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**FREE RADICAL OXIDATION  
IN THE BLOOD SYSTEM  
CHEMICAL POLLUTION  
ENVIRONMENT**

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Free radical oxidation in the blood system chemical pollution environment

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A study of rabbit blood chemiluminescence contained towns and rural areas of the Republic of Bashkortostan ( RB) . Assessing the level of free radical oxidation was conducted in terms of the light sum (S) and the maximum luminescence (J). Received negative indicators in the urban environment . Comparative study showed declines CL AFO process of phagocytosis of white blood cells and red blood cells increase in lipid peroxidation and serum of rabbits kept in the cities in terms of chemical pollution. Was investigated in parallel character of individual adaptation to chemical factors of low intensity environment in terms of FRO blood. For stays animals brought from the countryside to cities , industrial centers of RB for three months were marked by phase states - signs of adaptation and subsequent deadaptatsii , particularly depression of phagocytic activity and increased lipid peroxidation of blood, reflecting uncoupling of oxidative phosphorylation.

Keywords: blood chemiluminescence, town, village .

## **Free radical oxidation in the blood system chemical pollution environment**

### ***Relevance***

Contamination of the environment creates new challenges for the biotic environment. In particular, in the industrial centers of the Republic of Bashkortostan (RB) recorded a significant chemical pollution. [4]. Complex effects of negative factors of low intensity can adequately assessed only in the process of biological monitoring.

The aim of the present work was put on the establishment of the mammalian response effect of chemical pollutants in RB. A comparative analysis of blood parameters of rabbits are in urban and rural areas in a comparative perspective.

### ***Research methods***

The material was analyzed in adult chinchilla rabbits. A comparative analysis of free radical oxidation (FRO) of blood in animals finding in urban and rural areas in a comparative perspective. In order to establish the nature of adaptation to adverse environmental factors have been made dynamic observation of the animals brought from rural to urban conditions for 3 months. State of free radical oxidation (FRO) in the blood was investigated using biochemiluminometer BKL 06, wherein the detector was installed lights photomultiplier PV 000.335.557.TU. At the same time studied the oxidation of lipids (LPO) and red blood cell mass, (LPO) serum and chemiluminescence (CL) caused by the release of reactive oxygen species (FRO) during phagocytosis. Assessing the level of free radical oxidation was conducted in terms of the light sum (S) and the maximum luminescence (J) [1,6]. Statistical data processing was carried out under the program statistics MO Excel (definition of significant differences in the t -Studentt-test). [9].

### ***Results and discussion***

Application of chemiluminescence (CL) in the study of hematological parameters differentially expanded opportunities to evaluate the nature of the adaptive response of the organism under the influence of chemical factors of low-intensity environment. View of the state of FRO in the blood system was compiled on the basis of CL intensity of ROS during phagocytosis of red blood cells, as well as lipid peroxidation in erythrocytes and serum. FRO study was conducted in a relatively environmentally friendly zone - in

Gorny Chishminsky district as well as in the temperate zone of contamination - the village „Ceramics workshop“ Annunciation district and cities with heavy chemical pollution of the environment – Belebey, Ufa, Ishimbay [4].

Thus, the average values of the light sum for 300 seconds. Lumino initiated chemiluminescence of reactive oxygen species (ROS) during phagocytosis in rabbits finding in Gorny Chishminsky area was  $31.2 \times 10^2$  impulses. Amplitude maximum luminescence average equaled 26.9 pulses / sec. Obtained in this kinetic curves of CL had a gentle nature. For example, the rabbit N 3 slope of the curve changes in light intensity corresponded with an increase in radiation - 2.6 E - 0:2 and recession - 3.2 E - 0.2 C.

Research parameters initiated luminol chemiluminescence in the AFO tsiolitom stimulated phagocytosis in rabbits in the village. Gorny Chishminsky district showed that the average values of the light sum for 300 seconds. accounted for  $35.9 \times 10^2$  impulses amplitude maximum luminescence - 24.3 pulses / sec. Kinetic curves were similar with those observed in the experiments without stimulation of phagocytosis tsiolitom.

Parallel study of the AFO CL during phagocytosis of peripheral blood cells of rabbits contained in other regions of Belarus, revealed significant differences compared with data from Gorny Chishminsky district. For ease of comparison, figures CL Gorny animals were taken as 100%. Thus, data AFO CL process of phagocytosis of red blood cells contained in the village. „Pottery workshop“ Annunciation area were significantly lower than those in Gorny Chishminsky district.

Average value lightsum 300 sec. initiated luminol chemiluminescence ROS during phagocytosis without stimulation equaled  $23.1 \times 10^2$  impulses, representing 74.2 % of respective animals in Gorny soderzhavschihsya Chishminsky area ( $P < 0.05$ ). The average value of the amplitude of the maximum luminescence corresponded to 19.5 pulses / sec. - 72.8 % ( $P < 0.05$ ). Directly proportional shifts were identified and the process of phagocytosis stimulation tsiolitom. Average values lightsum within 300 seconds.  $\times 10^2$  impulses were 27.1 (75.5 %) ( $P < 0.05$ ). and the amplitude of the maximum illumination - 17.7 pulses / sec (72.8%) ( $P < 0.05$ ). Consequently, aggregates AFO CL initiated the process of phagocytosis without stimulation and with stimulation indicates a weakening of cellular immunity in animals kept in the village. „ Ceramic workshop „ Annunciation district. AFO CL study phagocytosis of red blood cells in rabbits in finding in BELEBEY revealed a reduction of the amplitude maximum luminescence and light sum compared with those of animals in Gorny Chishminsky district. Thus, the light sum for

300 seconds. luminol chemiluminescence initiated by ROS phagocytosis without stimulation average equals 22.1 impulses  $\times 10^2$  (71.1 %) ( $P < 0.05$ ) and the maximum amplitude of the luminescence - 18.8 imp / s (69.9 %) ( $P < 0.05$ ). These indicators initiated luminol chemiluminescence AFO process of phagocytosis stimulated tsiolitom respectively equaled 28.4  $\times 10^2$  impulses (79.2%) ( $P < 0.05$ ) and 18.9 impulses / sec (78.1%) ( $P < 0.05$ ). Consequently, in Belebey also was a decrease in phagocytic function from the peripheral blood leukocytes.

The rabbits were kept in Ufa, AFO CL process of phagocytosis of blood cells revealed a further decline in cellular immunity. Thus, the average value of the light sum for 300 seconds. initiated luminol chemiluminescence AFO not stimulated phagocytosis equaled 19.6  $\times 10^2$  impulses (62.9%) ( $P < 0.05$ ), and the amplitude of the maximum emission was 17.0 impulses / sec (63.4%) ( $P < 0.05$ ). These parameters initiated chemiluminescence AFO process tsiolitom stimulated phagocytosis average equaled 21.4  $\times 10^2$  impulses respectively (59.8 %) ( $P < 0.05$ ) and 15.0 imp / sec (61.9 %) ( $P < 0, 05$ ).

About the same level of changes in the phagocytic function of blood cells were observed in animals in finding in Ishimbay. Luminol CL light sum initiated by AFO during phagocytosis without stimulation averaged 19.0  $\times 10^2$  impulses 300 per sec. (61.1 %) ( $P < 0.05$ ) and the maximum amplitude of the luminescence - 16.1 imp / s (59.9 %) ( $P < 0.05$ ). The average value of the described indicators when stimulated phagocytosis tsiolitom equal respectively 21.9  $\times 10^2$  pulses (61.1%) ( $P < 0.05$ ) and 15.1 pulses / sec (62.1 %) ( $P < 0.05$ ).

Kinetic curves of CL initiated by AFO phagocytosis with stimulation and without it had roughly the same type of character. For example, in the rabbit under N 2 contained in Belebey, the value of the slope of the curve changes in light intensity radiation corresponded with an increase in  $E 5.1 - 0.2$ , while the decline was  $2.4 E - 0.2$ .

Thus, the study states in animals that were in the regions of RB, with varying degrees of chemical contamination by AFO CL initiated the process of phagocytosis and stimulated without stimulation showed a mixed picture. The most favorable level of cellular immunity was observed in animals kept in Gorny Chishminsky district. Several depression was found in rabbits that were in the village. „Pottery workshop,, and Belebey. Relatively lower rates of phagocytic function of blood cells observed in animals kept in the cities. Ufa, Ishimbai (table 1, Figure 1).

Bactericidal effect of elevated concentrations of FRO products used by phagocytes (leukocytes, tissue macrophages) for primary „oxidative attack,,

on alien membrane of bacteria, viruses, and then these FROs damaged membranes can be disassembled second acting factor - lysosomal hydrolytic enzymes. During phagocytosis has been increasing (explosion) consumption and activation of FROs. Phagocytes at the place of contact with the membrane in the opponent's cells begin to conduct an intensive one-electron reduction of oxygen in the electron transport chain at the level of oxidases ksantooksidazy, aldehyde. In such enzymatic patobiofizicheskom one or two-electron (instead of the normal four -electron to produce water) active oxygen reduction products formed hydrogen peroxide ( $H_2O_2$ ), superoxide anionradikal ( $O_2^-$ ), hydroperoxy radical ( $3O_2H$ ), hydroxyl radical ( $OH$ ). Formed radicals (especially active hydroxyl radical -  $OH$ ) penetrate into the lipid bilayer membranes of bacteria and viruses and initiate there FRO lipids. Reveals a special biological role of superoxide anion radical initiator as FROs lipid membranes alien during phagocytosis and its abundance in their own membranes.

