ZOETIS DIAGNOSTICS

vetscan OptiCell™

Hospital Resource Guide

LOOK DEEPER

zoetis

Welcome

to the Vetscan OptiCell™ Hospital Resource Guide.

This guide is designed to give you everything you need to get the most out of the Vetscan OptiCell analyzer. Throughout the chapters listed, you will find links to supplemental resources to help address questions.

We hope you find this guide useful. And as always, contact Diagnostic Technical Support for further assistance at:

(888) 963-8471 (option 5)

dxsupport@zoetis.com

Need guidance on a treatment plan?

Review results and a path forward for complex cases with remote specialist consultations at no additional cost for Zoetis Diagnostics customers.* Schedule at ZoetisDx.com.

* Requires the use of Vetscan Hub™ and at least one Zoetis Diagnostics analyzer or service.

Contents

Vetscan OptiCell Overview

What is Vetscan OptiCell?

Innovative technology, AI–powered processing and minimal maintenance come together to provide valuable, automated complete blood count (CBC) insights from your clinic.

Vetscan OptiCell (Figure 1.1) is the first automated CBC analyzer validated for veterinary species that integrates flow cytometry and digital imaging in a single platform.*[1] A next-generation, cartridge-based hematology analyzer, Vetscan OptiCell features 3 technological innovations:

- ✓ Microfluidic viscoelastic focusing (VEF)
- ✓ A self-contained, single-use cartridge system
- ✓ Imaging-based analysis using artificial intelligence (AI)

Figure 1.1 *The Vetscan OptiCell*

Vetscan OptiCell is a screenless analyzer controlled through use of the Vetscan Hub. It delivers highly accurate[1] automated CBC results with 22 parameters, including reticulocytes:

Measured Parameters

- ✓ White blood cell (WBC) count and differential counts
- ✓ Red blood cell (RBC) count
- ✓ Mean cell volume (MCV)
- ✓ Mean corpuscular hemoglobin (MCH)
- ✓ Red blood cell distribution width (RDW)
- ✓ Reticulocyte count
- ✓ Platelet (PLT) count
- ✓ Mean platelet volume (MPV)

Calculated Parameters

- ✓ WBC differential percentages
- ✓ Hemoglobin (HGB)
- ✓ Hematocrit (HCT)
- ✓ Mean corpuscular hemoglobin concentration (MCHC)
- ✓ Reticulocyte percentage

* Vetscan OptiCell reports do not include histograms or scattergrams at this time.

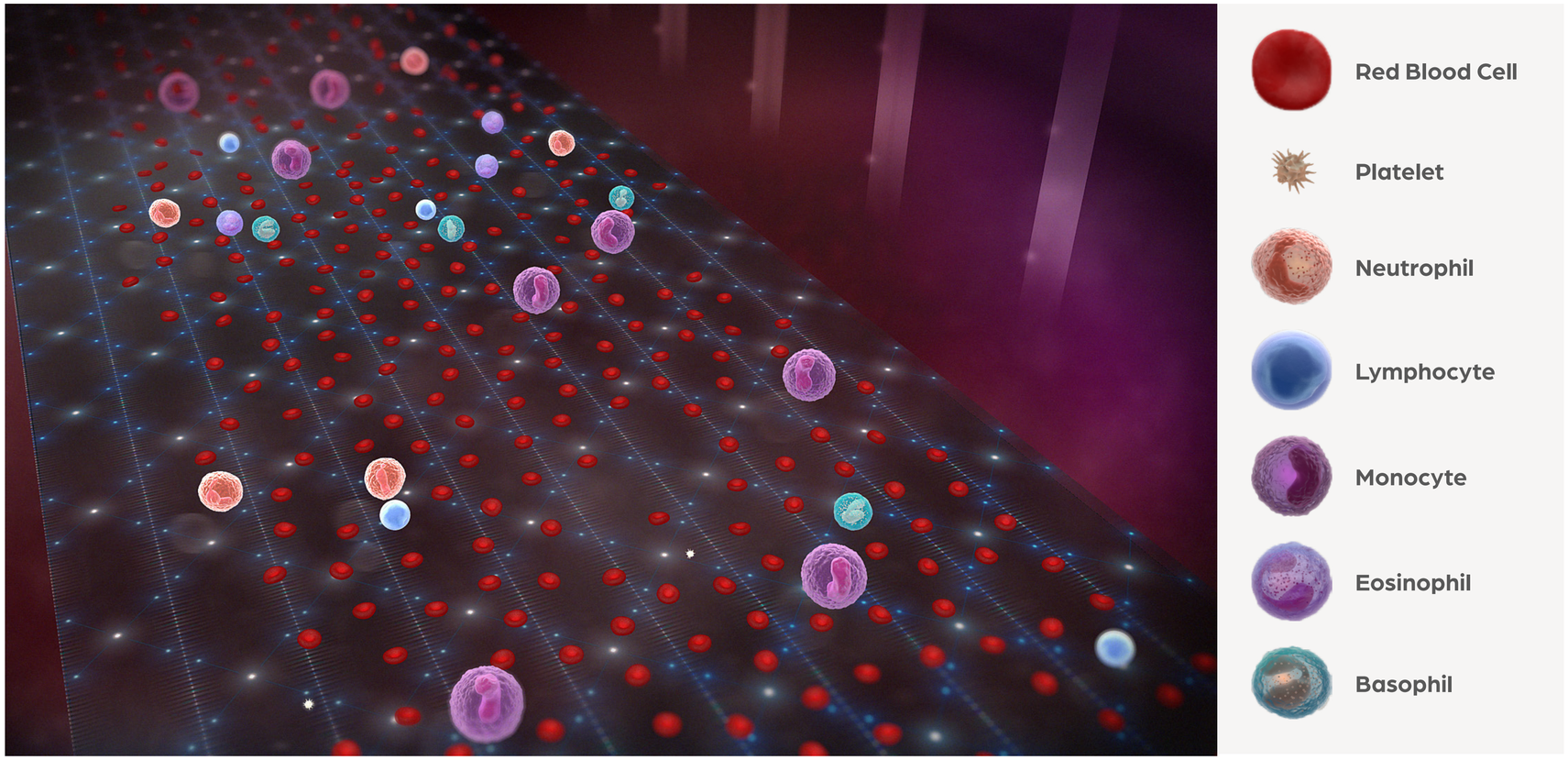
1. Data on file. Study No. DHXMZ-US-24-235, 2024, Zoetis Inc.

Vetscan OptiCell Overview

Viscoelastic focusing technology

- Viscoelastic focusing (VEF) is a patented microfluidics technology that causes blood cells to perfectly align into a single layer while flowing (Figure 1.2)
- The sharp focusing attained by VEF facilitates highly accurate[1] measurements which are based on image analysis akin to a virtual flowing blood smear
  - Images of platelet clumps allow individual platelets to be classified and counted

Figure 1.2 *Viscoelastic Focusing Cell Alignment*



VEF requires much lower reagent volume per sample run (compared to traditional technologies), making Vetscan OptiCell cost-effective and easy to use.

1. Data on file. Study No. DHXMZ-US-24-235, 2024, Zoetis Inc.

Vetscan OptiCell Overview

The future of in-clinic hematology is here with advanced, AI-powered CBC analysis.

Reference laboratory quality results[1]

- ✓ **Accurate results** comparable to that of the Advia® Reference Laboratory Hematology analyzer[1]
- ✓ Viscoelastic Focusing enables a cartridge-based design to **minimize errors**
- ✓ Detailed flags **identify abnormal cell morphology**

Streamlined practice workflow

- ✓ **Decrease staff hands-on time** with minimal maintenance
- ✓ **Simple, 3-step cartridge preparation** streamlines your diagnostic workflow and training
- ✓ **No reagent pack to replace**, liquid quality controls to manage or waste container to empty

Help improve efficiency and profitability

- ✓ **Help enhance profitability** with complete in-clinic hematology and specialist support in a single workflow
- ✓ **Standardized cost-per-run**, regardless of CBC test volume
- ✓ **Help optimize inventory management** with no wasted reagents and extended shelf-life for all cartridges

1. Data on file. Study No. DHXMZ-US-24-235, 2024, Zoetis Inc.
Advia is a registered trademark of Siemens Healthcare Diagnostics Inc.

Vetscan OptiCell Overview

Vetscan OptiCell Sample Cartridge[1]

Each Vetscan OptiCell cartridge has a measurement chamber, contains all necessary reagents and automatically prepares the blood sample for CBC analysis (Figure 1.3).

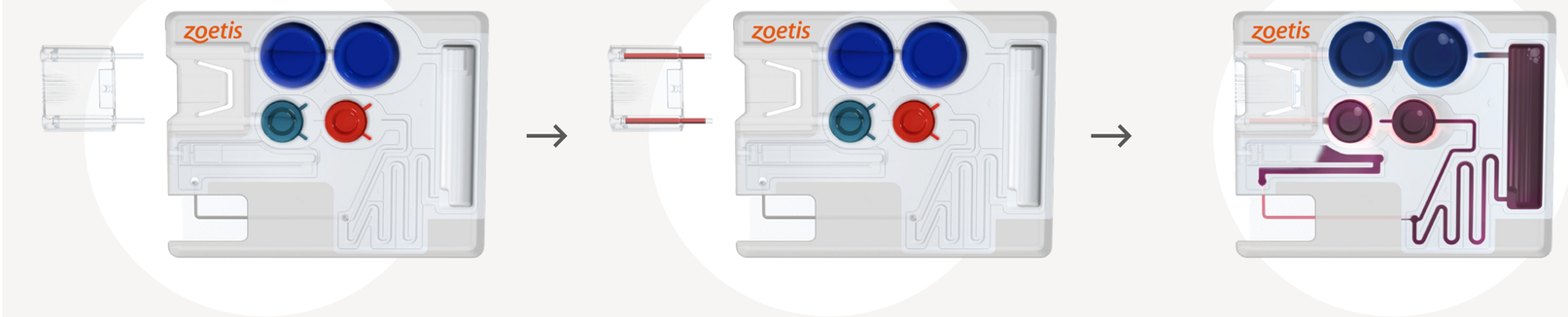
- There is no reagent pack to replace and no liquid waste container to empty
- Cartridges and samplers are stored at room temperature

Vetscan OptiCell's CBC Analysis – Key Details[1]

- Measures MCV and MPV directly based on each cell's geometry
- Utilizes digital images to measure MCH based on the optical density of red blood cells
- Calculates HGB based on MCH and RBC, rather than being measured by spectrophotometry

  HGB = (MCH x RBC)/10
- Differentiates between platelets, platelet clumps, cell fragments and other cells
- Generates flags and recommends blood smear review for:
  - Suspected presence of platelet clumps
  - Suspected morphologically abnormal cells
  - Suspected abnormal platelet size variation

Figure 1.3 *Self-Contained Cartridge*



Unused sampler and sample cartridge

Sampler filled with blood prior to insertion into cartridge

Used cartridge after a sample run

1. Vetscan OptiCell User Manual, 2024, Zoetis, Inc.

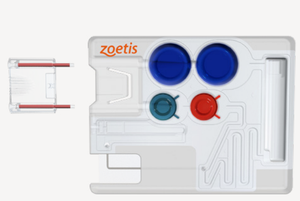
Vetscan OptiCell Overview

Sophisticated AI–driven algorithms reliably classify and count blood cells

Vetscan OptiCell uses AI-driven algorithms to “see” blood cell images and analyze the sample instantly based on hundreds of individual cell features (Figure 1.4). The AI-driven algorithms are trained using datasets of blood cell images that have been classified by trained experts.

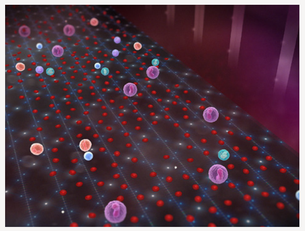
- With each measurement, hundreds of thousands of RBCs and thousands of WBCs are counted
- Hundreds of features are extracted from each cell to help classify it as a specific blood cell type based on staining properties and cell morphology traits, including:
  - Cytoplasm area, color and granularity
  - Nuclei color and shape

Figure 1.4 *How AI–trained Algorithms Analyze a Vetscan OptiCell Sample*



The cartridge (with sampler in place) is inserted into the analyzer for automatic sample preparation/staining and measurement

Once the cartridge is inserted, the blood sample mixes with reagents inside the cartridge, then advances through 2 microfluidic channels



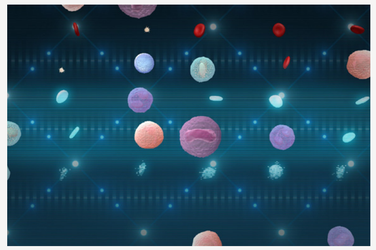
Cells flow out of each channel, then, through VEF, align in a single layer plane in the cartridge “chip” area where images are captured. Each image is analyzed by AI-driven algorithms.

