

Hematology and Serum Chemistry Reference Values for Rhesus Macaque (*Macaca mulatta*) Infants

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The rhesus macaque infants whose data are described in these tables were assessed for various hematology parameters at the mean age of 107.8 days (SD = 10.3, range = 89–130). Note that information presented by Capitanio *et al.* in Chapter 11 of this book reflects a single year's data; in the present set of tables (Tables 26–1, 26–2, and 26–3), data from a second year of assessments are included. Infants were hand captured from their field cage, corn crib, nursery, or indoor cage, separated from their companions, relocated to an unfamiliar indoor room, and placed in individual cages. Blood sampling occurred between 1030 and 1100 hr, approximately 2 hr after the separation and relocation. Each animal was hand captured from its individual cage and manually restrained while 1 ml of blood was drawn into an unheparinized syringe from a femoral vein. Blood was transferred to EDTA tubes, and hematology and flow cytometry were performed by California National Primate Research Center's (CNPRC) Clinical Laboratory. Complete blood counts were performed using a Serono Baker

Table 26–1. Rhesus Macaque Total White Cell and CD4 and CD8 T Cell Counts

Rearing group	Mean	95% CI		Median	Number of subjects
		Lower	Upper		
Total white cells ($10^3/\mu\text{l}$)					
Female corncrib	16.50	14.50	18.50	15.15	30
Female field cage	17.95	17.15	18.75	16.60	238
Female nursery	14.71	13.47	15.94	14.20	46
Female indoor mother	15.90	13.84	17.95	14.65	32
Male corncrib	15.22	11.58	18.85	13.60	18
Male field cage	16.70	15.95	17.46	15.85	186
Male nursery	14.78	13.00	16.57	15.05	26
Male indoor mother	16.08	14.32	17.84	14.70	19
CD4⁺ T cells (cells/μl)					
Female corncrib	1972.77	1423.00	2522.53	1766.00	30
Female field cage	1912.29	1813.58	2010.99	1802.00	237
Female nursery	3368.80	2964.49	3773.12	3345.50	46
Female indoor mother	3542.56	3045.64	4039.49	3456.50	32
Male corncrib	1848.44	1486.78	2210.11	1836.00	18
Male field cage	1885.32	1774.81	1995.84	1731.00	186
Male nursery	3302.23	2798.71	3805.75	3363.00	26
Male indoor mother	3741.68	3028.36	4455.00	3425.00	19
CD8⁺ T cells (cells/μl)					
Female corncrib	666.50	539.93	793.07	616.00	30
Female field cage	776.31	721.91	830.71	717.00	236
Female nursery	1100.61	941.64	1259.58	976.00	46
Female indoor mother	1376.22	1106.48	1645.96	1236.00	32
Male corncrib	747.67	560.67	934.66	700.50	18
Male field cage	758.27	697.44	819.11	662.00	186
Male nursery	1178.69	954.34	1403.04	1114.00	26
Male indoor mother	1347.05	1030.03	1664.07	1163.00	19

Table 26–2. Rhesus Infant Red Cell Measures

Rearing group	Mean	95% CI		Median	Number of subjects
		Lower	Upper		
Total red cells ($10^6/\mu\text{l}$)					
Female corncrib	5.61	5.43	5.78	5.62	30
Female field cage	5.77	5.69	5.84	5.71	238
Female nursery	5.81	5.62	6.00	5.79	46
Female indoor mother	6.08	5.81	6.35	6.04	32
Male corncrib	5.39	5.18	5.60	5.44	18
Male field cage	5.84	5.75	5.94	5.79	186
Male nursery	6.09	5.77	6.40	5.95	26
Male indoor mother	5.96	5.66	6.27	5.86	19

Table 26-2. *Continued*

Rearing group	Mean	95% CI		Median	Number of subjects
		Lower	Upper		
Hemoglobin (g/dl)					
Female corncrib	13.48	12.96	14.00	13.45	30
Female field cage	13.64	13.46	13.81	13.60	238
Female nursery	14.35	13.93	14.78	14.25	46
Female indoor mother	14.58	13.84	15.32	14.30	32
Male corncrib	13.14	12.40	13.89	13.00	18
Male field cage	13.66	13.43	13.89	13.50	186
Male nursery	16.79	12.35	21.24	14.40	26
Male indoor mother	13.88	13.28	14.49	13.80	19
Hematocrit (%)					
Female corncrib	39.50	38.17	40.84	39.00	30
Female field cage	40.07	39.57	40.57	39.90	238
Female nursery	41.11	40.01	42.21	40.85	46
Female indoor mother	42.38	40.18	44.59	41.85	32
Male corncrib	38.02	36.60	39.43	38.50	18
Male field cage	39.97	39.31	40.62	39.50	186
Male nursery	43.06	40.52	45.60	41.45	26
Male indoor mother	40.69	39.04	42.34	41.40	19
Mean cell volume (fl)					
Female corncrib	70.73	69.61	71.86	71.00	30
Female field cage	69.59	69.19	69.99	70.00	238
Female nursery	71.17	70.31	72.04	71.00	46
Female indoor mother	69.75	68.16	71.34	70.00	32
Male corncrib	70.67	69.46	71.87	71.00	18
Male field cage	68.60	68.01	69.19	69.00	186
Male nursery	70.69	69.79	71.60	71.00	26
Male indoor mother	68.32	66.48	70.16	69.00	19
Corpuscular hemoglobin (pg)					
Female corncrib	23.81	23.41	24.21	23.60	30
Female field cage	23.65	23.49	23.81	23.70	237
Female nursery	24.81	24.51	25.10	24.85	46
Female indoor mother	23.99	23.32	24.66	24.55	32
Male corncrib	23.89	23.40	24.39	23.95	18
Male field cage	23.44	23.20	23.67	23.50	186
Male nursery	24.39	24.06	24.73	24.35	26
Male indoor mother	23.40	22.48	24.32	24.00	19
MCH concentration (pg/fl)					
Female corncrib	33.74	33.22	34.26	33.35	30
Female field cage	34.04	33.89	34.19	34.20	238
Female nursery	34.90	34.62	35.17	35.10	46
Female indoor mother	34.45	33.93	34.97	34.50	32
Male corncrib	33.86	33.19	34.52	33.70	18
Male field cage	34.15	33.98	34.33	34.30	186
Male nursery	34.55	34.15	34.96	34.65	26
Male indoor mother	34.15	33.37	34.93	34.40	19

