

Cellular Constituents and Chemistry of the Hamster's Blood

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The contacts with tropical diseases which our armed forces have had during World War II have markedly increased the interest in this class of ailments. Beyond the investigations in bird and monkey malaria and the work on amebic dysentery in the monkey, very little has been done in this field, because there have been no suitable laboratory animals to act as hosts. The comparatively recent work of Adler (1) and Soong and Anderson (2) on the transmission of leishmaniasis to the hamster has made that animal very important in experimental therapy.

Considerable work has been done on the hamster, particularly in the field of infectious diseases. Although blood cell studies have been conducted (3,4), blood chemistry has not been attempted to a great extent. Since some knowledge of these factors is essential in the use of an animal for the investigation of the effect of drugs, we found it necessary to carry out certain experiments. Our work on the response of the hamster to drugs appears elsewhere (5).

The purpose of the present study was to establish some blood chemistry standards and to investigate some of the hematological elements concerned with the physiology of the hamster. Throughout our experiments, the Syrian or Golden Hamster, *Cricetus auratus*, was used.

The report on the hematology of the hamster by Stewart, Florio, and Mugrage (3) made it unnecessary for us to do a complete blood study. We did, however, make total erythrocyte and leucocyte counts, hemoglobin determinations, and differential counts (Table I). In addition, the more common blood chemistry tests, including those for uric acid, urea, creatinine, non-protein nitrogen, calcium, inorganic phosphorus, and prothrombin, were applied (Tables II, III, IV, and V).

Our animals were obtained from a dealer and allowed to become acclimated to our air-conditioned quarters for about a week. Their food consisted of a commercial diet, "Purina Laboratory Chow," with a liberal addition of kale. All hamsters were between 2 and 5 months old.

The hamster tends to bite anyone who handles it. It is necessary, therefore, to hold it with leather gloves. In order to draw blood for cell counting, the animal is placed in a telescope-like holder. The right hind leg is allowed to protrude from a slot in the side of the holder. A needle prick through the shaved skin into a superficial vein of the exposed leg will permit a sufficient blood flow. This procedure, however, does not allow withdrawal of enough blood for chemical analysis. It is necessary, therefore, to anesthetize the hamster and make a cardiac puncture.

The total erythrocyte and leucocyte counts are the average of duplicate counts on the same group of animals. The blood was col-

Table I. Blood Counts on the Hamster

Animal Number	Sex	Weight	Hemoglobin	Erythrocytes	Leucocytes	Neutrophiles	Lymphocytes	Monoocytes	Eosinophiles
		<i>gm.</i>	<i>gm. per 100 cc.</i>	<i>millions per cmm.</i>	<i>thousands per cmm.</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>	<i>per cent</i>
1	M	84	18.0	8.5	9.2	27	71	2	0
2	M	100	17.1	8.9	9.3	29	65	3	3
3	M	100	19.2	9.7	8.1	27	72	0	1
4	M	90	16.8	9.6	8.5	30	64	4	2
5	M	90	20.0	8.8	8.9	28	69	2	1
6	F	102	21.0	8.9	8.6	29	69	1	1
7	M	88	15.0	7.5	8.8	32	65	3	0
8	M	115	18.0	9.3	9.3	26	70	2	2
9	M	95	17.2	8.2	8.1	25	73	2	0
10	F	110	18.3	9.7	8.3	31	68	1	0
Mean ± Standard Error			18.06 ± 0.54	8.94 ± 0.24	8.69 ± 0.18	28.4 ± 0.7	68.6 ± 0.98	2 ± 0.37	1 ± 0.33