High resolution, microscopic 3D images are taken of the flowing cells

Cells from Channel 1 are counted:

Total WBC, PLT, RBC and Reticulocytes

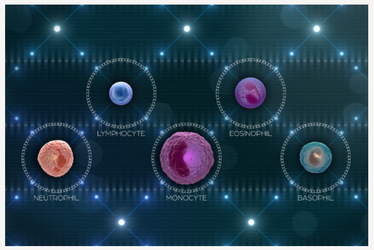
Based on:
Cell size, shape, color, morphology



After RBC lysing, cells from Channel 2 are counted:

WBC differential

Based on:
Staining properties of the cytoplasm, nucleus

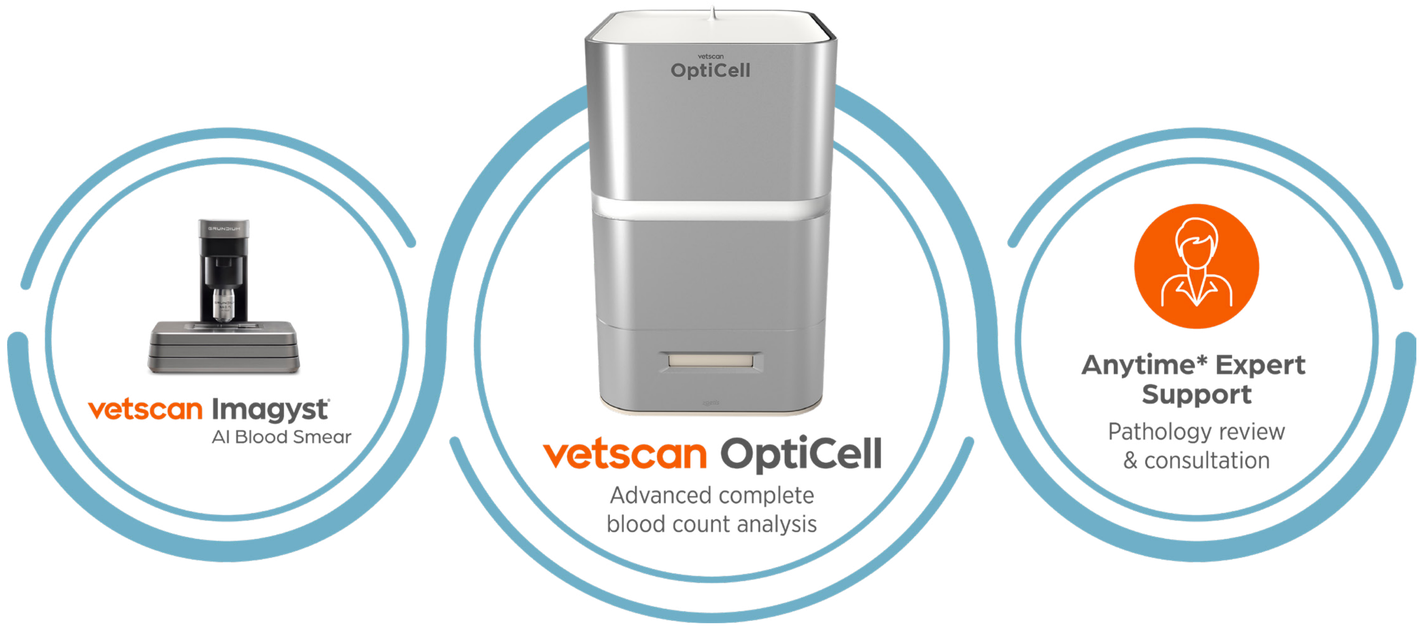


Vetscan OptiCell Overview

The Complete Hematology Picture

Integrated with the powerful Zoetis Diagnostics portfolio and supported by the Zoetis Virtual Laboratory (Figure 1.5), Vetscan OptiCell brings innovation to in-clinic diagnostics with advanced technology and AI-powered processing, enabling highly accurate[1] hematology insights, enhanced patient outcomes and elevated care.

Figure 1.5 *The Complete Zoetis Hematology Portfolio*



Comprehensive

- ✓ Pair Vetscan OptiCell advanced CBC analysis with Vetscan Imagyst® AI Blood Smear estimated cell counts for a complete hematology picture.

Connected

- ✓ Access CBC and AI Blood Smear results anytime, anywhere on your ZoetisDx portal, and connect with a network of experts for remote review of AI Blood Smear submissions,* when needed.

Supported

- ✓ Schedule a consultation with a board-certified specialist whenever you need a second opinion,† to help you confidently diagnose even the most challenging cases.

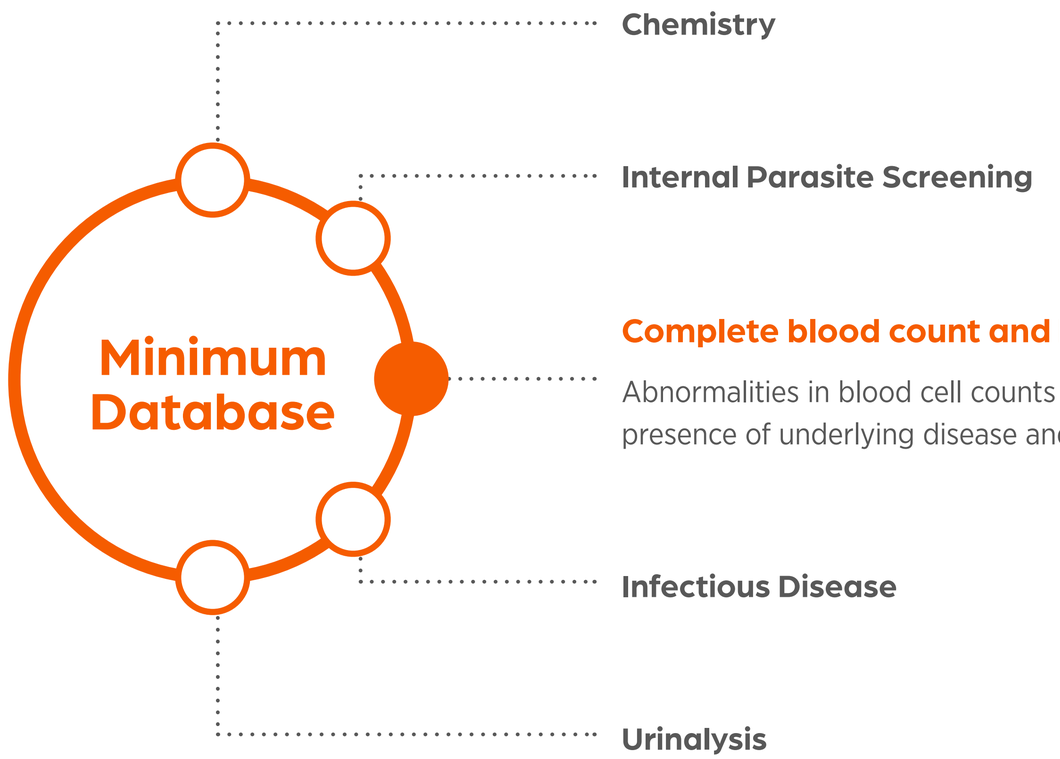
* Option to send digital slide image to our network of clinical pathologists as needed. Additional costs may apply.
† Dependent on consultant availability.
1. Data on file. Study No. DHXMZ-US-24-235, 2024, Zoetis Inc.

The Complete Hematology Picture

Define your laboratory testing minimum patient database[1]

A minimum database is a group of key diagnostic tests that provides veterinary healthcare teams with a complete clinical picture for each patient.

Figure 2.1 *Complete Minimum Database*



1. Kipperman BS. The demise of the minimum database. J Am Vet Med Assoc. 2014;244(12):1368-1370. doi:10.2460/javma.244.12.1368.

The Complete Hematology Picture

A complete hematologic picture includes the following CBC components:

1

Automated CBC (Quantitative)
+
Packed Cell Volume (PCV) (Quantitative)

2

Blood smear (Qualitative)

Manual or using Vetscan Imagyst AI Blood Smear

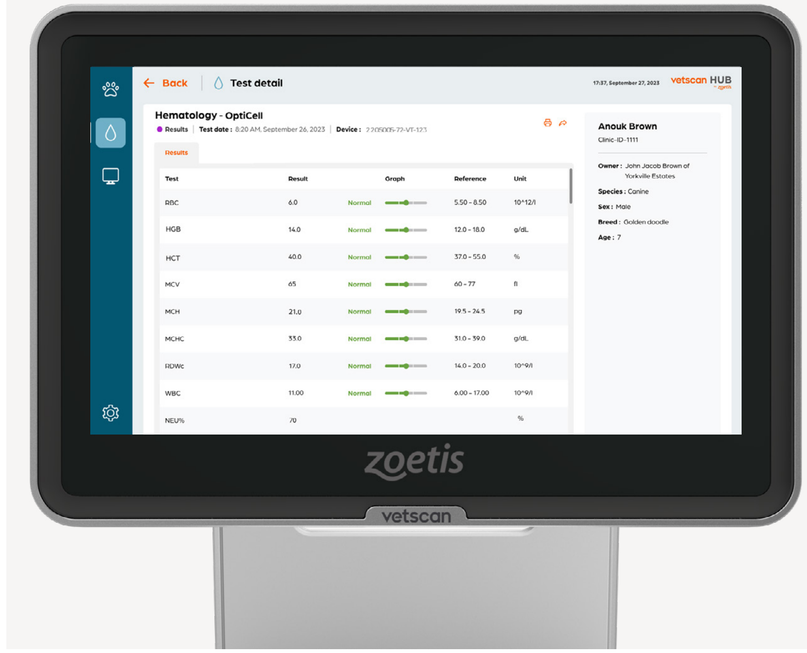
1. Quantitative evaluation: Automated CBC

The automated CBC, or hemogram, is a diagnostic tool that classifies, enumerates and differentiates the different types of cells present in the peripheral blood:

- Quantitative evaluation of the blood provides different cell population counts and their associated indexes when performed on an automated analyzer (Figure 2.2)
- Automated CBC includes a differential WBC count
- Each WBC has a very specific function—therefore, the differential count may be used to identify abnormal levels of specific WBC subpopulations and may offer diagnostic information about underlying health conditions

Vetscan OptiCell provides a 22-parameter CBC including reticulocyte absolute count and percentage.*

Figure 2.2 *Vetscan OptiCell CBC Results Displayed on the Vetscan Hub™*



* If your Vetscan OptiCell results show any warnings or errors, please refer to the User Manual for further guidance.

