12. Evidence of Biological Immune Effects from Exposure to EMF Radiation

As in the prior evidence sections filed by Intervenor, this list of positive effect studies was compiled from the AGNIR (2003 & 2012), SCENIHR (2007 & 2009) reviews and reviews listed below. Only eight (8), marked with an*, of the thirty six (36) positive studies listed below have been included by AGNIR or SCENIHR in their reviews of the evidence for biological effects of EMF radiation on these topics, even though many of the studies were published during the same time period covered by their reviews.

   
   Abstract: The object of this study was to investigate the immune system of 19 women with a mean age of 35 years, for at least 2 years (mean = 13 years) exposed to electromagnetic fields (ELMFs) induced by radiotelevision broadcasting stations in their residential area. In September 1999, the ELMFs (with range 500 KHz-3 GHz) in the balconies of the homes of the women were (mean +/- S.D.) 4.3 +/- 1.4 V/m. Forty-seven women of similar age, smoking habits and atopy composed the control group, with a nearby resident ELMF exposure of < 1.8 V/m. Blood lead and urinary trans-trans muconic acid (a metabolite of benzene), markers of exposure to urban traffic, were higher in the control women. The ELMF exposed group showed a statistically significant reduction of blood NK CD16+-CD56+, cytotoxic CD3(-)-CD8+, B and NK activated CD3(-)-HLA-DR+ and CD3(-)-CD25+ lymphocytes. 'In vitro' production of IL-2 and interferon-gamma (INF-gamma) by peripheral blood mononuclear cells (PBMC) of the ELMF exposed group, incubated either with or without phytohaemoagglutinin (PHA), was significantly lower; the 'in vitro' production of IL-2 was significantly correlated with blood CD16+-CD56+ lymphocytes. The stimulation index (S.I.) of blastogenesis (ratio between cell proliferation with and without PHA) of PBMC of ELMF exposed women was lower than that of the control subjects. The S.I. of blastogenesis of the ELMF exposed group (but not blood NK lymphocytes and the 'in vitro' production of IL-2 and INF-gamma by PBMC) was significantly correlated with the ELMF levels. Blood lead and urinary trans-trans muconic acid were barely correlated with immune parameters: the urinary metabolite of benzene of the control group was only correlated with CD16+-CD56+ cells indicating a slight effect of traffic on the immune system. In conclusion, this study demonstrates that high frequency ELMFs reduce cytotoxic activity in the peripheral blood of women without a dose-response effect.
2. *Busljeta I, Trosic I, Milkovic-Kraus S. Erythropoietic changes in rats after 2.45 GJz nonthermal irradiation.* Int J Hyg Environ Health. 2004 Dec;207(6):549-54. [http://www.ncbi.nlm.nih.gov/pubmed/15729835](http://www.ncbi.nlm.nih.gov/pubmed/15729835) **Abstract:** The purpose of this study was to observe the erythropoietic changes in rats subchronically exposed to radiofrequency microwave (RF/MW) irradiation at nonthermal level. Adult male Wistar rats (N=40) were exposed to 2.45 GHz continuous RF/MW fields for 2 hours daily, 7 days a week, at 5-10 mW/cm². Exposed animals were divided into four subgroups (n=10 animals in each subgroup) in order to be irradiated for 2, 8, 15 and 30 days. Animals were sacrificed on the final irradiation day of each treated subgroup. Unexposed rats were used as control (N=24). Six animals were included into the each control subgroup. Bone marrow smears were examined to determine absolute counts of anuclear cells and erythropoietic precursor cells. The absolute erythrocyte count, haemoglobin and haematocrit values were observed in the peripheral blood by an automatic cell counter. The bone marrow cytogenetic analysis was accomplished by micronucleus (MN) tests. In the exposed animals erythrocyte count, haemoglobin and haematocrit were increased in peripheral blood on irradiation days 8 and 15. Concurrently, anuclear cells and erythropoietic precursor cells were significantly decreased (p < 0.05) in the bone marrow on day 15, but micronucleated cells’ frequency was increased. In the applied experimental condition, RF/MW radiation might cause disturbance in red cell maturation and proliferation, and induce micronucleus formation in erythropoietic cells.

