POLYPLOID CELLS IN HEMATOPOIETIC TISSUE OF MAN AND ANIMALS

I. L. Gol'dman, D. S. Dobriyanov, and V. I. Budyakov

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The presence of polyploid cells in hematopoietic tissue is a normal karyologic feature in man and animals. The number of polyploid cells in hematopoietic tissue is a species characteristic. Polyploid cells are absent from normal human circulating blood.

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Polyploidy, as a genetic phenomenon, is an increase in the diploid number of chromosomes by a whole number of times. Normal physiological polyploidy of somatic tissues and spontaneous polyploidy and polyploidy induced by a pathological process or experimental procedure are distinguished.

Polyploidization, for example, is an invariable accompaniment of irradiation. Analysis of populations of human hematopoietic cells have revealed a relationship between the number of structural aberrations of chromosomes appearing in the cells and the number of polyploid cells [4, 7, 9, 13, 20]. The number of polyploid cells in human hematopoietic tissue can also be increased as a result of chemotherapy [16, 17, 19]. Polyploid cells are a component of the picture of karyologic changes characteristic of leukemia and of certain hematologic diseases [8, 15]. Polyploidization of hematopoietic tissue has been described several times in connection with chromosomal diseases [11, 12, 14, 18].

Cases in which a large number of polyploid cells in the blood in phenotypically normal individuals must also be mentioned [10].

In the present investigation the ploidy of a population of normal hematopoietic cells was studied in man and animals.

TABLE 1. Polyploids in Population of Hematopoietic Cells from Normal Human and Animal Bone Marrow

Species	Number of chromosomes in karyotype	Number of metaphases studied	Number of polyploid cells (in %)	P
Sus scrofa	38	11 893	1,98	<0,001
Mus musculus	40	6 700	0,82	<0,001
Rattus norvegicus	42	15 645	0,09	<0,05
Homo sapiens	46	10 214	0,73	<0,05
Bos taurus	60	17 535	0,11	<0,05
Cavia cobaya	64	8 974	1,40	<0,001

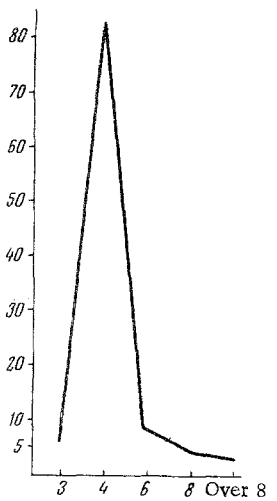

Fig. 1. Characteristics of polyploid cells in hematopoietic tissue of man and animals under normal conditions. Ordinate, number of polyploids (in %); abscissa, value of n.

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TABLE 2. Polyploid Cells in a Culture of Normal Circulating Human Leukocytes

Serial No.	Sex of subject	Number of metaphases studied	Number of polyploid cells (in %) for different times of fixation of culture*						
			60	62	66	72	80	84	90
1	M.	2 135	0	0	0	0,31	0,54	0,73	0,82 (0,02)†
2	M.	1 694	0	0	0	0,28	0,42	0,37	0,98
3	M.	342	—	—	—	0,29	—	—	—
4	M.	1 025	—	—	—	0,38	—	—	—
5	M.	3 362	—	—	—	0,24	—	—	—
6	F.	571	—	—	—	0,52	—	—	—
7	F.	855	—	—	—	0,23	—	—	—
8	F.	450	—	—	—	0,22	—	—	—
9	F.	1 081	—	—	—	0,36	—	—	—
10	F.	736	—	—	—	0,40	—	—	—
Total		12 251	—	—	—	0,34	0,48	0,55	0,90

*All polyploids contain 4 n.

† Percentage of tetraploids with a picture of endoreduplication of chromosomes.