The Complete Hematology Picture

Reticulocyte Basics

- Reticulocytes are immature red blood cells
- When using standard stain, the immature red blood cells are called polychromatophils
- When using special stains, the dye clumps and stains the RNA inside the cell, forming a blue "reticulum," which is why it's called a reticulocyte (Figures 2.3 and 2.4)
- In most species, a reticulocyte count is the easiest and most reliable indicator of bone marrow responsiveness to anemia[1,2]
  - Interpretation of the reticulocyte count must be made relative to the duration and severity of the anemia
  - When the reticulocyte count is appropriately increased for the level of anemia, this is defined as a regenerative response
  - If a reticulosis is not present or is not appropriately high enough for the level of anemia:
    - May be dealing with pre-regenerative anemia, where the bone marrow hasn't had time to respond, which can take 3-4 days
    - The anemia has been present for an adequate amount of time; may be in the presence of a non- or poorly regenerative response[1,3]

Figure 2.3 *Reticulocytosis. Canine. New–methylene blue stain.*

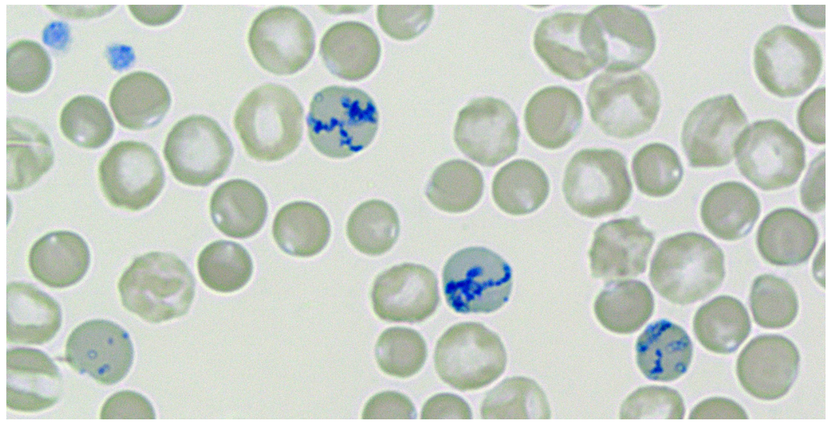
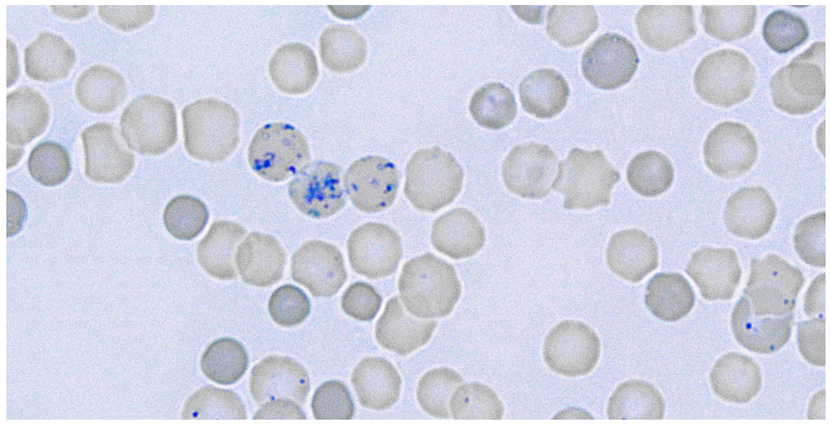


Figure 2.4 *Reticulocytosis. Feline. New–methylene blue stain.*



Knowing the reticulocyte count and percentage provides valuable information to aid clinicians in narrowing their differential diagnosis list and developing a therapeutic plan.[1-3]

Automated reticulocyte counts should be verified with a blood smear to examine RBC morphology and to confirm the automated reticulocyte count.

1. Latimer KS et al. Veterinary Laboratory Medicine Clinical Pathology, 5th Edition. Ames, IA: Blackwell Publishing Professional. 2011. Pgs. 21-35.
2. Grimes CN. Laboratory diagnosis and classification of anemia. Presented at: ACVIM Forum; June 9-11, 2016; Denver, Colorado.
3. Morissette, E. Don't Miss a Diagnosis: Comprehensive CBC with AI & Human Expertise in Your Practice. From 2022 AAFP Proceedings. TI-08501

The Complete Hematology Picture

1. Quantitative evaluation: PCV/TS

PCV is the direct centrifugal measurement (Figure 2.5) of the percentage of the blood that consists of RBC.

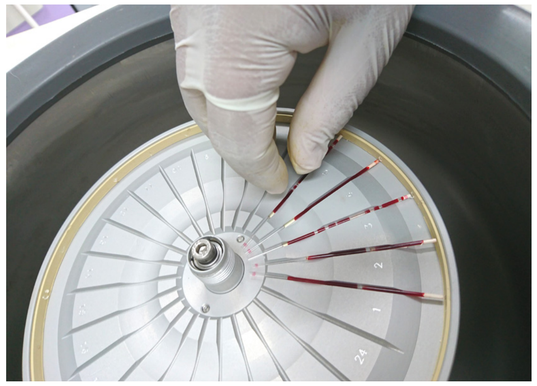
- It is an accurate measurement with minimal inherent error (+/- 1%)[1]

HCT is a calculated value of the percentage of the blood that consists of RBC.

- HCT (%)=(RBC/µL) x MCV (fL/10)[2]

Unlike PCV, the potential for error is greater with the HCT method because it is subject to MCV variation that can occur with certain hematologic conditions (eg, agglutination) and/or improper sample handling (eg, excess EDTA, hemolysis or inadequate mixing).[3]

Figure 2.5 *Centrifuge with PCV tubes*



To verify that HCT was not affected by artifactual errors, perform a PCV measurement.[4]

1. Brockus CW. Erythrocytes. In: Latimer KS, Mahaffey EA, Prasse KW, eds. Duncan & Prasse's Veterinary Laboratory Medicine: Clinical Pathology. 4th ed. Wiley-Blackwell; 2003:3-15.
2. Weiser G. Laboratory technology for veterinary medicine. In: Thrall MA, Weiser G, Allison RW, et al, eds. Veterinary Hematology and Clinical Chemistry. 2nd ed. Wiley-Blackwell; 2012:3-33.
3. Stockham SL, Scott MA. Erythrocytes. In: Stockham SL, Scott MA, eds. Fundamentals of Veterinary Clinical Pathology. 2nd ed. Wiley-Blackwell; 2008:110-221.
4. Erythrogram. Cornell University College of Veterinary Medicine. Accessed July 27, 2022. https://eclinpath.com/hematology/hemogram-basics/erythrogram/.

The Complete Hematology Picture

Overview of Hematology Parameters

Table 2.1 *Hematology Indices Explanation Table*[1]

Parameter	Definition	What it represents	What it is used for
RBC	The number of red blood cells per unit volume of blood	Indicates the oxygen-carrying capacity of the blood	Used to diagnose anemia, polycythemia and assess overall RBC health
RTC%	The percentage of reticulocytes (immature red blood cells) in the blood	Reflects the bone marrow's response to anemia through its production of new red blood cells	Used to assess the effectiveness of erythropoiesis and response to anemia
RTC	The number of reticulocytes per unit volume of blood	Reflects the bone marrow's response to anemia through its production of new red blood cells	Used to assess the effectiveness of erythropoiesis and response to anemia
HGB	The concentration of hemoglobin in the blood	Reflects the blood's ability to carry oxygen	Used to assess the severity of anemia and oxygen-carrying capacity
HCT	The percentage of blood volume occupied by red blood cells	Represents the overall red cell mass, indicative of blood's oxygen-carrying capacity	Used to assist in diagnosing anemia, polycythemia and monitor fluid balance
MCV	The average volume of individual red blood cells	Helps determine the average size of RBCs	Used to classify anemia as microcytic, normocytic or macrocytic

RBC =Red Blood Cell count. **HGB**=Hemoglobin. **HCT**=Hematocrit. **MCV**=Mean Cell Volume. **MCH**=Mean Corpuscular Hemoglobin. **MCHC**=Mean Corpuscular Hemoglobin Concentration. **RDWc**=Red Blood Cell Distribution Width (coefficient of variation).

1. Brooks MB, Harr KE, Seelig DM, Wardrop KJ, Weiss DJ, eds. Schalm's Veterinary Hematology. 7th ed. Wiley; 2022.

The Complete Hematology Picture

Overview of Hematology Parameters

Table 2.1 *Hematology Indices Explanation Table (cont.)*[1]

Parameter	Definition	What it represents	What it is used for
MCH	The average amount of hemoglobin per red blood cell	Indicates the hemoglobin content in an average red blood cells	Usually parallels the mean corpuscular hemoglobin concentration value
MCHC	The average concentration of hemoglobin in a given volume of red blood cells	Reflects the concentration of hemoglobin in red cells	Used to differentiate between hypochromic and normochromic anemias
RDWc	The variation in red blood cell size within a blood sample	Indicates the range of variation in red blood cell size, useful in classifying anemias	Used to evaluate the presence and type of anemia
WBC	The total number of white blood cells in a given volume of blood	Indicates the body's immune response and possible presence of infection or inflammation	Used to detect inflammatory pattern, infection or leukemia
WBC Differential	The percentage of each type of white blood cell in the blood	Provides detailed information on the relative proportions of different WBC types	Used to identify specific types of infections, inflammation and blood disorders
PLT	The number of platelets per unit volume of blood	Indicates the blood's ability to form primary clots	Used to assist in diagnosing thrombocytopenia, and monitor potential bleeding risks
MPV	The average size of platelets in the blood	Reflects platelet production and function	Used to assess bone marrow activity and platelet disorders

WBC=White Blood Cell count. **PLT**=Platelet count. **MPV**=Mean Platelet Volume. **RTC%**=Reticulocyte percentage. **RTC**=Reticulocyte count.

1. Brooks MB, Harr KE, Seelig DM, Wardrop KJ, Weiss DJ, eds. Schalm's Veterinary Hematology. 7th ed. Wiley; 2022.

The Complete Hematology Picture

2. Qualitative Evaluation: Blood Smear

Microscopic examination of a blood smear (Figure 2.6) can provide vital diagnostic information that is not identified on the automated CBC[1–4]:

- Confirm automated CBC results
- Assure quality
- Provide additional insights on cell morphology to guide diagnosis and treatment

Ideally, a blood smear evaluation (Figure 2.7) should be performed as a part of every CBC[5]

At a minimum, blood smears must be performed:

- **On every sick patient**
- **In each instance of abnormal counts or automated cell count flags (Table 2.2)**

Table 2.2 *Automated results that flag possible diseases states*

Automated cell count flag	Possible abnormality
Red blood cells (RBC)	Anemia[6,7]
White blood cells (WBC)	Cancer, infection, inflammation[6,7]
Platelets (PLT)	Disease and clumping[7]

Figure 2.6 *Image of blood smear*

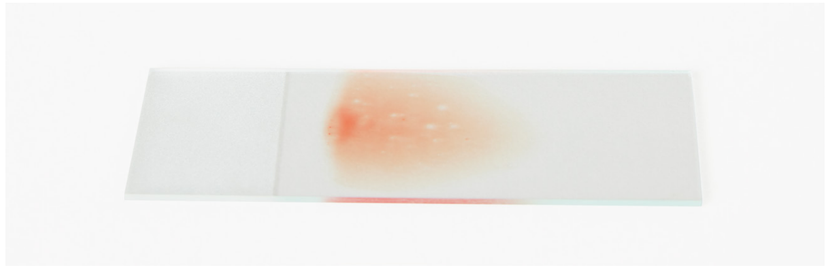
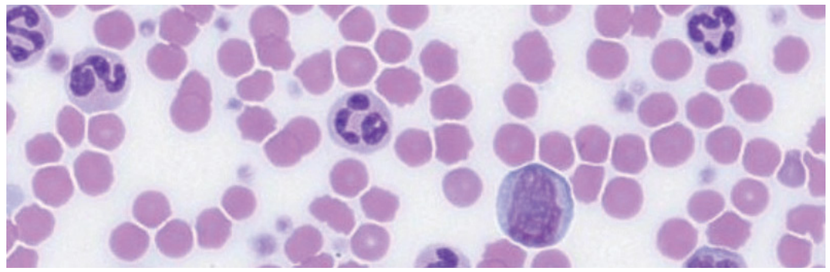


Figure 2.7 *High–resolution image from Vetscan Imagyst*



1. Zabolotzky SM, Walker DB. Peripheral blood smears. In: Cowell RL, Valenciano AC, eds. Cowell and Tyler's Diagnostic Cytology and Hematology of the Dog and Cat. 5th ed. Elsevier Inc.; 2019:438-467.
2. Weiss DJ, Tvedten H. The complete blood count, bone marrow examination, and blood banking: general comments and selected techniques. In: Willard MD, Tvedten H, eds. Small Animal Clinical Diagnosis by Laboratory Methods. 5th ed. Elsevier Inc.; 2012:12-37.
3. Stirn M, Moritz A, Bauer N. Rate of manual leukocyte differentials in dog, cat and horse blood samples using ADVIA 120 cytograms. BMC Vet Res. 2014;10:125. doi:10.1186/1746-6148-10-125.
4. Sharkey L, Heinrich D. In-clinic hematology: the blood film review. Today's Veterinary Practice. 2015. Accessed January 5, 2022. https://todaysveterinarypractice.com/in-clinic-hematology-the-blood-film-review/.
5. Harvey JW. Hematology procedures. In: Harvey JW, ed. Veterinary Hematology: A Diagnostic Guide and Color Atlas ed. Elsever Inc.;2021:11-32
6. Kahn CM, Line S, Aiello SE. Diagnostic procedures for the private practice laboratory. In: Kahn CM, Line S, Aiello SE, eds. The Merck Veterinary Manual. 10th ed. Merck & Co., Inc.; 2010:1487-1492.
7. Barger AM. The complete blood cell count: a powerful diagnostic tool. Vet Clin North Am Small Anim Pract. 2003;33(6):1207-1222. doi:10.1016/s0195-5616(03)00100-1.