3. Cleary SF, Liu LM, Merchant RE 1990. *In vitro lymphocyte proliferation induced by radio-frequency electromagnetic radiation under isothermal conditions.* Bioelectromagnetics 2(1):47-56. [http://www.ncbi.nlm.nih.gov/pubmed/2346507](http://www.ncbi.nlm.nih.gov/pubmed/2346507) **Abstract:** Whole human blood was exposed or sham-exposed in vitro for 2 h to 27 or 2,450 MHz radio-frequency electromagnetic (RF) radiation under isothermal conditions (i.e., 37 +/- 0.2 degrees C). Immediately after exposure, mononuclear cells were separated from blood by Ficoll density-gradient centrifugation and cultured for 3 days at 37 degrees C with or without mitogenic stimulation by phytohemagglutinin (PHA). Lymphocyte proliferation was assayed at the end of the culture period by 6 h of pulse labeling with 3H-thymidine (3H-TdR). Exposure to radiation at either frequency at specific absorption rates (SARs) below 50 W/kg resulted in a dose-dependent, statistically significant increase of 3H-TdR uptake in PHA-activated or unstimulated lymphocytes. Exposure at 50 W/kg or higher suppressed 3H-TdR uptake relative to that of sham-exposed cells. There were no detectable effects of RF radiation on lymphocyte morphology or viability. Notwithstanding the characteristic temperature dependence of lymphocyte activation in vitro, the isothermal exposure conditions of this study warrant the conclusion that the biphasic, dose-dependent effects of the radiation on lymphocyte proliferation were not dependent on heating.

(10(6)) cells in chromosome medium 1A were exposed for 5 days to conventional heating or to continuous wave (CW) or pulsed wave (PW) 2450-MHz radiation at non-heating (37 degrees C) and various heating levels (temperature increases of 0.5, 1.0, 1.5, and 2 degrees C). The pulsed exposures involved 1-microsecond pulses at pulse repetition frequencies from 100 to 1,000 pulses per second at the same average SAR levels as the CW exposures. Actual average SARs ranged to 12.3 W/kg. Following termination of the incubation period, spontaneous lymphoblastoid transformation was determined with an image analysis system. The results were compared among each of the experimental conditions and with sham-exposed cultures. At non-heating levels, CW exposure did not affect transformation. At heating levels both conventional and CW heating enhanced transformation to the same extent and correlate with the increases in incubation temperature. PW exposure enhanced transformation at non-heating levels. This finding is significant (P less than .002). At heating levels PW exposure enhanced transformation to a greater extent than did conventional or CW heating. This finding is significant at the .02 level. We conclude that PW 2450-MHz radiation acts differently on the process of lymphoblastoid transformation in vitro compared with CW 2450-MHz radiation at the same average SARs.

5. Dabrowski MP, Stankiewicz W, Sobiczewska E, Szmigielski S. Immunotropic effects of electromagnetic fields in the range of radio- and microwave frequencies. Pol Merkur Lekarski. 2001 Nov;11(65):447-51. Review. http://www.ncbi.nlm.nih.gov/pubmed/11852821 Abstract: On the grounds of reviewed literature and the results of own experiments, the authors present current views on the possible immunotropic influence of low energy electromagnetic fields, in the range of radio- and microwave frequencies. They conclude, that a more systematic and multidisciplinary investigations should be undertaken, comprising the wide spectrum of immune homeostatic tasks, including defensive, immunoregulatory and pro-regenerative capabilities of immune system exposed to rapid environmental spread of different electromagnetic emitters.

6. Fesenko EE, Makar VR, Novoselova EG, Sadovnikov VB. Microwaves and cellular immunity. I. Effect of whole body microwave irradiation on tumor necrosis factor production in mouse cells. Bioelectrochem Bioenerg. 1999 Oct;49(1):29-35 http://www.ncbi.nlm.nih.gov/pubmed/10619445 Abstract: Whole body microwave sinusoidal irradiation of male NMRI mice with 8.15-18 GHz (1 Hz within) at a power density of 1 microW/cm2 caused a significant enhancement of TNF production in peritoneal macrophages and splenic T lymphocytes. Microwave radiation affected T cells, facilitating their capacity to proliferate in response to mitogenic stimulation. The exposure duration necessary for the stimulation of cellular immunity ranged from 5 h to 3 days. Chronic irradiation of mice for 7 days produced the decreasing of TNF production in peritoneal macrophages. The exposure of mice for 24 h increased the TNF production and immune proliferative response, and these stimulatory effects persisted over 3 days after the termination of exposure. Microwave treatment increased the endogenously produced TNF more effectively than did lipopolysaccharide, one of the most potential stimuli of synthesis of this cytokine. The role of microwaves as a factor interfering with the process of cell immunity is discussed.
7. Gapeev AB, Sirota NP, Kudriavtsev AA, Chemeris NK. [Responses of thymocytes and splenocytes to low-intensity extremely high-frequency electromagnetic radiation in normal mice and in mice with systemic inflammation]. Biofizika. 2010 Jul-Aug;55(4):645-51. http://www.ncbi.nlm.nih.gov/pubmed/20968076 Abstract: Changes in T cell subsets and expression of cytokine genes in thymocytes and splenocytes after exposure of BAL/c mice to low-intensity extremely high-frequency electromagnetic radiation (42.2 GHz, 0.1 mW/cm², exposure duration 20 min) under normal conditions and in systemic inflammation were studied using flow cytometry and the methods of reverse transcription and real-time polymerase chain reaction. It was found that the number of CD4+ and CD8+ T cells statistically significantly increased in the thymus and considerably decreased in the spleen of exposed animals. Apparently, the exposure of animals leads to an intensification of the host defense, by activating the T-cellular immunity. As for effector functions, the increased expression of IL-1beta and IFNgamma genes in thymocytes and essentially enhanced expression of IL-1beta, IL-10, and TNFalpha genes in splenocytes were observed in mice exposed against the background of a progressive inflammatory process. The experimental data obtained specify that the directed (anti-inflammatory) response of an organism to a specific combination of effective exposure parameters of electromagnetic radiation can be realized by the activation of particular immunocompetent cells and changes in the cytokine profile.

