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USSR Space Life Sciences Digest

A QUARTERLY REVIEW

Volume 2, Number 2



Prepared for the
Life Sciences Division
National Aeronautics and Space Administration
Washington, D.C. 20546

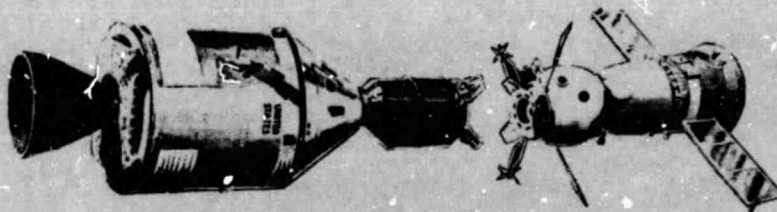
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Prepared by
Lyn D. Paulson

**BioTechnology, Inc.
3027 Rosemary Lane
Falls Church, Virginia 22042**

The goal of this publication is to inform personnel of the NASA Life Sciences Division of important developments in the Soviet Space Life Sciences Program in a manner that eliminates the task of locating and reviewing the voluminous Soviet literature.

Full translations of any literature cited in the Digest may be obtained by contacting:

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INTRODUCTION

Soviet scientists are making significant contributions to the field of space medicine and biology through their active manned space program, frequent biosatellites, and extensive ground-based research. It is important that U.S. space life scientists be familiar with the literature generated by the Soviet program. The purpose of this document is to provide an overview of the developments and direction of the USSR Space Life Sciences Program.

Information concerning the Soviet space program makes its way into U.S. information banks and publications via a number of routes. While many agencies survey the Soviet literature and produce helpful listings and translations, no agency reviews the full scope of Soviet life science literature pertinent to the space program, and no agency is specifically charged with the task of evaluating and integrating any of this information. This Quarterly Digest is designed to bridge that gap.

The information contained in this Digest is primarily obtained from the following sources:

- ^{NASA DATA BASE} NDB articles and abstracts in Soviet space biology and medicine and Summary World Broadcasts (abbreviated SWB) provided by the Library of Congress, Federal Research Division—NASA Unit II-G.
- *Aerospace Medicine and Biology*—A continuing bibliography (NASA SP-7011).
- *Scientific and Technical Aerospace Reports*—A bibliography produced by the Scientific and Technical Information Office, NASA.
- Foreign Broadcast Information Service, Volume III, Soviet Union—NTIS. Abbreviated FBIS.
- Daily Soviet News Abstracts Publication—Translated abstracts of news items from the Soviet press. Published by Foreign Technology Division, Battelle Columbus Laboratories. Abbreviated Daily SNAP.
- *Space Biology and Aerospace Medicine*—A complete translation of the Russian language monthly journal *Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina*, published in the U.S. by Joint Publications Research Service.
- *USSR Report, Biomedical and Behavioral Science*—Translated articles and abstracts in biochemistry, radiobiology, aerospace biology, and medicine, from a variety of Russian language sources. Published in the U.S. by Joint Publications Research Service.
- *USSR Report, Space*—Translated articles and abstracts of formal scientific reports and news items on the Soviet space program, from a variety of foreign language sources. Published in the U.S. by Joint Publications Research Service.
- *Aviation Week & Space Technology*—Weekly periodical published by McGraw-Hill, Inc. Abbreviated AW&ST.
- *Spaceflight*—Monthly periodical published by the British Interplanetary Society.

HIGHLIGHTS

Launches and Recoveries

The following table presents an overview of recent Soviet launches and recoveries.

<u>Spacecraft</u>	<u>Launch</u>	<u>Crew</u>	<u>Return</u>	<u>Comments</u>
Cosmos 1262	April 7, 1981	Unmanned		Space research
Cosmos 1263	April 9, 1981	Unmanned		Space research
Cosmos 1264	April 15, 1981	Unmanned		Space research
Cosmos 1265	April 16, 1981	Unmanned		Space research
Cosmos 1266	April 21, 1981	Unmanned		Space research
Cosmos 1267	April 25, 1981	Unmanned		Docked with Salyut 6 space station on June 19, 1981; research station prototype.
Cosmos 1268	April 28, 1981	Unmanned		Space research
Cosmos 1269	May 7, 1981	Unmanned		Space research
Soyuz 40	May 14, 1981	Popov, Prunariu (Rumanian)	Recovered, May 22, 1981	Crew docked with and transferred to the Salyut 6 station on May 15 for joint experimental research.
Meteor 2	May 15, 1981	Unmanned		Meteorological research of global images of cloud cover and the underlying surfaces of visible and infrared bands of the spectrum, and study of flows of penetrating radiation in near-Earth space.
Cosmos 1270	May 18, 1981	Unmanned		Space research
Cosmos 1271	May 19, 1981	Unmanned		Space research
Cosmos 1272	May 21, 1981	Unmanned		Space research
Cosmos 1273	May 22, 1981	Unmanned		Research of the Earth's natural resources.
Soyuz T-4	March 12, 1981	Kovalenok, Savinykh	Recovered, May 26, 1981	Completed a 75-day spaceflight mission.
Cosmos 1274	June 3, 1981	Unmanned		Space research
Cosmos 1275	June 4, 1981	Unmanned		Space research
Molniya 3	June 9, 1981	Unmanned		TV, telephone, and telegraph communications satellite.
Cosmos 1276	June 16, 1981	Unmanned		Research of Earth's natural resources.
Cosmos 1277	June 17, 1981	Unmanned		Space research
Cosmos 1278	June 19, 1981	Unmanned		Space research
Molniya 1	June 25, 1981	Unmanned		TV, telephone, and telegraph communications satellite.
Ekran	June 25, 1981	Unmanned		Television broadcasting satellite.

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New Programs

- A U.S. Coast Guard helicopter found the Soviet trawler Ekwater "fishing" at 2 a.m. on the launch date of the U.S. Columbia in a restricted area where the shuttle's two reusable boosters were expected to come down. A "stand off" order was obeyed only as long as the helicopter was in sight of the Soviet vessel. The Ekwater was finally turned away by a Coast Guard cutter although the trawler attempted to outmaneuver it several times. The Soviet captain finally stopped all engines, but outside the recovery work area. General-Lieutenant of Aviation Shatalov, however, stated in an interview that the Soviet Union has no plans to develop its own shuttle, considering it uneconomical. The scientific research they are engaged in "requires continuous, long-term work in orbit . . . orbiting stations of the Salyut type constitute the direction of Soviet cosmonautics."
- A successful docking of the Cosmos 1267 artificial satellite with the Salyut 6 space station was accomplished in mid-June. The sputnik was launched April 25, 1981; in the ensuing period, the Soviets exercised the station and the satellite extremely close to one another before the actual link-up. It was reported that before leaving the station in late May, Cosmonauts Kovalenok and Savinykh installed an adapter on one of the station's docking mechanisms to facilitate the Cosmos 1267 linkage. The complex represents a prototype of anticipated research stations where modules, such as various laboratories and living quarters, can be added to a core space station. Entire scientific labs and industrial complexes capable of carrying heavy equipment, large fuel reserves, and diverse instruments and of supporting large permanent crews are the goal. On June 29-30, the trajectory of the space complex was corrected, using the Cosmos 1267 powerplant.
- At Baykonur, Soviet scientists and technicians are preparing the launching of Salyut 7. A French cosmonaut and an Indian cosmonaut are being trained for participation in future flights aboard this station.
- The Soviet Union's "Orbita" system, initiated in 1965, today has 90 ground stations monitoring more than 60 communications satellites. The satellites include the "Molniya," "Raduga," "Ekran," and "Gorizont" series and allow about 85% of the USSR's population to receive Central Television broadcasts. A developing network called "Moskva" is reported to be leading the way for television transmission to remote regions.
- The Latvian Academy of Sciences' Physic Institute reported the use of electromagnetic fields to counteract gravity while creating alloys. Previously only possible in space, the procedure allows metals to be made that, under normal Earth conditions, become stratified in the molten state.
- The first charts of data gathered by Cosmos 1151 and Interkosmos 21 on the oceans have been compiled by the Ukrainian Academy of Science. Temperature of sea surface, wave formations, and the boundaries of ice cover were routinely monitored; the satellite information was supplemented by observations from ships and buoy stations in the Black and Mediterranean Seas, and the "Mikhail Lomonosov," now in the Atlantic Ocean. The charts are to be used for navigation and fishing.

- The Soviet Union and the European Space Agency are negotiating a data exchange agreement that would allow ESA to use data from Soviet satellites to make final targeting updates for its 1986 Giotto-Halley's Comet encounter within 200 km. The current target calls for 1,000-km flyby distance. Soviet probes will first fly past Venus as part of a mission including the landing of two separate vehicles on the Venusian surface. After Venus, one of the Soviet Halley probes may fly within 3,000 km of the comet while the other might fly within 10,000 km. The ESA Giotto craft with its protective dust shield will be able to make a closer pass. The proximity of Giotto may not improve imaging quality but will allow collection of more data on primary molecules that evaporate from the comet's surface.
- A new Soviet journal, *Nauka V SSSR* (Science in the USSR) was designed to address the broadest possible audience on the accomplishments of modern science. Published in Russian and English, future issues are also supposed to come out in Spanish, German, and French. *Nauka V SSSR* is to be an illustrated, bimonthly publication prepared primarily by prominent Soviet scientists.

Mission News

- As on previous flights, medical data were collected throughout the Salyut 6-Soyuz T-4 mission. Studies of the cardiovascular system were performed using a multifunctional clinical apparatus, the *Polimon-2M*, and the *Reograph* and *Beta* instruments. In conjunction with these studies, the *Chibis* vacuum suit was used. By the third week of flight, Commander Kovalenok's pulse was 60 beats per min while Flight Engineer Savinykh's pulse was 65. Arterial pressures were 120/65 and 120/60, respectively. By the end of the 7th week of flight, pulses were 60 beats per min for each man, with arterial pressures at 100/65 for the commander and 120/70 for the flight engineer.

Body mass and other anthropometric measurements were recorded regularly. Within the first weeks of the mission, the commander's weight decreased by 500 grams and the engineer's weight by 800 grams, but both men's weight had stabilized by the end of the third week. In the course of a day, the cosmonauts engaged in 2 hrs of physical exercises on an exercycle and on a comprehensive training set. The latter consisted of a running track, expansion equipment for strength-building exercises, and springs that create a load on the osteomuscular system. There were also training sessions with the *Chibis* vacuum suit which became more frequent toward the end of the flight.

