

LITTLE WHITE LIES; using blood cell morphology to investigate white cell counts or flags.

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IDEXX R&D Department

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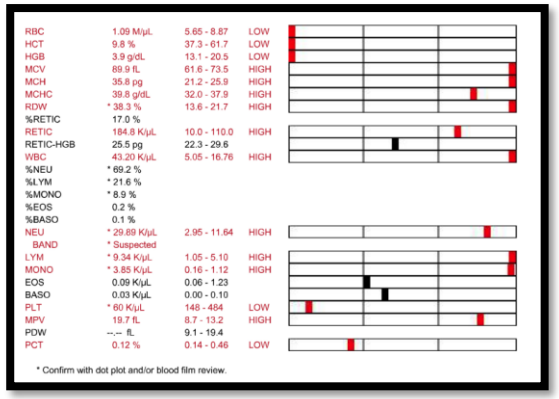
Disclosure:

I am an employee of IDEXX Laboratories Ltd.

Disclaimer:

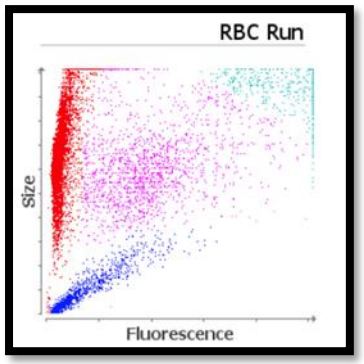
The information contained herein is intended to provide general guidance only. As with any diagnosis or treatment, you should use clinical discretion with each patient based on a complete evaluation of the patient, including history, physical presentation, and complete laboratory data. With respect to any drug therapy or monitoring program, you should refer to product inserts for a complete description of dosages, indications, interactions, and cautions. Diagnosis and treatment decisions are the ultimate responsibility of the primary care veterinarian.

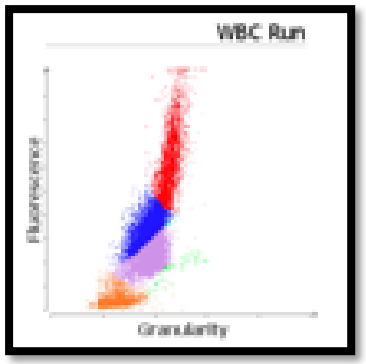
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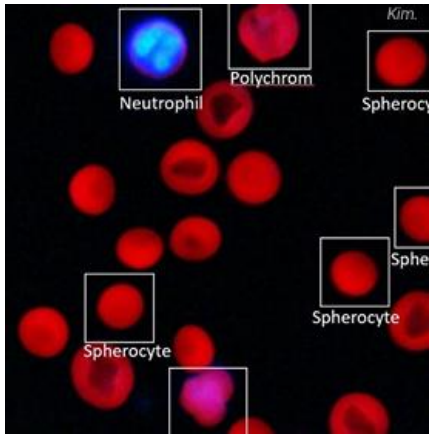
RBC	1.09 M/µL	5.65 - 8.87	LOW
HCT	9.8 %	37.3 - 61.7	LOW
HGB	3.9 g/dL	13.1 - 20.5	LOW
MCV	89.9 fL	61.6 - 73.5	HIGH
MCH	35.8 pg	21.2 - 25.9	HIGH
MCHC	39.8 g/dL	32.0 - 37.9	HIGH
RDW	* 38.3 %	13.6 - 21.7	HIGH
%RETIC	17.0 %		
RETIC	184.8 K/µL	10.0 - 110.0	HIGH
RETIC-HGB	25.5 pg	22.3 - 29.6	
WBC	43.20 K/µL	5.05 - 16.76	HIGH
%NEU	* 89.2 %		
%LYM	* 21.6 %		
%MONO	* 8.9 %		
%EOS	0.2 %		
%BASO	0.1 %		
NEU	* 29.89 K/µL	2.95 - 11.64	HIGH
BAND	* Suspected		
LYM	* 9.34 K/µL	1.05 - 5.10	HIGH
MONO	* 3.85 K/µL	0.16 - 1.12	HIGH
EOS	0.09 K/µL	0.06 - 1.23	
BASO	0.03 K/µL	0.00 - 0.10	
PLT	* 60 K/µL	148 - 464	LOW
MPV	19.7 fL	8.7 - 13.2	HIGH
PDW	--.-- fL	9.1 - 19.4	
PCT	0.12 %	0.14 - 0.46	LOW

* Confirm with dot plot and/or blood film review.









TIER 1

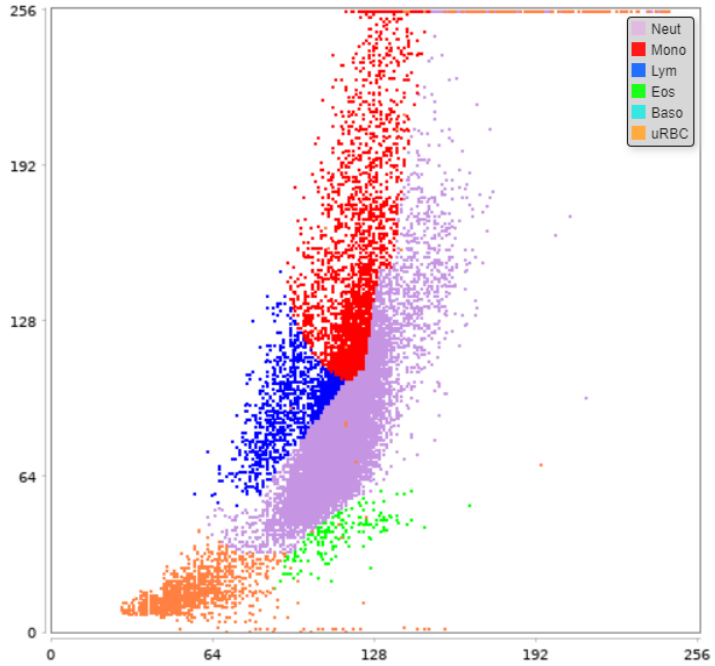
TIER 2

TIER 3

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When should blood cell morphology be reviewed ?

- Investigation of critically ill patient
- Moderately to severely anaemic patients
- Markedly high WBC counts
- Markedly low WBC/Plt counts
- Flags in dot plots/indistinct separation of clusters
- Unexpected or suspicious instrument results