8. Grigoriev Y. A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF) Section 8 Evidence for Effects on the Immune System Supplement 2012. BioInitiative Working Group, BioInitiative Report, 2012. Review [Copy filed in Docket] Excerpt (pg. 6): Considering the results of these three studies it can be concluded that long-term RF exposure at low intensity (50 µW/cm²) results in auto-allergic reactions. Excerpt (pg. 19): The main conclusions from our study were as follows (Grigoriev et al. 2010a): The results of our immunology study using the CFT and ELISA tests partly confirmed the results of the Soviet research groups on the possible induction of autoimmune responses (formation of antibodies to brain tissues) and stress reactions from RF exposure (30-day exposure for 7 h/day for 5 days/week at a power density of 5 W/m², i.e., long-term non-thermal RF exposure). The results of our study on prenatal development of offspring suggested possible adverse effects of the blood serum from exposed rats (30-day exposure for 7 h/day for 5 days/week at a power density of 5 W/m²) on pregnancy and embryo-fetal development in rats, in agreement with the earlier results of Shandala and Vinogradov (1982), although the model used by Shandala and Vinogradov (1982), which was intentionally replicated here, is not considered an appropriate one for assessing human health effects from RF exposure.

**Abstract:** The study using statistical analysis methods and the generalized logarithmic parameter describing the change in the condition of biological systems represents additional substantiations and proofs of the presence of the expressed amplification of the immune reaction in experimental animals after a long exposure to EMF RF non-thermal intensity with a power density of 500 microW/cm². A substantial growth of titers of antibodies to the brain tissue on the 14th day and to a number of other antigens on the 7th and 14th days after irradiation is shown with high reliability of 99.9%. It is shown that EMF RF exposure to non-thermal intensity within 30 day causes transition of an organism to an active adaptation described by an amplified strengthening of intensity of the regulation systems of the organism.


**Abstract:** This paper presents the results of a replication study performed to investigate earlier Soviet studies conducted between 1974 and 1991 that showed immunological and reproductive effects of long-term low-level exposure of rats to radiofrequency (RF) electromagnetic fields. The early studies were used, in part, for developing exposure standards for the USSR population and thus it was necessary to confirm the Russian findings. In the present study, the conditions of RF exposure were made as similar as possible to those in the earlier experiments: Wistar rats were exposed in the far field to 2450 MHz continuous wave RF fields with an incident power density in the cages of 5 W/m² for 7 h/day, 5 days/week for a total of 30 days, resulting in a whole-body SAR of 0.16 W/kg. Effects of the exposure on immunological parameters in the brain and liver of rats were evaluated using the complement fixation test (CFT), as in the original studies, and an additional test, the more modern ELISA test. Our results, using CFT and ELISA, partly confirmed the findings of the early studies and indicated possible effects from non-thermal RF exposure on autoimmune processes. The RF exposure resulted in minor increases in formation of antibodies in brain tissue extract and the exposure did not appear to be pathological. In addition, a study was conducted to replicate a previous Soviet study on effects from the injection of blood serum from RF-exposed rats on pregnancy and fetal and offspring development of rats, using a similar animal model and protocol. Our results showed the same general trends as the earlier study, suggesting possible adverse effects of the blood serum from exposed rats on pregnancy and fetal development of intact rats, however, application of these results in developing exposure standards is limited.
13. Grigor'ev YuG, Mikhailov VF, Ivanov AA, Mal'tsev VN, Ulanova AM, Stavrakova NM, Nikolaeva IA, Grigor'ev OA. [Autoimmune processes after long-term low-level exposure to electromagnetic fields (the results of an experiment). Part 4. Manifestation of oxidative intracellular stress-reaction after long-term non-thermal EMF exposure of rats]. Radiat Biol Radioecol. 2010 Jan-Feb;50(1):22-7. http://www.ncbi.nlm.nih.gov/pubmed/20297677 Abstract: This paper presents the results of the study of the effects of long-term low-level exposure of rats to microwaves. Rats were exposed in far field to 2450 MHz continuous wave fields providing an incident power density at the cages of 500 microW/cm2 [0.5 mW/cm2] for 7 hours daily for a total of 30 days resulting in a whole-body SAR of 0.16 +/- 0.04 W/kg. Three groups ("EMF-exposure", "sham-exposure" and cage-control) were formed, each consisting of 16 rats. Circulating antibodies (IgA, IgG and IgM) directed against 16 chemical substances were evaluated in coded serum from each group of rats by enzyme multiplied analysis (ELISA test). An increased amount of compounds resulting from interaction of amino acids with nitric oxide (NO) or its derivatives (NO2-Tyrosine, NO-Arginine, NO-Cysteine + NO-Bovine Serum Albumin, NJ-Methionine + NO-Asparagine + NO-Histidine, NO-BTrypnohan + NJ-Tyrosin), fatty acids with small chains, hydroxylated fatty acids, palmitic/myristic/oleic acid, AZE (product of oxidation of fatty acids) was found in blood serum from EMF-exposed rats. As a rule, antibodies to conjugated antigens were seen for IgM, rarely seen for IgG and were completely absent for IgA. The levels of antibodies were higher on day 7 after the exposure compared to those on day 14 after the exposure.


