

# MORPHOLOGY AND PATHOMORPHOLOGY

## NORMAL INDICES OF THE PERIPHERAL BLOOD AND BONE MARROW FOR THE MONKEY *Macacus rhesus*

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Data on the morphological composition of the peripheral blood of monkeys given by most writers are based on small numbers of observations incapable of statistical analysis. There is no information in the literature on the number of nucleated cells in the marrow and on its morphological composition.

The mean values of the erythrocyte count cited by most workers for *Macacus rhesus* are 4,900,000-6,000,000 in 1 mm<sup>3</sup> of blood, with large variations. Shukers, Langston, and Day [9] cite figures of 3,600,000-6,800,000 in 1 mm<sup>3</sup> of blood. The same remarks apply to the hemoglobin concentration, estimated to lie between 60 and 140% (Sahli) [7]. Figures cited by different writers for the number of reticulocytes are also conflicting [1, 9, 10].

The absolute platelet count varied in different investigations from 155,000 to 545,000 in 1 mm<sup>3</sup> of blood (mean 2000,000-455,000) [1, 5, 10].

The number of leukocytes in 1 mm<sup>3</sup> of blood, according to the literature, is 7450-14,150. Various writers [2, 9] report a wide range in the leukocyte count in normal conditions (10,000-25,000 or 9700-20,500 in 1 mm<sup>3</sup> of blood), while others [3] suggest that considerable seasonal variations may occur in the same monkeys (from 10,030 to 18,040 in 1 mm<sup>3</sup> of blood).

The data in respect to the differential leukocyte count are more consistent: neutrophils 25.7-53.29%, lymphocytes 45.7-62%, monocytes 3-6.6%, eosinophils 1.37-6.77%; plasma cells 0.25-1.0% [2-6]. According to M. I. Kuksova [4], the normal ESR varies from 2.35 mm in 1 h in February to 4.9 mm in 1 h in September.

Hence, in normal conditions, the indices of the morphological composition of the peripheral blood of lower monkeys (*Macacus rhesus*) show considerable variation.

We have investigated the morphological composition of the peripheral blood in 45 monkeys of the species *Macacus rhesus* (36 males, 9 females) aged 1-2 years and kept in Moscow. The animals were kept singly in cages (50 X 50 X 50 cm). None were carriers of nor suffering from tuberculosis. The marrow of only 14 of the animals was studied. Besides calculating the myelogram, we determined the total number of nucleated cells by means of Goryaev's counting chamber. The results of these investigations, analyzed statistically, are given in Tables 1 and 2.

Comparison of the erythrocyte and leukocyte counts in the males and females showed no significant difference between them. Nevertheless, analysis of the blood counts month by month revealed an increase in the leukocyte count on account of neutrophils in April and October, and a slight decrease in their number in March and September. Similar variations were observed by M. I. Kuksova [3].

In most cases, therefore, our findings were close to those given in the literature, although individual indices (total platelet count, percentage of neutrophils, ESR) were high.

Among the peculiarities of the morphological composition of the peripheral blood in *Macacus rhesus* attention should be drawn to the presence of polychromasia and anisocytosis of the erythrocytes because of micro- and macrocytes, and to the frequent appearance of single erythroblasts in peripheral blood films.

We also noted hypersegmentosis of the neutrophils and the presence of lymphocytes with nuclei of an atypical bean-shaped appearance, sometimes in a state of amitotic division. Numerous azurophilic granules could be seen in the cytoplasm of many of the lymphocytes. In several monkeys, in addition to the usual basophils, we observed forms with grayish-blue oval granules [8].

