COLLEGE of AMERICAN PATHOLOGISTS

Surveys and Anatomic Pathology Education Programs

Comprehensive Hematology with Automated Differential
FH13-A 2018

Participant Summary

0.5 Hours of Self-Reported Training Available

This document is available on e-LAB Solutions.

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2018 FH13-A
PARTICIPANT SUMMARY

Program Update

Beckman Coulter users: For optimal proficiency testing (PT) grading, your laboratory should be enrolled in the Surveys program recommended for your instrument system, as follows:

Coulter Instrument System	Recommended Survey		
	FH3	FH6	FH13
DxH 500	■		
Gen-S, HmX, LH 500, MAXM series, STKS, VCS		■	
LH 700 series, UniCel DxH			■

Don't Miss Out on this Educational Opportunity!

With your participation in CAP's Surveys programs, *every member of your team* can take part in education activities: earn Continuing Education (CE) credits or receive Self-Reported Training* at no additional charge.

This Survey mailing includes a Self-Reported Training activity. By reviewing the discussion that begins on page 32, your laboratory staff can earn **0.5 education hours** that can be used towards fulfilling education and certification of maintenance requirements. For your convenience, a form has been included to document your staff's participation in the activity. See page 45.

**CAP Self-Reported Training activities do not offer CE credit, but can be used towards fulfilling requirements for certification of maintenance by agencies such as the American Society of Clinical Pathology (ASCP). Please verify with your certifying agency to determine your education requirements.*

Evaluation Criteria

As published in the January 24, 2003 Federal Register, (42 CFR Part 493, Medicare, Medicaid, and CLIA Programs; Laboratory Requirements Relating to Quality Systems and Certain Personnel Qualifications; Final Rule) effective April 24, 2003, proficiency-testing (PT) providers are required to grade **all analytes regulated for PT at 80% participant or referee consensus**. For information on criteria for grading analytes not regulated for PT, please review your Participant Summary.

Analytes regulated for proficiency testing appear in **bold** type.

Quantitative

Analyte	Target Value	Evaluation Criteria
Basophils*	Peer Group	± 3 SD or ± 1.0 (whichever is greater)
Eosinophils*	Peer Group	± 3 SD or ± 1.0 (whichever is greater)
Hematocrit	Peer Group	± 6%
Hemoglobin	Peer Group	± 7%
Lymphocytes*	Peer Group	± 3 SD or ± 1.0 (whichever is greater)
MCH	Peer Group	± 3 SD
MCHC	Peer Group	± 3 SD

Evaluation Criteria, cont'd

Analyte	Target Value	Evaluation Criteria
MCV	Peer Group	± 3 SD
MPV	Peer Group	± 3 SD
Monocytes*	Peer Group	± 3 SD or ± 1.0 (whichever is greater)
nRBC	Peer Group	Educational (26)
Neutrophils/Granulocytes*	Peer Group	± 3 SD or ± 1.0 (whichever is greater)
Platelet Count	Peer Group	± 25%
RDW	Peer Group	± 3 SD
Red Blood Cell Count	Peer Group	± 6%
White Blood Cell Count	Peer Group	± 15%

Results for nRBC are **not** formally evaluated; however, statistics appear in the Participant Summary for your information.

Qualitative

Analyte	Evaluation Criteria
Blood Cell Identification*	80% referee or participant consensus

***Blood cell identification results are included in the CMS performance summary. In the event that Blood Cell Identification is not performed, results from the flow through differential will be reported.

The quantitative data tables provided in the Participant Summary include the mean, SD, and %CV. Data are not included for methods used by fewer than 10 laboratories. The limits of acceptability are located on your participant evaluation report.

Your results are evaluated based upon a range of acceptability. The range is determined using a target value and a limit. There must be at least 10 laboratories in the peer group. If a peer group of 10 is not established, your results may be evaluated against the **Instrument** group mean.

To provide a timely evaluation of your results, statistics presented in this Participant Summary reflect participant data received by the due date.

The CAP is required to submit PT results to the Centers for Medicare and Medicaid Services (CMS) for all labs that have provided a CLIA identification number. If you do not notify the CAP that your lab has discontinued testing of a regulated analyte, **a score of zero will be given**. Your reporting preferences are outlined on the CMS Analyte Reporting Selections document. If new products are ordered and/or canceled, this may affect your reporting selections, so it is recommended that you periodically check this report on e-LAB Solutions Suite, which will always reflect the most up-to-date information. This information can also be obtained by calling the Customer Contact Center at 800-323-4040, Option 1 (domestic) or 001-847-832-7000, Option 1 (international).

In the event a result is not graded, a numeric code will appear next to your result. A definition of the code will appear on the first page of your evaluation. Please see "Actions Laboratories Should Take when a PT Result is Not Graded" on page 43.

White Blood Cell Count - x 10^9/L or x 10^3/µL

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	116	4.10	0.09	2.1
	Coulter LH 780, 785	127	4.12	0.09	2.3
	Coulter UniCel DxH	1336	4.15	0.13	3.0
FH13-02	Coulter LH 750, 755	116	12.06	0.23	1.9
	Coulter LH 780, 785	126	12.09	0.23	1.9
	Coulter UniCel DxH	1335	12.22	0.20	1.7
FH13-03	Coulter LH 750, 755	118	3.05	0.08	2.8
	Coulter LH 780, 785	126	3.03	0.08	2.7
	Coulter UniCel DxH	1339	2.95	0.06	2.2
FH13-04	Coulter LH 750, 755	116	6.79	0.16	2.4
	Coulter LH 780, 785	126	6.78	0.17	2.5
	Coulter UniCel DxH	1275	6.34	0.15	2.4
FH13-05	Coulter LH 750, 755	118	16.09	0.29	1.8
	Coulter LH 780, 785	126	16.08	0.31	1.9
	Coulter UniCel DxH	1335	16.81	0.45	2.7

Red Blood Cell Count - x 10^{12}/L

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	118	6.291	0.065	1.0
	Coulter LH 780, 785	127	6.294	0.066	1.0
	Coulter UniCel DxH	1335	6.314	0.077	1.2
FH13-02	Coulter LH 750, 755	117	3.416	0.032	0.9
	Coulter LH 780, 785	125	3.420	0.032	0.9
	Coulter UniCel DxH	1336	3.375	0.046	1.4
FH13-03	Coulter LH 750, 755	117	2.936	0.029	1.0
	Coulter LH 780, 785	126	2.936	0.033	1.1
	Coulter UniCel DxH	1335	2.915	0.040	1.4
FH13-04	Coulter LH 750, 755	118	4.375	0.042	1.0
	Coulter LH 780, 785	125	4.382	0.036	0.8
	Coulter UniCel DxH	1337	4.331	0.055	1.3
FH13-05	Coulter LH 750, 755	118	5.246	0.049	0.9
	Coulter LH 780, 785	125	5.249	0.048	0.9
	Coulter UniCel DxH	1335	5.190	0.068	1.3

Hemoglobin

		No. Labs	g/dL Mean	g/dL S.D.	C.V.	g/L Mean	g/L S.D.
FH13-01	**Instrument**						
	Coulter LH 750, 755	117	17.08	0.16	1.0	170.75	1.63
	Coulter LH 780, 785	128	17.04	0.15	0.9	170.44	1.51
	Coulter UniCel DxH	1331	17.15	0.18	1.1	171.45	1.84
FH13-02	**Instrument**						
	Coulter LH 750, 755	116	9.36	0.09	0.9	93.55	0.87
	Coulter LH 780, 785	127	9.34	0.08	0.9	93.42	0.81
	Coulter UniCel DxH	1330	9.20	0.11	1.2	91.97	1.09
FH13-03	**Instrument**						
	Coulter LH 750, 755	117	7.21	0.08	1.1	72.11	0.77
	Coulter LH 780, 785	128	7.19	0.07	1.0	71.91	0.70
	Coulter UniCel DxH	1329	7.10	0.08	1.2	70.99	0.84
FH13-04	**Instrument**						
	Coulter LH 750, 755	116	12.08	0.10	0.8	120.77	0.95
	Coulter LH 780, 785	128	12.06	0.10	0.9	120.57	1.05
	Coulter UniCel DxH	1329	12.00	0.13	1.1	120.01	1.34
FH13-05	**Instrument**						
	Coulter LH 750, 755	117	16.14	0.14	0.9	161.44	1.39
	Coulter LH 780, 785	126	16.11	0.12	0.8	161.13	1.24
	Coulter UniCel DxH	1334	15.99	0.18	1.1	159.89	1.76

Hematocrit

		No. Labs	% Mean	S.D.	C.V.	L/L Mean	S.D.
FH13-01	**Instrument**						
	Coulter LH 750, 755	116	50.526	0.665	1.3	0.505	0.007
	Coulter LH 780, 785	128	50.523	0.721	1.4	0.505	0.007
	Coulter UniCel DxH	1330	51.667	0.729	1.4	0.517	0.007
FH13-02	**Instrument**						
	Coulter LH 750, 755	118	26.653	0.513	1.9	0.267	0.005
	Coulter LH 780, 785	127	26.661	0.475	1.8	0.267	0.005
	Coulter UniCel DxH	1331	27.273	0.498	1.8	0.273	0.005
FH13-03	**Instrument**						
	Coulter LH 750, 755	109	21.000	0.000	0.0	0.210	0.000
	Coulter LH 780, 785	117	21.000	0.000	0.0	0.210	0.000
	Coulter UniCel DxH	1337	21.782	0.429	2.0	0.218	0.004
FH13-04	**Instrument**						
	Coulter LH 750, 755	118	35.229	0.530	1.5	0.352	0.005
	Coulter LH 780, 785	128	35.266	0.494	1.4	0.353	0.005
	Coulter UniCel DxH	1332	35.893	0.531	1.5	0.359	0.005
FH13-05	**Instrument**						
	Coulter LH 750, 755	118	46.780	0.615	1.3	0.468	0.006
	Coulter LH 780, 785	127	46.843	0.635	1.4	0.468	0.006
	Coulter UniCel DxH	1326	47.345	0.686	1.4	0.473	0.007