Table II. Representative Blood Chemistry—Organic

Animal Number	Sex	Weight	Uric Acid	Urea	Creatinine	Non-Protein Nitrogen
		<i>gm.</i>	<i>mg. per 100 cc.</i>			
11	M	109	5.00	12.18	0.93	51.6
12	F	113	4.22	11.90	1.30	46.8
13	M	100	5.64	15.40	1.00	39.7
14	M	97	4.10	20.30	0.87	44.2
15	F	95	4.50	20.65	0.94	47.6
16	F	103	5.06	19.60	0.86	44.4
17	M	96	4.14	13.65	0.91	49.8
18	M	98	4.39	14.70	0.92	48.0
19	M	92	4.05	10.71	0.90	42.1
20	M	105	4.62	13.30	0.95	47.6
Mean \pm Standard Error			4.55 \pm 0.14	15.34 \pm 1.1	0.95 \pm 0.04	46.2 \pm 1.1

lected and diluted in pipettes certified by the Bureau of Standards, and the counts were made in a Spencer "bright line" counting chamber. For hemoglobin determinations, the blood (0.02 cc.) was diluted with 5 cc. of N/10 hydrochloric acid, and after allowing the mixture to stand for 30 minutes, it was placed in a Fisher Electro-Hemometer. The hemoglobin content was read directly in grams per 100 cc. of blood.

The differential leucocyte count of the hamster agreed with those of other rodents. The chief difference between these findings and those recorded for man is a reversal of the neutrophile and lymphocyte percentage values. In man, the neutrophiles are in the majority; they are the scavenger cells and phagocytize invading organisms. In the rodent, the lymphocytes are greater in number than the neutrophiles.

Hamster blood in amounts up to 2 cc. was collected by cardiac puncture for chemical studies. With the exception of the serum for calcium and inorganic phosphorus determinations, all the blood samples were oxalated immediately. The improved method of Folin (6) was utilized for blood uric acid. The values obtained from 10 animals were 4.05 to 5.62 mg. per 100 cc. of blood, with an average (arithmetic mean) of 4.55 ± 0.14 mg. per 100 cc. This is a little higher than the average range for man. Urea was calculated by the aeration method of Myers, Fine, and Lough (7). These values extended from 10.71 to 20.3 mg. per 100 cc. with an average of 15.34 ± 1.1 mg. per 100 cc. The range of blood creatinine by the method of Folin and Wu (8) was 0.87 to 1.3 mg. per 100 cc. with an average of 0.95 ± 0.04 mg. per 100 cc. Non-protein nitrogen was determined by the micro-Kjeldahl method of Wagner (9). The values for the blood of 10 hamsters ranged from 39.7 to 51.6 mg. per 100 cc. with an average of 46.2 ± 1.1 mg. per 100 cc.

Blood serum calcium studies were made on 30 animals. The amount of blood required by the Tisdall method (10) made it necessary to pool the blood from 10 hamsters for each set of determinations. The result ranged from 11.7 to 13.2 mg. per 100 cc., with an average of 12.47 ± 0.43 mg. per 100 cc. Inorganic phosphorus values, obtained by the procedure of Benedict (11), ranged from 3.85 to 5.81 mg. per 100 cc. with an average of 4.33 ± 0.17 mg. per 100 cc.

Table III. Representative Blood Chemistry-Inorganic

Animal Number	Sex	Weight <i>gm.</i>	Calcium <i>mg. per 100 cc.</i>
21	M	114	
22	F	112	
23	F	103	
24	M	95	
25	M	100	11.7
26	M	97	
27	M	94	
28	M	92	
29	F	108	
30	M	103	
31	M	87	
32	M	91	
33	F	100	
34	M	84	
35	F	96	13.2
36	M	92	
37	M	102	
38	M	113	
39	M	94	
40	M	89	
41	M	95	
42	M	98	
43	M	101	
44	F	88	
45	F	105	12.5
46	M	92	
47	M	94	
48	M	111	
49	F	90	
50	M	97	
Mean \pm Standard Error			12.47 ± 0.43

Table IV. Representative Blood Chemistry-Inorganic
(Continued)

Animal Number	Sex	Weight <i>gm.</i>	Phosphorus
			<i>mg. per 100 cc.</i>
51	F	96	4.10
52	F	102	5.00
53	M	115	3.95
54	M	110	4.15
55	M	117	4.60
56	M	99	5.51
57	M	112	3.95
58	M	111	4.20
59	M	108	4.00
60	M	106	3.85
Mean \pm Standard Error			4.33 \pm 0.17