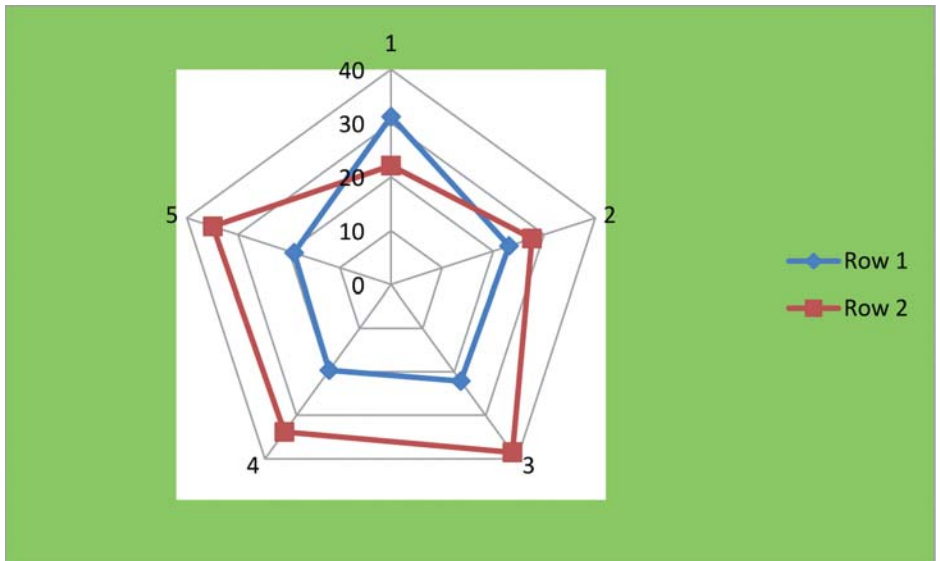


Fig. 1. Hemilyuminescensiya blood in different regions of RB; Row 1- AFO phagocytosis light sum - 300s . (imp.x.102). ;Row 1 - LPO erythrocytes light sum -60 . (imp x 102).; 1-2: pos. Gorny . 2-3: pos. „ Ceramic workshop.“ 3-4 : Belebey . 4-5: Ufa . 5-1 : Ishimbay .

With its excessive accumulation, damaged redox enzymes in the structure of the electron- transport chain or weakening of protective antioxidant function of enzymes (catalase, glutathione peroxidase, superoxide dismutase) begins defeat its own tissues and cells [6, 8]. Registration method CL stimulated cells are widely used in clinical and laboratory studies. Using this method is

carried out to study the effect of chemical agents, the pathogenesis of various diseases. Change CL phagocytes is a nonspecific indicator of the functional state of these cells as well as cell shape the immune response [1, 6].

The low intensity of the intrinsic emission of the samples and the strong dependence on his tramp forced to seek ways to enhance the CL. More acceptable to enhance the study of CL phagocytosis is chemiluminescent probe - luminol. It enhances the glow itself being subjected to chemical transformations. Luminol reacts with hypochlorite is accompanied by bright flash chemiluminescence especially in the presence of even small amounts of hydrogen peroxide. CL kinetics and reflects the kinetics of release of reactive oxygen species (ROS) -stimulated cells. For stimulation of phagocytes, for example, we used insoluble Stimulator - Tsiola. Increased intensity of chemiluminescence stimulated phagocytosis tsiolitom evidence of active metabolism of phagocytes. Reduced blood cells CL intensity reflects inhibition of phagocytic activity, indicating that inhibition of both the cellular immune response [6,8].

Parallel study of induced hydrogen peroxide with iron sulfate CL lipid peroxidation (LPO) of red blood cells in different regions of Belarus allowed to evaluate the nature of the process of FROs in red blood, depending on the degree of chemical pollution. Thus, light sum for 60 min. CL -induced lipid peroxidation of erythrocytes in peripheral blood of rabbits in Gorny Chishminsky area averaged 22.1 h102 pulses. The average value of the amplitude of the maximum luminescence thus equaled  $19.9 \times 10$  pulses / sec. In the following comparison figures obtained from other regions was conducted with these animals in the village. Chishminsky mountain area. Therefore, the above numeric values were arbitrarily taken as 100 %. Mean values lightsum CL and amplitude maximum luminescence in other regions of Belarus were more pronounced and significantly exceeded 100%. These indicators are in the village. „Pottery workshop,, Annunciation district respectively equaled  $27.7 \times 10^2$  impulses for 60 sec (124.9 %) [P <0.05] and  $25.4 \times 10$  impulses / sec (128.1 %) [P <0.05]. In Belebey aggregates induced CL peroxidation of erythrocytes exceeded the previous one. Average values lightsum 60 seconds were  $28.5 \times 10^2$  impulses (129.1 %) [P <0.05], and the amplitude of the maximum illumination -  $27.0 \times 10$  impulses / sec (135.9 %) [P <0.05]. In rabbits in Ufa and Ishimbai CL LPO red blood cells was most pronounced. Thus, the average value in Ufa lightsum CL 60 seconds equaled 33.8 h102 pulses (153.1 %) [P <0.05], the amplitude of the maximum illumination -  $30.4 \times 10$  pulses / sec (152.0 %) [P < 0.05]. In Ishimbay CL light sum and maximum amplitude of the glow on average, accounted for  $34.9 \times 10^2$  impulses for 60 sec (158.2 %) [P



<0.05] and  $32.1 \times 10$  pulses / sec (161.3 %) [P < 0.05]. (Table 1, Figure 1).

Kinetic curves induced by hydrogen peroxide with iron sulfate CL peroxidation of red blood cells of rabbits in different regions of Belarus had a relatively fungible nature. For example, a rabbit N4.v Ufa under the slope of the curve changes in light intensity with an increase in radiation was adequate -  $3.2 \text{ E} - 0.2$ , while the decline amounted to -  $1.1 \text{ E} + 0.0$ . In the rabbit under N 1 in the village. „ Ceramic workshop „ Annunciation area values of the slope of the curve changes in light intensity of radiation during the growth was  $4 : \text{E} - 0.1$ , while the decline was  $1.5 \text{ E} + 0.0$ .

Consequently, induced by hydrogen peroxide with iron sulfate CL peroxidation of red blood cells of rabbits had the largest numerical values Ishimbai city and Ufa, somewhat less pronounced cycles. „Pottery workshop„ and Belebey. The lowest averages lightsum CL and amplitude maximum luminescence observed in Gorny Chishminsky district.

Erythrocyte membranes are rich in polyunsaturated fatty acids, which are surrounded by heme iron. It is assumed that the conditions exist for the development of membrane lipids and FRO accumulation of peroxides as intermediates. It is known that this process normally proceeds at a low level. The reason for this is investigated objects in the presence of powerful antioxidant systems localized in erythrocyte membranes and cytosol. Lipid peroxidation in biological membranes is accompanied by polymerization of membrane proteins form a conjugated Schiff bases monoaldehydopodobnyh oxidation products with amino groups of proteins and phosphatidylethanolamine. These processes reduce the viscosity of the membrane lipids. Erythrocyte membranes become more fragile. In this state, they are more sensitive to various influences and begin hemolyzed, stick together, which is expressed in various pathological manifestations of the body [6].

Thus, an increase in lipid peroxidation CL rabbit erythrocytes in the village. „Pottery workshop„ Annunciation area Belebey and especially in the cities of Ufa and Ishimbai reflects activation FRO red blood in conditions of chemical pollution. In turn, the increase in erythrocyte FRO is probably one of the links of the mechanism hematological changes observed in this animal body, in particular erythropenia. Analysis of induced hydrogen peroxide with iron sulfate CL animal serum in different regions of Belarus, showed character received is directly proportional to changes in relation to CL peroxidation of erythrocytes.

Thus, light sum for 60 min. CL induced serum rabbits in Gorny Chishminsky area averaged  $42.4 \times 10^3$  pulses, and the average amplitude of the maximum

emission equaled 23.8 h102 pulses / sec. These values, as in previous studies, were taken as 100 %. Data obtained in the village. „Pottery workshop,, Annunciation area significantly exceeded those of the Gorny Chishminsky district. Sum light for 60 seconds. CL induced serum on average equal to  $59.5 \times 10^3$  impulses (141.2 %), and the mean amplitude of the maximum luminescence corresponded  $\times 10^2$  impulses / sec (135.9 %). Approximately the same level the CL animals in Belebey. Average values of the amplitude of the light sum and maximum luminescence induced chemiluminescence of blood serum were respectively  $56.0 \times 10^3$  (32.8%) and  $31.8 \times 10^2$  impulses / sec (133.8 %).