The Complete Hematology Picture

Vetscan Imagyst AI Blood Smear

The Vetscan Imagyst AI Blood Smear application (Figure 2.8) conveniently delivers AI-driven blood smear analysis, providing critical data to supplement CBC results and help guide diagnosis and treatment.[1]

The accuracy of Vetscan Imagyst AI Blood Smear is comparable to that of expert board–certified clinical pathologists[1]

Identifiable Cell Types

- ✓ WBC differential/estimated counts
  - – Neutrophils, lymphocytes, monocytes, eosinophils, basophils
- ✓ Platelet estimated count/identifies medium and large platelet clumps
- ✓ Identifies and counts polychromatophils as well as nucleated red blood cells

Morphological changes – Red Blood Cells

- ✓ Poikilocyte
- ✓ Acanthocyte
- ✓ Echinocyte (Crenated Erythrocyte)
- ✓ Keratocyte
- ✓ Schistocyte
- ✓ Eccentrocyte (erythrocyte hemighost)

Morphological changes – White Blood Cells

- ✓ Band Neutrophil

Different disease states result in specific RBC morphology changes. Confirming the presence of RBC shape changes helps a clinician narrow the differential diagnosis list.

Figure 2.8 *Vetscan Imagyst AI Blood Smear – images from web application*

Visit our website to learn more about adding AI Blood Smear for a complete hematology picture.

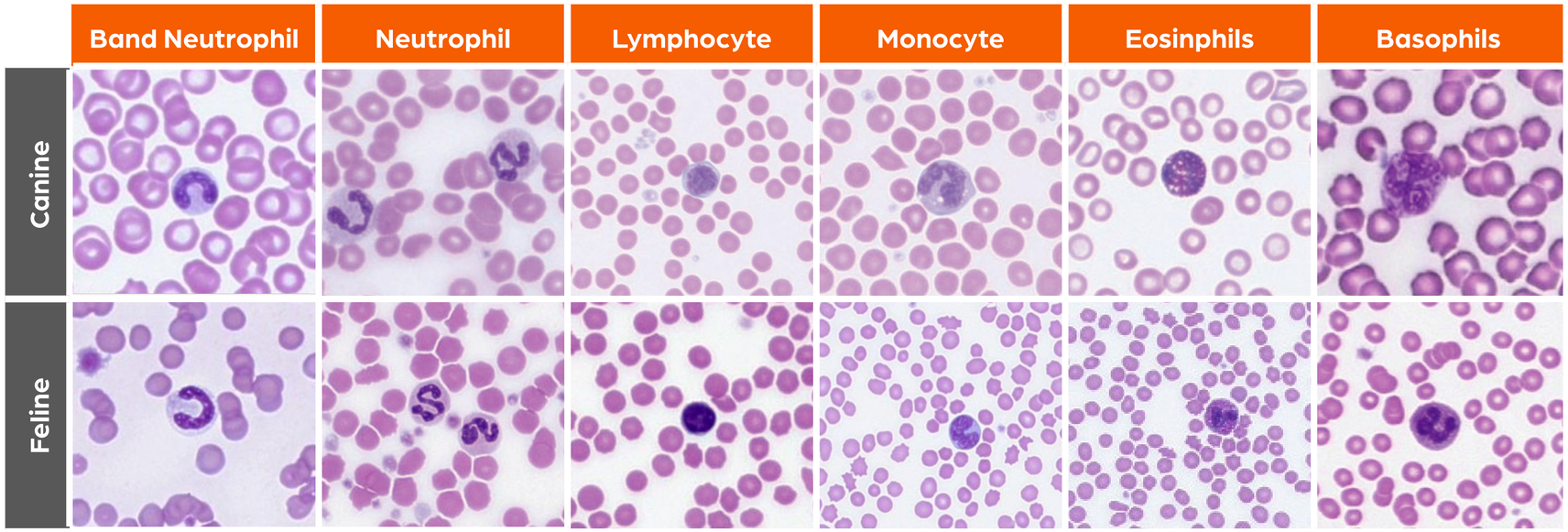
1. Data on file, Study No. D870R-US-21-045, 2021, Zoetis Inc.

The Complete Hematology Picture

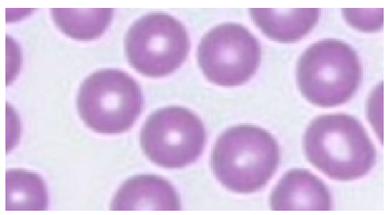
Blood Smear Evaluation Basics

All images used modified Wright's stain and were taken with Vetscan Imagyst unless otherwise noted.

White Blood Cells (WBCs; Leukocytes)



Red Blood Cells (RBCs; Erythrocytes)



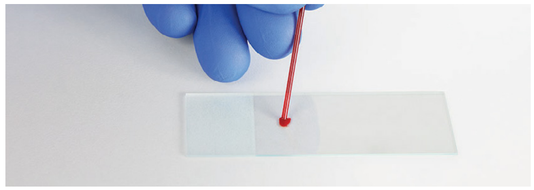
Poikilocytes

Acanthocyte | Echinocyte | Keratocyte | Schistocyte | Eccentrocytes

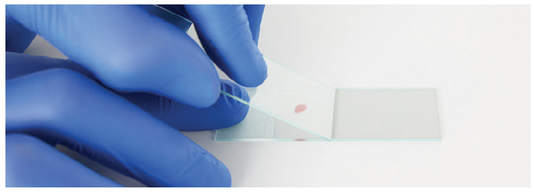
The Complete Hematology Picture

Blood Smear Evaluation Basics

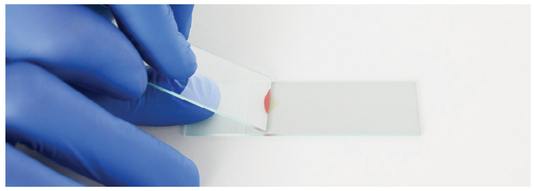
Preparing a Blood Smear



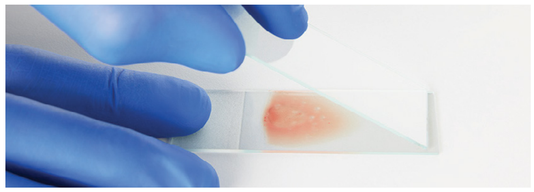
1. Place a droplet of blood near frosted end of slide using a microhematocrit capillary tube or micropipette. Do not use a wooden stick as PLT and WBCs may adhere to it.



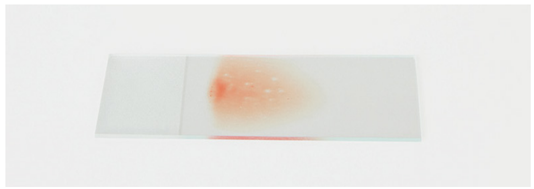
2. Place the spreader slide in front of the blood droplet at a 30° to 45° angle.



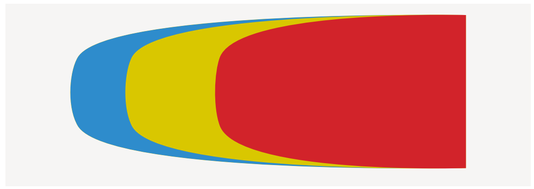
3. Draw spreader slide back to meet the blood droplet, allowing blood to spread toward edges of spreader slide. Do not allow blood to fully extend to slide edges.



4. Push spreader slide forward along the bottom slide without losing contact with the bottom slide.



5. Blood smear should cover ½ to ⅔ of the bottom slide.



Blood Smear Schematic

Feathered Edge Monolayer Body

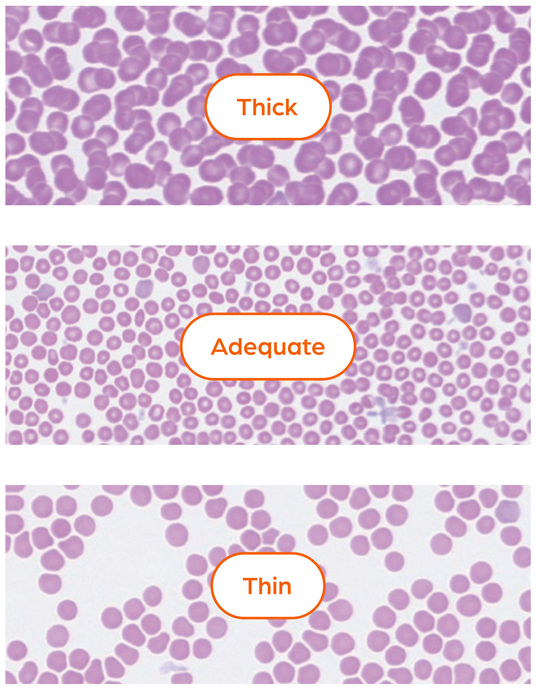
The Complete Hematology Picture

Blood Smear Evaluation Basics

A blood smear can be created and evaluated in just a few minutes using these simple steps:[1]

Lower Power Evaluation (10x–20x)

1. Examine the entire slide to assess overall sample thickness



2. Evaluate the feathered edge for PLT clumps, parasites and abnormal cells
3. Qualitatively observe white blood cell (WBC) number (8-10/low power field)

Moderate Power Evaluation (40x)

1. Estimate WBC count
   - Count 10-20 consecutive fields within monolayer and calculate the average WBC count/field
   - Using the average WBC count/field, calculate the WBC count/µL:
     - WBC count/µL= (avg WBC count/field) x (objective)^2 = avg WBC count/field x (40)^2
   - Determine predominant WBC type (typically neutrophils)
   - Check the feathered edge for parasites, PLT clumps and abnormal cells

High Power Evaluation (100x w/oil)

1. Examine RBC shapes and sizes; examine WBCs for pathologic changes
2. Manually confirm the PLT count from the automated hematology analyzer
   - Slide review: avg 8-10+/high power field (hpf) at 100x in monolayer (inaccurate if severe clumping)
   - Each PLT count/hpf represents 20,000-25,000 PLT in circulation
   - If PLT count is low and clumping is present, check the feathered edge to verify clumps
   - Perform a more specific count (required if PLT number <120,000)
     - Calculate average PLT count/field. Count number of PLT in minimum of 10 fields in monolayer on 100x
     - Calculate PLT count/µL=avg PLT count/field x 20,000

1. Eric Morissette DVM, Dipl. ACVP (Clinical Pathology)

The Complete Hematology Picture

Vetscan Imagyst AI Blood Smear Result Interpretation

Hematology Evaluation

Evaluation of a blood smear generates **estimated** blood cell counts. For this reason, actual reference intervals for the included parameters are not listed, due to the variability of estimated counts.

For each parameter, the blue band shown within the wider grey band is a generic representation of the estimated CBC counts.

