if needed.
2. Select **Drain**.

   The analyzer will make a series of clicking noises while it attempts the draining.
3. If the pressure error continues, touch **Re-Drain** and the analyzer will try again to clear the error by flushing fluids through the internal tubing.
4. If problem persists, open the analyzer's side door.

   a. Look for any debris in the tubing, especially around the puffer chamber (side door in the upper right, circled at right) and the tubing around the peristaltic pump (rear door lower left, as shown below).



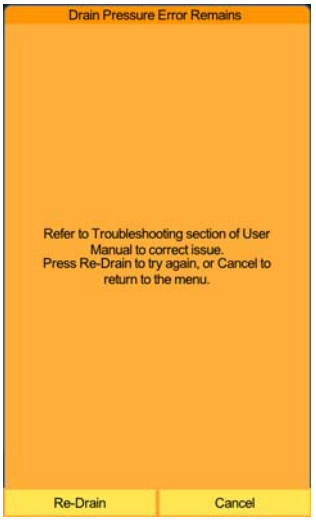


   b. Check the puffer chamber drain tube for clots, and massage out any clots if possible.

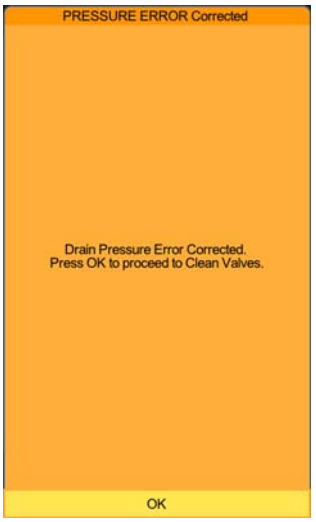
c. Check all tubing visible from the side door for clots, and remove and flush any tubing that has visible clots.

Note: *If any visible clot is found, after the warning is resolved, it is advisable to draw a fresh sample from the last patient.*

d. Make sure all internal tubing is properly connected to the correct ports, and no loose tubing ends are visible. Press **Re-Drain**.



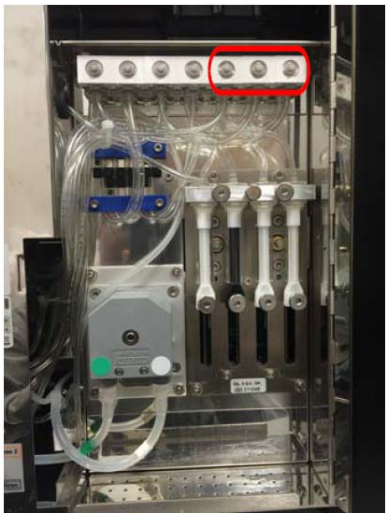
5. If the problem is not yet resolved, check whether the peristaltic pump tube has been overly flattened or is sticking to itself: see “Peristaltic Pump Tubing Replacement” on page 6-13.
6. Attempt to run a blank.
7. If the screen message indicates that the pressure error has resolved AND the blockage was due to clots in the valves, perform Valve Cleaning (only in software v2.3 and higher). The Valve Cleaning cycle will take about 20 minutes. Otherwise, select **Cancel**.
8. If the pressure error still persists, contact Abaxis Technical Support.



9.2.4 Vacuum Error

Vacuum errors can occur if a reagent bottle is empty, the Wash Head is moved without going through the on-screen prompts or one of the tubes inside the analyzer's back door becomes disconnected.

1. Open the analyzer's back door and look for any disconnected tubing and reconnect them. In particular, check the valves in the back door area as shown.



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Note: *If the tube falls off again immediately when the sample or blank run is attempted, the analyzer must be serviced: contact Abaxis Technical Support.*

2. Make sure no reagent bottles are empty.
3. Press each valve button several times to determine if any are stuck. Buttons should easily depress and pop back out. If a valve is stuck, contact Abaxis Technical Support.
4. Open the analyzer's side door to see if any liquid has spilled on the floor of the analyzer. Wipe up any liquid and power the analyzer off then on to re-home the needle. Run a blank to verify that the issue is resolved.
5. If the issue persists, open the analyzer's side door and look for any detached tubing. Dry and reconnect if any are found.
6. Grasp the measuring tube (shown at right) and push it in firmly while slightly rotating it to the right and left to be sure it is firmly seated.

7. Run a sample or blank to see if the issue is resolved.
8. If the issue persists, contact Abaxis Technical Support.

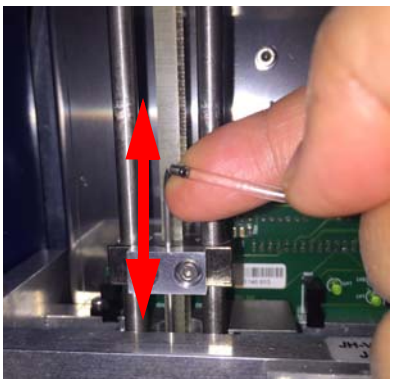
9.2.5 Needle Motor Errors

Sampling and Horizontal Needle Motor errors occur if the needle inside the analyzer's side door cannot move up and down or side to side, respectively.

9.2.5.1 Sampling Errors

Try the following in the order shown.

1. Open the side door, and locate the sampling needle (the thin tube which passes through the Wash Head).
    a. If the needle is bent or damaged, call Abaxis Technical Support.
    b. Move the needle away from any part it may be touching. If you move the needle, reboot the analyzer using the switch on the back of the analyzer.
    c. Make sure the Wash Head thumbscrews are tight (see picture of screws on the next page). Tighten them if they are loose and select **Retry**.
2. If the error repeats:
    a. Turn the analyzer off.
    b. Grasp the needle and move it up and down as far as able 3-4 times to relubricate the guide bars.
    c. Turn the analyzer back on and run a blank.



If the error continues, call Abaxis Technical Support.

9.2.5.2 Horizontal Needle Motor Errors

Try the following in the order shown.

1. Examine the area to the right and left of the needle and Wash Head assembly for any blockage (including salt build-up) preventing left and right motions. If anything is found:
    a. Remove the obstruction and/or clean the salt debris.
    b. Select **Retry**, or turn the analyzer off and on again, then attempt to run a blank.
    c. If the issue repeats, call Abaxis Technical Support.
2. If no obstruction is found:
    a. Turn the analyzer off.
    b. Move the needle out of the dilution chamber (if it is in the down position) then move the whole assembly left and right 3-4 times to redistribute the lubricant on the horizontal bars.
    c. Turn the analyzer back on and run a blank.
    d. If the issue repeats, call Abaxis Technical Support.

9.2.6 Sample Rotor Errors

The sample rotor turns the door to deliver the sample tube to the internal needle during a measurement. The Sample Rotor error indicates a blockage preventing the sample door from turning or an issue with the sample rotor motor.

Correct this error as follows:

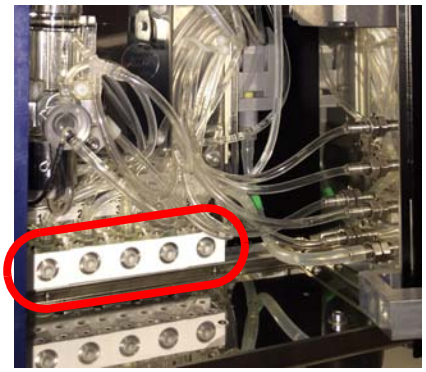
1. Open the door on the analyzer's right side.
2. Make sure the two thumbscrews holding the Wash Head bracket in place are tight. If they aren't, tighten them.
3. Look for and remove anything that may be blocking the sample door from rotating.
4. Select **Retry** or reboot the analyzer then attempt to run a blank to determine if the issue is resolved.
5. If the issue repeats, call Abaxis Technical Support.

9.2.7 MValve Errors

The MValve error occurs when the controlling computer board fails or if a valve is stuck.

Correct this error as follows:

1. Open the analyzer's back and side doors.
2. Push the clear button on the front of each of the 12 valves (valves 1-5 circled at right) 2-3 times.
3. If debris is visible in one of the tubes attached to the valves, detach and remove that tube and attempt to massage the debris out of the tube.
4. Reattach the tube to its connection point.
5. Select **Retry**.
6. If the issue persists, turn the analyzer off and then on again, then attempt to run a blank.



9.2.8 MicroDilutor Motor Error

A MicroDilutor Motor error indicates an issue with the motor that draws blood into the sample needle.

Correct this error as follows:

1. Turn the analyzer off and open its side door.
2. Locate the cylinder (circled), place a finger on it and spin it back and forth several times.
3. Turn the analyzer back on and attempt to run a blank.
4. If the blank runs, perform an Soak Cleaning.

9.2.9 Diluent and Lyse Dilutor Motor Errors

These errors refer to the motors that move the syringes in the back of the analyzer.

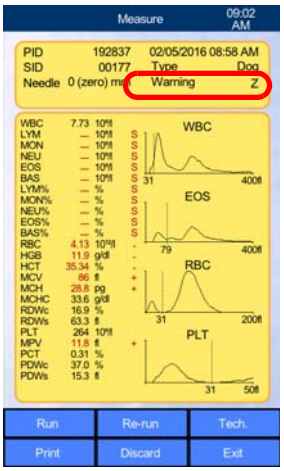
Correct this error as follows:

1. Check for kinks in the reagent tubing from the analyzer to the bottle caps or dip tube heads.
2. If no kinking is found, turn the analyzer off, open the back door of the analyzer and manually move the syringes up and down a few times.
   - ❑ If they move, turn the analyzer back on and attempt to run a blank.
   - ❑ If they do not move or appear to be damaged, call Abaxis Technical Support.

9.3 Evaluating Unexpected Results

If the analyzer results do not support the observed clinical symptoms, try the following steps:

1. Look for warning flags on the analyzer screen.

   If a flag is found, go to the troubleshooting procedure for that particular flag.

Note: *When viewing results through a practice management software, keep in mind that some PMS systems do not show the flags from the analyzer patient file.*

2. Examine the platelet histogram for signs of clumping.

   For details, see "Cat: Clumped PLT, Increased LYM" on page D-10 for interpretation. Redraw and rerun if the PLT histogram indicates clumping.

3. Open the side door of the analyzer and look for any salt or blood debris. If any is found, clean the area necessary. Go to "Additional Cleanings and Processes" on page 9-15 for various cleaning procedures which can be run.

4. Run a new blank then rerun the sample to see if results now clinically fit.

5. If results are still not supporting the clinical symptoms, call Abaxis Technical Support

9.4 Additional Cleanings and Processes

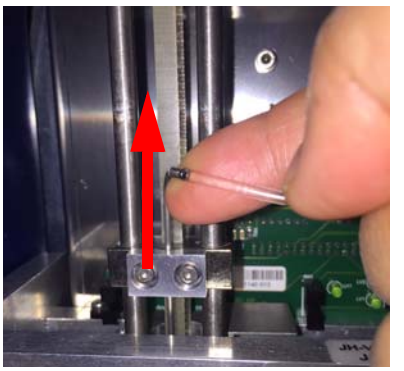
9.4.1 Removing and Cleaning the Wash Head

If salt or blood build-up on the Wash Head cannot be removed by merely wiping the surface or if salt debris is seen above the Wash Head, remove the Wash Head for more thorough cleaning.

1. Power off the analyzer using the switch on its back panel.

2. Open the door on the right side of the analyzer.

3. If the needle is not in the highest position, place a finger under the bend in the needle and push up until the needle will no longer rise.

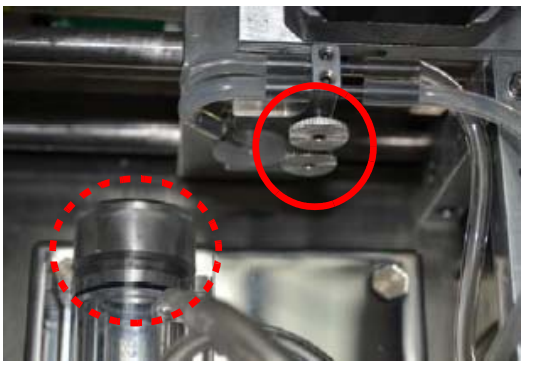


CAUTION: *Take care not to bend the needle in the dilution chamber below.*

4. Move the Wash Head assembly to the right (arrow) until it stops.

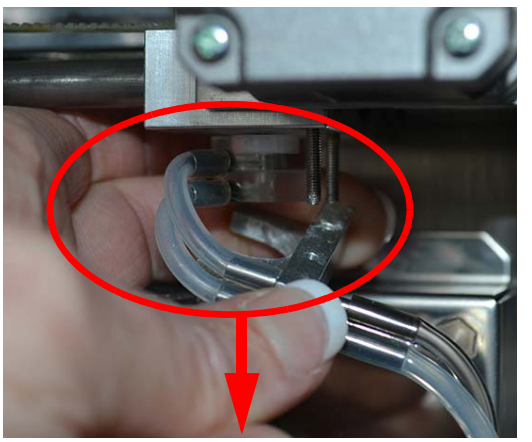
.

5. Loosen the thumbscrews (solid circle), and remove both completely. Take care not to drop them into the counting chamber (dashed circle).



6. Gently pull the Wash Head bracket (circled) straight down, then pull the Wash Head straight down.

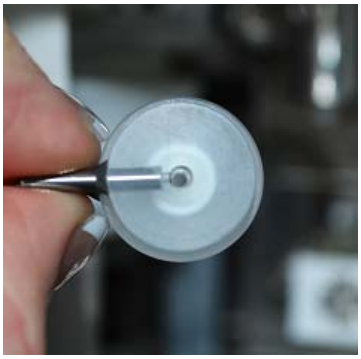
   If the needle is pulled down with the Wash Head, hold the needle in place from above so it doesn't descend with the Wash Head.



7. Remove the Wash Head from the tubing, and submerge it in a container of warm distilled water.

8. If the two tubes from the Wash Head bracket are dirty or clogged, remove them from the bracket and submerge them as well.

9. Holding the metal tube connectors on the Wash Head, swing the Wash Head back and forth while submerged in the warm distilled water to increase flow through the central hole.



CAUTION: *Do not insert anything through the center of the Wash Head, as the Teflon there is easily damaged.*

10. After it has soaked for a couple of minutes, clean the top and bottom surfaces of the Wash Head by wiping thoroughly with a moist, lint-free tissue to remove all salt residue. Large, hard salt residues may require longer soaking times.

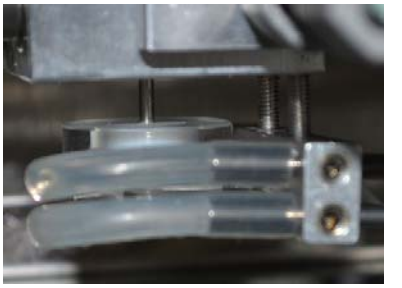
11. Inspect the Wash Head to make sure it is free of salt and blood build-up.

12. Reconnect the two tubes from the Wash Head bracket.

13. Make sure the Wash Head is right-side up, with the white disk facing upward as shown at right, and reinsert it into the round opening in the Wash Head bracket.

14. Slide the bottom of the Wash Head into the crescent-shaped notch, as shown.

15. Align the Wash Head with the needle, and the bracket with the two thumbscrew posts, as shown at right.
16. Push the Wash Head/bracket set upwards into place.
17. Screw on both thumbscrews tightly.