ProCyte Dx – Canine
Patient WBC Dot Plot

Bands	*Suspected

```
* Confirm with dot plot and/or blood film review.

Immature and/or toxic neutrophils likely present - consider inflammation
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CLINICALLY VALUABLE COMMENTS WERE COMMON ON VETERINARIAN-ORDRED BLOOD SMEAR REVIEW FOLLOWING IN-CLINIC COMPLETE BLOOD COUNT

Helen Michael, Corie Drake, Kim Yore
IDEXX Laboratories, Inc, Westbrook, ME, USA

Peripheral blood smear review is commonly performed to confirm results from automated hematology analyzers or to identify cancerous cells, morphologic changes, infectious agents, and other changes that are not definitively classified by automated analyzers. Studies in human patients have shown variable value of blood smear review depending on the indication for smear review. The value hasn't been extensively evaluated in veterinary species. In this study, we evaluated blood smear reviews submitted to IDEXX reference laboratories during 2022 by a veterinarian and associated with a CBC performed on an in-clinic hematology analyzer. Initial CBC results, instrument flags, and blood smear review comments were analyzed. Comments added clinical value if they provided additional or confirmatory information to the automated CBC results that could impact clinical management. Reports for 4176 smear reviews were analyzed. 51.0% of reviews were associated with an instrument flag, most commonly for abnormal platelet distribution, left shift, abnormal WBC distribution, nucleated RBCs, and platelet clumps. The corresponding CBC showed cytopenia in 59.4% and cytosis in 39.3%. Clinically valuable comments were present in 80.0% of reviews associated with instrument flags, 76.7% with cytopenia, and 85.4% with cytosis. 17.1% of smear reviews had no instrument flags or abnormal cell counts; 48.6% of these smears had clinically valuable comments. The most common comments were associated with platelet clumping, and toxic change. Veterinarian-ordered blood smear review following an in-clinic CBC had a high yield of clinically valuable results, particularly when the corresponding CBC had instrument flags or aberrant cell counts.

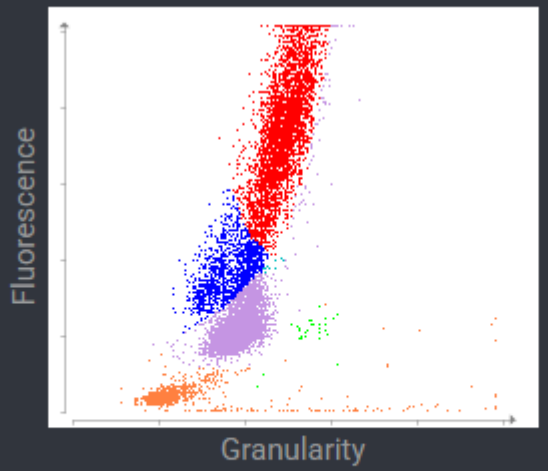
ACVP-ASVCP CHICAGO 2023

Although not stated in the abstract, it was also suggested that <1% of veterinarians requested a blood film review for a CBC

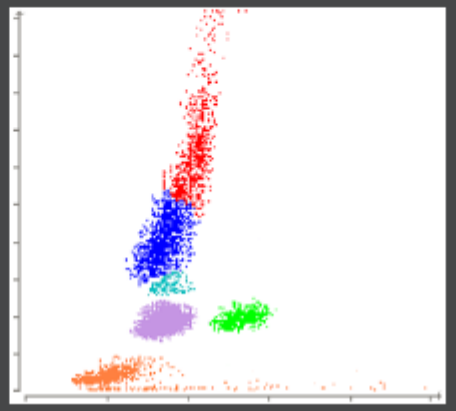
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18 Sept 2026

1 of 1



Normal WBC Run (Canine)



Dot plot legend

URBC	LYM
MONO	EOS
BASO	NEU

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Understand your in-clinic instrument

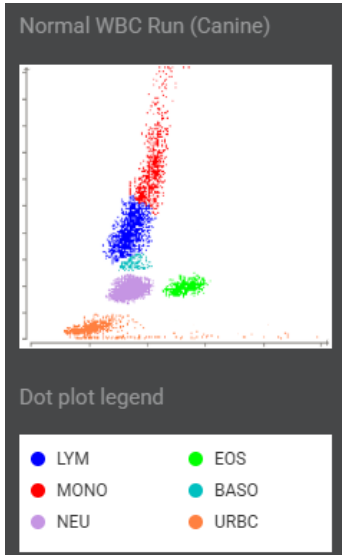