An experiment dubbed *Neptun* was performed to determine the effects of spaceflight on visual depth and acuity. With the arrival of the second visiting crew (Soyuz 40), other experiments were undertaken. The *Interferon* experiment was aimed at the examination of spaceflight effects on leukocytic ability to synthesize interferon. *Vorotnik* (collar) was performed by Popov and Prunariu to study the causes of unpleasant symptoms during the initial stages of adaptation to weightlessness. Special collars were worn that create an artificial load on the cervical vertebrae and limit head movement during the critical first 3 days. A related experiment called *Pnevmatik* employed a device by that name. The objective was to more actively control the redistribution of blood in the body during the

first days in 0 G. Compared with the *Chibis* suit, the *Pnevmatik* is more compact; it is essentially a pair of cuffs worn on the legs that impede the flow of blood. The purpose was to create hemodynamic conditions similar to those in Earth's gravity.

It has been reported that the activity of the right-hand sections of the heart becomes more intense from the increased intrathoracic blood during 0 G. The *Ballisto* experiment studied the magnitude of this imbalance and the rate at which it corrects itself during adaptation. The *Kardiokasset* was used to record so-called "ballistocardiograms" on magnetic tapes.

The visiting crew also performed the *Rabotospособnost* (working fitness), *Operator*, and *Informatsiya* experiments, directed toward obtaining data on human work ability in conditions of spaceflight, and on the speed and precision of an operator's work. With a specially prepared list of questions, the cosmonauts made evaluations of subjective sensations during adaptation to spaceflight.

Kovalenok and Savinykh returned to Earth May 26. A medical examination found them to be in good health. Their postflight condition was assessed as similar to that of other crews which have taken part in prolonged expeditions.

- Kovalenok and Savinykh undertook various maintenance chores onboard the orbital complex. These included replacement of the water regeneration system, cleaning the thermoregulation system fans, preventive repair work on individual onboard systems, and general cleaning. A technical experiment was also performed for the purpose of perfecting prospective parts of the temperature control system; individual structural elements of the station were photographed for analysis on Earth. On May 7, correction of the Salyut complex's trajectory was made using the Soyuz T-4 engine.
- The crew's workload gave prominence to geophysical research. Toward this end, the cosmonauts regularly conducted observations and photographed the Earth's surface. Regions photographed included Mongolian territory, the Caucasus, the Aral' and Caspian Seas, the southern Urals, Kazakhstan, Central Asian republics, southern Siberia, and the Atlantic Ocean.
- *Gologramma* experiments began March 28. The objective was to use holography to examine new and more informative methods of recording and transmitting images of objects. Using a portable apparatus that includes a helium-neon laser and recording devices, Kovalenok and Savinykh made holograms of a window bearing traces of the impact of micrometeorites on its outer surface. Dzhanibekov and Gurracha, the first visiting crew, photographed the dissolution of a sodium chloride crystal in zero gravity. Holograms were transmitted by television communication channels. It was determined from the images that whereas salt crystals dissolve in water in about 30 min on Earth, the same process takes more than 12 times longer in space. This was attributed to the absence of convection in conditions of weightlessness, which has the effect of slowing down the process of the crystal's diffusion.
- The *SpLav* electric furnace was used for numerous technological experiments. Two attempts were made at obtaining a single crystal of cadmium-mercury-tellurium semiconductor material. Crystal growth takes 6 days; the ampule containing the crystal must be protected from vibrations during that time. An element cut from this crystal is supposed to be used in

an instrument to be delivered to the Salyut station for future studies of outer space. Other experiments were trials for obtaining gallium arsenide, gallium antimonide, gallium bismuth, germanium silicon, lead-zinc, and bismuth-antimony in conditions of microgravitation.

The *Splav* furnace was also used for the *Kapillyar* experiment. A *Kristall* instrument, which is a special molybdenum matrix with capillary channels, was immersed in a germanium melt produced by the furnace. The molten metal runs into the capillaries, fills them, and hardens. This method reportedly can be used to control crystal purity. In the future, it may be employed in the production of silicon material for solar batteries and other types of single crystals for space use.

- The *Struktura* experiment in the *Pion* unit was designed to investigate processes of heat and mass transfer during the growth of crystals from aqueous solutions, as well as unexpected effects occurring in the space furnace (e.g., interaction of molten metal with container walls). *Pion* is said to be a miniature electronics factory consisting of a light source, a test section into which solutions are placed, a heat source for these solutions, and a motion picture camera which photographs all processes taking place in the solution. Elapsed time and container temperature were recorded, the latter reportedly as high as 400° on occasion.
- The *Isparitel* (vaporizer) apparatus was utilized for experiments on applying metal coatings by vaporization and subsequent condensation in conditions of space vacuum and zero gravity. With the *Isparitel* installed in an opened airlock chamber, spray-coating of a titanium specimen with copper and, subsequently, silver was accomplished. To more precisely understand the conditions of the experiment, temperature of the specimen being coated was monitored. The objective of such experiments was to perfect the technology to a point where cosmonauts could use it for maintenance. For example, the radiator of the heat control system has coated plates on the exterior of the Salyut station. If the coefficient of heat reflection and absorption diminishes past an acceptable level, it is hoped that a cosmonaut can take the *Isparitel* unit outside and restore the plates' coating.
- A new instrument called *Nanovesy* was used to ascertain the weight of a sample before and after coating with a thin transparent film of silicon dioxide and exposure to space. The machine is said to be capable of distinguishing changes in weight on the order of billionths of a gram. Slight decreases in the weight of a plate under study are detected with a sensitive quartz resonator; the electronic unit responds to changes of weight with changes in frequency of its own oscillation. Specialists are interested in improving protection of space station components, such as solar battery elements; coating the panels with a thin film of silicon dioxide is a possible method. Popov and Prunariu conducted experiments on the effects of prolonged spaceflight on the performance and protective properties of SiO_2 , using the *Nanovesy* to ascertain the extent of protection it provided.
- Research on ways of perfecting space methods of obtaining polyurethane foam in various shapes for the manufacture of parts of future space structures was termed the *Lotos* experiment. A special aerosol unit was used to produce the foam structures; it is hoped that numerous strong, lightweight elements can be made from this material on orbiting space stations in the future.

- Radiation was the subject of other studies done by the crew of the Salyut 6-Soyuz T-4 complex. Kovalenok and Savinykh used the miniature *Yelena* telescope to measure gamma radiation and charged particles in near-Earth space. Other astrophysical experiments utilized the onboard submillimeter telescope BST-1M, which was prepared to operate with the multiband photographic equipment MDK-5M and the *Yelena* telescope. The operation of the telescope in the submillimeter wave band was accomplished using a closed-cycle cryogenic system for cooling the radiation receivers to minus 269°. Data from the studies were collected to obtain more information on the structure of the Earth's atmosphere and also to formulate more precise methods of forecasting physical processes occurring in the atmosphere.

Popov and Prunariu conducted an experiment called *Minidosa* (minidose) to evaluate the radiation contributed by the Van Allen belts to the total dose of cosmic radiation in near-Earth space.

The Soyuz 40 crew delivered dielectric detectors to record heavy charged particles of cosmic radiation. *Astro-1* was placed in an airlock chamber, while *Astro-2* was installed in the station's working area. The *Astro* units have five detectors for studying atomic nuclei, and are said to be more sensitive than previous apparatus. One detector, which is movable, traced the station's sinusoidal path of movement with respect to latitude, allowing the location of cosmic particles' flows to be established with respect to geographic coordinates.

- A daily chore of the Soyuz T-4 crew was tending plants that were cultivated in space station "hothouses": the *Oasis*, *Vazon* (flower pot), *Malakhit*, and *Svetoblok* (light block). The cosmonauts maintained the necessary conditions in these units and recorded the developments of peas, onions, orchids, and *Arabidopsis*. An experiment for evaluating the effects of a heterogeneous magnetic field on the orientation and development of *Crepis* sprouts was performed in the *Biogravitat* unit. Observations were also made of the mutation processes in plants under the influence of spaceflight conditions.
- The cosmonauts observed that electronic watches work well in space, while mechanical ones do not keep time.
- The Soyuz 40 was the last spacecraft of its series to be used in manned orbital flight. Soyuz ships have been in use for almost 15 years. Subsequent missions are to employ only space-ships of the Soyuz T series. However, all Soviet manned flights will be suspended for several months.
- V.A. Shatalov, director of Soviet cosmonaut training, noted that Popov and Prunariu's mission was the last flight of the Interkosmos program. Nine international crews of cosmonauts from socialist countries have flown in orbit and to the Salyut 6 space station under this program.

Personnel News

- **Leonid Ivanovich Popov:** Pilot-Cosmonaut Popov was born August 31, 1945, in the city of Aleksandriya, Kirovograd region. A 1968 graduate of the Chernigov Higher Military Aviation School for Pilots, he served as a fighter pilot in the air force. Popov joined the cosmonaut corps in 1970 and took part in controlling flights of spacecraft. Concurrently, he studied and graduated from the Yuriy Gagarin Air Force Academy. His first flight was made in 1980 when, as commander of the main expedition on board the Salyut 6 space station, he and Ryumin completed a 185-day mission.
- **Dumitru Prunariu:** Senior Lieutenant-Engineer Prunariu is a citizen of Romania. He was born September 27, 1952, in the city of Brasov. Following graduation from Bucharest Polytechnical Institute in 1976, he worked as an engineer at an aircraft factory. Subsequently, he graduated from a military aviation school and served in the air force regiment of the Romanian People's Army. The researcher-cosmonaut of the spaceship Soyuz 40 started cosmonaut training in 1978 under the Intercosmos program and completed the course of study for the manned spaceship Soyuz and orbital space station Saryut.

Meetings

- The 15th conference of the permanent working group "Space Physics" of the socialist countries participating in the Intercosmos Program started on May 20 in Yerevan.

Space physics research topics include the Earth's magnetosphere and ionosphere, interplanetary plasma, short-wave solar and extra-solar astronomy, cosmic rays, the solid component of interplanetary matter, the moon and planets, observations by artificial Earth satellites for geodetic and geophysical purposes, space scientific instrumentation, information processing, and space materials science.

Under the auspices of the Intercosmos Program, 21 "Intercosmos" series satellites and 8 "Vertikal" research rockets have been launched, scientific experiments have been accomplished with "Prugnoz" satellites with high apogees, and 8 international crews have carried out research onboard the Salyut 6-Soyuz orbiting complex.

An international seminar will be held in Tsakhkadzor after the meeting of the working group to continue discussion of scientific results and plan experiments in the field of ionospheric, magnetospheric, and solar-wind physics.

- An international comet meeting has been set for September in Italy in connection with the International Astronautical Federation's Rome conference. The session on Halley's Comet is expected to include representatives from ESA, the USSR, Japan, and the U.S.