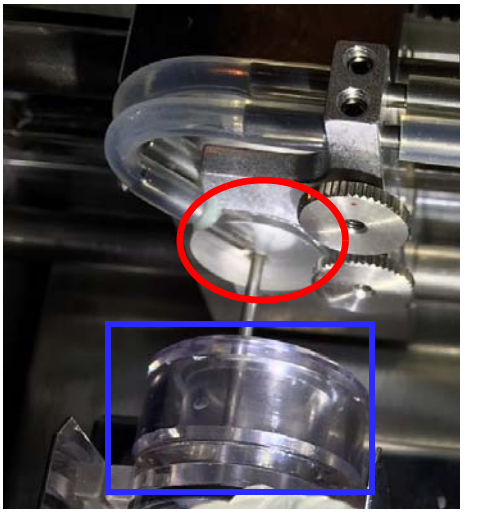


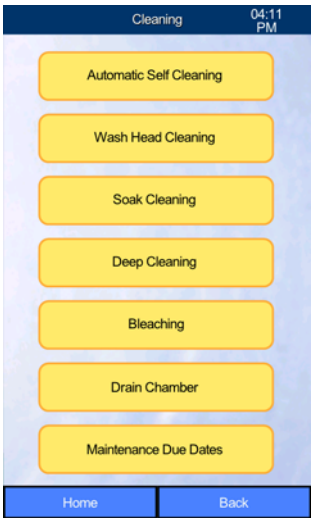
9.4.2 Deep Cleaning

Deep Cleaning should be performed as an emergency cleaning procedure when an analyzer is displaying a trend of high HCT (particularly due to increasing MCV), even when routine Soak Cleaning has been regularly performed. This procedure will perform a more thorough cleaning of the HM5. Call Abaxis Technical Support before performing this procedure.

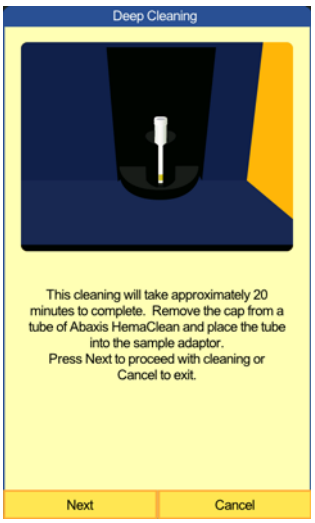
This procedure requires a lint-free cloth moisturized with distilled water, a new tube of HemaClean and an in-date (not expired) unopened HM5 normal control.

1. Open the side door and identify the Wash Head (Red Circle) and the dilution chamber (Blue Rectangle).
2. If salt or blood debris is found on the Wash Head proceed to clean the Wash Head: See “Cleaning the Wash Head” on page 6-4.
3. Navigate to **Maintenance > Deep Cleaning**.





4. Remove the cap from a new tube of HemaClean and place the tube on the tube holder at the front of the analyzer.
5. Select **Next** to start the cleaning. The Deep Cleaning will be complete in approximately 20 minutes.
6. Run Quality Control using a new, unopened HM5 control. For detailed instructions, go to "Quality Control" on page 5-2. If any warning message pops up, contact Abaxis Technical Support.



Note: *The analyzer will prompt to run a Blank before the first QC measurement.*

7. If two out of three Quality Control runs are within target range, the analyzer is ready to run blood work. If two out of three runs fall out of target range or have any error warnings, call Abaxis Technical Support at (844) 247-5271 for help in calibrating the instrument.

9.4.3 Removing and Cleaning the Aperture

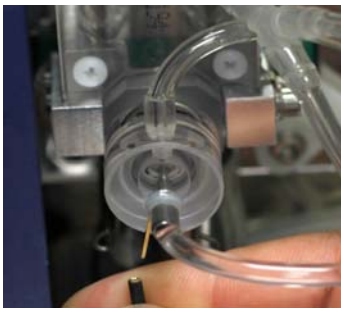
The analyzer's aperture may get clogged or collect debris over time. If Soak Cleaning or Deep Cleaning does not resolve the problem, the aperture may need a more thorough cleaning or replacement.

Clean the aperture as follows:

1. First remove the fluid from the dilution chamber by selecting **Maintenance > Cleaning > Drain Chamber**.

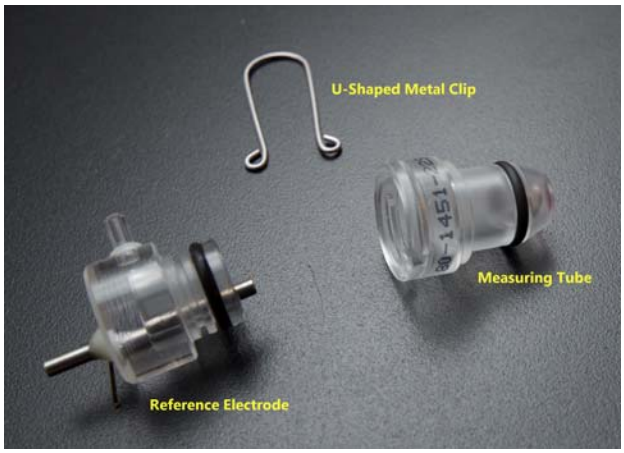
2. Open the door on analyzer's right side, and locate the measuring tube which contains the aperture (circled at right).

3. Disconnect the black wire from the left side of the measuring tube assembly by sliding it down and to the left.



4. Grasp the measuring tube and pull while slightly twisting left and right, until it comes off. This is a push-fit part so it should pull straight out.

5. Disconnect the tubing and pull off the U-shaped clip so the two pieces can be separated.



6. Place the measuring tube on a clean counter with the red or pink aperture facing up. Drop two drops of bleach onto the aperture and let it soak for ten minutes.

7. Rinse off the bleach with distilled water.

8. Put the reference electrode and measuring tube back together, and slide the U-shaped clip back into place.

9. Push the probe back into the body of the dilution chamber and reattach tubing.

10. Reattach the black wire.
11. Run a blank.
12. If the blank displays flags and results in red, contact Abaxis Technical Support.

9.4.4 Bleach Cleaning

If reagent pack contamination is suspected, use this procedure to decontaminate the analyzer and reagent tubing before attaching a new reagent pack. Soak Cleaning should be performed first to resolve any high values or blanks.

CAUTION: *Call Abaxis Technical Support before performing a Bleach Cleaning.*

This process requires distilled water (380 ml) and bleach (20 ml regular strength or 12 ml concentrated).

1. From the Home screen, select **Maintenance > Cleaning > Bleaching**.
2. Follow the on-screen directions.

   The analyzer drains the remaining fluids from inside the analyzer, then draws in the bleach solution. It then performs a soak for ten minutes. The bleach is then drained, and distilled water is pulled into the analyzer to soak for six minutes. The distilled water is then drained and the analyzer is ready for a new reagent pack to be installed.

9.5 Printer Troubleshooting

The analyzer can print to its built-in printer (on top of the unit) or to certain external USB printers. Use these suggestions to solve problems with either printer.

9.5.1 Built-in Printer

If the analyzer's built-in printer is not printing, check the following in this order:

1. Is the lid closed properly? If the light is blinking, one side of the printer lid may not have snapped shut.
2. Is the paper roll inserted correctly? Make sure to lower the paper roll in with the paper coming up the front from the bottom of the roll. Pull 1 or 2 inches of paper out and snap the lid closed. If the paper is inserted upside down, the paper will feed but will be blank.
3. If the paper is inserted, but it is not rolling properly, open the printer lid and clean the roller with a lint-free tissue to remove any debris.
4. If nothing prints and the analyzer was previously connected to an external printer, from the Home screen select **Settings > Printer**, then set **Device** to built-in. If a USB cable is still attached to the external printer, disconnect the cable from the analyzer.

9.5.2 External Printer

The analyzer can print to selected external USB printers. For a list of current compatible printers, call Abaxis Technical Support.

If an external printer encounters a problem, it attempts to transmit an error message to the analyzer. If the HM5 is unable to interpret that information it may freeze. Try resolving the printer issue, then reboot the analyzer.

1. Make sure the external printer is powered on and that the ink cartridges are not low on ink, empty or expired. If no ink lights are blinking or solid, try resetting the printer by unplugging it from power for 60 seconds.
2. Make sure the printer does not have a paper jam.
3. Try printing a test page from the printer.
4. Check the printer settings in the analyzer: from the Home page, select **Settings > Printer > Device**. If the analyzer shows **USB** for this setting, it is probably not recognizing the printer attached. Try reseating the USB cable from the printer to the HM5 then reboot the analyzer. If the device setting still shows USB instead of the exact printer type, try to print a result to trigger the connection.
5. Check that the USB A-B cable is securely attached to the analyzer and to the printer. Most printers have an Ethernet and a USB B port. Make sure the USB B end of the cable is not inserted into the Ethernet port.

9.5.2.1 If Results Are Not Combining With the VS2

Try the following in the order shown.

1. Check that VS2 communication is enabled: from the Home page, select **Settings > Communication > VSx Communication**, then set **VSx Link** to **USB** and **VSx-HM5 Combining** as needed.
2. From the Home page, select **Settings > Printer > Device**, and make sure the paper size is set to the size of the paper being used.
3. Select **Printout** and make sure the margins are correct: top and left margin both = 0.5.
4. Select **Format** and make sure **VSx Separate Page** is set to **Disabled** to combine on one page.
5. Make sure the Patient ID matches that on the VS2.
6. Make sure the date is the same in both analyzers and that the **Combine Within** setting is inclusive of the dates of the run.
7. Check the USB A-B cable attaching the VS2 to the HM5: make sure the B (square) end is in the USB B port on the back of the VS2, and the A (flat) end is in a USB A port on the back of the HM5.

Section 10

Specifications

This section contains technical specifications for the VetScan HM5 system, and lists its linearity ranges.

Section Contents

10.1 VetScan HM5 Specifications

Sample volume	25 µl of whole blood in three-part mode, 50 µl of whole blood in five-part mode. 50 µl of whole blood in five-part prediluted mode of 1:6; 25 µl of prediluted blood in three-part prediluted mode of 1:6.
Chambers	1 unified chamber for diluting whole blood and counting.
Reagent system	VetScan HM5 Reagent pack.
Aperture diameter	80 µm.
Throughput	24–30 tests/hour in three-part mode, 16–20 tests/hour in five-part mode.
Sampling method	Open tube system with automatic sample rotor, support for all HM2 and VetScan HM5 test tubes.
Sample types	Five-part mode: dog, cat, horse, alpaca, llama, cynomolgus macaque, rhesus macaque, control. Dog2 and Cat2 are the dog and cat profiles, but may be adjusted for puppy and kitten reference ranges, if desired. Three-part mode: mouse, rat, rabbit, ferret, pig, cow, sheep, goat, guinea pig, primate (primate is research only).
Clog prevention	High-voltage pulse on aperture in each analysis cycle and chemical cleaning of the aperture using Cleaner reagent.
Cleaning procedure	High-voltage burn of the aperture, deep cleaning, chemical cleaning of the aperture.
Quality control	Support for five-part differential control blood. QC parameters include: mean, ± range, SD and CV for all measured and calculated parameters, 16- and 64-day Levy-Jennings charts, separate QC database.
Calibration	Three-measurement automatic calibration of WBC, HGB, RBC, PLT, MCV, RDWc, MPV, and EOS absolute.
Multi-user feature	Three-level multi-user operation with selective privilege levels, user identification with ID and password. Contact Abaxis for more information.
User interface	Easy-to-use, menu-driven touchscreen user interface with on-screen help.
Languages available	English, French, German, Italian, Spanish, Czech, Polish, Portuguese, and Russian. For other languages, contact Abaxis Technical Support — see page 1-3.
Data capacity	5000 results, including RBC, PLT, WBC three-part and five-part histograms on-board. Data can be saved to USB drive or downloaded to computer.
Host computer interface	Four USB A ports, one USB B port, and one Ethernet port. Support for ASCII-based communication protocol only (V3.1).
Data back-up method	Port for USB drive on side and back panels.
Software upgrade method	USB drive.
External printer interface	USB.
Built-in printer	“Easy Paper Operation” built-in thermal printer.
Display	240x128-dot, high-contrast, backlit, graphics liquid crystal diode.
External keyboard	Standard USB-compatible keyboard.
Power requirement	12V DC, 5 A, 60 W.
Power supply unit	External, auto-ranging power unit for 100–120 or 200–240 VAC, 50–60Hz.
Operating temperature	59–86 °F (15–30 °C). Optimal temperature is 77 °F (25 °C).
Dimensions (W x D x H)	12.6 x 10.2 x 14.4 in (320 x 260 x 365 mm).
Net weight	27 lbs (12.3 kg).

10.2 Linearity Ranges

The VetScan HM5 is guaranteed to provide specified accuracies within its linearity range when properly calibrated and maintained. Beyond this range, results may still be displayed, but accuracy is no longer guaranteed.

If the value is over the maximum range of guaranteed linearity, the instrument cannot measure it, and the result will be marked with an **E**, **m**, **M**, or **N** flag.

To measure a sample whose parameters exceed the maximum linear value indicated in the table below, predilution is recommended.

The following tables list the linearity ranges for primary parameters in normal measuring mode and prediluted mode.

Table 10-1: Linearity Ranges in Normal Measuring Mode

Parameter	Linearity Ranges	Maximum	Unit
WBC	0–100	150	10^9 cells/liter
EOS	0.2–3.0	10.0	10^9 cells/liter
RBC	0–15	20	10^{12} cells/liter
PLT	0–700	1000	10^9 cells/liter
HGB	0–250	400	g/l
HCT	0–100	—	%
MCV	30–150	—	Fl
MPV	3–30	—	Fl

Table 10-2: Linearity Ranges for Prediluted Mode

Parameter	Linearity Ranges	Maximum	Unit
WBC	2–200	300	10^9 cells/liter
EOS	0.2–3.0	10.0	10^9 cells/liter
RBC	1–30	40	10^{12} cells/liter
PLT	100–2000	3000	10^9 cells/liter

10.3 Precision

The following precision parameters were established using normal level control on one instrument, with ten replicate measurements performed in one day.

Table 10-3: Control Parameter Precision

Parameter	Mean	SD	%CV
WBC (10^3 cell/µl)	8.05	0.15	1.89%
RBC (10^6 cells/µl)	4.49	0.111	2.44%
EOS (10^3 cell/µl)	5.00	0.07	1.32%
HCT (%)	40.39	1.01	2.51%
HGB (g/L)	125.66	1.71	1.36%
MCV (fL)	90.03	0.50	0.56%
PLT (10^3 cell/µl)	248.36	18.30	7.37%
MPV (fL)	12.69	0.177	1.39%

Appendix A

Introduction to Veterinary Hematology

This appendix introduces several fundamental concepts of veterinary hematology. Having a basic knowledge of these concepts will help you better understand the results from the analyzer.

Appendix Contents

A.1 Function of Blood

Blood circulates in the body and acts as a transport medium that carries oxygen, essential nutrients, and other materials to the cells of the body. It also serves to transport waste products for disposal. Neurons, muscle cells, connective tissue cells, and epithelial cells draw their nourishment from interstitial spaces, and respond to the glucose and oxygen content of that environment. Fresh supplies of oxygen and glucose are exchanged with the blood circulating in the capillaries. Blood receives its oxygen from the lungs and glucose from the intestines and liver.