The prothrombin time of the hamster blood plasma was recorded in seconds by a modified method of Campbell, Smith, Roberts, and Link (12), in which 'Hemagulen' (Brain Thromboplastic Suspension, Lilly) was used in place of dried rabbit brain suspension. The range for whole plasma was 13 to 15 seconds, with an average of 14 ± 0.16 seconds; and for 12.5 percent plasma (diluted with physiological saline), 20 to 30 seconds with an average of 25.45 ± 0.9 seconds.

Table V. Representative Blood Chemistry-Coagulation

Animal Number	Sex	Weight <i>gm.</i>	Prothrombin Time	
			Whole Plasma <i>seconds</i>	12.5% Plasma <i>seconds</i>
61	M	119	13.0	25.5
62	M	104	14.0	29.5
63	M	113	15.0	27.0
64	F	99	14.0	30.0
65	M	105	13.0	20.0
66	M	90	13.5	20.0
67	F	106	14.0	27.0
68	M	117	14.5	21.0
69	M	113	14.0	24.9
70	M	100	15.0	30.0
Mean \pm Standard Error			14 \pm 0.16	25.45 \pm 0.90

Summary

In order to establish a firm basis for pharmacological experimentation on the Syrian hamster, blood cell counts and blood chemical analyses have been carried out. With the exception of creatinine, all values approached or exceeded the upper limits of the standards usually given for man.

References

1. Adler, S., 1942. The action of some aromatic diamidines on infections of *Leishmania donovani* in the Syrian hamster (*Cricetus auratus*). *Ann. Trop. Med. and Parasitol.*, **36**:11-16.
2. Soong, H. Y., and Anderson, H. H., 1941. The evaluation of drugs in experimental leishmaniasis. *Am. J. Trop. Med.*, **21**:461-467.
3. Stewart, M. O., Florio, L., and Mugrage, E. R., 1944. Hematological findings in the golden hamster (*Cricetus auratus*). *J. Exper. Med.*, **80**:189-196.
4. Knoll, W., 1932. Das morphologische blutbild der säugetiere. I. Allgemeine und spezielle morphologie der kernhaltigen blutzellen der säugetiere. *Jahrb. Morph. u. Mikrosk. Anat. Abt. II. Zeit. Mikrosk. Anat. Forsch.*, **30**:116-150; 1934, *Biol. Abs.*, **8**:9558.
5. Chen, K. K., Powell, C. E., and Maze, N., 1945. The response of the hamster to drugs. *J. Pharmacol. and Exper. Therap.*, **85**:348-355.
6. Folin, O., 1930. An improved method for the determination of uric acid in blood. *J. Biol. Chem.*, **86**:179-187.
7. Myers, V. C., Fine, M. S., and Lough, W. G., 1916. The significance of the uric acid, urea and creatinine of the blood in nephritis. *Arch. Int. Med.*, **17**:570-583.
8. Folin, O., and Wu, H., 1919. A system of blood analysis. *J. Biol. Chem.*, **38**:98-100.
9. Wagner, E. C., 1940. Titration of ammonia in presence of boric acid. *Indust. and Eng. Chem., Anal. Ed.*, **12**:771-772.
10. Tisdall, F. F., 1923. A note on the Kramer-Tisdall method for the determination of calcium in small amounts of serum. *J. Biol. Chem.*, **56**:439-441.
11. Benedict, S. R., and Theis, R. C., 1924. A modification of the molybdc method for the determination of inorganic phosphorus in serum. *J. Biol. Chem.*, **61**:63-66.
12. Campbell, H. A., Smith, W. K., Roberts, W. L., and Link, K. P., 1941. Studies on the hemorrhagic sweet clover disease. II. The bioassay of hemorrhagic concentrates by following the prothrombin level in the plasma of rabbit blood. *J. Biol. Chem.*, **138**:1-20.