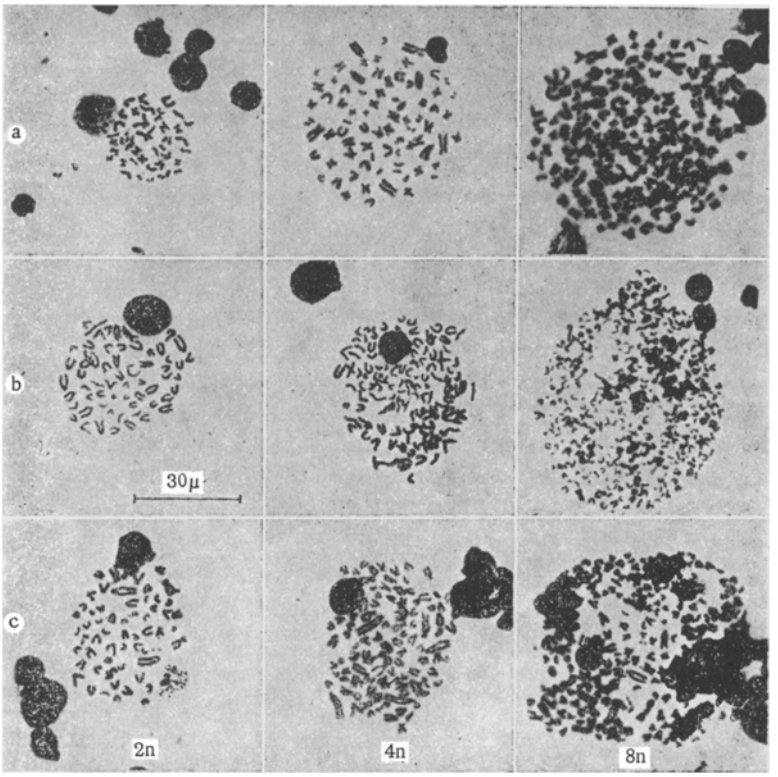

Fig. 2. Polyploid cells in hematopoietic tissue of animals. a) Sus scrofa; b) Bos taurus; c) Cavia cobaya.

EXPERIMENTAL METHOD

The number of chromosomes in bone marrow cells and in a culture of circulating blood leukocytes of the following species was studied: man (15 donors); rat (Rattus norvegicus), 8 animals; guinea pig (Cavia cobaya), 17 animals; pig (Sus scrofa), 25 animals; mouse (Mus musculus), 20 animals, and ox (Bos taurus), 25 animals. Healthy sexually mature individuals with a normal karyotype were investigated. In all cases the same method was used for obtaining preparations of chromosomes [1-3, 5, 6]. The number of chromosomes in the polyploid cells was counted in photomicrograph.

TABLE 3. Characteristics of Polyploid Cells in Human Bone Culture of Human Circulating Leukocytes under Normal Conditions

Index	Polyploids	
	bone marrow	circulating blood
Number of polyploid cells (in %)	0.73	60-66 hours-0 72 hours-0.34 80-84 hours-0.50 90 hours-0.90
Value of n	From 3 to 8 (mainly 4 n)	4 n only
Endoreduplication of chromosomes	None found	Single cells after prolonged cultivation
Aneuploidy	Higher for polyploid than for diploid cells	Same as for bone marrow

EXPERIMENTAL RESULTS

Investigation of the population of hematopoietic cells revealed definite species differences in the proportion of polyploid cells (Table 1).

As Table 1 shows, the least number of polyploid cells was found in Rattus norvegicus (0.09%) and the greatest in Sus scrofa (1.89%). In man, the mean number of polyploid cells in the bone marrow was 0.73%. This figure is evidently independent of the sex and age of the individual.

In parallel tests on the same preparations, aneuploidy and structural aberrations of the chromosomes were analyzed.

Aneuploidy, formed mainly by hypodiploids, reached its greatest degree in species with the largest number of chromosomes in their karyotype, evidently because of an increase in the degree of probability of loss of chromosomes in the course of cytologic treatment of these cells.

In the species investigated, the range of variation in structural aberrations of the chromosomes was smaller. These were essentially aberrations of chromatid type, with a mean frequency of affected hematopoietic cells of 1:100.

In the analysis of 70,961 metaphases in bone marrow of 6 species, altogether 462 polyploid cells were found and studied. In most cases they were orthoploid with a tetraploid number of chromosomes (Fig. 1). None of these cells showed the picture of endoreduplication of chromosomes (Fig. 2).

The results of counting the number of polyploid cells in a culture of circulating human leukocytes are shown in Table 2 in relation to the period of cultivation.

Comparison of the data for polyploid cells studied by analysis of human bone marrow and circulating blood is given in Table 3.

Assuming that polyploids in normal hematopoietic tissue are mitotically dividing multinuclear cells (such as megakaryocytes or osteoclasts), this could explain the species differences observed experimentally between the numbers of polyploid cells. Clearly the view expressed above is nothing more than an interesting speculation, because the proportions of such cells in the myelograms of the investigated species are not yet known.

If the polyploid cells are considered from the standpoint of genome mutations, it would follow at once that their frequency would differ significantly in man and the animals investigated. It is difficult to justify tackling the problem in this way at the present time because within the range of the species investigated the level of spontaneous variation among chromosomes is to a certain extent identical.

The nature of the polyploid cells in human and animal hematopoietic tissues under normal conditions cannot therefore be explained at present.

The situation is different with respect to interpretation of polyploid cells found in a culture of circulating human leukocytes. They are obviously genome mutations arising in the culture. This conclusion can be reached on the basis that polyploids are absent in the early periods of cultivation of blood cells and appear only at the level of the second mitosis. This conclusion is also confirmed by numerous autoradiographic investigations and qualitative analysis of chromosomes in polyploid cells, which in a leukocyte culture are entirely tetraploids.

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