Normal cell function depends on the rapid removal of toxic metabolic products (CO_2 and NH_3) from the interstitial fluid environment. These waste products are taken up by the plasma and red blood cells, and eliminated as the blood passes through the kidneys and lungs. Blood also delivers hormones, lipids, amino acids, salts, and vitamins, and removes urea and conjugated acids.

Blood distributes the heat generated by metabolizing body cells, so that body temperature is maintained at a constant level. In the event of vascular injury, blood platelets and plasma coagulation mechanisms prevent blood loss by aggregating with other platelets to form large hemostatic plugs (clots).

White blood cells protect against infections by identifying and killing invasive bacteria.

The number, size and distribution of blood cells provide important information for clinical diagnosis and therapy.

A.2 Composition of Blood

Whole blood contains three cellular components:

- Red blood cells (erythrocytes, RBC)
- White blood cells (leukocytes, WBC)
- Platelets (thrombocytes, PLT)

Table A-1: Cell Composition of Whole Blood*

	Red Blood Cells	White Blood Cells	Platelets
Normal density	5–12 x 10^{12} cells/l	6–15 x 10^{9} cells/l	100–700 x10^{9} cells/l
Nucleated?	No **	Yes	No
Sub-populations and their percentages	RBC: 99.9% NRBC: ** (Nucleated RBC) 0.1%	GRAnulocytes: 65% NEUtrophil: 60% EOSinophil: 4% BASophil: 1% LYMphocytes: 32% MONocytes: 3%	
Shape, size	Biconcave (donut) shape diameter: 5–7 µm thickness: 1.8–2 µm	GRAnulocytes: 13–16 µm LYMphocytes: 8–15 µm MONocytes: 15–25 µm	Fragments with a diameter of 2–4 µm
Volume of cell	30–80 fl	50–1500 fl	5–15 fl
Volumetric% in whole blood	40–45%	0.1%	0.3%

* Data generated using whole human blood.
** Mature mammalian RBCs are non-nucleated.

A.3 Blood Cell Parameters

A.3.1 Red Blood Cells, Hemoglobin

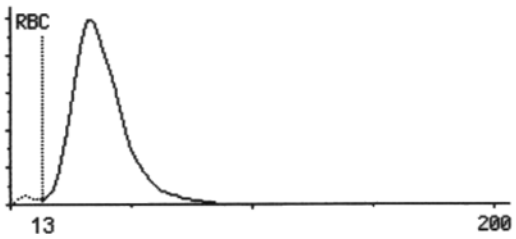
Red blood cells — RBC — are formed in the bone marrow. A mature dog red blood cell is non-nucleated, and has a mean corpuscular volume (MCV) of approximately 70 fl. RBCs are the most numerous cell type in blood. There are approximately 5–10 x 10^{12} cells/l in the blood of a healthy dog. RBC counts and MCV are directly measured primary parameters.

Hematocrit — HCT — is the ratio of the volume of RBCs to the total volume of blood. HCT is the simplest way to measure the degree of anemia, and is calculated from the RBC and MCV values:

$$HCT_{percent} = (RBC \times MCV) / 10$$

$$HCT_{absolute} = HCT_{percent} / 100$$

Red Blood Cell Distribution Width — RDW — is a measure of RBC anisocytosis, the degree of cell size variation. In a healthy sample, RBCs demonstrate a normal (Gaussian) distribution (bell curve), as shown at right. RDW can be characterized by a standard deviation (RDW-SD) or a coefficient of variation (RDW-CV) represented as a percentage.



Hemoglobin — HGB — is the main component of RBCs. It is a conjugated protein (with Fe), and its main function is to transport oxygen from the lungs to tissues and carbon dioxide from the tissues back to the lungs. HGB is the best measure of blood's oxygen-carrying capacity.

Mean Corpuscular Hemoglobin — MCH — is the average hemoglobin content of RBCs, and is calculated from RBC and HGB values:

MCH = (HGB / RBC) x 10, reported in picograms or fmol

Mean Corpuscular Hemoglobin Concentration — MCHC — is the concentration of HGB in an *average* RBC, calculated from the HGB and HCT values:

$MCHC = HGB / HCT_{absolute}$, reported in g/dl, g/l or mmol/l

Mean Corpuscular Volume — MCV — is the average size (volume) of red blood cells in the blood.

A.3.2 White Blood Cells

White Blood Cells — WBC — are formed in the bone marrow. During their maturation sequence they differentiate from the stem cells into mature sub-populations. WBCs are nucleated and classified as granulocytes (neutrophils, eosinophils, and basophils), lymphocytes, and monocytes. WBCs are equipped with all cell organelles necessary to perform vital protective functions in the body.

Normal WBC counts are a fraction of the RBC population. In pathological conditions, the WBC count can increase dramatically (up to 300 x 10^9 cells/l in extreme leukemia). In these cases, predilution of the sample is recommended for the most accurate results (see “Three-Part Differential Method” on page B-3).

Three-part differential histograms (volume distribution curves) of WBCs can be used as a simple, visual evaluation of the number and relative percentage of lymphocytes (LYM, LYM%), monocytes (MON, MON%), and granulocytes (GRA, GRA%).

WBC-related parameters are defined as follows:

WBC = LYM + MON + GRA

LYM% = LYM / WBC

MON% = MON / WBC

GRA% = GRA / WBC

NEU% = (GRA – EOS – BAS) / WBC

EOS% = EOS / WBC

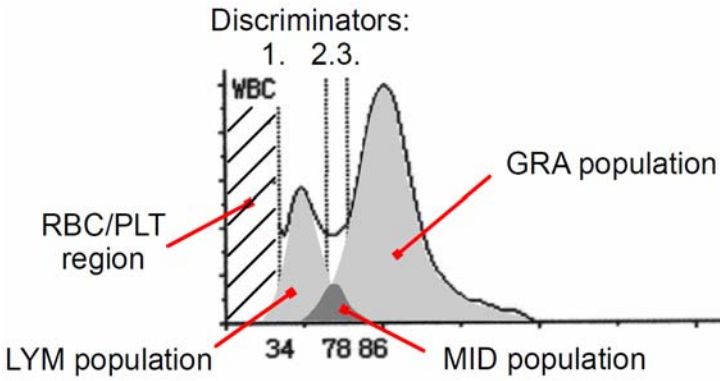
BAS% = BAS / WBC

Elevated WBC counts can affect other differential parameters. It is highly recommended that abnormal WBC and other cell differentials be confirmed by a manual blood smear, as is the case with all automated hematology analyzers.[1]

A.3.3 Automated WBC Classification

The analyzer evaluates each sample as a unique population, using dynamic cellular discriminators to assess the cellular distribution most accurately. To determine WBC sub-populations, the analyzer first sets “discriminator 1” at the limit of hemolysed RBCs + PLTs (on the left in the following graph) and LYM population, then fits normal distribution curves to the remaining WBC histogram (shown below in different shades of gray).

1. Bessman, JD. *Automated Blood Counts and Differentials. A Practical Guide.* (Baltimore: Johns Hopkins University Press, 1986), p. 107.

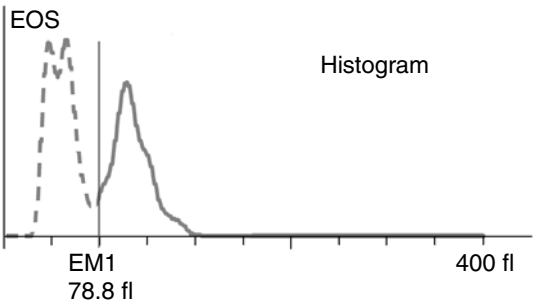


Eosinophilia is occasionally depicted as a peak between the MON and GRA classifications.

As with any automated system, good laboratory practice requires that all abnormal results be verified by slide (blood smear) review.

A.3.4 Eosinophils

Eosinophils — EOS — are granulocytes that are specialized to attack parasites, such as worms and protozoa. They are also the primary effector cells in allergic symptoms. In most species they can be identified morphologically by the presence of eosin-staining (red) granules.



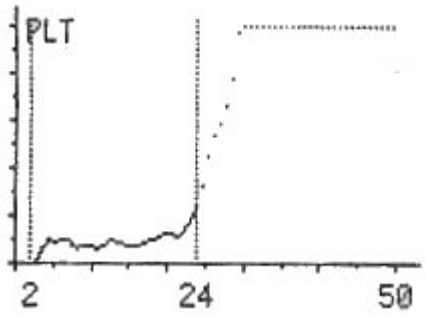
A.3.5 Platelets

Platelets — PLT — are non-nucleated fragments of the megakaryocyte in mammals. Note that platelets are formed by cellular fragmentation. Therefore, the platelet histogram normally has a logarithmic shape on the left side, and a normal shape on the right side ("log-normal" distribution).

Normal PLT concentrations range from 200–800 x 10^9 cells/l (for dogs), depending on the mean platelet volume (MPV), but can vary from 0–1000x10^9 cells/l under certain circumstances.

PLTs are relatively small compared to RBCs. The mean platelet volume — MPV — is approximately 10 fl, so in many species PLTs can effectively be separated from RBCs by their size.

Platelet aggregation is common, particularly in feline species, and is often depicted by a flattened, lumpy histogram, as shown at right. This effect can be minimized with proper sample collection and vortex mixing of the sample (up to 30 seconds) before analysis.



The analyzer calculates the volumetric ratio of PLTs in whole blood as follows:

$PCT_{percent}$ = (PLT x MPV) / 10

$PCT_{absolute}$ = $PCT_{percent}$ / 100

Typically, PCT = 0.003 = 0.3%

Platelet Distribution Width — PDW — is a measure of platelet anisocytosis, the degree of size variation. In a healthy sample, platelets demonstrate a Log normal distribution. PDW can be characterized by a standard deviation (PDW-SD) or a coefficient of variation (PDW-CV) represented as a percentage.

A.4 Normal Hematology Ranges

The following table summarizes normal ranges of blood cell parameters. Keep in mind that normal values vary from population to population, even geographically.

Parameter	Unit	Dog	Cat	Horse	Cow	Pig	Mouse	Rhesus–RUO*	Cyno–RUO*
WBC	10^9 cells/l	6–17	5.5–19.5	5.4–14.3	4–12	11–22	6–15	9.3-22.0	2.0-21.0
LYM	10^9 cells/l	1.00–4.80	1.5–7.0	1.50–7.70	2.50–7.50	5.5–11.1	3.40–7.44	4.0-13.86	0.94-9.26
MON	10^9 cells/l	0.2–1.50	0.0–1.50	0.0–1.50	0.0–0.84	0.66–1.32	0.0–0.6	0.0-0.76	0.01-0.57
NEU (or GRA)	10^9 cells/l	3.0–12.0	2.50–14.0	2.30–9.50	0.6–6.70	(5.0–10.0)	(0.5–3.80)	1.3-11.0	0.0-14.21
EOS	10^9 cells/l	0.0-0.8	0.0-1.0	0.0-1.0	0.1–1.0			0.0-0.25	0.00-0.23
RBC	10^{12} cells/l	5.5–8.5	5–10	6.8–12.9	5–10	5–8	7–12	4.4-6.2	5.0-6.5
HCT	%	37–55	24–45	32–53	24–46	32–50	35–45	36.0-48.0	38.0-52.0
MCV	fl	60–77	39–55	37–59	40–60	50–68	45–55	71-86	69-87
HGB	g/l	120–180	80–150	110–190	80–150	100–160	122–162	109-147	120-156
MCH	pg	19.5–24.5	12.5–17.5	12.3–19.7	11–17	17–21	11.1–12.7	21.8-26.2	21.4-26.2
MCHC	g/l	310–390	300–360	310–390	300–360	300–340	223–320	287-323	278-330
PLT	10^9 cells/l	165–500	300–800	100–400	100–800	325–715	200–450	216-502	261-629
MPV	fl	3.9–11.1	12–17						6.8-11.6

Parameter	Unit	Rat	Rabbit	Ferret	Guinea pig	Sheep	Goat
WBC	10^9 cells/l	2.1–19.5	3–11.5	2–10	5.0–17.0	4–12	4.0–13.0
LYM	10^9 cells/l	2.0–14.1	2.0–9.10	0.4–6.50	2.0–15.0	2.0–9.0	2.0–9.0
MON	10^9 cells/l	0.0–0.98	0.0–0.5	0.1–0.7	0.0–0.0	0.0–0.75	0.0–0.5
(GRA)	10^9 cells/l	(0.1–5.40)	(0.0–2.80)	(0.8–4.50)	(1.0–11.0)	(0.7–7.30)	(1.20–8.00)
RBC	10^{12} cells/l	5.3–10	5–9	7.8–13	4.8–6.3	9–15.8	5.5–8.5
HCT	%	35–52	36–50	36–56	30–44	27–45	37–55
MCV	fl	50–62	57–70	40–48	50–90	28–40	60–77
HGB	g/l	140–180	127–163	124–187	80–150	90–150	120–180
MCH	pg	16–23	17.5–23.5	13.5–16.5	12–13	8–12	19.5–24.5
MCHC	g/l	310–400	300–380	321–355	300–360	310–340	310–340
PLT	10^9 cells/l	500–1370	218–641	96–776	200–600	100–800	200–500
MPV	fl						

*RUO is Research Use Only

A.5 Veterinary Hematology References

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Appendix B

Operating Principles

This appendix explains the basic operating principles of the analyzer.

Appendix Contents

B.1 Complete Blood Count (CBC)

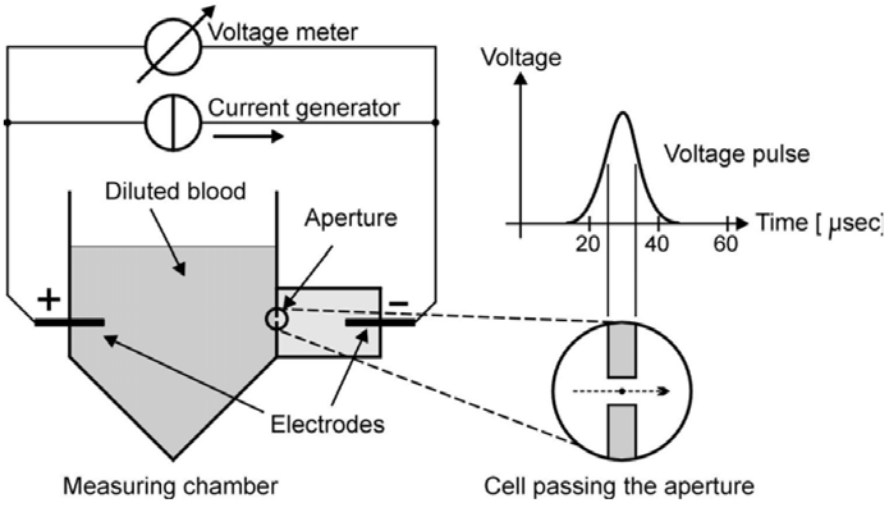
The analyzer utilizes impedance technology whereby electrically neutral blood cells pass through an electrically charged aperture thereby generating a “pulse.” Cell counts are determined by the number of pulses measured in a given volume of blood over a set period of time. The decrease in electrical conductance (degree of intensity) as measured is directly proportional to the cell volume. This size discrimination, along with susceptibility to various lysing agents distinguish the basic cell types (red, whites, platelets).

