

# Soviet and Japanese Aerospace Literature

Throughout 1988 the *AIAA Journal* will carry selected abstracts on leading research topics from the Soviet aerospace literature and, as space permits, from similar Japanese literature. The topics will be chosen and the abstracts reviewed for pertinency by *AIAA Journal* editors. This month features Aerospace Medicine from the USSR and Aerodynamics from Japan.

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## Soviet Aerospace Literature This month: *Aerospace Medicine*

**A88-21932 Optimal regulation of blood circulation and erythropoiesis under changes of motor activity (Optimal'naia regulatsiia krovoobrashcheniia i krovetvoreniiia pri izmenenii dvigatel'noi aktivnosti)** I. F. OBRAZTSOV, M. A. KHANIN, and I. B. BUKHAROV, *Akademiia Nauk SSSR, Doklady* (ISSN 0002-3264), Vol. 297, no. 1, 1987, pp. 248-250. 12 Refs.

A mathematical model of the functional state of the blood circulation and erythropoiesis under changes of the motor activity (especially under hypodynamia) is presented with reference to conditions arising during prolonged stay in weightlessness. It is shown that functional shifts under hypodynamia (lowering of the hematocrit and the volume of circulating blood, and an increase in the blood minute volume) should be viewed as a normal physiological adaptation. Here, the blood circulation and erythropoiesis systems pass into a new functional state, corresponding to minimum energy expenditures.

**A88-21902 Procedural approaches for detecting hyperlipemia in flight personnel (Metodicheskie podkhody k vyiaвлению giperlipidemii u letnogo sostava)** S. A. BUGAROV, R. K. KISELEV, V. E. POTKIN, T. A. ORLOVA, V. I. PLAKHATNIUK, et al. *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), Sept. 1987, pp. 48, 49.

The definition of the state of hyperlipemia in a subject depends upon the norms set for the control levels of atherogenic plasma lipoproteins. A relationship is proposed for the determination of the coefficient of atherogenicity, which expresses the ratio between the contents of atherogenic and nonatherogenic lipoproteins, i.e., the ratio between the low-density and high-density cholesterol fractions. This relationship was used to analyze the status of lipid metabolism in 44 pilots in the 23-41 yr bracket, comparing the results with those of two conventional methods (comparisons of individual cholesterol values with its upper limits or with the age-normalized 'proper' levels). Using the coefficient of atherogenicity, hyperlipemia was diagnosed in 21 subjects; only seven subjects were diagnosed hyperlipemic by all three methods used.

**A88-19620 Restoration of work capacity in flight personnel (K probleme vosstanovleniia professional'noi rabotosposobnosti letnogo sostava)** V. A. BODROV, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), Aug. 1987, pp. 46-48.

This paper discusses the problem of partial work capacity loss by flight personnel due to functional aberrations in the nervous and cardiovascular systems, occurring before the appearance of clinical symptoms of a

disease. These functional disorders may manifest themselves in elevated irritability, fatigability, decreased tolerance to the conditions of flight, and the development of fear sensation during flight. Methods for testing the preclinical functional aberrations are suggested, and procedures directed towards the correction of such conditions are considered. These programs must include medical, psychosociological, and occupational rehabilitation programs.

**A88-19619 Endocrine-metabolic changes during adaptation to high temperature (Endokrinno-metabolicheskie izmeneniia v protsesse adaptatsii k vysokoi temperature)** I. D. KUDRIN, A. I. KARPISHCHENKO, and N. A. STOLIAROVA, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), Aug. 1987, pp. 40-43.

The effect of living and working at 29-35°C on the functional activity of the hypophyseal-adrenal (HA) system and the thyroid gland, as well as on some features of energy metabolism was studied in male subjects flown from temperate-climate locations into a region of hot dry climate. The blood levels of ACTH, cortisol, thyroxine, glucose, and lactate, and blood lipids were measured on the 1st, 8th, 15th, and 22nd day after arrival at the new location. The results indicated an almost immediate (1st day) increase of ACTH and cortisol levels, which continued at least to the 8th day, indicating a stressed HA system. Physical exercise led to increases of glucose and lactate levels. After 15-22 days, the parameters of the HA system and of energy metabolism started to decrease towards normal values. Complete adaptation to hot climate occurred only after 2.5 months.

**A88-18033 Biorhythms of binocular vision (Bioritmy binokuliarnogo zreniia)** T. P. TETERINA, V. V. VOLKOV, and L. P. KOCHETKOVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), vol. 13, Sept.-Oct. 1987, pp. 779-782. 16 Refs.

The biorhythms of monocular perception in the process of binocular fixation were investigated together with the effects of the subjects' age and physical load on the rhythms. It was found that, during binocular vision of an immobile object in free space, there takes place a rhythmic synchronous alternation of the monocular perceptions by each of the two eyes. Average rhythm frequency in subjects with normal binocular vision was found to be 10.9 ± 0.3/min, with a period duration of about 4.78/sec and a monocular-phase duration of between a fraction of a second and 1-3 seconds. Monocular rhythm frequency varied during the 24-h period, being lowest in the morning and highest around 6 PM. The rhythm frequency was found to be also affected by the age of an individual, being higher in young

adults than in children aged 10-14 years, and by exercise, which increased the rhythm frequency.

**A88-18032 Temporal characteristics of object-image recognition with filtering of high spatial frequencies (Vremennye kharakteristiki opoznaniia predmetnykh izobrazhenii pri fil'tratsii vysokikh prostanstvennykh chastot)** A. A. NEVSKAIA, V. N. PAUK, V. B. MAKULOV, T. S. BULASHEVICH, and V. D. GLEZER, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Sept.-Oct. 1987, pp. 757-766. 16 Refs.

