

NUMBER AND PHAGOCYTIC ACTIVITY OF LEUKOCYTES  
DURING PREGNANCY UNDER NORMAL CONDITIONS  
AND DURING EXPOSURE TO STRESS

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During normal pregnancy in rabbits the number of leukocytes in the blood decreases, the percentage of polymorphs is slightly reduced, while the number of lymphocytes and eosinophils is slightly increased. The phagocytic activity of the leukocytes is considerably increased. During the action of stress, when pregnancy ends in the birth of physiologically immature or dead fetuses, these indices correspond more closely to those in nonpregnant animals.

Conflicting values are given in the literature for the leukocyte count and formula in pregnant women [3, 5, 7, 9, 14]. This is because in the corresponding investigations no strict differentiation was made between normal pregnancy and the various forms of abnormal pregnancy. Virtually no attempt has been made to study this problem experimentally in animals. Work in the authors' laboratory has shown that the new level of homeostasis arising in the body during pregnancy is controlled by the gestation dominant. Exposure of the pregnant organism to various types of stress causes inhibition of the gestation dominant, leading either to death of the fetus or to birth of physiologically immature animals [1, 2, 12]. Knowledge of the characteristics of the leukocytic system and, in particular, of the phagocytic activity of the leukocytes during pregnancy is very important in connection with the role of the corresponding characteristics of homeostasis in the mother as a factor determining the genesis of physiological maturity or immaturity of the newly born animals.

The object of the present investigation was to study changes in the leukocyte count, leukocyte formula, and phagocytic activity of the leukocytes in normal pregnancy and during inhibition of the gestation dominant by the action of stress.

EXPERIMENTAL METHOD

Rabbits were used as experimental animals. The state of normal pregnancy was strictly defined, using birth of physiologically mature organisms as the main criterion.

The leukocyte count and leukocyte formula were investigated by normal hematological methods [14, 16]. Films for studying the differential leukocyte count were stained by the Romanowsky-Giemas method. The phagocytic activity of the leukocytes was determined by Latysheva's method [6] as modified by Miklashevskii [8]. The object of phagocytosis was a suspension of a pathogenic strain of *Staphylococcus aureus* obtained from the L. A. Tarasevich Government Control Institute of Medical and Biological Preparations. The bacterial suspension was prepared from a 24-h agar culture. The percentage of phagocytosis (the number of neutrophils carrying out phagocytosis in 100 cells), the number of staphylococci ingested by these neutrophils, and the phagocytic index (the ratio between the number of ingested staphylococci and the number of phagocytes) were determined in films fixed with methyl alcohol and stained by the Romanowsky-Giemas method. The gestation dominant was inhibited by the action of stress (combined exposure to electrical and acoustic stimulation, the latter consisting of the sound of an automobile horn), by the method

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TABLE 1. Leukocyte Count and Formula in Rabbits (M±m)

Characteristics of leukocytes	Physiological state of rabbits			Experimental neurosis in pregnant rabbits	
	non-pregnant	14th-20th day of pregnancy	23rd-30th day of pregnancy	before neurosis	after neurosis
Total number	9000±630	7900±530	6700±380	7900±900	8680±290
Stab cells	0,30±0,10	0,4±0,17	0,30±0,05	0,4±0,2	0,1±0,5
Polymorphs	40,7±2,7	31,9±2,1	36,6±1,4	31,2±1,2	57,5±2,6
Eosinophils	0,60±0,05	1,4±0,06	0,96±0,18	1,1±0,28	0,8±0,26
Monocytes	0,50±0,19	0,50±0,20	0,60±0,20	0,9±0,30	0,1±0,12
Lymphocytes	59±2,6 (12)	65,84±2,1 (14)	61,4±6,1 (29)	66,1±2,5 (8)	40,5±2,6 —

Note. Here and in Table 2, number of animals given in parentheses.

TABLE 2. Phagocytic Activity of Leukocytes in Rabbits (M±m)

Index	Physiological state of rabbits			Experimental neurosis in pregnant rabbits	
	non-pregnant	14th-20th day of pregnancy	23rd-30th day of pregnancy	before neurosis	after neurosis
Percent phagocytosis	6,1±0,6	6,1±0,7	6,3±0,16	8,4±1,0	3,4±0,20
No. of staphylococci ingested	9,2±1,2	11,3±1,6	12,9±1,02	13,4±1,9	4,3±0,20
Phagocytic index	1,46±0,09 (12)	1,83±0,16 (14)	2,09±0,10 (29)	1,71±0,13 (8)	1,27±0,30

developed in the laboratory [2, 10, 11]. Blood tests were carried out before and after exposure to stress, which was on the 19th-26th day of pregnancy. The blood was tested for 3-7 days after exposure to stress. Physiological maturity and immaturity of the newborn animals were diagnosed by methods developed previously in the laboratory, both in the neonatal period and during subsequent development [2, 10, 11]. The numerical results were analyzed by parametric and nonparametric statistical methods (chiefly the Wilcoxon and Mann-Whitney methods). In all cases, differences indicated in the descriptions of the experiments are significant if  $P < 0.01$ .