(Material in the "Highlights" is drawn from SWB, April-June, 1981; FBIS, April-June, 1981; Daily SNAP, April-June, 1981; and AW&ST, April-June, 1981.)

GROUND-BASED RESEARCH

Space Medicine and Physiology

Metabolism

Key words: *orthostasis, circulatory system, pathology, pharmacological compounds*

A healthy person going from a horizontal position to a vertical one experiences characteristic physiological changes, including a slight migration of blood to the legs, reduced cardiac stroke volume and systolic arterial pressure, increased cardiac contractions, correspondingly decreased minute volume, and a rise in total peripheral resistance. Although there are individual variations, especially when considering different age groups, Moskalenko and Glezer (1979) strongly recommended the use of the orthostasis test by cardiologists to assess the hemodynamic condition of their patients. Certain disturbances are diagnostic for many diseases and drugs, and are expressed by the sympathetico-adrenal reaction during the test. Aberrations in blood circulation, hypertension, neurogenic disease or damage (e.g., from tertiary syphilis, alcoholic encephalopathy), and vasodepressor hypotension characterize four groups of disturbances that can be detected. To evaluate hemodynamic shifts and obtain an idea of the conditions of the regulating systems, physicians were urged to record cardiac contraction rate and arterial pressure when the patient is horizontal, and then vertical. Additional information can be gleaned by recording EKGs during the test. EKGs can detect hidden myocardial changes not recorded during examination in the horizontal position only and when the bicycle ergometric test is not possible. The orthostasis test was also recommended for evaluation of conditions of internal organs, especially the kidneys and vascular walls, and to appraise the effectiveness of therapeutic drugs. Compounds for the treatment of hypertension, for instance, can be assessed using the orthostasis test to measure the body's overall response to blood redistribution and its regulation.

Key words: *adaptation, ecology, stress*

The problems of man's physiological adaptation to northern, polar, high-altitude, desert, tropical, and maritime climates are dealt with in *Human Ecological Physiology* (Gazenko, 1980). Biochemical responses, including neurohormonal reactions and the involvement of social factors to these stressful environments are described, and data concerning adaptation of various physiological systems are presented and discussed.

Key words: *cardiovascular system, myocardium, hemodynamics, innervation, hormone*

Articles in *Physiology of the Heart* (Arronet, 1980) address the function, properties, and structure of the heart. Beginning with the ultrastructure of the myocardium and its biochemical characteristics, the book contains discussions of the regulation and contractile processes of the heart and methods of monitoring them. It continues by considering the effects upon the organ of hormones, nervous system responses, and other physiological systems.

Key words: neurophysiology, afferent stimulation, hypothalamus

Raytses (1980) reviewed the literature and presented his own research in a short book on the functional organization of internal (visceral) analyzers and the interaction of visceral afferent signals and sensory messages from somatic, vestibular, and visual receptors going to the central nervous system. The involvement of the hypothalamus and the limbic structures of the brain in the control of sensory processes and mechanisms of interaction between internal and external signal reception is discussed. Furthermore, the significance of visceral signals to formation and expression of certain forms of emotional responses and purposeful behavior is examined, as are emotional disorders arising from visceral pathology.

Key words: renal function, metabolism

A book by S.I. Ryabov and A.D. Kozhevnikov (1980) provides a summary of clinical studies of renal function. The influence of the kidneys on metabolic pathways and the alteration of these processes when renal function fails are discussed in detail, and the etiology of and treatment for various pathologies are characterized.

Key words: erythropoiesis, hemoglobin, biochemistry

Erythropoiesis is the subject of a book edited by I.Ya. Ashkinazi and associates (1979). Data are presented concerning innervation and blood supply of bone marrow, hemopoietic stem cells and their microenvironment, and the morphology of erythroid cells of bone marrow. There is a detailed analysis of the role of erythropoietin in regulating erythropoiesis in normal and pathological states, the mechanisms of its action, and erythropoietic inhibitors. Also described are methods for purifying erythropoietin and the biochemistry of these blood components.

Key words: vascular system, musculoskeletal system

Regulation of Vascular Tonus (Khayutin, 1979) is the 23rd volume of the *Advances in Science and Technology* series. The surveys comprising the book are articles on myogenic tonus and mechanics of blood vessels, functional hyperemia of skeletal muscles, the kinin system and regulation tonus, and electrophysiological studies of the vasoconstrictive system.

Key words: stress, adaptation, ulcer, cardiovascular disease, neuroendocrines

The involvement of the stress reaction in long-term adaptation and prevention of stress-induced diseases were the subjects of a discussion by F.Z. Meyerson (1981), who emphasized the role of neuroendocrine mechanisms. Physiological processes that form a response to environmental factors were broken down into four stages. The first stage is typified by mobilization of pre-existing

adaptation mechanisms or the formation of functional systems. This is seen as hyperfunction of the organism, such as maximum minute circulatory volume and respiration, and high blood lactate concentration. The second stage is transition from immediate to long-term adaptation and characterized by increased nucleic acid and protein synthesis in cells of systems specifically responsible for adaptation. The third stage is defined by the absence of the stress syndrome and improved adaptation to the given factor or situation. A fourth stage, exhaustion, does not always follow; it develops only in response to excessive, stressful adaptation. Adaptation may be hindered at any stage where there is a shift from adaptative processes to pathogenesis, from which numerous stress-related diseases can arise (e.g., gastric ulcers, severe heart damage). Meyerson advocated active prevention of adaptation diseases by capitalizing on natural physiological mechanisms used by the body itself. The prevention of stress-related injuries includes administration of gamma-oxybutyric acid, inderal, alpha-tocopherol, and verapamil; the author's research dealing with these protocols was summarized. He concluded that the combination of adaptive and chemical prevention based on imitation of natural antistress systems creates a hopeful prognosis for prevention of stress-induced diseases.

Key words: collagen, electrolyte, weightlessness, sodium, epinephrine

Physiological studies connected with spaceflight have shown loss of electrolytes from humans and animals is a response to weightlessness. Gabuda and Yakovlev (1981) of the Institute of Inorganic Chemistry reported the demonstration that collagen, one of the most widely distributed proteins in the body, has specific binding sites for sodium and, in effect, may function as a storage site for the element. Biochemical studies revealed that under in vitro conditions, epinephrine facilitates the release of bound sodium from the collagen molecule. Since weightlessness constitutes a form of physiological stress, and since such conditions elicit increased release of epinephrine from the adrenals, the interaction of epinephrine with collagen may be a mechanism involved in the observed loss of sodium.

Key words: electrolyte, cardiovascular system, orthostatic test

Studies during spaceflights have shown that water and electrolyte intake improves the response of the cardiovascular system to orthostatic tests. Balakhovskiy and Dlusskaya (1981) undertook more detailed studies of the effects of water and water-salt loads (1.5 and 2% of body weight) on the frequency of myocardial contractions and arterial blood pressure during vertical and horizontal body positions, and on changes in blood volume and extracellular spaces. The data indicated that while both water and water-salt loads induced a short-term increase in the circulating blood volume, the effects with water alone were more pronounced. However, water-salt intake increased the extracellular spaces which water alone did not. Both water administration and water-salt intake increased the diastolic pressure and somewhat lowered the pulse rate in the horizontal position, while significantly lowering the pulse in the vertical position. Consequently, it remains difficult to determine whether water or water-salt intake improves orthostatic stability in the healthy subject.

Hypokinesia

Key words: electrostimulation, bedrest, cardiovascular system, muscular system

Physical exercises and pharmacological agents are not always sufficient to combat the degenerative effects of hypokinesia. Dukhin and Zhukov's'kyy (1979) applied electrostimulation to muscles in an attempt to retard the deconditioning effect of enforced bedrest on surgical tuberculosis patients. Rheograms and oscillograms were recorded to determine minute volume, stroke volume, heart rate, systolic, diastolic, and average arterial pressures, and pulse blood flow in muscles and in the brain. The total peripheral resistance and left ventricular output were also calculated. All indices were measured at the beginning of the study, on day 10 of the procedure, and on the fifth day of the recovery period. Electrostimulation of the patients' muscles resulted in increases in the work of the cardiac muscles and the regional circulation, and some decrease in peripheral resistance and heart rate. The functional state of the cardiac muscle improved, as measured during physical loading and leveling off of the hemodynamic indices. During prolonged hypokinesia (13 to 24 mos), some restoration of the tone of the central nervous system and the volume of circulating blood and an increase in the energy demands of the tissues were noted after electrostimulation. It was therefore recommended as a treatment of the effects of hypokinesia.

Key words: plasma electrolytes, osteoarticular tuberculosis, bedrest

Blood electrolyte content was monitored in hypokinetic and mobile osteoarticular tuberculosis patients by Zakutaeva (1978). Plasma potassium, sodium, and magnesium were among the parameters studied. Upon admission, both groups of patients manifested low plasma potassium levels. While the mobile group's levels began reaching normal concentrations by the third month of treatment, the hypokinetic group's levels became significantly reduced. Plasma sodium content was found to respond in the same manner. However, Na/K ratios did not change during the study period, indicating the two electrolytes remained in equilibrium. Plasma magnesium content was normal when the patients were first examined. Those people with unlimited physical activity exhibited increased levels after 3 mos of treatment, while an increase was not seen in the hypokinetic group until 1 mo after the bedrest regime was ended. From these observations, Zakutaeva concluded (1) plasma potassium content is diagnostic for the mineral imbalance from tubercular infection of the bone tissues; (2) elevated extracellular magnesium levels have prognostic value; and (3) bedrest as a treatment for osteoarticular tuberculosis requires constant electrolytic monitoring with correction of any resulting imbalances.

Key words: circulatory system, hypodynamia, head-down tilt

The changes in circulation that result from prolonged hypodynamia were studied by Maksimov and Domracheva (1979). Fifteen men, aged 23 to 28 yrs, were involved in the experiment. Six men spent 30 days in strict bedrest at a -40° head-down tilt; the other 9 subjects spent 49 days in the same position. The following circulatory parameters were monitored: cardiac contraction rate, per-beat and per-minute volume of circulation, arterial pressure, general peripheral vascular

resistance, pulse blood filling, and vascular tone. A phasic pattern of hemodynamic changes was revealed. Within the 1st wk of bedrest, per-beat and per-minute volumes increased while main vessel tone decreased and small peripheral vessel tone increased. Subsequently, these indices reversed and became clearly pronounced by the 4th to 7th wk of hypokinesia. Normalization of these circulatory parameters was not seen before 3 to 4 wks after the termination of bedrest.

