Hematological Studies in Normal Rhesus Monkeys (*Macaca mulatta*)[1]

1. Venous Blood Studies
2. Bone Marrow Studies

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In a review of the literature dealing with hematological findings in monkeys, the writers were struck by the scarcity of publications on the peripheral blood stream and the total absence of articles on the subject of the bone marrow of these animals. It was found that the peripheral blood picture was discussed in no more than twenty-four publications, the most recent having been published in 1938.

Scarborough,[2] in an analysis of the published data, called attention in several instances to the deficiency there exists in the study of many of the blood constituents of monkeys. According to him, the red blood cells were biconcave discs, showing some variation in size. Rarity of abnormal forms was the rule, and polychromatophilia was moderately frequent. However, after studying four different species of monkeys, Hayem[3] failed to encounter nucleated cells in their peripheral blood. Anderson and Neill[4] found one single nucleated cell in ten monkeys studied, and Krumbhaar[5] explained that the average of reticulated cells in monkey blood is around 0.3 percent, with a normal variation of 0 to 0.8 percent, the reticulations being more delicate than in either man or other animals. The size of the erythrocytes was equal to that of man with, according to Hayem,[6] an average diameter of 7.1 micra.

The average number of total red blood cells, reported by four

1. Received for publication May 16, 1942. This work was carried on with the aid of Rhesus monkeys of the Santiago Island Primate Colony, where environmental conditions approach as much as possible the native habitat of these animals.

2. R. A. Scarborough, *Yale J.Biol. & Med.*, IV (1942), 199.
3. G. Hayem, "*Du Sang et de ses altérations anatomiques.*" Paris, 1889.
4. J. F. Anderson and M. H. Neill, *J.Med.Research*, XXXIII (1915), 141
5. E. B. Krumbhaar, *J.Lab. & Clin.Med.*, VIII (1922), 11.
6. Hayem, *op. cit.*

authors,[7] and corroborated by Scarborough,[8] was around 5,590,000 per cmm., with a normal range fluctuating between 5,000,000 and 7,000,000. Krumbhaar and Musser[9] found no influence of age or size of the animal upon the number of red blood cells. Results from their study of thirty-six animals demonstrated that the hemoglobin estimations varied tremendously. This was in agreement with the findings of three different authors,[10] who reported minima of 63, 73, 88, and 85 percent, averages of 75, 67, 85, 103, and 95 percent, and maxima varying from 82 to 115 percent. Their estimations, however, were calculated by different methods and lack dependability.

Krumbhaar and Musser[11] described the polymorphonuclear cells as having as many as ten to fifteen lobules in their nuclei, and the lymphocytes as being larger than in man. Lucas and Prizer[12] found that it was quite difficult to differentiate the large lymphocytes from the monocytes. The total number of leukocytes, as reported by nine investigators,[13] averaged 16,210 with a normal range of 8,000 to 25,000, their average differential findings being:

	Percent	
Polymorphonuclears	42.2	(30–50)
Lymphocytes	52.8	(40–60)
Large mononuclears, or transitionals	1.5	(1–12)
Eosinophils	3.7	(1–5)
Basophils	0.32	(.1–.5)

The average count of platelets in the peripheral blood stream of monkeys, as reported by Krumbhaar and Musser,[14] was 267,000 per cmm., with a variation of 155,000 to 424,000.

7. Hayem, *op. cit.*
   Anderson and Neill, *op. cit.*
   E. B. Krumbhaar and J. H. Musser, *J.Med.Research*, XLII (1921), 105.
   J. J. Wells and J. E. Sutton, *Am.J.Physiol.*, XXXIX (1915), 31.
8. Scarborough, *op. cit.*
9. Krumbhaar and Musser, *op. cit.*
10. Anderson and Neill, *op. cit.*
    Krumbhaar and Musser, *op. cit.*
    C. Klieneberger and W. Carl, "*Die Blut-Morphologie der Laboratoriums-Tiere.*" Leipzig, 1912.
11. Krumbhaar and Musser, *op. cit.*
12. W. P. Lucas and E. L. Prizer, *J.Med.Research*, XXVI (1912), 181.
13. Hayem, *op. cit.*
    Anderson and Neill, *op. cit.*
    Krumbhaar and Musser, *op. cit.*
    Wells and Sutton, *op. cit.*
    Lucas and Prizer, *op. cit.*
    L. Hektoen and H. E. Eggers, *J.A.M.A.*, LVII (1911), 1833.
    A. W. Sellards and W. A. Baetjer, *Johns Hopkins Hosp.Bull.*, XXVI (1915), 29.
    H. D. Taylor, *J.Exper.Med.*, XXIX (1919), 97.
    H. D. Taylor, W. D. Witherbee, and J. B. Murphy, *J.Exper.Med.*, XXIX (1919), 53.
14. Krumbhaar and Musser, *op. cit.*

