According to data in the literature, if a stimulus acts on a cell population immediately after irradiation, its action is potentiated [7-12].

In the control experiments the cell culture irradiated in the same way remained undamaged. The results of the control tests with simple glass as the support were negative.

LITERATURE CITED

1. V. P. Kaznacheev, L. P. Mikhailova, and S. P. Shurin, in: Abstracts of Proceedings of the 9th International Congress on Microbiology [in Russian], Moscow (1966), p. 509.
2. V. P. Kaznacheev, L. P. Mikhailova, et al., in: Bioenergetics and Biological Spectrophotometry [in Russian], Moscow (1967), pp. 80-85.
3. V. P. Kaznacheev and S. P. Shurin, in: Problems in Biophysics [in Russian], Novosibirsk (1967), pp. 20-25.
4. V. P. Kaznacheev, L. P. Mikhailova, and S. P. Shurin, in: Progress in Biological and Medical Cybernetics [in Russian], Moscow (1974), pp. 314-339.
5. K. A. Samoilova, in: The Biological Action of Ultraviolet Radiation [in Russian], Moscow (1975), pp. 20-31.
6. L. N. Voronina and V. N. Sakharov, in: The Biological Action of Ultraviolet Radiation [in Russian], Moscow (1975), pp. 82-84.
7. O. I. Epifanova, Tsitologiya, No. 9, 1033 (1967).
8. G. S. Kalendo, Usp. Sovrem. Biol., 73, No. 1, 59 (1972).
9. A. M. Kuzin and N. I. Yusifov, Radiobiologiya, No. 1, 3 (1967).
10. V. Ya. Aleksandrov, Trudy Inst. Tsitol. Gistol., Émbriol., 3, No. 1, 3 (1948).
11. J. M. Cork, Radiat. Res., 7, 551 (1957).
12. L. Carlson et al., Radiat. Res., 7, 190 (1957).

CORRELATIONS BETWEEN MITOTIC INDICES OF BONE MARROW CELLS IN DOGS

T. A. Ivanova, A. A. Gordeeva, and M. P. Kalandarova

UDC 611-018.46-018.15

The mitotic indices of erythroblasts, basophilic and polychromatophilic normoblasts, myeloblasts, promyelocytes, and myelocytes were shown to decrease depending on the degree of differentiation of the cells in the ratio of 4:2:1. The values of the mitotic indices were shown to be an inverse power function of the number of cells.

KEY WORDS: mitotic indices; number of cells; correlation.

Many new methods by which the proliferation of bone marrow cells under normal and pathological conditions can be studied have recently been developed. In particular, the results of autoradiographic investigations and the results of investigation of cell proliferation in bone marrow cultures and in splenic colonies have been widely published [5, 9-12]. The results of detailed morphological investigations of bone marrow are sufficiently informative in this respect [4]. For instance, investigations of mitotic indices (MI) of whole bone marrow (per 1000 nucleated cells), of the myeloid and erythroid series (per 1000 erythronormoblasts and granulocytes), and in 100 erythroblasts, basophilic and polychromatophilic normoblasts, myeloblasts, etc., reflect the intensity of division of bone marrow cells.

Parallel determination of the ratio between different forms of cells of the erythroid and granulocytic series (erythrocyte and granulocyte counts) makes it possible to record activity of the influx of committed cells from the higher division.

The study of correlation between mitotic indices and the relative number of cells in erythrocyte and granulocyte counts can shed light on the existence and character of any significant correlation between these indices.

Institute of Biophysics, Ministry of Health of the USSR.

(Presented by Academician of the Academy of Medical Sciences of the USSR P. D. Gorizontov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 87, No. 5, pp. 471-473, May, 1979. Original article submitted April 27, 1978.

0007-4888/79/8705-0495$07.50

TABLE 1. Dependence of MI of Erythroblasts and Basophilic and Polychromatophilic Normoblasts on Number of These Cells in Erythrocyte Count

	Statistical index	Erythroblasts		Basophilic normoblasts		Polychromatophilic normoblasts	
		limits of variations					
		1—2	3—4	1—5	6—11	86—90	91—96
Number of cells, %	M $\pm m$	1,9 0,08	3,4 0,07	4,7 0,13	7,9 0,3	88,6 0,27	93,3 0,2
MI, %	M $\pm m$	13,4 0,8	11,0* 0,8	9,2 0,6	8.0 0.4	3,5 0,18	2,0† 0,1

Legend. Here and in Table 2: *P < 0.05, †P < 0.001.

