

Appendices

Appendix I. Avian Hematologic Reference Ranges*

Determination	African grey	Amazon	Budgerigar	Canary	Cockatiel	Cockatoo	Conure	Eclectus
WBC x 10 ³ /μl	5-11	6-11	3-8.5	4-9	5-10	5-11	4-11	4-10
RBC x 10 ⁶ /μl	2.4-3.9	2.4-4	2.4-4	2.5-3.8	2.2-3.9	2.4-4.2	2.5-4.1	2.4-3.9
HCT (%)	40-48	40-50	40-50	40-49	40-49	40-48	40-49	40-47
Hets (%)	55-75	55-80	50-75	50-80	55-80	55-80	55-75	55-70
Eos (%)	0-2	0-1	0-2	0-2	0-2	0-2	0-2	0-1
Baso (%)	0-1	0-1	0-1	0-1	0-2	0-1	0-1	0-2
Monos (%)	0-3	0-3	0-2	0-1	0-2	0-1	0-2	0-2
Lymphs (%)	25-45	20-45	25-45	20-45	20-45	20-45	25-45	30-45

Determination	Jardine's	Lory	Lovebird	Macaw	Parakeet	Pionus	Quaker	Senegal
WBC x 10 ³ /μl	4-10	4.5-8.5	3-8.5	6-12	4.5-9.5	4-11.5	4-10	4-11
RBC x 10 ⁶ /μl	2.4-4.2	2.5-4.1	2.3-3.9	2.4-4.2	2.2-3.9	2.4-4	2.3-4.1	2.4-4.1
HCT (%)	38-48	39-50	38-50	39-48	39-48	40-47	40-49	39-48
Hets (%)	55-75	50-70	55-80	58-78	50-75	50-75	55-80	55-75
Eos (%)	0-1	0-2	0-1	0-1	0-2	0-2	0-1	0-1
Baso (%)	0-1	0-1	0-1	0-1	0-1	0-1	0-2	0-1
Monos (%)	0-2	0-2	0-3	0-3	0-2	0-2	0-3	0-2
Lymphs (%)	25-45	23-45	20-45	20-45	25-45	25-45	20-45	25-45

*Provided by University of Miami Avian and Wildlife Laboratory: RBC and WBC count by Unopette method from blood collected in EDTA; Spun HCT; Diff based on 100-cell count using smear made at the time of sample acquisition.

Appendix II. Avian Hematologic Reference Ranges for Clinically Normal Psittacines**

In an attempt to establish ranges for clinically normal birds of various psittacine species, the following criteria were used to determine the acceptability of individual values for incorporation into the following statistics:

- 1) The bird was presented for a wellness examination, at which time the sample was obtained.
- 2) At least one previous CBC was performed and documented at the same hospital, utilizing the same techniques, and was also performed during a wellness examination.
- 3) No other concurrent disease was detected or treated, with the exception of behavioral concerns.
- 4) The total WBC did not vary more than 25% between the two values.

Determination	African greys	Amazon sp.	Budgerigars	Cockatiels	Umbrella cockatoos	Aratinga conures	Eclectus parrots
	(n = 150)	(n = 150)	(n = 50)	(n = 200)	(n = 100)	(n = 50)	(n = 25)
WBC x 10 ³ /μl	8-11	7.5-12.5	2.5-6.5	4.0-8.8	7-11.5	7.0-11.7	7.0-11.8
PCV (%)	42-50	44-49	42-53	45-57	38-48	42-49	41-49

Determination	Lovebirds	Macaws	Pionus sp.	Quaker (monk) parakeets	Senegal parrots
	(n = 25)	(n = 100)	(n = 25)	(n = 50)	(n = 25)
WBC x 10 ³ /μl	4.5-9.0	8.5-15.5	7.0-11.5	5.5-12.5	6.5-12
PCV (%)	39-51	39-52	44-51	38-48	37-48

** Compiled 1989-2001 by Teresa L. Lightfoot, DVM, Dipl ABVP-Avian: All calculations were done using the Eosinophil Unopette method; an average of the total WBC counts for the two or more CBCs that were performed was used to develop the above ranges.