No comparison could be established for the bone marrow studies, since the writers were unable to find citations in the literature referring to this subject.

VENOUS BLOOD STUDIES

Materials and methods. Blood was obtained from one of the peripheral veins in the legs of thirty-eight normal Rhesus (*M. mulatta*). Of these, eight were infants; four, young; and twenty-six, adults. Twenty-three were males and fifteen, females. Their ages varied from six months to fifteen years; their weights, from 0.74 to 11.47 kilos.

The hemoglobin determinations were conducted by the Sahli-Hellige method, in which 100 percent is equivalent to 14.5 gm. of hemoglobin per 100 cc. of blood. White blood cells were counted in standard pipettes with a 2 percent acetic acid solution as diluting fluid, and the red blood cells and platelets, with a sodium citrate solution (0.5 gm. in 16 cc. of distilled water). Wright's stain was utilized in the smear for differential counts, and a dried drop of a saturated solution of Cresyl blue in 95 percent ethyl alcohol, for the reticulocyte estimations.

Outline of results. (*a*) *Infants:* Five males and three females were submitted to the tests. Their ages varied between six months and two years; their weights, from 0.74 to 3.06 kilos. Estimations were made in one blood sample from each of these animals. Hemoglobin percentages ranged between 76 and 94, with an average of 84.62 percent, equivalent to 11, 13.6, and 12.2 gm., respectively.

The range of the red blood cells fluctuated between 3,560,000 and 4,760,000 per cmm., with an average of 4,197,500. The platelet count ranged between 240,000 and 420,000, with an average of 311,857 in the seven animals on which the counts were made. The range of the reticulocyte counts was between 1.4 and 6.8 percent, with an average of 2.9 percent in seven of the infant monkeys. A difference in the red blood cell count and hemoglobin estimation was not evident for either males or females, but the reticulocyte count was higher in two of the latter.

The white blood cell counts fluctuated between 10,050 and 21,750, with an average of 15,107, the highest and the lowest being found in two six-month-old males.

The metamyelocytes averaged 0.76 percent, with a range of 0 to 3. Polymorphonuclear neutrophils were encountered in numbers of 31 to 43 percent, with an average of 36.12 percent. Eosinophils were found in seven out of the eight animals studied, with a range of 0 to 6 and an average of 3.06 percent. Basophils were seen in but three of the specimens, ranging from 0 to 2 and averaging 0.44 percent. On the other hand, lymphocytes were seen in abundance with a variation of 50.5 to 66, and averaging 57.76 percent; monocytes, present in numbers of 0.5 to 3 percent, averaged 0.18.

(*b*) *Young:* Four young animals were studied—two males and two females. Their ages varied from three to four years and their weights, from 3.86 to 5.11 kilos.

Their hemoglobin ranged from 80 (11.6 gm.) to 110 percent (15.9 gm.), with an average of 90.5 percent (13.1 gm.). The red blood cells averaged 5,172,500, with a variation of 4,490,000 to 6,050,000; platelets, 377,750 with a range of 210,000 to 561,000. Three of the animals had 350,000, or more. Reticulocytes appeared in numbers of 1.4 to 2.4 percent and averaged 1.85 percent.