B.2 Measurement Methods

This section provides an overview of the hematology measurement methods used by the analyzer.

B.2.1 Volumetric Impedance Method

The analyzer uses a volumetric impedance method of counting blood cells. The following figure illustrates this method.

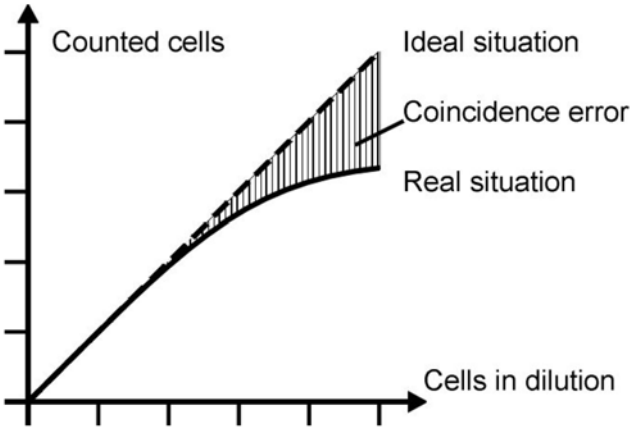


The principle of this method is that blood diluted with an isotonic solution (Diluent) conducts electric current by ionic conduction. A counting chamber made of an insulating material (plastic) holds this diluted blood, while a small circular hole (aperture) in this chamber allows the flow of diluted blood. (The analyzer aperture diameter and length is 80 µm — the optimal size for veterinary hematology.)

Placing two electrodes on the two sides of this aperture and applying constant electric current causes the isotonic solution to conduct electricity, and allows a voltage to be measured on the aperture.

Applying pressure to the diluted sample causes it to flow through the aperture. When a cell is passing the aperture, a small change in electric impedance occurs, so that the voltage rises somewhat and a small electric pulse occurs. The amplitude of this pulse is proportional to the ratio of the cell volume (size) and the aperture volume: the bigger the cell, the higher the pulse.

Proper counting (or differentiation) of cells requires passing of only one cell through the aperture at a time. To help ensure this, the blood samples must be diluted, since cell concentrations are otherwise too high.



Although diluted blood is used, in cases of extremely high concentrations (such as leukemia) WBC density can be 100x higher than normal, causing two or more cells to pass through the aperture at a time, generating one pulse instead of two (or more). This is called coincidence, and results in non-linear counting of cells. Flags **m**, **M**, and **N** appear in this case.

The WBC linearity range is 100 x 10^9 cells/l.

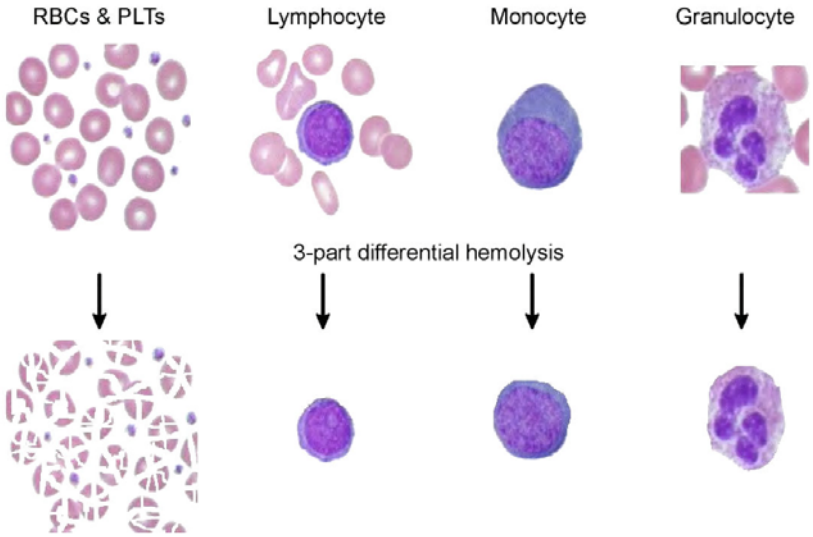
In cases of cell counts beyond the linear range, an external predilution of the sample is recommended.

B.2.2 Three-Part Differential Method

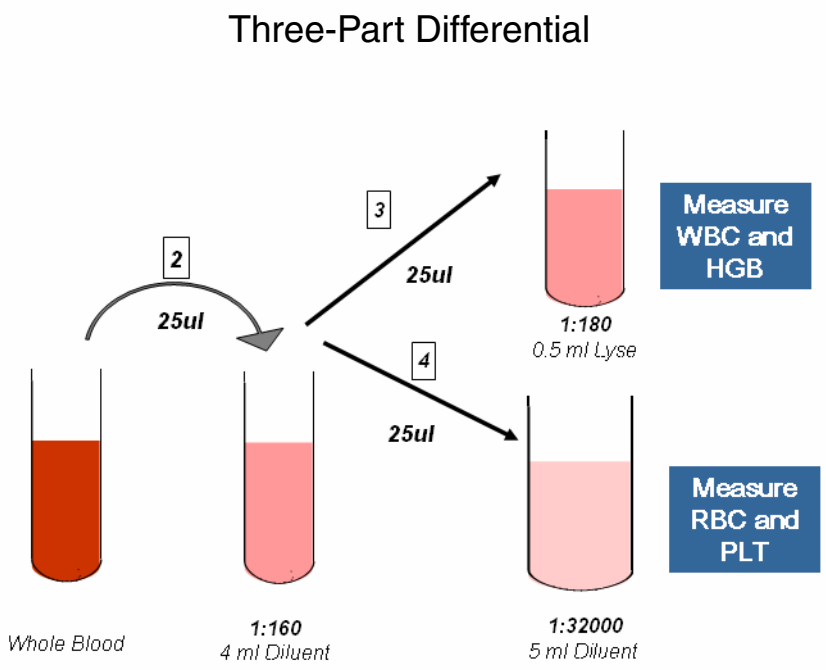
To perform a three-part WBC differential count, the RBCs must first be lysed since RBCs are typically 1000 times more numerous in normal blood than are WBCs and would interfere with WBC counting if left intact. Lysing also releases the hemoglobin stored in the RBCs for direct analysis in the solution.

Therefore, a hemolysing reagent (Lyse) is used to dissolve cellular membranes, thus destroying RBCs, and creating a complex solution suitable for photometry of HGB and counting WBCs.

The following figure shows the changes in blood cell characteristics that occur during three-part differential hemolysis.

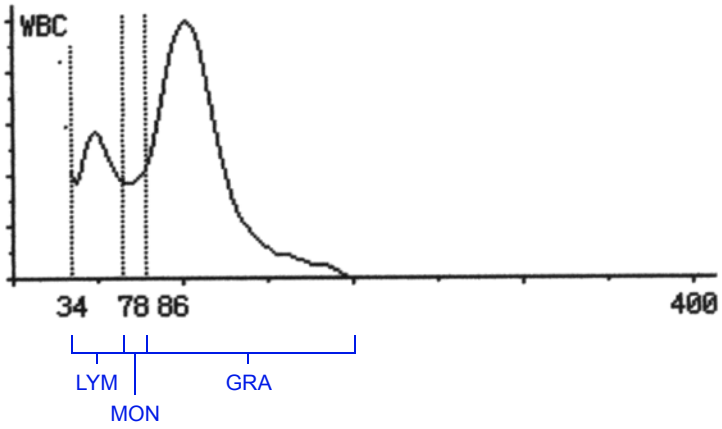


The membranes of the WBCs become selectively permeable, so that they begin to shrink down to their nuclei in the slightly hypertonic Lyse solution. Effectively hemolysed samples contain WBC particles in the 30–300 fl region (for veterinary species).



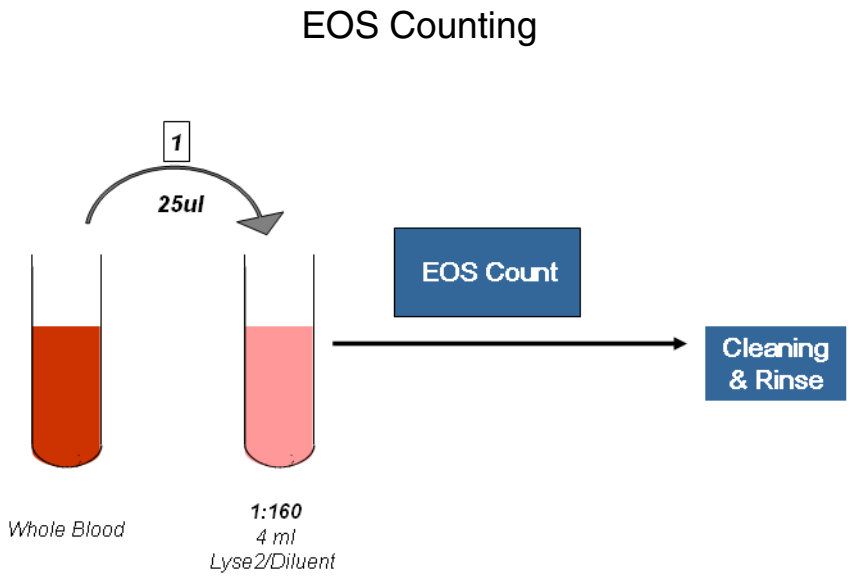
For the three-part counting, a primary dilution of 1:160 is created by diluting 25 µl of whole blood with 4 ml of Diluent into the chamber. After taking the RBC sample of 25 µl, the remaining diluted blood is treated with 0.5–0.7 ml of Lyse reagent — this depends on the animal profile selected — to destroy red blood cells. The remaining solution is suitable for photometric measurements of HGB, and counting of WBC. After these measurements are done, the software is able to determine HGB, WBC, LYM, LYM%, MON, MON%, total GRA, and GRA%. GRA contains all types of granulocytes: GRA = NEU + EOS + BAS, and GRA% = NEU% + EOS% + BAS%. Volume distribution of three-part measurement can be seen on the three-part histogram. The cells are separated in three regions depending on their sizes: LYM, MON, and GRA, from left to right, separated by discriminators.

The figure below shows a typical three-part differential WBC histogram of selective hemolysis (dog).



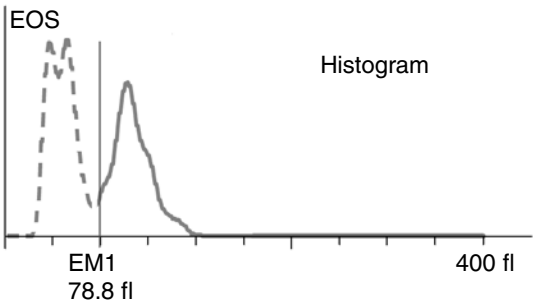
B.2.3 Five-Part WBC Differential Method

Five-part WBC differential results are determined using two separate dilutions, and two counting sessions. The first session is used to count EOS, while the second is the three-part differential and RBC counting described above. In three-part only measurements, the EOS counting is omitted.



To determine EOS, EOS% and BAS, BAS%, a second sample preparation and counting is required. 25 µl of whole blood sample is diluted with a species-dependent volume of Lyse 2 solution, a hemolytic reagent and Diluent, to form a 1:200 dilution. During the incubation time, white blood cells will be differentially hemolysed, so that eosinophils will retain a higher cellular volume.

After counting and sizing the cells, the software will interpret all cells above the discriminator as eosinophils. The user can observe the distribution of the cells on the EOS histogram.



The number and percentage of BAS cells will be calculated using EOS and other internal parameters using a mathematical formula.

The EOS count is then followed with a three-part differential count (described above) to provide the rest of the WBC count, the RBC and the PLT and related parameters.

B.3 Hemoglobin Determination

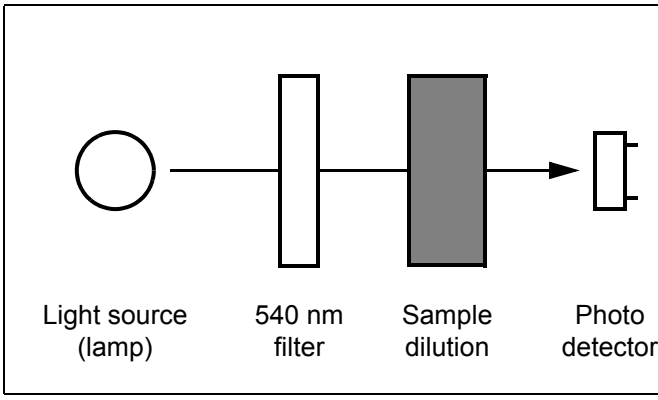
Hemoglobin is measured directly by means of the traditionally used cyanomethoglobin reaction, but the HM5 uses cyanide-free substances to reach the same endpoint.

Hemoglobin concentration is measured photometrically.

B.3.1 Hemoglobin Determination by Photometry

HGB determination is one of the most important hematology parameters, as it relates to the oxygen carrying capacity of blood.

The analyzer uses cyanide-free lysing reagents to minimize negative effects on user safety and the environment. The effect of cyanide-free Lyse is very similar to that of Lyse containing cyanide, but the chemical reaction is slightly different. The figure below illustrates the HGB measurement method.



HGB is measured by passing light (540 nm) through the WBC dilution, and measuring the transmitted light with a photo detector.

The light intensity (I) of the sample liquid is logarithmically proportional to the concentration of HGB:

$HGB \approx \log (I_{reference} / I_{sample})$

B.4 Measured and Calculated Parameters

Each sample is analyzed to produce a complete, 24-parameter, five-part differential blood count (CBC), including the following measured or calculated parameters:

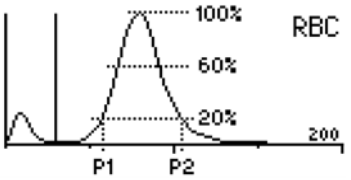
- WBC — total white blood cell count
- LYM — lymphocyte count
- MON — monocyte count*
- NEU — neutrophil count
- EOS — eosinophil count
- BAS — basophil count
- LYM% — lymphocyte percentage
- MON% — monocyte* percentage
- NEU% — neutrophil percentage
- EOS% — eosinophil percentage
- BAS% — basophil percentage
- RBC — red blood cell count
- HGB — hemoglobin
- HCT — hematocrit
- MCV — mean corpuscular volume
- MCH — mean corpuscular hemoglobin
- MCHC — mean corpuscular hemoglobin concentration
- RDWc, RDWs (std dev) — red cell distribution width, coefficient of variation
- PLT — platelet count
- PCT — platelet crit
- MPV — mean platelet volume
- PDWc, PDW (std dev) — platelet distribution width, coefficient of variation

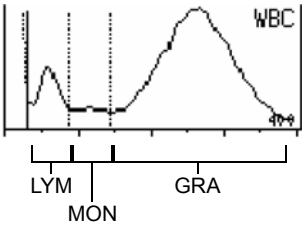
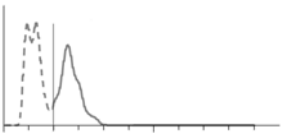
* The monocyte category consists primarily of monocytes. Impedance counters categorize white blood cell types (differential) according to size, and therefore a certain percentage of eosinophils may have a mass that falls in the normal range for monocytes (the exact percentage depends on the individual animal and is generally inconsequential due to the very low numbers of eosinophils in a healthy animal). Eosinophilias, however, can sometimes be visualized as a distinct peak between the monocyte range and the granulocyte peak on a histogram.