The temporal characteristics of object recognition from images processed with different cut-off filtering limits of high spatial frequencies were determined using computer-processed half-tonal photographs of individual objects which were presented to different observers. The results indicate that recognition of the form is determined by the harmonic composition of the image. When the time of presentation is not limited, the recognition is possible with seven lower harmonics. The addition of high frequencies (but not above 28 harmonics), increases the speed of recognition.

**A88-16150 Man in space flight** O. G. GAZENKO, E. B. SHUL'ZHENKO, A. I. GRIGOR'EV, and A. D. EGOROV, IAF, International Astronautical Congress, 38th, Brighton, England, Oct. 10-17, 1987. 8 pp. 31 Refs. Report No.: IAF PAPER 87-527

Physiological changes that occur in man during spaceflight are examined. The mechanisms which cause these main physiological changes, such as a change in the afferent load, the elimination of hydrostatic pressure, and the lack of weight load on the musculoskeletal system, are discussed, and methods for countering these mechanisms are described. Changes in man's vestibular functions, motor system, fluid-electrolyte metabolism, cardiovascular system, calcium metabolism, circulatory system, and immunology system during spaceflight are considered.

**A88-15339 Comparative assessment of vestibular, optokinetic, and optovestibular stimulation in the development of experimental motion sickness** EDUARD I. MATSNEV, MIKHAIL P. KUZ'MIN, and LIUDMILA N. ZAKHAROVA, *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), Vol. 58, Oct. 1987, pp. 954-957. 17 Refs.

The contribution of vestibular, optokinetic, and optovestibular stimulation to experimental motion sickness was evaluated in 29 volunteer subjects. Vestibular stimulation (Coriolis effect) was found to induce the most significant vestibular-autonomic disorders. Optokinetic stimulation (pseudo-Coriolis effect) and optovestibular stimulation could provoke such disorders only in susceptible subjects. In quantitative terms, optokinetic and optovestibular stimulation were less effective than vestibular Coriolis stress. Nystagmic reactions of susceptible subjects to the three types of stimulation differed significantly from those of tolerant subjects. This may be important from the theoretical point of view because susceptibility to motion sickness and responses to vestibular and optokinetic stimulation may be universal and associated with the general CNS mechanism, i.e., inhibition mechanism. The identified correlation between the duration of postoptokinetic illusion and motion sickness susceptibility may be used to differentiate susceptible and tolerant subjects.

**A88-14731 The role of the individual characteristics of vegetative reactions during the action of adaptogens on physical and mental work capacity (Rol' individual'nykh osobennostei vegetativnykh reaktiv pri deistvii adaptogenov na fizicheskuiu i umstvennuiu rabotosposobnost')** T. I. SHUSTOVA, F. V. OS'MININ, V. A. NIBUSH, A. F. ERSHOV, and A. P. PISANKO, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, July-Aug. 1987, pp. 696-698.

The effect of an adaptogen (Eleuterococcus extract) on physical and mental work capacity was investigated in subjects with different types of vegetative reactions. Two-hundred healthy men were separated according to the reaction of pulse rate to various functional tests into three groups: sympathotonic, normotonic, and parasympatonic. Results on changes in work capacity showed that the adaptogenic effect of the extract was enhanced by physical training. The effect of a given dose depended on the individual type of the subject. Subjects of the parasympatic type of reaction displayed the highest stimulating effect on the work capacity.

**A88-14730 Physiological mechanisms of thermoregulation in humans during adaptation to cold (O fiziologicheskikh mekhanizмах termoregulatsii cheloveka pri adaptatsii k kholodu)** V. I. SOBOLEV and G. I. CHIRVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, July-Aug. 1987, pp. 647-652. 13 Refs.

Male subjects were adapted to cold by being exposed (2 h daily for 24 days) to 14°C in a climatic chamber, and changes in their tympanic and skin temperatures and respiratory coefficient, as well as the values of the indices of muscle contractile activity and thermogenesis, were measured at different stages of adaptation. The exposures to cold were found to initiate the development of physiological thermoregulatory processes characteristic of adaptation. Thus, the 'engagement' of processes responsible for thermogenesis was detected in the subjects much sooner at the end of 24 days than in the same subjects at the beginning of the experiment. In the cold-adapted subjects, cold-induced shivering became more effective than in the control state: heat production per one unit of muscle contraction increased by a factor of 5, and the energy expenditure of homeothermy fell by 70 percent.

**A88-14728 Regulation of the hemodynamics during the simulation of weightlessness (Mathematical modeling) (Regulatsiia gemodinamiki pri imitatsii perekhoda k nevесomosti /Matematicheskoe modelirovanie/)** B. L. PALETS, A. A. POPOV, M. A. TIKHONOV, and V. S. PANCHENKO, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, July-Aug. 1987, pp. 627-632. 7 Refs.

A mathematical model of human circulation dynamics, based on the model of Palets et al. (1985), was used to study rapid responses of the cardiovascular system to the onset of weightlessness. The model was also used to study the effects on circulation of some weightlessness-counteracting methods, such as hypovolemia, lower-body negative pressure (LBNP), and hip cuffs. The analytical results show that upon the onset of weightlessness the right heart ventricle, due to the blood-volume overload, starts to function in a 'plateau' range of the accretion function. Hypovolemia, LBNP, and occlusion cuffs all function to decrease the volume load of the right ventricle. Among the counter-weightlessness methods, the LBNP is the most effective.

**A88-14727 The dynamics of the lipid metabolism and hormonal background during adaptation to long-term psychoemotional and physical loads (Dinamika lipidnogo obmena i gormonal'nyi fon v protsesse adaptatsii k dlitel'ny'm psikhoemotsional'ny'm i fizicheskim nagruzkam)** S. D. POLOZHENTSEV, D. A. RUDNEV, and A. V. KUVSHINNIKOV, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, July-Aug. 1987, pp. 616-620. 13 Refs.