White blood cells numbered 17,562 per cmm., as an average, with a range of 14,550 to 22,500. Metamyelocytes ranged from 0 to 1 percent, with an average of 0.5 percent. The polymorphonuclear neutrophils averaged 38 percent, with a range of 26 to 51 percent; eosinophils, from 3 to 5 percent, with an average of 4 percent. No basophils were found in any of the four samples. The lymphocytes found in numbers of 45 to 69 percent gave an average of 56.74, while the monocytes averaged only 0.75 percent.

(*c*) *Adult:* Among the twenty-six adult monkeys of the experiment, there were sixteen males and ten females, with an age variation of four to fifteen years and a weight variation of 5.56 to 11.47 kilos.

In twenty-five hemoglobin determinations made, the average was found to be 91.16 percent (13.2 gm.), with a range of 76 to 117 percent (11 to 17.1 gm.). Six animals had an average of 80 percent, or less, and four only, 100 percent, or more. The red blood cell counts in the twenty-six monkeys varied from 3,550,000 to 6,860,000, with an average of 5,233,076 cells. In one instance only, the count was below 4,000,000; in twenty, it was above 5,000,000, and three animals had more than 6,000,000 red cells in their venous blood. The platelet count in twenty-five samples was found to range from 180,000 to 560,000, with an average of 306,880. In twenty specimens, the reticulocyte count was from 0.6 to 2.6, with an average of 1.58 percent.

Twenty-five samples averaged 9,999 for the white blood cell count, with a range of 5,000 to 15,750; in fifteen, the count was

10,000, or less; and in only three was it less than 6,000. The metamyelocytes ranged from 0 to 3 percent with an average of 1.15; these cells were found in the venous blood of all but eight animals. The polymorphonuclear neutrophils appeared in numbers from 32 to 79 percent and averaged 50.23 percent; in fourteen, the average was 50 percent, or more; in four, above 60 percent, and in four, below 40 percent. The eosinophils were found in all specimens with a range of 1 to 12 percent and averaged 4.92 percent; in fourteen, the average was 4 percent, or more; and in six, above 8 percent.

Lymphocytes ranged from 14 to 66 percent with an average of 42.19 percent; an average below 40 percent was found in eight only. Monocytes ranged from 0 to 4 percent, with an average of 1.19 percent.

Morphology. The granulocytes showed an increased number of lobulations in their nuclei, with sometimes as many as twelve or thirteen lobes. Lymphocytes appeared to be larger than those of humans; in many of them the cytoplasm had moderately coarse granules. Hall[15] reported similar findings in 1929. In only one monkey (No. 172) was a normoblast seen; otherwise, the blood smears looked like those of normal human blood.

Comment. Study of the venous blood of thirty-eight Rhesus of various ages and weights revealed that the average hemoglobin in the infant animal was lower than in the young and adult, the young having a percentage almost as high as that of the adult animal. The red blood cell count of the infant monkey was also lower than that of the young or adult, the latter two presenting an average count of over 5,000,000, while the infant averaged a little over 4,000,000. The average platelet count for all animals was above 300,000, the highest being encountered in the young. The reticulocyte count was higher in the infant than in either the young or adult. The infant and young monkeys presented a higher total leukocyte count than the adult. There were more metamyelocytes in the adult than in either the infant or the young animals' venous blood.

The venous blood of the infant and young was richer in lymphocytes than that of the adult. Polymorphonuclear neutrophils, as well as eosinophils, were encountered in higher numbers in the adult monkey's blood than in either infant or young, but the average of eosinophils in the young animals' blood approached that of the

15. B. E. Hall, "Morphology of Cellular Elements of Blood of the Monkey, Macacus Rhesus," *Folia haemat.*, XXXVIII (1929), 30.

adult. The neutrophils and eosinophils showed an increased number of lobulations in their nuclei; sometimes as many as thirteen to fourteen lobes were counted. Lymphocytes appeared larger than human ones and, in many of them, the cytoplasm presented moderately coarse granules. Otherwise, the blood smears appeared to be similar to those for human blood.

BONE MARROW STUDIES

Materials and methods. Of forty healthy Rhesus monkeys submitted to bone marrow aspirations, twenty-one were males and nineteen females, with ages ranging from six months to twelve years, and weights fluctuating between 1.51 and 11.48 kilos. There were four infants, eight young, and twenty-eight adults among them.