MCV – Femtoliters (fL)

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	116	80.21	0.69	0.9
	Coulter LH 780, 785	128	80.22	0.69	0.9
	Coulter UniCel DxH	1332	81.77	0.59	0.7
FH13-02	Coulter LH 750, 755	118	77.85	0.84	1.1
	Coulter LH 780, 785	127	77.80	0.77	1.0
	Coulter UniCel DxH	1324	80.76	0.60	0.7
FH13-03	Coulter LH 750, 755	118	71.54	0.70	1.0
	Coulter LH 780, 785	127	71.43	0.65	0.9
	Coulter UniCel DxH	1325	74.46	0.55	0.7
FH13-04	Coulter LH 750, 755	118	80.39	0.74	0.9
	Coulter LH 780, 785	128	80.42	0.74	0.9
	Coulter UniCel DxH	1322	82.73	0.57	0.7
FH13-05	Coulter LH 750, 755	115	89.17	0.79	0.9
	Coulter LH 780, 785	126	89.15	0.79	0.9
	Coulter UniCel DxH	1324	91.11	0.63	0.7

MCH – Picograms (pg)

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	116	27.14	0.31	1.1
	Coulter LH 780, 785	126	27.07	0.30	1.1
	Coulter UniCel DxH	1323	27.15	0.33	1.2
FH13-02	Coulter LH 750, 755	117	27.36	0.34	1.2
	Coulter LH 780, 785	127	27.34	0.32	1.2
	Coulter UniCel DxH	1333	27.26	0.39	1.4
FH13-03	Coulter LH 750, 755	117	24.55	0.32	1.3
	Coulter LH 780, 785	127	24.48	0.31	1.3
	Coulter UniCel DxH	1328	24.37	0.33	1.4
FH13-04	Coulter LH 750, 755	117	27.61	0.35	1.3
	Coulter LH 780, 785	126	27.52	0.27	1.0
	Coulter UniCel DxH	1326	27.71	0.33	1.2
FH13-05	Coulter LH 750, 755	117	30.77	0.35	1.1
	Coulter LH 780, 785	125	30.70	0.31	1.0
	Coulter UniCel DxH	1325	30.81	0.40	1.3

MCHC

		No. Labs	g/dL Mean	g/dL S.D.	C.V.	g/L Mean	g/L S.D.
FH13-01	**Instrument**						
	Coulter LH 750, 755	116	33.85	0.45	1.3	338.47	4.47
	Coulter LH 780, 785	128	33.75	0.45	1.3	337.52	4.51
	Coulter UniCel DxH	1331	33.21	0.44	1.3	332.07	4.37
FH13-02	**Instrument**						
	Coulter LH 750, 755	117	35.16	0.52	1.5	351.58	5.21
	Coulter LH 780, 785	126	35.14	0.50	1.4	351.40	5.01
	Coulter UniCel DxH	1334	33.77	0.52	1.5	337.67	5.20
FH13-03	**Instrument**						
	Coulter LH 750, 755	117	34.32	0.50	1.4	343.18	4.96
	Coulter LH 780, 785	126	34.30	0.50	1.5	343.02	4.97
	Coulter UniCel DxH	1335	32.73	0.47	1.4	327.30	4.72
FH13-04	**Instrument**						
	Coulter LH 750, 755	117	34.36	0.50	1.4	343.61	4.95
	Coulter LH 780, 785	128	34.23	0.46	1.4	342.30	4.64
	Coulter UniCel DxH	1331	33.49	0.44	1.3	334.93	4.39
FH13-05	**Instrument**						
	Coulter LH 750, 755	116	34.51	0.46	1.3	345.13	4.58
	Coulter LH 780, 785	126	34.46	0.44	1.3	344.59	4.44
	Coulter UniCel DxH	1331	33.82	0.48	1.4	338.17	4.83

Platelet Count – x10^9/L

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	114	82.2	4.0	4.9
	Coulter LH 780, 785	122	83.0	3.9	4.6
	Coulter UniCel DxH	1330	82.0	3.8	4.6
FH13-02	Coulter LH 750, 755	116	424.2	14.2	3.3
	Coulter LH 780, 785	125	422.6	14.0	3.3
	Coulter UniCel DxH	1333	422.4	12.6	3.0
FH13-03	Coulter LH 750, 755	115	83.9	3.5	4.1
	Coulter LH 780, 785	126	84.2	3.5	4.2
	Coulter UniCel DxH	1328	79.2	3.0	3.8
FH13-04	Coulter LH 750, 755	117	232.1	8.0	3.5
	Coulter LH 780, 785	127	230.5	8.3	3.6
	Coulter UniCel DxH	1332	233.9	7.3	3.1
FH13-05	Coulter LH 750, 755	118	617.0	20.9	3.4
	Coulter LH 780, 785	126	612.3	19.1	3.1
	Coulter UniCel DxH	1335	629.8	19.0	3.0

MPV – Femtoliters (fL)

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	101	9.22	0.20	2.2
	Coulter LH 780, 785	113	9.23	0.21	2.3
	Coulter UniCel DxH	1216	8.85	0.27	3.1
FH13-02	Coulter LH 750, 755	103	8.89	0.18	2.0
	Coulter LH 780, 785	114	8.87	0.17	1.9
	Coulter UniCel DxH	1240	8.42	0.15	1.8
FH13-03	Coulter LH 750, 755	102	9.21	0.23	2.5
	Coulter LH 780, 785	115	9.22	0.27	2.9
	Coulter UniCel DxH	1239	9.79	0.20	2.0
FH13-04	Coulter LH 750, 755	102	8.97	0.16	1.8
	Coulter LH 780, 785	114	8.97	0.14	1.6
	Coulter UniCel DxH	1239	8.48	0.14	1.7
FH13-05	Coulter LH 750, 755	102	8.92	0.14	1.6
	Coulter LH 780, 785	112	8.93	0.14	1.6
	Coulter UniCel DxH	1236	8.35	0.13	1.6

RDW-% (RDW-CV)

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	118	16.59	0.26	1.6
	Coulter LH 780, 785	123	16.62	0.23	1.4
	Coulter UniCel DxH	1306	16.20	0.23	1.4
FH13-02	Coulter LH 750, 755	116	17.94	0.26	1.4
	Coulter LH 780, 785	124	17.92	0.36	2.0
	Coulter UniCel DxH	1308	17.54	0.26	1.5
FH13-03	Coulter LH 750, 755	116	21.27	0.48	2.2
	Coulter LH 780, 785	125	21.25	0.41	1.9
	Coulter UniCel DxH	1307	20.92	0.39	1.8
FH13-04	Coulter LH 750, 755	117	17.09	0.28	1.6
	Coulter LH 780, 785	125	17.09	0.28	1.7
	Coulter UniCel DxH	1305	16.67	0.25	1.5
FH13-05	Coulter LH 750, 755	118	14.80	0.23	1.5
	Coulter LH 780, 785	124	14.82	0.19	1.3
	Coulter UniCel DxH	1303	14.61	0.19	1.3

RDW-fL (RDW-SD)

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter UniCel DxH	20	50.00	0.44	0.9
FH13-02	Coulter UniCel DxH	20	52.45	0.83	1.6
FH13-03	Coulter UniCel DxH	20	58.34	1.02	1.7
FH13-04	Coulter UniCel DxH	20	52.19	0.71	1.4
FH13-05	Coulter UniCel DxH	20	49.66	0.87	1.8

Red cell distribution width (RDW-SD vs. RDW-CV) discussion:

The red cell distribution width (RDW) is a calculated value which quantitatively reflects the degree of anisocytosis, or variation in red blood cell size, in a given blood sample. The RDW, in conjunction with the mean cell volume (MCV) and other red cell indices, may be a useful parameter in the laboratory evaluation of anemia and other hematologic conditions. An elevated RDW generally conveys increased variation in red blood cell size, and is seen in a variety of clinical settings including iron deficiency, autoimmune hemolysis, and in some patients with myelodysplastic syndrome.

Many modern automated hematology analyzers produce two distinct RDW measurements. The most commonly used and reported in clinical practice is the coefficient of variation RDW (RDW-CV), which is based on the coefficient of variation of the red blood cell distribution volume. The RDW-CV is calculated using the formula below, and the reference range in adults is typically 11.0-15.0%.

$$\text{RDW} - \text{CV} = \frac{1\text{SD}}{\text{MCV}} \times 100$$

Another way of expressing the RDW is the red cell distribution width-standard deviation, or RDW-SD. The RDW-SD is an actual measurement of the width of the red cell distribution curve and provides an absolute value in femtoliters (fL). The RDW-SD more accurately reflects red cell anisocytosis because it is directly measured and is not influenced by the MCV. The reference range for RDW-SD in adults is typically 36-47 fL.

The RDW-CV and RDW-SD are different expressions of the RDW and laboratories should exercise caution so as not to confuse them for purposes of clinical reporting as well as proficiency testing.

Jay Patel, MD
Hematology and Clinical Microscopy Resource Committee

References:

1. Constantino, BT. The red cell histogram and the dimorphic red cell population. *LabMedicine*. 2011; 42(5):300-308.
2. Kjeldsberg CR, Perkins SL, eds. *Practical Diagnosis of Hematologic Disorders*. 5th ed. Singapore: American Society for Clinical Pathology; 2010.
3. MediaLab, Inc. Website. http://www.medialabinc.net/spg579122/red_blood_cell_distribution_width_rdw_definition_a.aspx. Accessed June 3, 2013.