- The ProCyte One and ProCyte Dx both use laser flow cytometry with resulting light scatter for cell differentiation, in addition the ProCyte Dx also uses optical fluorescence.
- The ProCyte One does not assess presence of band neutrophils. The ProCyte Dx also does not enumerate band neutrophils but will flag for potential presence of band neutrophils within the white cell differential.
- The inVue Dx enumerates band neutrophils.

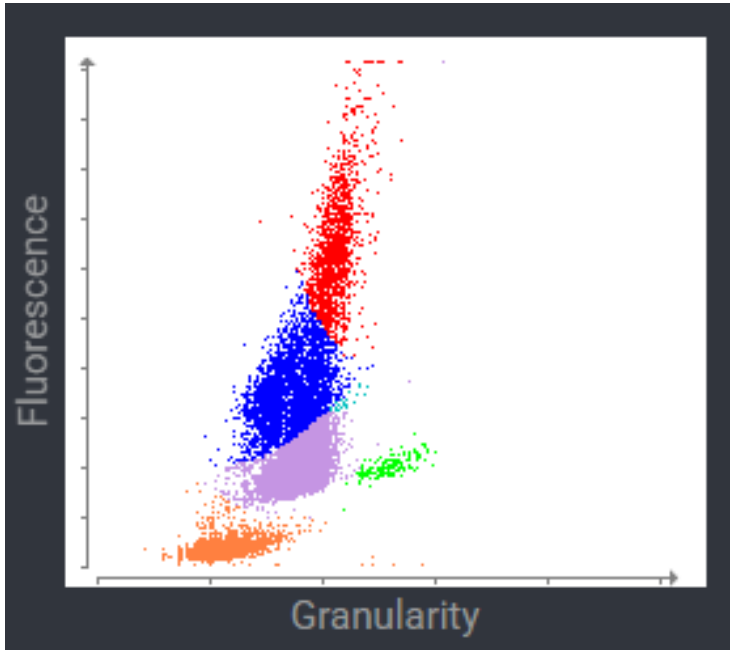
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Jimmy revisited, 2 year-old, male neutered, mixed breed dog

Hematology		3/22/25 6:33 PM	3/22/25 6:24 PM	
WBC	b	52.53	52.53	5.05 - 16.76 x10^9/L
% Neutrophils		86.4	76.6	%
% Lymphocytes		6.5	16.4	%
% Monocytes		6.6	6.3	%
% Eosinophils		0.5	0.6	%
% Basophils		0.0	0.1	%
Neutrophils		45.38	40.19	2.95 - 11.64 x10^9/L
Lymphocytes		3.42	8.64	1.05 - 5.10 x10^9/L
Monocytes		3.47	3.33	0.16 - 1.12 x10^9/L
Eosinophils		0.26	0.32	0.06 - 1.23 x10^9/L
Basophils		0.00	0.05	0.00 - 0.10 x10^9/L
Platelets		>150 x10^9/L (Adequate)	*189	148 - 484 x10^9/L
Platelet Estimate		>150 K/uL (A...		

b. WBC results imported from ProCyte. The white blood cell differential has beer updated based on cellular analysis.



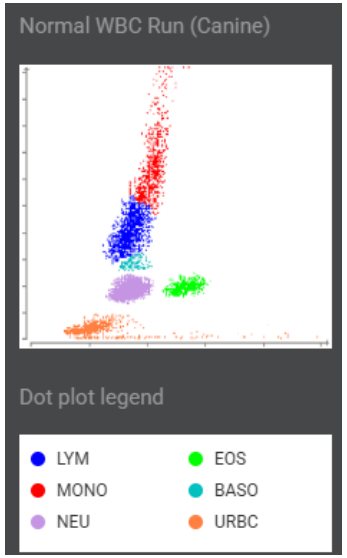


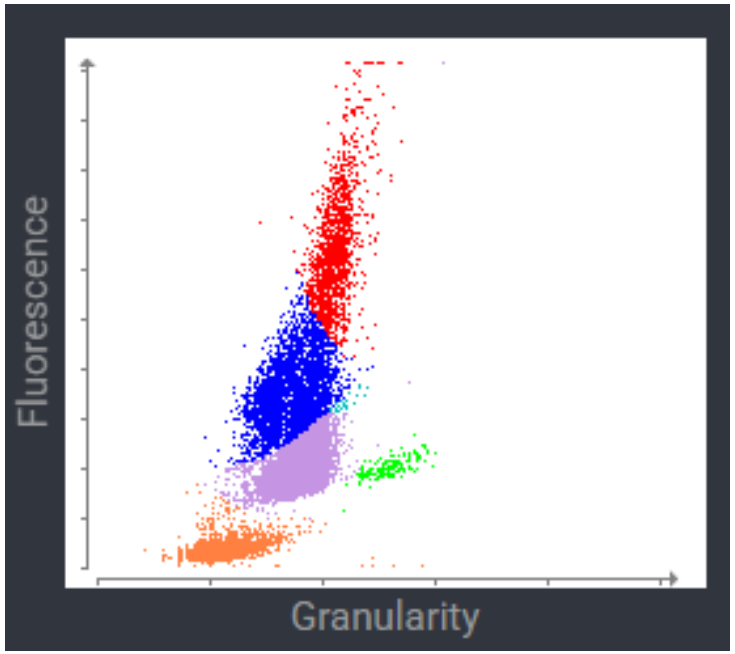
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Jimmy, 2 year-old, male neutered, mixed breed dog

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Platelet Estimate		>150 x10^9/L (Adequate)		

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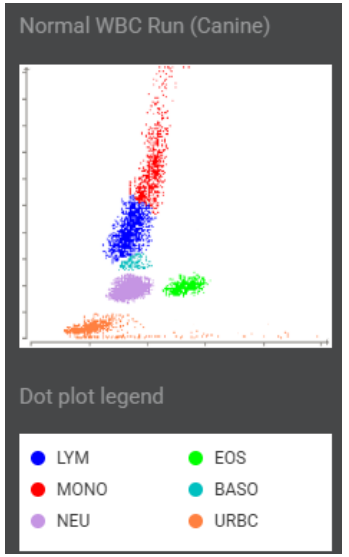


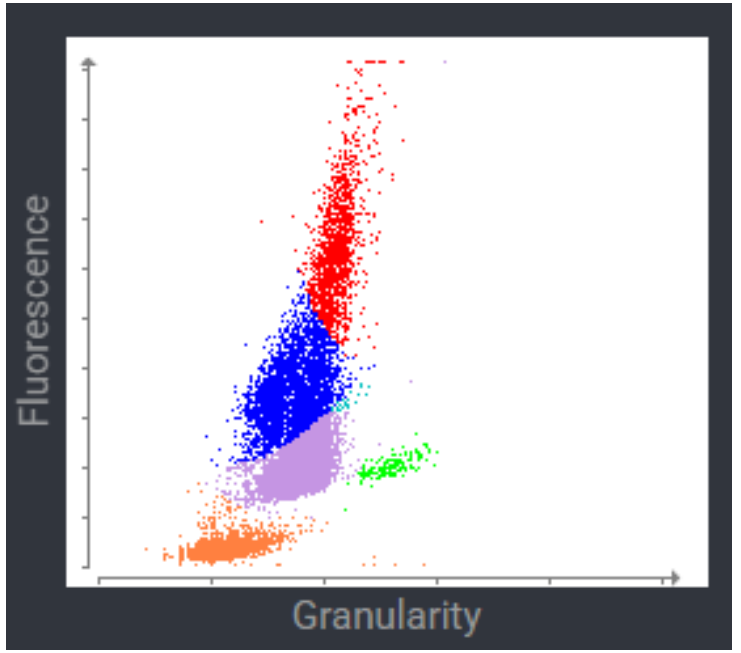
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Monocytes		3.47	3.33	0.16 - 1.12 x10^9/L
Eosinophils		0.26	0.32	0.06 - 1.23 x10^9/L
Basophils		0.00	0.05	0.00 - 0.10 x10^9/L
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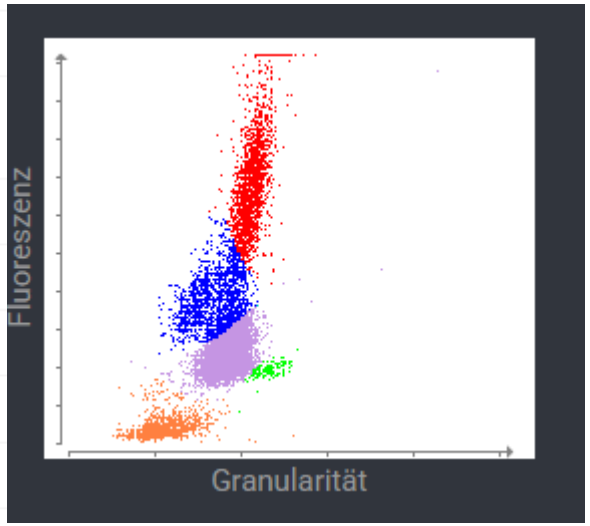


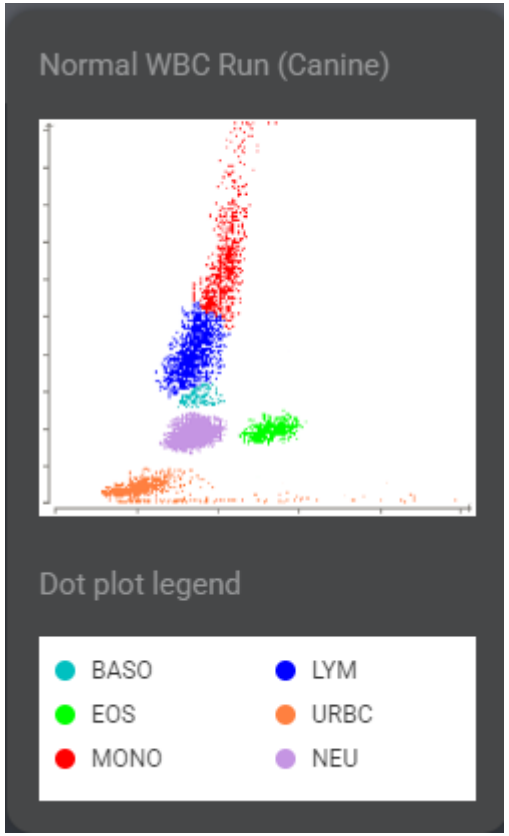


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Yoshi, 13 year old, entire male dog

Neutrophils	*12,30	2,95 - 11,64 x10^9/L
Bands	*Suspected	
Immature Neutrophils		
Lymphocytes	*2,28	1,05 - 5,10 x10^9/L
Monocytes	*2,29	0,16 - 1,12 x10^9/L
Eosinophils	0,16	0,06 - 1,23 x10^9/L
Basophils	0,00	0,00 - 0,10 x10^9/L
Platelets	277	148 - 484 x10^9/L
Platelet Estimate		
PDW	13,7	9,1 - 19,4 fL
MPV	12,3	8,7 - 13,2 fL
Plateletcrit	0,34	0,14 - 0,46 %

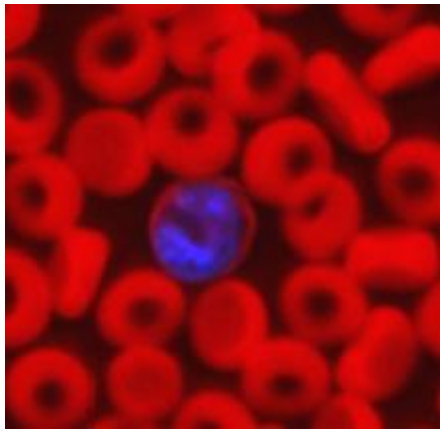


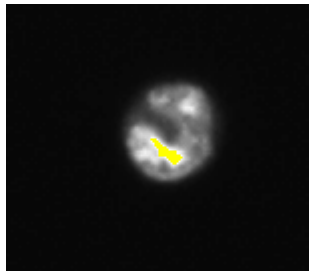


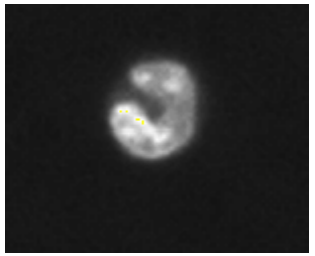
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Yoshi, 13 year old, entire male dog-inVue instrument

Neutrophils	12,33	2,95 - 11,64 x10^9/L	
Bands			
Immature Neutrophils	0,61	x10^9/L	
Lymphocytes	1,12	1,05 - 5,10 x10^9/L	
Monocytes	2,85	0,16 - 1,12 x10^9/L	