15. Grigor'ev YuG, Grigor'ev OA, Ivanov AA, Liaginskaia AM, Merkulov AV, Stepanov VS, Shagina NB. [Autoimmune processes after long-term low-level exposure to electromagnetic fields (the results of an experiment). Part 1. Mobile communications and changes in electromagnetic conditions for the population. Needs for additional substantiation of the existing hygienic standards]. Radiat Biol Radioecol. 2010 Jan-Feb;50(1):6-11. http://www.ncbi.nlm.nih.gov/pubmed/20297674 Abstract: Mobile communications provides a new source of electromagnetic exposure for almost the whole population of the Russian Federation. For the first time in the history of civilization the brain of mobile phone users was exposed to localized radiofrequency (RF) electromagnetic fields (EMF). Population exposure from the base stations is also considered to be specific. However, existing standards for limiting the exposure do not account for this special EMF source and may not ensure the absence of health effects. There was a need for reliable information that would extend databases used for development of new standards. As recommended by the World Health Organization an additional experiment was performed under the supervision of foreign experts, which
showed changes in autoimmune status in rats after long-term low-level RF EMF exposure with an incident power density of 500 microW/cm² [0.5 mW/cm²].

16. Ivanov AA, Grigor'ev IuG, Mal'tsev VN, Ulanova AM, Stavrakova NM, Skachkova VG, Grigor'ev OA. [Autoimmune processes after long-term low-level exposure to electromagnetic fields (the results of an experiment). Part 3. The effect of the long-term non-thermal RF EMF exposure on complement-fixation antibodies against homologenous tissue]. Radiats Biol Radioecol. 2010 Jan-Feb;50(1):17-21. http://www.ncbi.nlm.nih.gov/pubmed/20297676 Abstract: This paper presents the results of the study of immunological effects of long-term low-level exposure of rats to microwaves. Rats were exposed in the far field to 2450 MHz continuous wave fields providing an incident power density at the cages of 500 microW/cm² [0.5 mW/cm²] for 7 hours daily for a total of 30 days, resulting in a whole-body SAR of 0.16 +/- 0.04 W/kg. Effects of the exposure on immunological parameters in the brain and liver of rats were studied using Complement Fixation Test at low temperature (4 degrees C). Three groups ("EMF-exposure", "sham-exposure" and cage-control) were formed, each consisting of 16 rats. On the 14th day after the 30-day exposure, titers of antibodies against brain tissue were 0.69 +/- 0.08 in the cage-control group, 0.89 +/- 0.05 in the sham-exposed group and 1.19 +/- 0.07 in the EMF-exposed group. The appearance of antibodies against liver antigens was less. The increase in titres of antibodies against brain homogenates in the sham-exposed and EMF-exposed groups could be explained by the stress-reaction of the animals and autoimmunization of organism.