In the cities of Ufa and Ishimbai these figures are more significant and CL exceeded compared with those in animals in Gorny Chishminsky district. Light sum 60 sek.indutsirovannyo CL serum rabbits in Ufa, amounted on average  $67.4 \times 10^3$  impulses (159.8 %) [P <0.05], and the average amplitude of maximum luminescence corresponded h102 38.8 imp / sec (163.1 %) [P<0.05]. Average values lightsum 60 seconds. and the amplitude of the maximum luminescence induced CL serum of rabbits in g.Ishimbae respectively amounted to  $68.0 \times 10^3$  impulses (162.3 %) [P <0.05] and  $37.1 \times 10^3$  impulses / sec (156.2 %) [P < 0.05]. Consequently, the analyzed indicators CL serum, as well as the CL LPO erythrocytes, rising rhythm rose in the following sequence: pos. „Pottery workshop,, Annunciation area, Belebey, Ufa, g.Ishimbay.

Kinetic curves induced by hydrogen peroxide with iron sulfate CL serum of rabbits in different areas, had about the same type of character. So, the rabbit under N 2 contained in Gorny Chishminsky district, the value of the slope of the curve changes in light intensity of radiation at - 6.3 E 00 +, while the decline was equal to - 1.1 E + 01.

Thus, the chemical pollution of the environment has been a gain FRO blood serum components.

In order to study the mechanism of adaptive reactions of the body to the action of chemical factors of low intensity, polluting the environment, was undertaken dynamic monitoring indicators SRO animals brought them to the countryside – pos. Gorny Chishminsky area in urban conditions.

AFO CL analysis of phagocytosis of red blood cells was performed to determine the level of nonspecific protection and resistance cell shape of the immune system in the implementation of compensatory mechanisms during adaptation to high concentrations of chemical factors of low intensity. Study parameters CL peroxidation in erythrocytes and serum expanded idea of the features of the FRO in the body as the development and adaptation

deadaptatsii chemical pollution environment. SRO level in the blood system was determined in parallel hematology research in the course of field experiments in three different degree of chemical pollution zones :

- 1- intensive chemical contamination, 3 km from the „Khimprom“ in Ufa ;
- 2 - moderate chemical pollution „Ceramic workshop" 7 km from the Ufa refinery complex;
- 3 - of-town (pos. Gorny Chishminsky area about 60 km from the city of Ufa).

In all the three data areas CL blood components recorded in baseline and after 10, 30, 60, 90 days of the experiment (fig. 2.3, tab. 2, 3, 4). The results obtained were compared with the reference level which is taken as 100 %.

Aggregates initiated luminol chemiluminescence AFO during phagocytosis in animals I zone in baseline had the following numerical values lightsum within 300 seconds. averaged  $28.5 \times 10^2$  impulses The average value of the amplitude of the maximum luminescence equaled 23.2 imp / sec. After 10 days the average values of the light sum for 300 seconds. and emission maximum amplitude decreased slightly and thus equaled  $22.2 \times 10^2$  impulses ( $P < 0.05$ ) (78.1 %) and 17.0 imp / sec (73.4 %) ( $P < 0.05$ ).

During the following periods experience a further decrease was observed numerical values initiated luminol chemiluminescence AFO phagocytosis of blood cells. So, after 30 days of the trial sum light for 300 seconds and the maximum amplitude of the emission, respectively averaged  $19.4 \times 10^2$  impulses ( $P < 0.05$ ) (68.2 %) and 16.2 impulses / sec. ( $P < 0.05$ ) (69.5 %). After 60 days of the trial averages lightsum for 300 seconds were equal to  $20.0 \times 10^2$  impulses ( $P < 0.05$ ) (70 %), the maximum amplitude of the emission of 15.3 impulses / sec. ( $P < 0.05$ ) (66.1 %). Close to this level of performance were observed after 90 days : light sum for 300 seconds. average - 19.6 impulses ( $P < 0.05$ ) (68.9 %), the maximum amplitude of the luminescence - 16.5 pulses / sec. ( $P < 0.05$ ) (71.2 %).

Consequently, after 10 days of stay in chemical pollution indicators in animals phagocytic function of blood cells decreased, and the further extension of field experiments, this process becomes more pronounced.

Register initiated luminol chemiluminescence in the AFC tsiolitom stimulated phagocytosis of blood cells in different tenures rabbits in an environment with heavy chemical pollution also indicates a decline fagotsitornoy function. However, the numerical values thus were subject to some fluctuations.

Despite the last CL indicators corresponding to 10, 30, 60, 90 days were significantly different from baseline. Thus, the light sum for 300 seconds in the

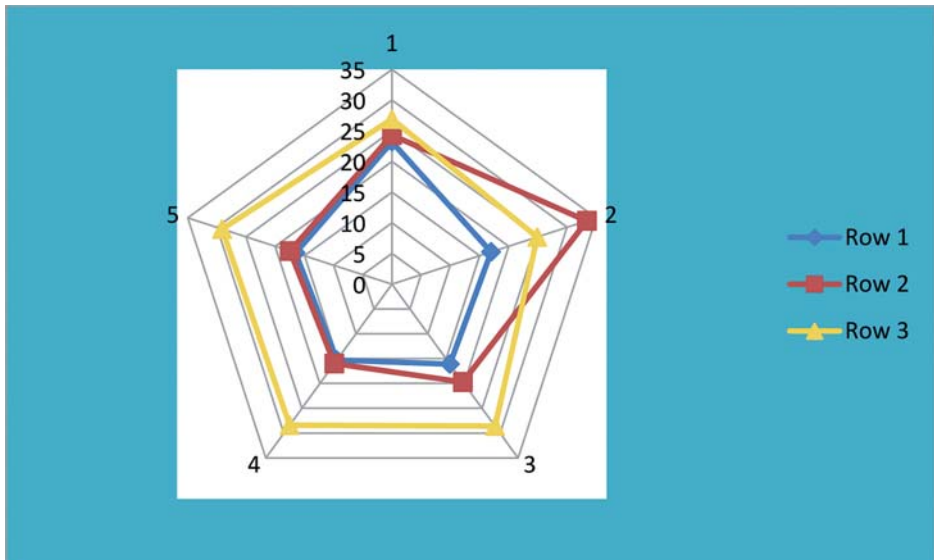


Fig. 2. Chemiluminescence of blood in the adaptation process. AFO fagatsitoza - maximum fluorescence (imp. / sec.). Row 1, the first zone. Row 2 - second zone. Row 3, the third zone. 1-2: original condition. 2-3 : 10 days. 3-4:30 day. 4-5: 60 days. 5-1 : 90 days.

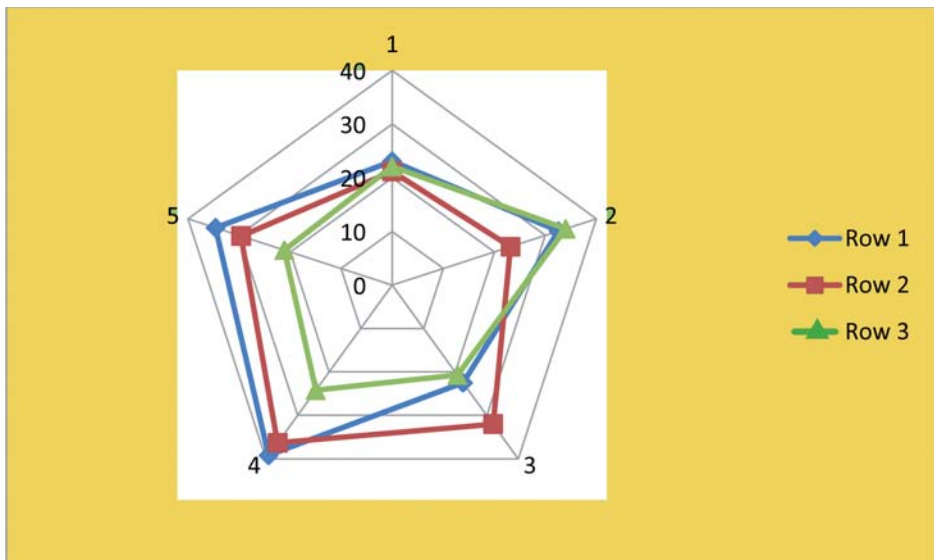


Fig.3. Chemiluminescence of blood in the process of adaptation, (LPO erythrocytes light sum -60 - imp.x 10<sup>2</sup>). Row 1, the first zone. Row 2 - the second zone. Row 3, the third zone. 1-2: original condition. 2-3 : 10 days. 3-4:30 day. 4-5: 60 days. 5-1 : 90 days.

baseline average equaled  $38.3 \times 10^2$  impulses, and the average value of the amplitude maximum luminescence - 28.1 impulses / sec. After 10 days of the trial, these figures dropped quite dramatically and accordingly constituted  $25.6 \times 10^2$  impulses 300 per sec. ( $P < 0.05$ ) (67.1 %) and 17.9 imp / sec. ( $P < 0.05$ ) (63.9 %). After 30 days the animals stay in the zone of intense chemical pollution, showed a slight increase in CL compared with the previous period, but still remained lower than in the initial state. Sum light for 300 seconds. averaged  $29.7 \times 10^2$  wherein impulses ( $P < 0.05$ ) (77.8 %), the average maximum amplitude of light - 22.2 impulses / sec. ( $P < 0.05$ ) (79.1 %). CL indicators in subsequent periods for some swing also were below the initial level. So, after 60 days of the trial initiated by CL light sum AFC stimulated phagocytosis tsiolitom average 300 seconds.  $\times 10^2$  was 27.1 impulses ( $P < 0.05$ ) (70.8 %), and the average amplitude of the maximum illumination - 19.0 impulses / sec. ( $P < 0.05$ ) (67.7 %). After 90 days the animals' stay in chemical pollution, these figures were equal to the average.  $28.0 \times 10^2$  impulses within 300 seconds. ( $P < 0.05$ ) (73.3 %) and 19.9 imp. / sec. ( $P < 0.05$ ) (70.1 %). Consequently, under the influence of environmental chemical factors going steady decline initiated luminol chemiluminescence AFO tsiolitom stimulated phagocytosis of blood cells.