Eosinophils	0,09	0,06 - 1,23 x10^9/L	
Basophils	0,03	0,00 - 0,10 x10^9/L	
Platelets			
Platelet Estimate	>150 K/uL (Adequate)		
PDW			
MPV			
Plateletcrit			



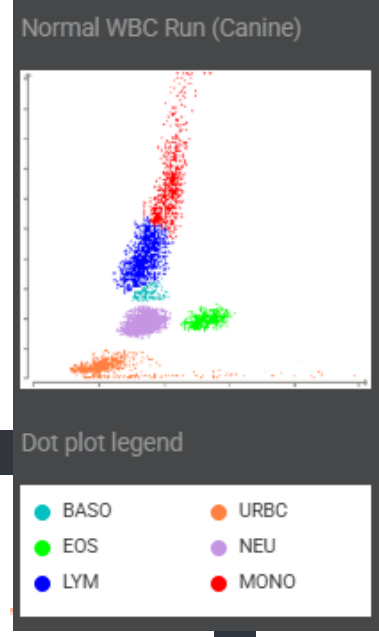


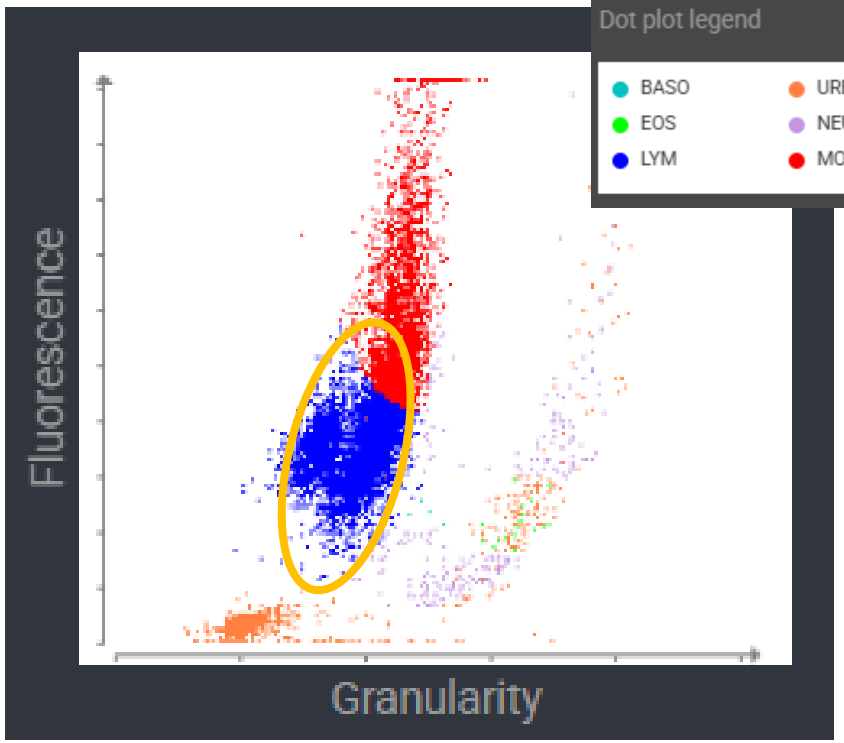


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Milo, 3 months-old, male entire, beagle

Haematology	31/10/2025 11:19	31/10/2025 10:36	
WBC d	11.16	*11.16	5.05 - 16.76 x10^9/L
% Neutrophils	70.8	*2.3	%
% Immature Neutrophils	4.2		
% Lymphocytes	15.0	*63.4	%
% Monocytes	9.1	*34.1	%
% Eosinophils	0.9	*0.2	%
% Basophils	0.1	*0.0	%
Neutrophils	7.90	***0.26**	2.95 - 11.64 x10^9/L
Bands		*Suspected	
Immature Neutrophils	0.46		
Lymphocytes	1.67	***7.08**	1.05 - 5.10 x10^9/L
Monocytes	1.01	***3.80**	0.16 - 1.12 x10^9/L
Eosinophils	0.11	***0.02**	0.06 - 1.23 x10^9/L
Basophils	0.01	*0.00	0.00 - 0.10 x10^9/L
Platelets		*250	148 - 484 x10^9/L
Platelet Estimate	>150 x10^9/L (Adequate)		





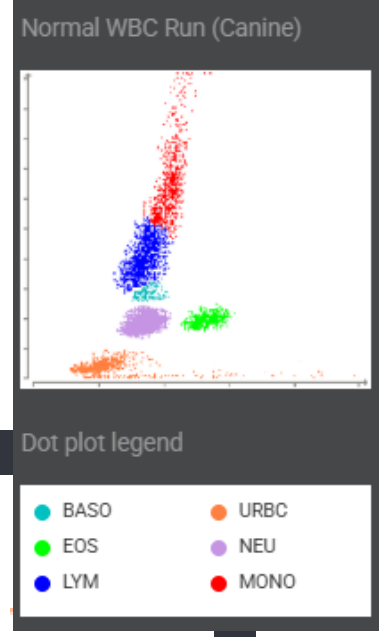
d. WBC results imported from ProCyte. The white blood cell differential has been updated based on cellular analysis.

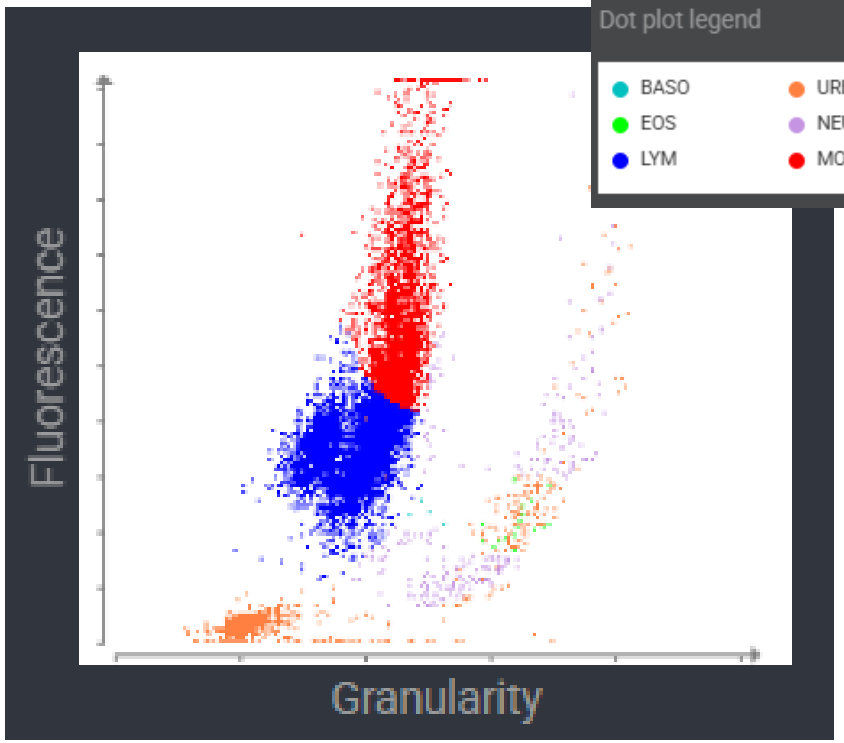
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Milo, 3 months-old, male entire, beagle

Haematology

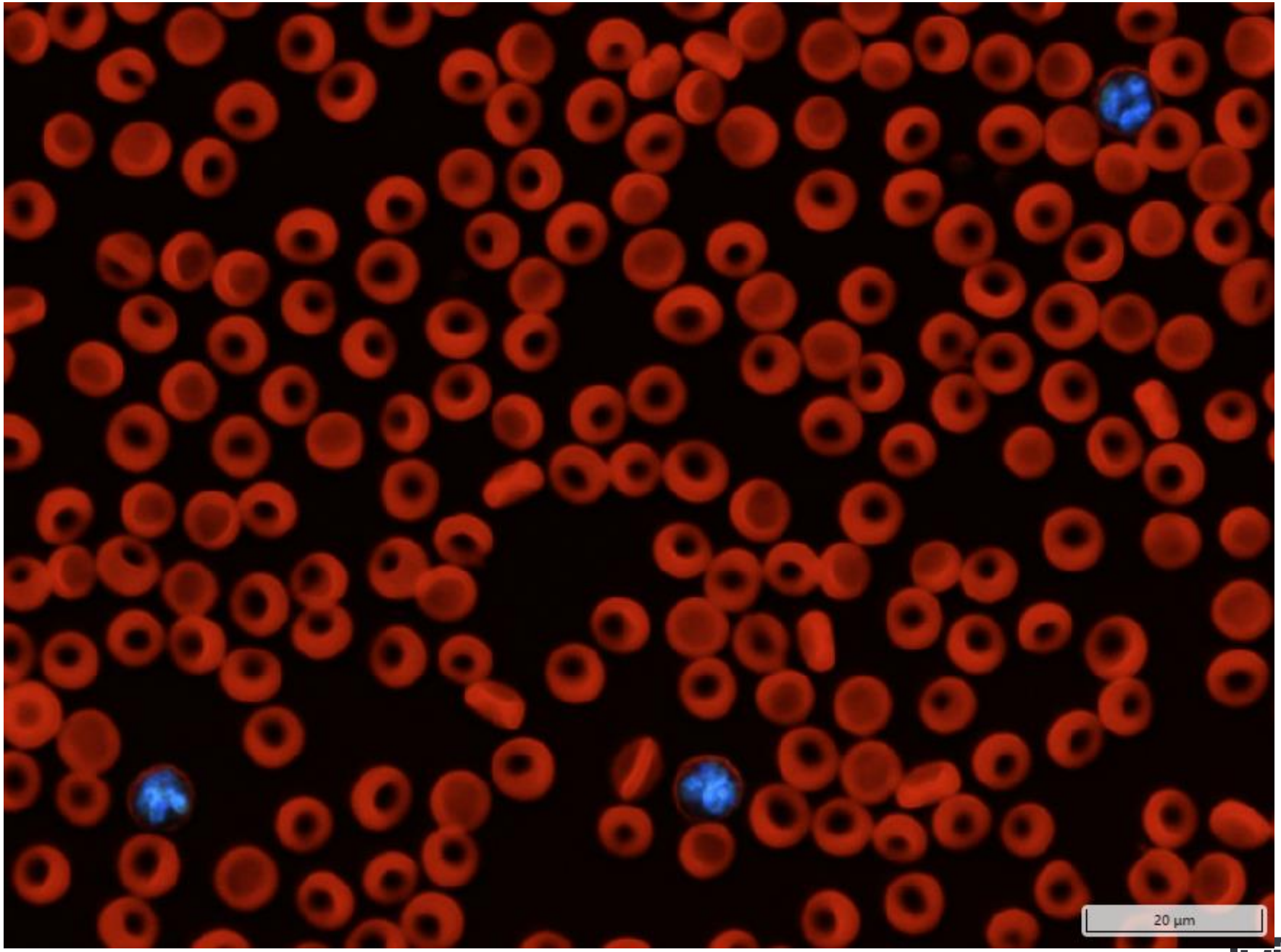
	31/10/2025 11:19		31/10/2025 10:36		
WBC	d	11.16	*11.16	5.05 - 16.76 x10^9/L	
% Neutrophils		70.8	*2.3	%	
% Immature Neutrophils		4.2			
% Lymphocytes		15.0	*63.4	%	
% Monocytes		9.1	*34.1	%	
% Eosinophils		0.9	*0.2	%	
% Basophils		0.1	*0.0	%	
Neutrophils		7.90	***0.26**	2.95 - 11.64 x10^9/L	
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Basophils		0.01	*0.00	0.00 - 0.10 x10^9/L	
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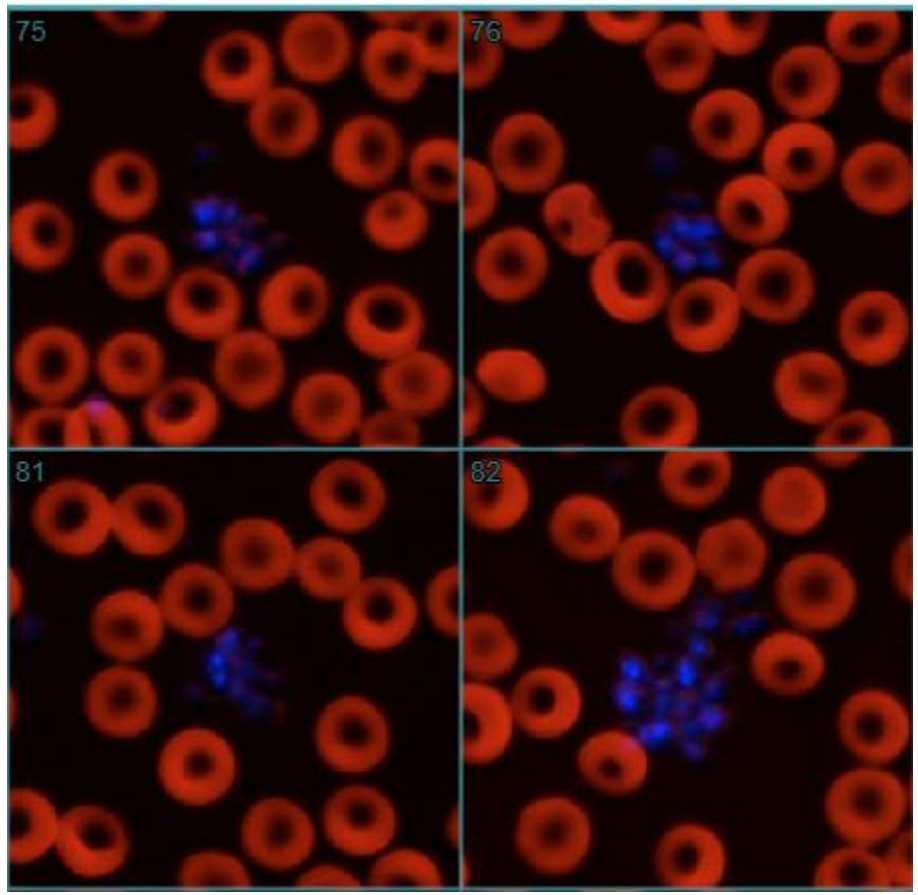


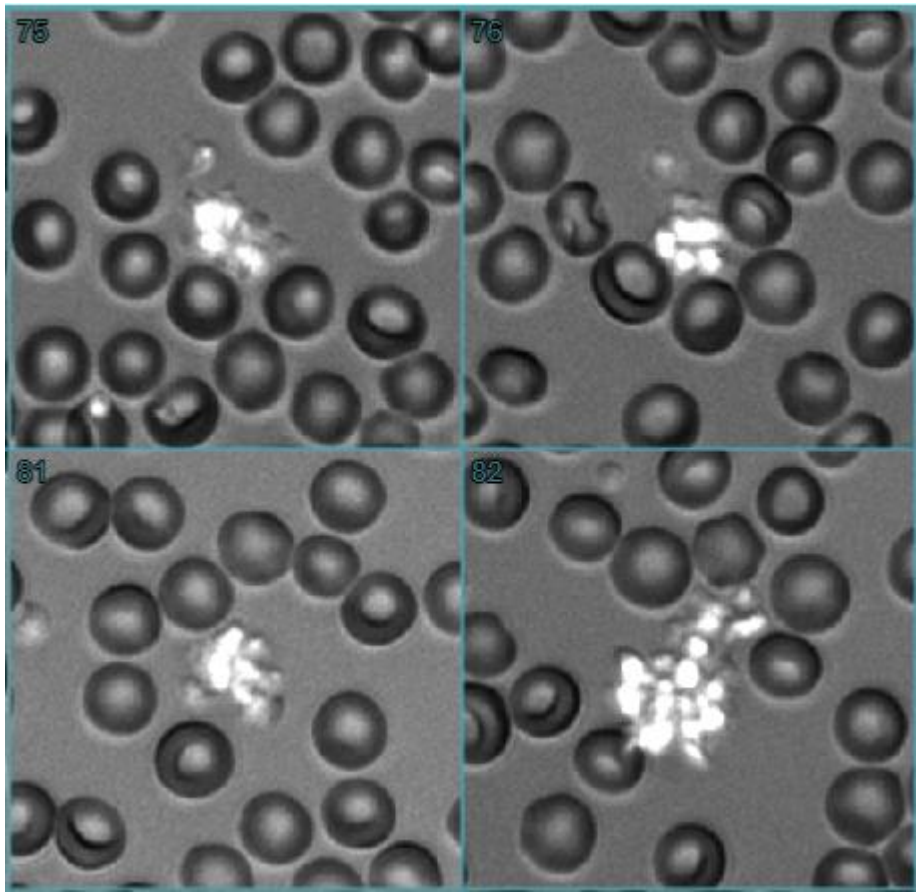
d. WBC results imported from ProCyte. The white blood cell differential has been updated based on cellular analysis.

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Milo, 3 months-old, male entire, beagle









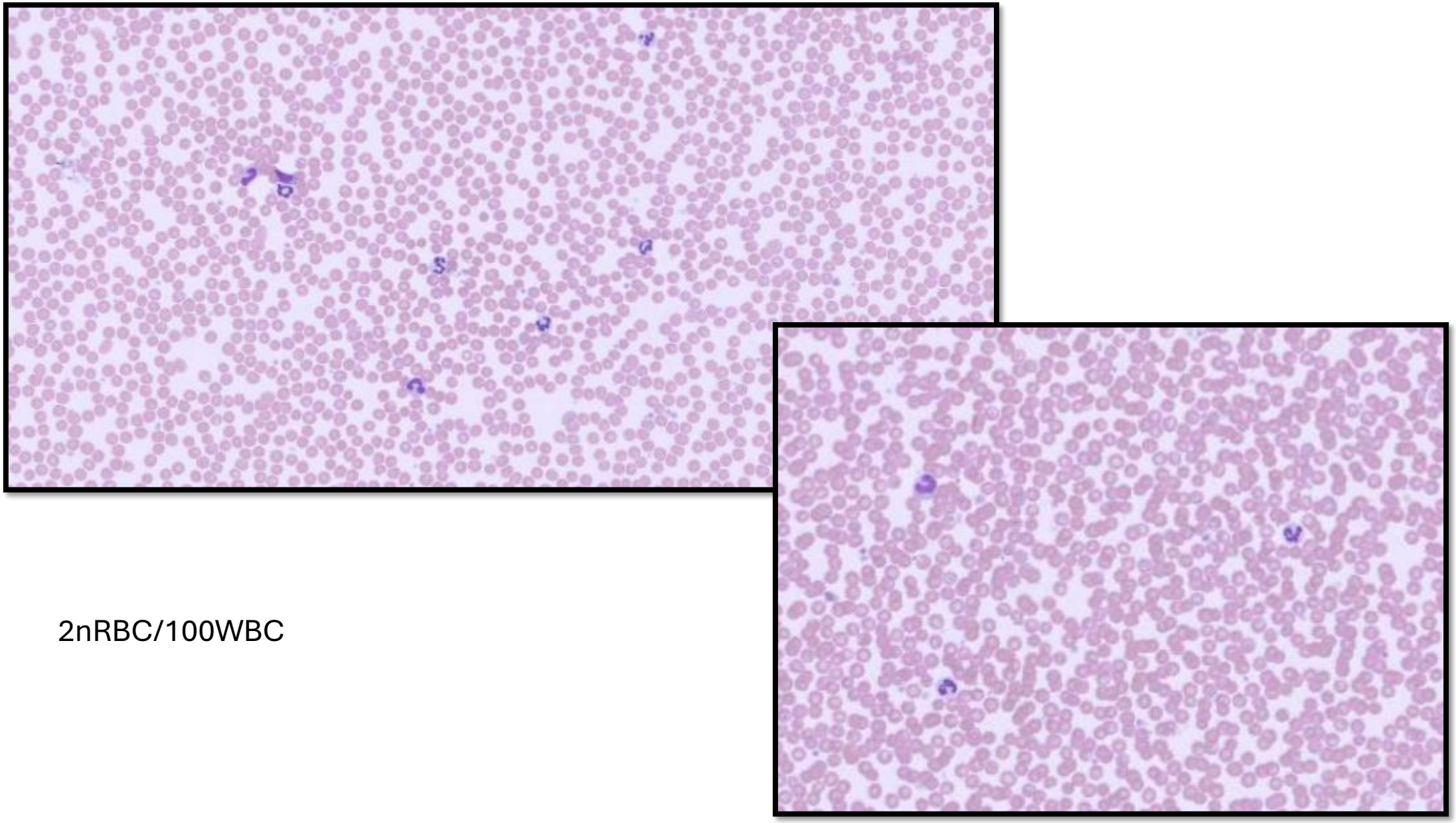
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PRTP: Moya Attwood 11y female neutered pug… no history!

WBC	20.8
% Neutrophils	79.0
% Lymphocytes	6.0
% Monocytes	10.0
% Eosinophils	2.0
% Basophils	0.0
Neutrophils	16.43
Lymphocytes	1.25
Monocytes	2.08
Eosinophils	0.42
Basophils	0.00
Platelets	204

Blood Film Evaluation	No morphological abnormalities detected in red blood cells and there is no increase in polychromasia. Neutrophilia with Band cells present. A few neutrophils show Dohle bodies. Platelet clumps are seen. Platelet count should be considered the minimum value. Manual differential performed by a haematological technician to replace or complete automated results.