Appendix III. Avian Biochemistry Reference Ranges*

Determination	African grey	Amazon	Budgerigar	Canary	Cockatiel	Cockatoo	Conure	Eclectus
Alk phos (U/L)	20-160	15-150	10-80	20-135	20-250	15-255	80-250	150-350
ALT (U/L)	5-12	5-11	5-10	5-11	5-11	6-12	5-13	5-11
AST (U/L)	100-365	130-350	145-350	145-345	95-345	145-355	125-345	120-370
Amylase (U/L)	210-530	205-510	200-500	190-485	205-490	200-510	100-450	200-645
BUN (mg/dL)	3-5.4	3.1-5.3	3-5.2	3-5	2.9-5	3-5.1	2.8-5.4	3-5.5
Ca (mg/dL)	8.5-13	8.5-14	6.5-11	5.5-13.5	8-13	8-13	7-15	7-13
Chol (mg/dL)	160-425	180-305	145-275	150-400	140-360	145-355	120-400	130-350
Creat (mg/dL)	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.4
CO ₂ (mmol/L)	13-25	13-26	14-25	14-26	13-25	14-25	14-25	14-24
CPK (U/L)	165-412	55-345	90-300	55-350	30-245	95-305	35-355	220-345
GGT (U/L)	1-10	1-12	1-10	1-14	1-30	1-45	1-15	1-20
Glu (mg/dL)	190-350	190-345	190-390	205-435	200-445	185-355	200-345	145-245
LDH (U/L)	145-465	155-425	145-435	120-450	120-455	220-550	120-390	200-425
Lipase (U/L)	35-350	35-225	30-300	29-255	30-280	25-275	30-290	35-275
Phos (mg/dL)	3.2-5.4	3.1-5.5	3.0-5.2	2.9-4.9	3.2-4.8	2.5-5.5	2-10	2.9-6.5
Potassium (mmol/L)	2.9-4.6	3-4.5	2.2-3.9	2.2-4.5	2.4-4.6	2.5-4.5	3-4.5	3.5-4.3
Sodium (mmol/L)	157-165	125-155	139-165	135-165	130-153	130-155	135-149	130-145
Total bili (mg/dL)	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1
Total protein (g/dL)	3-4.6	3-5	2.5-4.5	2.8-4.5	2.4-4.1	3-5	3-4.2	2.8-3.8
Trig (mg/dL)	45-145	49-190	105-265	60-265	45-200	45-205	50-300	70-410
Uric acid (mg/dL)	4.5-9.5	2.3-10	4.5-14	4-12	3.5-10.5	3.5-10.5	2.5-11	2.5-11

Determination	African grey	Amazon	Budgerigar	Canary	Cockatiel	Cockatoo	Conure	Eclectus
Bile acids (μmol/L)	13-90	18-60	15-70	23-90	20-85	25-87	15-55	10-61
T ₄ (μg/dL)	0.2-1.5	0.1-1.1	0.3-1.5	0.3-1.8	0.4-1.9	0.3-1.8	0.3-1.9	0.3-2.0
Pre-albumin (g/dL)	0.03-1.35	0.35-1.05	0.48-1.21	0.35-0.98	0.8-1.6	0.24-1.18	0.18-0.98	0.05-0.74
Albumin (g/dL)	1.57-3.23	1.9-3.52	0.79-1.35	0.81-1.23	0.7-1.8	1.8-3.1	1.9-2.6	2.3-2.6
Alpha-1 (g/dL)	0.02-0.27	0.05-0.32	0.08-0.21	0.08-0.16	0.05-0.30	0.05-0.18	0.04-0.23	0.09-0.19
Alpha-2 (g/dL)	0.05-0.25	0.07-0.32	0.05-0.16	0.05-0.22	0.05-0.30	0.04-0.36	0.08-0.26	0.11-0.21
Beta (g/dL)	0.35-0.66	0.38-0.76	0.35-0.75	0.3-0.71	0.3-0.78	0.35-0.82	0.38-0.77	0.35-0.62
Gamma (g/dL)	0.11-0.71	0.17-0.76	0.15-0.55	0.16-0.63	0.11-0.53	0.21-0.65	0.32-0.61	0.22-0.51
A/G ratio	1.6-4.3	1.9-5.0	1.5-4.1	1.3-4.5	1.5-4.3	2.0-4.5	2.2-4.3	2.6-4.1

* University of Miami Avian and Wildlife Laboratory: All reference ranges obtained from heparinized plasma samples; regular chemistry performed on Ortho (Kodak Ektahem) 700XR; TP by non-temperature compensated refractometer; bile acids and T₄ by RIA; EPH by Beckman Paragon SPEP II gels; represent adult ranges.