Neutrophils/Granulocytes – %

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	107	49.15	0.76	1.5
	Coulter LH 780, 785	122	49.07	0.94	1.9
	Coulter UniCel DxH	1296	50.49	0.95	1.9
FH13-02	Coulter LH 750, 755	112	59.63	0.79	1.3
	Coulter LH 780, 785	122	59.69	0.69	1.2
	Coulter UniCel DxH	1313	61.14	0.92	1.5
FH13-03	Coulter LH 750, 755	111	45.16	0.78	1.7
	Coulter LH 780, 785	122	45.06	0.77	1.7
	Coulter UniCel DxH	1312	46.73	0.83	1.8
FH13-04	Coulter LH 750, 755	113	56.50	0.88	1.6
	Coulter LH 780, 785	121	56.49	0.90	1.6
	Coulter UniCel DxH	1315	57.40	0.87	1.5
FH13-05	Coulter LH 750, 755	113	67.92	0.74	1.1
	Coulter LH 780, 785	123	67.83	0.90	1.3
	Coulter UniCel DxH	1320	69.21	0.82	1.2

Neutrophils/Granulocytes – x 10^9/L

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	106	2.011	0.064	3.2
	Coulter LH 780, 785	123	2.018	0.065	3.2
	Coulter UniCel DxH	1284	2.101	0.078	3.7
FH13-02	Coulter LH 750, 755	111	7.202	0.183	2.5
	Coulter LH 780, 785	125	7.210	0.181	2.5
	Coulter UniCel DxH	1295	7.473	0.172	2.3
FH13-03	Coulter LH 750, 755	110	1.376	0.060	4.4
	Coulter LH 780, 785	124	1.362	0.056	4.1
	Coulter UniCel DxH	1297	1.384	0.048	3.5
FH13-04	Coulter LH 750, 755	110	3.836	0.119	3.1
	Coulter LH 780, 785	123	3.818	0.120	3.1
	Coulter UniCel DxH	1271	3.640	0.108	3.0
FH13-05	Coulter LH 750, 755	110	10.930	0.242	2.2
	Coulter LH 780, 785	124	10.908	0.260	2.4
	Coulter UniCel DxH	1291	11.633	0.323	2.8

Lymphocytes – %

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	115	37.24	0.91	2.4
	Coulter LH 780, 785	125	37.28	0.94	2.5
	Coulter UniCel DxH	1294	36.14	1.01	2.8
FH13-02	Coulter LH 750, 755	115	25.03	0.75	3.0
	Coulter LH 780, 785	125	25.10	0.79	3.1
	Coulter UniCel DxH	1304	23.56	0.89	3.8
FH13-03	Coulter LH 750, 755	113	40.48	0.69	1.7
	Coulter LH 780, 785	124	40.63	0.72	1.8
	Coulter UniCel DxH	1306	38.76	0.89	2.3
FH13-04	Coulter LH 750, 755	116	28.97	0.87	3.0
	Coulter LH 780, 785	123	28.99	0.81	2.8
	Coulter UniCel DxH	1310	28.34	0.86	3.0
FH13-05	Coulter LH 750, 755	116	18.33	0.72	3.9
	Coulter LH 780, 785	125	18.34	0.74	4.0
	Coulter UniCel DxH	1313	17.51	0.74	4.2

Lymphocytes – x 10^9/L

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	109	1.529	0.059	3.8
	Coulter LH 780, 785	126	1.533	0.058	3.8
	Coulter UniCel DxH	1273	1.500	0.074	5.0
FH13-02	Coulter LH 750, 755	109	3.021	0.111	3.7
	Coulter LH 780, 785	123	3.030	0.111	3.7
	Coulter UniCel DxH	1280	2.875	0.127	4.4
FH13-03	Coulter LH 750, 755	109	1.228	0.047	3.8
	Coulter LH 780, 785	125	1.229	0.048	3.9
	Coulter UniCel DxH	1284	1.144	0.051	4.4
FH13-04	Coulter LH 750, 755	109	1.971	0.076	3.9
	Coulter LH 780, 785	123	1.959	0.077	3.9
	Coulter UniCel DxH	1277	1.797	0.084	4.7
FH13-05	Coulter LH 750, 755	109	2.946	0.125	4.2
	Coulter LH 780, 785	124	2.948	0.125	4.2
	Coulter UniCel DxH	1284	2.942	0.160	5.4

Monocytes – %

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	114	8.059	0.442	5.5
	Coulter LH 780, 785	123	8.132	0.476	5.8
	Coulter UniCel DxH	1303	7.667	0.503	6.6
FH13-02	Coulter LH 750, 755	116	8.387	0.440	5.2
	Coulter LH 780, 785	125	8.372	0.434	5.2
	Coulter UniCel DxH	1312	8.088	0.497	6.1
FH13-03	Coulter LH 750, 755	115	8.244	0.381	4.6
	Coulter LH 780, 785	124	8.247	0.398	4.8
	Coulter UniCel DxH	1302	8.341	0.417	5.0
FH13-04	Coulter LH 750, 755	116	8.720	0.490	5.6
	Coulter LH 780, 785	124	8.819	0.462	5.2
	Coulter UniCel DxH	1309	8.372	0.481	5.7
FH13-05	Coulter LH 750, 755	113	7.991	0.396	5.0
	Coulter LH 780, 785	125	7.976	0.477	6.0
	Coulter UniCel DxH	1317	7.343	0.504	6.9

Monocytes – x 10^9/L

		No. Labs	Mean	S.D.	C.V.
FH13-01	**Instrument**				
	Coulter LH 750, 755	109	0.321	0.035	11.0
	Coulter LH 780, 785	123	0.319	0.036	11.3
	Coulter UniCel DxH	1194	0.302	0.009	3.0
FH13-02	**Instrument**				
	Coulter LH 750, 755	108	1.009	0.056	5.6
	Coulter LH 780, 785	122	1.009	0.057	5.6
	Coulter UniCel DxH	1292	0.985	0.072	7.3
FH13-03	**Instrument**				
	Coulter LH 750, 755	110	0.255	0.043	16.9
	Coulter LH 780, 785	124	0.250	0.046	18.6
	Coulter UniCel DxH	1292	0.239	0.047	19.6
FH13-04	**Instrument**				
	Coulter LH 750, 755	110	0.595	0.039	6.5
	Coulter LH 780, 785	124	0.600	0.037	6.1
	Coulter UniCel DxH	1279	0.526	0.050	9.5
FH13-05	**Instrument**				
	Coulter LH 750, 755	110	1.289	0.076	5.9
	Coulter LH 780, 785	124	1.285	0.081	6.3
	Coulter UniCel DxH	1290	1.232	0.094	7.6

Eosinophils – %

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	110	5.55	0.51	9.2
	Coulter LH 780, 785	118	5.42	0.39	7.1
	Coulter UniCel DxH	1309	5.73	0.43	7.5
FH13-02	Coulter LH 750, 755	113	6.89	0.48	6.9
	Coulter LH 780, 785	120	6.79	0.40	6.0
	Coulter UniCel DxH	1313	7.23	0.41	5.6
FH13-03	Coulter LH 750, 755	112	6.10	0.48	7.9
	Coulter LH 780, 785	120	5.98	0.49	8.2
	Coulter UniCel DxH	1319	6.20	0.39	6.2
FH13-04	Coulter LH 750, 755	112	5.71	0.46	8.0
	Coulter LH 780, 785	119	5.69	0.40	7.1
	Coulter UniCel DxH	1312	5.92	0.39	6.6
FH13-05	Coulter LH 750, 755	114	5.77	0.57	9.9
	Coulter LH 780, 785	122	5.86	0.55	9.4
	Coulter UniCel DxH	1311	5.93	0.39	6.7

Eosinophils – x 10^9/L

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	107	0.222	0.036	16.2
	Coulter LH 780, 785	113	0.204	0.011	5.4
	Coulter UniCel DxH	1281	0.226	0.042	18.8
FH13-02	Coulter LH 750, 755	108	0.836	0.067	8.1
	Coulter LH 780, 785	119	0.824	0.059	7.2
	Coulter UniCel DxH	1282	0.884	0.057	6.4
FH13-03	Coulter LH 750, 755	102	0.197	0.009	4.5
	Coulter LH 780, 785	121	0.196	0.016	8.2
	Coulter UniCel DxH	1286	0.199	0.006	2.8
FH13-04	Coulter LH 750, 755	107	0.395	0.036	9.2
	Coulter LH 780, 785	118	0.388	0.031	8.1
	Coulter UniCel DxH	1292	0.386	0.040	10.4
FH13-05	Coulter LH 750, 755	109	0.931	0.097	10.5
	Coulter LH 780, 785	122	0.940	0.098	10.4
	Coulter UniCel DxH	1281	0.999	0.077	7.7

Basophils – %

	Instrument	No. Labs	Mean	S.D.	C.V.*
FH13-01	Coulter LH 750, 755	113	0.01	0.03	*
	Coulter LH 780, 785	114	0.00	0.00	0.0
	Coulter UniCel DxH	1239	0.00	0.00	0.0
FH13-02	Coulter LH 750, 755	116	0.01	0.03	*
	Coulter LH 780, 785	125	0.01	0.03	*
	Coulter UniCel DxH	1286	0.00	0.00	0.0
FH13-03	Coulter LH 750, 755	105	0.00	0.00	0.0
	Coulter LH 780, 785	117	0.00	0.00	0.0
	Coulter UniCel DxH	1296	0.00	0.00	0.0
FH13-04	Coulter LH 750, 755	116	0.01	0.03	*
	Coulter LH 780, 785	126	0.01	0.03	*
	Coulter UniCel DxH	1289	0.00	0.00	0.0
FH13-05	Coulter LH 750, 755	106	0.00	0.00	0.0
	Coulter LH 780, 785	114	0.00	0.00	0.0
	Coulter UniCel DxH	1254	0.00	0.00	0.0

*When low results are reported on an analyte, a high coefficient of variance (CV) may result.