Analyser ID	Results generated by SYSMEX XN-V 45378

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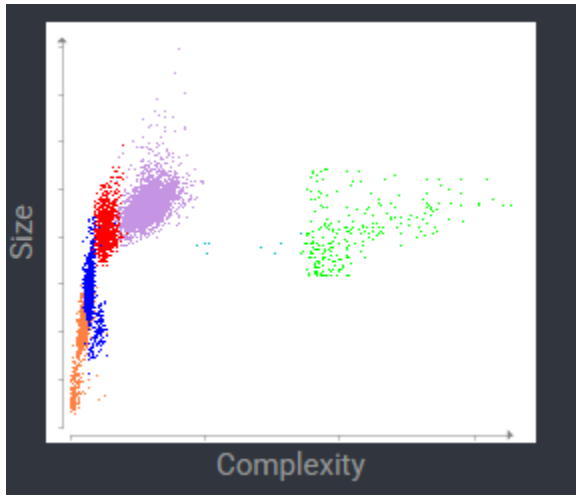


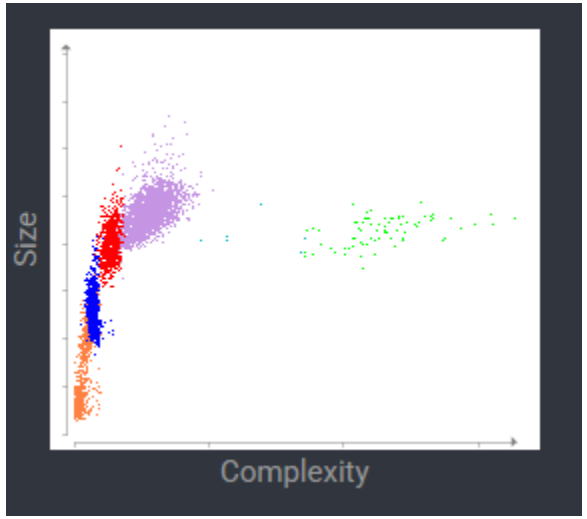
2nRBC/100WBC

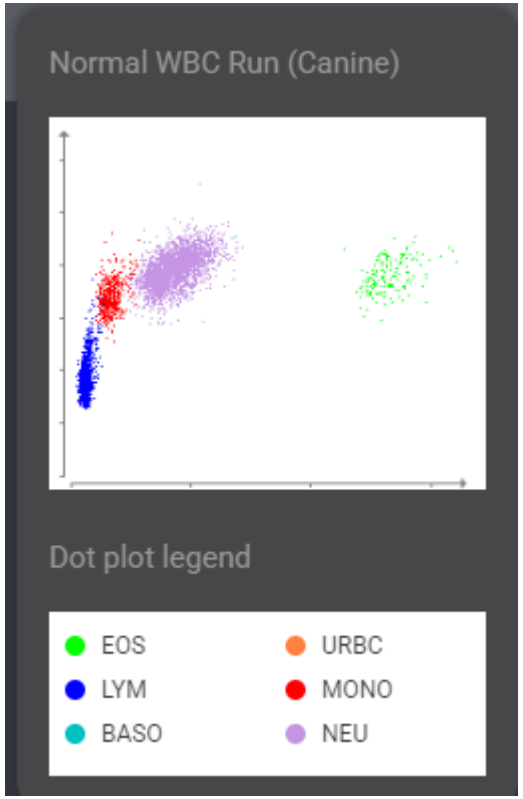
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In Clinic ProCyte One results

WBC	*35.59	*36.04
% Neutrophils	*40.6	*43.6
% Lymphocytes	*52.5	*48.4
% Monocytes	*6.7	*7.2
% Eosinophils	*0.2	*0.9
% Basophils	*0.0	*0.0
Neutrophils	14.44	15.71
Lymphocytes	*18.67	*17.43
Monocytes	2.38	2.58
Eosinophils	0.09	0.31
Basophils	0.01	0.01
Platelets	282	296







Clinic ran ProCyte One twice the day before reference laboratory submission

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ProCyte One and unlysed red cells

- The ProCyte One uses laser flow light scatter
- The red cell lysis step is essential for accurate white cell assessment
- For some patients, for unknown reasons, the red cells are not lysed and therefore interfere with the white cell assessment(see reference in following slide)
- The instrument has flagged both WBCC and the differential as ‘it’ is aware there is a miscalculation
- Sometimes a repeat analysis can be beneficial but not always
- MORPHOLOGICAL EXAMINATION to include inVue Dx would have identified this issue as demonstrated here
- Thanks to Joe Alves Moreira for invaluable technical input

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Vet Clin Pathol. 2025 Nov 4;54(4):338–354. doi: 10.1111/vcp.70071

Comparison of the IDEXX ProCyte One to the ProCyte Dx and ADVIA 120 in Dogs and Cats

Richard J Dulli [1,2,✉], Kim Yore [3], Jeremy Hammond [3], Dennis B DeNicola [4], Mary B Nabity [1]

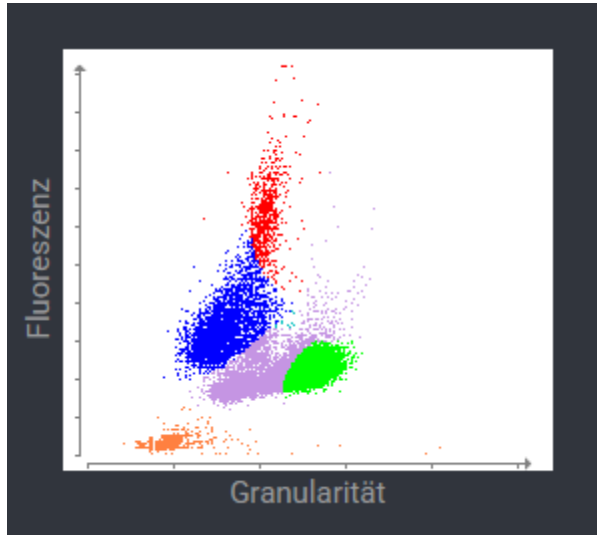
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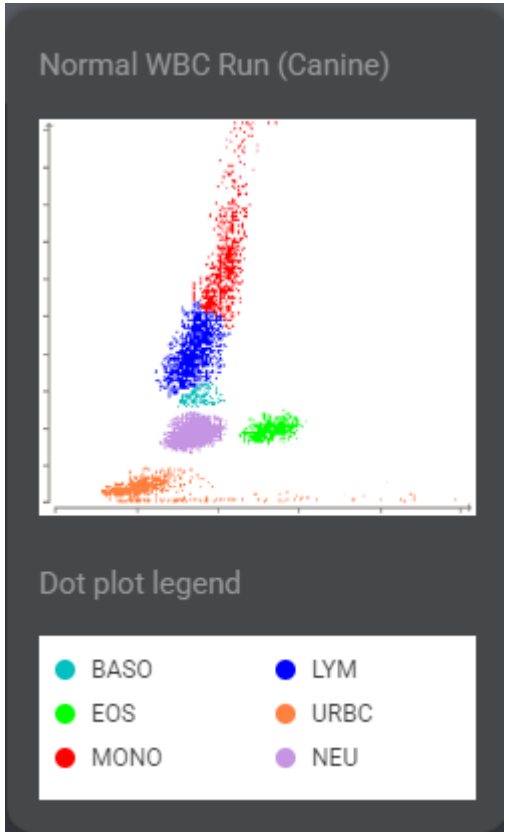
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Janosch, less than one year old, entire male dog

WBC	***45,63**	5,05 - 16,76 x10^9/L
% Neutrophils	*23,4	%
% Immature Neutrophils		
% Lymphocytes	*14,6	%
% Monocytes	*2,6	%
% Eosinophils	*59,4	%
% Basophils	*0,0	%
Neutrophils	*10,68	2,95 - 11,64 x10^9/L
Bands	*Suspected	
Lymphocytes	***6,64**	1,05 - 5,10 x10^9/L
Monocytes	***1,19**	0,16 - 1,12 x10^9/L
Eosinophils	***27,10**	0,06 - 1,23 x10^9/L
Basophils	*0,02	0,00 - 0,10 x10^9/L

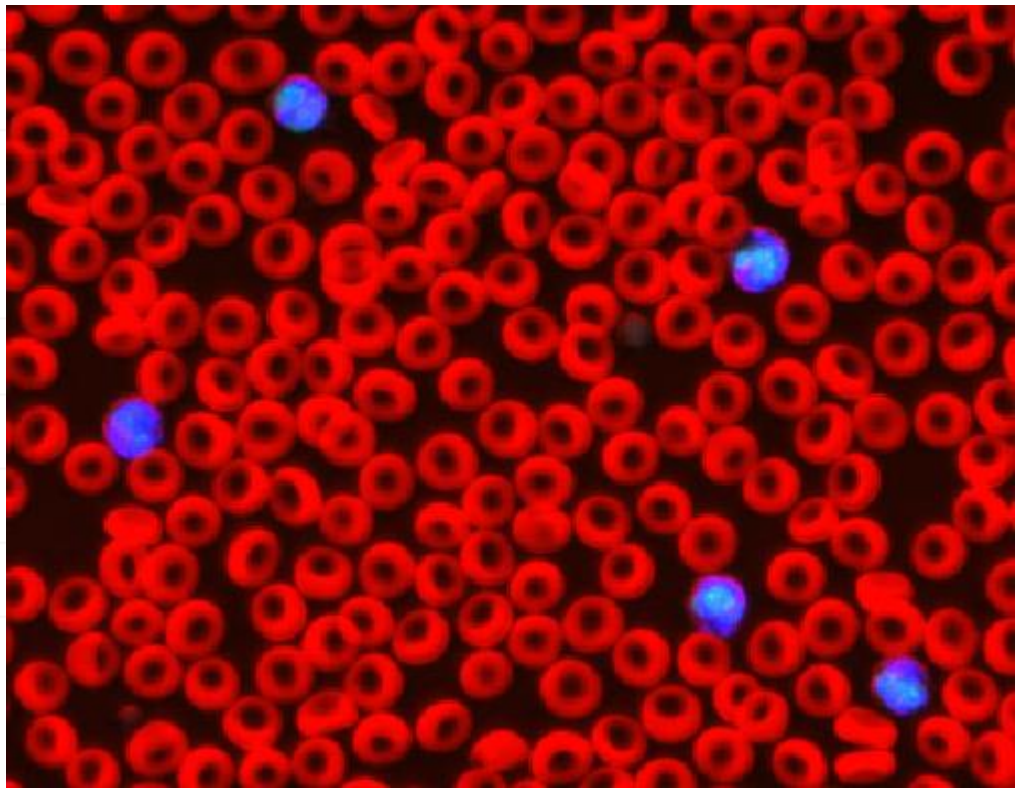


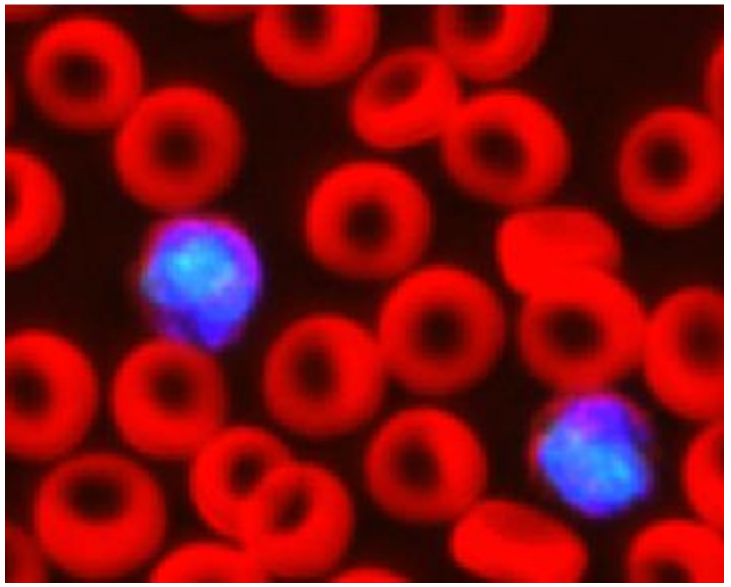


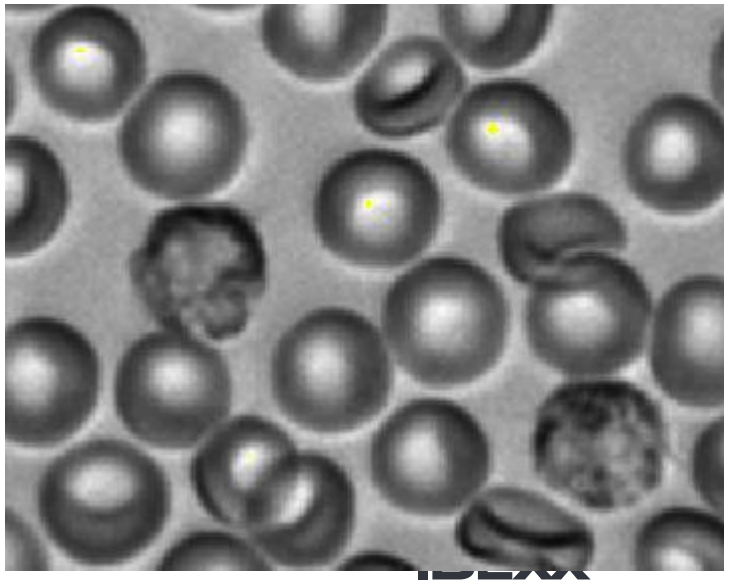
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Janosch, <1 year old, entire male dog

WBC	e -	--.--
% Neutrophils		17,3
% Immature Neutrophils		1,5
% Lymphocytes		15,7
% Monocytes		3,7
% Eosinophils		61,5
% Basophils		0,3
Neutrophils		



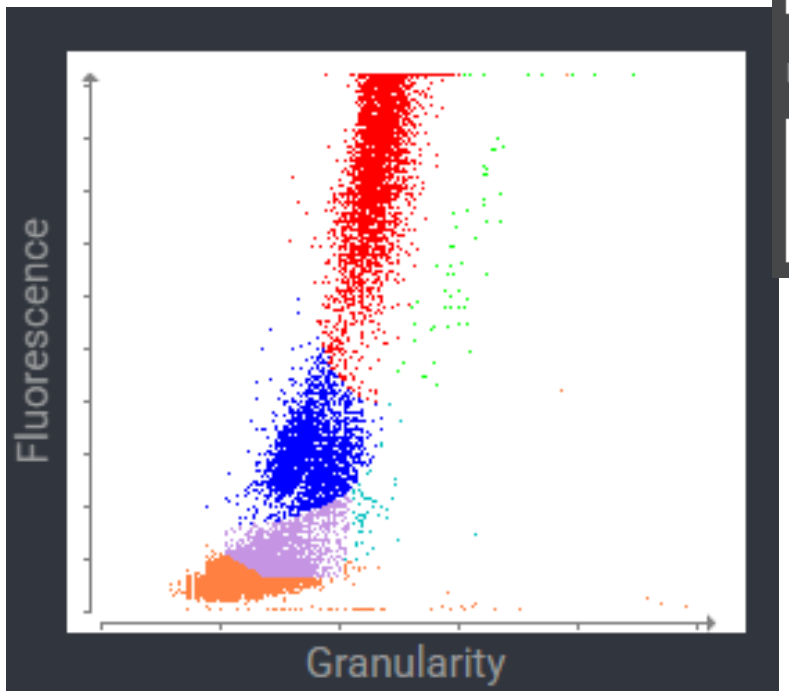