Thus, the animals stay in the zone of intense chemical pollution, accompanied by a decrease initiated luminol chemiluminescence AFO process of phagocytosis as tsiolitom stimulated and unstimulated, reflecting the suppression of the body of the phagocytic function of blood cells in all stages of experience without noticeable signs of the formation of long- perfect adaptation of the natural immune status organism as a functional system. Immunodeficiency in the body and in time (30 days of the trial), when there were signs of the formation of long- perfect adaptation in functional systems responsible for energy supply, in particular, erythron indicates high „price adjustment.“ The immune system plays the role of „flawed,, because of the functional system of active adaptive redistribution of resources in favor of life perfection of mechanisms of energy supply to the body in a crisis situation.

Analysis of induced CL peroxidation of red blood cells of rabbits kept in zone I with intense chemical pollution in the process of full-scale experiments revealed certain features of the mechanism of adaptive reactions to the negative impact. Observed shifts CL peroxidation of erythrocytes in various tenures animals in an environment contaminated by chemical factors had a wavy character. Thus, in initial level of light sum for 60 min. averaged  $23.1 \times 10^2$  pulses, and the average value of the maximum value of the amplitude of light -  $19.4 \times 10$  pulses / sec. Baseline data for the convenience of comparison

with the results of various experiments were taken as 100%. After 10 days of the trial investigated parameters were tested pretty drastic changes. The average value lightsum 60 seconds. h102 was 32.6 pulses ( $P < 0.05$ ) (141.2%), the amplitude of the maximum illumination -  $27.1 \times 10$  pulses / sec. ( $P < 0.05$ ) (139.8%). Increase of aggregates initiated CL LPO erythrocytes clearly indicates increased FRO oxidation erythron membrane system under the action of low-intensity chemical factors of the environment in a relatively short time - within 10 days. After 30 days of the trial indices of lipid peroxidation induced CL took a few red blood cells close to baseline condition. Average value lightsum 60 seconds. at this time was equal to  $22.5 \times 10^2$  impulses ( $P > 0.05$ ) (97.8%), the maximum amplitude of the luminescence -  $19.8 \times 10$  impulses / sec. ( $P > 0.05$ ) (102.1%). Restoring the CL LPO erythrocytes clearly indicates normalization FROs erythron by forming a structural system trace perfect adaptation in functional systems responsible for energy supply under hypoxic condition caused by exposure to chemical factors of the environment of low intensity.

Datalogging CL LPO red blood cells at 60, 90 days revealed a completely opposite picture. CL investigated parameters were largely increased. So, after 60 days the animals' stay in the area with heavy pollution lightsum average value of 60 seconds. CL peroxidation of red blood cells was  $39.2 \times 10^2$  impulses ( $P < 0.05$ ) (170.1%), and the amplitude maximum luminescence average equaled  $32.3 \times 10$  impulses / sec. ( $P < 0.05$ ) (166.1%). After 90 days of the trial, these figures were  $34.6 \times 10^2$  impulses for 60 seconds. ( $P < 0.05$ ) (149.8%) and  $29.7 \times 10$  impulses / sec. ( $P < 0.05$ ) (153.5%). Therefore, in a time frame compatible 60, 90 days of experience, level of SROs in erythron rose sharply, which is obviously associated with the development process in terms of inadequate deadaptatsii negative impact.

Thus, the application of CL revealed that during chemical exposure, when there was a picture erythron deficit, and noted increased lipid peroxidation of erythrocytes. With the stabilization of regenerative equilibrium erythron advancing normalization FROs in erythrocyte membrane system. This confirms the known position of the important role of FROs in the mechanism of development and adaptation deadaptatsii body in crisis situations.

Simultaneously with the study of lipid peroxidation in erythron study was undertaken induced CL animal serum contained in the I zone with intense pollution chemical factors. The results obtained are generally directly proportional. As in the study of lipid peroxidation in erythrocytes, serum parameters of CL in the full-scale experiments have experienced noticeable fluctuations. Initially, a sharp increase occurred, followed by normalization,

and further increase the glow again, that was obviously connected with the adaptive processes that determine the chemical environment.

In the baseline sum light for 60 seconds CL serum average equaled  $45.2 \times 10^3$  impulses, and the average value of the amplitude maximum luminescence was  $20.8 \times 10^2$  impulses / sec. These data for benchmarking obtained in various other terms of experience, were taken as 100%.

After 10 days of the trial sum light CL 60 seconds. on average equal to  $73.1 \times 10^3$  impulses ( $P < 0.05$ ) (161.8%) and the average amplitude of maximum luminescence  $h_{102}$  33.2 pulses / sec. ( $P < 0.05$ ) (159.8%). Relatively high level shift towards increased serum CL within this period, obviously due to the exigencies of the reaction of redox processes in the animal organism to adverse effects of chemical environmental factors with prevalence proportions ARO compared with biological enzymatic oxidation.

After 30 days of experiments, there are signs that reflect a tendency to normalization of the glow. Thus, the average value of the CL light sum for 60 min. in this period was  $46.7 \times 10^3$  impulses ( $P > 0.05$ ) (103.4%), and the amplitude maximum luminescence -  $h_{102}$  20.1 pulses / sec. ( $P > 0.05$ ) (96.6%). Approximation parameters CL serum on the 30th day to the initial level of experience, obviously linked to the restoration of physiological balance between the two types - ARO free radical and enzymatic oxidation in the blood system.

However, after 60, 90 days of the trial re-establish high levels of serum CL. The average value lightsum 60 seconds. and the maximum amplitude of the luminescence respectively after 60 days were  $72.3 \times 10^3$  impulses ( $P < 0.05$ ) (160.1%) and  $34.1 \times 10^2$  impulses / sec. ( $P < 0.05$ ) (149%). Observed in these terms shifts glow obviously associated with an increase in FRO system and blood disorders reflect the processes of adaptive mechanisms due to prolonged exposure to adverse environmental factors.

Kinetic curves of CL peroxidation of erythrocytes and serum wore the same type of character. For a time equal to 60 sec., Recorded a period of rapid flash, which corresponded to the maximum amplitude of the indicator glow and glow beyond oppression.

Thus, the study of induced hydrogen peroxide with iron sulfate CL peroxidation of erythrocytes and blood serum of animals kept in the zone I with intense chemical pollution of the environment has revealed a definite pattern in the dynamics of changes in the implementation of FRO adaptive mechanisms in the body. So, after 10 days, when there was a violation of physiological homeostasis, FRO gain occurred in the blood system. However, after 30 days,

during the formation of systemic structural trace perfect adaptation, there was normalization of the FROs in the blood. In subsequent periods - 60, 90 days - when there comes a stage deadaptatsii again there was an increase in the blood system of FROs.

CL study of the various components of the blood of rabbits kept in zone II with moderate chemical pollution of the environment, revealed a somewhat different process dynamics FRO. Investigations initiated luminol chemiluminescence AFO during phagocytosis of blood cells established the following picture. At baseline CL light sum for 300 seconds. average equaled  $29.6 \times 10^2$  pulses, and the average amplitude of the maximum emission was 24.3 pulses / sec. Digital data obtained at different times of experiments, compared with baseline. Therefore parameters recorded AFO CL phagocytosis baseline were taken as 100%. After 10 days of the trial CL light sum for 300 seconds. average equaled  $41.7 \times 10^2$  impulses ( $P < 0.05$ ) (141.2%), the average amplitude of the emission maximum was 33.4 impulses / sec. ( $P < 0.05$ ) (137.5%). Consequently, indicators AFO CL phagocytosis in this period tended to strengthen, reflecting the increase in phagocytic function of blood cells after a relatively brief exposure to chemical factors of low intensity in the study area.

However, in subsequent periods experience a marked decrease in the AFO CL process of phagocytosis of red blood cells. Thus, after 30 days of the trial the mean value 300 sec lightsum.  $h10^2$  pulses equal to 23.6 ( $p < 0.05$ ) (79.8%) and the maximum amplitude of the luminescence was 19.7 pulses / sec. ( $P < 0.05$ ) (81.1%). After 60 days of the trial, these figures respectively average equaled  $21.6 \times 10^2$  pulses ( $P < 0.05$ ) (73.1%) and 16.0 imp / sec. ( $P < 0.05$ ) (65.9%). To the end of the experiment, i.e. after 90 days, the light sum AFO CL phagocytic process for 300 seconds. averaged  $20.6 \times 10^2$  impulses ( $P < 0.05$ ), the average value of the maximum amplitude equal to 20.6 luminescence imp./ sec. ( $P < 0.05$ ) (69.7%).