17. Johansson O. Disturbance of the immune system by electromagnetic fields-A potentially underlying cause for cellular damage and tissue repair reduction which could lead to disease and impairment. Pathophysiology 2009. 16 (2-3):157-77. http://www.ncbi.nlm.nih.gov/pubmed/19398310 Abstract: A number of papers dealing with the effects of modern, man-made electromagnetic fields (EMFs) on the immune system are summarized in the present review. EMFs disturb immune function through stimulation of various allergic and inflammatory responses, as well as effects on tissue repair processes. Such disturbances increase the risks for various diseases, including cancer. These and the EMF effects on other biological processes (e.g. DNA damage, neurological effects, etc.) are now widely reported to occur at exposure levels significantly below most current national and international safety limits. Obviously, biologically based exposure standards are needed to prevent disruption of normal body processes and potential adverse health effects of chronic exposure. Based on this review, as well as the reviews in the recent Bioinitiative Report [http://www.bioinitiative.org/] [C.F. Blackman, M. Blank, M. Kundi, C. Sage, D.O. Carpenter, Z. Davanipour, D. Gee, L. Hardell, O. Johansson, H. Lai, K.H. Mild, A. Sage, E.L. Sobel, Z. Xu, G. Chen, The Bioinitiative Report-A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF), 2007]), it must be concluded that the existing public safety limits are inadequate to protect public health, and that new public safety limits, as well as limits on further deployment of untested technologies, are warranted.

18. Johansson O. A Scientific Perspective on Health Risk of Electromagnetic Fields; Section 8 Evidence For Effects On The Immune System. BioInitiative Working Group,

Excerpt (pg. 30): • Both human and animal studies report large immunological changes with exposure to environmental levels of electromagnetic fields (EMFs). Some of these exposure levels are equivalent to those of e.g. wireless technologies in daily life. • Measurable physiological changes (mast cells increases, for example) that are bedrock indicators of allergic response and inflammatory conditions are stimulated by EMF exposures. • Chronic exposure to such factors that increase allergic and inflammatory responses on a continuing basis may be harmful to health. • It is possible that chronic provocation by exposure to EMF can lead to immune dysfunction, chronic allergic responses, inflammatory responses and ill health if they occur on a continuing basis over time. This is an important area for future research. • Specific findings from studies on exposures to various types of modern equipment and/or EMFs report over-reaction of the immune system; morphological alterations of immune cells; profound increases in mast cells in the upper skin layers, increased degranulation of mast cells and larger size of mast cells in electrohypersensitive individuals; presence of biological markers for inflammation that are sensitive to EMF exposure at non-thermal levels; changes in lymphocyte viability; decreased count of NK cells; decreased count of T lymphocytes; negative effects on pregnancy (uteroplacental circulatory disturbances and placental dysfunction with possible risks to pregnancy); suppressed or impaired immune function; and inflammatory responses which can ultimately result in cellular, tissue and organ damage. • Electrical hypersensitivity is reported by individuals in the United States, Sweden, Switzerland, Germany, Denmark and many other countries of the world. Estimates range from 3% to perhaps 10% of populations, and appears to be a growing condition of ill-health leading to lost work and productivity.

19. Lushnikov KV, Gapeev AB, Sadovnikov VB, et al. Effects of extremely high frequency electromagnetic radiation of low intensity on parameters of humoral immunity in healthy mice. Biofizika 2001; 46: 753-60 http://www.ncbi.nlm.nih.gov/pubmed/11558390 Abstract: The modification of indices of the humoral immune response to thymus-dependent antigen (sheep erythrocytes) after a whole-body exposure of healthy mice to low-intensity extremely-high-frequency electromagnetic radiation was studied. Male NMRI mice were exposed in the far-field zone of horn antenna at a frequency of 42.0 GHz and energy flux density of 0.15 mW/cm2 under different regimes: once for 20 min, for 20 min daily during 5 and 20 successive days before immunization, and for 20 min daily during 5 successive days after immunization throughout the development of the humoral immune response. The intensity of the humoral immune response was estimated on day 5 after immunization by the number of antibody-forming cells of the spleen and antibody titers. Changes in cellularity of the spleen, thymus and red bone marrow were also assessed. The indices of humoral immunity and cellularity of lymphoid organs changed insignificantly after acute exposure and series of 5 exposures before and after immunization of the animals. However, after repeated exposures for 20 days before immunization, a statistically significant reduction of thymic cellularity by 17.5% (p < 0.05) and a decrease in cellularity of the spleen by 14.5% (p < 0.05) were revealed. The results show that low-intensity extremely-high-frequency electromagnetic radiation with the frequency and
energy flux density used does not influence the humoral immune response intensity in healthy *mice but influences immunogenesis under multiple repeated exposures*.

20. Lushnikov KV, Gapeev AB, Shumilina IV, *et al*. *Decrease in the intensity of the cellular immune response and non-specific inflammation upon exposure to extremely high frequency electromagnetic radiation*. Biofizika 2003; 48: 918-25. [http://www.ncbi.nlm.nih.gov/pubmed/14582420](http://www.ncbi.nlm.nih.gov/pubmed/14582420) **Abstract:** The effect of low-intensity extremely high-frequency electromagnetic radiation (EHF EMR, 42.0 GHz, 0.1 mW/cm², 20 min daily) on cell-mediated immunity and nonspecific inflammatory response in mice was studied. The intensity of cell-mediated immune response in the reaction of delayed-type hypersensitivity and nonspecific inflammation was estimated by a relative increase in the thickness of foot pad after immunization of animals by sheep red blood cells or zymosan. It was shown for the first time that the radiation reduces both immune and nonspecific inflammatory responses. It was shown with the use of models of acute inflammation and full-thickness skin wounds that EHF EMR suppresses the nonspecific inflammatory response but does not influence the duration of the pathological process. We suppose that the basis of the effects revealed is the modification of functional activity of phagocytic cells under the influence of EHF EMR. The results suggest that some therapeutic effects of EHF EMR can be realized via the inhibition of inflammatory processes.