Basophils – x 10^9/L

	Instrument	No. Labs	Mean	S.D.	C.V.
FH13-01	Coulter LH 750, 755	108	0.000	0.000	0.0
	Coulter LH 780, 785	125	0.000	0.000	0.0
	Coulter UniCel DxH	1292	0.000	0.000	0.0
FH13-02	Coulter LH 750, 755	104	0.000	0.000	0.0
	Coulter LH 780, 785	122	0.000	0.000	0.0
	Coulter UniCel DxH	1284	0.000	0.000	0.0
FH13-03	Coulter LH 750, 755	110	0.000	0.000	0.0
	Coulter LH 780, 785	126	0.000	0.000	0.0
	Coulter UniCel DxH	1293	0.000	0.000	0.0
FH13-04	Coulter LH 750, 755	106	0.000	0.000	0.0
	Coulter LH 780, 785	126	0.000	0.000	0.0
	Coulter UniCel DxH	1293	0.000	0.000	0.0
FH13-05	Coulter LH 750, 755	103	0.000	0.000	0.0
	Coulter LH 780, 785	119	0.000	0.000	0.0
	Coulter UniCel DxH	1278	0.000	0.000	0.0

nRBC – % or nRBC/100 WBC

		No. Labs	Mean	S.D.	C.V.*
FH13-01	**Instrument**				
	Coulter LH 750, 755	44	3.57	1.27	35.6
	Coulter LH 780, 785	66	3.87	0.76	19.7
	Coulter UniCel DxH	923	0.04	0.05	*
FH13-02	**Instrument**				
	Coulter LH 750, 755	44	2.32	1.39	59.8
	Coulter LH 780, 785	68	2.66	1.18	44.5
	Coulter UniCel DxH	934	0.00	0.02	*
FH13-03	**Instrument**				
	Coulter LH 750, 755	41	4.30	0.91	21.2
	Coulter LH 780, 785	67	4.38	0.88	20.0
	Coulter UniCel DxH	900	0.12	0.41	*
FH13-04	**Instrument**				
	Coulter LH 750, 755	41	17.70	1.60	9.1
	Coulter LH 780, 785	65	17.70	1.97	11.1
	Coulter UniCel DxH	901	24.66	1.40	5.7
FH13-05	**Instrument**				
	Coulter LH 750, 755	42	1.83	1.17	64.1
	Coulter LH 780, 785	66	1.64	1.20	72.8
	Coulter UniCel DxH	927	0.02	0.04	*

*When low results are reported on an analyte, a high coefficient of variance (CV) may result.

nRBC Absolute – x 10^3/µL

		No. Labs	Mean	S.D.	C.V.*
FH13-01	**Instrument**				
	Coulter LH 750, 755	34	0.140	0.069	49.7
	Coulter LH 780, 785	59	0.154	0.058	37.5
	Coulter UniCel DxH	814	0.001	0.003	*
FH13-02	**Instrument**				
	Coulter LH 750, 755	34	0.272	0.182	66.7
	Coulter LH 780, 785	58	0.323	0.144	44.6
	Coulter UniCel DxH	817	0.001	0.003	*
FH13-03	**Instrument**				
	Coulter LH 750, 755	33	0.118	0.044	37.7
	Coulter LH 780, 785	59	0.126	0.045	35.4
	Coulter UniCel DxH	790	0.004	0.017	*
FH13-04	**Instrument**				
	Coulter LH 750, 755	32	1.214	0.129	10.7
	Coulter LH 780, 785	58	1.207	0.135	11.2
	Coulter UniCel DxH	802	1.550	0.110	7.1
FH13-05	**Instrument**				
	Coulter LH 750, 755	34	0.296	0.225	76.0
	Coulter LH 780, 785	56	0.263	0.192	73.1
	Coulter UniCel DxH	799	0.004	0.006	*

*When low results are reported on an analyte, a high coefficient of variance (CV) may result.

Blood Cell Identification – Graded

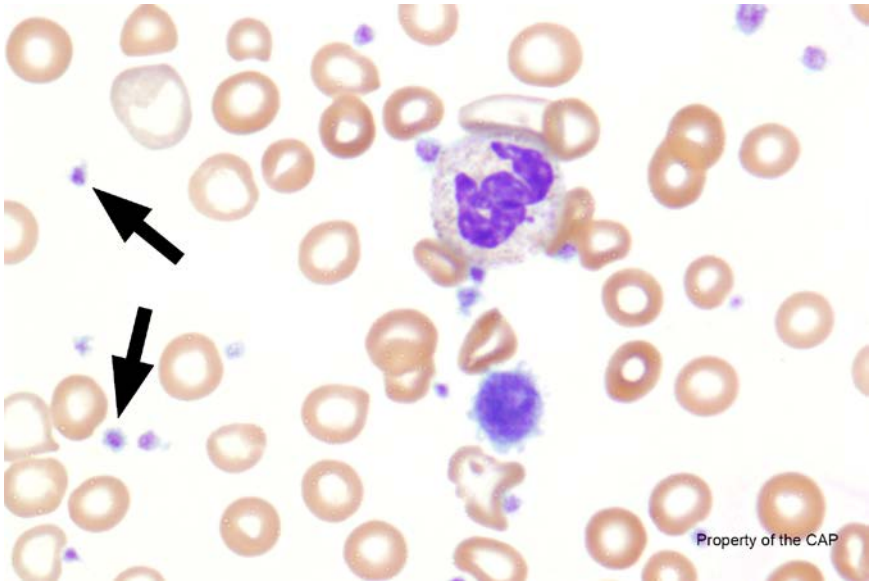
Case History

This blood film is from a 20-year-old woman with a month long history of appearing pale and feeling fatigued. Laboratory data include: WBC = 18.2 x 10E9/L; RBC = 2.12 x 10E12/L; HGB = 3.2 g/dL; HCT = 11.8%; MCV = 56 fL; MCHC = 27.1 g/dL; RDW = 22%; and PLT = 839 x 10E9/L. Identify the arrowed image(s).

(PERIPHERAL BLOOD, WRIGHT-GIEMSA)

To access the online Hematology Glossary, please click the hyperlink below:
http://www.cap.org/ShowProperty?nodePath=/UCMCon/Contribution%20Folders/WebContent/pdf/hematology-glossary.pdf

BCP-01

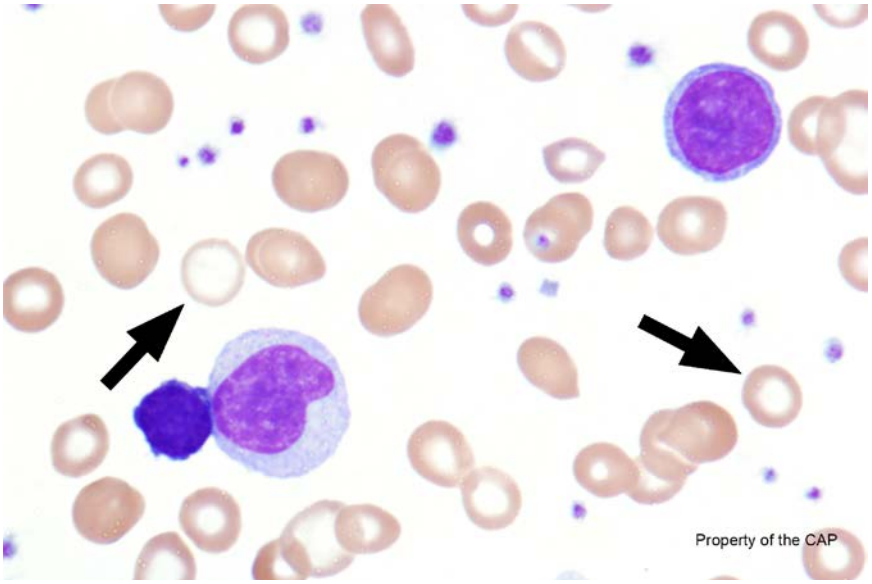


Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Platelet, normal	117	100.0	4955	99.5	Good

The arrowed cells are normal platelets, as correctly identified by 100.0% of referees and 99.5% of participants. Platelets are also known as thrombocytes, measure 1.5 - 3 µm in diameter, and contain fine purple-red granules. Platelets are essential for normal hemostasis.

Blood Cell Identification – Graded

BCP-02



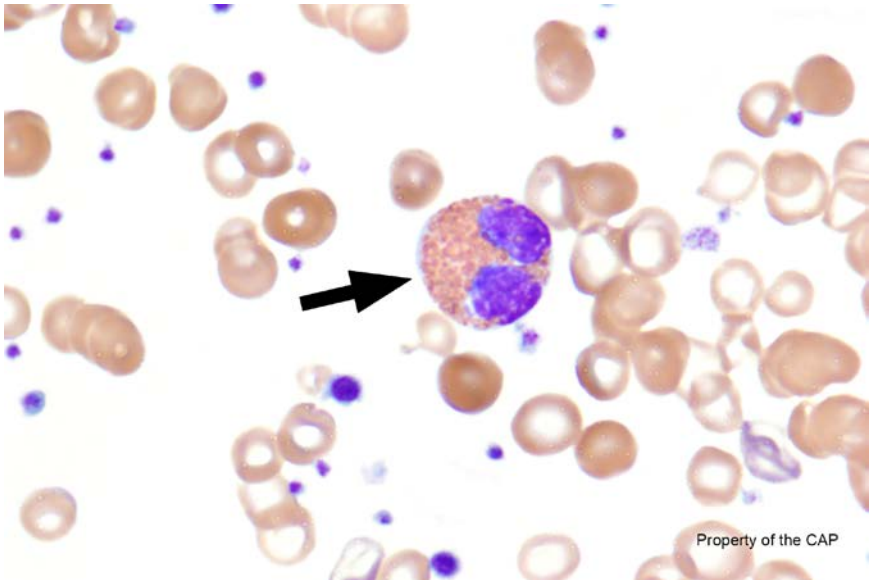
Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Microcyte (with increased central pallor)	34	29.1	1316	26.4	Good
Hypochromasia	83	70.9	3653	73.4	Good

The arrowed cells are microcytes (with increased central pallor), as correctly identified by 29.1% of referees and 26.4% of participants. These erythrocytes demonstrate greater than 50% central pallor and are smaller than the nucleus of a resting lymphocyte (less than 6 µm in diameter). These cells are often seen in iron deficiency anemia but can also be seen in other types of anemias as well.