WBC Differential+

	Low – High	
WBC Count (CBC)	23.0 K/uL	
Neutrophil	18.9 K/uL	
Band Neutrophil	0.6 K/uL	
Segmented Neutrophil	18.3 K/uL	
Lymphocyte	2.1 K/uL	
Monocyte	1.7 K/uL	
Eosinophil	0.3 K/uL	
Basophil	0.0 K/uL	

WBC Percent	
Neutrophil	
Band Neutrophil	2.6%
Segmented Neutrophil	79.4%
Lymphocyte	9.2%
Monocyte	7.3%
Eosinophil	1.5%
Basophil	0.0%

	Low – High	
Platelet Count Estimate (K/uL)	133.8 K/uL	
Aggregated Platelet	Absent	

Red Blood Cell	
Nucleated RBC/100 WBC	1.7/100 WBC
Polychromatophil (K/uL)	72.5 K/uL
Acanthocyte	Present
Eccentrocyte	Absent
Echinocyte	Absent
Keratocyte	Absent
Schistocyte	Absent

Generic reference intervals

Results

The Complete Hematology Picture

Vetscan Imagyst AI Blood Smear Result Interpretation

Table 2.4 *Hematology Evaluation*

Hematology Evaluation	
WBC Differential	Estimated WBC differential is based on 200 WBC's in the monolayer. Review results in conjunction with automated CBC Results. If discrepancy occurs, assess the whole slide image for signs WBCs are pushed to the feather edge. Consider Add-on Expert Review to verify and rule out significant disease states.
Platelets	**If aggregated platelets are reported:** – Evaluate scanned image for PLT clumps, including the feathered edge, and assess level of clumping with the platelet count measured by Vetscan Imagyst
Band Neutrophils	Immature neutrophils, typically ranging from 0-300/µL in dogs and cats[1]. An increase in band neutrophils, or left shift, often accompanies inflammation. A regenerative left shift, with a predominance of mature neutrophils, indicates an adequate bone marrow response. In contrast, degenerative left shift occurs when band neutrophils outnumber mature neutrophils, often with a low or normal neutrophil count, signaling severe inflammation or compromised marrow function.
Nucleated RBC	– Most automated hematology analyzers, including Vetscan OptiCell, count nRBC as WBC, and the presence of high numbers of nRBC will affect the total WBC count – nRBC: value ≥ 5 nRBC / 100 WBC is clinically significant – If Vetscan Imagyst finds ≥ 5 nRBC / 100 WBC, the automated analyzer WBC needs to be corrected using this formula:[2] – **Corrected WBC = initial WBC cell count x [100 ÷ (nRBC + 100)]**
Reticulocyte/ Polychromatophil (PCM)	Reticulocyte numbers increase in response to anemia caused by either the destruction (hemolysis) or loss (hemorrhage) of RBCs. Identifying and quantifying reticulocytes helps assess the bone marrow's response to anemia by evaluating its capacity to produce new RBCs over time. For further details, refer to the full anemia algorithm on **Page 35.**

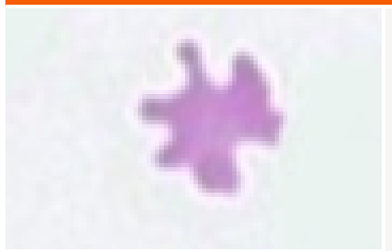
* Based on Zoetis Study on File DH7MR-US-21-038, Zoetis demonstrating PCM is an estimate for Reticulocytes on the Vetscan Imagyst AI

1. Zoetis Reference Lab. Data on file.
2. K. S. Latimer, E. et. al. Duncan & Prasse's Veterinary Laboratory Medicine: Clinical Pathology 5th Edition, Iowa State Press, Iowa City, 2011. p 59.

The Complete Hematology Picture

Vetscan Imagyst AI Blood Smear Result Interpretation

Table 2.5 *Red Blood Cell Morphology*

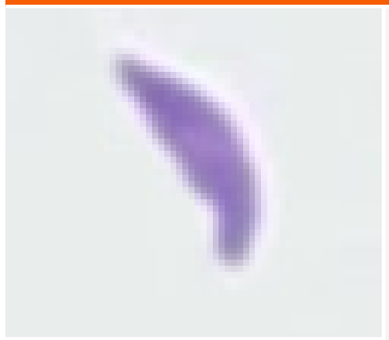
Red Blood Cell Morphology	
 **Acanthocytes**	– Generally form due to alterations in lipid/cholesterol composition of RBC membrane or fragmentation injury to RBCs – Observed in liver disease, hemangiosarcoma, disseminated intravascular coagulation or DIC (dog), vasculitis (dog) lymphosarcoma, gastrointestinal disease, glomerulonephritis, osteosarcoma, and high cholesterol diets have been associated with acanthocytosis – In cats with liver disease, acanthocytes are reported as the most common poikilocyte[1,2,3]
 **Echinocytes (Crenated Erythrocytes)**	– Generally form due to the expansion of the outer layer of the erythrocyte membrane – When observed in stained blood films, echinocytosis is usually an artifact that results from excess EDTA, improper smear preparation or prolonged sample storage before blood film preparation – The appearance of the echinocytes can vary depending on the thickness of the blood film[4] – In dogs, echinocytes have been reported with glomerulonephritis, lymphoma, hemangiosarcoma, and other neoplasms, immunemediated hemolytic anemia, rattlesnake envenomation, and doxorubicin toxicosis among others[1,5] – Cats likely have echinocytes with many of these diseases as well, but echinocytes have been specifically reported with chronic doxorubicin administration[1]
 **Keratocytes**	– Generally form due to oxidant or fragmentation injury of erythrocytes such as observed in iron-deficiency anemia, liver disorders and various disorders having concomitant acanthocytes (fragmentation) and eccentrocytes (oxidant)[1,4,6]

1. Barger A. Erythrocyte morphology. In: Brooks MB, Harr KE, Seelig DM, Wardrop KJ, Weiss DJ, eds. Schalm's Veterinary Hematology. 7th ed. Wiley Blackwell; 2022:188-197.
2. Hirsch V, Jacobsen J, Mills JH. A retrospective study of canine hemangiosarcoma and its association with acanthocytosis. Canadian Veterinary Journal. 1981;22(5).
3. Warry E, Bohn A, et al. Disease distribution in canine patients with acanthocytosis: 123 cases. Veterinary Clinical Pathology. 2013;42(4).
4. Harvey J. Veterinary Hematology: A Diagnostic Guide and Color Atlas. Elsevier; 2012:65-67.
5. Sabina R, Woodliff J, Giger U. Disturbed erythrocyte calcium homeostasis and adenine nucleotide dysregulation in canine phosphofructokinase deficiency. Comparative Clinical Pathology. 2008;17(2).
6. O'Keefe D, Schaeffer J. Hematologic toxicosis associated with doxorubicin administration in cats. Journal of Veterinary Internal Medicine. 1992;6(4).

The Complete Hematology Picture

Vetscan Imagyst AI Blood Smear Result Interpretation

Table 2.5 *Red Blood Cell Morphology (cont.)*

Red Blood Cell Morphology	
 **Schistocytes**	Typically caused by the fragmentation of erythrocytes due to vascular abnormalities and/or mechanical fragility of red blood cells. Erythrocyte fragments with pointed extremities are called schistocytes or schizocytes, and they are smaller than normal red blood cells. Microangiopathic fragmentation has been described in dogs in several different disorders including DIC, glomerulonephritis, hemangiosarcoma, hemophagocytic histiocytic disorders, myelofibrosis, hemolytic uremic syndrome, heart failure, severe irondeficiency anemia, caudal vena cava syndrome of dirofilariasis and chronic doxorubicin toxicosis.[1,2] Schistocytes are seen in cats with hepatic disease, DIC and doxorubricin toxicity.[1,3,4]
 **Eccentrocytes (Hemighosts Erythrocytes)**	Typically caused by direct oxidative damage to the erythrocyte inner cytoplasmic membrane and cytoskeleton, resulting in adhesion of opposing cytoplasmic sides of the erythrocyte membrane. In dogs, it is generally secondary to increased endogenous oxidants associated with ketoacidotic diabetes, inflammation, neoplasia (especially lymphoma) and Babesia canis infection. Eccentrocytes have been seen in dogs ingesting or receiving oxidants including onions and garlic, acetaminophen and nonsteroidal anti-inflammatory drugs, vitamin K and vitamin K antagonist rodenticides, naphthalene, and prolonged propofol anesthesia. Eccentrocyte formation also occurs in cats following oxidant damage.[5]

1. Harvey JW. Veterinary Hematology: A Diagnostic Guide and Color Atlas. Elsevier; 2012.
2. Barger AM. Erythrocyte Morphology. In: Brooks MB, Harr KE, Seelig DM, Wardrop KJ, Weiss DJ, eds. Schalm's Veterinary Hematology. 7th ed. Wiley Blackwell; 2022:188-197.
3. Tholen I, Weingart C, Kohn B. Concentration of D-dimers in healthy cats and sick cats with and without disseminated intravascular coagulation (DIC). Journal of Feline Medicine and Surgery. 2009;11(10).
4. Christopher MM, Lee SE. Red cell morphologic alterations in cats with hepatic disease. Veterinary Clinical Pathology. 1994;23(1).
5. Caldin M, Carli E, et al. A retrospective study of 60 cases of eccentrocytosis in the dog. Veterinary Clinical Pathology. 2005;34(3):224-231.

The Complete Hematology Picture

Combined Quantitative and Qualitative Evaluation

Complete Hematology Picture

The powerful combination of Vetscan OptiCell and Imagyst AI Blood Smear provides a complete hematology picture.

- Vetscan OptiCell and AI Blood Smear both rely on trained clinical pathologists to classify blood cell images that are used to train AI algorithms
- Access expert support through:
  1. The Add-on Expert Review* for Vetscan Imagyst AI Blood Smear tests
  2. Complimentary specialist consultations via your ZoetisDx portal when you are presented with CBC abnormalities

Key Takeaways

- A blood smear evaluation should not be utilized as a replacement for an automated cell count. If properly maintained, automated analyzers are more precise and accurate than manual cell counts[1]
- Vetscan OptiCell counts a significantly higher number of cells than a blood smear review (several thousand vs. ~200 cells)
- AI Blood Smear review evaluates ~200 cells in the monolayer
- Reticulocytes and polychromatophils (PCM) are the same immature red blood cells, simply stained differently
- An estimated PCM count from an AI Blood Smear report does not replace a reticulocyte count from the Vetscan OptiCell
- **Your AI Blood Smear report will always be needed to assess cell morphology changes (Table 2.6)**

Table 2.6 *Morphological changes that may be identified by a blood smear[1–3†]*

Platelets (PLTs)	Red blood cells (RBCs)	White blood cells (WBCs)
Macroplatelets‡	Polychromasia‡	Left shift (increased neutrophil band cells)
	Anisocytosis	Toxic changes
	Spherocytes	Reactive lymphocytes
PLT clumping‡	Heinz bodies	Blast cells
	Fragmented RBCs	
	Nucleated RBCs‡	Mast cells
	RBC parasites	

* Additional costs may apply.
† Table includes common examples and is not intended to be an exhaustive list.
‡ Indicates morphological changes currently identified by Vetscan Imagyst AI blood smear analysis. Other morphology can be assessed via Vetscan Imagyst Digital Cytology Image Transfer.

1. Harvey JW. Hematology procedures. In: Harvey JW, ed. Veterinary Hematology: A Diagnostic Guide and Color Atlas. Elsevier Inc; 2012:11-32.
2. Villiers E. Introduction to haematology. In: Villiers E, Ristic J, eds. BSAVA Manual of Canine and Feline Clinical Pathology. 3rd ed. British Small Animal Veterinary Association; 2016:27-37.
3. Weiser G. Laboratory technology for veterinary medicine. In: Thrall MA, Weiser G, Allison RW, Campbell TW, eds. Veterinary Hematology and Clinical Chemistry. 2nd ed. John Wiley & Sons, Inc.; 2012:3-33.

Sample Handling

Patient Preparation

The recommendations in Table 3.1 apply to all laboratories — whether point-of-care or reference.

Table 3.1 *Patient preparation*

	Before the appointment	Rationale
	– Avoid feeding patients for 10 to 12 hours prior to appointment unless contraindicated – In horses and ruminants, fasting prior to hematology analysis is not required	– A postprandial sample may cause lipemic interference – Food consumption can cause fluctuations in hematology results—including HGB, MCH and MCHC[1] – This is a problem with hematology devices using spectrophotometry to measure HGB. The OptiCell, however, calculates HGB concentration directly from RBC measurements.
	– Consider timing of patient appointment relative to when hematologic testing will be completed – Understand that certain medications may impact test results	– Age-related changes can lead to artifacts in the blood sample for hematology testing—such as RBC crenation, WBC chromatin swelling, platelet clumping[2] – Several chemotherapeutic drugs, NSAIDs and antimicrobial medications are associated with hematologic adverse drug events[3]
	– Avoid exercise and minimize excitement/fear prior to the appointment	Can cause: – Physiological leukocytosis[1] – Transient hyperglycemia in cats[4]
	At the clinic	**Rationale**
	– Minimize excitement/fear during the appointment – Consider the use of sedation and antianxiety medications to help decrease stress for anxious animals and enable safer and gentler restraint, when appropriate	Can cause: – Physiological leukocytosis[1] – Transient hyperglycemia in cats[4]
	– With a sick patient, anticipate that analyte results may be impacted	– Visually inspect for clots that can falsely impact cell counts and harm the analyzer – Visual assessment of the sample preanalysis can highlight abnormalities (eg, hemolysis can indicate poor sample quality) or may indicate the presence of disease
	At time of sampling	**Rationale**
	– Good sample collection technique is critical (clean needle puncture of the vein, etc)	– Lack of good technique leads to an increased risk of clotted sample or hemolysis

1. Monti P, Archer J. Quality assurance and interpretation of laboratory data. In: Villiers E, Ristic J, eds. BSAVA Manual of Canine and Feline Clinical Pathology. 3rd ed. British Small Animal Veterinary Association; 2016:11-26.
2. Sample collection. Cornell University College of Veterinary Medicine. Accessed August 3, 2022. https://eclinpath.com/hematology/sample-collection-heme/.
3. Weiss DJ. Drug-associated blood cell dyscrasias. Compend Contin Educ Vet. 2012;34(6):E2.
4. Allison RW. Laboratory evaluation of the pancreas and glucose metabolism. In: Thrall MA, Weiser G, Allison RW, et al, eds. Veterinary Hematology and Clinical Chemistry. 2nd ed. Wiley-Blackwell; 2012:425-440.