21. McRee DI. *Review of Soviet/Eastern European research on health aspects of microwave radiation*. Bull N Y Acad Med. 1979 December; 55(11): 1133–1151. [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1807746/pdf/bullnyacadmed00125-0169.pdf](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1807746/pdf/bullnyacadmed00125-0169.pdf) **Excerpt (pg 1135):** In 1971 the United States and the Soviet Union agreed to cooperate in health-related research areas. In March 1972 an agreement was signed between the U.S. Department of Health, Education and Welfare and the U.S.S.R. Ministry of Health to cooperate in the area of cancer, heart and lung disease, and environmental health. The directors of the National Cancer Institute, National Institute of Heart and Lung Diseases, and the National Institute of Environmental Health Sciences were appointed to work with Soviet counterparts to develop cooperative plans for research in each of the specified areas. The formal agreement to cooperate in the area of the biological effects of microwave radiation was signed in October 1975. Since 1975 there have been yearly exchange visits by scientists from both countries. **Excerpt (pg 1139):** Most Soviet research is performed, therefore, at low levels of exposure for long exposure duration. They consider that power densities above 1mW/cm² are high enough to produce harmful effects, and see no reason to perform research above this level. When we respond that in some of our experiments we see no significant changes at exposure levels above 1mW/cm², their answer is that we did not expose long enough. **Most of their low level experiments are for six months to a year, while American experiments are usually in terms of a few weeks. Long-term experiments using low levels of microwaves must be performed in the United States before the Soviet results can be verified or refuted…** American research consisted primarily of acute experiments with exposure levels generally of 5 mW/cm² and above, while Soviet experiments were long-term, low-level experiments at 500,mW/cm² and below. **At the end of the first year of the cooperation, the Soviets reported changes in bioelectric brain activity at 10, 50, and**
500,uW/cm.2 in rats and rabbits exposed for 7 hours/day for 30 days to 2,375 MHz.
radiation. Levels of 10 and 50,uW/cm.2 stimulated brain activity, while 500,uW/cm.2
suppressed activity as seen from an increase of slow, high amplitude A-wave in rabbits.
At 500 gW/cm.2 a decrease in capacity for work, in investigative activity, and sensitivity
to electric shock threshold in rats were reported. Research by American investigators on
rats exposed to 5 mW/cm.2 for shorter durations of exposure to 2,450 MHz. radiation
showed no statistical difference in electroencephalogram, no change in locomotive
activity in a residential maze, and no change in performance on a fixed ratio schedule
of reinforcement below 5 mW/cm.2 (0.5 and 1.0 mW/cm.2) but a trend toward decrease
in performance at 5 mW/cm.2 and a large decrease in performance at 10 and 20
mW/Cm.2. It became obvious that, except for our being more familiar with their
experimental design, we were no closer to understanding differences between American
and Soviet results. It was then decided to perform a duplicate experiment to determine
whether similar effects could be observed. Rats were exposed from above for seven
hours/day, seven days/week for three months to 500 uW/cm.2. Dr. Richard Lovely of
the University of Washington, project leader on the duplicate project, spent four weeks
in the Soviet Union to observe the behavioral and biochemical tests performed on the
animals. The American study found a drop in sulphydryl activity and blood
cholinesterase as reported in the Soviet study. Blood chemical analyses at the
termination of three months exposure indicated that exposed animals, relative to
controls, suffered from aldosteronism. The latter interpretation of the high sodium-low
potassium levels found in the blood was confirmed by necropsy and histopathologic
study of the adrenal glands, revealing that the zona glomerulosa was vacuolated and
hypertrophied. In addition, all behavioral parameters assessed at the end of three-
month exposures revealed significant differences between groups in the same direction
as those reported in the Soviet study, i.e., increased threshold to footshock detection,
decreased activity in an open field, and poorer retention of an avoidance response
when reassessed following conditioning. This replication of the Soviet results at 500
puW/cm.2 emphasizes the need for additional long-term, low-level microwave
bioeffects research.