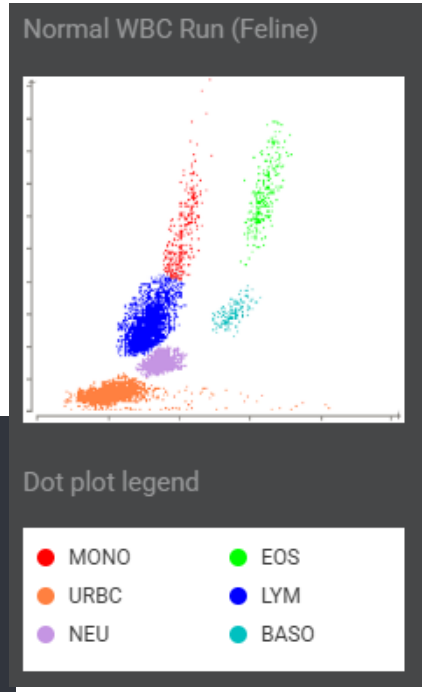


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Cassie 10-year-old, female spayed, DSH cat
Other nucleated cells (ONC)

Hematology		4/30/24 12:10 PM
WBC	*11.86	2.87 - 17.02 x10*9/L
% Neutrophils	*24.3	%
% Lymphocytes	*26.6	%
% Monocytes	*48.1	%
% Eosinophils	*0.5	%
% Basophils	*0.5	%
Neutrophils	*2.88	2.30 - 10.29 x10*9/L
Bands	*Suspected	
Lymphocytes	*3.15	0.92 - 6.88 x10^9/L
Monocytes	*5.71	0.05 - 0.67 x10^9/L
Eosinophils	*0.06	0.17 - 1.57 x10^9/L
Basophils	*0.06	0.01 - 0.26 x10^9/L

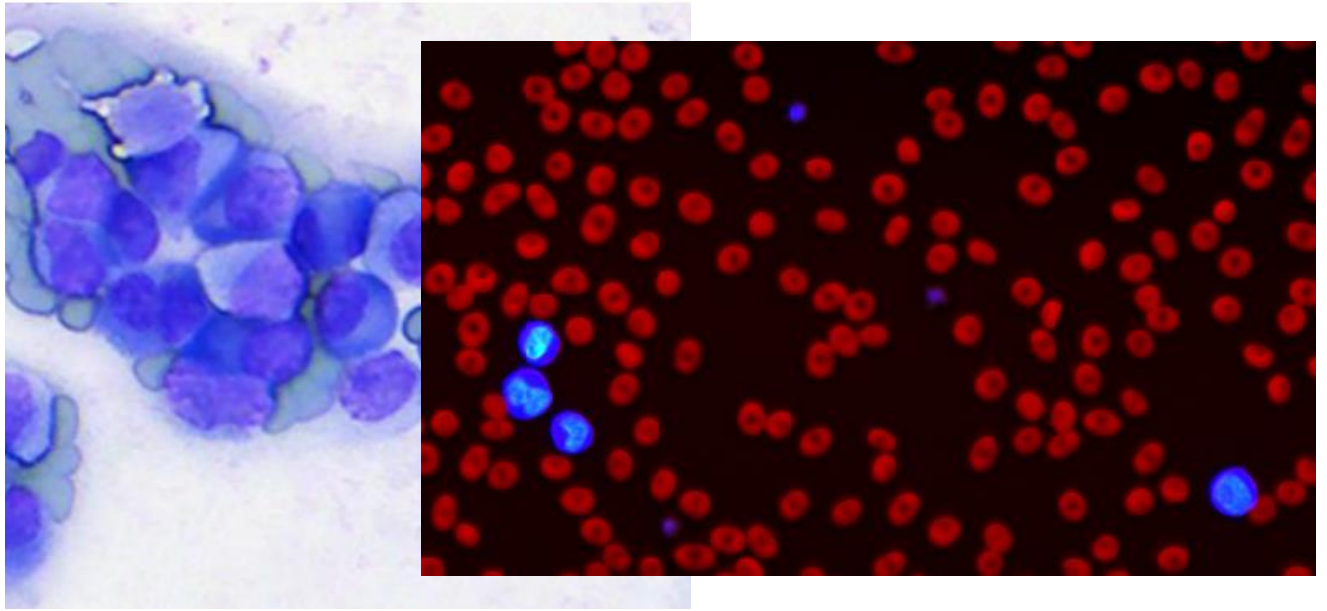




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Other Nucleated Cells

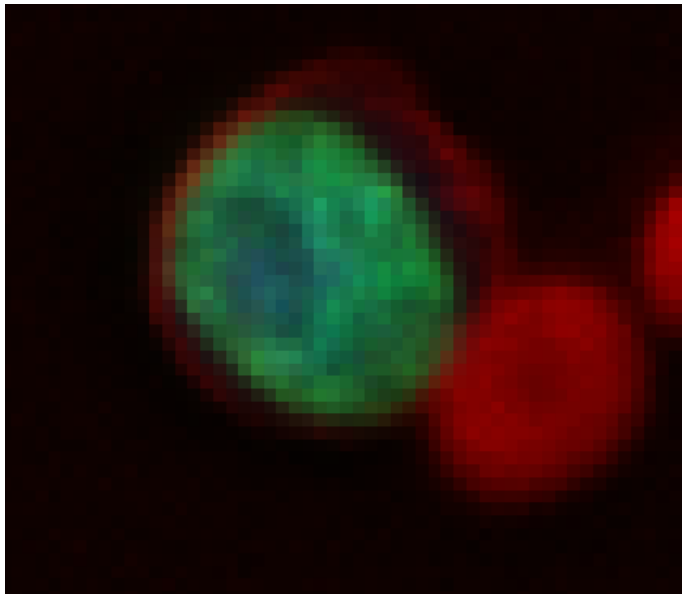
When detected on the analyzer a message appears in the diagnostic considerations block to prompt pathologist blood film review



- Message: Other nucleated cells detected. Other nucleated blood cells include early precursor cells, reactive and neoplastic cell proliferations. When this finding occurs, pathologist evaluation of a traditional blood film may be pursued to provide further information about the patient's hematologic abnormalities.

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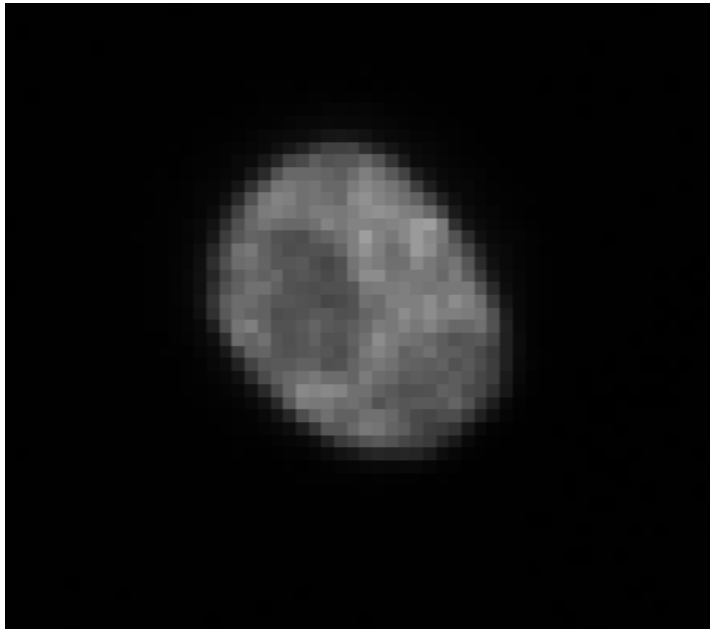


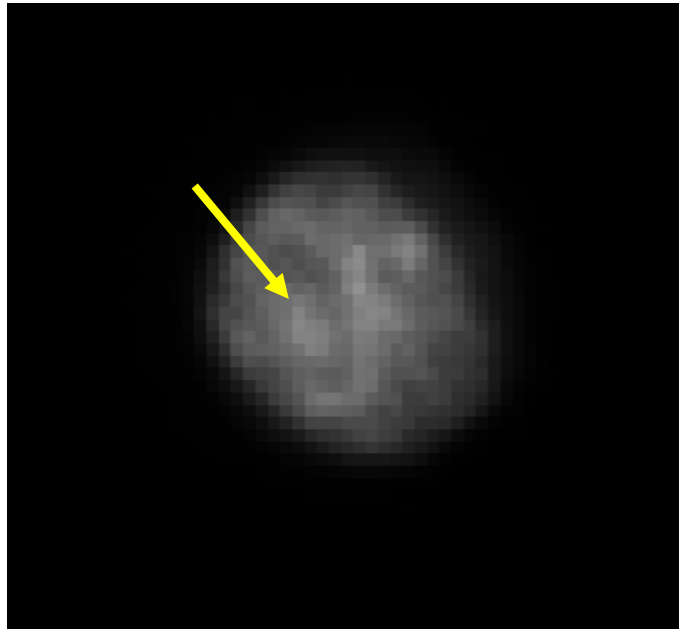


Large mononuclear cell

Bottom left: Flu 1(Fluv) – see nuclear chromatin features

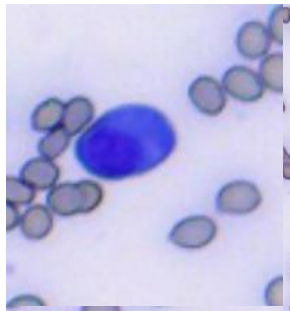
Bottom right: Flu 2(Flbl) – arrow points to nucleolus.

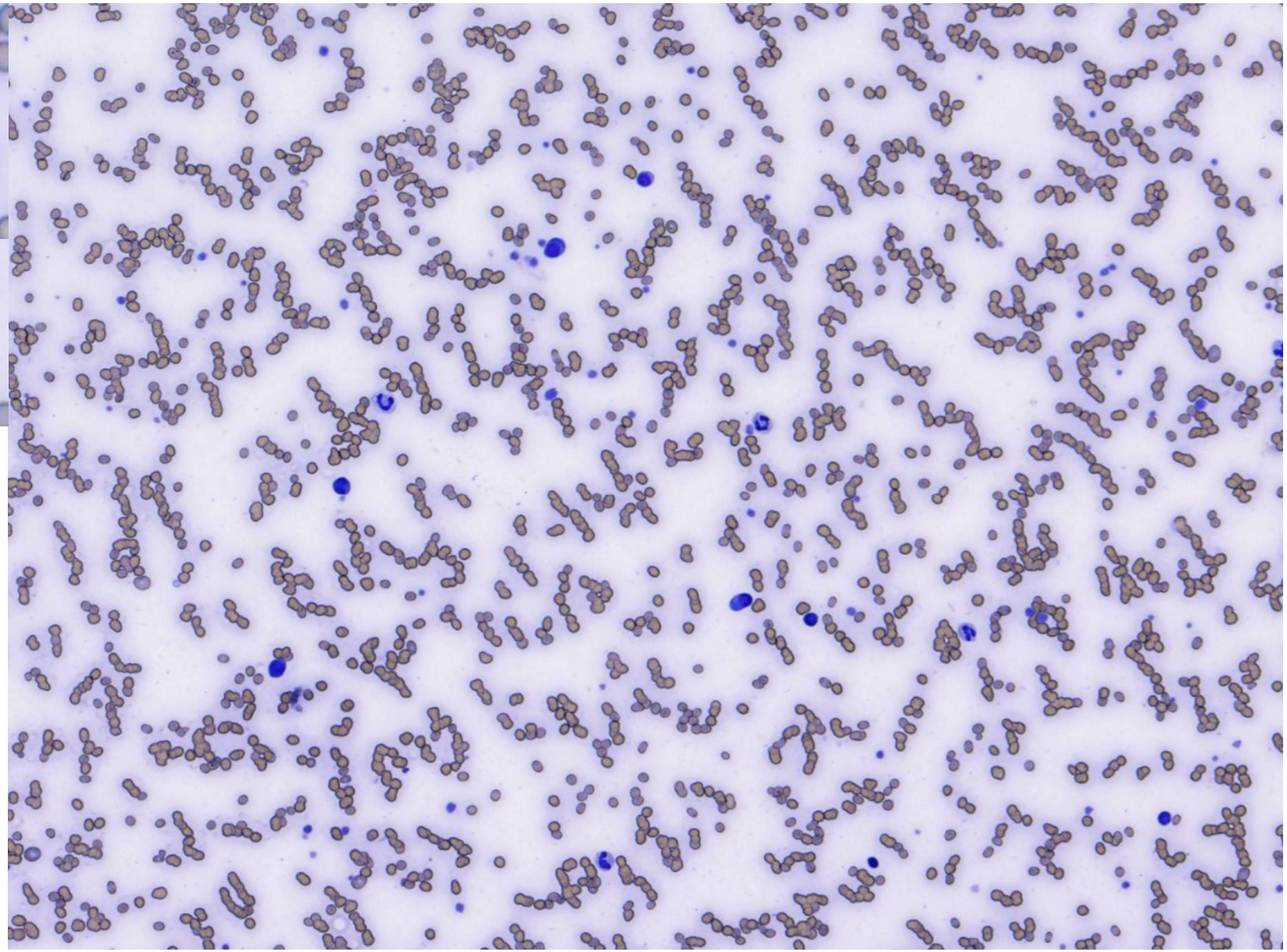




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Blood Film Results





Rouleaux

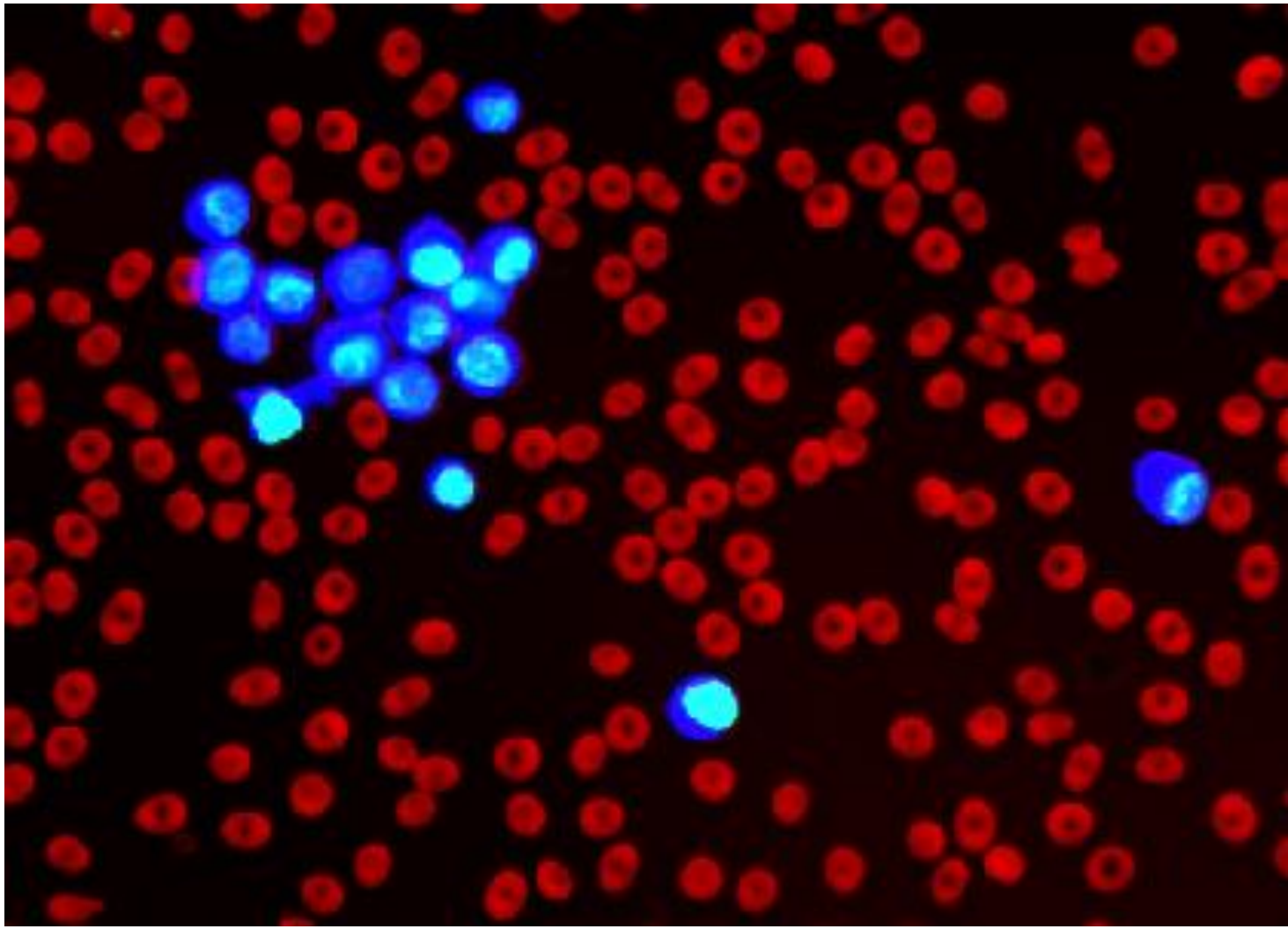
Atypical large mononuclear cells



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Composite: Cluster of large mononuclear cells



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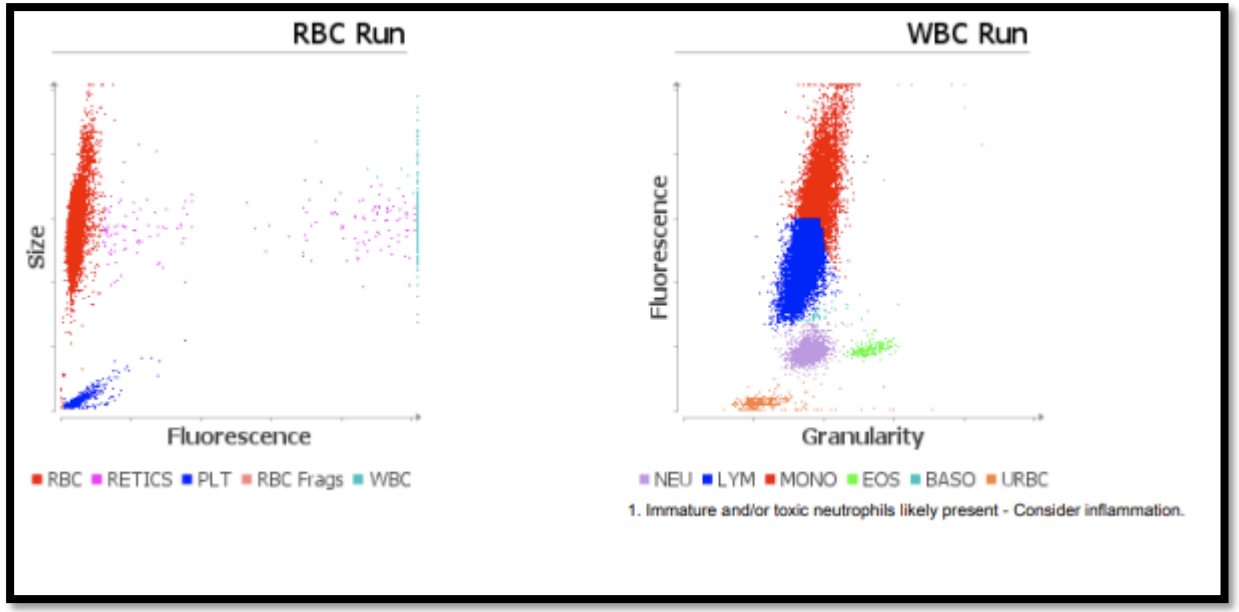
Sully, 11-year-old female neutered Golden Retriever

ProCyte Dx (September 25, 2026, 11:24 AM)

Test	Results	Reference Interval		8/14/26 8:10 AM
RBC	7.37 M/µL	5.65 - 8.87		6.79 M/µL
HCT	47.2 %	37.3 - 61.7		44.2 %
HGB	16.2 g/dL	13.1 - 20.5		15.6 g/dL
MCV	64.0 fL	61.6 - 73.5		65.1 fL
MCH	22.0 pg	21.2 - 25.9		23.0 pg
MCHC	34.3 g/dL	32.0 - 37.9		35.3 g/dL
RDW	18.0 %	13.6 - 21.7		16.4 %
%RETIC	0.8 %			0.7 %
RETIC	60.4 K/µL	10.0 - 110.0		48.9 K/µL
RETIC-HGB	23.3 pg	22.3 - 29.6		25.3 pg
WBC	56.53 K/µL	5.05 - 16.76	HIGH	18.38 K/µL
%NEU	* 9.8 %			* 18.3 %
%LYM	* 54.8 %			* 69.7 %
%MONO	* 34.8 %			* 9.2 %
%EOS	0.5 %			1.9 %
%BASO	0.1 %			0.9 %
NEU	* 5.53 K/µL	2.95 - 11.64		* 3.34 K/µL
BAND	* Suspected			* Suspected
LYM	* 30.96 K/µL	1.05 - 5.10	HIGH	* 12.82 K/µL
MONO	* 19.67 K/µL	0.16 - 1.12	HIGH	* 1.70 K/µL
EOS	0.29 K/µL	0.06 - 1.23		0.35 K/µL
BASO	0.08 K/µL	0.00 - 0.10		0.17 K/µL