Thus initiated luminol chemiluminescence AFO process of phagocytosis of red blood cells of rabbits in soderzhavshihsiya II zone with moderate environmental pollution had wavy character. In general, the dynamics of CL reflected after the 10-day period of steady decline in the phagocytic function of the body.

A parallel study initiated luminol chemiluminescence in the AFO tsiolitom stimulated phagocytosis of blood cells revealed similar shifts. Thus, the source light sum level for 300 sec. averaged  $40.1 \times 10^2$  impulses, and the average amplitude of the maximum emission equaled 28.8 impulses / sec. These data for comparison were taken as 100%. After 10 days of the trial indicators glow



within 300 seconds.  $\times 10^2$  impulses were equal to 56.4 ( $p < 0.05$ ) (140.8%) and 39.0 amplitude maximum luminescence imp./ sec. ( $P < 0.05$ ) (135.5%).

Later, as the AFO CL without stimulation showed a decrease of luminescence. After 30 days of the trial initiated by luminol CL light sum AFO stimulated phagocytosis tsiolitom 300 sek.v srenem equaled  $29.4 \times 10^2$  impulses ( $P < 0.05$ ) (73.5%), and the average amplitude of the maximum illumination - 20.5 impulses / sec. ( $P < 0.05$ ) (71.2%). After 60 days of the trial, these figures are averaged  $27.3 \times 10^2$  impulses 300 per sec. ( $P < 0.05$ ) (68.1%). Approximately at the same level were investigated parameters after 90 days of the trial. Thus, the mean value 300 sec lightsum  $\times 10^2$  impulses was 28.7 ( $p < 0.05$ ) (71.8%) and the maximum amplitude of the pulse emission of 21.1 / s. ( $P < 0.05$ ) (73.3%).

Hence, the difference in terms of the AFC CL during phagocytosis of blood cells of animals soderzhavschihsy in zone II with moderate environmental pollution, while stimulating tsiolitom and without incentive was not to shift the dynamics and intensity of luminescence. AFO CL values in experiments with stimulation of phagocytosis by almost 1/3 higher than those without incentives.

Along with the study of phagocytosis AFO CL, we undertook a study of induced hydrogen peroxide with iron sulfate CL peroxidation of red blood cells in rabbits II zone. At baseline light sum for 60 min. average equaled  $21.2 \times 10^2$  impulses the average amplitude of the maximum emission was  $18.6 \times 10$  impulses / sec. These data for subsequent comparisons were taken as 100%. After 10 days the animals' stay in moderate chemical pollution has been some strengthening glow. Thus, the light sum CL LPO red blood cells for 60 seconds. average was equal to  $23.2 \times 10^2$  impulses ( $P < 0.05$ ), which was 109.8% of the baseline. The average value of the maximum emission in this period amounted to  $21.3 \times 10$  impulses / sec. ( $P < 0.05$ ), corresponding to 114.7% of that before the start of full-scale experiments. As can be seen from the summary measures changes after 10 days were insignificant, which is obviously due to the relatively short period of exposure to chemical factors of low intensity. However, in subsequent periods shifts towards increased CL were greater. So, after 30 days of the trial and the amplitude of the light sum maximum luminescence CL peroxidation of red blood cells, respectively, on average equaled  $32.0 \times 10^2$  impulses for 60 seconds. ( $P < 0.05$ ) (151.2%) and  $27.6 \times 10$  impulses / sec. ( $P < 0.05$ ) (148.5%). After 60 days the animals' stay in zone II with moderate environmental pollution emission light sum equal to an average of  $36.3 \times 10^2$  impulses for 60 seconds. ( $P < 0.05$ ) (171.3%), while the average maximum amplitude of light -  $30,3 \times 10$  imp / sec. ( $P < 0.05$ ) (163.2%).

Therefore, with increasing length of stay in the environment of chemical contamination of animals, FRO increasingly intensified. But after 90 days of the trial shifts CL softened somewhat, although remained high compared with baseline. Thus, the average values lightsum glow in 60 seconds. and amplitude maximum luminescence were respectively  $29.6 \times 10^2$  impulses ( $P < 0.05$ ) (139.8%) and  $27.2 \times 10$  pulses / sec. ( $P < 0.05$ ) (146.4%).

Thus, CL peroxidation of red blood cells of rabbits contained in zone II with moderate chemical pollution of the environment in the process of full-scale experiments reflect an imbalance between the FRO and the antioxidant system in the blood system. As the chemical factors of low intensity environment FRO process intensified with maximum expression at 60 day of the experiment. Only after 90 days, apparently due to a slight increase in antioxidant activity of system structures blood FRO value slightly decreased, but at the same time remaining significantly above baseline.

Analysis of induced hydrogen peroxide with iron sulfate CL animal serum zone II showed similar CL peroxidation of red blood cells shifts. At baseline light sum for 60 min. averaged  $42.1 \times 10^3$  impulses, the average amplitude of maximum luminescence  $\times 10$  equaled 24.3 impulses / sec. These data were taken of the initial state in subsequent comparisons for 100%. During the full-scale experiments, a gradual increase in indicators glow. Thus, after 10 days of the trial averages lightsum 60 seconds. and amplitude maximum luminescence were respectively  $49.7 \times 10^3$  impulses ( $P < 0.05$ ) (118.2%) and  $27.9 \times 10^2$  impulses / sec. ( $P < 0.05$ ) (115.1%). After 30 days, these figures have increased slightly. Sum light for 60 seconds. on average equal to  $63.4 \times 10^3$  pulses ( $P < 0.05$ ) (150.8%) and the average amplitude of the maximum illumination -  $h_{102}$  36.0 impulses / sec. ( $P < 0.05$ ) (148.2%). The greatest expression driven indicators observed after 60 days of the trial. Mean values lightsum 60 seconds. and amplitude maximum luminescence were respectively  $71.5 \times 10^3$  impulses ( $P < 0.05$ ) (169.9%) and  $41.6 \times 10^2$  impulses / sec. ( $P < 0.05$ ) (171.3%). However, after 90 days of the trial induced CL serum compared with the previous period decreased slightly. Sum light for 60 seconds. amounted to an average of  $62.7 \times 10^3$  impulses ( $P < 0.05$ ) (149.1%), and the mean amplitude of the maximum luminescence was  $37.3 \times 10$  pulses / sec. ( $P < 0.05$ ) (153.8%).

Thus, under the influence of chemical exposure during the experiment occurred in zone II a steady increase in FRO oxidation in serum. Some fluctuations in the different periods of FRO experience probably reflects the dynamics of interaction between the FRO and the antioxidant system in the circulating blood.

Studying the process of FRO in the dynamics of adaptation in the suburban area of III revealed quite contrasting picture when compared with full-scale experiments in zones I and II, respectively, with intense and moderate pollution by chemical factors (table 4, figure 3).

The degree of zone III animals CL as the AFC process of phagocytosis, and lipid peroxidation of erythrocyte, serum, unlike the CL data into zones II and I, marked changes, including all time experience, not tested. Observed shifts recorded indices in either direction were within the physiological range. At baseline, the mean value of the light sum for 300 seconds. initiated luminol ROS during phagocytosis of blood cells of rabbits *soderzhavschihsy* III in a suburban area, equal to  $31.2 \times 10^2$  impulses, and the amplitude maximum luminescence averaged 26.9 impulses / sec. These data, as well as in studies in other areas, were taken as 100 %.

After 10 days of the trial, these figures slightly decreased and amounted to an average of  $29.3 \times 10^2$  300 impulses per sec. ( $P > 0.05$ ) (94.1 %) and 24.9 imp/ sec. ( $P > 0.05$ ) (92.8 %). In the next term experience - 30 days - there was a slight gain of CL. Sum light for 300 seconds. averaged  $31.8 \times 10^2$  impulses ( $P > 0.05$ ) (102.1%) and the average amplitude of the maximum illumination - 28.6 impulses / sec. ( $P > 0.05$ ) (106.6 %). After 60 days of the trial the degree of chemiluminescence remained approximately at the same level. Average values lightsum within 300 seconds. and the amplitude of the emission maximum were respectively  $34.0 \times 10^2$  impulses ( $P > 0.05$ ) (109.2 %) and 28.4 cpm / sec. ( $P > 0.05$ ) (105.9 %). After 90 days of the trial averages lightsum slightly decreased, and the amplitude of the maximum emission is also slightly increased. And these figures in this period equaled  $30.9$  respectively  $\times 10^2$  300 pulses per sec. ( $P > 0.05$ ) (99.3 %) and 29.1 cpm / sec. ( $P > 0.05$ ) (108.5 %). Consequently, under the conditions of stay of animals in a suburban area III within 90 days, according to the AFO CL initiated in phagocytic function of blood cells no significant changes occurred.