Table 26-3. Other Hematology Measures for Rhesus Infants

Rearing group	Mean	95% CI		Median	Number of subjects
		Lower	Upper		
Platelets (10⁵/μl)					
Female corncrib	6.05	5.56	6.55	6.19	30
Female field cage	6.14	5.92	6.36	6.15	238
Female nursery	7.13	6.62	7.64	7.08	46
Female indoor mother	6.57	5.98	7.17	6.27	32
Male corncrib	6.38	5.66	7.10	6.55	18
Male field cage	6.17	5.91	6.43	6.05	186
Male nursery	6.47	5.80	7.14	6.52	26
Male indoor mother	5.67	5.00	6.35	5.81	19
Plasma protein (g/dl)					
Female corncrib	6.95	6.82	7.09	6.90	30
Female field cage	7.01	6.95	7.07	7.00	236
Female nursery	6.94	6.77	7.10	6.90	46
Female indoor mother	7.06	6.93	7.19	7.10	32
Male corncrib	6.86	6.67	7.05	6.80	18
Male field cage	6.97	6.90	7.04	6.90	186
Male nursery	6.85	6.71	6.98	6.90	26
Male indoor mother	7.00	6.85	7.14	7.00	19
Neutrophils (cells/μl)					
Female corncrib	10861.77	9445.81	12277.72	10044.00	30
Female field cage	11711.16	11021.53	12400.80	10723.00	238
Female nursery	6825.74	6004.93	7646.55	6381.00	46
Female indoor mother	7872.88	6420.30	9325.45	7100.50	32
Male corncrib	9574.11	6415.11	12733.11	7968.00	18
Male field cage	10661.48	9990.10	11332.87	9788.00	186
Male nursery	7158.08	5579.07	8737.08	7434.50	26
Male indoor mother	8220.16	6690.32	9750.00	7599.00	19
Lymphocytes (cells/μl)					
Female corncrib	5264.20	4281.93	6246.47	4988.50	30
Female field cage	5811.51	5503.80	6119.21	5478.00	237
Female nursery	7344.80	6518.81	8170.80	6784.00	46
Female indoor mother	7659.34	6512.03	8806.65	6820.00	32
Male corncrib	5345.44	4193.61	6497.28	4949.00	18
Male field cage	5489.20	5187.24	5791.16	5248.50	186
Male nursery	7251.42	6326.05	8176.80	7156.50	26
Male indoor mother	7610.21	6344.25	8876.17	7056.00	19
Monocytes (cells/μl)					
Female corncrib	236.77	122.84	350.69	143.50	30
Female field cage	277.57	222.07	333.06	143.50	238
Female nursery	343.89	207.46	480.32	215.50	46
Female indoor mother	241.13	74.60	407.65	93.00	32
Male corncrib	475.89	-234.85	1186.63	89.50	18
Male field cage	364.26	276.88	451.64	190.00	186
Male nursery	217.15	111.25	323.06	112.50	26
Male indoor mother	179.89	75.00	284.79	148.00	19

Table 26-3. *Continued*

Rearing group	Mean	95% CI		Median	Number of subjects
		Lower	Upper		
Eosinophils (cells/μl)					
Female corncrib	129.97	41.73	218.20	0.00	30
Female field cage	107.69	83.60	131.78	0.00	238
Female nursery	191.04	115.85	266.23	97.00	46
Female indoor mother	123.53	68.51	178.56	93.00	32
Male corncrib	424.39	-288.76	1137.54	0.00	18
Male field cage	108.63	75.80	141.47	0.00	186
Male nursery	157.96	92.89	223.03	146.00	26
Male indoor mother	68.68	21.21	116.16	0.00	19

Diagnostic System (Allentown, PA), and all electronic counts were verified by a manual differential.

Aliquots of whole blood (50 μ l) were labeled directly with phycoerythrin (anti-CD4-M-T477; BD Pharmingen), peridinin chlorophyll- α protein (anti-CD8-SK1; BD Pharmingen), and fluorescein isothiocyanate (anti-CD3-SP34; BD Pharmingen). A Coulter Q-prep (Coulter Corp., Miami, FL) was used to lyse the red blood cells and fix the sample in paraformaldehyde. Lymphocytes were gated by forward and side light scatter. A FACS Calibur flow cytometer (BD Pharmingen) was used to phenotype the lymphocyte subsets.

Using the criterion of little or no overlap in confidence intervals, the data reveal the following effects. (1) CD4, CD8, and total lymphocytes have clearly higher values in the two indoor groups than in the two outdoor groups. In contrast, animals from the outdoor groups had more neutrophils than did animals from the indoor groups. This effect is especially strong for females. This may suggest that outdoor groups are exposed to more infectious sources than indoor groups. (2) Values for total red cells, mean corpuscular hemoglobin (MCH), and MCH concentration (MCHC) tend to be higher for indoor groups than for outdoor groups. This may indicate that iron levels are higher for indoor infants, regardless of whether they are nursery or mother reared. (3) Male corn crib monkeys had especially high variability in monocytes and eosinophils, suggesting that some animals had active infections or high stress levels.