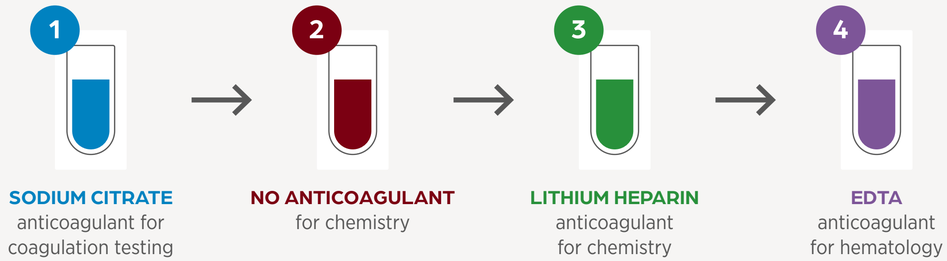
Sample Handling

Keys to successful sample collection

The quality of the sample analyzed is directly related to the quality of the results (Table 3.2).

Table 3.2 *Keys to successful sample collection*

Avoid vein collapse when drawing samples	– Minimize suction on the syringe, and do not draw back too quickly
Prevent hemolysis	– Use the largest vein and needle appropriate for blood collection – Avoid use of any needle smaller than a 23 gauge (though certain exotic species may require a smaller needle) – Use minimal alcohol on fur/skin – Remove the needle from the syringe before dispensing into the blood tube unless using a closed vacuum blood collection system
Ensure the correct ratio of anticoagulant to blood	– Fill EDTA tube to manufacturer's sample fill line – Immediately after filling tube, cap the tube and invert at least 15 times to sufficiently mix with anticoagulant (more inversions would be needed in case of 0.25 mL, 0.5 mL or 1.3 mL tubes)

Ensure appropriate tube use	– Select tubes based on the testing requirements and size of patient
	– Ensure tubes have not expired
	– Always fill blood tubes in the correct order to avoid contamination
	  – EDTA contamination of chemistry samples may affect electrolyte results and cause a falsely low Ca and falsely high K+
	  – If improper tube-filling order occurs, the sample should be redrawn
	Blood tube fill order* 

Prevent unwanted blood clotting	– Do not hold off the vein for more than a few seconds before venipuncture – For feline samples collected from the medial saphenous vein, a vacuum blood collection system instead of a syringe is recommended
Do not allow samples to degrade	– Run samples as soon as possible after drawing

* Blood tube cap colors may vary by country.

Sample Handling

Running a sample on the Vetscan OptiCell[1]

Figure 3.1 *Vetscan OptiCell Sample Dos and Don'ts*

Do

- Always use a validated EDTA collection tube
- Always fill the collection tube to the manufacturer's sample fill line
- Test as soon as possible after sample collection
- Refrigerate if it will be >20 minutes until sample can be run to preserve cell morphology
  - Allow sample to warm to room temperature prior to running on the Vetscan OptiCell
- Reinvert at least 15 times times after the sample is collected AND again just prior to running on the Vetscan OptiCell
- Create a blood smear shortly after collection — no need to stain or evaluate slide right away
- Check for blood clots before running the sample
- Select the correct species to be analyzed, as the algorithms and cell sizes differ by species
  - If the original species selected was incorrect (eg, if a canine sample was run as a feline), rerun the sample under the correct species

Do not

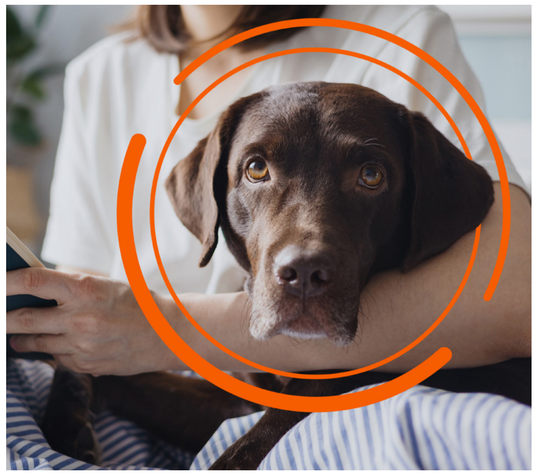
- Do not freeze a sample
- Do not use if the tube is not filled to the manufacturer's sample fill line — an incorrect ratio of EDTA to blood can affect results
- Do not run a sample with a visible blood clot
- Do not run a sample straight from the refrigerator
- Do not use a loaded sampler with visible bubbles

1. Vetscan OptiCell User Manual, 2024, Zoetis, Inc.

Responsible Patient Trending

What is Responsible Patient Trending?

Responsible Trending, available only in the ZoetisDx online portal, shows test analyte results in a chronological sequence. **This visual format provides a clear story of each patient's trends in test results over time — with results from different analyzers displayed together, but always relative to each analyte's reference interval on its respective analyzer.**



What is Responsible Patient Trending?

1. **Due to biological variations, the best reference values are a pet's own diagnostic values over time, encompassing breed, age, sex and individual variation.**
   - One of 20 healthy animals is expected to have a measured value outside of the reference interval[1]
   - Individual patient trending is more sensitive and better at detecting pathologic changes than reliance on published reference values for chemistry and hematology[2]
2. **Senior Patients**
   - The common occurrence of physical exam and laboratory abnormalities in apparently healthy senior dogs and cats emphasizes the need for regular health screening, including regular laboratory testing[3,4]
   - Visit/exam frequency and testing recommendations should be based on patient's age, breed and lifestyle
   - Senior and geriatric dogs and cats should be examined at least semiannually to allow for earlier intervention of chronic disease

1. Zabolotzky SM, Walker DB. Peripheral blood smears. In: Cowell RL, Valenciano AC, eds. Cowell and Tyler's Diagnostic Cytology and Hematology of the Dog and Cat. 5th ed. Elsevier Inc.; 2019:438-467.
2. Walton RM. Subject-based reference values: biological variation, individuality, and reference change values. Vet Clin Pathol. 2012;41(2):175-181. doi:10.1111/j.1939-165X.2012.00414.x.
3. Weiss DJ, Tvedten H. The complete blood count, bone marrow examination, and blood banking: general comments and selected techniques. In: Willard MD, Tvedten H, eds. Small Animal Clinical Diagnosis by Laboratory Methods. 5th ed. Elsevier Inc.; 2012:12-37.
4. Stirn M, Moritz A, Bauer N. Rate of manual leukocyte differentials in dog, cat and horse blood samples using ADVIA 120 cytograms. BMC Vet Res. 2014;10:125. doi:10.1186/1746-6148-10-125.

Responsible Patient Trending

Keys to successful application of patient trending

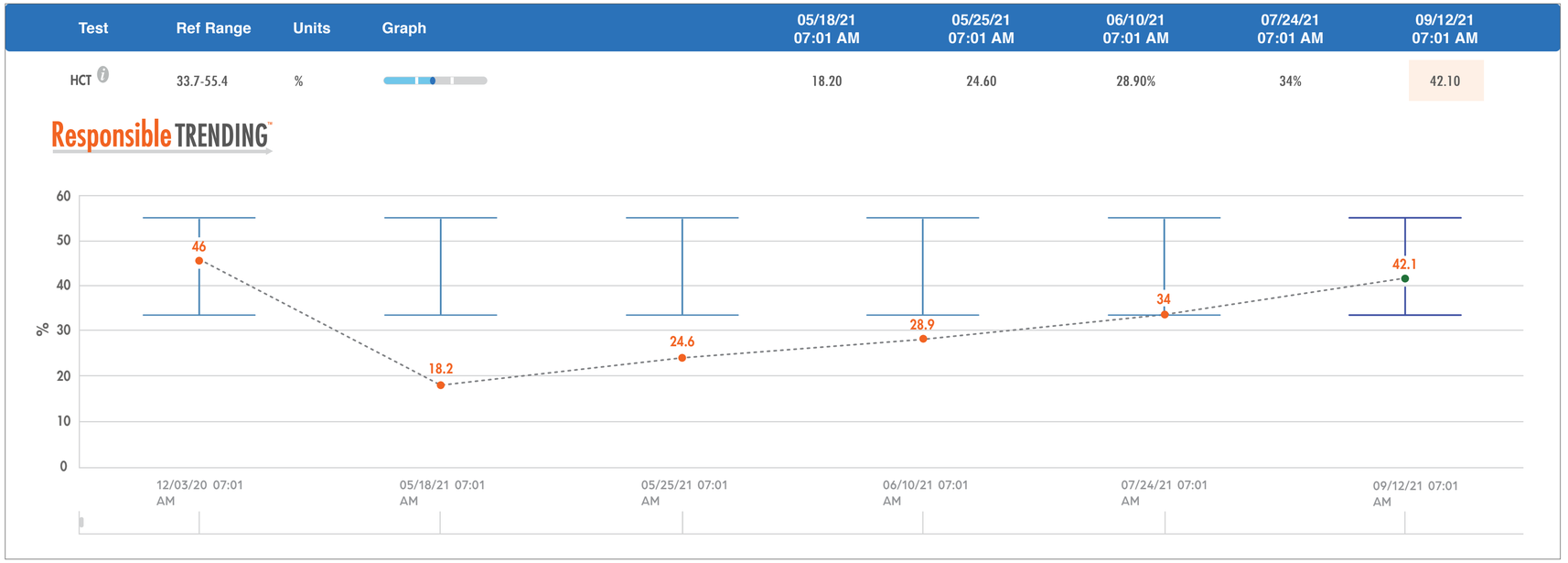
The best practice is to monitor a patient on the same analyzer using the same analytical methods

Whenever comparing or trending analyte results (Figure 4.1), it is important to trend using best practices and responsible trending to have a consistent comparison.

1. Use the same analyzer every time, when possible
2. Perform the test in the same way (sample type, number of hours pre- or post treatment, fed or fasted state, etc)
3. Keep in mind that different assays and instruments have reference intervals that may differ among analyzers and/or laboratories
4. Perform a quality check or verifying with a different test, methodology or laboratory if a value does not match the clinical picture

When comparing results between different analyzers or labs and inherent methodology differences, it is imperative to interpret the raw value with respect to the reference interval provided and not the raw number.

Figure 4.1 *Responsible Patient Trending seen on ZoetisDx*



Medical Interpretation Guide

Understanding classic leukogram patterns

Changes in total and differential leukocyte counts are usually grouped into patterns that facilitate interpretation.

Table 5.1 *Classic leukogram patterns*

Pattern	Description	NEU	Left Shift	Toxic Δ*	LYM	MON	Inflammation
Stress leukogram	– A result of cortisol released by the adrenal gland – Occurs due to a wide range of processes – Systemic illness; metabolic disturbance; pain – Mimicked by corticosteroid therapy	↑	No	No	---	↑ canine > feline	+/–
Physiological leukocytosis	– A result of epinephrine or norepinephrine release – Also called a flight-or-fight response – Most often seen in cats (of any age) and possibly in the young of other species – Usually transient and generally resolves about 30 minutes after the patient relaxes	↑	No	No	↑ (mostly feline)	Normal	Unusual

*Δ=Change.

