

REFERENCE INTERVALS

Biochemistry

	Units	Canine	Feline	Bovine	Equine	Porcine	Ovine
Sodium	mmol/L	144-151	149-156	135-151	135-148	140-150	143-151
Potassium	mmol/L	3.9-5.3	3.3-5.2	3.9-5.9	3.0-5.0	4.7-7.1	4.6-7.0
Chloride	mmol/L	105-117	112-122	96-110	98-110	100-105	102-116
Calcium	mmol/L	2.02-2.91	2.28-2.85	2.11-2.75	2.80-3.44	1.80-2.90	2.30-2.86
Phosphorus	mmol/L	0.84-1.83	0.94-1.95	1.08-2.76	1.00-1.80	1.30-3.55	0.82-2.66
Magnesium	mmol/L	0.70-1.16	0.74-1.12	0.80-1.32	0.74-1.02	0.78-1.60	0.90-1.26
Urea	mmol/L	2.8-9.8	6.4-11.8	3.0-7.5	3.5-7.0	3.0-8.5	2.0-10.0
Creatinine	μmol/L	54-122	67-157	40-148	78-143	90-240	69-105
Glucose	mmol/L	4.0-6.3	3.2-6.7	1.8-3.8	3.6-5.6	3.6-5.3	1.2-3.6
Cholesterol	mmol/L	3.87-8.39	1.80-5.83	-	1.20-4.60	-	-
Total Bilirubin	μmol/L	0-4	0-4	0-30	4-102	0-4	0-5
Direct Bilirubin	μmol/L	0-4	0-4	0-3	0-7	0-4	0-5
ALP	IU/L	18-113	14-49	0- 121	95-233	10-400	66-158
CK	IU/L	44-249	58-489	0- 350	0- 500	0- 500	0- 350
AST	IU/L	18-55	11-44	46-118	197-429	25-57	48-128
ALT	IU/L	13-69	34-90	-	10-23	34-58	-
GGT	IU/L	0-7	0-6	0-31	0- 25	0- 25	0- 79
Total Protein	g/L	56-71	65-84	66-78	60-77	34-60	61-81
Albumin	g/L	30-36	25-37	23-43	25-36	18-22	27-39
Globulin	g/L	25-38	33-54				
A/G Ratio	-	0.7-1.5	0.50-0.90	0.66-1.30	0.60-1.50	0.60-1.50	0.54-1.22
Amylase	IU/L	324-1005	639-1364	-	-	-	-
Lipase	IU/L	78-583	16-139	-	-	-	-
SDH	IU/L	0-10	0-18	4-25	1-15	1-10	5-28

Blood Gases:

pH	-	7.31-7.42	7.24-7.40	7.35-7.50	7.20-7.55	7.30-7.50	7.32-7.50
pCO₂ venous	mmHg	34-45	25-35	34-45	38-46	35-45	35-45
pO₂ arterial	mmHg	80-110	80-110	80-110	80-110	80-110	80-110
HCO₃	mmol/L	24±4	24±4	24±4	24±4	24±4	24±4
Base Excess	-	0±3	0±3	0±3	0±3	0±3	0±3

Biochemistry and Coagulation

	Units	Canine	Feline	Bovine	Equine	Porcine	Ovine
Protein Electrophoresis (agarose gel)							
Albumin	g/L	24-40	26-44	24-36	29-38	19-24	28-34
Alpha 1	g/L	2-4	6.5-9	-	7-13	9-12	2-6
Alpha 2	g/L	4-9	6.5-9	7-12	7-13	-	2-6
Beta	g/L	13-17	10-15	6-12	4-12	8-11	3-7
Gamma	g/L	4-8	12-27	16-32	9-15	3-7	7-13
Iron	μmol/L	14.5-22	14.5-38	14.5-29	14.5-25	14.5-36	29-40
TIBC	μmol/L	All species	44.8-62.7				
Bile Acids							
(pre)	μmol/L	0- 7	0- 7				
(post)	μmol/L	0- 15	0- 15				
Osmolarity	mOsm/kg	285-315	285-315	285-315	285-315	285-315	285-315
Fibrinogen	g/L	-	-	< 6.0	< 5.0	-	-
PT Range	seconds	6.1-8.0	8.4-14.7	N/A	N/A	N/A	N/A
PTT Range	seconds	8.8-14.8	10.8-16.9	N/A	N/A	N/A	N/A