Another appropriate response is hypochromasia as identified by 70.9% of referees and 73.4% of participants. In iron deficiency anemia, cells are often smaller and have less hemoglobin which makes them appear paler than normal red cells. In the laboratory, hypochromasia can be confirmed using the MCHC, calculated as 27 g/dL, which is low in this case.

Blood Cell Identification – Graded

BCP-03

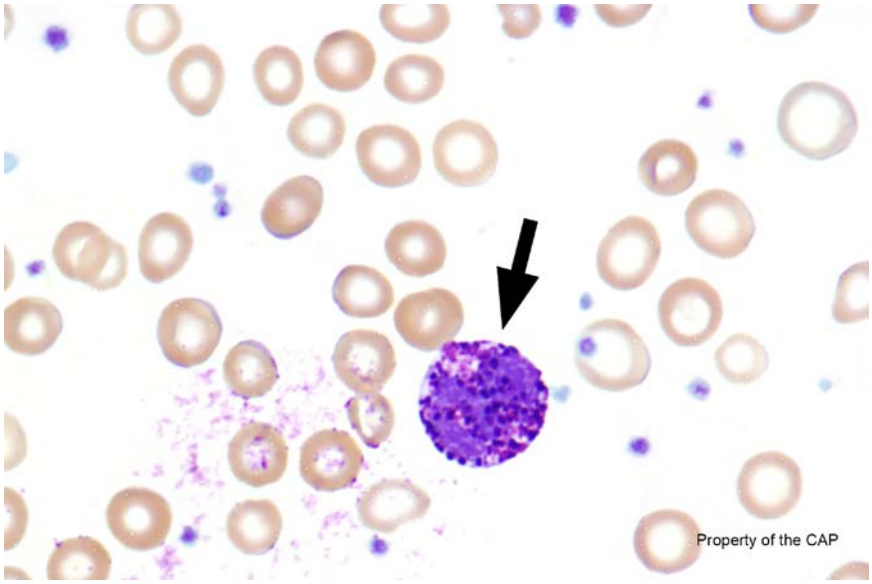


Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Eosinophil, any stage	117	100.0	4974	99.9	Good

The arrowed cell is an eosinophil, as correctly identified by 100.0% of referees and 99.9% of participants. The eosinophil is characterized by coarse, orange-red granules of uniform size and is similar to a neutrophil in diameter (10 - 15 µm). Normally, the nucleus demonstrates condensed chromatin and nuclear segmentation with two or three nuclear lobes.

Blood Cell Identification – Graded

BCP-04

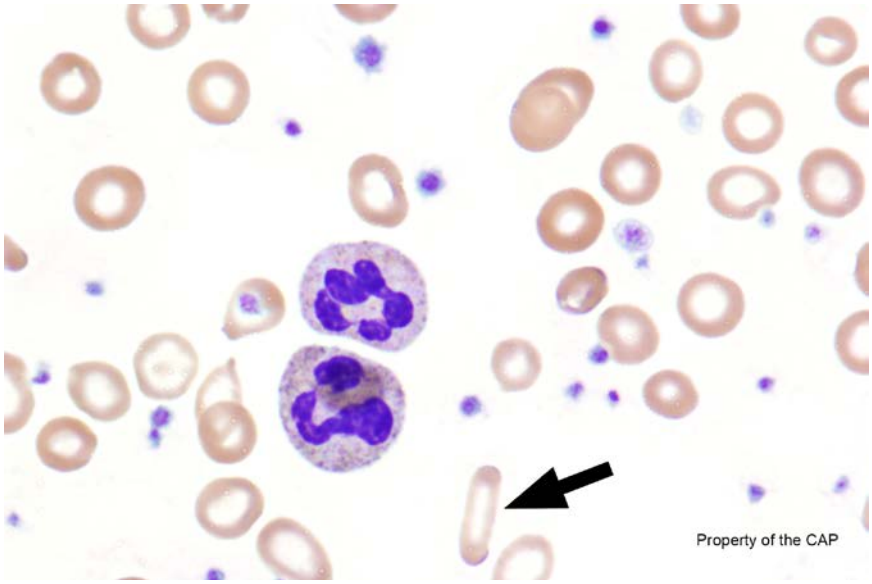


Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Basophil, any stage	116	99.2	4968	99.8	Good
Basophilic stippling (coarse)	1	0.8	4	0.1	Unacceptable

The arrowed cell is a basophil, as correctly identified by 99.2% of referees and 99.8% of participants. Basophils are the least common circulating granulocytes. Unlike neutrophils with 3 - 5 lobed nuclei and fine pink or eosinophilic granules, basophils typically have only two prominent nuclear lobes and cytoplasm with numerous dense purple or basophilic granules, often obscuring the nuclear detail. Basophils are an important part of the allergic immune response, and infrequently circulate in appreciable number (typically representing < 0.3% of peripheral leukocytes).

Blood Cell Identification – Graded

BCP-05



Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Ovalocyte (elliptocyte)	117	100.0	4958	99.6	Good

The arrowed cell is an ovalocyte (elliptocyte), as correctly identified by 100.0% of referees and 99.6% of participants. These cells are often seen in patients with iron deficiency anemia. They have blunt ends and parallel sides which help differentiate ovalocytes from sickle cells. They are also seen in patients with hereditary elliptocytosis (greater than 25% of erythrocytes).

Case Presentation:

This blood film is from a 20-year-old woman with a month long history of appearing pale and feeling fatigued. Laboratory data include: WBC = 18.2 x 10E9/L; RBC = 2.12 x 10E12/L; HGB = 3.2 g/dL; HCT = 11.8%; MCV = 56 fL; MCHC = 27.1 g/dL; RDW = 22%; and PLT = 839 x 10E9/L.

(PERIPHERAL BLOOD, WRIGHT-GIEMSA)

Case Discussion: Iron deficiency anemia

Iron deficiency anemia is a very common cause of microcytic, hypochromic anemia. The etiology in adults is often blood loss, either from menstruation or loss from the gastrointestinal/genitourinary tract. If a source of blood loss is not readily apparent, the patient should be evaluated for an occult malignancy. In children and infants, deficiency may arise due to insufficient iron intake or absorption to meet growth requirements. In infants, iron deficiency anemia can occur with breast feeding around six months of age. The clinical symptoms of iron deficiency vary. If the anemia is severe, the patient will have symptoms related to diminished oxygen-carrying capacity including pallor, dizziness, fatigue, and palpitations. Rarely, patients may have nail abnormalities or suffer from cheilitis or pica.

Morphologic features of iron deficiency anemia are usually readily apparent when it is severe, as in this case. Increased central pallor in erythrocytes is often present. The normal amount of central pallor should be 1/3 or less of the diameter of the cell. If the central pallor is more than 1/2 of the cell diameter, this is considered hypochromic. The cells will also be smaller than normal erythrocytes. Normal erythrocytes should be the size of a resting (small) lymphocyte nucleus. If many of the cells are smaller than normal, this is consistent with microcytosis (reflected by the low MCV). Anisocytosis (variation in cell size as reflected by the RDW) is typically increased in iron deficiency anemia and elliptocytes (pencil cells or ovalocytes) may be seen. In addition to the red cell abnormalities, the patient may have a reactive thrombocytosis as is present in this case. Basophilic stippling should be absent. As in any cause of anemia, the cells may be widely-spaced at the feathered edge of the smear, indicating a low red blood cell count. In mild cases of iron deficiency anemia, the morphology may be nearly normal and difficult to discern on routine peripheral blood smear review. Correlation of peripheral blood smear morphology with CBC indices is necessary.

Laboratory testing can be used to confirm iron deficiency anemia. The serum ferritin will be low unless the patient has an elevated ferritin from a concomitant inflammatory disorder. The total iron-binding capacity is usually normal or high. The serum iron level is low. The percent transferrin saturation is typically less than 15% in iron deficiency anemia. An algorithmic approach to laboratory testing can be used to differentiate between iron deficiency anemia and other causes of microcytic anemia including thalassemia trait and anemia of chronic disease.

Lauren B. Smith, MD
Hematology and Clinical Microscopy Resource Committee

References:

1. Kjeldsberg CR, Perkins SL, eds. *Practical Diagnosis of Hematologic Disorders*. 5th ed. Singapore, China: American Society for Clinical Pathology; 2010.

Blood Cell Identification – Ungraded

Case History

This peripheral blood smear is from a 72-year-old man presenting with painless cervical lymphadenopathy, weight loss, and fatigue. Laboratory data include: WBC = 45.2 x 10E9/L; RBC = 3.67 x 10E12/L; HGB = 10.7 g/dL; HCT = 33.0%; MCV = 90 fL; MCHC = 32.4 g/dL; RDW = 20%; and PLT = 200 x 10E9/L. Identify the arrowed image(s).