## EXPERIMENTAL RESULTS

The results of the characteristics of the leukocytes studied in nonpregnant and pregnant rabbits are given in Tables 1 and 2. The characteristics for the nonpregnant females are in general agreement with results obtained by other investigators [4, 14]. Predominance of lymphocytes over neutrophils is characteristic of the leukocyte formula in rabbits. Most neutrophils are polymorphs. The percentage of stab cells, and also of eosinophils and monocytes, is extremely small. In pregnant rabbits the leukocyte count was lower than in nonpregnant animals (on the average by 13-23%). Changes affecting the leukocyte formula are shown in Table 1. The decrease in the leukocyte count observed in the pregnant rabbits, i.e., the decrease in their concentration index, remembering the increase in the total circulating plasma volume in these animals demonstrated by the authors [13], by itself does not imply a decrease in the total number of these cells in the blood system. Furthermore, if the decrease in the concentration index is compared with the increase in the total circulating plasma volume, it is apparent that the leukopenia in the pregnant rabbits was not a true leukopenia. It also evidently developed against the background of increased leukocyte production, for the degree of decrease in the leukocyte count was less than the increase in plasma volume, which amounts to 24-72% [13].

The phagocytic activity of the leukocytes in the pregnant rabbits was increased (Table 2). Their phagocytic index rose throughout the period of pregnancy on the average by 25-43%, being highest at its end. The increased phagocytic activity of the leukocytes suggests that the mechanisms of nonspecific immunologic resistance are strengthened during pregnancy. This provides an explanation of the increased resistance during pregnancy to various pathogenic factors [2]. The increased phagocytic index correlates with the increased concentration of  $\gamma$  globulins in the blood during pregnancy [12].

Experiments in which inhibition of the gestation dominant was created were carried out on 17 animals. In 8 cases, pregnancy ended in the birth of dead or physiologically immature newborn animals, and

in 9 cases death and resorption of the fetuses took place before parturition. Experiments with the production of neurosis, terminating in the birth of either dead or living but physiologically immature young animals at term, are illustrated in Tables 1 and 2. In this case the stillborn animals showed no signs of resorption. Compared with normal pregnancy, the leukocyte count was raised (on the average by 11%). Except for a marked decrease in the lymphocyte count, the characteristics of the leukocytic system showed an apparent return to those of the nonpregnant animals. The phagocytic activity was reduced considerably, as regards all its criteria, not only by comparison with normal pregnancy, but also by comparison with its level in nonpregnant animals. Inhibition of the gestation dominant thus causes a decrease in the immunologic characteristics as reflected in the indices of phagocytic activity of the neutrophils. This decrease can be assumed to be due to the action of the shift in acid-base homeostasis toward acidosis, which accompanies inhibition of the gestation dominant [10, 11], on the granulopoietic system.

#### LITERATURE CITED

1. I. A. Arshavskii, in: Current Problems in Obstetrics and Gynecology [in Russian], Moscow (1957), p. 320.
2. I. A. Arshavskii, Outlines of Age Physiology [in Russian], Moscow (1967).
3. E. A. Bulygina, A. A. Lebedev, and K. N. Tsitsul'skaya, *Gin. i Akush.*, No. 3, 18 (1933).
4. A. V. Vasil'ev, Hematology of Domestic Animals [in Russian], Moscow (1948).
5. M. A. Daniakhii, *Akush. i Gin.*, No. 3, 262 (1936).
6. I. I. Latysheva, *Zh. Mikrobiol.*, No. 1, 76 (1955).
7. E. M. Liozina, Hematopoiesis in Normal and Pathological Pregnancy [in Russian], Kiev (1952).
8. V. E. Miklashevskii, *Pat. Fiziol.*, No. 2, 35 (1961).
9. R. P. Milyashkevich, *Gin. i Akush.*, No. 3, 236 (1931).
10. M. G. Nemets, *Byull. Éksperim. Biol. i Med.*, No. 2, 45 (1963).
11. M. G. Nemets, *Byull. Éksperim. Biol. i Med.*, No. 8, 27 (1967).
12. M. G. Nemets, Z. F. Surovtseva, and S. P. Nogina, Proceedings of the 6th Scientific Conference on Age Morphology, Physiology, and Biochemistry [in Russian] (1965), p. 155.
13. M. G. Nemets and T. O. Bekmagambetov, *Fiziol. Zh. SSSR*, No. 12, 1422 (1968).
14. V. N. Nikitin, Hematological Atlas of Domestic and Laboratory Animals [in Russian], Moscow (1956).
15. E. I. Freifel'd, Hematology [in Russian], Moscow (1947).
16. D. I. Yanovskii, The Blood Picture and Its Clinical Significance [in Russian], Kiev (1957).