Hematology

	Units	Canine	Feline	Bovine	Equine	Porcine	Ovine
HgB	G/L	135-198	89-156	80-150	110-190	100-160	80-160
Hct	L/L	0.40-0.56	0.28-0.44	0.24-0.46	0.32-0.52	0.32-0.50	0.24-0.50
RBC	X 10 ¹² /L	5.7-8.4	6.4-11.5	5.0-10.0	6.5-12.5	5.0-8.0	8.0-16.0
MCV	FL	64-75	35-52	40-60	34-58	50-68	23-48
MCH	Pg	22-25	12-17	11-17	11-19	16.6-22.0	9.0-12.0
MCHC	G/L	334-357	310-381	300-360	310-370	300-340	310-380
Reticulocytes	%	0-1 %	0-1.2%	0 - 0.5%	0%	0-1%	0%
	X 10 ⁹ /L	0-85	0-85				
WBC	X 10 ⁹ /L	5.4-14.3	4.7-17.0	4.0-12.0	5.5-12.5	11.0-22.0	4.0-12.0
Segmented Neutrophils	X 10 ⁹ /L	2.8-10.1	2.2-9.5	0.6-4.0	2.7-6.7	3.1-10.4	0.7-6
Bands Neutrophils	X 10 ⁹ /L	0.0-0.3	0.0-0.1	0.0-0.12	0.0-0.1	0.0-0.88	Rare
Eosinophils	X 10 ⁹ /L	0.0-1.5	0.0-1.5	0.0-2.4	0.0-0.93	0.06-2.42	0.0-1.0
Basophils	X 10 ⁹ /L	0.0-0.1	0.0-0.2	0.0-0.2	0.0-0.17	0.0-0.44	0.0-0.3
Lymphocytes	X 10 ⁹ /L	0.9-4.6	0.5-7.5	2.5-7.5	1.5-5.5	4.29-13.6	2.0-9.0
Monocytes	X 10 ⁹ /L	0.1-1.4	0.0-0.6	0.03-0.84	0.0-0.8	0.22-2.2	0.0-0.75
Platelets	X 10 ⁹ /L	218-470	306-517	100-800	100-600	310-510	250-750

Endocrine

Test	Units	Canine	Feline	Bovine	Equine
Cortisol					
Baseline	nmol/L	14-180	13-110	10-140	70-180
Post-ACTH	nmol/L	231-571 (2hrs post)	163-409-1hr 115-507-2hr		2-3x Baseline at 8hrs
Post Dexa	nmol/L	<35 (8hrs Post Dex at 0.01mg/kg IV)	<35 (8hrs Post Dex at 0.1mg/kg IV)		<30 (19 hrs Post Dex at 0.04 mg/kg IM)
Estrone Sulfate					
Pregnant	ng/ml				> 20 (> 90 days)
Non-Pregnant/ True Gelding	ng/ml				< 5 (> 90 days)
Stallion/ Cryptorchid	ng/ml				> 10
Progesterone					
Diestrus (luteal)	ng/ml	< 2	5-15	> 3.0	7-20
LH Peak	ng/ml	2 - 4	-	-	-
Estrus (follicular)	ng/ml	4 - 12	< 1.0	< 1.0	< 1.0
Pregnant	ng/ml	> 12	5-15	> 3.0	7-20
T3 (triiodothyronine)					
Baseline	nmol/L	0.6-2.4	0.3-1.7	0.8-1.9	0.9-3.1
T4 (thyroxine)					
Baseline	nmol/L	15-52	8-40	-	13-35
Testosterone					
	ng/ml	1.0-7.0 male <0.4 bitch or neutered male	1.0-6.0		1.0-4.0 Stallion, breeding season < 1.0 Stallion, non- Breeding Season < 0.3 Mares, Geldings
TSH	ng/ml	< 0.50			
Urine Cortisol/ Creatinine Ratio		0.5-17.7 x10 ⁻⁶	0.5-17.7 x10 ⁻⁶		

Toxicology – Animal Mineral Levels

BOVINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney	Heparinized Blood
Normal	0.004-0.40	0.018-0.40	0.03-0.05
High	1.0-50	1.5-5.0	
Toxic - acute	2.0-15	3.5-38	0.17-6.7
- chronic	7.0-100	5.0-53	

CADMIUM

	Liver	Kidney
Normal	0.02-1.0	0.05-1.5
High	1.4-9.0	5.0-36
Toxic - chronic	50-160	100-250
- acute	> 50	> 200