B.5 Measured and Calculated Values

The VetScan HM5 measures and calculates the following values from tested blood samples.

Table B-1: Measured and Calculated Values

Values	Definitions
White Blood Cells — **WBC** (reportable as: cells/l, cells/µl)	Total number of leukocytes (white blood cells).
Red Blood Cells — **RBC** (reportable as: cells/l, cells/µl)	Total number of erythrocytes (red blood cells).
Hemoglobin concentration — **HGB** (reportable as: g/dl, g/l, mmol/l)	Measured photometrically at 540 nm (see "Volumetric Impedance Method" on page B-2 for details). • $HGB = HGB_{cal} \times (HGB_{measured} - HGB_{blank})$
Mean Corpuscular Volume — **MCV** (fl)	Average volume of individual erythrocytes derived from the RBC histogram.
Hematocrit — **HCT** (reportable as: percentage, absolute)	Also known as Packed Cell Volume (**PCV**). Calculated from the RBC and MCV values: • $HCT_{percentage} = RBC \times MCV / 10$ • $HCT_{absolute} = HCT_{percentage} / 100$
Mean Corpuscular Hemoglobin — **MCH** (reportable as: picogram, fmol)	Average hemoglobin content of erythrocytes, calculated from RBC and HGB values: • $MCH = HGB / RBC$
Mean Corpuscular Hemoglobin Concentration — **MCHC** (reportable as: g/dl, g/l, mmol/l)	Calculated from the HGB and HCT values: • $MCHC = HGB / HCT_{absolute}$
Red Cell Distribution Width — (reportable as: **RDW-SD** [fl], **RDW-CV** [absolute])	Measure of the degree of RBC anisocytosis. Calculated using the distribution width of the erythrocyte or platelet population derived from the histogram at 20% of peak: 
Platelet — **PLT** (reportable as: cells/l, cells/µl)	Number of thrombocytes (platelets). • $PLT = PLT_{cal} \times$ (cells/l, cells/µl)
Mean Platelet Volume — **MPV** (fl)	Average volume of individual platelets derived from the PLT histogram.
Platelet Distribution Width — (reportable as: **PDW-SD** [fl], **PDW-CV** [absolute])	Measure of the degree of platelet anisocytosis.
Platelet Hematocrit (Thrombocrit) — **PCT** (reportable as: percentage, absolute)	Calculated from the PLT and MPV values: • $PCT_{percentage} = PLT \times MPV / 10$ • $PCT_{absolute} = PCT_{percentage} / 100$

Values	Definitions
White Blood Cell Differential: **LYM, LYM%:** lymphocytes **MON, MON%:** monocytes **GRA, GRA%:** neutrophil, eosinophil and basophil granulocytes	Absolute values counted in the channels determined by the three WBC discriminators:  Percentages calculated from the absolute WBC value.
Eosinophils — **EOS**, **EOS%** (reportable as: cells/l, cell/µl, %)	Absolute values counted in channels as determined by the EOS discriminator.  Percentage calculated from the absolute EOS and WBC values.
Basophils — **BAS**, **BAS%** (reportable as cells/l, cells/µl, %)	BAS is the absolute count of basophils. BAS% is the percentage of basophils in the total WBC.
Neutrophils — **NEU**, **NEU%** (reportable as cells/l, cells/µl, %)	NEU is the absolute count of neutrophils. NEU% is the percentage of neutrophils in the total WBC.

Appendix C

Potential Sample Interferences

Appendix Contents

Table C-1 lists situations in which substances in the samples themselves can interfere with accurate analysis, and provides possible solutions.

Table C-1: Intrinsic Substances: Potential Sample-Induced Interferences

Sample Condition	Indicators	Results Affected	Causes	Solutions
Lipemia	• Cloudy, white plasma. • High MCHC.	Increased HGB, MCHC, MCH. RBCs may be smudged on blood film.	Non-fasted sample	Redraw fasted sample.
			Metabolic disorder[a]	Use RBC, PCV, MCV, and RDW rather than HGB, MCH, MCHC values to assess anemia.
Hemolysis	Pink or red plasma.	• Decreased RBC, PCV • Increased MCHC	Traumatic venipuncture	Redraw w/ clean venipuncture. Remove needle before dispensing blood into tube.
			Hemolytic anemia	N/A
Clumped platelets	• Decreased platelet count w/ platelet clumps often visible on blood smear or applicator stick dipped in sample. • Rising left side of lymphocyte curve. • Small pale clots stick to wooden applicator stick swirled in sample. • Low platelet histogram with a rising right side. • Possible tailing on right side of granulocyte curve.	Decreased PLT +/- increased WBC	Traumatic venipuncture or feline species	Redraw; collect blood in anti-coagulated syringe or use vacutainer system; invert tube several times immediately after filling; vortex sample immediately before testing.
			Excess potassium EDTA (under-filled tube)	Fill tube at least halfway, or remove portion of potassium EDTA before filling tube.
			Miscellaneous/ idiopathic	Use alternative anti-coagulant as heparin or citrate; vortex sample immediately prior to sampling.
Giant platelets	Right side of platelet histogram runs into RBC histogram.	Decreased PLT, decreased MPV	Thrombopoiesis, feline species	Confirm platelet estimate on smear and/or manual platelet count.
Clotted sample	• Visible clot in sample. • Red clot(s) stick to wooden applicator stick swirled in sample. • Platelet clumps may or may not be visible on blood smear.	Decreased PLT, decreased WBC, and/or decreased RBC (varies with clot size)	Traumatic venipuncture and/or delayed transfer to anti-coagulant	Redraw with clean venipuncture; use vacutainer system or anti-coagulated syringe; mix collection tube by multiple inversions immediately after filling. Clotted sample may clog the sample needle.
Lyse-resistant RBCs	• Rising left side of lymphocyte curve. • L flag in dogs.	Increased WBC, increased Lymphs	Idiopathic (most commonly with felines)	Lyse volume may be adjusted for the sample (for additional information, contact Abaxis Technical Support — see page 1-3).

a).Diabetes mellitus, nephrotic syndrome, hypothyroidism, lipoprotein lipase deficiency, acute pancreatitis, cholestasis, hyperadrenocorticism, hypercholesterolemia in briards, idiopathic hyperlipidemia of miniature schnauzers.

Appendix D

Veterinary Case Studies

The following pages present a variety of veterinary case studies.

Appendix Contents

D.1 Normal Level Control

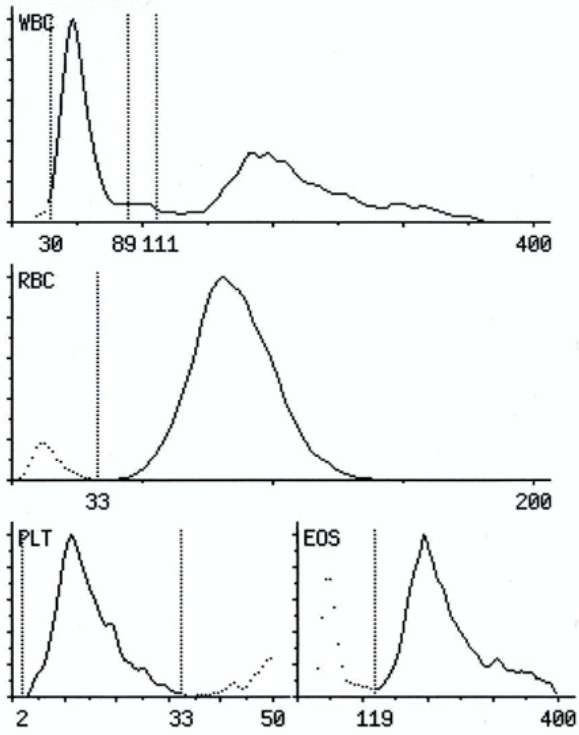
The following report shows typical histograms of normal level control blood run in test mode (the control results are the same in test mode as in QC mode).

Note the differences in cell populations: human samples and control blood contain larger cells than animal blood.

Samples run under the species “Control” do not display reference range bars or cell percentages.

VetScan HM5

Patient ID:		90742		Doctor:	
Name:				Age/Sex:	0 years / -
Test time:		11.05.2007	04:29PM	S/N:250315	
Mode:		Control		Report date:	11.29.2007
WBC	7.57	10^9/l			
LYM	3.03	10^9/l			
MON	0.46	10^9/l			
NEU	4.09	10^9/l			
EOS	4.27	10^9/l			
BAS	0.11	10^9/l			
LY%		%			
MO%		%			
NE%		%			
EO%		%			
BA%		%			
RBC	4.56	10^12/l			
HGB	12.1	g/dl			
HCT	39.07	%			
MCV	86	fl			
MCH	26.6	pg			
MCHC	31.0	g/dl			
RDWc	16.2	%			
PLT	228	10^9/l			
PCT	0.34	%			
MPV	15.0	fl			
PDWc	32.6	%			

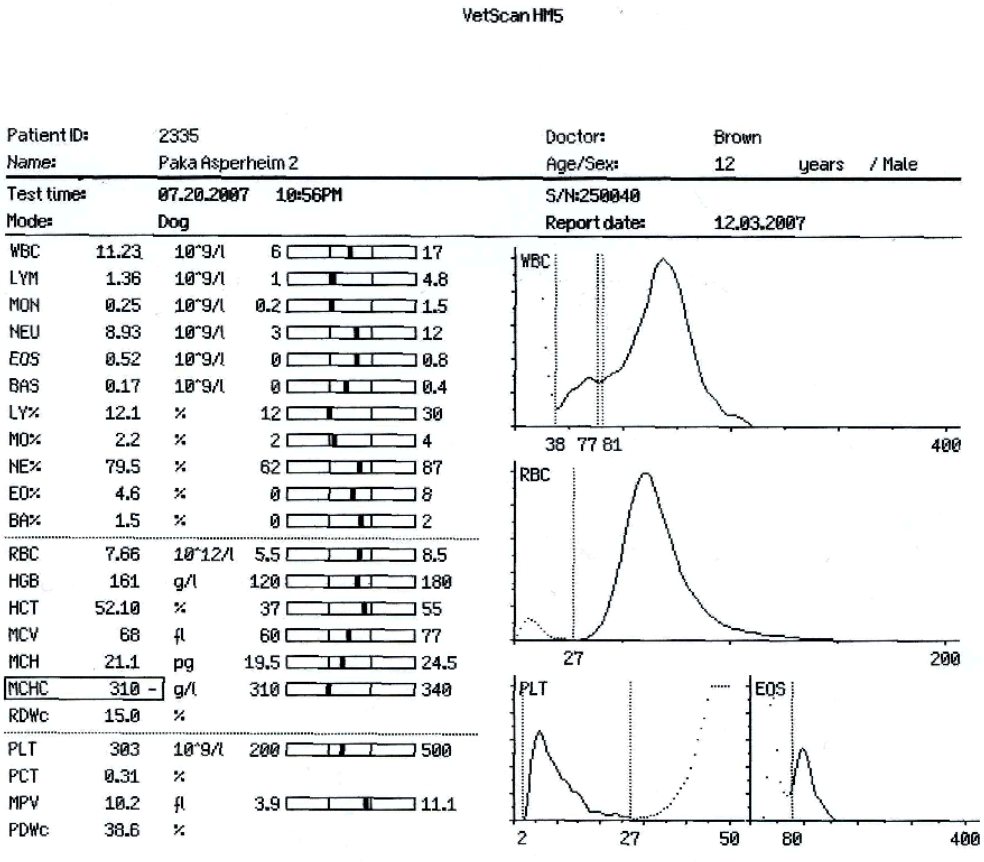


D.2 Dogs

Dog samples show RBC peaks around 60–70 fl with a good separation of the PLTs from the RBCs. Canine lymphocyte populations (lymphocytes, monocytes, and granulocytes) can overlap as a result of similar cell sizes.

D.2.1 Dog: Normal Sample

The following shows a normal dog histogram.



These histograms indicate the following:

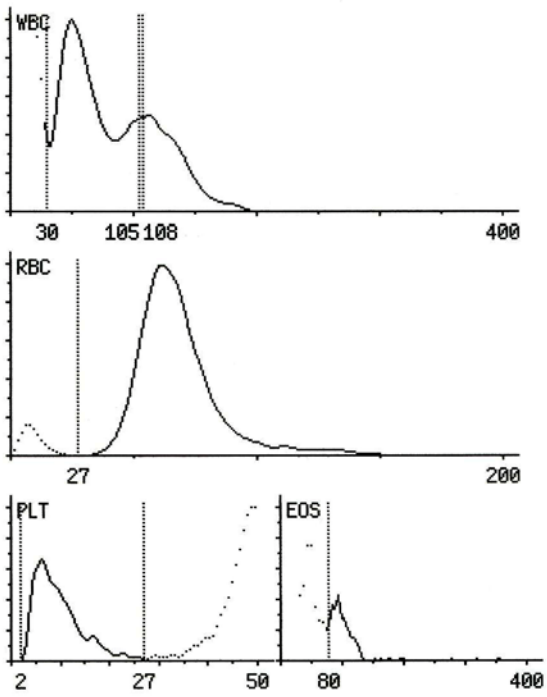
- WBC — All cells larger than approximately 40 fl are counted as WBCs (indicated by discriminator 1). Discriminators 2 and 3 show the MON population. The histogram shows well-defined LYM and GRA peaks, with MON in the valley between them.
- RBC — All cells larger than 25 fl are counted as RBCs. The RBC histogram follows a normal distribution. The MCV is near 68 fl, and the RBC is near 7.66 x 10^{12} cells/l.
- PLT — PLT cell population is between 2 and 27 fl. The PLT histogram follows a log-normal distribution.
- EOS — An ideal EOS peak is shown, well-separated from other cell types to the left.

D.2.2 Dog: High LYM%, Low GRA%

The following shows a sample that has high LYM%. (LYM% is normally near 12–30% for dogs.) This case shows a lymphocytosis.

VetScan HM5

Patient ID:		4052			Doctor:		
Name:		Amelia			Age/Sex:	7	months / Female
Test time:		05.24.2007	08:57AM		S/N:250315		
Mode:		Dog			Report date:	11.29.2007	
WBC	10.74	10^9/l	6	17			
LYM	7.45 +	10^9/l	1	4.8			
MON	0.32	10^9/l	0.2	1.5			
NEU	2.49 -	10^9/l	3	12			
EOS	0.35	10^9/l	0.1	1			
BAS	0.14	10^9/l	0	0.5			
LY%	69.4 +	%	12	30			
MO%	3.0	%	2	4			
NE%	23.2 -	%	62	87			
EO%	3.2	%	1	8			
BA%	1.3	%	0	3			
RBC	6.03	10^12/l	5.5	8.5			
HGB	14.6	g/dl	12	18			
HCT	42.06	%	37	55			
MCV	70	fl	60	77			
MCH	24.3	pg	19.5	24.5			
MCHC	34.8 +	g/dl	31	34			
RDWc	14.7	%					
PLT	305	10^9/l	200	500			
PCT	0.32	%					
MPV	10.6	fl	3.9	11.1			
PDWc	39.6	%					



These histograms indicate the following:

- WBC — High LYM%, low NEU%.
- RBC — Normal.
- PLT — Normal.