TABLE 1. Peripheral Blood Indices of Monkeys (*Macacus rhesus*) in Normal Conditions

Index	M	$x_{\min}$	$x_{\max}$	$\sigma^*$	m	N
Erythrocytes (millions)	5.5	4.6	7.3	0.61	$\pm 0.09$	45
Hemoglobin (in g%)	12.93	10.7	14.4	0.86	$\pm 0.13$	39
Reticulocytes (in ‰)	7.78	1	19	4.09	$\pm 0.62$	44
Platelets (absolute No. in thousands)	373.66	205	607	92.62	14.47	41
Leukocytes (in thousands)	10.95	5.5	19.5	3.21	$\pm 0.50$	35
Lymphocytes (absolute No. in thousands)	3.82	1.8	102	1.99	$\pm 0.34$	35
Neutrophils (absolute No. in thousands)	5.87	2.5	10.8	1.97	$\pm 0.33$	35
Monocytes (absolute No. in thousands)	0.36	0	1.07	0.25	$\pm 0.04$	35
Eosinophils (absolute No. in thousands)	0.22	0	0.39	0.09	$\pm 0.01$	35
Neutrophils (in ‰)	52.31	21	69	11.4	$\pm 1.92$	35
Lymphocytes (in ‰)	38.5	20.5	70	11.78	$\pm 1.99$	35
Monocytes (in ‰)	4.06	0	8.5	2.02	$\pm 0.34$	35
Eosinophils (in ‰)	2.21	0	6	1.42	$\pm 0.34$	35
Basophils (in ‰)	0.15	0	1			
Plasma cells (in ‰)	0.81	0	3	0.71	$\pm 0.12$	35
ESR (mm in 1 h)	4	1	9	11.95	$\pm 0.35$	31

\*Determined by the degree of scatter.

TABLE 2. Indices of the Morphological Composition of the Bone Marrow of Normal Monkeys (*Macacus rhesus*) in Percentages

Index	M	$x_{\min}$	$x_{\max}$	$\sigma^*$	m	N
Hemohistioblast	0.14	0	1	0.29	$\pm 0.08$	14
Reticulo-endothelial cell	1.94	0.2	5.2	1.46	$\pm 0.39$	14
Proerythroblasts	0.93	0.2	3	0.82	$\pm 0.22$	14
Basophilic macroblasts	1.55	0	3.2	0.93	$\pm 0.27$	14
Basophilic normoblasts	15.86	3	21.8	5.51	$\pm 1.52$	14
Polychromatophilic normoblasts	10.83	3	19	4.69	$\pm 1.26$	14
Oxyphilic normoblasts	1.7	0	3.4	1	$\pm 0.23$	14
Total number of erythroblastic cells	30.87	10.9	38.2	8	$\pm 2.13$	14
Mitoses in the red series	0.58	0	1.2	0.35	$\pm 0.09$	14
Myeloblasts	1.28	0.8	2	0.35	$\pm 0.09$	14
Promyelocytes	1.41	0.6	3.6	0.88	$\pm 0.23$	14
Myelocytes	2.7	0.2	5.2	1.46	$\pm 0.39$	14
Juvenile	4.96	1.2	9.8	2.52	$\pm 0.67$	14
Stab cells	21.51	10.8	38	8.97	$\pm 2.39$	14
Segmented	27.04	9.5	56.2	13.66	$\pm 3.65$	14
Basophils	0.14	0	0.5	0.14	$\pm 0.04$	14
Eosinophils	2.76	0.8	5.2	1.29	$\pm 0.34$	14
Total No. of myeloid cells	58.9	43.5	71.6	8.24	$\pm 2.2$	14
Lymphocytes	8.6	0.8	23	6.51	$\pm 1.74$	14
Monocytes	1.23	0.2	5.2	1.46	$\pm 0.39$	14
Plasma cells of the red series	0.92	0.2	3	0.82	$\pm 0.22$	14
Plasma cells of the white series	0.66	0	1.8	0.52	0.14	14
Mitoses in the white series	0.2	0	0.8	0.23	$\pm 0.06$	14
Megakaryoblasts	0.06	0	0.5	—	—	—
Megakaryocytes	0.03	0	0.2	—	—	—

\*Determined by the degree of scatter.