For the purposes of the experiment, the animal was tied to a table, his head turned to one side, and the mid sternum cleaned with iodine and alcohol. The needle, an 18-gauge attached to a 20 cc. syringe, was introduced into the midline, and the site of greatest resistance located in the sternum. The needle was then screwed obliquely with very slight pressure, at an angle of 45°, into the marrow cavity. Since strong negative pressure is needed to obtain even minute quantities of marrow, aspiration at times was quite difficult, yielding marrow for only a few smears, which was probably due to its scarcity and richness in fat. The sternum of the monkey is quite soft; cartilaginous, or soft, bone was often traversed by the needle with no obtention of marrow. It is therefore advisable to perforate the hardest portions of the bone that are usually encountered in the mid sternum.

After staining with Jenner-Giemsa stain, smears of the marrow were studied. Differential counts were performed on all forty specimens, an average of 500 cells being counted in each specimen.

Outline of results. (*a*) *Infants:* In four infant Rhesus, the bone marrow differential counts yielded the following results: megaloblasts appeared to be scarce; in only one sample was there found 1 percent and, in the other, 0.5 percent. In the other two samples, no megaloblasts were seen. The average was 0.37 percent. Early erythroblasts ranged from 0 to 2.5 percent, with an average of 1.32 percent, while late erythroblasts had a variation between 2 and 9.3 percent, and an average of 5.82. The normoblasts were present in percentages of 6.1 and 20.5, with an average of 12.3.

There were no myeloblasts in any of the samples of the bone marrow of infant monkeys; there were very few pre-myelocytes, with

an average only of 0.55 percent, but with 5.42 percent for neutrophilic myelocytes, 0.67 for eosinophilic myelocytes, and 0.12 for basophilic myelocytes. There was an average of 5.2 percent of metamyelocytes, with a range of 4.5 to 6 percent, while 40.05 percent was recorded as an average for the adult neutrophils with a variation of 34.5 to 45 percent. There were 2.3 eosinophils and 0.2 percent basophils, as average for the four specimens.

Lymphocytes ranged between 12 and 33.3 percent in these same samples, with an average of 25.57 percent, while the percentage of plasma cells was not more than 0.07 (Table 4).

(*b*) *Young:* The marrow of eight young monkeys was studied, giving an average percentage of megaloblasts of 0.23, with a range of 0 to 1 percent. Early erythroblasts were slightly less than in the infant monkeys, reaching an average of 0.91 percent. The same thing could be said of late erythroblasts, which yielded an average of 4.75 percent. The normoblasts were less than in infant monkeys, numbering 10.78 percent.

Myeloblasts were found in two samples, with a total average of 0.11 percent. Pre-myelocytes averaged 1.18 percent, thus doubling the count in infant monkeys. The neutrophilic myelocytes averaged 4.25 percent; the eosinophilic and the basophilic, 0.33 and 0.02, respectively. Metamyelocytes appeared as 7.18 percent; adult polymorphonuclear neutrophils amounted to 42.55 percent, while eosinophilic and basophilic leukocytes reached an average of 2.15 and 0.17 percent, respectively.

There were as many lymphocytes in the bone marrow of the infant as in that of the young animals, averaging 25.2 percent. However, 0.05 percent monocytes and 0.56 percent plasma cells were found in the marrow of the young monkeys (Table 5).

(*c*) *Adult:* Twenty-eight adult Macacus were studied. In each of them a differential count of the bone marrow was performed, as previously explained for infant and young monkeys. In the adult series, there was found an average of 0.15 percent megaloblasts, lower than in the infant and young, 0.98 of early erythroblasts, 4.35 late erythroblasts, and 10.30 normoblasts. The megaloblasts had a range of 0 to 0.8 percent, being below 1 percent in all specimens.