Key words: long-term spaceflight, exercise, catecholamines, acetylcholine, neuromediators, antiorthostatic bedrest

Krupina et al. (1980) presented the results of physiological responses to 182 days of anti-orthostatic hypokinesia (-4°). Three experimental groups of 6 males, aged 32 to 41 yrs, were used to assess changes in general health and the effect of exercising. The experiment was divided into people using the space program's exercise regime, or using the regime at 50% energy expenditure, or undertaking no exercise at all. Adrenalin, noradrenalin, and acetylcholine blood levels were measured every 20 days and subjective and objective analyses of the subjects' psychological and physical state were assessed throughout the period.

By the 10th day, all volunteers had adapted to the antiorthostatic position. Heightened sensitivity, short mental endurance, and sleep pattern deterioration were seen in the men by the start of the 2nd mo; these symptoms increased as the bedrest period continued. Muscular atrophy and cardiovascular deconditioning that accompany hypokinesia were also noted. The most pronounced clinical disturbances were seen within the first 100 days, after which the symptoms became stabilized at a new level (exclusive of the vascular dysfunctions and the asthenization problems mentioned above). Neuromediators fluctuated, depending on the group studied. The nonexercisers exhibited more pronounced changes in catecholamine and acetylcholine levels: during the entire antiorthostatic period, acetylcholine content stayed below normal, while the catecholamines fluctuated. Men exercising at 50% expenditure showed increased catecholamine levels that rose during the first 2 mo, then leveled off at above normal amounts. Within the 54-day readaptation period, the neuromediators had not reattained initial values, indicating substantial deterioration of the autonomic-regulatory system.

The authors concluded that these observations emphasize that the crew members' health and work capacity during long spaceflights requires further information concerning physiological response to hypodynamia and development of methods of prophylaxis and prevention of disorders that develop in weightlessness.

Lower Body Negative Pressure

Key words: catalase, muscular exertion, peroxide, oxygen metabolism, decompression

Taneyeva and colleagues (1979) studied the activity of catalase levels in the blood during local decompression and muscle exertion. Athletes aged 20 to 27 yrs were subjected to decompression around an arm for 10 min. During some of the tests, the subjects performed work on a hand ergograph for 5 min. Blood was taken from the cubital vein for analysis; erythrocyte and hemoglobin content were determined, as was catalase activity. A significant increase in erythrocyte

number and hemoglobin level resulted from the local decompression. A corresponding decrease in catalase activity was also noted. When muscle work was performed in conjunction with the decompression, the blood components' increases and enzyme decrease were even more pronounced.

The authors associated the reduction in catalase activity with inhibition from high concentrations of peroxides in the bloodstream: increased numbers of erythrocytes and hemoglobin content are accompanied by higher levels of peroxide by-products. Another explanation of the decreased activity, not mutually exclusive of inhibition, is that oxygen is being utilized at a faster than normal rate, especially during muscular exertion. Catalase accelerates the bonding and emission of oxygen, which would be detrimental in a situation where increased oxygen metabolism is required.

Key words: passive orthostatic test, circulatory system, mathematical model

Grigoryan and Palets (1980) investigated the response of the circulatory system to lower body negative pressure (LBNP) and compared it with the response to the passive orthostatic test using a mathematical model. The model of baroreflex regulation of hemodynamics under orthostatic effects was used with modification: an additional factor was used to take into account the effect of external pressure on circulation when describing hemodynamics in the vascular channel. The mathematical model permits detailed analysis of the regulation of hemodynamics and determination of the information content of the LBNP test compared with the passive orthostatic test.

Exercise

Key words: occupational hypokinesia, circadian rhythms

Smirnov (1980) discussed occupational hypokinesia and its effects on humans in their lives and work. Technological advances have resulted in more sedentary, less strenuous occupations for the vast majority of people. The physiological results of the ensuing inadequate motor activity include health disorders, increased risk for certain diseases (especially cardiovascular), reduced job efficiency, emotional disorders from boredom, and misalignment of circadian rhythms (the majority of energy expenditure does not occur during work hours). To counteract the lack of physical exertion, Smirnov recommended higher levels of activity. These may be in the form of short, regimented exercise breaks during the day, improved work conditions, and encouraging increased activity during off-hours.

Key words: medical technology, sports medicine

Sedov (1980) of the USSR Ministry of Health reviewed advances in space medicine and medical technology and their applications to sports medicine. He mentioned that information obtained from physiological studies conducted with weightlessness in mind has expanded medical knowledge and application, especially in situations of stress and physical load. The prevention of disorders from circadian rhythm disruption and the role biorhythms play in daily life are also considered advances

that came from space medicine research; he recommended consideration of biorhythms when athletes are competing, especially when out of the country, to calculate peak activity. Sedov also cited the clinical use of pharmacological compounds for improving nervous and mental stability and efficiency that were initially investigated for use in space. Additionally, a number of bioinstruments were developed for use in space that are smaller and more sensitive than was previously available; these are recommended for monitoring athletes during competition to analyze performance and predict health status.

Key words: circulatory system, physical load, functional load, conditioning, pressure chamber

Panferova (1980) investigated reasons why studies conducted during spaceflights do not always detect significant changes in circulatory system reactions to physical loads. Five healthy men participated in two series of experiments conducted in a pressure chamber: the first studied the dynamics of pulse rate changes during habitual (walking) and nonhabitual (pulling down a cross-beam) physical loads; the second was designed to identify the differences in pulse rates during functional tests that were part of the conditioning exercises (bicycle ergometer) and those that were used only as diagnostic tests (step test). At the end of the study, all subjects exhibited decreased work capacity. The results indicated that the changes in heart response depend on the subject's conditioning to the given type of exertion. The use of functional tests with frequently repeated muscular movements during the stay in the pressure chamber masked the general deconditioning of the men.

Key words: musculoskeletal system, bioelectrical potential, atrophy, weightlessness

Aleyev and coworkers (1980) produced a monograph that described the use of Myoton programmed multichannel units to bioelectrically control human movements. Transformed bioelectrical potentials of muscles are used to control contractile activity of skeletal muscles. These artificial control systems can be used to restore lost motor functions and to assist movement and muscle conditioning under certain circumstances (e.g., weightlessness). The direct stimulation of nerves and muscles makes it possible to prevent muscular atrophy when there is an absence or weakening of motor function as well as increase the force of muscular contractions. The Myoton unit and its development and uses are described in this book, as are its practical uses in rehabilitation therapy and special situations where muscular activity suffers.

Key words: cardiology, computer

A system of automated heart rhythmogram analysis prepared with the help of computers is described in a book edited by Tel'ksnis (1979). The results of analyses of data registered during sleep, physical load, and balneologic procedures are presented.

Key words: *cardiovascular system, cardioleader, sports*

A portable electronic trainer-cardioleader was used in experiments by Utkin (1979) to evaluate optimal patterns of cyclic movement to facilitate sports training. The advantages of testing with the portable device were: (1) they produced reliable data from which standards could be defined; (2) the tests provided more information than past laboratory examinations because they were conducted under the conditions of training (running track, ski slope); and (3) the cardioleader allowed evaluation of not only physical but also technical-tactical preparedness of the athlete. Utkin studied trained and untrained subjects who performed walking, running, cycling, or skiing tasks. Testing under conditions of regulated tachycardia made it possible to objectively evaluate the special physical preparedness and to determine the most economical patterns of cyclic movements.

Acceleration

Key words: *cardiovascular system, G-load, centrifuge*

The overall state of the body and the responses of the cardiovascular system during prolonged longitudinally directed "head-pelvis" G-loads of 1 to 2 G were studied by Vil'-Vil'yams (1981). A total of 495 tests were conducted on 58 male volunteers who were rotated on medium- and short-radius centrifuges. The subjects on the short-radius centrifuge showed a high tolerance to prolonged effects of head-pelvis G-loads. Tolerance to G-loads on medium-radius centrifuges decreased in 5.8% of the cases from disturbances of circulation in the head. Vestibular disturbances, however, were observed in only 2.2% of the medium-radius centrifugation tests.

Vibration

Key words: *tonal audiometry, pulsed noise, cardiovascular system*

Mel'nichenko (1981) examined people's reactions to intensive pulsed noise, giving consideration to the nature, severity of disturbances, and time of restoration to initial levels. Subjects were exposed to 5 to 50 pulses of a 0-10 kHz range with most pulses falling in the 0-400 Hz range. The pulses lasted up to 10 ms with 10-sec intervals. The effect of the noise was evaluated with tonal audiometry, heart and respiration rates, arterial pressures, EKGs, modified cancellation tests, and reactions to a moving object. The volunteers' subjective views were obtained with questionnaires.

A direct correlation between noise intensity and duration, and performance quality was detected. Overall, pulsed noise contributed an inhibitory influence on testing accuracy and efficiency. The EKGs showed no appreciable deviations, although noticeable changes in heart rate and arterial pressure were found. Increased intensity of pulsed noise was accompanied by an increase in the number of subjects with changes of heart rate and blood pressure that varied in direction (tachycardia or bradycardia, hyper- or hypotension) with each individual. These parameters reverted to base levels within 1 to 2 hrs. No significant alterations in respiratory rates were seen. The volunteers' subjective states underwent distinct worsening with very loud noises (165 dB and higher).

Radiation

Key words: genetics, mutation, immunogenetics, plant

The mutagenic effect of physical factors is considered in a monograph edited by Dubinin (1980). The genetic hazard to man from radiation, as well as to natural populations of plants and animals, and patterns of spontaneous and induced mutability of organisms are characterized. The emphasis of the book is on the consequences of radiation, including a chapter on mutagenic factors of spaceflight.

Key words: ionizing radiation, gases

Metabolic Products in the Presence of Radiation Lesions (Tiunov & Kustov, 1980) is a summary of the authors' studies of the effect of ionizing radiation on formation and elimination of metabolic products involved in forming the gas composition of an atmosphere of an ecologically confined system. There is a discussion of the patterns of formation and elimination of ammonia, acetone, carbon monoxide, and hydrogen peroxide after acute and chronic irradiation. Information is furnished about the modifying effects of radioprotective and radiosensitizing agents on these processes in the presence of radiation lesions.

Key words: neutron, occupational exposure, cytogenetics, aneuploid, polyploid, dicentrics

Romanova and colleagues (1981) performed cytogenetic analyses on 39 field workers of geophysical expeditions exposed to neutron Po-Be sources. Two control groups were also studied: 10 people working in the general area of radiation but not previously exposed to occupational radiation, and 9 individuals working in the field but not exposed to any radiation. The irradiation was not uniform, and did not exceed the maximum permissible dose. Chromosomes in peripheral blood leukocytes taken from 60-hr metaphase cultures were studied. In comparison to the two control groups, the study group had a significantly higher percentage of chromosomal aberrations, including a higher number of aneuploids and polyploids. The most frequent anomalies were paired fragments and dicentrics without fragments. The authors stated that the latter seem to be sensitive indicators of chronic low dose radiation.