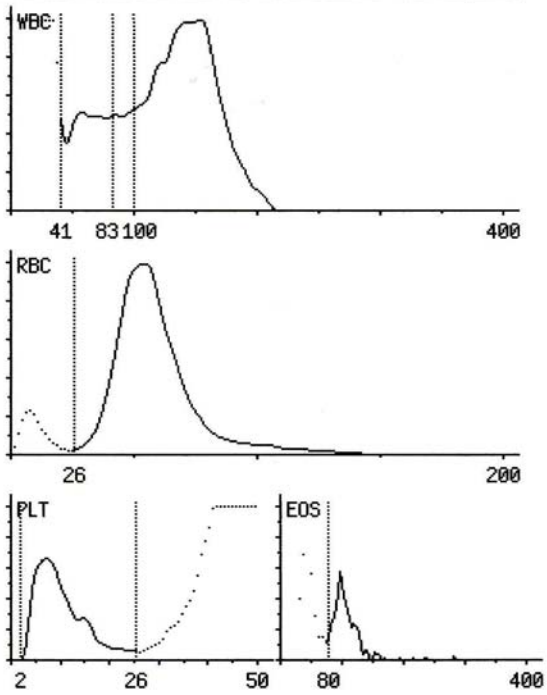
D.2.3 Dog: High PLT

In this sample, the absolute value of PLT is high, and the LYM population is much smaller than the GRA population. This case demonstrates a thrombocytosis.

VetScan HM5

Patient ID:	1377				Doctor:		
Name:	BAILEY ROY				Age/Sex:	12 years	/ Male
Test time:	05.30.2007	03:26PM			S/N:250315		
Mode:	Dog				Report date:	11.29.2007	

WBC	8.32	10^9/l	6	17
LYM	1.75	10^9/l	1	4.8
MON	0.82	10^9/l	0.2	1.5
NEU	5.18	10^9/l	3	12
EOS	0.45	10^9/l	0.1	1
BAS	0.12	10^9/l	0	0.5
LY%	21.0	%	12	30
MO%	9.9 +	%	2	4
NE%	62.3	%	62	87
EO%	5.4	%	1	8
BA%	1.5	%	0	3
RBC	7.21	10^12/l	5.5	8.5
HGB	16.0	g/dl	12	18
HCT	43.66	%	37	55
MCV	61	fl	60	77
MCH	22.2	pg	19.5	24.5
MCHC	36.7 +	g/dl	31	34
RDWc	17.2	%		
PLT	589 +	10^9/l	200	500
PCT	0.64	%		
MPV	10.9	fl	3.9	11.1
PDWc	39.4	%		

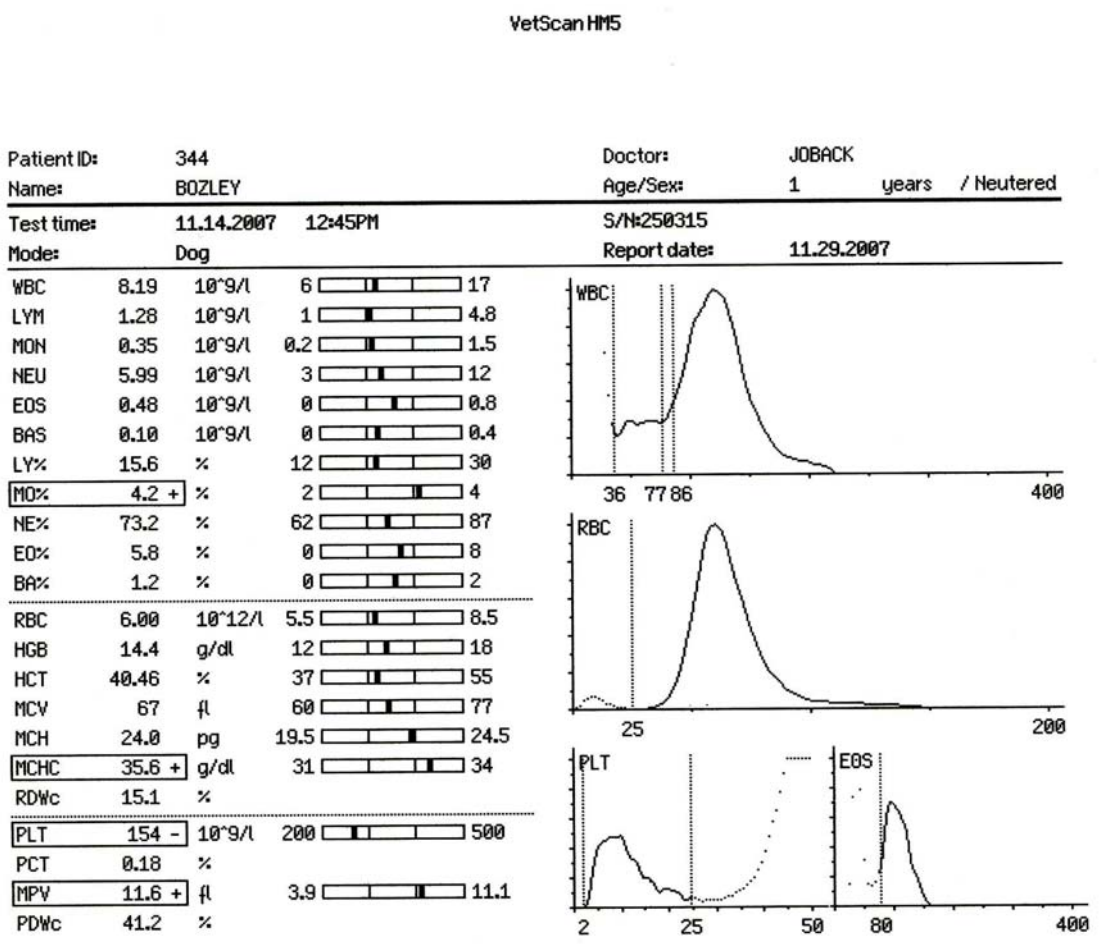


These histograms indicate the following:

- WBC — Three-part differential curve with good separation between populations.
- EOS — Normal EOS count.
- RBC — Normal.
- PLT — High PLT. No sign of PLT clumping.

D.2.4 Dog: Low PLT, Low MPV

This sample shows a very low PLT, while the WBC and the differential are normal. This case demonstrates a thrombocytopenia.

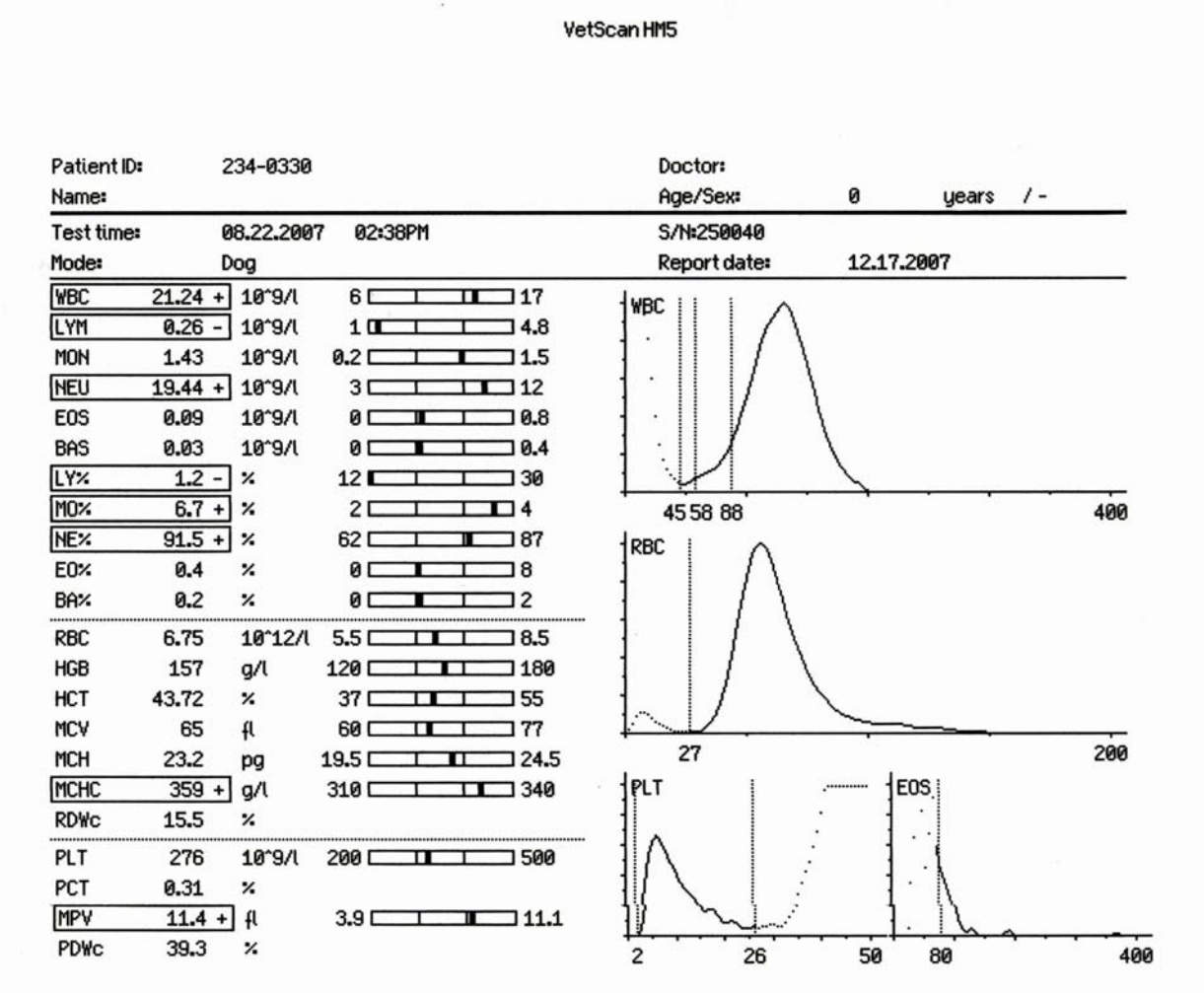


These histograms indicate the following:

- WBC — Discriminator 1 is at 36 fl, which is slightly lower than normal. Otherwise, the histogram appears to be normal. Discriminators 2 and 3 are placed correctly according to the WBC population.
- RBC — Normal.
- PLT — Low PLT. The nicely shaped PLT curve indicates that no clumping has occurred, but a manual smear is recommended for confirmation.

D.2.5 Dog: Stress Leukogram

When dogs are stressed before the sample draw, they often show an increase in total WBC count, with an elevated NEU count and a decreased LYM count. Dogs that are stressed but otherwise healthy display results similar to those shown below.



These histograms indicate the following:

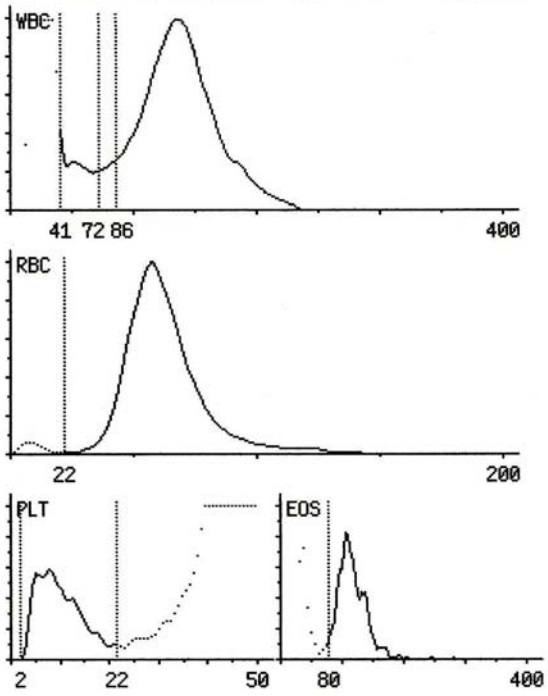
- WBC — Very high total leukocyte count, with a pronouncedly shrunken LYM peak and an elevated NEU with suppressed EOS.
- RBC — Normal.
- PLT — PLT count is normal for this sample.

D.2.6 Dog: Eosinophilia

This sample demonstrates an eosinophilic canine patient.

VetScan HM5

Patient ID:	2942				Doctor:		
Name:	gracie raskas				Age/Sex:	12 years	/ Female
Test time:	05.29.2007 05:29PM				S/N:250315		
Mode:	Dog				Report date:	11.29.2007	
WBC	8.55	10^9/l	6	17			
LYM	0.87 -	10^9/l	1	4.8			
MON	0.37	10^9/l	0.2	1.5			
NEU	5.98	10^9/l	3	12			
EOS	1.21 +	10^9/l	0.1	1			
BAS	0.13	10^9/l	0	0.5			
LY%	10.1 -	%	12	30			
MO%	4.4 +	%	2	4			
NE%	69.9	%	62	87			
EO%	14.1 +	%	1	8			
BA%	1.5	%	0	3			
RBC	8.08	10^12/l	5.5	8.5			
HGB	17.8	g/dl	12	18			
HCT	51.81	%	37	55			
MCV	64	fl	60	77			
MCH	22.0	pg	19.5	24.5			
MCHC	34.3 +	g/dl	31	34			
RDWc	15.7	%					
PLT	186 -	10^9/l	200	500			
PCT	0.20	%					
MPV	10.6	fl	3.9	11.1			
PDWc	40.2	%					



These histograms indicate the following:

- WBC — The histogram shows a fairly normal WBC profile.
- EOS — The absolute count of eosinophils and EOS% are above normal. The high EOS value indicates a need for a manual blood smear.
- PLT — The distinct peak shows a slight thrombocytopenia, with no detectable clumping.