Myeloblasts appeared in a 0.11 percent average. Pre-myelocytes ranged from 0 to 5.6, with an average of 1.18 percent, thus doubling the average counts for young and adult animals. Neutrophilic myelocytes ranged between 1.2 and 13, averaging 4.25 percent, a count which was less than in both young and infant monkeys, while

eosinophilic and basophilic myelocytes had an average of 0.33 and 0.02, respectively. The metamyelocytes ranged between 2.5 and 18 percent, averaging 7.18 a count, and higher than in infant and young monkeys. Adult polymorphonuclear leukocytes amounted to 46.86 percent, a little higher than in the younger animals; eosinophilic and basophilic adult polynuclears averaged 1.86 and 0.07 percent, respectively, a little less than in the infant and young monkeys.

Lymphocytes appeared averaging 21.56 percent, an amount almost equal to the count in infants, but less than for the young animals. The monocytes were found in larger numbers in the adult than in the younger animals, with 0.10 percent as average. The percentage of plasma cells was 0.62, a little higher than in the young and very much greater than in the infant animals. In none of the samples were megakariocytes encountered, except in two adults, where the percentage was 0.2 (Table 6).

In the infant animals the total erythrocytic series averaged 19.82 percent; the total average for the granulocytic series was 54.52 percent, and for the lymphocytic, 25.65 percent. There was a total average of 16.68 for the erythrocytic series in the young monkeys, while in the adult, it averaged 15.79 percent. The total granulocytic series for the adult was 61.89 percent; the lymphocytic, 22.31 percent.

The erythrocytic component of the bone marrow in infant and young monkeys was thus higher than in the adult animals. The granulocytic component was higher in the adult than in either the young or infant monkeys, there being a gradual decrease with age, contrary to the erythrocytic component. The lymphocytic series were in all higher in the infant and young than in the adult animal. However, it was very interesting to note that, even in the adult monkeys, the lymphocyte count was quite high, i.e., 22.31 percent (Tables 4, 5, and 6). Ratios between erythrocytic and granulocytic series were as follows: infant, 1:2.8; young, 1:3, and adult, 1:4.

Morphology. The cells resembled those of human bone marrow. The lobes of the nuclei of the polymorphonuclears were numerous in some specimens. Lymphocytes appeared larger in size than in human marrow, a great number showing many coarse granules in the cytoplasm. With the exception of two specimens, megakariocytes were totally absent. Many loose nuclei resembling reticuloendothelial cells were encountered, but only in a very few samples was there seen a definite cytoplasmic component in the cells.

Comment. The bone marrow picture of the infant monkey was characterized by a higher count in megaloblasts, early erythroblasts, late erythroblasts, and normoblasts than in the young or adult animal, but the number of cells of the granulocytic series was lower in the infant than in the young or adult monkey. The lymphocytes were more numerous in the marrow of the infant than in that of the adult animal, but equal to that in the young. The same thing may be said about the bone marrow of the young monkey, which appeared to present the same picture as in the infant with relation to the adult. Thus, the averages for the erythrocytic series were higher than in the adults, the averages for the granulocytic component less than in the latter, and the averages for lymphocytes, higher than in the older animals.

The ratio of the erythrocytic series to the granulocytic was as follows: in the infant, 1:2.8; in the young, 1:3; in the adult, 1:4 (megakariocytes were found only in two adult samples).

SUMMARY

1. Hemoglobin estimations for thirty-eight Rhesus monkeys were as follows: infant monkeys, 84.62 percent; young, 90.5 percent; adult, 91.16 percent, with ranges of 76 to 94, 80 to 110, and 76 to 117 percent, respectively.

2. Red blood cell count averaged 4,197,500 in the infant, 5,172,500 in the young, and 5,235,000 in the adult animal.

3. Platelet count averaged over 300,000.

4. Reticulocyte counts were 2.9 percent for infant, 1.85 percent for young, and 1.58 percent for the adult animals.

5. The average total leukocyte count was 15,107 for infant, 17,562 for young, and 9,999 for the adult animals.

6. Metamyelocytes averaged 0.75 percent in the infant, 0.5 in the young, and 1.15 in the adult animals.

7. Neutrophils were more abundant in the venous blood of the adult than in that of the young or infant monkeys, the average for the infant being 36.12 percent, for the young, 38 percent, and for the adult, 50.25 percent.