Extreme Temperatures

Key words: aircraft, microclimate, adaptation, protection

The effects of different microclimates in aircraft on functional systems of the body are the topics of a book by A.M. Azhayev (1979). Particular attention is paid to heat transfer, fluid-electrolyte metabolism, and cardiovascular, respiratory, and muscular systems. The adaptive mechanisms involved in heat regulation at high and low temperatures are considered, as are the methods of developing suitable protection from fluctuating adverse conditions.

Space Motion Sickness

Key words: nystagmus, caloric stimulation, slow component, pathology

Levashov (1979) reported a simple method that makes it possible to visually evaluate the intensity of nystagmus to compute the coefficients of labyrinthine asymmetry and directional dominance, as well as approaches that facilitate interpretation of pathological conditions. Visual observations are given relative values; that is, the frequency of nystagmus induced by caloric stimulation is described as "rare, average, or frequent," which are given the quantitative values of 1, 2, or 3 and dimensions of s^{-1} . Amplitude is described as "small, average, or large," and given the same respective values in degrees. Their product is $degrees/s^{-1}$, which is close in meaning to the rate of the slow component of nystagmus and recommended for approximate evaluation of intensity. To define precisely what is, for example, average intensity, visual observation is to be restricted to the culmination period, within 30 to 80 sec, counting from the beginning of irrigation and directly after it. Levashov provides example calculations to analyze the formal results.

Key words: vestibular recruitment, nystagmus, caloric stimulation, sinusoidal rotation, Meniere's disease

Tsemakhov (1979) reviewed the literature on vestibular recruitment. Vestibular recruitment is viewed as an objective phenomenon seen during the affection of the vestibular receptor. Its diagnostic value is considered valuable for discerning peripheral and central affections of the vestibular system, and is based on the assumptions that recruitment depends on the methods of stimulation used, and on the selection of parameters for evaluation of the nystagmic reaction.

Key words: nystagmus, infant, saccades

Sergiyenko (1980) studied optokinetic nystagmus of infants 4 to 24 wks old. Equipment based on a continuous band with black and white stripes was used to elicit the response; horizontal eye movements were recorded by electrooculography. Optokinetic reaction was found in 89% of infants. Their nystagmus exhibited an intermittent rapid component followed by a smooth slow component. During the first 6 mos of life, the amplitude of optokinetic nystagmus increased three-fold, whereas saccadic and smooth eye movements were operating at birth. The reactions of infants differed from adults by a slower rhythm of optokinetic nystagmus and greater amplitude variation.

Circadian Rhythms

Key words: industrial psychology, labor organization, biorhythm

An industrial psychology book edited by Slonim (1980) dealt with distinctions of biorhythms and the way they change during industrial work shifts. Work is a primary form of human behavior. The outside rhythm of technological processes alters the physiological rhythms, constituting a

strong factor affecting the worker's health and general well-being. When trying to improve production, the authors state that consideration of biorhythms can disclose some important clues to man's behavior at work and his actions within the man-machine environment. This book addresses labor organization and the amelioration of working conditions from the standpoint of biorhythms of workers and their integration into the work and rest schedule.

Key words: sleep dynamics, diurnal sleeping-waking, adaptation

Litsov (1979) considered the effect of double alternation of sleeping-waking cycles, such as those imposed on certain specialists (pilots, cosmonauts, etc.). Two groups of males submitted to either a pattern of two 4-hr intervals of sleep (1400 to 1800 and 2300 to 0300) or a pattern of 6- and 2-hr intervals (from 1000 to 1600 and from 2300 to 0100).

The double 4-hr regime produced four distinct phases: on the 1st day, good sleep was preserved in both intervals; in the 2nd phase (2-5 days) there was sharp impairment of sleep in both intervals; the 3rd phase (5-7 days) was characterized by alternation of improvement and impairment of sleep in one of the intervals; and the 4th phase (7-9 days) was one of sleep improvement and increase in its duration to 5-6 hrs during the day, and a reduction to 2 hrs at night.

In contrast, three periods could be isolated during adaptation to the 6 and 2 double sleep cycle. The 1st (1-3 days) was characterized by an impairment of sleep during both intervals; the 2nd phase (3-5 days) could be defined by improvement in sleep only during the daytime intervals; and the 3rd phase (5-8 days) was a time of improvement in sleep indices also in the nighttime intervals.

It was observed that less pronounced disorders of sleep and restoration of sleep were characteristic of nonuniform alternation of the intervals; disorders were more severe with the two 4-hr sleep intervals. Litsov stated the non-uniform distribution could be explained by the majority of people being able to use daytime sleep in addition to the nighttime and that the 6-hr intervals guarantee repeated exchange of slow-wave and paradoxical sleep. He concluded that operators who are required to undergo double cycles of sleeping-waking should use the nonuniform distribution of sleep intervals; the two 4-hr intervals could be used only for 1 or 2 days with subsequent transition to the optimal diurnal arrangement.

Key words: sleep, delta waves, work efficiency

Kandror and Rotenberg (1980) reviewed the literature concerning sleep and mental efficiency. A direct relationship was established between the duration and quality of sleep and human performance. In general, when deprived of sleep, the individual compensates with increased delta-, or deep, sleep. However, deprivation of rapid sleep phases has a negative effect on the performance of creative tasks. The sequence of various sleep phases seems to differ from one individual to the next, yet work efficiency, according to some data, appears to depend on the sleep pattern experienced.

Psychology Research

Key words: crew selection, closed life support, cabin environment, long-term flight

Designing the Living and Working Conditions of Cosmonauts (Gurovskiy et al., 1980) is a book that addresses the medical and technical requirements necessary for the creation of appropriate psychological climates in spacecraft. Working within the frame of long-term flight—that is, two years in space to reach Mars—the authors consider among other things the following: cosmonaut selection, crew compatibility, work and rest regimes, cabin decoration and layout and its effect on the crew, and possible psychological problems that might arise and their solutions.

Key words: stress, adaptation, disease prevention

A book by Kaznacheyev (1980) examined the correlation between the processes of human adaptation to new environments and the pathological states that sometimes accompany this process. The development of new regions of the USSR that were previously uninhabited (mainly the extreme north and Siberia) and the creation there of industrial complexes has brought people into different climatic, geographic, and industrial conditions. Recommendations to safeguard and develop the health of the population and some principles for diagnosis of different emotional and physiological states are discussed; their significance is analyzed with respect to early prevention of mental and physical disease.

Key words: adaptation, central regulatory system, memory, brain

The physiological mechanisms of adaptation as a function of efficient operation of the central regulatory system and memory are the topics of *Memory and Adaptation* (Il'yuchenok, 1979). Analysis of data obtained during human adaptation to different climates and geographical conditions revealed three phases in the adaptation process which are based on various physiological mechanisms. Emphasis is given to memory processes and functional asymmetry of the brain at the different stages of adaptation.

Key words: ergonomics, human factor, stress, mathematical model

Research concerning man-machine systems and improving the efficiency of the human factor is reviewed in a book by Ivanov-Muromskiy et al. (1980). The authors attempted to investigate and model human behavior under stress conditions in laboratory situations and in the workplace itself. They also presented methods of processing physiological data about the state of operators in stress situations to evaluate the workers' ability, efficiency, and future performance.

Key words: communication, stress, closed life support system

The Problem of Communication in Psychology (Lomov, 1981) contains discussions of the conditions and means of human communication, as well as the influence of personality and surroundings. With respect to space medicine, certain chapters deal with the role of stress upon personal interactions; Novikov's article specifically concerns the psychological factors involved in spacecrew compatibility and their interactions in closed life support systems.

Pharmacology

Key words: aeron, dedalon, pipol'fen, plavefin, motion sickness, vestibular inhibition

Bazarov (1981) described methods of combating motion sickness symptoms. Cited were a number of pharmaceutical preparations, including aeron, dedalon, and pipol'fen. These are prescribed 30 to 60 min before the beginning of a flight or voyage and are reported to reduce vestibular disturbances in 50 to 80% of travelers. A compound called plavefin is reported even more effective, eliminating motion sickness in 70 to 80% of travelers. Also mentioned were physiological methods, such as portable electrostimulators. This machine is said to inhibit vestibular reactions by stimulating visual, aural, and olfactory senses.

Key words: neuromediators, respiratory system, trauma

The role of neuromediators in the regulation of respiration under normal conditions and conditions of injury and disease is the subject of a book by Bazaravich et al. (1979). Protocols requiring pharmacological agents that affect mediator metabolism were developed for experimental therapy of resultant respiratory disturbances and are described. Other experiments designed to study the response of the body to mediators such as catecholamines, serotonin, and cholinesterase led the authors to develop and make use of methods that normalize respiration in the presence of trauma, massive hemorrhage, and peritonitis. These clinical uses are stated.

Key words: plants, vitamin, health

Man and Biologically Active Substances, by I.I. Brekhman (1980), contains a discussion of biologically active substances of natural origin that enhance man's resistance to disease and adaptability to different living conditions. The effect of fortifying substances from plants, including eleuterococcus, lemon tree, aralia, ginseng, and others, are described. Also addressed are the effects of such biologically active compounds as vitamin C, pantocrin (hormone from reindeer horns), tea, and coffee. In the author's opinion, use of these substances is one of the ways of strengthening overall health.

Key words: *ionizing radiation, radioprotection, thiol, indole*

Vladimirov and Zaytseva (1981) surveyed the literature concerning radioprotective pharmaceutical agents (RPAs). The development of RPAs currently centers on combined prescriptions which contain at least one chemical that attenuates the effects of ionizing radiation and another that prevents or lessens the side effects from the radioprotective drugs. Sulfur-containing RPAs (e.g., cystamine, aminoethylisothiuronium) comprise the majority of radioprotective formulae. Usually, indolyl alkylamine products are used in conjunction with the thiols. These two types of chemicals together provide high radioprotective activity, enhancing the protection each provides alone. It has also been demonstrated that the protective action of sulfur-containing compounds and indolyl alkylamines administered together is prolonged over that obtained when they are given separately.

The mechanism of thiol and indole synergy is unknown. One hypothesis is that sulfur-containing compounds enhance the pharmacological action of the indoles by depressing monoamine oxidase activity, creating more favorable conditions in the gastrointestinal tract. Various combinations of RPAs have also been shown to markedly depress DNA synthesis and extend the cell cycle of small intestine stem cells; cAMP is implicated in this phenomenon.