D.3 Cats

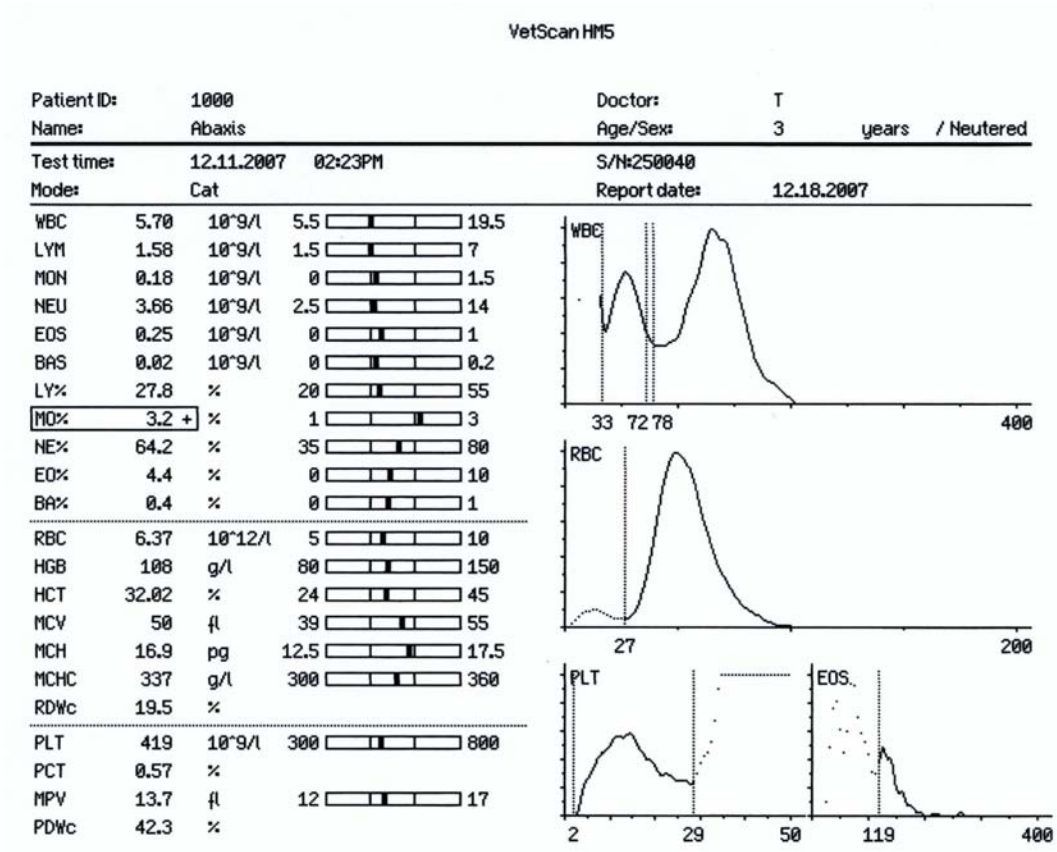
An important characteristic of cat blood is that the RBCs are much smaller than those of dogs, potentially causing the RBC and PLT histograms to overlap slightly.

Cats also commonly demonstrate both platelet aggregation and giant platelets. The analyzer minimizes these effects with a proprietary technology and dynamic discriminator approach to maximize accuracy.

Some clinics have minimized stress-induced platelet aggregation by collection from the saphenous vein. Analyzing the sample as close to the time of draw as possible also minimizes PLT clumping. Pre-analytical vortex mixing (up to 30 seconds) also helps disaggregate platelets, with no deleterious effects.

D.3.1 Cat: Optimal Sample

The following shows an optimal normal cat sample.

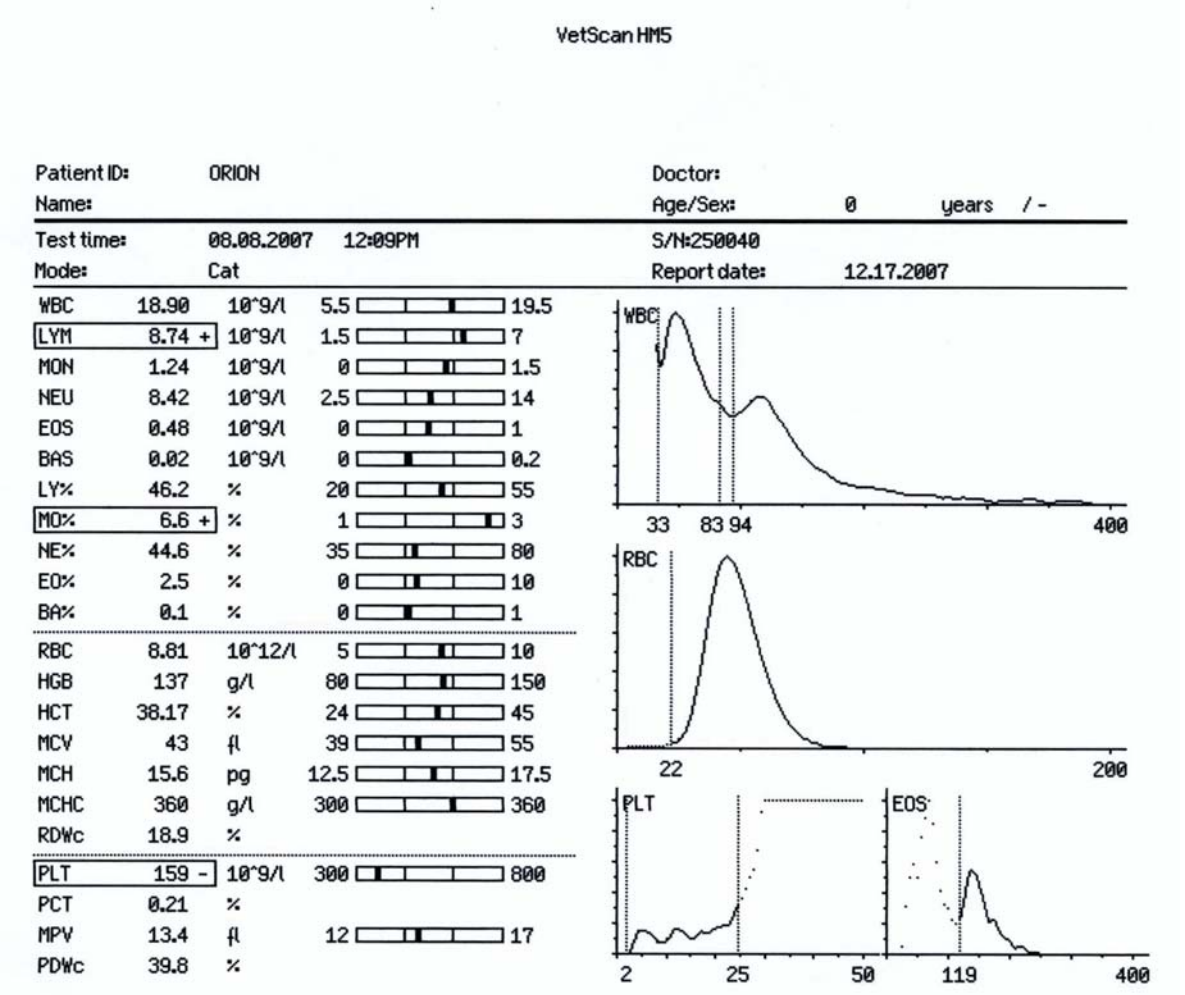


These histograms indicate the following:

- WBC — Normal. Well-defined and well-separated LYM and GRA (granulocyte) peaks.
- RBC — Normal.
- PLT — Optimal: the PLT is well separated from the RBC in a well-defined peak.

D.3.2 Cat: Clumped PLT, Increased LYM

The histograms for this cat indicate that clumped PLTs are affecting the WBC count:

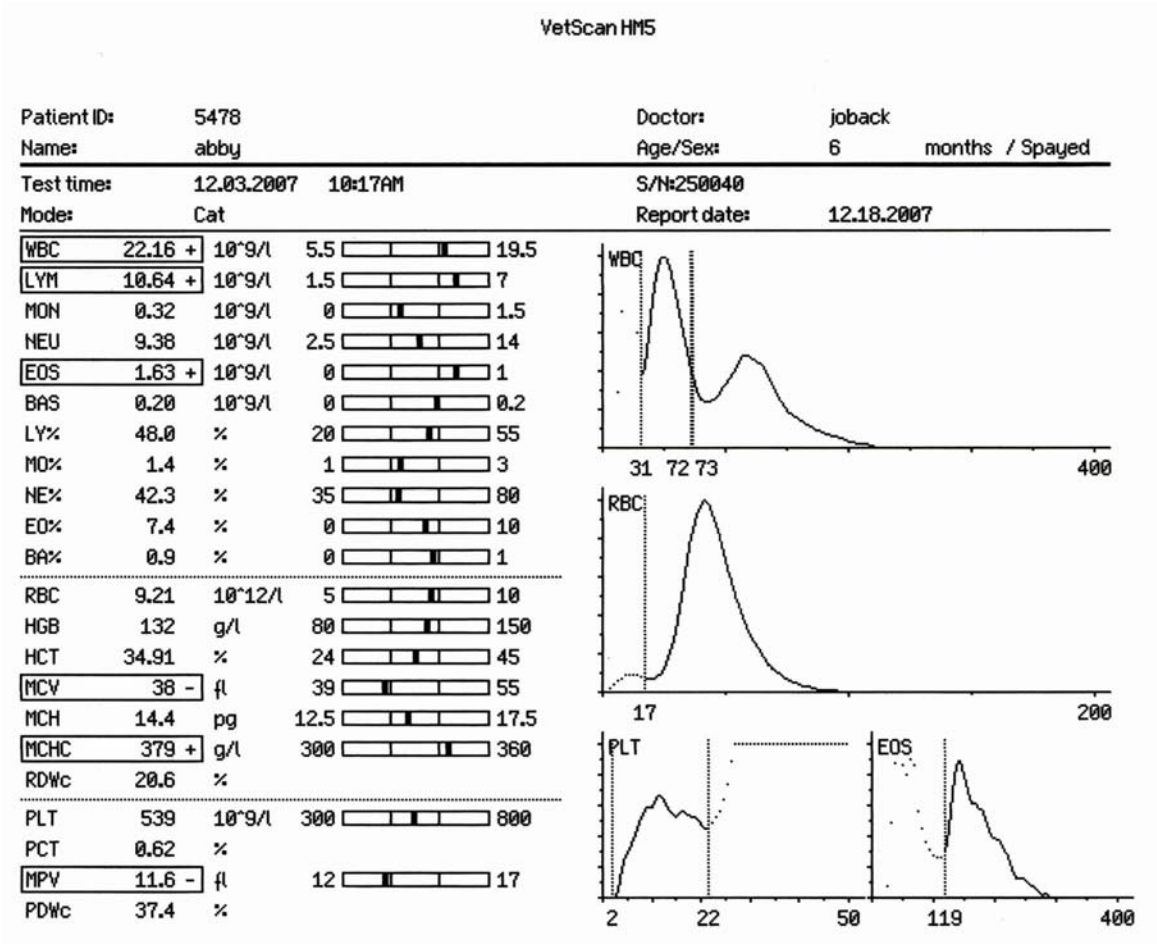


These histograms indicate the following:

- WBC — The increased size of the LYM peak relative to the GRA peak and the high LYM result on a cat sample suggest that the user should examine the PLT histogram. The clumped platelets (PLT) increase the LYM count in this sample, and also contribute to cell aggregates, shown in the extended tail on the right of the histogram.
- PLT — The PLT histogram lacks a defined peak and slopes upward to the right, indicating the presence of clumped platelets.

D.3.3 Cat: Eosinophilia and Lymphocytosis

This sample demonstrates a lymphocytosis and eosinophilia in a feline patient.



These histograms indicate the following:

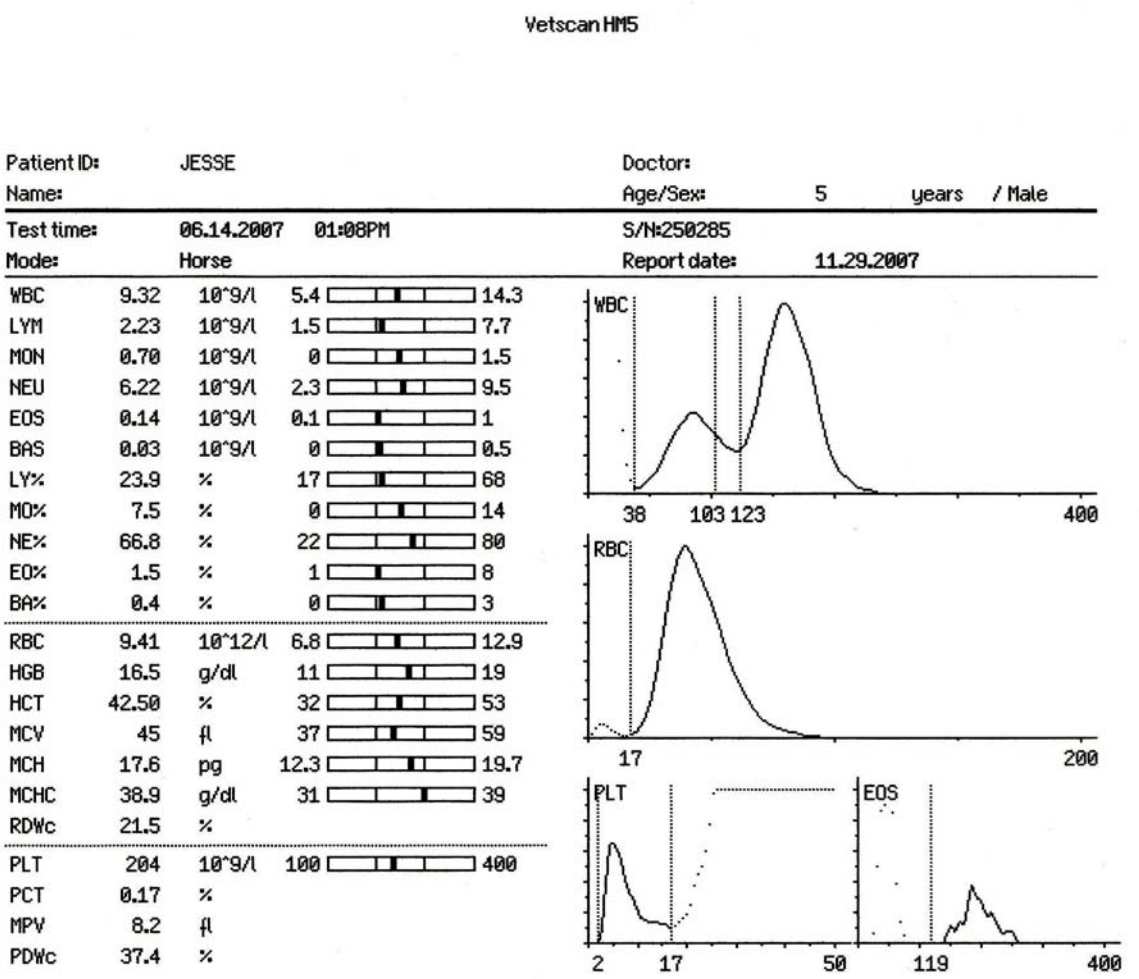
- WBC — Large increase in LYM with a relative decrease in GRA. The large LYM count and uniform shape of the histograms indicate that this is likely a genuine lymphocytosis.
- EOS — The EOS histogram shows a single broad peak, which causes the high EOS count.
- RBC — Normal, with normal distribution.
- PLT — The PLT curve slopes up and indicates some clumping in this sample.

D.4 Horses

Horse samples typically show a good separation of PLT/RBC, and well-separated WBC populations. The MCV is relatively low, while the RBC is high — around $10x10^{12}$ cells/l — giving an HCT near 40%.