Simultaneous study initiated luminol chemiluminescence AFO during phagocytosis *tsiolitom* stimulated blood cells in situ experiments for statistically significant changes were found. In the baseline sum light for 300 seconds. average equaled  $35.9 \times 10^2$  impulses, and the average amplitude of the maximum emission was 24.3 impulses / sec. These figures, as usual, were taken as 100 %. In subsequent periods dynamics minor fluctuations recorded performance was similar to that, as in the investigation of phagocytosis AFO CL without incentives. So, after 10 days the average values of the light sum for 300 seconds. and the maximum amplitude of the luminescence after some

reduction amounted to 32,7 respectively  $\times 10^2$  impulses ( $P > 0.05$ ) (91.2 %) and 21.2 imp / sec. ( $P > 0.05$ ) (87.3 %). After 30 days of the trial there was a slight increase in CL and light sum for 300 seconds. averaged  $37.8 \times 10$  impulses ( $P > 0.05$ ) (105.5%), and the mean amplitude of the maximum luminescence equaled 26.4 impulses / sec. ( $P > 0.05$ ) (108.8 %). In the next study period, ie 60 days - these figures were approximately at the same level and accordingly constituted  $38.7 \times 10^2$  impulses ( $P > 0.05$ ) (107.8 %) and 24.8 impulses / sec. ( $P > 0.05$ ) (102.2 %). By the end of the experience - 90 days CL intensity compared with previous periods decreased slightly. Sum light for 300 seconds. average equaled  $34.5 \times 10^2$  pulses ( $P > 0.05$ ) (96.2 %), and the average amplitude of the maximum emission was 21.6 impulses / sec. ( $P > 0.05$ ) (89.1 %).

Thus, the study initiated by the AFO CL process of phagocytosis of red blood cells with and without stimulation in rabbits III contained in a suburban area, not statistically significant shifts revealed. Available CL some hesitation towards enhance or reduce obviously reflect physiological fluctuations in the phagocytic function of the cellular elements in the blood system.

Study during full-scale experiments induced by hydrogen peroxide with iron sulfate CL peroxidation of red blood cells of rabbits contain in a suburban III area, also showed no significant changes. At baseline CL light sum for 60 seconds. averaged  $22.1 \times 10^2$  impulses, the average amplitude of the maximum luminescence equaled  $19.9 \times 10$  impulses / sec. These figures, as in previous studies, were taken as 100 %. After 10 days of the trial, these figures were, respectively, on average,  $24.0 \times 10^2$  impulses for 60 sec (108.9 %) and  $20.4 \times 10$  impulses / sec (102.8 %). However, after a slight gain in this period of CL experience, after 30 days, there was some decrease in the intensity of luminescence. Sum light for 60 seconds. amounted to an average of  $20.7 \times 10^2$  impulses ( $P > 0.05$ ) (93.9 %), and the mean amplitude of the maximum luminescence was  $17.8 \times 10$  impulses / sec. ( $P > 0.05$ ) (89.7 %). 60 days CL slightly increased, and after 90 days, there was a slight decline glow. Thus, after 60 days of light sum for 60 min. averaged  $24.2 \times 10^2$  impulses ( $P > 0.05$ ) (109.9 %), the average value of the maximum amplitude equal to  $20,6 \times 10$  luminescence imp./ sec. ( $P > 0.05$ ) (103.9 %). After 90 days of the trial, these figures were, respectively, on average,  $21.1 \times 10^2$  impulses ( $P > 0.05$ ) (95.5%) and  $18.3 \times 10$  impulses / sec. ( $P > 0.05$ ) (92.2 %). Consequently, the aggregates induced by hydrogen peroxide with iron sulfate CL LPO red blood cells reflect only minor shifts in the direction of the FRO parameters gain or oppression in the dynamics of field experiments conducted in a suburban area III. These changes in intensity did not exceed the limits of physiological fluctuations.

Aggregates induced by hydrogen peroxide with iron sulfate CL rabbit serum contained in the suburban area III, had a similar pattern to previous studies on the intensity and dynamics. At baseline light sum for 60 min. amounted to an average of  $42.2 \times 10^3$  impulses, and the average amplitude of the emission maximum was  $23.8 \times 10^2$  impulses / sek. Further data for comparison with those of other terms were adopted as 100%.. As in the study of CL peroxidation of erythrocytes after 10 days of the trial, it was noted a slight increase in serum indicators glow. Light sum for 60 sec averaged  $44.8 \times 10^3$  impulses ( $P > 0.05$ ) (106.3 %), the average amplitude of maximum luminescence  $\times 10^2$  equaled 26.0 impulses / sec. ( $P > 0.05$ ) (109.3 %). After 30 days of the trial sum light sek. 60 about the initial level and the average was  $41.3 \times 10^3$  impulses ( $P > 0.05$ ) (98.1 %) and the average amplitude of maximum luminescence increased slightly and amounted to  $25.9 \times 10^2$  impulses / s. ( $P > 0.05$ ) (109.2 %). After 60 days of the trial the mean value of the light sum for 60 min. slightly increased and amounted to  $44.0 \times 10^3$  pulses ( $P > 0.05$ ) (104.3 %), and the mean amplitude remained almost at the initial level and amounted to  $23.5 \times 10^2$  impulses / sec. ( $P > 0.05$ ) (98.9%). After 90 days of the trial the mean value of the light sum decreased slightly, and the average amplitude of the maximum emission remained approximately at the same level. These figures were  $38.4 \times 10^3$  counts per 60 seconds. ( $P > 0.05$ ) (91.1 %) and  $23.2 \times 10^2$  impulses / sec ( $P > 0.05$ ) (97.8 %).

Thus, FROs and serum lipid peroxidation of red blood cells in the process of full-scale experiments conducted in a suburban area III, experienced the same type of changes that have remained in intensity within the physiological range.

Summarizing the results of chemiluminescence produced in situ during the experiments in various zones, it should be noted :

1) I area with intense chemical pollution of the environment (3 km from the „Khimprom“), changes in the AFO CL during phagocytosis, on the one hand, CL peroxidation of erythrocytes and serum, on the other hand, wore ambiguous. Phagocytic function of blood cells for the duration of the experiment was depressed. FRO process in erythrocytes and serum had wavy dynamics. So, after 10 days of experience marked by an increase of FRO, and was observed on the 30th day of its normalization. In subsequent periods again there was an increase in the intensity of the FRO erythrocytes and serum. Consequently, the state of leukocytes as an indicator of the immune system and red blood cells, the mechanism of implementing the adaptive response of an organism in response to chemical agents of low intensity ambient zone I, was in principle

the different positions. Red blood as functional system responsible for adaptation, as the dominant element in the maintenance of energy balance in the body, due to the formation of the structural system trace perfect adaptation on the 30 th day of experience back to the parameters close to the original level. However, excessive inadequate to physiological functions and lasting impact in subsequent periods led to the destruction formed adaptive mechanisms and the development of pathological deadadaptatsii. Nedostatochnolsti state ,s natural defenses to continue to experience all I zone, apparently expresses a situation where the formation of pronounced systemic structural trace in dominant functional system responsible for adaptation (structural dominance of the system) can be accompanied by varying degrees of atrophy or functional other insolvency systems. Therefore, inhibition of phagocytic function of blood cells with no signs of improvement even after 30 days of the trial, when there was a perfect adaptation of the system erythron, probably due to the fact that the mechanisms of natural resistance took the role of „ flawed functional system „ in the implementation of the redistribution of resources in the process of life adaptation to adverse conditions.

2) In zone II with moderate chemical pollution of the environment (7 km from the refinery complex) dynamic changes SRO wore a somewhat different character. Phagocytic function of blood cells on day 10 of the experiment was somewhat more pronounced, which is obviously associated with immune stress, supports the efforts of urgent adaptation mechanism in the early stages of exposure. And in terms of further marked reduction in the phagocytic activity of leukocytes, as a sign of development of pathological deadadaptatsii.

CL aggregates in erythrocytes and serum indicates increased SROs in the blood system in all stages of field research experiments carried out in zone II. High level of CPO in erythrocytes and serum throughout the experiment, apparently reflects the dynamics of an adaptive response of the organism to the negative effects. In these conditions one can assume at least two situations. First, when after a period of urgent adaptation in excessive force effects on the body is not implemented long-term mechanism of perfect adaptation. Second, when, after the formation of systemic structural trace long-term adaptation, a period of „ localized depletion „ and erasing mechanisms perfect adaptation of the dominant functional systems, including blood system. However, we have not had to register signs formed a perfect adaptation to the intensity normalization of FROs in the blood system. But it does not mean the absence of perfect adaptation period for the stay of animals in the contaminated zone. Normalization FRO blood could come in between studies. In both situations,

as a result of the alleged prolonged chemical exposure at staying in animals II zone advancing pathological deadaptatsiya, the mechanism of which is present in red blood cells increased FRO and serum.

3) The results of CL obtained in field experiments conducted in a suburban area III, did not extend beyond the physiological fluctuations. Such dynamics of the process of FRO in the blood system indicates the preservation of physiological homeostasis, due to the low level of pollution, which are within the adaptive capacity of the organism.