The interaction of radioprotective drugs is a primary concern in the development of RPAs. Administration of thiols and indoles at different preradiation times, when using them in combination, can result in the peak protective actions of the two chemicals to coincide, providing maximum protection. Additionally, the different rates of absorption and elimination of the products must be considered when seeking a combined pharmaceutical effect.

Simulation Studies

Key words: *cybernetics, mathematical model, biological system*

Methods of Mathematical Biology, edited by V.M. Glushkov (1980), presents the systematization of various mathematical methods that have been applied to studies of various biological systems. To encourage broad use, portions of the book have explanations of the development of theoretical constructs of different biosystems to delineate a range of problems. The book details the methodology used in various fields, describes the means and stages of modeling, and ways of obtaining solutions. Written as an educational aid, it is also suggested for theoretical biologists.

Space Biology

Metabolism

Key words: *stress, pepsinogen, histamines, cimetidin, metiamid, ulcers, rat*

Gavrovskaya and Agranovskaya (1979) studied the role of endogenous histamines in experimental gastric ulcer formation. Rats, given water but no food for 2 days before the experiment, were subjected to various forms of stress (pyloric ligation, duodenal trauma, immobilization,

electrical stimulation). Some animals received intraperitoneal injections of histamine H2-blockers cimetidin and metiamid 20 min before or 1½ hrs after the beginning of the stress. Animals were sacrificed 3 hrs after the stress; the number and size of the lesions were determined and the pepsinogen content in the fundal area tissues was measured.

Lesions of the gastric mucous membrane (hemorrhagic erosions and ulcers) were observed in all experimental animals subjected to stress. The lesion index was 8 to 15 mm. These lesions were accompanied by an average of 57% decrease in tissue pepsinogen content. However, cimetidin and metiamid injections before stress were found to decrease the number and size of lesions fourfold; concomitantly, they normalized the pepsinogen content in the gastric tissues, although the level could not reach that of intact animals. The results of the experiments verified other works implicating histamine H2 in the formation of dystrophic lesions.

Key words: tenotomy, extensor, soleus, receptors, cat

Arutyunyan (1979) studied the effect of tenotomy on the function of fast and slow muscles. Using cats, the musculus extensor digitorum longus was selected as the fast muscle while the musculus soleus was used as the slow. The activity of primary and secondary endings of the fast and slow muscle spindles was compared in normal muscles and after cutting the tendon. Three measurements were made in the tissues: (1) spontaneous pulse activity after 3 min or more of relaxation; (2) background activity from passive stretching of the muscles with a 100-g load; and (3) induced activity when the muscle was additionally stretched by 3, 6, 9, and 12 mm at a rate of 20 and 40 mm/sec and kept that way for 3 sec.

No differences were discerned in normal or tenotomized muscles in the spontaneous activity of primary and secondary receptors of either muscle type. When stretched with a 100-g load, normal fast and slow muscle also showed no differences in background activity. After tenotomy, no changes were noted in loaded fast muscle spindles either, but an increase was seen in background activity of the primary and secondary endings of the loaded slow muscle spindles. Additional passive stretching showed no further differences in responses of either muscle spindle. Following tenotomy, however, the sensitivity of muscle spindles increased, as was demonstrated by sharply increased frequencies of discharges during stretching. This was more pronounced in the receptors of slow muscles.

Key words: stress, gamma aminobutyric acid, adrenergic system, hypophyseal-adrenal system, rat

Pavlova and associates (1981) showed that during prolonged and repeated stress, such as immobilization or pain, activation of the adrenergic and hypophyseal-adrenal systems becomes less pronounced. Severe pain was developed in experiments using female Wistar rats; administration of gamma oxybutyric acid (GOBA) was found to alleviate the stress reaction and prevent gastric mucosa damage. The activation of the hypophyseal-adrenal system during the pain stress also activated the gamma-aminobutyric acid (GABA) system and increased GOBA formation, alleviating stress and preventing stress injury. The researchers assumed that the GABA inhibition system is a nonspecific mechanism activated regularly during stress, relieving it and preventing stress-induced damage.

Key words: *cholesterol, stress, atherosclerosis, glycogen, glycolysis, liver, rabbit*

Ryl'nikov (1980) subjected rabbits to hypokinesia with or without additional administration of saccharose in order to investigate the contention that restricted mobility life styles and increased intake of simple carbohydrates result in higher blood cholesterol levels and predisposition to atherosclerosis. During the two-month experiment, he monitored various metabolic compounds and analyzed the condition of livers from sacrificed animals. Both groups exhibited hypercholesterinemia: their physiological response to the experiment conditions was increased cholesterol and cholic acid secretion. The hypokinetic animals were found to have virtually no glycogen and reduced glycolytic assimilation of carbohydrates in the liver. Their counterparts in group two, receiving daily doses of saccharose (3 g/kg body mass) were observed to initially undergo a reduction in liver glycogen, but by the 30th experimental day, their liver glycogen content equalled that of controls. No dysfunction of glycolytic assimilation was noted in this group. More atherogenic compounds (cholesterol, pre-beta- and beta-lipoproteins, mucopolysaccharides) were found in the blood streams of rabbits receiving the combined treatments, but there were still no increases in liver cholesterol deposits. The administration of saccharose seemed to normalize glycogen levels and glycolysis, which decrease during hypokinesia. Therefore, saccharose restored the reduced protective secretory functions of the liver which inhibited an increase of lipid infiltration. Nevertheless, pre-beta-, beta-lipoprotein, and cholesterol levels remained higher than normal in both groups throughout the experiment.

Key words: *stress, vascular system, carbohydrate metabolism, rat*

The effects of fixation stress, with or without prior hypokinetic stress, were studied by Kovalev and coworkers (1980). Groups of rats were restrained in narrow cages for 7 days. Fixation stress was effected by tying the animal on its back to a stand for 1 or 4 hrs. The animals were injected with chromium ⁵¹-labeled erythrocytes and iodine ¹³¹-labeled albumin; the ratio of radioactivity to total activity of the mixture introduced was used as the hematocrit value.

Fixation stress that followed 7 days of hypokinesia was found to induce moderate hypotension and increased carbohydrate exchange indices (lactic acid, pyroracemic acid, lactic acid/pyroracemic acid ratio, surplus lactate). The increases were more pronounced after the 4-hr stress than the 1-hr exposure. Furthermore, a redistribution of circulating blood from the liver and several internal organs to the lungs, skin, muscle, and bone were measured. Those animals immobilized for 1 hr were also found to have increased blood in the adrenals.

Rats that had been only exposed to fixation stress exhibited different reactions. Those animals undergoing 1-hr exposure showed decreases in the relative concentration of blood in many organs (stomach, pancreas, intestines, spleen, bladder, testicles) and the muscles and bones of the extremities. No change was noted in the blood distribution to the liver. An increase in the percent concentration of blood of the brain, myocardium, lung, and muscles and bones of the head, neck, and chest was also recorded.

Animals tied to the stand for 4 hrs were found to have decreased blood concentrations in the skin, muscle, bone, and internal organs. Increased concentrations were noted in the liver, myocardium, and lungs.

It was proposed that the fixation stress induced disturbances in the sympathetic nervous system and the hypothalamic-hypophyseal-adrenal system from increased vascular tonus. The disturbance was more evident after 4 hrs of stress. Hypokinesia is a stressor itself; the additional stress from fixation was thought to cause exhaustion of neurohumoral constriction effects and local vascular expansion from metabolic disturbances, such as changes in carbohydrate metabolism.

Key words: circulatory system, acid-base balance, capillaries, rats

Changes in the microcirculatory bed were revealed by Shtykhno and Udovichenko (1978) in experiments on rats following 30 days of restricted motor activity. These alterations included a reduction in number of capillaries, the appearance of nonfunctioning empty vessels, and the opening of the arterio-venular shunts. Changes in the acid-base balance in the direction of reduced blood buffer content were also noted.

Key words: vascular system, sympathetic trunk, rabbit

The effect of hypokinesia on blood vessels of the sympathetic trunk in rabbits was examined by Muratikova (1980). Animals were restricted in small cages for periods of 1, 2, 3, 4, 6, 8, or 22 wks; blood vessels were then histologically prepared and examined. It was determined that 1 wk of hypokinesia produced little change in the vascular bed under study; only minor venous dilation was observed. With increasing time, more severe alterations appeared, the most intensive changes occurring within the 3- to 4-wk period of confinement. These changes included arterial bed constriction, vessel dilation, and increasing disorder of orientation. In the caudal region in particular, the intraorgan veins became dilated and tortuous, forming dead-end outgrowths and venous wall diverticuli. The vessel deterioration was linked to disruption of vascular tone.

Key words: capillary, blood supply, muscle, hypoxia, atrophy, dystrophy, rat

Kaplanskiy and coworkers (1980) histologically analyzed the condition of muscle fibers differing in function and composition after 20 days of hypokinesia. After sectioning and fixing the soleus, gastrocnemius, tibia, and biceps femoris, the number of functioning (containing erythrocytes) capillaries and the total number of capillaries in 500 muscle fibers were computed. The analysis was broken down between white and red fibers in the gastrocnemius.

Atrophy of the hind extremity muscles, the gastrocnemius, tibia, and biceps, was accompanied by a reduction of functional capillaries by 19, 30, and 30%, respectively. Furthermore, the number of functioning capillaries in the red fibers of the gastrocnemius was reduced 24%; the reduction in the white fibers (9%) was statistically unreliable.

The results indicated a direct correlation between functional load on the muscles and the blood supply. Lessening of the load on the red fibers was accompanied by a reduction in capillary action. The white fibers, which depend to a large extent on glycolytic respiration, were less affected.

Functioning capillaries in the soleus remained constant. Instead, large numbers of dilated capillaries and small veins full of blood were seen. These phenomena were associated with disruption of the "muscle pump" so that the flow of blood is slowed down. Consequently, the tissues suffer from hypoxia, becoming dystrophic, although not atrophic.

Key words: *reticular formation, evoked potential, rat*

Klimovskaya (1980) studied the effects of the midbrain reticular formation on evoked bioelectric activity of the cerebellum in hypokinetic rats. Following 30 days of restricted motor activity, the experimental animals showed increased depressant effects of the reticular formation on evoked cerebellar activity. The initial evoked potential amplitude of controls was 635 mcv; during reticular formation stimulation (10 v) it was 277 mcv. In hypokinetic rats, these values were 658 and 70 mcv, respectively. Even with 1 volt stimulation, hypokinetic animals reacted with a decrease in the amplitude of the cerebellar evoked potential. Therefore, hypokinesia significantly increased the effectiveness of reticular formation stimulation. It was noted that the reticular formation might be the cause of the disturbances in the regulation of postural tone and coordination of movement seen after long-term hypokinesia or exposure to weightlessness.