PLT	182 K/µL	148 - 484		143 K/µL
MPV	12.0 fL	8.7 - 13.2		11.8 fL
PDW	10.5 fL	9.1 - 19.4		11.2 fL
PCT	0.22 %	0.14 - 0.46		0.17 %

* Confirm with blood morphology (IDEXX inVue Dx, dot plot, and/or blood film review).

* Confirm with blood morphology (IDEXX inVue Dx, dot plot, and/or blood film review).



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Sully, continued;

Hematology (September 25, 2026, 11:40 AM)

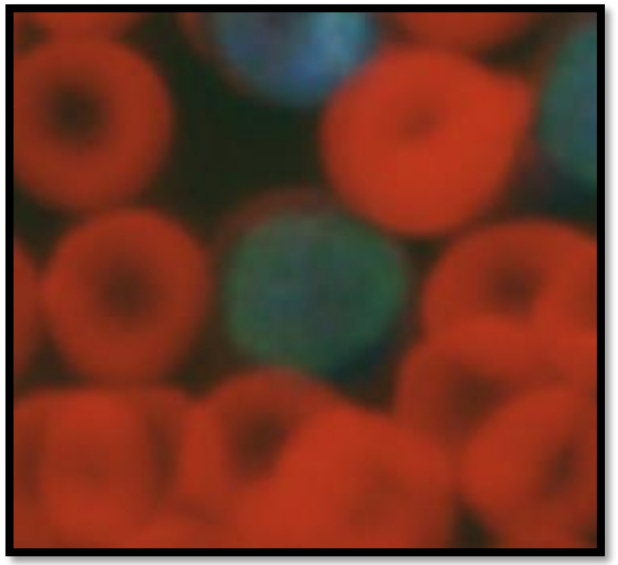
RBC	a,b 7.37 M/µL	5.65 - 8.87	
Hematocrit	a 47.2 %	37.3 - 61.7	
Acanthocytes	0.56% (Mild)		
Keratocytes	0.57% (Mild)		
% Reticulocytes	0.8 %		
Reticulocytes	a 60.4 K/µL	10.0 - 110.0	
WBC	c 56.53 K/µL	5.05 - 16.76	HIGH
Platelet Estimate	>150 K/uL (Adequate)		

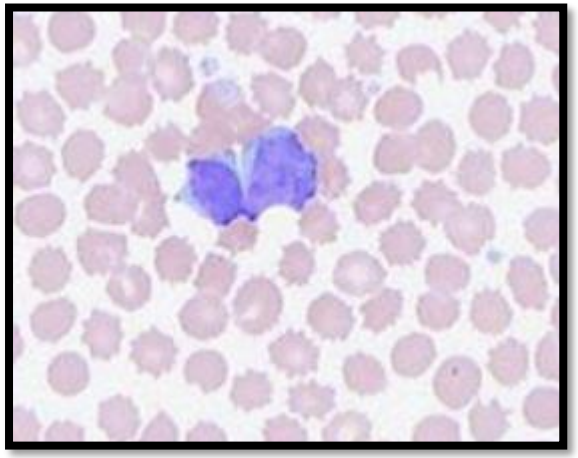
Diagnostic Considerations

Other nucleated cells suspected. Other nucleated blood cells may include early precursor cells, and reactive and neoplastic cell proliferations. When this finding occurs, pathologist evaluation of a traditional blood smear may be pursued to provide further information about the patient's hematologic abnormalities.

Red blood cell changes may suggest RBC fragmentation injury. Causes of RBC fragmentation injury include RBC damage or shearing trauma (e.g., disseminated intravascular coagulopathy, vasculitis, and vascular neoplasms) and increased RBC fragility (e.g., liver disease, high cholesterol diet, and iron deficiency). Careful clinical evaluation, further diagnostics (e.g. imaging) and/or monitoring is warranted.

This platelet estimate incorporates enumeration of individual platelets and platelets within clumps. Platelet count is above 150 K/uL.





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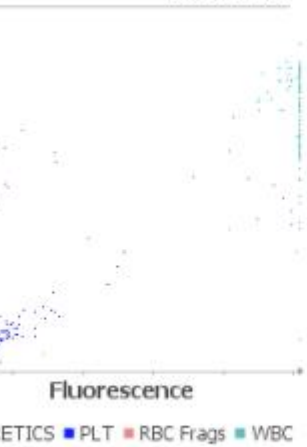
Sully, continued;

Flow Cytometry - Blood	SOURCE/HISTORY: Peripheral blood. INTERPRETATION: T-cell lymphocytosis with aberrant antigen expression-suggestive for lymphoproliferative disease (chronic lymphocytic leukemia or intermediate cell lymphoma) or possible thymoma with paraneoplastic lymphocytosis (see comments) COMMENTS: The majority of the lymphocytes are intermediate T cells that express both CD4 and CD8 (double positive T-cells). Very few double positive cells should be present in circulation of normal dogs. The presence of this aberrant population (size and phenotype) suggests that these are neoplastic lymphocytes (lymphocytic leukemia or circulating neoplastic cells from lymphoma), but another underlying disorder (such as a thymoma) cannot be completely excluded. With thymoma, the lymphocyte population should be polyclonal (not neoplastic).

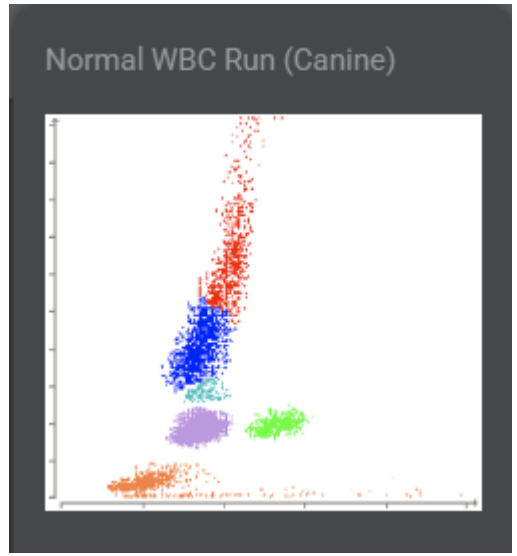
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Molly, 8-year-old female neutered Bernese Mountain Dog