Determination	Jardine's	Lory	Lovebird	Macaw	Parakeet	Pionus	Quaker	Senegal
Alk phos (U/L)	80-156	75-155	10-90	20-230	20-120	80-290	70-300	70-300
ALT (U/L)	5-12	5-13	5-13	5-12	5-12	5-12	5-11	5-11
AST (U/L)	150-278	150-350	110-345	100-300	145-395	150-365	150-285	100-350
Amylase (U/L)	100-425	90-422	90-400	150-550	150-525	200-500	100-400	190-550
BUN (mg/dL)	2.8-5.6	2.7-5.7	2.8-5.5	3-5.6	3.1-5.3	3-5.4	2.9-5.4	2.9-5.4
Ca (mg/dL)	7-13	6.5-13	8-14	8.5-13	5.5-13.5	7-13.5	7-12	6.5-13
Chol (mg/dL)	100-300	95-295	95-335	100-390	150-400	130-295	100-295	130-340
Creat (mg/dL)	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.5	0.1-0.4	0.1-0.4	0.1-0.4	0.1-0.4
CO ₂ (mmol/L)	14-25	14-26	14-25	14-25	14-25	14-24	14-26	14-25
CPK (U/L)	110-310	110-330	52-245	100-300	50-400	100-300	110-320	100-330
GGT (U/L)	1-15	1-16	2.5-18	1-30	1-12	1-18	1-15	1-15
Glu (mg/dL)	199-348	200-300	195-405	145-345	205-345	125-300	200-350	140-250
LDH (U/L)	119-335	115-330	105-355	70-350	145-445	125-380	120-300	150-350
Lipase (U/L)	30-255	25-250	30-320	30-250	30-220	30-250	25-225	35-250
Phos (mg/dL)	2-6.8	2-6.5	2.8-4.9	2-12	2.9-4.9	2.9-6.6	2.9-6.5	2.5-9.5
Potassium (mmol/L)	3-4.5	3-4.4	2.1-4.8	2-5	2.3-4.2	3.5-4.6	2.8-4.6	3-5
Sodium (mmol/L)	133-153	130-155	125-155	140-165	138-166	145-155	140-155	130-155
Total bili (mg/dL)	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1	0-0.1
Total protein (g/dL)	2.8-4	2-3.5	2.8-4.4	2.1-4.5	3-4.4	2.2-4	2.8-3.6	3.5-4.4
Trig (mg/dL)	60-130	65-140	45-200	60-135	55-250	60-225	50-200	45-145
Uric acid (mg/dL)	2.5-12	2.8-11.5	3.5-11	2.5-11	4.5-12	3.5-10	3.5-11.5	2.3-10

Determination	Jardine's	Lory	Lovebird	Macaw	Parakeet	Pionus	Quaker	Senegal
Bile acids (μ mol/L)	25-65	20-65	13-65	6-35	18-79	14-60	25-65	20-85
T ₄ (μ g/dL)	0.2-1.5	0.3-1.2	0.2-2.3	0.2-1.9	0.4-1.8	0.5-1.9	0.4-2.1	0.5-2.3
Pre-albumin (g/dL)	0.18-0.32	0.48-0.76	0.6-1.2	0.05-0.7	0.6-1	0.19-0.93	0.48-1.13	0.19-0.64
Albumin (g/dL)	1.85-2.23	1.26-1.96	2-2.8	1.24-3.11	1.9-3	2.19-3.29	1.26-2.52	1.45-2.28
Alpha-1 (g/dL)	0.07-0.15	0.04-0.14	0.08-0.21	0.04-0.25	0.06-0.16	0.1-0.19	0.04-0.25	0.02-0.20
Alpha-2 (g/dL)	0.08-0.15	0.04-0.23	0.08-0.25	0.04-0.31	0.07-0.20	0.08-0.15	0.05-0.28	0.08-0.16
Beta (g/dL)	0.38-0.66	0.35-0.58	0.34-0.68	0.48-0.68	0.22-0.45	0.30-0.60	0.41-0.63	0.36-0.58
Gamma (g/dL)	0.26-0.51	0.13-0.29	0.2-0.48	0.2-0.5	0.19-0.30	0.18-0.42	0.13-0.48	0.14-0.23
A/G ratio	2.9-3.5	2.3-4.0	2.5-4.6	1.6-4.3	4-5.3	3.4-5.0	2.2-3.2	2.2-3.9

* University of Miami Avian and Wildlife Laboratory: All reference ranges obtained from heparinized plasma samples; regular chemistry performed on Ortho (Kodak Ektachem) 700XR; TP by non-temperature compensated refractometer; bile acids and T₄ by RIA; EPH by Beckman Paragon SPEP II gels; represent adult ranges.

For assistance on biochemistry conversions: www.vin.com/scripts/labquest/converthtml.pl

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