22. McRee DI, Elder JA, Gage MI, Reiter LW, Rosenstein LS, Shore ML, Galloway WD,
Adey WR, Guy AW. Effects of nonionizing radiation on the central nervous system,
Review http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1637719/pdf/envhper00475-
0118.pdf [Copy filed in Docket] Abstract: This paper presents a progress report on the
U. S. research which has been designated as collaborative research with the Soviet Union
to study the biological effects of nonionizing radiation on the central nervous system,
behavior, and blood. Results of investigations to study the effects of microwaves on
isolated nerves, synaptic function, transmission of neural impulses,
electroencephalographic recordings, behavior, and on chemical, cytochemical and
immunological properties of the blood are presented. Specifically, the effects of
microwave exposure on chick brain and cat spinal cords, on EEG patterns of rats, on
behavioral of neonatal rats exposed during development, on behavior of adult rats, on
behavior of rhesus monkeys and on the pathology, hematology, and immunology of
rabbits will be reported in a summary format. Much of the information is new and has not
been published previously. Excerpt (Pg 131): Based on the limited data obtained in this study, it may be concluded that microwave exposure suppresses, at least slightly, immune competence. Based on results reported, microwaves most likely suppress both T- and B-cell populations. PHA and ConA are strict T-cell mitogens, while PWM is mitogenic for both T- and B-cells.

23. Moszczynski P, Lisiewicz J, Dmoch A, Zabinski Z, Bergier L, Rucinska M, Sasiadek U 1999. (The effect of various occupational exposures to microwave radiation on the concentrations of immunoglobulins and T lymphocyte subsets) Wiad Lek 52(1-2):30-34. http://www.ncbi.nlm.nih.gov/pubmed/10335122 Abstract: The immunoglobulins' concentrations and T lymphocyte subsets during occupational exposures to microwave radiation were assessed. In the workers of retransmission TV center and center of satellite communications on increased IgG and IgA concentration and decreased count of lymphocytes and T8 cells was found. However, in the radar operators IgM concentration was elevated and a decrease in the total T8 cell count was observed. The different behaviour of examined immunological parameters indicate that the effect of microwave radiation on immune system depends on character of an exposure. Disorders in the immunoglobulins' concentrations and in the T8 cell count did not cause any clinical consequences.

24. Novoselova EG, Fesenko EE, Makar VR, Sadovnikov VB 1999. Microwaves and cellular immunity. II. Immunostimulating effects of microwaves and naturally occurring antioxidant nutrients. Bioelectrochem Bioenerg 49(1):37-41. http://www.ncbi.nlm.nih.gov/pubmed/10619446 Abstract: The effect of 8.15-18 GHz (1 Hz within) microwave radiation at a power density of 1 microW/cm² on the tumor necrosis factor (TNF) production and immune response was tested. A single 5 h whole-body exposure induced a significant increase in TNF production in peritoneal macrophages and splenic T cells. The mitogenic response in T lymphocytes increased after microwave exposure. The activation of cellular immunity was observed within 3 days after exposure. The diet containing lipid-soluble nutrients (beta-carotene, alpha-tocopherol and ubiquinone Q9) increased the activity of macrophages and T cells from irradiated mice. These results demonstrate that irradiation with low-power density microwaves stimulates the immune potential of macrophages and T cells, and the antioxidant treatment enhances the effect of microwaves, in particular at later terms, when the effect of irradiation is reduced.


28. Stankiewicz W, Dąbrowski M, Sobiczewska E, Szmigielski S. Non thermal effects and mechanisms of interaction between EMF and living matter; Immunotropic effects of low-level microwave exposures in vitro. Eur. J. Oncol. Library, vol. 5, an ICEMS Monograph, 2010. Review [Copy Filed in Docket] Excerpt (pg 150): In the available literature no reports exist on the complex assessment of immune phenomena under EMF influence, all investigations were aimed to evaluate only selected, fragmentaric reactions of the system or selected types of immune cells. At the present state of knowledge it is, therefore, not possible to conclude about the specific immunotropic potencies of MW radiation, as the assessment of the immunotropic potency requires a general insight into the whole complex immune network, taking in advance the determination of immune status of the host or the investigated cellular population prior to the MW exposure. The final effect of exposition of biological material to MW radiation depends Excerpt (pg 150): Our observations suggest that a 900 MHz GSM signal is immunostimulatory and may increase the immune reaction of lymphocytes and monocytes already participating in the immune response. Testing possible immunotropic influences of 900 MHz GSM signal on human b Excerpt (pg 155): Conclusion: The presented data suggest, that exposition in vitro of human blood mononuclear cells to different radiofrequencies of low energy MW (e.g. 900 and 1300 MHz) is potent to modulate the immune activity of lymphocytes and monocytes. The range of affected immune parameters depend not only on the wave length, frequency and intensity of EMF but also on the timing of exposures (before or during the culture) and on the initial immune status of the donor of immune cell.