Medical Interpretation Guide

Understanding classic leukogram patterns

Table 5.1 *Classic leukogram patterns (cont.)*

Pattern	Description	NEU	Left Shift	Toxic Δ*	LYM	MON	Inflammation
Inflammatory leukogram	– Represents the balance between tissue demand and bone marrow supply – May vary depending on source and severity of inflammation and timing of sample collection – NEU numbers may vary from severely depressed to markedly increased – A left shift indicates the presence of immature NEU – Usually, but not always, indicates an inflammatory leukogram – Inflammation is possible in patients without an inflammatory leukogram	Mild/Chronic Inflammation					
		↑	+/-	No	Normal or ↓	↑ (chronic)	Hopefully
		Acute Inflammation					
		↑	↑	Frequent	↓	Normal or ↑	Yes
		Overwhelming Inflammation					
		↓	↑ to ↑↑	Present	↓	No	Yes
Leukemoid reaction	– Characterized by a marked neutrophilic leukocytosis (>50,000 cells/µL) with a concurrent, orderly left shift – Toxic changes may or may not be present – Resembles granulocytic leukemia but is caused by another process – Also referred to as extreme neutrophilic (granulocytic) leukocytosis	↑↑↑	+/-	Occasional	Normal or ↓	Normal or ↑	?

*Δ=Change.

Medical Interpretation Guide

Understanding anemia

Anemia is one of the most common hematologic abnormalities encountered in veterinary clinical practice. It is the manifestation of an underlying disorder, like a fever, and not a diagnosis. It can be a primary sign of disease (eg, hemorrhage or immune-mediated hemolytic anemia) or a marker of underlying disease (eg, cancer or chronic kidney disease). Therefore, even mild, asymptomatic anemia should be investigated thoroughly to diagnose and treat the primary problem.

Anemia is defined by a PCV, HCT, HGB or RBC count below the reference intervals for that species. Anemia can be mild, moderate or severe and could be caused by an acute disease process or have been ongoing for a long time due to a chronic condition.

When evaluating an anemic patient, hematology testing MUST include BOTH quantitative automated cell count and qualitative blood smear evaluation.

> **Note:** Anemia can be masked by concomitant dehydration. Decreased measured erythrocyte parameters may also be observed when the total-body erythrocyte mass is normal but there is an expansion of the vascular space faster than the expansion of the total-body erythrocyte mass (relative anemia).[1-3]

Once we receive abnormal RBC, HCT, HGB or PCV results, how do we proceed?

1. Evaluate the hematology results in the context of the entire patient, including the patient's signalment and clinical status as well as the minimum database and other diagnostic tests.
2. Consider the potential for laboratory or sampling error.
3. If an automated count is performed and anemia detected:
   - Confirm with a PCV, since this is the direct measurement of the proportion of blood comprised of RBC
   - Assess if a regenerative response is present by review of reticulocyte percentage and reticulocyte absolute count results
   - Perform a blood smear to examine the RBC morphology and confirm automated cell counts to aid in determining a diagnosis and prognosis

1. Breznock EM, Strack D. Effects of the spleen, epinephrine, and splenectomy on determination of blood volume in cats. Am J Vet Res. 1982;43(11):2062-2066.
2. Allard RL, Carlos AD, Faltin EC. Canine hematologic changes during gestation and lactation. Compan Anim Pract. 1989;19(3):3-6.
3. Berman E. Hemogram of the cat during pregnancy and lactation and after lactation. Am J Vet Res. 1974;35(3):457-460.

Medical Interpretation Guide

Further diagnostic testing to determine the underlying cause of anemia[1]

Blood smear examination provides information about blood cell pathology and the potential for blood parasites not available with automated analyzers. In addition, evaluation of RBC morphology (Table 5.2) can help pinpoint a diagnosis, determine the recommended treatment and monitor the response to treatment for anemia.

Table 5.2 *Common RBC morphologies*

IMHA	Regenerative anemia	RBC damage due to microangiopathy*	Oxidative damage	Iron deficiency
Spherocytes	Anisocytosis	Schistocytes	Eccentrocytes	Schistocytes
Agglutination	Howell-Jolly bodies	Acanthocytes	Heinz bodies	Microcytes
Ghost cell	Polychromasia	Keratocytes	Spherocytes	Leptocytes

Consider the whole patient

– Because anemia is a manifestation of an underlying disorder and not a diagnosis, further diagnostic testing is usually necessary to determine the underlying cause

– Use additional diagnostic tests based on the differential diagnosis suggested by the classification of anemia (see Anemia algorithm on page 35)

Additional diagnostic tests

– Clinical chemistry profile/urinalysis +/- endocrine testing

– Virology, serology if infection is likely (eg, fever, lymphadenopathy, etc)

– Bone marrow examination may reveal many diagnoses (eg, myelofibrosis, aplastic anemia, bone marrow necrosis/inflammation, dyserythropoiesis, leukemia, metastatic neoplasia, myelodysplastic syndromes, etc)

* Associated with neoplasia, disseminated intravascular coagulation, glomerulonephritis or vasculitis.

1. Grimes CN. Laboratory diagnosis and classification of anemia. Presented at: ACVIM Forum; June 9-11, 2016; Denver, Colorado.

Medical Interpretation Guide

Two ways to classify anemia:

1. Bone marrow responsiveness

– Classification of anemia in accordance with bone marrow responsiveness is based on the presence or absence of an increased number of immature erythrocytes in circulation (known as reticulocytosis, polychromasia) or erythroid hyperplasia in the bone marrow. Evaluation must be interpreted relative to the duration and severity of the anemia[1]

– In most species, a reticulocyte count (RETIC) is considered the easiest, most reliable measure of marrow responsiveness.

– Interpretation must be made relative to the duration and severity of the anemia. Simply relying on a reference interval may lead to misinterpretation of the erythroid response. See Anemia algorithm on page 35 for examples.

Reticulocyte counts can be interpreted by either absolute or corrected counts to determine if regeneration exists (Figure 5.1).

– What might appear to be an elevated reticulocyte percentage (% RETIC) in a very anemic patient could give a false impression that the bone marrow is responding well. However, the absolute reticulocyte count will be low, indicating that RBC production is truly inadequate.

– Therefore, to interpret properly, the reticulocyte percentage should be corrected using the following formulas:

Figure 5.1 *Absolute/Corrected reticulocyte count calculations*

1. Berman E. Hemogram of the cat during pregnancy and lactation and after lactation. Am J Vet Res. 1974;35(3):457-460.

Medical Interpretation Guide

Anemia Algorithm[1,2]

Anemia present

Evidence of regeneration*

Reticulocytosis/elevated PCM count†

YES

Regenerative anemia
Absolute RETIC/PCM count:

- ≥100,000/µL (canine)
- ≥60,000/µL (feline)

Measure total protein (TP)

TP normal

Hemolysis

- Immune mediated
- Infectious
- Fragmentation/physical damage to RBC membrane
- Oxidative damage
- Congenital red cell abnormalities

TP low

Blood loss

- External blood loss
- Internal blood loss

NO

Nonregenerative anemia
Absolute RETIC/PCM count:

- <100,000/µL (canine)
- <60,000/µL (feline)

Preregenerative anemia

Following the onset of hemolysis or acute blood loss if RETIC response is mild or if sufficient time has not elapsed for a prominent RETIC response to occur

Primary bone marrow disorder

Some examples include:
- Pure red cell aplasia
- Aplastic anemia
- Viral infection (parvovirus, FeLV)
- Myelodysplastic syndrome

Secondary suppression of bone marrow from systemic disease

- Anemia of chronic inflammatory disease
- Chronic renal failure
- Endocrine disorder

* Evaluation of the adequacy of the bone marrow regenerative response in the individual patient should also include consideration of severity and chronicity of the anemia, suspected cause of the anemia and potential for multiple causes contributing to the patient's anemia. Trending the anemia and RETIC/PCM count through sequential CBC may be helpful.

† RETIC/PCM counts supporting regeneration can be seen in nonanemic patients. This may reflect a normal physiological response or a response to an increased need. Serial evaluations of the CBC should be done to rule out an emerging anemia in these patients. RETIC or elevated PCM counts in the absence of anemia (RAA) may indicate recovery from anemia or may be associated with nonanemic chronic hypoxia (eg, cardiovascular disease, pulmonary disease). RAA has also been observed in patients with gastrointestinal, inflammatory and neoplastic disorders and in dogs with osteoarthritis or receiving osteoarthritis treatments (eg, anti-inflammatory drugs, nutraceuticals).

1. Data on file, FUNdamentals of Hematology: Diagnosing Anemia, Zoetis Inc.
2. Data on file, TI-08180, 2022, Zoetis Inc.

Medical Interpretation Guide

Two ways to classify anemia:
2. Red blood cell indexes

In addition to reticulocyte and PCM counts, it is important to review the pertinent RBC parameters found on the automated CBC report to aid in classification of the anemia:

1. **MCV** describes the median red blood cell size (Table 5.3)
   - **Terms:** Microcytic, Normocytic, Macrocytic
2. **MCHC** describes HGB concentration of the red blood cells
   - **Terms:** Hypochromic, Normochromic, Hyperchromic

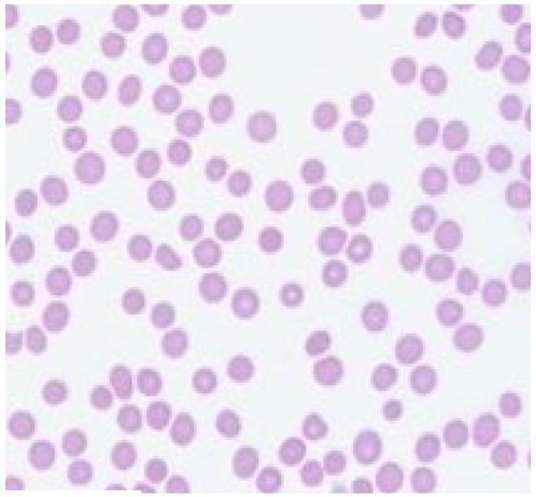
See Anemia algorithm on the previous page for additional information.

Table 5.3 *MCV classifications*

MCV	Description	Common Pathology
Decreased	Microcytic	– Iron deficiency – Hepatic portocaval vascular shunts – Normal breed variation (eg, Shiba Inu, Akita)
Normal	Normocytic	– Usually nonregenerative, poorly or early regenerative – “Early regenerative” refers to blood loss or blood destruction anemia in which evidence of regeneration is not yet apparent because the bone marrow has not had time to respond to acute loss
Increased	Macrocytic	– Regeneration: bone marrow is responding and is releasing PCM/RETIC that are larger than normal – Congenital poodle macrocytosis – Hereditary stomatocytosis – Myelodysplasia – FeLV

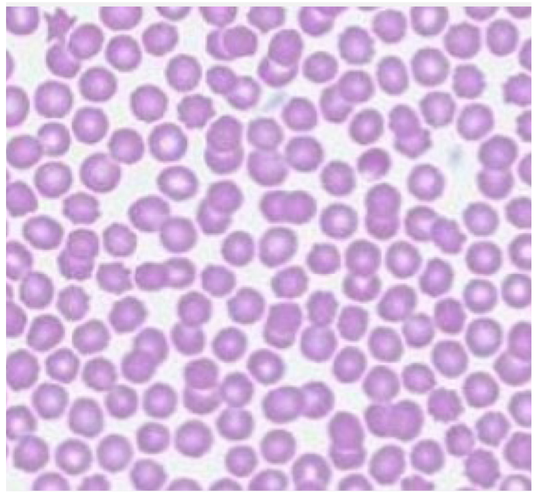
Medical Interpretation Guide

The 3 most important and relevant anemia diagnostic patterns using RBC indexes are: *[1]



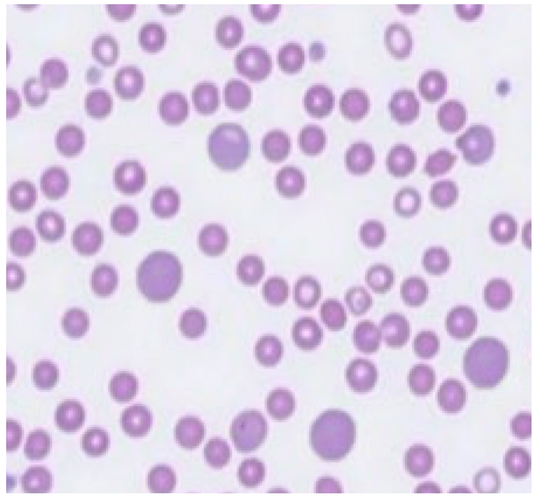
Microcytic Hypochromic

Usually due to iron deficiency anemias



Normocytic Normochromic

Nonregenerative anemias with residual normal erythrocytes



Macrocytic Hypochromic

Regenerative anemias with large, young erythrocytes that are not fully hemoglobinized

* Images obtained from Vetscan Imagyst.