(PERIPHERAL BLOOD, WRIGHT-GIEMSA)

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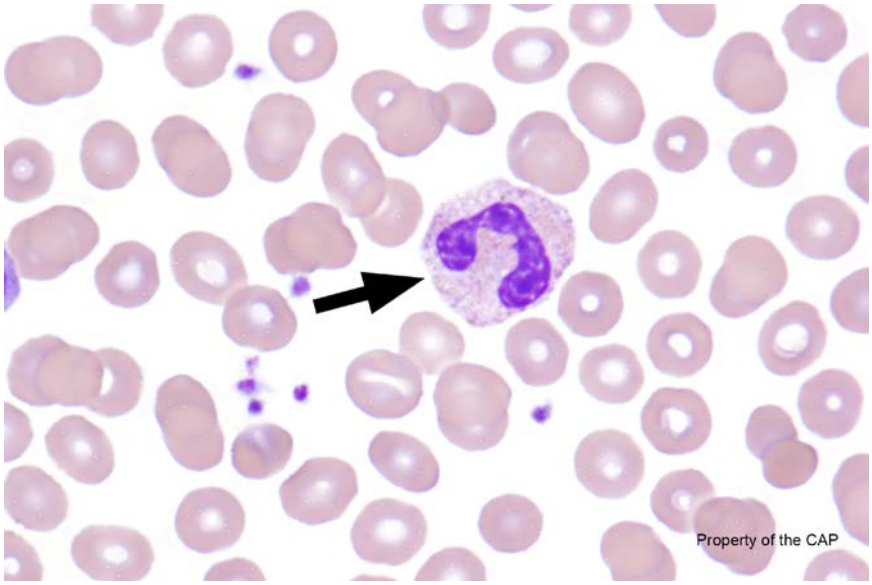
BCP-06



Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Neutrophil, segmented or band	113	100.0	4909	99.6	Educational

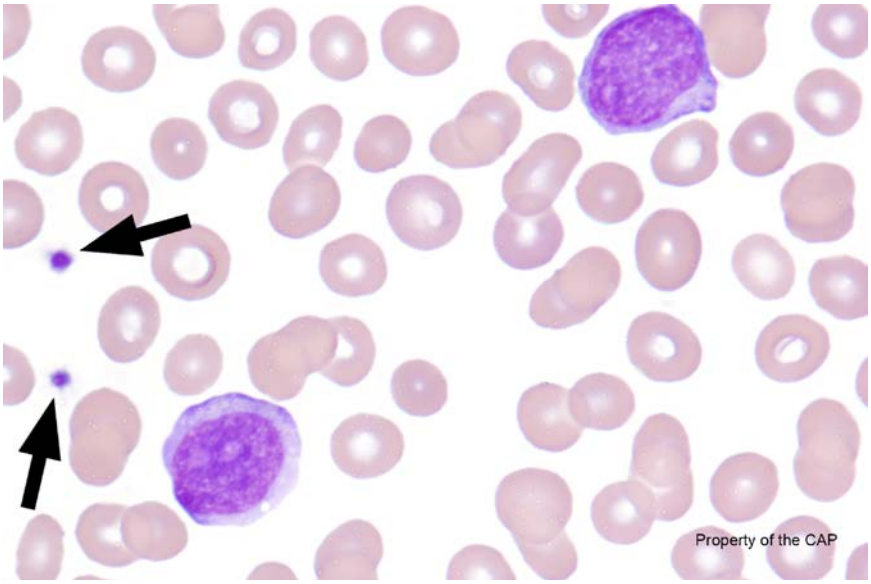
The arrowed cell is a neutrophil, segmented/band, as correctly identified by 100.0% of referees and 99.6% of participants. Segmented neutrophils, the mature cells of the myeloid series, constitute 40% to 70% of the white blood cells in the peripheral blood. Band neutrophils, also known as stabs, are the immediate precursors of segmented neutrophils and constitute 5% - 10% of the white blood cells in the peripheral blood during normal conditions. Increased numbers of bands appear in the blood in a number of physiologic and pathologic states. The band is round to oval and 10 - 18 µm in diameter. The nuclear-to-cytoplasmic ratio is 1:1.5 to 1:2, and the nuclear chromatin is condensed. The nucleus is indented to more than half the distance to the farthest nuclear margin, but in no area is the chromatin condensed to a single filament. The nucleus can assume many shapes: it can be band-like; sausage-like; S-, C-, or U-shaped; and twisted and folded on itself. The cytoplasm is similar to that of other post mitotic neutrophilic cells, with specific granules predominating in the pale cytoplasm. The segmented neutrophil mimics the band in size (10 - 15 µm), shape (round to oval), and cytoplasmic appearance (pale pink cytoplasm with specific granules).

BCP-06 (cont)

The N:C ratio is 1:3, the most mature of any cell in the neutrophilic series, and the nuclear chromatin is condensed. The nucleus is segmented or lobated (two to five lobes normally). The lobes are connected by a thin filament that contains no internal chromatin, giving it the appearance of a solid, thread-like dark line. The presence of these thread-like filaments is the basis for distinguishing the segmented neutrophil from the band neutrophil. However, in repeated proficiency testing studies, it has not been possible to achieve consistent differentiation between bands and segmented neutrophils. Therefore, for the purposes of proficiency testing, it is not required that these maturational stages be differentiated.

Blood Cell Identification – Ungraded

BCP-07

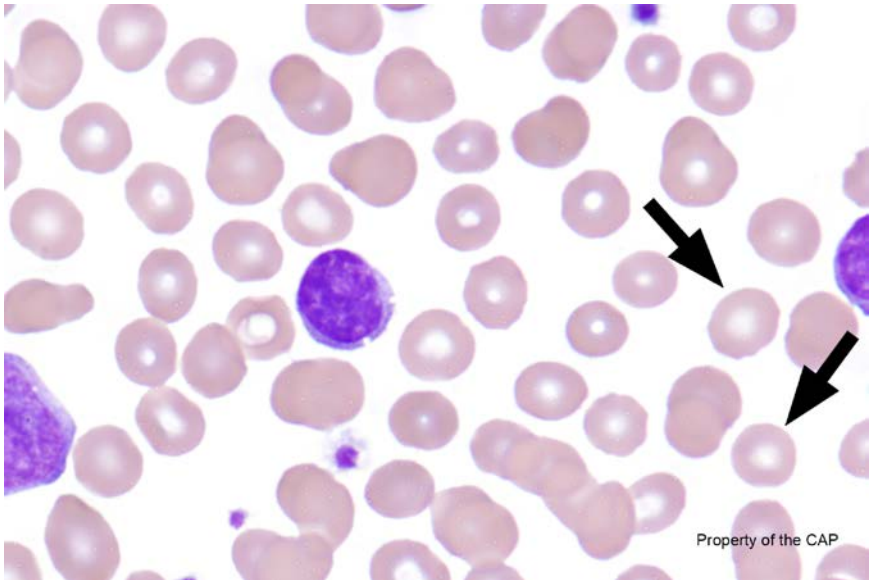


Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Platelet, normal	112	99.1	4814	99.4	Educational
Platelet, hypogranular	1	0.9	10	0.2	Educational

The arrows point to platelets, normal, as correctly identified by 99.1% of referees and 99.4% of participants. Platelets, also known as thrombocytes, are small, blue-gray fragments of megakaryocytic cytoplasm. Most are 1.5 to 3 µm in diameter. A few small platelets, less than 1.5 µm in diameter, and a few large platelets, 4 - 7 µm in diameter, can also be seen in normal blood films. Fine, purple-red granules are dispersed throughout the cytoplasm or are sometimes aggregated at the center. These granules are platelet alpha granules. Platelet delta granules (or dense granules) are not visible on light microscopy. Platelets may be variable in shape, but most normal platelets are round or very slightly elliptical. Some have short cytoplasmic projections or ruffled margins. They are typically single but may form aggregates, particularly in fresh (fingerstick) preparations.

Blood Cell Identification – Ungraded

BCP-08

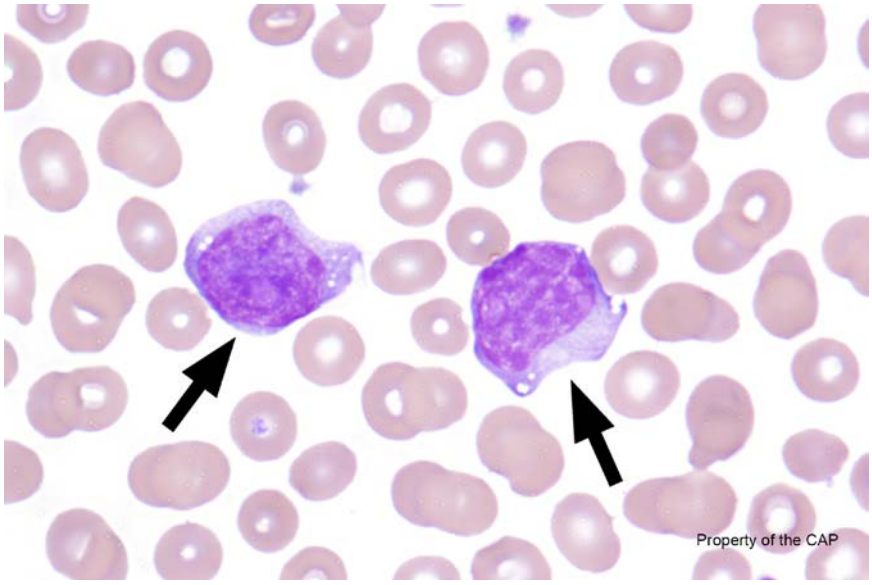


Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Erythrocyte, normal	112	99.1	4615	95.3	Educational
Microcyte (with increased central pallor)	1	0.9	119	2.5	Educational

The arrowed cells are erythrocytes, normal, as correctly identified by 99.1% of referees and 95.3% of participants. An erythrocyte is a mature, non-nucleated biconcave cell of fairly uniform diameter (6.7 - 7.8 µm) with a uniform round area of central pallor. It contains hemoglobin and stains uniformly pink-red. The zone of central pallor is due to the biconcavity of the cell and occupies approximately one third (2 - 3 µm) of the cell diameter. Normal erythrocytes circulate in the peripheral blood for approximately 120 days before they undergo catabolism or destruction in the spleen.