D.4.1 Horse: Normal Sample

The following shows a typical normal sample for a horse:

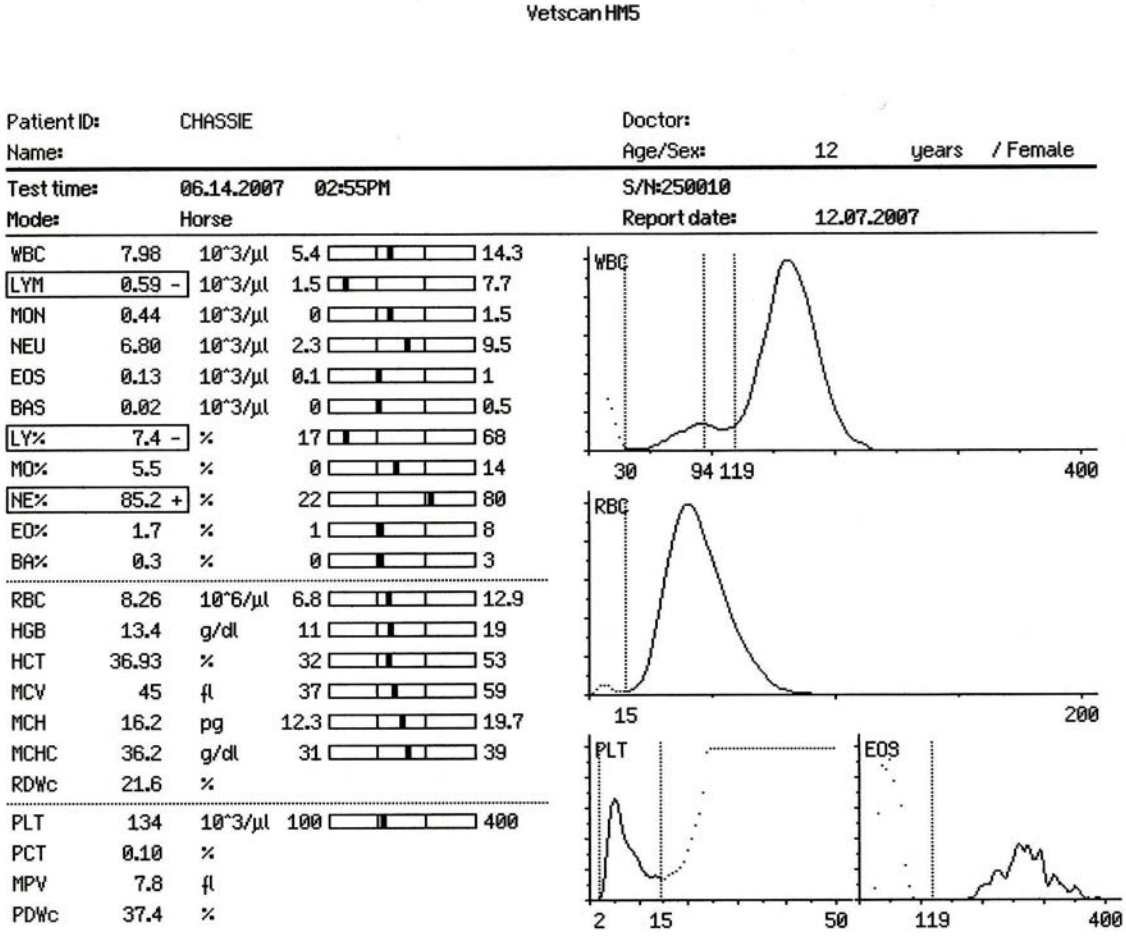


These histograms indicate the following:

- WBC — WBC value is normal, the cells are well separated, and the discriminators are set accurately.
- RBC — Normal. (Compare dog and horse histograms to see the smaller cells in the horse.)
- PLT — PLT is correct. (Note the good separation at the PLT/RBC discriminator.)

D.4.2 Horse: Low LYM%, High GRA%

The following is a typical horse sample with a lymphopenia.



These histograms indicate the following:

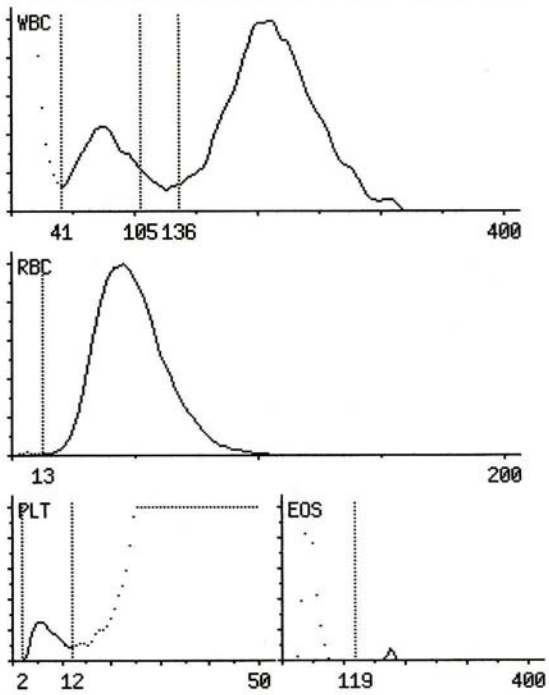
- WBC — Low LYM% and a high GRA%. Discriminators are set accurately.
- RBC — Normal.
- PLT — Normal. (Note the good separation from RBCs.)

D.4.3 Horse: Low PLT and WBC (Leukopenia/Lymphopenia)

In some cases, the PLT will be low. You can compare the height of the PLT peak to the RBC peak on the RBC histogram.

Vetscan HM5

Patient ID:		HOWARD			Doctor:		
Name:					Age/Sex:	18 years	/ Male
Test time:		09.19.2007	03:27PM		S/N:250285		
Mode:		Horse			Report date:	11.29.2007	
WBC	3.97 -	10^9/l	5.4	14.3			
LYM	0.74 -	10^9/l	1.5	7.7			
MON	0.18	10^9/l	0	1.5			
NEU	3.04	10^9/l	2.3	9.5			
EOS	0.01	10^9/l	0	1			
BAS	0.00	10^9/l	0	0.3			
LY%	18.6	%	17	68			
MO%	4.5	%	0	14			
NE%	76.6	%	22	80			
EO%	0.3	%	0	10			
BA%	0.0	%	0	2			
RBC	9.53	10^12/l	6.8	12.9			
HGB	17.0	g/dl	11	19			
HCT	47.08	%	32	53			
MCV	49	fl	37	59			
MCH	17.8	pg	12.3	19.7			
MCHC	36.1	g/dl	31	39			
RDWc	22.6	%					
PLT	27 -	10^9/l	100	400			
PCT	0.02	%					
MPV	7.3	fl					
PDWc	33.8	%					

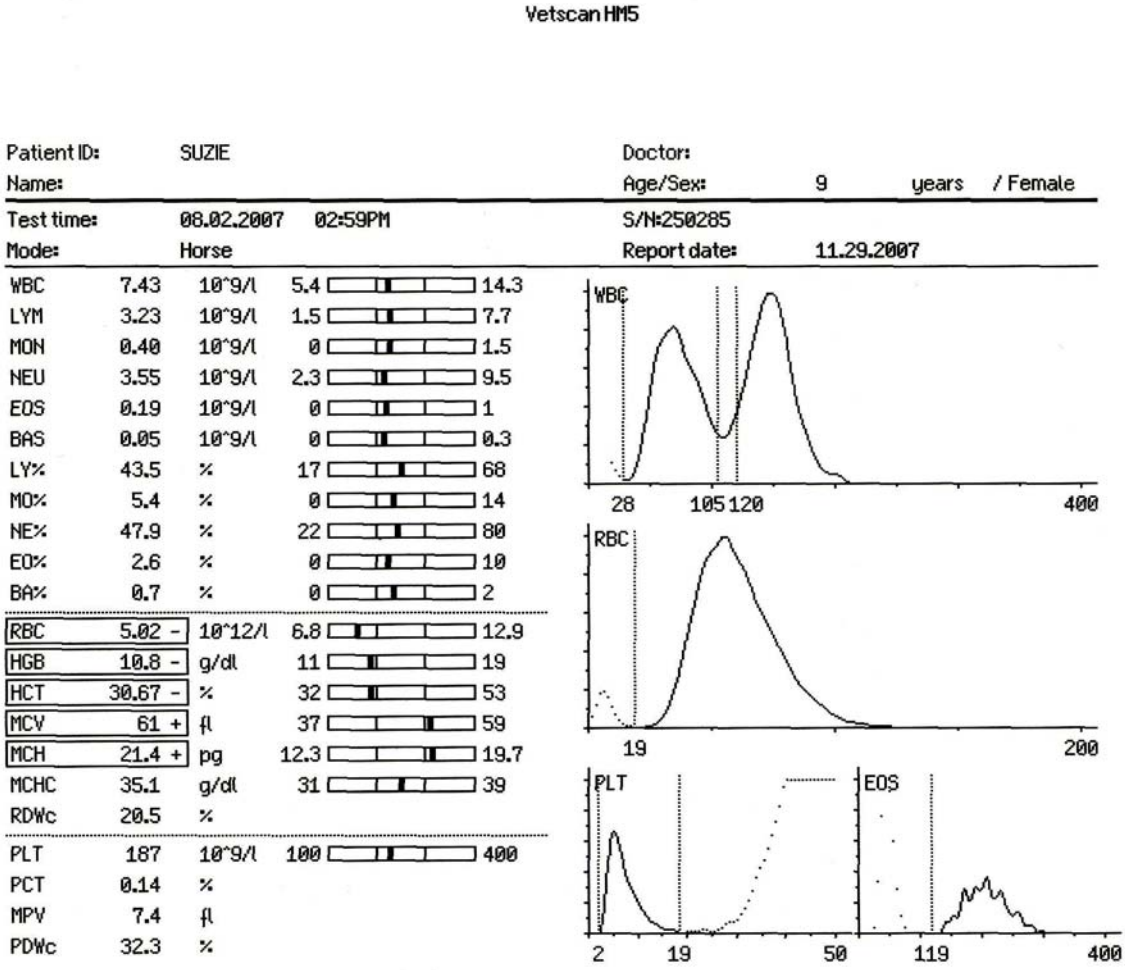


These histograms indicate the following:

- WBC — Low WBC and LYM, with accurately placed discriminators.
- RBC — Normal.
- PLT — Low PLT.

D.4.4 Horse: Low RBC and HGB

This case shows a normal sample, with a slightly low RBC and HGB. It also shows good separation of the WBC populations from the RBC and from each other.



These histograms indicate the following:

- WBC — This is a well-separated WBC histogram, showing clear populations and good WBC differentials.
- RBC — Low RBC (HCT) and HGB, indicating possible anemia. MCV is slightly higher, and the RBC histogram is slightly skewed to the larger end, indicating the presence of larger, perhaps immature RBCs.
- PLT — Normal. (Note the good separation from RBCs.)

Appendix E

CBC Parameters and Associated Indications

Complete Blood Count (CBC) parameters are useful in assessing overall wellness of a patient, as well as identifying and monitoring certain disease states. This appendix outlines the various CBC parameters and associated clinical indications.

Appendix Contents

E.1 White Blood Cell Parameters and Associated Indications

Table E-1: White Blood Cell Parameters and Associated Indications

White Blood Cell (Leukocyte)	Role	Increase in Disease State	Decrease in Disease State
Non-Granulocytic			
Lymphocytes	**B-cells**: humoral immunity (antibody synthesis) **T-cells**: cellular immunity	• Chronic inflammation • Acute infection/recovery • Lymphocytic leukemia • Hypoadrenocorticism	• Acute/severe disease • Viral disease • Endotoxemia • Hyperadrenocorticism • Stress-related corticosteroid response
Monocytes	Immature macrophages — phagocytosis of debris/foreign material, killer-cell activation	Necrotic, malignant, hemorrhagic, or immune-mediated disease	Rare, no known significance
Granulocytes			
Neutrophils ***Left shift:*** Increased numbers of immature neutrophils/band cells. • regenerative: up to 50% bands, neutrophilia, absence of myelocytes/metamyelocytes • degenerative: > 10% bands, depressed total neutropenia, presence of myelocytes/metamyelocytes (poor prognostic indicator) ***Right shift:*** Increased number of hypermature (hyper-segmented) neutrophils, often seen with non-infectious inflammatory process (e.g. malignancy)	Phagocytize/kill microorganisms, initiate and modify inflammatory process, cytotoxic	• Inflammation • Neoplasm • Stress • Exercise/excitement	• Bacterial infection • Viral infection • Drug-induced (bone marrow depression)
Eosinophils	• Parasiticidal • Cytotoxic • Phagocytic	• Parasitic infection • Allergic responses • Hypoadrenocorticism	• Stress • Hyperadrenocorticism • ACTH therapy
Basophils	• Initiate inflammation • Prevent coagulation • Activate lipoprotein lipase	• Allergic reactions • Parasitic infection • Neoplasia	No known significance

E.2 Red Blood Cell Parameters and Associated Indications

Table E-2: Red Blood Cell Parameters and Associated Indications

Parameter	Definition	Diagnostic Consideration
Hematocrit (HCT)	Percentage of total cellular constituents (primarily red blood cells) in a unit of whole blood	Anemia exists when the HCT falls below the reference range for the species. Hematocrit will normally have a value of approximately three times the hemoglobin value.
Hemoglobin (HGB)	The oxygen-carrying component of red blood cells; allows for the calculation of MCH and MCHC	Hemoglobin normally falls in the range of 1/3 of the hematocrit value.
RBC Indices Anemia Characterization		
MCV Mean Corpuscular Volume	Measure of the volume of an average RBC	• Increase: most commonly associated with reticulocytes/regenerative anemia. • Decrease: iron-deficiency anemia. • Normal MCV is consistent with non-regenerative anemia, often due to chronic disease. MCV should always be interpreted in light of other clinical data.
MCH Mean Corpuscular Hemoglobin	Calculated HGB concentration of an average RBC: • MCH = (HGB x 10) / RBC (in picograms)	• Increase: most commonly the result of hemolysis. • Decrease: hypochromasia common in iron-deficiency anemia and reticulocytosis.
MCHC Mean Corpuscular Hemoglobin Concentration	Calculated HGB concentration in an average RBC: • MCHC = MCH / MCV (in grams of HGB per 100 ml RBCs)	• In the anemic state, normal MCHC (with normal MCV) is consistent with non-regenerative anemia due to chronic disease. • Decrease: hypochromasia common in iron-deficiency anemia and reticulocytosis.
RDW Red Cell Distribution Width	Measure of red blood cell anisocytosis (cell size variation)	• Elevated RDW is typically indicative of anisocytosis. In the anemic state, increased RDW with an associated increase in MCV can indicate increased levels of immature RBCs.

E.3 Platelet Parameters and Associated Indications

Table E-3: Platelet Parameters and Associated Indications

Parameter	Increase in Disease State	Decrease in Disease State
Total Platelet Count	Thrombocytosis is present with excess bleeding, iron deficiency anemia and myeloproliferative syndromes.	• Disseminated intravascular coagulation • Bone marrow depression • Autoimmune hemolytic anemia • Severe hemorrhage • Liver disease • Parasites
MPV Mean Platelet Volume	Indirect evidence of increased (bone marrow) megakaryocyte response.	Not an accurate predictor of decreased megakaryocyte response.
PCT Platelet Hematocrit	Volume of platelets expressed as a percentage of whole blood (used as a research tool).	Volume of platelets expressed as a percentage of whole blood (used as a research tool).
PDW Platelet Distribution Width	Increased measure of platelet anisocytosis (platelet size variation) indicative of active platelet release.	No known clinical significance.

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