Key words: *behavior, catecholamines, adrenaline, noradrenaline, acetylcholine, EEG, rat*

To duplicate insufficient motor activity and its results, Ayrapetyants et al. (1979) subjected rats to intermittent restraint for periods of 1, 3, and 6 wks. The research group monitored behavior, EEGs and characteristics of sleep-wake cycles, and blood chemicals through each experimental phase. One week of intermittent immobilization resulted in excessive motor excitation, disrupted learned behavior, unstable sleep-wake patterns, and increased blood levels of catecholamines and adrenaline. The 3-wk experiment revealed an improvement in the conditioned reflex activity, stabilization in sleep-wake cycles, and a sharp increase in noradrenaline, accompanying a further increase of catecholamine release. The 6-wk intermittent restraint induced intensified grooming behavior, degeneration of the conditioned reflex reaction, altered sleep patterns, and a drop in blood catecholamines and acetylcholine.

Key words: *morphology, vascular system, gravitational overloading, medulla oblongata, rabbit*

Preobrazhenskaya (1979) presented morphological observations of rabbit brain vascularization after gravitational overloading and hypokinesia. Rabbits were divided into 3 groups. In each, changes in blood vessels of the medulla oblongata were recorded. The first group of rabbits experienced one overloading in the cranio-caudal direction and 4 wks of hypokinesia. Medulla oblongata veins were greatly enlarged and deformed following this protocol. After 8 wks of hypokinesia that followed the same overloading, even more enlarged and deformed veins were seen. All changes were characteristic of those seen from hypokinesia alone of the same duration in rabbits, suggesting the gravitational overloading effect had time to normalize. After 8 to 12 wks of readaptation, the changes were somewhat reduced.

Following gravitational overloading, 4 wks of hypokinesia, and repeated overloading, the medulla oblongata exhibited sharply winding vessels of the microcirculatory channel, constrictions, and deformed vessels. The constricted vessels were a manifestation of the gravitational overloading; deformity and winding vessels reflected the limited mobility.

Animals of the second group were subjected to one overloading in the caudo-cranial direction and 4 or 12 wks of hypokinesia. All blood vessels were constricted. Changes in the medulla

oblongata differed sharply from those seen after only one of the two stresses. No enlarged or deformed vessels were seen, suggesting the caudo-cranial direction of gravitational overloading changed the reaction of the blood flow channels of the brain to the successive effect of long-term hypokinesia. Repeated overloading after 4 wks of hypokinesia led to changes characteristic of the effect of overloading; i.e., sharp enlargement of all vessels, especially veins, and intensification of the coiled nature of the microcirculatory channel.

The third group of animals was subjected to a one-time effect of overloading in a ventrodorsal direction and hypokinesia for 15 or 18 wks. The changes were characteristic of long-term hypokinesia.

It was concluded that the effect of gravitational overloading, such as cosmonauts experience upon returning to Earth, and restricted mobility similar to weightless conditions is extensive morphological change. However, readaptation illustrated the reversibility of the induced morphological shifts.

Key words: catecholamine, brain, rabbit, rat

Mel'nik and coworkers (1980) studied shifts of catecholamines in the brains of rabbits and rats subjected to hypokinesia, and attempted to correct them with pharmaceutical agents. Under examination were the hypothalamus, cerebral hemispheres, and some nuclei of the hypothalamic region; the bioelectrical activity of the animal brains during hypokinesia was also recorded. The researchers reported that melipramine and intermedine produced normalization of catecholamine levels, and justified their use.

Key words: mitochondria, cristae, ultrastructure, cardiomyocyte, rat

Levkova and coworkers (1981) performed quantitative ultrastructural studies of cardiomyocyte mitochondria of rats subjected to 30 days of hypokinesia. Whereas mitochondria of control rats were essentially unchanged, most mitochondria of experimental animals were swollen, possessing thin matrices and reduced or fragmented cristae. These changes continued to accumulate through the 20th experimental day. The authors considered this structural-functional rearrangement was a manifestation of pathogenesis; metabolic disturbances, reduced contractibility, and changes in the protein-synthesizing and contractile apparatus were held responsible.

Key words: stress, lipoperoxide, superoxide anion, regulation, rat

Mikayelyan and associates (1979) examined the effect of stress, which is accompanied by a growth in lipid peroxide concentration in the tissues, on the activity of the enzymes that detoxify them: glutathione peroxidase and glutathione reductase. Rats were immobilized by restraining the head and extremities for 150-min periods. Upon sacrifice immediately after the immobilization or 24 or 48 hrs after, tissues were analyzed. The researchers found that the peroxidase and reductase increase in response to stress, possibly induced by the increase in the lipoperoxide substrate. Differential, tissue-dependent responses were noted, however. Enzyme activity grew gradually

as duration of restraint increased. In contrast, the brain showed immediate enzyme activation which increased sharply with the first immobilization and remained at the same level through all subsequent tests. The different responses were characteristic of isozymes: only selenium-dependent glutathione peroxidase was found in the heart, while the brain and liver possessed both selenium-dependent and -independent forms. Poststress analysis of animals revealed the activity of the two enzymes remained significantly higher than the control.

In spite of the accumulation of lipid peroxides during stress, superoxide dismutase (which catalyzes the conversion of superoxide anions to hydrogen peroxide and free oxygen, thereby inhibiting lipid peroxidation) was found to be somewhat suppressed after most stress periods, but not actively reacting to the lipoperoxide build-up. Thus, immobilization stress does not inhibit lipoperoxide formation at the genesis of the superoxide radical, but results in increased activity of glutathione peroxidase and reductase. Mikayelyan et al. inferred from this an imbalance of the processes of the formation and removal of lipoperoxides in response to stress, with consequent harmful contributions to the pathological phenomena that result.

Radiation

Key words: superoxide dismutase, peroxide oxidation, ionizing radiation, radioprotection

Goncharenko and coworkers (1981) reported on the radioprotective effects of superoxide dismutase (SODM). Superoxide anion radicals are formed in cytoplasm in response to ionizing radiation, and can participate in the peroxide oxidation of lipids. SODM, present in cells of aerobic organisms, regulates the level of active forms of oxygen. The experimental protocol involved irradiating Wistar rats with 700 or 1,000 rads of ionizing radiation and assaying the enzymatic activity. The lower dose produced no effect on SODM activity, while irradiation with 1,000 rads produced a transient reduction of SODM activity in liver cells alone. Known radioprotectors, serotonin and MEA, did not affect SODM activity, leading the researchers to speculate the protective function of SODM against radiation is an independent link in cellular radiation protection.

Key words: gamma radiation, electron microscope, histology, neuroendocrine system, rat

Dedov et al. (1981) used histological methods and electron microscopy to study the neuroendocrine system (hypophysis, adrenals, thyroid, ovaries, mammary gland, and uterus) of 88 3-mo-old rats at different times in their lives (1 to 24 mos) following a single, whole body exposure to gamma radiation (100 rads). They reported that the dosage produced disturbances of the hormonal balance and the estrus cycle and facilitated formation of tumors of the endocrine glands and the target organs.

Key words: cobalt-60, potassium/sodium ratio, radiation sickness, rat

Darenskaya and coworkers (1981) attempted to predict the probability of death of rats according to changes in blood potassium/sodium ratios (K/Na). Male Wistar rats were exposed to ⁶⁰Co doses of 800 or 850 R; the K/Na ratio was assessed using the parabolic distribution method

and Gaussian distribution curves. The alteration of the K/Na ratio provided data allowing accurate prediction of radiation sickness; the greatest accuracy was obtained by using data from the Gaussian method.

Key words: cobalt-60, potassium/sodium ratio, cortisol, leukocyte, radiation sickness, Macacca rhesus

Darenskaya and Korotkevich (1981) performed the same type of experiment as above on *Macacca rhesus* monkeys. Adrenal cortex activity was evaluated from blood cortisol levels, K/Na ratios, and leukocyte counts. A highly accurate (81 to 100%) prediction of outcome of radiation sickness was found to be possible using data calculated from Gaussian distribution. Blood cortisol levels were determined to be the most reliable indicator of adrenal cortex activity. The monkeys were divided into 3 groups, hypo-, normo-, and hyperreactive, depending upon their physiological responses. The highest mortality rate was among the normoreactive group.

Extreme Temperatures

Key words: stress, invertase, corticosteroids, rat

Rakhimov and Aleksandrova (1979) subjected rats of varying ages to stress from heat or cold and then measured invertase activity in small intestine mucous membranes. Without stress, invertase activity was negligible in 10-day-old rats, low in 20-day-old animals, and sharply increased in the 30-day-old group; it remained fairly constant through old age. When stress was administered, the two youngest groups manifested significant increases in invertase activity. This response was barely seen in the 30- and 120-day-old rats, but reappeared in the oldest group (28-30 mos). It was proposed that the mechanism of this phenomenon is the stimulation of corticosteroid synthesis by stress; the hormones then affect enteric enzyme metabolism. This physiological response was seen when hydrocortisone was injected in lieu of subjecting the animals to stress per se. Based on the above observations, the authors advised consideration of age-related responses of enzyme regulation to hormonal signals when using hormone therapies.

Space Motion Sickness

Key words: orthostatic test, cerebral blood flow, autoregulation, rabbit, cat

The autoregulation of cerebral blood circulation during orthostatic stress was examined by Gayevyy and coworkers (1979). It is known that rapid changes from the horizontal to the vertical (either head up or down) is accompanied by characteristic alterations in the dynamics of cerebral blood perfusion; however, the control mechanisms involved in continuing to provide the brain with a sufficient blood supply when body position is changed are incompletely defined.

Twenty-five unanesthetized rabbits were fastened to a table that allowed positional changes. Cerebral blood flow (CBF) was recorded from both common carotids. Resistance of cerebral vessels (CVR) at various levels of perfusion pressure (PP) during orthostatic tests was also measured.

Orthostatic testing, lasting 3-5 min, was accomplished by turning the table and the animal (head up or down) at an angle of 40-80° from the horizontal.

When the head was moved up from the horizontal, PP decreased, as did CVR. In 25-30% of the tests, a stable blood flow was maintained. In 25-30% of the tests, an increased cerebral blood flow was recorded. In about 40% of the tests, CBF decreased, especially when PP was less than 60-50 mmHg. Apparently this is the lower limit for autoregulation in rabbits.

When the head was moved down from the horizontal, PP increased, as did CVR. In 30% of the tests, a stable blood flow was maintained. In 30% of the tests, CBF decreased, providing evidence that the vascular autoregulation reduction resulted in an immoderate increase in CVR. In 40% of the tests, CBF increased. The autoregulation appeared inadequate. Similar results were obtained for 5 cats, although not quite as pronounced, probably because some anesthesia was used. The investigation confirmed the existence of some sort of regulatory response to orthostatic loads. The method of autoregulation appears to be that changes in perfusion pressure induce corresponding cerebral vessel reactions, stabilizing cerebral blood flow.