8. Eosinophilia was quite pronounced in the young and adult monkeys, which may be attributed to intestinal parasitism. Averages of 3.06 were found for infant animals, 4 percent for young, and 4.92 for adult.

9. Lymphocytes were found in higher percentages in both infant and young animals than in adult, such percentages being above 40 in all the series analyzed. Averages were given of 57.75 for the infant, 56.75 for the young, and 42.19 for the adult animals.

10. It was the authors' impression that there is a relative proportion of different blood elements in the monkey comparable to those of the human infant and young; however, these differed slightly from the venous blood of the adult human.

11. Morphologically, the neutrophils and eosinophils appeared to have multiple lobulations in their nuclei; sometimes as many as thirteen to fourteen lobes were counted in one cell. The lymphocytes appeared to be larger than in human blood and, in many cases, coarsely granulated.

The following results were obtained among the forty Macacus submitted to bone marrow aspirations:

1. The average erythrocytic series in the infant was higher than in either the young or the adult animal.

2. The average granulocytic series was higher in the adult than in either the infant or young, the young animal's marrow being richer in those cells than the infant's.

3. The young monkey had more erythrocytic cells in its marrow than the adult.

4. Lymphocytes were more numerous in the infant and the young than in the adult monkey.

5. Ratios for erythrocytic and granulocytic components were as follows: infant, 1:2.8; young, 1:3; adult, 1:4.

6. Morphologically, the cells of the bone marrow resembled those of humans, except for the multiple lobulations of the nuclei of the polymorphonuclear leukocytes and for the larger size of the lymphocytes of the animal.

7. Megakariocytes were seen in very low percentages, 0.2 in only two adult animals. None were seen in either young or infant monkeys.

8. If it were not for the high number of lymphocytes, the bone marrow of the monkey would approach the human picture at different life stages.

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TABLE 1

Peripheral Blood Picture of Eight Infant Rhesus Monkeys

	Range	*Average*
Weight (kilograms)	0.74–3.06	2.09
Hemoglobin (percent)	76–94	84.63
Hemoglobin (grams)	11.0–13.6	12.23
Red blood cells per cmm.	3.56–4.76	4,197,500
Platelets (thousands)	240–420	311,857
Reticulocytes (percent)	1.4–6.8	2.9
White blood cells per cmm.	10.05–21.75	15,107
Differential count (percent):		
Metamyelocytes	0–3	0.75
Neutrophils	31–43	36.13
Eosinophils	0–6	3.06
Basophils	0–2	0.44
Lymphocytes	50.5–66	57.75
Monocytes	0.5–3	1.88

TABLE 2

Peripheral Blood Picture of Four Young Rhesus Monkeys

	Range	*Average*
Weight (kilograms)	3.86–5.11	4.34
Hemoglobin (percent)	80–110	90.5
Hemoglobin (grams)	11.6–15.9	13.1
Red blood cells per cmm.	4.49–6.05	5,172,500
Platelets (thousands)	210–561	377,750
Reticulocytes (percent)	1.4–2.4	1.85
White blood cells per cmm.	14.55–22.5	17,562
Differential count (percent):		
Metamyelocytes	0–1	0.5
Neutrophils	26–51	38.0
Eosinophils	3–5	4.0
Basophils	0–0	0
Lymphocytes	45–69	56.75
Monocytes	0–2	0.75

TABLE 3

Peripheral Blood Picture of Twenty-six Adult Rhesus Monkeys

	Range	*Average*
Weight (kilograms)	5.56–11.5	8.84
Hemoglobin (percent)	76–117	91.16
Hemoglobin (grams)	11.0–17.1	13.22
Red blood cells per cmm.	3.55–6.86	5,233,076
Platelets (thousands)	180–560	306,880
Reticulocytes (percent)	0.6–2.6	1.58
White blood cells per cmm.	5.0–15.75	9,999
Differential count (percent):		
Metamyelocytes	0–3	1.15
Neutrophils	32–79	50.23
Eosinophils	1–12	4.92
Basophils	0–2	0.30
Lymphocytes	14–66	42.19
Monocytes	0–4	1.19