1. Data on file, FUNdamentals of Hematology: Diagnosing Anemia, Zoetis Inc.

Medical Interpretation Guide

Anemia classification by red blood cell indexes[1]

Anemia present

Microcytic

Hypochromic/ normochromic

- Chronic iron deficiency
- Portosystemic shunts (often not anemic)
- Anemia of inflammatory disease (usually normocytic)
- Hepatic lipidosis in cats (usually normocytic)
- Normal Akita and Shiba dogs (not anemic)
- Familial dyserythropoiesis of English springer spaniels (rare)
- Hereditary elliptocytosis in dogs (rare)
- Spurious when PLT are included in erythrocyte histograms
- Spurious in dogs with persistent hyponatremia (not typically anemic)

Normocytic

Normochromic

- Preregenerative anemia
- If RETIC response is mild or if sucient time has not elapsed for a prominent RETIC response to occur
- Early iron deficiency anemia before microcytes predominate
- Chronic inflammation and neoplasia (sometimes slightly microcytic)
- Chronic renal disease
- Endocrine deficiencies
- Selective erythroid aplasia
- Aplastic and hypoplastic bone marrow
- Lead toxicity (may not be anemic)
- Cobalamin deficiency

Macrocytic

Hypochromic

- Regenerative anemias with marked reticulocytosis
- Hereditary stomatocytosis in dogs (often slight reticulocytosis)
- Increased erythrocyte osmotic fragility in Abyssinian and Somali cats (reticulocytosis is usually present)
- Spurious with prolonged storage of blood sample

Normochromic

- Regenerative anemias (decreased MCHC is not always present)
- FeLV infections with no reticulocytosis (common)
- Myelodysplastic syndromes
- Nonregenerative immune-mediated anemia and/or myelofibrosis in dogs
- Poodle macrocytosis (not anemic)
- Hyperthyroid cats (slight macrocytosis without anemia)
- Folate deficiency (rare)
- Spurious with erythrocyte agglutination
- Spurious in cats and dogs with persistent hypernatremia (maybe hypochromic)

1. Data on file, TI-08180, 2022, Zoetis Inc.

Reference Intervals

Vetscan OptiCell Reference Intervals, SI Units

Table 6.1 *Vetscan OptiCell Reference Intervals, SI Units*

Parameter	Unit	Dog		Cat	
		LL	UL	LL	UL
RBC	10^{12}/L	5.7	8.7	6.6	11.1
HGB	g/L	123.0	200.0	86.0	163.0
HCT	%	36.7	59.6	28.0	48.0
MCV	fL	61.2	73.6	35.8	50.4
MCH	pg	18.9	26.4	11.6	16.8
MCHC	g/L	301.0	388.0	266.0	338.0
RDWc	%	11.8	13.9	13.9	17.9
WBC	10^9/L	4.0	14.1	4.0	14.5
NEU	10^9/L	2.3	9.8	1.4	9.7
LYM	10^9/L	0.7	3.7	0.4	6.2
MON	10^9/L	0.0	0.4	0.0	0.2
EOS	10^9/L	0.0	0.8	0.0	1.1
BAS	10^9/L	0.0	0.8	0.0	0.1
PLT	10^9/L	121.6	440.6	109.4	487.4
MPV	fL	9.5	13.6	11.2	19.7
RTC%	%	0.0	1.1	0.0	0.2
RTC	10^9/L	0.0	100.0	0.0	60.0

Canine and feline species have been validated on the Vetscan OptiCell. At this time, testing of non-validated species blood on the Vetscan OptiCell is not supported by Zoetis Diagnostics.

RBC=Red Blood Cell count. **HGB**=Hemoglobin. **HCT**=Hematocrit. **MCV**=Mean Cell Volume. **MCH**=Mean Corpuscular Hemoglobin. **MCHC**=Mean Corpuscular Hemoglobin Concentration. **RDWc**=Red Blood Cell Distribution Width (coefficient of variation). **WBC**=White Blood Cell count. **NEU**=Neutrophil count. **LYM**=Lymphocyte count. **MON**=Monocyte count. **EOS**=Eosinophil count. **BAS**=Basophil count. **PLT**=Platelet count. **MPV**=Mean Platelet Volume. **RTC%**=Reticulocyte percentage. **RTC**=Reticulocyte count.

1. Data on file, Study No. DHX6Z-US-23-229, Zoetis Inc.

Reference Intervals

Vetscan OptiCell Reference Intervals, Common Units

Table 6.2 *Vetscan OptiCell Reference Intervals, Common Units*

Parameter	Unit	Dog		Cat	
		LL	UL	LL	UL
RBC	$10^6/\mu L$	5.7	8.7	6.6	11.1
HGB	g/dL	12.3	20.0	8.6	16.3
HCT	%	36.7	59.6	28.0	48.0
MCV	fL	61.2	73.6	35.8	50.4
MCH	pg	18.9	26.4	11.6	16.8
MCHC	g/dL	30.1	38.8	26.6	33.8
RDWc	%	11.8	13.9	13.9	17.9
WBC	$10^3/\mu L$	4.0	14.1	4.0	14.5
NEU	$10^3/\mu L$	2.3	9.8	1.4	9.7
LYM	$10^3/\mu L$	0.7	3.7	0.4	6.2
MON	$10^3/\mu L$	0.0	0.4	0.0	0.2
EOS	$10^3/\mu L$	0.0	0.8	0.0	1.1
BAS	$10^3/\mu L$	0.0	0.8	0.0	0.1
PLT	$10^3/\mu L$	121.6	440.6	109.4	487.4
MPV	fL	9.5	13.6	11.2	19.7
RTC%	%	0.0	1.1	0.0	0.2
RTC	$10^3/\mu L$	0.0	100.0	0.0	60.0

Canine and feline species have been validated on the Vetscan OptiCell. At this time, testing of non-validated species blood on the Vetscan OptiCell is not supported by Zoetis Diagnostics.

RBC=Red Blood Cell count. **HGB**=Hemoglobin. **HCT**=Hematocrit. **MCV**=Mean Cell Volume. **MCH**=Mean Corpuscular Hemoglobin.
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NEU=Neutrophil count. **LYM**=Lymphocyte count. **MON**=Monocyte count. **EOS**=Eosinophil count. **BAS**=Basophil count. **PLT**=Platelet count.
MPV=Mean Platelet Volume. **RTC%**=Reticulocyte percentage. **RTC**=Reticulocyte count.

1. Data on file, Study No. DHX6Z-US-23-229, Zoetis Inc.

More on the Zoetis Virtual Laboratory

The Virtual Laboratory

The Virtual Laboratory is an integrated support network of board-certified specialists paired with expert-level AI[1-10], enhancing every element of your diagnostic practice to help you diagnose and treat with confidence.

- ✓ Convenient expert pathologist review and complimentary specialist consultations available via Zoom or email, for the support you need to diagnose any case.
- ✓ Cutting-edge AI across multiple analyzers with Vetscan OptiCell and Vetscan Imagyst, for accurate insights within minutes.[1-10]
- ✓ A fully integrated workflow with point-of-care results, specialist consultation insights and Zoetis Reference Laboratories — all accessible in your ZoetisDx portal.

Figure 7.1 *The Zoetis Diagnostics Portfolio*

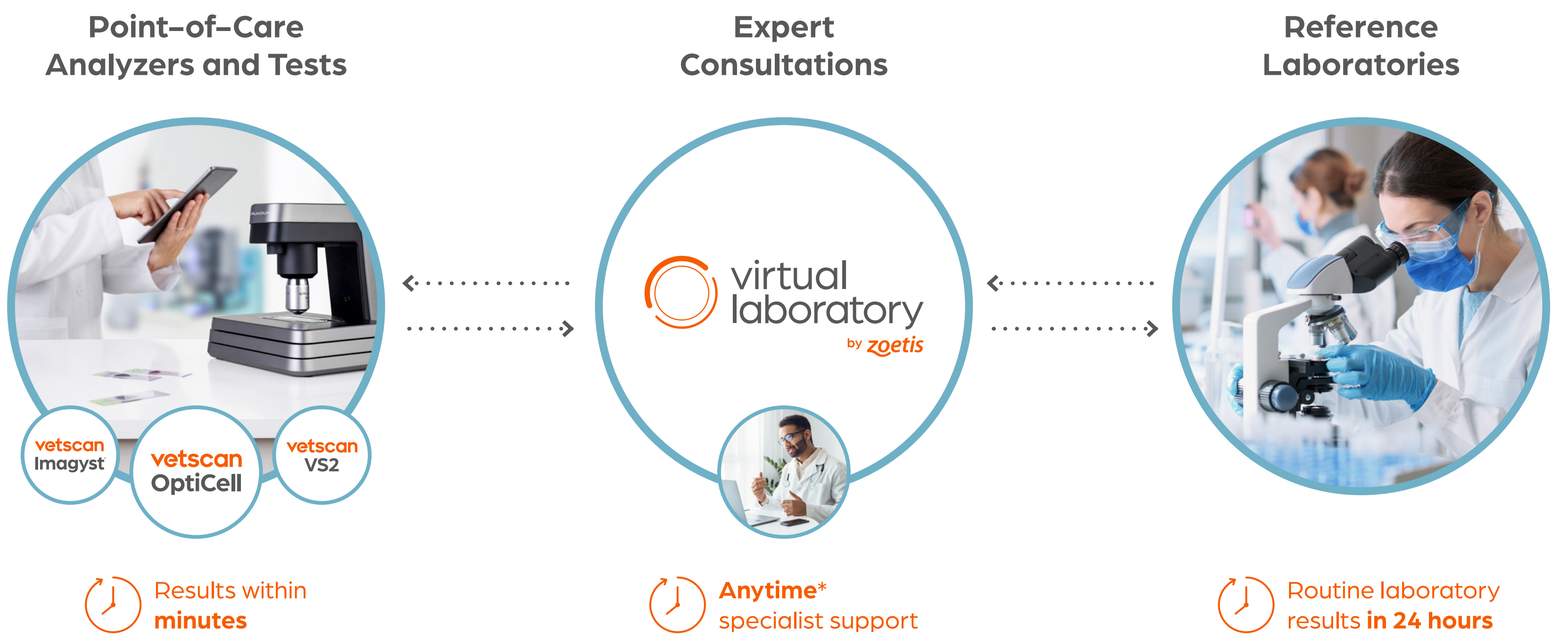
1. Data on file, Study No. DHXMZ-US-24-235, 2024, Zoetis Inc.
2. Data on file, Study No. DHX6Z-US-23-205, 2024, Zoetis Inc.
3. Data on file, Study No. DHX6Z-US-23-206, 2024, Zoetis Inc.
4. Data on file, Study No. DHX6Z-US-23-209, 2024, Zoetis Inc.
5. Data on file, Study No. DHX6Z-US-24-257, 2024, Zoetis Inc.
6. Data on file, Study No. DHX6Z-US-24-242, 2024, Zoetis Inc.
7. Data on file, Study No. DHXMZ-US-24-275, 2024, Zoetis Inc.
8. Data on file, Study No. DHXMZ-US-24-276, 2024, Zoetis Inc.
9. Data on file, Study No. DHX6Z-US-23-222, 2023, Zoetis Inc.
10. Data on file, Study No. DHX6Z-US-22-131, 2022, Zoetis Inc.

More on the Zoetis Virtual Laboratory

ZoetisDx

With a single log in, your ZoetisDx portal allows you to review and share diagnostic results, request complimentary specialist support and order testing from Zoetis Reference Laboratories, bringing together the Virtual Laboratory offerings in an easy-to-use online platform.

Figure 7.2 *The Virtual Laborotory Workflow*



Zoetis Reference Laboratories

Zoetis Reference Laboratories enable fully-informed treatment plans with a comprehensive test menu and reliable turnaround times backed by expert support, all easily accessible through innovative connectivity solutions.

Vetscan Point–of–Care Analyzers and Tests

The Vetscan Point-of-Care portfolio includes a comprehensive array of diagnostic analyzers and rapid tests across chemistry, hematology, urinalysis and more, for fast, actionable insights and enhanced workflow efficiency.

* Dependent on consultant availability.

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