The effects of psychoemotional stress (such as separation from the family, changes in the daily routine, and/or changes in the occupational environment) and physical load (such as physical work or intensive physical training) on the changes in lipid metabolism and in hormonal status were investigated in healthy men living under otherwise identical circumstances. The concentrations of adrenaline and noradrenaline in urine, and the indices of lipid metabolism (total cholesterol, triglycerides, lipid hydroperoxides, and the cholesterol contents of low- and high-density lipoproteins) were measured in stressed and control subjects during two periods: the initial 20 days after the start of stress and the period between the 35th and 50th day. A long-lasting hormonal disbalance was recorded in subjects under psychoemotional stress, causing distortions of lipid metabolism. Such abnormalities can potentially cause the thinning of arterial walls and the formation of lipoprotein deposits in the arterial walls.

**A88-13696 The significance of the phase mismatch of sensory signals in mechanisms of motion-sickness development (Znachenie fazovogo rassoglasovaniia sensornykh signalov v mekhanizмах razvitiia ukachivaniia)** O. A. VOROB'EV, *Akademiia Nauk SSSR, Izvestiia, Seriya Biologicheskaya* (ISSN 0002-3329), Sept.-Oct. 1987, pp. 753-761. 45 Refs.

Using previously obtained data, the features of the coordinated stimulation of the vestibular and the extralabyrinth systems which induce the development of motion sickness are analyzed. A hypothesis according to which human motion-sickness is mostly determined by the level of phase mismatch of signals from various sensory analyzers is substantiated. Accordingly, the motion sickness is believed to arise as a result of the appearance of 'spatial' excitation in the central nervous system, involving higher vegetative centers.

**A88-12973 Metabolic and hormonal status of crewmembers in short-term spaceflights** A. I. GRIGOR'EV, I. A. POPOVA, and A. S. USHAKOV, (NASA, Universities Space Research Association, Baylor University, and International Academy of Astronautics, 7th International Man in Space Symposium, Houston, TX, Feb. 10-13, 1986) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), Vol. 58, Sept. 1987, pp. A121-A125. 11 Refs.

In order to clarify biochemical adaptation of the human body to short-term microgravity, metabolic and hormonal parameters were investigated in 20 cosmonauts who performed orbital flights of 4 to 14 d in duration. The specific feature of adaptation to this exposure is the transition to a new level of hormonal regulation with a significant increase of the content (production) of glucocorticoids, catecholamines, components of the renin-angiotension-aldosterone system (which determines a modified activity of tissue hormones), and fluid-electrolyte homeostasis, as well as simultaneous increase of insulin secretion (which diminishes the metabolic effects of glucocorticoids and catecholamines).

**A88-12963 Ultrasound techniques in space medicine** O. I. ATKOV, V. S. BEDNENKO, and G. A. FOMINA, (NASA, Universities Space Research Association, Baylor University, and International Academy of Astronautics, 7th International Man in Space Symposium, Houston, TX, Feb. 10-13, 1986) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), Vol. 58, Sept. 1987, pp. A69-A73. 19 Refs.

Ultrasound examinations have been performed on 15 cosmonauts who have remained in orbit for flights ranging from 2.5 to 8 months in duration. Soviet researchers have combined hemodynamic assessments with parallel attempts to develop improved ultrasound techniques and equipment for use onboard space stations. These techniques and equipment are reviewed, as are findings relative to exercise effects on hemodynamic changes. In general, longitudinal echocardiographic studies have suggested that (1) few differences exist between resting preflight and on-orbit cardiac contractility measures; (2) declines in orthostatic stability

after long-term flights are not due to deterioration of the myocardial functional state; and (3) lower stroke volumes and heart rate increases occurring during exertion may be considered compensatory hemodynamic resettings rather than indications of a disturbed left ventricular contractility.

**A88-12960 Central and coronary circulation of the normal man during orthostatic and lower body negative pressure tests** V. E. KATKOV, V. V. CHESTUKHIN, L. I. KAKURIN, A. M. BABIN, and E. M. NIKOLAENKO, (NASA, Universities Space Research Association, Baylor University, and International Academy of Astronautics, 7th International Man in Space Symposium, Houston, TX, Feb. 10-13, 1986) *Aviation, Space, and Environmental Medicine* (ISSN 0095-6562), Vol. 58, Sept. 1987, pp. A55-A60. 25 Refs.

The effects of the tilt test (60-70 deg for 20 min) and lower body negative pressure (LBNP) test (-30 and -60 mm Hg for 20 min each) on the basic parameters of circulation (15 subjects) and coronary circulation (11 subjects) were investigated. The study was performed using thermistor-equipped catheters implanted into the pulmonary artery and coronary sinus and Teflon catheters implanted into the brachial artery. The effect of the tilt test and LBNP test on the basic parameters of central and coronary circulation, blood acid-base equilibrium, and oxygenation was compared.

**A88-12464 Controlled water immersion as a model of weightlessness** I. D. PESTOV and A. V. POKROVSKII, (International Union of Physiological Sciences, Commission on Gravitational Physiology, 8th Annual Meeting, Tokyo, Japan, Nov. 4-8, 1986) *Physiologist, Supplement* (ISSN 0031-9376), Vol. 30, Feb. 1987, pp. S-125 to S-128.

The use of a controlled water immersion model to simulate weightlessness is examined. The control parameter for the model is a variable level of hydrostatic pressure exerted by the immersion medium on the lower body; methods for achieving this effect are discussed. The capabilities of the model are described. Some data derived using the model are presented. The controlled water immersion model is applicable to: a short-time simulation of qualitatively different states of gravity tolerance; a study of the cause-effect relationship between controlled changes in the blood distribution pattern and resulting reactions; and an analysis of space physiology problems.