29. Stankiewicz W, Dąbrowski MP, Kubacki R, et al. Immunotropic influence of 900 MHz microwave GSM signal on human blood immune cells activated in vitro. Electromagn Biol Med 2006; 25: 45-51. http://www.ncbi.nlm.nih.gov/pubmed/16595333 Abstract: In an earlier study we reported that G(o) phase peripheral blood mononuclear cells (PBMC) exposed to low-level (SAR = 0.18 W/kg) pulse-modulated 1300 MHz microwaves and subsequently cultured, demonstrate changed immune activity (Dabrowski et al., 2003). We investigated whether cultured immune cells induced into the active phases of cell cycle (G(1), S) and then exposed to microwaves will also be sensitive to electromagnetic field. An anechoic chamber of our design containing a microplate with cultured cells and an antenna emitting microwaves (900 MHz simulated GSM signal, 27 V/m, SAR 0.024 W/kg) was placed inside the ASSAB incubator. The microcultures of PBMC exposed to microwaves demonstrated significantly higher response to mitogens and higher immunogenic activity of monocytes (LM index) than
control cultures. LM index, described in detail elsewhere (Dabrowski et al., 2001), represents the monokine influence on lymphocyte mitogenic response. The results suggest that immune activity of responding lymphocytes and monocytes can be additionally intensified by 900 MHz microwaves.

30. * Trosic I, Busljeta I, Pavicic I. Blood-forming system in rats after whole-body microwave exposure; reference to the lymphocytes. Toxicol Lett. 2004 Dec 1;154(1-2):125-32. http://www.ncbi.nlm.nih.gov/pubmed/15475186 Abstract: The influence of 2.45 GHz microwave (RF/MW) irradiation on blood-forming cells after whole-body irradiation of rats was investigated. The exposures were conducted with a field power density of 5-10 mW/cm², and whole-body average specific absorption rate (SAR) of 1-2 W/kg. Four experimental subgroups were created and irradiated 2, 8, 15 or 30 days, for 2 h a day, 7 days a week. Concurrent sham-exposed rats were also included in the study. The cell response was assessed by number and type of the bone marrow nuclear cells and peripheral blood white cells using standard laboratory methods. Significant decrease in lymphoblast count was obtained at 15 and 30th experimental day (P < 0.05), whereas other examined parameters did not significantly differ in comparison to the sham-exposed controls. The findings point out at stress response in blood-forming system in rats after selected microwave exposure, which could be considered rather as sign of adaptation than malfunction.

31. * Trosic I, Busljeta I. Erythropoietic dynamic equilibrium in rats maintained after microwave irradiation. Exp Toxicol Pathol. 2006 Jan;57(3):247-51. Epub 2005 Oct 3. Abstract: The aim of study was to define influence of radiofrequency microwave (RF/MW) radiation on erythropoiesis in rats. The kinetics of polychromatic erythrocytes (PCEs) and micronucleated (MN) PCEs in the bone marrow (BM) and peripheral blood (PB) of rats during the intermittent subchronic experiment was followed. Rats were exposed 2 h/day, 7 days/week to RF/MW of 2.45 GHz and whole-body specific absorption rate (SAR) of 1.25+/−0.36 W/kg. Control animals were included in the study. Each exposed and control group was killed on the final day of irradiation. Acridine-orange stained BM and blood smears were examined by fluorescence microscope. PCEs were obtained by inspection of 2000 BM and 1000 PB erythrocytes/slides. BMMMNs and PBMMNs frequency was obtained by observation of 1000 PCEs/slides. BMPCEs were increased on day 8 and 15, and PBPCES were elevated on days 2 and 8 (p<0.05). The BMMN frequency was increased on experimental day 15, and MNPCES in the PB was increased on day 8 (p<0.05). Findings of BM and PBPCES or MNPCES declined nearly to the control values until the end of the experiment. Such findings are considered to be indicators of radiation effects on BM erythropoiesis consequently reflected in the PB. Rehabilitated dynamic haemopoietic equilibrium in rats by the end of experiment indicates possibility of activation adaptation process in rats to the selected experimental conditions of subchronic RF/MW exposure.

with albino rats exposed to microwaves (500 microW/cm²), a model of adaptive immunity was developed by transferring lymphoid cells of exposed animals. The effect of microwave radiation was shown to cause autoimmune disorders that were displayed against the background of the structural and functional disturbances of the hematoencephalic barrier.


Abstract: The authors discuss the possibility of stimulating the autoimmune reactions of the organism by microwave irradiation. The immunochemical analysis of protein fractions of blood serum has revealed a destabilization of functional activity of the immune system humoral factors at 500 W/cm² [.05 mW/cm²] which is manifested by the formation of a new protein with the immunoglobulin G physico-chemical properties.


35. *Vinogradov GI, 1974