### **Conclusions**

1. Izuchenie AFO CL phagocytosis allowed to establish a direct negative relationship status nonspecific protection, as well as mammalian cell immunity from environmental pollution in industrial centers of Belarus chemical factors of low intensity.

2. Data analysis LPO erythrocytes and serum of rabbits showed a negative effect on the body's metabolic processes of chemical pollution in the industrial cities of Belarus, in particular, increased free radical oxidation.

3. Issledovanie dynamics of phenotypic adaptation of animals during their stay in the zone of intense chemical pollution showed a decrease in the body of the phagocytic function of blood cells throughout the observation without noticeable signs of the formation of long- perfect adaptation. Low levels of phagocytosis in the body and in time (30 days of the trial), when there were signs of the formation of long- perfect adaptation in functional systems responsible for energy supply, in particular, erythron indicates high „ price adjustment.“ Phagocytic activity was provided as a „ flawed „ system due to the functional active adaptive redistribution of resources in favor of life perfection of mechanisms of energy supply to the body in a crisis situation.

3. Izuchenie CL LPO erythrocytes and blood serum of animals kept in the zone I with intense chemical pollution of the environment identified in the phase state of the dynamics of changes in the implementation of SRO adaptive mechanisms in the body. So, after 30 days, during the formation of systemic structural trace perfect adaptation, there was normalization of the SROs in the blood. In subsequent periods - 60, 90 days - when there comes a stage deadaptatsii again there was an increase in the blood system of FRO

## References

1. Bezrukavnikov LM, LM Kurepina Chemiluminescence serum zksperimentalnykh animals exposed polymetallic dust / Hygiene and Occupational Diseases. - M. : 1986. - № 9. - P.48 -51.
2. Vozrastnye features free radical lipid peroxidation and antioxidant protection in erythrocytes of healthy people / ETC Zhuravlev, SI Supletov, NS Kiyanyuk, DB Abubakirova // Clinical laboratory diagnostics. -M. : 2003. - 8. - P.17 -18.
3. Volozhin AI Poryadin GV Pathophysiology. -M. „ Academy „ - Volume 1. 2006. - P.171.
4. State Report on the Natural Resources and Environment of the Republic of Bashkortostan in 2011 - Ufa : 2012. -367 With.
5. Zayko NN Bytsya Y. Pathological physiology. M. MEDpress Inform 2004. - P.212.
6. Kuzmenko DI Serebrov VY, Udintsev SN Free radical oxidation, reactive oxygen species and antioxidants : role in physiology and pathology of the cell. M.: 2007. - P.22 -27 ;
7. Mihaylov VI Methodological bases of antioxidant protection of the population from the effects of harmful environmental and occupational factors / New medical equipment, new medical technologies. -M. : 2007. - 18.- P.5- 10.
8. Novitsky VV. Goldberg ED, Urazova OI Pathophysiology -M. : GEOTAR Media, 2012. Volume 1. -C. 486-487.
9. Petrov PK Mathematics and static analysis of the results of educational research. - Izhevsk : 2006. - 85 p.

## References in transliteration

1. Bezrukavnikova L.M., Kurepina L.M. Khemiluminescenciya syvorotki kpovi eksperimentalnykh zhivotnykh pri vozdeictvii polimetalicheskoy pyli / Gigiena truda i profzabolevaniy.-M.: 1986. 9.S.48- 51.
2. Vozrastnye osobennosti svobodnoradikalnogo okisleniy lipidov I antioksidantnoy zaschity v eritratsitakh zdorovykh lyudey / T. D.Zhuravleva, S. I. Supletov, N.S / Kiyanyuk, D.B. Abubakirova // Klinicheskaya laboratornaya diagnostika.-M.: 2003.-S.17- 18.
3. Volozhin A.I., Poryadin G.V. Patofiziologia /-M.: «Akademiya», tom 1. 2006.-S. - 171.
4. Gosudarstvennyy doklad o sostoyanii prirodnykh resursov i okruzhayaschei sredy Respubliki Bashkortstan v 2011 g. - Ufa. 2012. - S.22- 27 /
5. Zaiko N.N. Bytso YU. B. Patofiziologia. -M.: Medpress-inform, 2004. - S. - 212.
6. Kuzmenko D.I., Serebrov B.YU., Udintsov. Svobodnoradikalnoe okislenie, aktivnyye formy kisloroda i antioksidanty: rol v fiziologii i patologii kletki. M.: 2007. - S.22- 27.
7. Mikhailov BI Metodologicheskie osnovy antioksidantnoi zaschity naseleniea ot vliyaniya vrednykh dlya zdorovya ekologicheskikh I proizvodstvennykh faktorov / Novoe meditsinskoe oborudovanie, novye meditsinskie tekhnologii - M.: 2007. - S.5- 10.
8. Novitskiy V.V. Golberg E.D., Urazova O.I.. Patofiziologia. -M.: Geotar-Media, 2012. Tom 1. - S. - 486-487.



### Annex 1

**Table 1**

Aggregates rabbit blood chemiluminescence different regions of RB (I<sub>max</sub> - maximum illumination ; S- light sum, X± m; n -10, \* - P < 0.05, compared with data Pos Gorny)

Data blood pos.	Pos Gorny ..	Pos. Ceramic workshop	Belebey City	City Ufa	City Ishimbai
AFO fagatsitoza - maximum fluorescence ( imp. / sec.).	26,9±0,41	19,5±0,36*	18,8±0,36*	17,0±0,34*	16.1±0,35*
AFO fagatsitoza - maximum fluorescence (%).	100,0	72,8	69,9	63,4	59,9
AFO phagocytosis light sum - 300s . ( imp.x.10 <sup>2</sup> ).	31.2±0,42	23,1±0,39*	22,1±0,37*	19,6±0,32*	19.0±0,36*
AFO phagocytosis light sum – 300 s . ( %).	100.0	74,2	71,1	62.9	61,1
AFO fagatsitoza (tsiolit) - maximum fluorescence ( imp. / sec.).	24,3±0.39	17,7±0,31*	18,9±0,35*	15,0±0,38*	15,1±0,32*
AFO fagatsitoza (tsiolit)- maximum fluorescence ( % ) .	100,0	72,8	78,1	69,1	62,1
AFO phagocytosis light sum - 300s .(tsiolit) ( imp.x.10 <sup>2</sup> ).	35,9±0,66	27,1±0,59*	28,4±0,61*	21,4±0,58*	21,9±0,55*
AFO phagocytosis (tsiolit)light sum - 300s . ( %).	100,0	75,5	79,2	59,8	61,1
LPO erythrocyte -I <sub>max</sub> ( x 10 imp/ sec .)..	19,9±0,44	25,4±0,49*	27,0±0,48*	30,4±0,52*	32,1±0,53*
LPO erythrocyte -I <sub>max</sub> (%).	100,0	128,1	135,9	152,9	161,3
LPO erythrocytes light sum -60 s. ( imp.x10 <sup>2</sup> ).	22,1±0,41	27,6±0,48*	38,5±0,51*	33,8±0,53*	34,9±0,55*
LPO erythrocytes light sum -60 s. (%).	100,0	124,9	129,8	153,1	158,2
CL serum - I <sub>max</sub> (x 10 <sup>2</sup> imp/cek.).	23,8±0,51	32,3±0,58*	31,8±0,53*	38,8±0,61*	37,1±0,57*
CL serum - I <sub>max</sub> (%)	100,0	135,9	133,8	163,1	156,2
CL serum - S-60 s. (imp.x 10 <sup>3</sup> )	42,2±1,2	59,5±1,4*	56,0±1,3*	67,4±1,2*	68,0±1,5*
CL serum - S-60 s.(%)	100,0	141,2	132,8	159,8	161,3

**Annex 2****Table 2**

Summarized performance chemiluminescence rabbit blood I- zone (3 km from the „Khimprom“ - Ufa) ( $I_{max}$  - maximum illumination ; S - light sum,  $X \pm m$ ; n -10, \* -  $P < 0.05$ , compared to origina condition)