Blood Cell Identification – Ungraded

BCP-09



Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Malignant lymphoid cell (other than blast)	48	42.5	1630	33.7	Educational
Monocyte	20	17.7	725	15.0	Educational
Lymphocyte, reactive (to include plasmacytoid and immunoblastic forms)	19	16.8	1001	20.7	Educational
Blast cell	11	9.7	657	13.6	Educational
Monocyte, immature (promonocyte, monoblast)	4	3.5	384	7.9	Educational
Neutrophil, myelocyte	2	1.8	94	1.9	Educational
Lymphocyte	1	0.9	74	1.5	Educational
Neutrophil, promyelocyte	1	0.9	22	0.5	Educational

The arrowed cells are malignant lymphoid cells (other than blasts), as correctly identified by 42.5% of referees and 33.7% of participants. Lymphoma cells can exhibit a variety of appearances depending on the lymphoma subtype and definitive diagnosis can be difficult. These cells can exhibit a variety of sizes, shapes, and nuclear and cytoplasmic characteristics. Cell size ranges from 8 - 30 µm, and the nuclear to cytoplasmic ratio varies from 7:1 to 3:1. It is critical to obtain an accurate clinical history, since knowledge of a previous diagnosis of lymphoma greatly aids in the identification of these cells. Supplemental studies, such as immunophenotyping, are often necessary to arrive at a definitive diagnosis. In blood smears, it may be difficult to distinguish reactive lymphocytes from lymphoma cells. However, careful examination can aid in distinguishing these two. The nuclear to cytoplasmic ratio tends to be low in reactive lymphocytes, while it is high in lymphoma cells. In addition, reactive lymphocytes are characterized by a spectrum of morphologic appearances within the same blood smear. In contrast, while lymphoma cells can exhibit a wide range of morphologic appearances, any individual case tends to show a more monotonous population of the abnormal cells.

BCP-09 (cont)

17.7% of referees and 15.0% of participants chose monocyte. Monocytes are slightly larger than neutrophils, ranging from 12 - 20 µm in diameter. The majority of monocytes are round with smooth edges, but some may have pseudopod-like cytoplasmic extensions. The cytoplasm is abundant, with a gray or gray-blue ground-glass appearance, and may contain vacuoles or fine, evenly distributed azurophilic granules. The nuclear to cytoplasmic ratio ranges from 4:1 to 2:1. The nucleus is usually indented, often resembling a three-pointed hat, but it can also be folded or band-like. The chromatin is condensed, but is usually less dense than that of a neutrophil or lymphocyte. Nucleoli are generally absent, but occasional monocytes may contain a small, inconspicuous nucleolus. Monocyte is an incorrect choice in this example as the cells within the photomicrograph show prominent nucleoli. Moreover, the nuclear to cytoplasmic ratios are more increased than typically seen in monocytes.

16.8% of referees and 20.7% of participants chose lymphocyte, reactive. The key distinguishing feature of reactive lymphocytes is their wide range of cellular sizes and shapes, as well as nuclear sizes, shapes, and chromatin patterns. These lymphocytes are reacting to an immune stimulus and are frequently increased in viral illnesses. A variety of reactive lymphocyte forms have been described and they are often seen concurrently in the same blood film. These round to ovoid to irregular cells range from 10 - 25 µm in size with a nuclear to cytoplasmic ratio that varies from 3:1 to 1:2. Lymphocyte, reactive is an incorrect choice in this example as the cells within the photomicrograph are monotonous in appearance, consistent with a neoplastic/clonal process (ie, lymphoma).

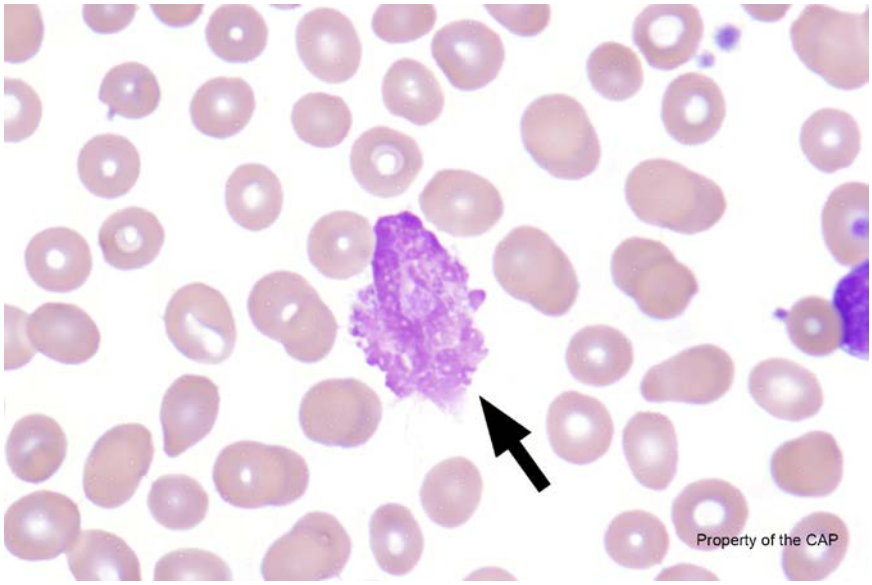
9.7% of referees and 13.6% of participants chose blast. A blast is a large, round-to-oval cell, 10 - 20 µm in diameter. The nuclear to cytoplasmic ratio is high, varying from 7:1 to 5:1. The blast often has a round to oval nucleus, but sometimes it is indented or folded. The blast cell has fine, lacy, or reticular chromatin. One or more prominent nucleoli may be seen. The cytoplasm is variably basophilic and typically agranular. The morphologic features of a blast cell frequently do not permit determination of the cell lineage, ie, myeloblast versus lymphoblast. The one exception is the presence of Auer rods, which are diagnostic of myeloid lineage. In the absence of Auer rods, immunophenotyping is required to determine the lineage of a given blast cell. As blasts are quite variable in appearance, it is often impossible to correctly classify an individual cell based on the morphology alone. Blasts may rarely be morphologically indistinguishable from lymphoma cells. For identification purposes, one should classify individual cells exhibiting this type of morphology as blast cells when additional confirmatory information is unavailable. Given that confirmatory testing was not provided in this example, blast is an acceptable choice. However, the chromatin pattern within the cells in the photomicrograph is more condensed than typically seen within a blast. Therefore, malignant lymphoid cell is the more appropriate choice.

BCP-09 (cont)

3.5% of referees and 7.9% of participants chose monocyte, immature. For the purposes of proficiency testing, selection of the response “monocyte, immature” should be reserved for malignant cells in the context of acute monocytic/monoblastic leukemia, acute myelomonocytic leukemia, chronic myelomonocytic leukemia, or myelodysplastic syndromes (ie, promonocytes and monoblasts). The malignant monoblast is a large cell, usually 15 - 25 µm in diameter. It has relatively more cytoplasm than a myeloblast with the nuclear to cytoplasmic ratio ranging from 7:1 to 3:1. The monoblast nucleus is round or oval and has finely dispersed chromatin and distinct nucleoli. The cytoplasm is blue to gray-blue and may contain small, scattered azurophilic granules. Some monoblasts cannot be distinguished morphologically from other blast forms; in these instances, additional tests are required to accurately assign blast lineage. Promonocytes have nuclear and cytoplasmic characteristics that are between those of monoblasts and mature monocytes. They are generally larger than mature monocytes, but they have similar-appearing gray-blue cytoplasm that often contains uniformly distributed, fine azurophilic granules. Cytoplasmic vacuolization is not a typical feature. The nuclei show varying degrees of lobulation, usually characterized by delicate folding or creasing of the nuclear membrane, in contrast to the rounder nuclear profile of monoblasts. Nucleoli are present but may not be as distinct as in monoblasts. Monocyte, immature is an incorrect choice in this example as the cells within the photomicrograph show more condensed chromatin than would be expected for a monoblast/promonocyte (ie, monocyte, immature).

Blood Cell Identification – Ungraded

BCP-10



Identification	Referees No.	Referees %	Participants No.	Participants %	Evaluation
Basket cell/smudge cell	113	100.0	4773	98.6	Educational

The arrowed cell is a basket cell/smudge cell, as correctly identified by 100.0% of referees and 98.6% of participants. Basket cells or smudge cells are most commonly associated with cells that are fragile and easily damaged in the process of making a peripheral blood smear. The nucleus may either be a non-descript chromatin mass or the chromatin strands may spread out from a condensed nuclear remnant, giving the appearance of a basket. Cytoplasm is either absent or indistinct. Smudge cells are usually lymphocytes, but there is no recognizable cytoplasm to give a clue to the origin of the cell. They are seen most commonly in disorders characterized by lymphocyte fragility, such as infectious mononucleosis and chronic lymphocytic leukemia. Basket cells should not be confused with necrobiotic neutrophils, which have enough cytoplasm to allow the cell to be classified.

Case Presentation:

This peripheral blood smear is from a 72-year-old man presenting with painless cervical lymphadenopathy, weight loss, and fatigue. Laboratory data include: WBC = 45.2 x 10E9/L; RBC = 3.67 x 10E12/L; HGB = 10.7 g/dL; HCT = 33.0%; MCV = 90 fL; MCHC = 32.4 g/dL; RDW = 20%; and PLT = 200 x 10E9/L.