**A88-12453 Characteristics of vestibular reactions to canal and otolith stimulation at an early stage of exposure to microgravity** M. G. SIROTA, B. M. BABAEV, I. B. BELOOZEROVA, A. N. NYROVA, and S. B. IAKUSHIN, et al. (International Union of Physiological Sciences, Commission on Gravitational Physiology, 8th Annual Meeting, Tokyo, Japan, Nov. 4-8, 1986) *Physiologist, Supplement* (ISSN 0031-9376), Vol. 30, Feb. 1987, pp. S-82 to S-84.

The otolith organs and semicircular canals of the vestibular apparatus of monkeys were excited in space during the Cosmos 1667 experiment. The semicircular canals were examined using the rapid gaze fixation reaction model and the otolith organs using the lift reaction model. The velocities and amplitudes of the horizontal eye and head movements, and the activity of the medial vestibular nuclei neurons were analyzed. It is observed that task fulfillment increases in the first days of flight; however, by days 5 and 7 hypersensitivity decreases gradually and returns to preflight values. The data reveal that the exposure of monkeys to microgravity causes an increase in vestibular neurons responses to canal and otolith stimuli.

**A88-12437 Hormonal regulation in space flights of varying duration** I. A. POPOVA, B. V. AFONIN, N. A. DAVIDOVA, and A. I. GRIGOR'EV, (International Union of Physiological Sciences, Commission on Gravitational Physiology, 8th Annual Meeting, Tokyo, Japan, Nov. 4-8, 1986) *Physiologist, Supplement* (ISSN 0031-9376), Vol. 30, Feb. 1987, pp. S-42 to S-44. 6 Refs.

Changes in the blood content of various hormones and in the responses of target organs to each of these hormones were studied as functions of the space-flight time, using data obtained during the short-term and the prolonged space flights. It was found that flights of up to 14-day duration induce a moderate stress on the sympatho-adrenal system, but the effect of catecholamines at the tissue level remains adequate. The long-term flights, on the other hand, lead to changes that suggest a reduction of the functional activity of receptors in response to space flight effects. Similar changes were detected in prolonged bed rest studies; cell sensitivity to hormones varied in the fashion observed in weightlessness.

**A88-12436 Central circulation during exposure to 7-day microgravity (head-down tilt, immersion, space flight)** V. E. KATKOV, L. I. KAKURIN, V. V. CHESTUKHIN, and K. KIRSCH, (International Union of Physiological Sciences, Commission on Gravitational Physiology, 8th Annual Meeting, Tokyo, Japan, Nov. 4-8, 1986) *Physiologist, Supplement* (ISSN 0031-9376), Vol. 30, Feb. 1987, pp. S-36 to S-41. 16 Refs.

The effects of simulated-microgravity exposure by 7 days of 15-deg head-down tilt (HDT) or water immersion on central circulation were investigated and compared. It was found that in the first 7 hours of exposure, the effects on the parameters of central circulation were more distinct in immersion than in HDT. The circulation parameters ceased to change on test days 2 or 3, and the absolute values of most circulation parameters became identical by the end of both exposures. The CVP measured during space flights was found to agree closely with the values measured during both simulations.

**A88-12427 Mechanisms of acute and chronic effects of microgravity** O. G. GAZENKO, A. I. GRIGOR'EV, and I. B. KOZLOVSKAIA, (International Union of Physiological Sciences, Commission on Gravitational Physiology, 8th Annual Meeting, Tokyo, Japan, Nov. 4-8, 1986) *Physiologist, Supplement* (ISSN 0031-9376), Vol. 30, Feb. 1987, pp. S-1 to S-5. 17 Refs.

The intrinsic mechanisms responsible for homeostasis in altered gravity fields are examined with respect to specific adaptation processes in motor systems and in systems of neuro-humoral regulation. The data reviewed indicate the complexity of these mechanisms and their heterogeneous and sometimes opposite character at different stages of exposure to microgravity, and show significant differences in the mechanisms of the acute and the delayed adaptive responses. The results are interpreted in the framework of a hypothesis, according to which these processes occur as independent reactions controlled by different systems and induced by different triggers: (1) by microgravity that causes immediate, acute reactions and (2) by microgravity-induced variations in the inner medium that lead to delayed (secondary) reactions.

**A88-12107 Assessment of the functional reserves of an organism (K otsenke funktsional'nykh rezervov organizma)** V. V. PASTUKHOV, N. N. PLAKHOV, and Z. K. SULIMO-SAMUILLO, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), May 1987, pp. 38, 39.

The role of preliminary tests to assess functional reserves in individuals assigned for work under stressful physical or environmental conditions is discussed. Special consideration is given to particular physiological tests which make it possible to identify individuals with low levels of functional reserves. These workers must be given training consisting of gradual exposures to the particular type of the occupational/environmental stress to which they will be subjected in the future. It was shown that such preliminary training is very effective in ameliorating changes in cardiorespiratory indices that characterize physical stress and/or exhaustion.

**A87-53539 Biological effectiveness of helium ions and protons of relativistic energies (Biologicheskaya effektivnost' ionov geliia i protonov relativistskikh energii)** B. S. FEDORENKO, N. IA. SAVCHENKO, S. V. VOROZHTSOVA, V. N. GERASIMENKO, and A. N. KABACHENKO, et al. *Radiobiologiya* (ISSN 0033-8192), Vol. 27, May-June 1987, pp. 339-343. 5 Refs.

The relative biological effectiveness (RBE) of accelerated He(2+) and high-energy proton rays encountered by space vehicles was investigated in a laboratory, using gamma-rays of Co-60 and high-energy X-rays for whole-body irradiation of rats and mice and in vitro irradiation of isolated human blood lymphocytes. The RBE coefficients of protons (9 GeV) and accelerated He ions (4 GeV/nucleon) were found to vary from 1.0 to 11.6 and 1.0 to 7.2, respectively, depending upon the object, the estimation criterion, the time of the registration of the biological effect, and the dose.