Turning now to the analysis of the percentages of the cells composing the marrow (see Table 2), let us first consider the total number of nucleated cells. In our investigations this varied from 56,000 to 201,000, with a mean value of 101,000 in 1 mm<sup>3</sup>. We observed similarly large variations in the numbers of both erythroblastic and myeloid cells.

Analysis of the constituents of the erythroblastic and myeloid series showed that young erythroblasts (proerythroblasts and basophilic macroblasts) accounted for 7% of the total number of erythroblastic cells, and young myeloid cells (myeloblasts, promyelocytes, and myelocytes) for 9.9% of the total number of the cells of this series. Hence, myeloid cells were more common than erythroblastic cells in the marrow of the monkeys, as in man and the dog. We normally found the following cytological variants and cell forms:

In films of the peripheral blood—pyknosis 0.3%, hypersegmentosis 2.35%, fragmentosis 2.32%, giant forms 0.02%, chromatinolysis 0.1%, cytolysis 3.83%, lymphocytes with Rieder type of nucleus 0.25%, amitosis of lymphocytes 0.03%, vacuolation of cytoplasm of monocytes 0.06%;

in films of bone marrow—pyknosis 1.8%, chromatinolysis 0.19%, rhexis of nuclei of erythroblasts 0.14%, giant forms 0.45%, hypersegmentosis 0.3%, fragmentosis of nucleus 0.41%, vacuolation of cytoplasm of cells 0.2%, phagocytosis 0.17%, pigment 0.21%, and cytolysis 10%.

#### SUMMARY

A study was made of the indices of peripheral blood (45) and of bone marrow (14) in healthy monkeys (Macacus rhesus) in Moscow. The total erythrocyte count in the monkeys observed was  $5.5 \pm 0.9$  million, thrombocyte count  $-373.66 \pm 47$  thousand, reticulocyte count  $7.78 \pm 0.62/100$ , leukocyte count  $-10.95 \pm 0.50$  thousand, erythrocyte sedimentation rate  $-4 \pm 0.35$  mm/h. The total number of the nuclei-containing forms in the bone marrow puncture material averaged 101 thousand. 30.87% of total number of cells were erythroblastoid elements, 58.9% being myeloid and 8.6% lymphoid cells.

#### LITERATURE CITED

1. N. G. Vishnevskii, "The morphological composition of the blood in monkeys." Zhurn. obshchei biol. 2, 1, 94 (1933).
2. O. P. Grigorova and M. F. Nestrakh, "The morphology of the blood of the lower catarrhine monkeys of the marmoset sub-family." Trudy Moskovskogo zool. parka 3, 95 (1946).
3. M. I. Kuksova, "Seasonal and diurnal fluctuations in the white blood indices in the lower monkeys." Zhurn. obshchei biol. 20, 1, 732 (1959).
4. M. I. Kuksova, "Seasonal and diurnal fluctuations in the red blood indices in monkeys." In the collection: Theoretical and Practical Problems of Medicine and Biology in Experiments on Monkeys [in Russian] (Medgiz, 1956).
5. A. S. Petrova, The State of the Blood Platelets in Acute Radiation Sickness and Their Role in the Development of the Hemorrhagic Syndrome. Dissertation, (Moscow, 1959).
6. A. M. Fridman, "Investigation of the blood in monkeys." Russkii zhurnal tropicheskoi meditsiny 7, 9, 620 (1929).
7. H. Fox, The blood count of Macacus rhesus, Folia haematologica, 1928, v. 35, No. 1, p. 272.
8. Hall and E. Byron, The morphology of the cellular elements of blood of the monkey Macacus rhesus. Folia haematologica, 1929, v. 35, No. 1, p. 30.
9. Shukers, Carrol, Langston, and Day, The Normal Blood Picture of the Young Rhesus Monkey. Folia haematologica, 1938, v. 60, No. 4, p. 416.
10. Krumbhaar and Musser, J. Med. Res., 1921, v. 42, p. 105.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. Some or all of this periodical literature may well be available in English translation. A complete list of the cover-to-cover English translations appears at the back of this issue.

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