COPPER

	Liver	Kidney	Serum (No Selenium Supplement)	Serum (Selenium Supplement)
Deficient	0.5-10.0	1.0-5.0	0.02-1.00	0.10-1.20
Marginal	5.0-25.0	3.0-5.5	0.55-1.20	0.30-1.20
Adequate	25.0-100	4.0-6.0	0.8-1.5	0.32-1.20
High	200-550	5.0-7.0	2.5-4.0	0.50-2.50
Toxic	250-800	10-122	4.0-11.0	0.60-10.0

	Liver - Fetal
Deficient	2.0-20
Marginal	20-30
Adequate	30-150
High	200

Toxicology – Animal Mineral Levels (continued)

BOVINE Values in ppm Wet Weight

LEAD

	Liver	Kidney	Heparinized Blood	Hair *	Bone *
Normal	0.1-1.0	0.2-2.0	0.01-0.2	0.5-5	1.0-7.0
High	2-10	3-20	0.30-0.40	3.5-90	30-75
Toxic	5-300	5-700	0.35-32	10-100	30-100

* ppm dry weight

SELENIUM

	Liver	Kidney	Serum or Plasma (No Supplement)	(Se Supplement)
Deficient	0.02-0.17	0.18-0.40	0.002-0.025	
Marginal	0.12-0.25	0.40-1.00	0.030-0.060	0.020-0.060
Adequate	0.25-0.50	1.00-1.50	0.080-0.300	0.025-0.150
High	0.75-1.25	2.00-2.50	2.5-3.5	0.800-3.500
Toxic - chronic	1.25-7.00	2.50-5.00	3.5-4.1	
- acute	7.00-47.0	1.00-8.00		

ZINC

	Liver	Kidney	Serum
Deficient	<20-40	16-20	0.20-0.40
Marginal	25-40	16-20	0.50-0.60
Adequate	25-100	18-25	0.80-1.40
High	300-500	50-140	2.00-5.00
Toxic	120-500	130-480	3.00-15.0

Toxicology – Animal Mineral Levels (continued)

CANINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney
Normal	< 0.2	< 0.2
Toxic	> 10.0	> 10.2

CADMIUM

	Liver	Kidney
Normal	0.037	0.12-0.18
High	1.0-7.0	4.0-17.0
Toxic		> 200

COPPER

	Liver	Kidney	Serum
Deficient	< 20	< 5.0	< 0.20
Normal	30.0-100	5.0-15.0	0.20-0.80
Toxic	400-3000	> 20	

LEAD

	Liver	Kidney	Heparinized Blood	Hair *
Normal	0.1-3.5	0.1-2.5	0.01-0.10	0-88
High	3.6-5.0	5.0-10.0	0.30-0.80	0-87
Toxic	50-200	10-50	0.60-7.4	> 88
				* ppm dry weight

ZINC

	Liver	Kidney	Serum
Deficient	< 15	< 8	0.20-2.00
Adequate	30-70	16-30	0.70-2.00
Toxic	369	295	10.0-32.0

Toxicology – Animal Mineral Levels (continued)

EQUINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney
Normal	< 0.4	< 0.4
High	1.0-5.0	
Toxic	7.0-15	> 10.0

CADMIUM

	Liver	Kidney
Normal	0.01-5.0	0.05-10.0
High	15-30	4.2-100
Toxic	> 80	75-170

COPPER

	Liver	Kidney	Serum
Deficient	< 3.5	< 4.0	0.60-0.80
Adequate	4.0-7.5	7.3-9.3	0.85-2.00
High	1000-1500	30-50	

LEAD

	Liver	Kidney	Heparinized Blood	Brain	Bone*
Normal	0.08-1.4	0.03-1.30	0.04-0.25	0.5	3.0-4.0
High	3.0-5.0	3.0-5.0	0.30-0.60	1.0-5.0	8.9-40
Toxic - chronic	4.0-50	5.0-140	0.33-140	3.0-30	40-350
- acute	10-500	20-200	0.60-2.5		
					* ppm dry weight

Toxicology – Animal Mineral Levels (continued)

EQUINE Values in ppm Wet Weight

SELENIUM

	Liver	Kidney	Serum
Deficient	0.14-0.20	0.14-1.10	0.008-0.053
Marginal	0.20-0.30	0.35	0.053-0.120
Adequate	0.30-1.00	0.70-2.00	0.140-0.250
High			0.350-1.000
Toxic - chronic	10.0		1.400-2.000
- acute	> 2.5	> 2.0	