**A88-11325 Psychophysiological principles of setting work norms in flight training (Psikhofiziologicheskie printsipy normirovaniia truda v protsesse letnogo obucheniia)** N. I. FROLOV, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), June 1987, pp. 48-50.

The methods used in norm setting for the activities of pilots and pilot trainees are discussed together with the systems of activity grading. It is emphasized that the daily work norm should not only be based on the flight activity, but that the ground activities of a pilot should also be taken into consideration. It is shown that the maximal learning of piloting skills occurs only in cases when the physiological condition of the organism is maximal. The appearance of the symptoms of the motor-vegetative system activation under the conditions of the work load increase precedes the onset of a slack in the work capacity; thus, these physiological symptoms can be used for setting individual flight and work limits.

**A87-50950 The effect of elevated oxygen and carbon dioxide contents in air on the condition of the cardiorespiratory system (Vliianie povyshennogo soderzhanii v vozdukhnoi srede kisloroda i uglekislogo gaza na sostoiianie kardiorespiratornoi sistemy)** V. G. ALTUKHOV, M. A. GREBENIK, and A. A. SHAPOVOLOV, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), April 1987, pp. 39, 40.

The effect of prolonged (up to 4 months) breathing of an artificial atmosphere (AA) containing 21.3-26.3 kPa O<sub>2</sub> and 0.1-0.4 kPa CO<sub>2</sub> on the parameters of the cardiorespiratory system was studied in 20 volunteers, divided into two equal groups: an experimental group, which exercised on a bicycle ergometer three times a week, and a nonexercising control group. With increasing time in the AA, the subjects of both groups exhibited symptoms typical of moderate hyperoxia: decreases in pulse rate and minute blood volume, O<sub>2</sub> intake and CO<sub>2</sub> elimination, respiratory coefficient, and energy consumption at rest. At the same time, the coefficient of O<sub>2</sub> utilization, the minimal arterial pressure, and the peripheral vessel resistance increased. Exercise decreased these deleterious effects.

**A87-49682 Amplifying the effect of oxygen on the organism in the presence of helium (Ob usilenii vliianiia kisloroda na organizm v prisutstvii geliia)** M. M. SEREDENKO and E. V. ROZOVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, May-June 1987, pp. 463-468. 18 Refs.

The effect of replacing nitrogen by helium in oxygen-containing mixtures on the parameters of respiratory activity and alveolar gas

exchange was investigated in 105 normal human subjects breathing (for 20 min) mixtures of 40, 21, 14.5, and 11 percent O<sub>2</sub> in N<sub>2</sub> or He. In addition, 78 subjects with chronic pulmonary insufficiency were tested at 40 and 21 percent O<sub>2</sub> in N<sub>2</sub> or He. Helium (compared to nitrogen) was found to increase the effect of relative oxygen concentration on the organism, ameliorating the effect of hypoxia. The use of normal oxygen concentration (21 percent) in helium mixtures caused symptoms of hyperoxia.

**A87-49681 Oculomotor control of physical effort under hyperthermia (Zritel'no-motornyi kontrol' fizicheskogo usiliia pri gipertermii organizma)** V. A. KUZ'MENKO, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, May-June 1987, pp. 425-431. 27 Refs.

The effect of hyperthermia on the quality of muscular effort was studied in human male subjects performing a simple physical work assignment (compressing a rubber bulb to effect the movement of a pointer to a certain mark on a scale) before and after being subjected to hyperthermia (80-85 C for 8-12 min each time for 5-6 times with week-long intervals). Body temperature, hemodynamic indices, and respiration parameters served as indicators of the organism's condition. Hyperthermia caused an increase in the integral error in the regulation of the physical effort. The degree of the deterioration of the oculomotor control of an individual could vary widely; it was inversely proportional to the value of the initial error in regulation. In addition, the degree of deterioration depended on heart activity: regardless of the initial regulation ability, the increase in error due to hyperthermia was less pronounced on days when a subject's heart activity was lowered by hyperthermia.

**A87-43687 The relationship between cellular reactions in the blood of flight personnel and some functional states of the organism (Zavisimost' kletochnykh reaktsii krovi letchikov ot nekotorykh iskhodnykh funktsional'nykh sostoianii organizma)** P. S. PASHCHENKO, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), March 1987, pp. 45-47.

Cytochemical reactions in white blood cells on a work load of three flights per shift were evaluated in pilots grouped into three categories according to their psychophysiological state. The division, based on the type of the white-blood-cell morphological reactions to psychological stimuli, was as follows: (1) the subjects with the white-cell blood picture specific for a reaction to a weak stimulus, (2) subjects reacting by low activation to a moderate stimulus, and (3) subjects with an elevated-type of leukocyte reaction to a moderate stimulus. Compared to nonstressed subjects of the first and the second groups, the subjects of the third group displayed higher levels of cell deformation, lymphocyte and granulocyte vacuolization, lowered contents of glycogen and elevated levels of phosphorylase in neutrophils, as well as high levels of lymphocytic LDH and alpha-glycerophosphate activities. At the same time, the levels of cytochrome oxidase, succinate dehydrogenase, and G-6-P-dehydrogenase activities in lymphocytes of these subjects were decreased.

**A87-43685 The correlation of annual biorhythms in the leukocyte numbers in the peripheral blood of healthy humans with heliogeophysical rhythms. (Sviaz' godovykh bioritmov chisla leukotsitov v perifericheskoi krovi zdorovykh liudei s geliogeofizicheskimi ritmami. I.)** F. I. KOMAROV, E. N. CHIRKOVA, L. S. SUSLOV, and V. V. NEMOV, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), March 1987, pp. 27-32. 12 Refs.