TABLE 2. Dependence of MI of Myeloblasts, Promyelocytes, and Myelocytes on Number of These Cells in Granulocyte Count

	Statistical index	Myeloblasts		Promyelocytes		Myelocytes	
		limits of variations					
		1—3	4—6	1—15	16 and over	60—75	76—90
Number of cells, %	M $\pm m$	2,1 0,1	5,0 0,16	10,9 0,4	21,1 0,6	69,2 0,8	84,6 0,5
MI, %	M $\pm m$	8,8 0,6	6,2* 0,8	4,7 0,2	4,0† 0,2	3,6 0,2	1,6† 0,1

EXPERIMENTAL RESULTS

The results of an investigation of bone marrow puncture material from 44 dogs are described. MI of erythroblasts, basophilic and polychromatophilic normoblasts, myeloblasts, promyelocytes, and myelocytes was found to decrease depending on the degree of differentiation of the cells, in the numerical ratio of 4 : 2 : 1. For instance, the number of mitoses per 100 erythroblasts was 12 ± 0.6%, per 100 basophilic normoblasts 6 ± 0.5%, per 100 polychromatophilic normoblasts 3 ± 0.1%; the number of mitoses per 100 myeloblasts was 8 ± 0.7%, per 100 promyelocytes 4 ± 0.1%, and per 100 myelocytes 2 ± 0.1%.

As the results given above show, MI of erythronormoblasts (MIE) at all levels of differentiation was 1.5 times greater than MI of the granulocytes (MIG). On average, with normal ratios between the number of cells in the erythrocyte and granulocyte counts, MIE and MIG were 36 ± 1.3 and 26 ± 2.0 ‰ respectively in adult dogs, and the overall mitotic index was 13.2 ± 0.7 ‰.

The results of dispersion analysis showed (Tables 1 and 2) that MI of the erythroblasts, basophilic and polychromatophilic normoblasts, myeloblasts, promyelocytes, and myelocytes was inversely proportional to the relative number of these cells in the erythrocyte and granulocyte counts, the relationship being expressed by a power function.

The results of investigation of MI of erythroblasts, basophilic and polychromatophilic normoblasts, myeloblasts, promyelocytes, and myelocytes thus demonstrate clearly the normal level and limits of variation of mitotic activity of the cells at different stages of differentiation. The morphological data confirm the results of autoradiographic studies of the kinetics of bone marrow cell proliferation and they agree with the conclusions that the mitotic cycle lengthens and the intensity of metabolism falls as the cells differentiate and mature [2, 6, 13].

Together with existing information, these results enable the absolute magnitude and weakening of mitotic activity to be expressed quantitatively as a function of the degree of cell differentiation.

Morphological investigations also show that MI of erythroid cells at all stages of differentiation is 1.5-2 times higher than MI of the granulocytes. The results, together with data in the literature, show that ultimately for every newly formed granulocyte there are two erythrocytes [14]. The results of dispersion analysis showed that mitotic indices of erythronormoblasts and granulocytes are inversely proportional to the number of these cells. These facts are convincing evidence of intercellular connections and close-acting regulation of the intensity of cell proliferation. An examination of the literature also reveals similar information obtained by the study of proliferative processes in different animals and plants, evidence that these correlations exist as a general biological rule in the regulation of cell proliferation [1, 3, 7, 9, 10, 12, 15].

LITERATURE CITED

1. B. B. Gerdon, in: Intercellular Interaction in Differentiation and Growth [in Russian], Moscow (1970), pp. 102-117.
2. A. I. Zosimovskaya, Arkh. Anat. No. 11, 99 (1962).
3. V. B. Ivanov, in: Intercellular Interaction in Differentiation and Growth [in Russian], Moscow (1970), pp. 226-241.
4. T. A. Ivanova and A. A. Gordeeva, Probl. Gematol., No. 5, 52 (1976).
5. S. V. Kanaev, L. M. Rozanova, et al., Probl. Gematol., No. 9, 3 (1970).
6. L. G. Lajtha, The Use of Isotopes in Hematology [Russian translation], Moscow (1963).
7. A. Ya. Monichev, "Some results of the use of mathematical models for the investigation of the dynamics of postradiation repair of hematopoietic tissue," Author's Abstract of Candidate's Dissertation, Pushchino (1975).
8. V. Ya. Plotkin, S. Yu. Shekhter, and M. I. Avstrikh, Med. Radiol., No. 10, 26 (1968).
9. A. Ya. Fridenshtein, R. K. Chailakhyan, et al., Probl. Gematol., No. 10, 14 (1973).
10. M. L. Chertkov and A. I. Vorob'ev, Probl. Gematol., No. 10, 3 (1973).
11. I. L. Chertkov, Probl. Gematol., No. 5, 3, (1976).
12. E. A. McCulloch and J. E. Till, Hemopoietic Cellular Proliferation, New York (1970), p. 15.
13. P. Beizenstein, Acta Med. Scand., 172, 685 (1962).
14. K. O. Skärberg, Acta Med. Scand., 195, 313 (1974).
15. N. S. Wolf and J. J. Trentin, J. Exp. Med., 127, 205 (1968).