(PERIPHERAL BLOOD, WRIGHT-GIEMSA)

Case Discussion: Mantle cell lymphoma

The CBC indices are indicative of leukocytosis with accompanying anemia. Platelets are normal in number. Review of the images reveals malignant lymphoid cells. The malignant lymphoid cells are quite large in size, using background red blood cells for reference. They have partially condensed chromatin with prominent nucleoli. Basophilic cytoplasm is seen with few cytoplasmic vacuoles. Although it is not possible to sub-classify this lymphoma on morphology alone, the cells are clearly neoplastic given the aforementioned features and their monotonous appearance.

Further workup of this patient, including immunophenotyping by flow cytometry, reveals findings diagnostic of mantle cell lymphoma. Mantle cell lymphoma is a mature B-cell neoplasm, which comprises approximately 5-10% of all non-Hodgkin lymphomas in the United States. It typically occurs in middle aged or older individuals with a male predominance. Lymph nodes are the most common involved site. The spleen, peripheral blood, and bone marrow are frequently involved as well. Moreover, gastrointestinal involvement, sometimes in the form of lymphomatous polyposis, is not uncommon. Most patients present with high stage disease (stage III or IV), which correlates with poor clinical outcome. Unlike the other “small B-cell lymphomas”, mantle cell lymphoma is not an indolent disease with a median survival of only approximately 3 - 5 years. However, a subset of mantle cell lymphoma patients will have a more indolent disease course. Today, there is no definitive marker which identifies indolent cases. However, a subset of indolent cases are characterized by leukemic, non-nodal presentation, splenomegaly, mutated immunoglobulin genes, low CD38 expression, interstitial involvement of the bone marrow (ie, non-nodular), and a low number of genomic aberrations. These cases are frequently SOX11 negative by immunohistochemistry.

Although mantle cell lymphoma is typically comprised of monotonous small to medium sized lymphoid cells with irregular nuclear contours, a spectrum of morphologic variants are recognized including the blastoid and pleomorphic variants. These two variants are significant with poorer prognosis noted. The blastoid variant may resemble lymphoblasts with more dispersed chromatin. The pleomorphic variant shows many large cells with oval to irregular nuclear contours and prominent nucleoli, as in our case.

Immunophenotyping studies, via flow cytometry and/or immunohistochemistry, are routinely performed in the workup of patients with possible lymphoma. Mantle cell lymphoma frequently expresses intense surface IgM/IgD with lambda light chain restriction. The lymphoma cells usually express CD5, FMC-7, and CD43. They are typically negative for CD10 and BCL6, markers of germinal center derivation. Unlike chronic lymphocytic leukemia/small lymphocytic lymphoma (another CD5 positive non-Hodgkin B-cell lymphoma), CD23 is usually negative. Almost all cases express cyclin D1. Cyclin D1 negative cases can be identified via SOX11 staining. Cytogenetic analysis will usually show t(11;14)(q13;q32), which results in an abnormal *IGH-CCND1* (cyclin D1) fusion gene that drives lymphomagenesis in these patients.

Natasha M. Savage, MD, FCAP
Hematology and Clinical Microscopy Resource Committee

References:

1. Sander B, Quintanilla-Martinez L, Ott G, et al. Mantle cell lymphoma-a spectrum from indolent to aggressive disease. *Virchows Arch*. 2016;468(3):245-257.

2. Swerdlow SH, Campo E, Pileri SA, et al. The 2016 revision of the World Health Organization classification of lymphoid neoplasms. *Blood.* 2016;127(20):2375-2390.

Actions Laboratories Should Take when a PT Result is Not Graded

The College uses Exception Reason Codes that signify the proficiency testing (PT) for an analyte has not been graded. The Exception Reason Code is located on the evaluation report in brackets to the right of the result. Your laboratory must identify all analytes with an exception reason code, review and document the acceptability of performance as outlined below and retain documentation of review for at least 2 years. The actions laboratories should take include but are not limited to:

Code	***Exception Reason Code Description***	***Action Required***
11	Unable to analyze.	Document why the specimens were not analyzed (eg, instrument not functioning or reagents not available). Perform and document alternative assessment (ie, split samples) for the period that commercial PT was not tested to the same level and extent that would have been tested.
20	No appropriate target/response; cannot be graded.	Applies to a response that is not formally evaluated when a peer group is not established due to fewer than 10 laboratories reporting. Document that the laboratory performed a self-evaluation using the data presented in the Participant Summary and compared its results to a similar method, or all method, or all participant statistics if provided. Perform and document the corrective action of any unacceptable results. If comparison is not available, perform and document alternative assessment (ie, split samples) for the period that commercial PT was not tested to the same level and extent that would have been tested.
21	Specimen problem.	Document that the laboratory has reviewed the proper statistics supplied in the Participant Summary. Perform and document alternative assessment for the period that commercial PT was not tested to the same level and extent that would have been tested. Credit is not awarded in these cases.
22	Result is outside the method/ instrument reportable range.	Document the comparison of results to the proper statistics supplied in the Participant Summary. Verify detection limits. Perform and document the corrective action of any unacceptable results.
24	Incorrect response due to failure to provide a valid response code.	Document the laboratory's self-evaluation against the proper statistics and evaluation criteria supplied in the Participant Summary. Perform and document the corrective action of any unacceptable results. Document corrective action to prevent future failures.
25	Inappropriate use of antimicrobial.	Document the investigation of the results as if they were unacceptable and review the proper reference documents to gain knowledge of the reason your response is not appropriate.
26	Educational challenge.	Review participant summary report for comparative results and document performance accordingly. Evaluation criteria are not established for educational challenges. Laboratories should determine their own evaluation criteria approved by their laboratory director for self-evaluation. Response to the CAP is not required
27,31	Lack of participant or referee consensus.	Document that the laboratory performed a self-evaluation and compared its results to the intended response when provided in the Participant Summary. If comparison is not available, perform and document alternative assessment (ie, split samples) for the period that commercial PT reached non-consensus to the same level and extent that would have been tested.
28	Response qualified with a greater than or less than sign; unable to quantitate.	Applies to a response that is not formally evaluated when a less than or greater than sign is reported. Document that the laboratory performed a self-evaluation and compared its results to the proper statistics supplied in the Participant Summary. Verify detection limits. Perform and document the corrective action of any unacceptable results.
30	Scientific Committee decision.	Applies to a response that is not penalized based on Scientific Committee Decision. Document that the laboratory has reviewed the proper statistics supplied in the Participant Summary

Actions Laboratories Should Take when a PT Result is Not Graded

The College uses Exception Reason Codes that signify the proficiency testing (PT) for an analyte has not been graded. The Exception Reason Code is located on the evaluation report in brackets to the right of the result. Your laboratory must identify all analytes with an exception reason code, review and document the acceptability of performance as outlined below and retain documentation of review for at least 2 years. The actions laboratories should take include but are not limited to:

Code	***Exception Reason Code Description***	***Action Required***
33	Specimen determined to be unsatisfactory after contacting the CAP.	Document that the laboratory has contacted the CAP and no replacements specimens were available. Perform and document alternative assessment (ie, split samples) for the period that commercial PT was not tested to the same level and extent that would have been tested.
40 41	Results for this kit were not received. Results for this kit were received past the evaluation cut-off date.	Document why results were not received, corrective action to prevent recurrence and the laboratory's self-evaluation of the results by comparing results to the proper statistics and evaluation criteria supplied in the Participant Summary. If PT specimens were not analyzed, perform and document alternative assessment (ie, split samples) for the period that commercial PT was not tested to the same level and extent that would have been tested.
42	No credit assigned due to absence of response.	The Participant Summary indicates which tests are graded (see evaluation criteria) and which tests are Not Evaluated/Educational. Updates to grading will also be noted. If a test is educational, the laboratory is not penalized for leaving a result(s) blank. The code 42 that appears on the evaluation is **not** a penalty. However, if a test is graded (regulated and non-regulated analytes) and your laboratory performs that test, results cannot be left blank. The laboratory is required to submit results for **all** challenges within that test or use an appropriate exception code or indicate test not performed/not applicable/not indicated. Exceptions may be noted in the Kit Instructions and/or the Result Form. Document corrective actions to prevent future failures.
44	This drug is not included in our test menu. Use of this code counts as a correct response.	Verify that the drug is not tested on patient samples and document to ensure proper future reporting.
45	Antimicrobial agent is likely ineffective for this organism or site of infection	Document that the laboratory performed a self-evaluation of written protocols and practices for routine reporting of antimicrobial susceptibility reports to patient medical records. Document that routine reporting of this result to clinicians for patient care is compliant with specific recommendations of relevant Medical Staff and Committees (eg, infectious Diseases, Pharmacy and Therapeutics, Infection Control). Response to the CAP is not required.
77	Improper use of the exception code for this mailing.	Document the identification of the correct code to use for future mailings.
91	There was an insufficient number of contributing challenges to establish a composite grade.	Document the investigation of the result as if it were an unacceptable result. Perform and document the corrective action if required.
35, 43, 88, 92	Various codes.	No action required.

COLLEGE of AMERICAN PATHOLOGISTS

Attestation of Participation of Self-Reported Training*

We the participants below have completed the review of the CAP FH13-A 2018 (Product Mailing, Year) Participant Summary/Final Critique report and can self-report the recommended 0.5 (Education Hours) hours towards fulfilling education and certification of maintenance requirements.

Participant	Date	Participant	Date
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

_____ _____

Director (or Designee) Signature - I have verified that the individuals listed above have successfully participated in this activity. Date

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