The individual and group-average characteristics of annual biorhythms in the leukocyte blood counts of healthy subjects were studied in the period between Dec. 1984 and Dec. 1985, i.e., during a minimum phase of the solar activity cycle. The leukocyte biorhythms were correlated with the annual rhythms in heliogeophysical indices in order to establish seasonal norms in leukocyte numbers for army recruits. The results indicated a possible presence of an 11-y biorhythm in the leukocyte counts. There also was a tendency for leukocyte counts to increase at the beginning phases of the spring and the fall seasons and to decrease at the end phases of the winter and the summer seasons, which must be taken into consideration when diagnosing blood disorders. Sex differences were found in the number averages and in the amplitude and phase characteristics of annual biorhythms, while the duration of biorhythms was similar in both sexes.

**A87-43589 The effect of moderate altitude-hypoxia on the functional status and the work capacity of humans as a function of the ambient temperature (Vliianie umerennoi vysotnoi gipoksii na funktsional'noe sostoianie i rabotosposobnost' cheloveka v zavisimosti ot temperatury okruzhaiushchei sredy)** I. U. V. BUSHOV, A. F. ERSHOV, A. P. PISANKO, F. V. OS'MININ, and B. A. NIBUSH, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Mar.-Apr. 1987, pp. 284-289. 14 Refs.

The effect of simultaneously applied moderate altitude hypoxia (MAH) and hyperthermia on the physiological status and the work capacity of humans was studied using normal male subjects placed for 60 min in an altitude chamber (at 3500 m) that was maintained at 20 or 40 C. Arterial pressures (APs), pulse rate (PR), minute blood volume (MBV), systolic blood volume (SBV), body temperature (T), oxygen blood saturation, and EEG parameters were measured at rest and during bicycle ergometer rides or a mental test. Control subjects were exposed to altitude-only or high-temperature-only conditions. At 20 C, exposure to MAH led to lowering of O<sub>2</sub> saturation and systolic AP, as well as to a decrease in physical-work capacity and to an increase in PR; the mental-work capacity and body T were not affected. The exposure to MAH at 40 C was accompanied by lesser decreases of O<sub>2</sub> saturation levels and by increases of PR and systolic AP, while the physical work capacity was not affected.

**A87-43586 Analysis of the relationship between pulse-wave propagation velocity and arterial pressure changes in humans subjected to functional loads (Analiz vzaimosvazi skorosti rasprostraneniia pul'sovoi volny s izmeneniami arterial'nogo davleniia u cheloveka pri funktsional'nykh nagruzkakh)** V. G. MARKMAN and E. L. KOROLEVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Mar.-Apr. 1987, pp. 259-264. 17 Refs.

The possibility of using the pulse-wave propagation velocity (PWPV) as an index of changes in the arterial pressure (AP) during functional tests was investigated, measuring the systolic and diastolic AP values and the ECG, pneumogram, and sphygmogram indices before and during applications of a physical load and a psychoemotional test. Among the subjects tested, the character and the magnitude of linear correlations between various AP and PWPV parameters varied. However, a significant correlation was observed in 12 (out of 18 total) subjects between the values of the systolic AP and the time interval between the ventricle depolarization and the appearance of the pulse wave in the carotid artery.

**A87-43585 Characteristics of cardiac rhythm regulation during the development of ergothermia (Osobennosti regulatsii serdechnogo ritma v usloviakh razvitiia rabochei gipertermii)** A. S. PAVLOV and V. V. SHIGALEVSKII, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Mar.-Apr. 1987, pp. 252-258. 12 Refs.

The effect of ergothermic load on cardiac rhythm was investigated in three groups of men at various stages of physical training. The components of cardiac rhythm were analyzed, performing the ECG and rhythmography simultaneously and using the method of mathematical analysis described by Baevskii et al. (1981, 1984). It was found that as the level of training increased, the magnitudes of the mode value and the delta R-R value increased, while the magnitudes of the mode amplitude, alpha index, stress index, vegetative equilibrium index, and the functional status index decreased. During physical activity and with increasing hyperthermia, the physically trained subjects displayed an intensification of the mechanisms regulating cardiac rhythms.

**A87-43583 Increasing the functional reserves of the human organism by means of respiratory training using an accessory dead space (Povyshenie funktsional'nykh vozmozhnostei organizma cheloveka putem trenirovok dykhaniiem cherez dopolnitel'noe mertvloe prostanstvo)** L. TS. IOFFE, R. I. LIUBOMIRSKAIA, V. S. SVERCHKOVA, A. G. REKHTMAN, and G. I. ISRAILOVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Mar.-Apr. 1987, pp. 241-244. 11 Refs.

The effect of breathing through an accessory dead space (ADS) on the respiratory and cardiovascular systems of humans was studied by measuring changes in the parameters of the two systems effected by the ADS respiratory training. Lung ventilation indices, O<sub>2</sub> and CO<sub>2</sub> exchange volumes (measured during periods of rest, physical activity, and recovery), and indices of cardiovascular activity were assessed before and after 20 days (20 min each) of training by breathing through an ADS device described by Sverchkova and Liubomirskaiia (1984). Subjects who have undergone the ADS training exhibited increased physical endurance. Compared with untrained controls, these subjects exhibited increases in the values of minute blood volume, stroke volume, heart index, and maximal and reserve lung ventilation.

**A87-42163 Diagnosing coronary insufficiency in flight personnel (O diagnostike koronarnoi nedostatochnosti u letnogo sostava)** V. I. KOLEDENOK, A. K. KOCHETOV, and N. A. LYSOGOR, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), Jan. 1987, pp. 42-45. 9 Refs.