ZINC

	Liver	Kidney	Serum
Deficient			< 0.50
Adequate	40-125	20-50	0.60-1.70
High	160-500	65-150	1.60-3.50
Toxic	1300-1900	295-580	1.00-3.50

Toxicology – Animal Mineral Levels (continued)

PORCINE Values in ppm Wet Weight

ARSENIC			
	Liver	Kidney	Heparinized Blood
Normal	0.003-0.20	0.03-0.10	0.01
CADMIUM			
	Liver	Kidney	
Normal	0.04-5.0	0.15-0.99	
High	3.0-30.0	2.0-50	
Toxic	> 13	> 270	
COPPER			
	Liver	Kidney	Serum
Deficient	0.30-1.02	2.0-4.0	0.09-0.40
Marginal	4.0-7.0	4.0-7.0	0.40-1.50
Adequate	5.0-25.0	7.0-10.0	1.30-3.00
High	15-200	12.0-25.0	1.70-3.00
Toxic	150-15000	300-1200	4.5-77
SELENIUM			
	Liver	Kidney	Serum
Deficient	0.03-0.10	0.40-0.77	0.005-0.060
Marginal	0.12-0.25	0.77-1.10	0.060-0.100
Adequate	0.40-1.20	1.50-2.90	0.140-0.300
High	1.50-12.0	3.00-18.0	0.400-0.800
Toxic	3.00-120	3.80-90.0	0.500-2.360
ZINC			
	Liver	Kidney	Serum
Deficient	9.6-25		0.18-0.25
Marginal	25-35		0.40-0.80
Adequate	40-90	15-30	0.70-1.50
High	> 200		
Toxic	500-3100	190-367	1.40-2.80

Toxicology – Animal Mineral Levels (continued)

OVINE Values in ppm Wet Weight

ARSENIC

	Liver	Kidney	Heparinized Blood
Normal	0.01-0.20	0.01-0.30	0.01-0.08
High	4.0-8.0	1.0-6.0	0.04-0.50
Toxic	10.0-50.0	10.0-40.0	5.0-14.5

CADMIUM

	Liver	Kidney
Normal	0.02-1.40	0.06-0.48
High	2.0-20.0	4.0-12.0
Toxic	50-600	50-400

COPPER

	Liver	Kidney	Serum
Deficient	0.50-4.0	3.0-4.0	0.10-1.00
Marginal	5.0-20	4.0-5.0	0.40-1.00
Adequate	25-100	4.0-5.5	0.70-2.0
High	100-500	4.0-10	1.00-5.00
Toxic	250-1000	18-260	3.3-20

LEAD

	Liver	Kidney	Heparinized Blood	Brain	Bone (Tibia)*
Normal	0.03-0.80	0.10-0.80	0.02-0.25	0.1-0.5	1.0-3.0
High	5-25	5-100	0.70-0.90	1.2-2.0	10-40
Toxic	10-100	5-200	1.0-5.0		> 70
					* ppm dry weight

Toxicology – Animal Mineral Levels (continued)

OVINE Values in ppm Wet Weight

SELENIUM

	Liver	Kidney	Serum
Deficient	0.01-0.10	0.046-0.600	0.006-0.030
Marginal	0.15-0.25	0.70-1.10	0.030-0.060
Adequate	0.25-1.50	0.90-3.00	0.080-0.500
High	2.00-10.0	4.00-6.00	
Toxic	15.0-30.0	6.00-15.00	> 3.0
Toxic – injected (IM)	3.6-18.2	3.39-8.70	

ZINC

	Liver	Kidney	Serum
Deficient	20-30	15-30	0.22-0.45
Marginal			0.40-0.80
Adequate	30-75	20-40	0.80-1.20
High	100-400	50-1000	4.0-5.0
Toxic	> 400	240-1600	30.0-50.0

NOTE:

- Tissue mineral levels are quoted from Mineral Levels in Animal Health, Diagnostic Data by Robert Puls, 3rd printing, 1990.
- Conversion of units between wet and dry weight:

$$\text{Units in dry weight:} \quad \frac{\% \text{ dry matter}}{100} = \text{units in wet weight}$$

$$\text{Units in wet weight:} \quad \frac{100}{\% \text{ dry matter}} = \text{units in dry weight}$$