Data blood pos.	Origina condition.	10 days	30 days	60 days	90 days
AFO fagatsitoza - maximum fluorescence ( imp. / sec.).	23,2±0,31	17,0±0,28 *	16,1±0,26*	15,3±0,23*	16,5±0,29*
AFO fagatsitoza - maximum fluorescence (%).	100,0	73,4	69,5	66,1	71,2
AFO phagocytosis light sum - 300s . ( imp.x.10 <sup>2</sup> ).	23,5±0,42	22,2±0,43 *	19,4±0,37*	20,0±0,41*	19,6±0,39*
AFO phagocytosis light sum - 300 s . ( %).	100,0	78,1	68,2	70,3	69,9
AFO fagatsitoza (tsiolit) - maximum fluorescence ( imp. / sec.).	28,1±0,43	17,9±0,39 *	22,2±0,41*	19,0±0,38*	19,9±0,42*
AFO fagatsitoza (tsiolit)- maximum fluorescence ( %).	100,0	63,9	79,1	67,7	70,1
AFO phagocytosis light sum - 300s .(tsiolit) ( imp.x.10 <sup>2</sup> ).	38,3±0,63	25,6±0,58 *	29,7±0,61*	27,1±0,57*	28,0±0,62*
AFO phagocytosis (tsiolit)light sum - 300s . ( %).	100,0	67,1	77,8	70,8	73,3
LPO erythrocyte -I <sub>max</sub> ( x 10 imp/ sec ).	19,4±0,39	27,1±0,42 *	19,8±0,33*	32,2±0,41*	29,7±0,43*
LPO erythrocyte -I <sub>max</sub> (%).	100,0	139,8	102,1	166,1	153,5
LPO erythrocytes light sum -60 s. ( imp.x10 <sup>3</sup> ).	23,1±0,44	32,6±0,46 *	22,5±0,39*	39,2±0,48*	34,6±0,72*
LPO erythrocytes light sum -60 s. (%).	100,0	141,2	97,8	170,1	149,8
CL serum - I <sub>max</sub> (x 10 <sup>2</sup> imp/cek.).	20,8±0,44	33,2±0,43 *	20,1±0,39	34,1±0,45*	31,1±0,42*
CL serum - I <sub>max</sub> (%)	100,0	159,8	96,6	163,5	149,2
CL serum - S-60 s. (imp.x 10 <sup>3</sup> )	45,2±0,88	73,1±1,12 -*	46,7±0,92*	72,3±1,35*	68,2±1,1*
CL serum - S-60 s.(%)	100,0	161,8	103,4	160,1	151,1

**Annex 3**

**Table 3**

*Aggregates rabbit blood chemiluminescence II- zone (7 km from the refinery complex - pos. («Pottery workshop»)) (I<sub>max</sub> - maximum illumination ; S- light sum, X± m; n -10, \* - P < 0.05, compared to origina condition)*

Data blood pos.	Origina condition.	10 days	30 days	60 days	90 days
AFO fagatsitoza - maximum fluorecence ( imp. / sec.).	24,3±0,39	33,4±0,41 *	19,7±0,3 8*	16,0±0,3 6*	17,5±0,3 6*
AFO fagatsitoza - maximum fluorecence (%).	100,0	137,5	81,1	65,9	72,1
AFO phagocytosis light sum - 300s . ( imp.x.10 <sup>2</sup> ).	29,6±0,42	41,7±0,45 *	23,6±0,4 1*	21,6±0,3 8*	20,6±0,3 9*
AFO phagocytosis light sum – 300 s . (%)	100,0	141,2	79,8	73,1	69,7
AFO fagatsitoza (tsiolit) - maximum fluorecence ( imp. / sec.).	28.8±0,61	39.0±0,66 *	20.5±0,5 8*	20.1±0,5 6*	21,1±0,5 9*
AFO fagatsitoza (tsiolit)- maximum fluorecence (%) .	100,0	135,5	71,2	69,7	73,3
AFO phagocytosis light sum - 300s . (tsiolit) ( imp.x.10 <sup>2</sup> ).	40,1±0,77	56,4±0,81 *	29,4±0,7 2*	27,3±0,7 1*	28,7±0,6 8*
AFO phagocytosis (tsiolit)light sum - 300s . (%)	100,0	140,8	73,5	68,1	71,8
LPO erythrocyte -I <sub>max</sub> ( x 10 imp/ sec .).	18,6±0,44	21,3±0,39 *	27,6±0,4 1*	30,3±0,4 6*	27,2±0,4 3*
LPO erythrocyte -I <sub>max</sub> (%). (%)	100,0	114,7	148,5	163,2	146,4
LPO erythrocytes light sum -60 s. ( imp.x10 <sup>2</sup> ).	21.2±0,48	23,2±0,51 *	32,0±0,4 9*	36,3±0,5 3*	29,6±0,4 6*
LPO erythrocytes light sum -60 s. (%)	100,0	109,8	151,2	171,3	139,8
CL serum - I <sub>max</sub> (x 10 <sup>2</sup> imp/сек.).	24,3±0,51	27,9±0,53 *	36,0±0,6 1*	41,6±0,6 3*	37,7±0,5 9*
CL serum - I <sub>max</sub> (%)	100,0	115,1	148,2	171,3	153,8
CL serum - S-60 s. (imp.x 10 <sup>3</sup> )	42,1±0,85	49,7±0,93 *	63,4±1,3 *	71,5±1,4 *	62,7±1,1 *
CL serum - S-60 s.(%)	100,0	118,2	150,8	169,9	149,1

**Annex 4****Table 4**

*Aggregates rabbit blood chemiluminescence III- suburban zone (Pos Mountain)(I<sub>max</sub> - maximum illumination ; S- light sum, X ± m; n -10, \* - P < 0.05, compared to origina condition)*

Data blood pos.	Origina condition.	10 days	30 days	60 days	90 days .
AFO fagatsitoza - maximum fluorescence ( imp. / sec.).	26,9±0,55	24,9±0,59	28,6±0,61	28,4±0,66	29,1±0,71
AFO fagatsitoza - maximum fluorescence (%).	100,0	92,8	106,6	105,9	108,5
AFO phagocytosis light sum - 300s . ( imp.x.10 <sup>3</sup> ).	31,2±0,69	29,3±0,58	31,8±0,66	34,0±0,77	30,9±0,71
AFO phagocytosis light sum – 300 s . ( %).	100,0	94,1	106,6	105,9	108,5
SFO fagatsitoza (tsiolit) - maximum fluorescence ( imp. / sec.).	24,3±0,48	21,2±0,41	26,4±0,52	24,8±0,55	21,6±0,38
AFO fagatsitoza (tsiolit)- maximum fluorescence ( % ) .	100,0	87,3	108,8	102,2	89,1
AFO phagocytosis light sum - 300s .(tsiolit) ( imp.x.10 <sup>3</sup> ).	35,9±0,73	32,7±0,69	37,8±0,79	38,7±0,81	34,5±0,66
AFO phagocytosis (tsiolit)light sum - 300s . ( %).	100,0	91,2	105,3	107,8	96,5
POL erythrocyte -I <sub>max</sub> ( x 10 imp/ sec )..	19,9±0,41	20,4±0,44	17,8±0,38	20,6±0,36	18,3±0,42
POL erythrocyte -I <sub>max</sub> (%). (%)	100,0	102,8	89,7	103,9	92,2
POL erythrocytes light sum -60 s. ( imp.x10 <sup>2</sup> ).	22,1±0,46	24,0±0,51	20,7±0,39	24,2±0,52	21,1±0,41
(POL erythrocytes light sum -60 s. (%).	100,0	108,9	93,9	109,9	95,6
CL serum - I <sub>max</sub> (x 10 <sup>2</sup> imp/cek.).	23,8±0,61	26,0±0,63	25,9±0,66	23,5±0,58	23,2±0,55
CL serum - I <sub>max</sub> (%)	100,0	109,3	109,2	98,9	97,8
CL serum - S-60 s. (imp.x 10 <sup>3</sup> )	42,2±1,2	44,8±1,5	41,3±0,9	44,0±1,4	38,4±0,8
CL serum - S-60 s.(%)	100,	10,6	98,1	104,3	91,1

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Свободнорадикальное окисление в системе крови в условиях химического загрязнения среды

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Проведено исследование хемилюминесценции крови кроликов, содержащихся в городах и сельской местности Республики Башкортостан (РБ). Оценка уровня свободнорадикального окисления проводилась по показателям светосуммы (S) и максимального свечения (J). Получены негативные показатели в городской среде. Сравнительное изучение выявило снижение показателей ХЛЛ АФК процесса фагоцитоза лейкоцитов крови и повышение ПОЛ эритроцитов и сыворотки крови кроликов, содержащихся в городах в условиях химического загрязнения среды. Параллельно было исследован характер индивидуальной адаптации к действию химических факторов малой интенсивности окружающей среды по показателям СРО крови. При пребывании животных, привезенных из сельской местности в промышленные центры городов РБ на протяжении трех месяцев были отмечены фазовые состояния – признаки адаптации и последующей деадаптации, в частности, угнетение фагоцитарной активности, а также усиление перекисного окисления липидов крови, отражающее разобщение окислительного фосфорилирования.

Ключевые слова: кровь, хемилюминесценция, город, село.

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***Vorstand und Beirat***

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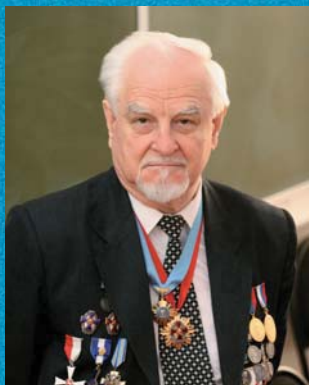
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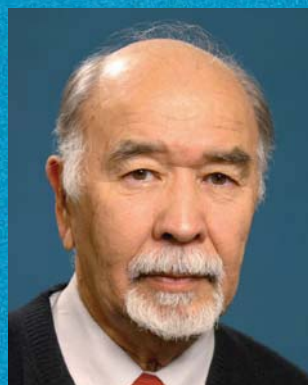


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