Results obtained by using the orthostatic and the voluntary hyperventilation tests for diagnosing coronary insufficiency in flight personnel were compared with results of bicycle ergometer tests performed after intake of obsidian or nitroglycerin. Subjects included 95 men who have exhibited, during the submaximal load tests, a lowering (by more than 1 mm) of the EKG ST segment. It is shown that only when all three load tests are used is it possible to separate ischemic changes appearing on the EKG during the bicycle ergometry from the false positive results obtained sometimes in the orthostatic or the hyperventilation tests. The shape of the ST segment displacement and the proportionality of the degree of this displacement to the load magnitude are of major importance in diagnosing the ischemic condition.

**A87-42162 Evaluation of adaptation to high altitude from the statistical indices of the cardiac rhythm (Otsenka adaptatsii k usloviyam vysokogor'ia po statisticheskim pokazateliu ritma serdtsa)** A. L. MAKSIMOV and A. P. LATOVIN, *Voenno-Meditsinskii Zhurnal* (ISSN 0026-9050), Jan. 1987, pp. 40, 41.

A portable apparatus (Elektronika 01Ts) for measuring parameters of heart activity was used to evaluate the extent of adaptation to high-altitude hypoxia from the values of complex statistical indices of the cardiac rhythm (the pulse rate, the rhythm stability index, the vegetative rhythm index, and the stress index). In preliminary experiments performed at sea level all subjects (89 men aged from 18 to 45 y) were tentatively divided into three groups depending on their stability to hypoxia. After the subjects arrived at high-altitude locations (3200-3600 m above sea level), the statistical indices of cardiac rhythm were determined periodically (3 d, 15 d, 30 d, 2 months, and 1.5 year). It was found that cardiac adaptation (i.e., stabilization of the indices) occurred one month after ascent. The values of the statistical indices correlated well with the objective evaluation of the well-being of the subjects and are considered to be reliable indicators of adaptation to hypoxia.

**A87-41809 The dynamics of the bioenergetics indices under hypercapnia (Dinamika pokazatelei bioenergetiki pri giperkapnii)** V. L. MAKAROV, I. A. MOROZOV, and A. I. BORISOV, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 139-143. 21 Refs.

The effect of hypercapnia on contents of ATP, ADP, AMP, LDH isozymes, G6PD, and ATPase in blood was studied in healthy male operators exposed for 5 days to an atmosphere containing 2.0-2.5 percent CO<sub>2</sub>. Blood analyses were performed before the exposure, at the end of the 5th day, and 14 days later. It was found that total blood concentrations of ATP and ADP nucleotides remained unchanged during the course of the experiment; this stability is believed to be due to simultaneous decreases in both the nucleotide synthesis and their utilization. Hypercapnia caused increases in the relative activities of LDH-4 and LDH-5 in serum, indicating a metabolic shift towards anaerobic processes. In erythrocytes, concentrations of ATPase and LDH activities decreased, while those of ATP and G6PD increased, indicating a disruption of normal metabolic processes. These changes are considered to be adaptive rather than pathological.

**A87-41807 Normal levels of blood lipids in healthy humans (Dolzhnye velichiny lipidov krovi u zdorovogo cheloveka)** R. K. KISELEV, R. V. BELEDA, A. P. IVANCHIKOV, and V. I. PLAKHATNIUK, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 109-112. 17 Refs.

A method is proposed for estimating individual norms of blood cholesterol and triglycerides from the data of subjects' age, height, and body weight. Data were collected from 2100 healthy males aged 18-57 and were used to compute linear regressions correlating chemically-analyzed blood concentrations of cholesterol or triglycerides with the three body parameters. Various linear combinations of power and logarithmic functions were considered. It was shown that in healthy subjects actual concentrations of both lipid groups agree within 10 percent with the established lipid norms. Subjects with atherogenic cardiovascular abnormalities displayed lipid cholesterol and triglyceride concentrations that were each more than 10 percent above the established normal levels.

**A87-41805 The mechanism of voluntary and involuntary regulation of human activity under extreme conditions (Mekhanizm proizvol'noi i neproizvol'noi regulatsii deiatel'nosti cheloveka v ekstremal'nykh usloviyakh)** V. I. MEDVEDEV, E. K. ZAV'IALOVA, and M. V. POLIKARPOVA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 90-95. 9 Refs.

A method for assessing the characteristics of the voluntary and involuntary regulation of the learning process in humans was developed and applied to assess the effects of 48 hour-long sleep deprivation and of sydnocarb intake on the type of learning-process regulation. It was found that in rested subjects the prevailing mechanism of learning is the voluntary regulation of the learning process, mediated by word command, while in subjects deprived of sleep the regulating function was transferred

to the orientation reactions; thus, the relative efficiency of involuntary learning was greater in these subjects than in the rested controls. The sleep-deprived subjects committed more errors and signal misses and exhibited slower reactions to light signals (whether or not light signals were accompanied by sound signals) than did the controls. The intake of sydnocarb (four 17.5-mg doses) by sleep-deprived subjects had a beneficial effect, correcting insomnia-induced changes in the learning process.

**A87-41802 The responses of the human respiratory system to hypoxic and hypercapnic stimuli during adaptation to high altitude (Otvety dykhatel'noi sistemy na gipoksicheskie i giperkapnicheskie stimuly pri adaptatsii cheloveka k usloviyam vysokogor'ia)** T. V. SEREBROVSKAIA and T. G. DUBROVSKAIA, *Fiziologiya Cheloveka* (ISSN 0131-1646), Vol. 13, Jan.-Feb. 1987, pp. 58-64. 33 Refs.