Test	Results	Reference Interval	LOW / NORMAL / HIGH
ProCyte Dx (September 18, 2026, 9:44 AM)			
RBC	4.70 M/µL	5.65 - 8.87	LOW
HCT	31.2 %	37.3 - 61.7	LOW
HGB	10.8 g/dL	13.1 - 20.5	LOW
MCV	66.4 fL	61.6 73.6	
MCH	23.0 pg	21.2 - 25.9	
MCHC	34.6 g/dL	32.0 - 37.9	
RDW	15.5 %	13.6 - 21.7	
%RETIC	0.1 %		
RETIC	4.7 K/µL	10.0 - 110.0	LOW
RETIC-HGB	25.0 pg	22.3 - 29.6	
WBC	15.20 K/µL	5.05 - 16.76	
%NEU	58.9 %		
%LYM	9.9 %		
%MONO	30.9 %		
%EOS	0.2 %		
%BASO	0.1 %		
NEU	8.96 K/µL	2.95 - 11.64	
LYM	1.50 K/µL	1.05 - 5.10	
MONO	4.70 K/µL	0.16 - 1.12	HIGH
EOS	0.03 K/µL	0.06 - 1.23	LOW
BASO	0.01 K/µL	0.00 - 0.10	
PLT	* 15 K/µL	148 - 484	LOW
MPV	17.2 fL	8.7 - 13.2	HIGH
PDW	--.-- fL	9.1 - 19.4	
PCT	0.03 %	0.14 - 0.46	LOW

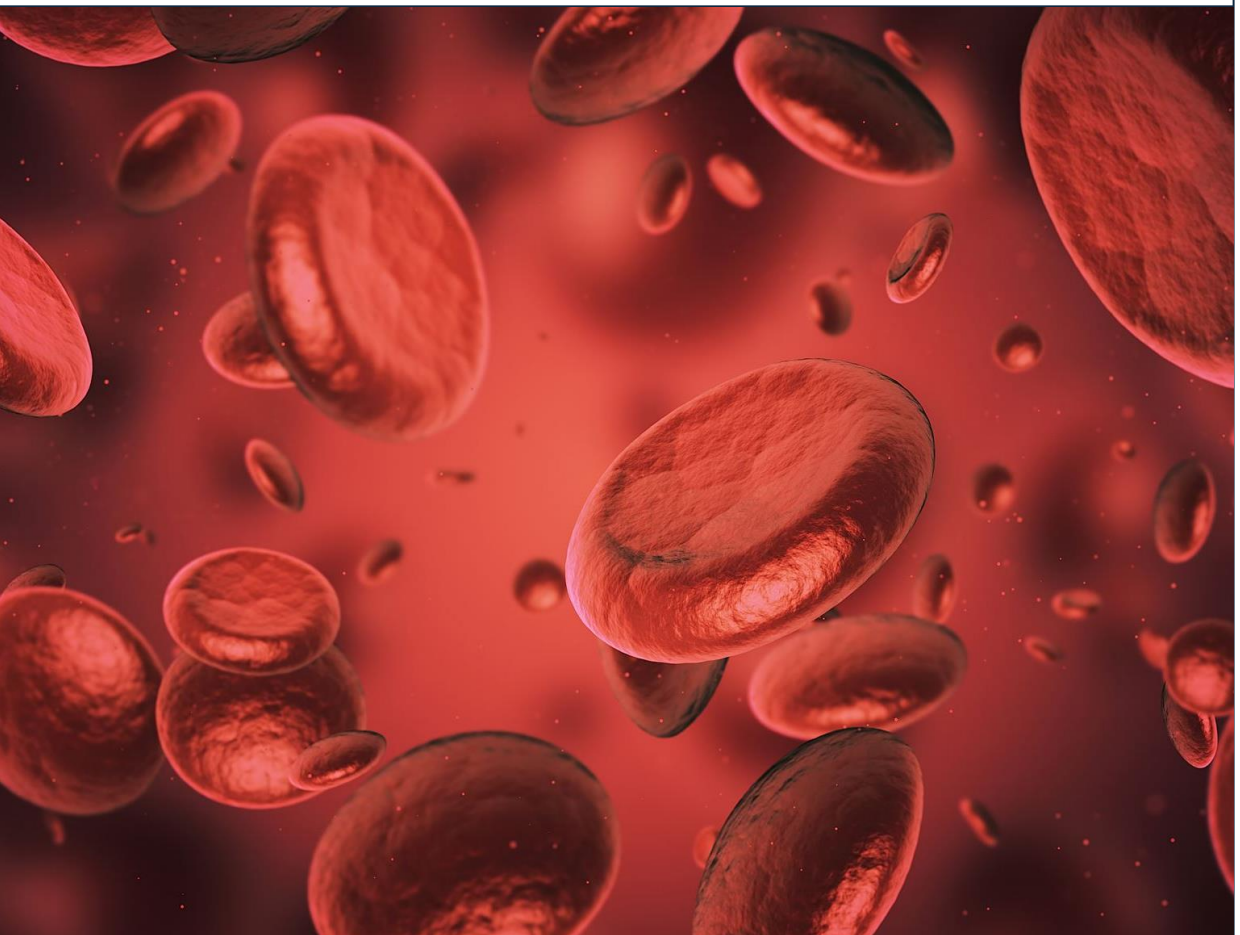


* Confirm with blood morphology (IDEXX inVue Dx, dot plot, and/or blood film review).



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Practical Applications of Blood Morphology



Rule in

- RBC regeneration: anisocytosis, polychromasia, nRBCs, reticulocytosis
- Immune-mediated haemolysis: spherocytes and agglutination
- Systemic inflammation/infection: immature neutrophils
- Presence of immature or atypical cells
- True thrombocytopaenia: reduced platelet count without aggregates

Rule out

- Absence of regeneration
- Non-immune-mediated anaemia
- Pseudothrombocytopaenia: reduced platelet count with aggregates



IDEXX inVue Dx™

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How is the InVue DX™ Cellular Analyser different?

- It is unique within the market there is no blood smear examination from a slide
- The cells are suspended within a fluid medium and analysed using a combination of modalities which highlight cell structure and complexity
- This is not a counting machine giving total cell counts, the analyser identifies upto 2000 nucleated cells and then provides a relative and absolute differential count if the total white cell count has been provided
- This is an analyser for which intelligence software is being constantly optimised

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More about the InVue Dx technology

- The use of a fluid medium allows cells to be examined in their natural state reducing cell preparation artefact seen with smears, particularly blood smears made with aged blood
- InVue Dx uses a combination of two brightfields, and with the addition of the fluorescent stain in the diluent, also uses two fluorescent channels.
- This combination of modalities allows for examination of cell shape and structure to include DNA, RNA and protein complexity
- A fifth image is also generated called the composite which combines a brightfield and both fluorescent channels

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