TABLE 4

Bone Marrow Picture of Four Infant Rhesus Monkeys

	Range Percent	*Average Percent*	
Sternal Marrow:			
Megaloblasts	0–1.0	0.37	
Early erythroblasts	0–2.5	1.32	
Late erythroblasts	2.0–9.3	5.82	
Normoblasts	6.7–20.5	12.3	
Total (red cell series)	10.5–31.0		19.82
Myeloblasts	0–0	0	
Pre-myelocytes	0.5– 0.7	0.5	
Neut. Myelocytes	1.5–13.5	5.42	
Eos. Myelocytes	0.5– 1.0	0.67	
Baso. Myelocytes	0 – 0.5	0.12	
Metamyelocytes	4.5– 6.0	5.2	
Poly. Neutrophils	34.5–45.0	40.05	
Poly. Eosinophils	1.0– 4.0	2.3	
Poly. Basophils	0 – 0.3	0.2	
Total (granulocytic series)	43.0–67.5		54.52
Lymphocytes	12.0–33.3	25.57	
Monocytes	0 –0	0	
Plasma cells	0 – 0.3	0.07	
Megakariocytes	0 –0	0	
Total	12.0–33.6		25.65

TABLE 5

Bone Marrow Picture of Eight Young Rhesus Monkeys

	Range Percent		*Average Percent*	
Sternal Marrow:				
Megaloblasts	0 – 1.0		0.24	
Early erythroblasts	0 – 1.6		0.91	
Late erythroblasts	0.4– 7.5		4.75	
Normoblasts	7.0–14.2		10.79	
Total (red cell series)		10.6–21.0		16.69
Myeloblasts	0 – 0.5		0.11	
Pre-myelocytes	0 – 1.0		0.6	
Neut. Myelocytes	3.4– 9.5		5.8	
Eos. Myelocytes	0 – 2.4		0.62	
Baso. Myelocytes	0 –0		0	
Metamyelocytes	1.5–15.0		5.49	
Poly. Neutrophils	37.6–49.5		42.55	
Poly. Eosinophils	0 – 4.0		2.15	
Poly. Basophils	0 – 0.5		0.17	
Total (granulocytic series)		50.2–70.2		57.5
Lymphocytes	8.6–34.0		25.2	
Monocytes	0 – 0.2		0.05	
Plasma cells	0 – 2.0		0.56	
Megakariocytes	0 – 0		0	
Total		9.2–34.8		25.81

TABLE 6

Bone Marrow Picture of Twenty-eight Adult Rhesus Monkeys as Compared with the Normal Human

	Adult Monkeys				*Normal Human*[a]
	Range Percent		*Average Percent*		*Average Percent*
Sternal Marrow:					
Megaloblasts	0 – 0.8		0.15		0.0
Early erythroblasts	0 – 4.5		0.99		14.8
Late erythroblasts	0.2–10.0		4.35		
Normoblasts	3.0–20.4		10.30		18.2
Total (red cell series)		3.6–27.4		15.80	33.0
Myeloblasts	0 – 0.5		0.11		0.6
Pre-myelocytes	0 – 5.6		1.18		9.0
Neut. Myelocytes	1.2–13.0		4.25		34.6
Eos. Myelocytes	0 – 1.5		0.33		2.0
Baso. Myelocytes	0 – 0.4		0.03		0.0
Metamyelocytes	2.5–18.0		7.18		14.6
Poly. Neutrophils	25.0–60.5		46.86		3.0
Poly. Eosinophils	0 – 7.5		1.86		
Poly. Basophils	0 – 1.2		0.08		
Total (granulocytic series)		40.0–78.2		61.89	63.8
Lymphocytes	5.8–47.2		21.57		0.0
Monocytes	0 – 0.6		0.11		2.2
Plasma cells	0 – 2.5		0.62		0.0
Megakariocytes	0 – 0.2		0.01		1.0
Total		7.8–47.4		22.31	3.2

[a]R. P. Custer and E. B. Krumbhaar, *Am.J.Med.Sc.*, CLXXXIX (1935), 620.

(Courtesy of the Puerto Rican News Bureau)

RHESUS MONKEYS (*M. mulatta*) IN THE SANTIAGO ISLAND PRIMATE COLONY