The sensitivity of the respiratory system to hypoxia and hypercapnia in healthy males living at sea level was compared with the sensitivity of men adapted to high-altitude conditions by living for one year at 1680 or 3650 m. Results of measurements of ventilation and gas-exchange parameters after exposures to experimental hypoxia and hypercapnia indicated that, in the subjects who have lived at the altitude of 3600 m, the ventilatory response to both the hypoxic and the hypercapnic stimuli was higher than in the other groups. These subjects could also tolerate a lower critical level of P(A)O<sub>2</sub> but had a lower maximal level of tolerated hypercapnia. It was also found that subjects who exhibited elevated ventilation sensitivity to hypoxia at high altitude exhibit high work capacity at that altitude, elevated oxygen consumption, and lower levels of anaerobic glycolysis. However, these subjects were less stable to the critical levels of hypoxia.

**A87-34404 The role of Vavilov-Cerenkov radiation in visual sensations induced by protons (Rol' izlucheniia Vavilova-Cherenkova v zritel'nykh oshchushcheniakh vyzvannykh protonami)** P. V. GRAMENITSKII and I. N. FETISOV, *Biofizika* (ISSN 0006-3029), Vol. 32, Jan.-Feb. 1987, pp. 125-127. 10 Refs.

The mechanism responsible for the detection of ionizing particles by the human eye and for the production of a 'flash' sensation was studied using 1-ms monoenergetic proton beams directed at the subject's eye and recording the location, the features and the moment of the appearance of the 'flash' sensations. In particular, the relative importance in this mechanism of the Vavilov-Cerenkov radiation induced in the vitreous humor, as opposed to the importance of alternative mechanisms (the scintillation of the eye tissues or the direct stimulation of the retina), was investigated by comparing the sensations caused by 460 and 1850 MeV beams and by irradiating the eye from different angles. Bright diffuse flashes were seen with the 1850-MeV beams but not with the 460-MeV beams even when high-intensity 460-MeV beams were used. This evidence and other results (e.g., localization of the flash in the vision field after lateral) indicate that the proton-induced Cerenkov radiation in the vitreous body plays a dominant role in the sensitization of the retina.

## Japanese Aerospace Literature This month: Aerodynamics

**A88-24508 Shock wave/turbulent boundary-layer interactions induced by a semicone** NOBUMI SAIDA and TOMONARI OOKA, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 30, Nov. 1987, pp. 173-185. 12 Refs.

This paper presents an experimental study of shock wave/turbulent boundary-layer interactions induced by a semicone placed on the floor of a wind tunnel. The experiments were carried out in an 8 x 10 sq cm supersonic wind tunnel at free-stream Mach numbers of 1.98 and 2.48. Corresponding unit Reynolds numbers at the test section were in both cases 3.8 x 10 to the 7th/m. Semicone models with half angles varying from 20 to 90 deg were used in this study. Surface static pressure measurements, oil flow studies, and Schlieren photographs of the flow field were made. It was found that, on a flat plate, the shape of the separation line is insensitive to the cone angle of over 40 deg. Furthermore, a secondary separation region embedded in the shock-induced primary separated flow exists along the semicone and plate junction.

**A88-22318 Fluctuation of heat transfer in shock wave/turbulent boundary layer interaction** MASANORI HAYASHI, SHIGERU ASO, and ANZHONG TAN, AIAA Paper 88-0426 presented at the AIAA 26th Aerospace Sciences Meeting, Reno, NV, Jan. 11-14, 1988. 8 pp. 12 Refs.

A novel method based on a newly developed thin-film heat transfer gage yielding high spatial resolution, and applicable for both shock tunnels and wind tunnels with long flow duration, is presently used to measure fluctuating heat fluxes in the interaction region of shock waves and turbulent boundary layers. Attention is given to experimental results obtained at Mach 4 and Reynolds number of 12.6 million, in both separated and unseparated boundary layer conditions; in the former, significant fluctuations of heat transfer rate are observed throughout the interaction region.

**A88-22135 Prediction of three-dimensional turbulent flows in a dump diffuser** YASUNORI ANDO, MASAFUMI KAWAI, YUKINORI SATO, and HIDEMI TOHI, AIAA Paper 88-0185 presented at the AIAA 26th Aerospace Sciences Meeting, Reno, NV, Jan. 11-14, 1988. 13 pp. 7 Refs.

A finite volume method for the solution of three-dimensional incompressible steady Navier-Stokes equations based on a general curvilinear coordinate system was employed to study the characteristics of turbulent flow in dump diffuser of gas-turbine combustor. The standard k-epsilon turbulence model is used to characterize the effect of turbulence. In order to achieve a saving in CPU time for calculation, present calculation was performed by lending itself to vector computer architecture of the FACOM VP-50 supercomputer. This method is applied to prediction of turbulent flow in a three-dimensional dump diffuser with and without the fuel nozzle. The calculated results are compared with the corresponding experimental data obtained in this work. General features of the flow pattern are adequately predicted, although discrepancies in detail seem to indicate deficiencies in the turbulence model used in present study.

**A88-14250 On steady supersonic flow over two-dimensional airfoils** HAMDI T. HEMDAN, *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), Vol. 30, Aug. 1987, pp. 111-129. 13 Refs.

The problem of steady supersonic flow over two-dimensional airfoils with attached shock waves is considered. By combining the Newtonian limit with a geometric limiting process, new approximate equations are derived which can be used for a wide range of supersonic flows. Newtonian flow can be recovered from those equations as a special case. The work is restricted to moderate supersonic flow only for which two systems of linearized equations are derived and used to obtain closed-form formulas for the coefficient of surface pressure and other aerodynamic parameters. The results are compatible with the theory of characteristics and experiments and improve over other existing approximate methods.

**A88-13546 A design of the cascade for a shock-in-rotor supersonic axial-flow compressor** TAKAAKI HASHIMOTO, *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), Vol. 35, no. 403, 1987, pp. 401-404. 6 Refs.

A design method of the cascade for a shock-in-rotor supersonic axial-flow compressor is presented. The inlet flow is uniform and satisfies