Key words: Coriolis acceleration, head incline, otolith, semicircular canal, receptor

Lapayev and colleagues (1979) studied the production of motion sickness from Coriolis accelerations. Prior research has shown that motion sickness development during the effects of Coriolis accelerations depends on the intensity of horizontal rotation. These researchers consequently centered their experiment on the effect varying velocity of head inclines had on the development of motion sickness during acceleration. Volunteers were rotated at 180°/sec while the head was tilted in the frontal plane at a 30° angle to each side. The time for moving the head from one side to the other was 1, 2, 4, or 8 sec. Subjects reported decreasing tolerance to the test with increasing time up to 4 sec. It was also determined that the type of symptoms experienced were not the same: with rapid rocking of the head, the symptoms developed gradually and were not initially unpleasant (overall warmth, perspiration, and in some cases nausea); slow rocking produced unpleasant motion sickness symptoms quickly (headache, dull pain, chills, cold sweat, and overwhelming nausea).

The scientists pointed out that unequivalent shifts occur in the vestibular receptors in opposite directions. A constant component from this is accumulated for deviation of the vestibular receptors in relation to the position of rest. They hypothesized the less pronounced symptoms were governed by smaller differential deviations in the receptors; slower rocking of the head resulted in increased differential deviation of the receptors. This very low frequency of oscillation would also cause a greater delay in the processing of sensory information from different receptors; i.e., an apparent increase in conflict of information would be received from otoliths and semicircular canals, resulting in motion sickness.

Coriolis accelerations in particular have complex effects on both otoliths and semicircular canals. The cupulo-endolymphatic system has more significant damping properties than otolithic receptors; therefore, an increase in the lag of reaction of the semicircular canals would occur at lower frequencies of oscillating head movements.

Key words: *vestibular system, labyrinthectomy, visual apparatus, guinea pig*

Gorgiladze (1979) studied the role of the visual apparatus in compensation of vestibular dysfunction. Mechanical destruction of a labyrinth through the middle ear of adult guinea pigs was performed. The experiment involved 5 groups, 4 with destroyed labyrinths: group 1 was the control; group 2 was subjected to 2- to 3-min stays in darkness at different times following labyrinthectomy; group 3 had both eyelids tightly sutured 1 to 2 days before labyrinthectomy; group 4 had enucleation of both eyeballs 15 days before labyrinthectomy; and group 5 had eyes removed on the 15th day after labyrinth destruction. Nystagmus was measured by an electro-oculographic method and the animals were photographed. Blinding the animals delayed compensation greatly, but placing the animals in the dark or stitching the eyelids produced a shorter, less severe effect. These data indicated that delay of vestibular compensation in blinded animals is due not so much to the absence of visual information as to the result of prolapse of the constant automatic activity of the retina. However, the participation of the tonic activity of the retina in vestibular compensation was found to be of limited duration.

Pharmacology

Key words: *hypodynamia, neurotropic agents, toxicity, stress, mice*

Kirichek (1979) experimentally tested the effect of hypodynamia on drug sensitivity to assess the physiological role of fear and stress. Using 2,600 mice, reduced motor activity was produced with cages that restricted movement. At the end of 24 hrs, which is when the mouse stress reaction reaches its maximum expression, the following substances were administered: sodium oxibutyrates, barbamy, amizyl, reserpine, morphine, analgine, ethymizol, strychnine, eleutherococcus, ephedrine, or melipramine. Pharmacological activity was assessed visually or determined instrumentally, and toxicity was judged by animal death. It was determined that hypodynamia did not cause change in the mode of action of the neurotropic agents, although the degree of pharmacological activity was altered. There was also no substantial change in toxicity of the drugs to the hypodynamic mice: only the LD₅₀ of ephedrine went down. Risk levels were determined to be identical to controls. However, mouse "resistance" to the substances under study was more labile when hypodynamic. Therefore, short-term hypodynamia has no effect on the type of action exerted by the tested compounds. An increase in the activity of all but barbamy and ethymizol and an increase in the range of pharmacological effects were noted, but no changes in toxicity were discerned.

Plant Research

Key words: *tissue culture, physiology, virus, metabolism*

A recent publication addressed the topic of plant tissue culture methods and their uses in plant physiology and biochemistry (Kalinin et al., 1980). The technical aspects of culture conditions are listed, as are the possible uses, metabolism, and effects of extreme condition on the cells and tissues of various plant organs. The use of plant tissue cultures to study viruses, mycoplasmas, nematodes, etc. are also discussed.

Toxicology

Key words: *hyperbaric conditions, submarines, inert gases, respiratory systems*

Volume 39 of *Problems of Space Biology* (Kurenkov et al., 1980) deals with the physiological effect of hyperbaric environments, which is a main concern of submarine biology and medicine. Particular attention is paid to questions of saturation and desaturation of body tissues with inert gases when the atmospheric pressure and composition change, as well as respiratory function in a high-density environment, toxic effects of high oxygen pressures, effect of inert gases on the nervous system under hyperbaric conditions, and heat exchange in man under water at high pressures. Results are presented from experiments using human and animal subjects.

Key words: *radiation, adaptation, social structure, ecology*

General Ecological Physiology and Physiology of Adaptation (Slonim, 1979) is a book containing data on research in these fields. Special attention is given to the genetic effects of natural environmental factors on the organism, such as radiation, magnetic fields, air, temperature, barometric pressure, and pollutants. Individual physiological adaptation to an environment is reviewed in detail, as is the effect of society and social structures on organisms.

Key words: *hypoventilation, nitrogen, hypercapnia, reserve time*

Katkov and Kovalenko (1981) conducted hypoventilation studies with pure nitrogen to determine the feasibility of prolonging "reserve time" (time of useful consciousness) by diminishing oxygen loss in case of accidental decompression aboard a spaceship. Twenty-two male volunteers, 28 to 42 yrs old, were studied. Analysis of the results showed that free breathing of pure nitrogen increased the reserve time to 55 to 70 sec over the reported values of 10 to 15 sec; slow breathing or hypoventilation of pure nitrogen increased this value to 85 to 250 sec. The basic mechanism consisted of an increased sensitivity threshold of the respiratory center to hypoxic and hypercapnic stimulation which decreased the rate of deoxygenation in combination with hypoventilation. Partial oxygen pressure of the skin capillaries decreased to 48% of normal values in free breathing, and to 32% during hypoventilation. These observations were ascribed to a more pronounced peripheral vasospasm during hypoventilation since oxygen loss was approximately equal under the two conditions.

Closed Life Support

Key words: *prokaryotes, algae, Chlorella, ecosystems, book*

Role of Lower Organisms in Recycling of Substances in Closed Ecological Systems, edited by V.A. Kordyum (1979), is a book centered on the creation of life support systems. Directed toward

space biologists and ecologists, the emphasis is on lower plant forms; a large number of articles report studies with the unicellular green alga *Chlorella*. The range of organisms is from bacteria and blue-green algae through eukaryotic algae (fresh-water and marine), with a few reports concerning fungi and higher plants. Topics include not only optimal culture conditions in closed life support systems, but also radiation effects, biochemical consideration of proteins (e.g., RuDP-carboxylase), mathematical modeling of growth, and proposed biotechnical facilities and their components. Observations are presented on organisms following spaceflight on various artificial satellites; also described is an account of a 4-mo experiment with a closed man-higher plants-lower plants ecosystem.

Exobiology

Key words: lunar soil, silicosis, rat

Kustov et al. (1980) studied the biological effects of lunar soil administered intratracheally. Thirty Wistar rats were divided into 3 groups. The first group received a suspension of lunar soils in starch solution; the second was given silicon dioxide in starch solution; and the control group received intratracheal injections of the starch solution only. While the second group developed experimental silicosis, the lunar soil administration, similar to inspiration of dust from the moon's surface, produced less marked changes. These alterations consisted of growth lags and increases in respiration rate. No other biological effects were observed, although histological examinations were not performed.

SPACEFLIGHT RESULTS

Space Medicine and Physiology

Mission Reviews

Key words: Soyuz 26, Soyuz 29, Salyut 6, cardiovascular system, exercise, nutrition, readaptation

Vorob'ev et al. (1981) reported the preliminary results of medical tests on Salyut 6 cosmonauts. During and after the 96- and 140-day flights (Soyuz 26 and 29, 1978), the four men were monitored by rheography, EKGs, use of a massmeter, phlebography, and other techniques. The physiological changes observed during spaceflight corresponded, overall, to preflight estimations and reflected the processes of adaptation to weightlessness. Displacements of the circulatory patterns were seen (e.g., increased blood flow to head, decreased flow to tibia), as well as variations in basic hemodynamic indices. After flight, readaptation consisted of reactions of a functional nature, i.e., circulatory shifts back to preflight conditions under the influence of gravity. The cosmonauts returning from the 140-day flight manifested less marked reactions to gravity than the preceding crew.

Metabolism

Key words: visual acuity, Soyuz 18, Soyuz 32, Soyuz 35, weightlessness, color perception

Rodikov (1981) commented on unusual psychophysiological features of visual perception during spaceflight. Many cosmonauts have reported a slight loss of visual acuity during the initial phases of flights, which was attributed to adaptation to weightlessness. After the second week, super-acute vision was experienced by some while observing Earth. Sevast'yanov (Soyuz 18) could distinguish islands, seas, and mountain ranges on Earth over which the Salyut 4 station was passing. Other cosmonauts, including Valeriy Ryumin (Soyuz 32, Soyuz 35) described perceptual changes of colors: vegetation appeared dark brown rather than green when viewed from space, possibly from filtration of short-wave light by the atmosphere. The author proposed that chemical substances might be developing in weightlessness that result in visual intensification, and urged further research.

Neurophysiology

Key words: otolith reflex, statokinesis

Kornilova and associates (1979) analyzed otolith function in cosmonauts returning from spaceflights of varying duration. Repression of the otolith reflex during the initial period of weightlessness is well documented. To clarify postflight response, examination of members of two flight crews returning from long-term flights (30 and 96 days) were conducted on the 2nd, 4th-5th,

8th, 12th-14th, and 32nd days. For two crews of short-term flights (7 days), the examinations were on the 1st, 3rd-4th, and 12th days.

In the first days following long-term flights, a sharp degree of otolith stimulation was observed in the cosmonauts, indicating bilateral hyperreflexia. This was more pronounced in the crew that was in space for 30 days than the other crew. In addition, these 4 cosmonauts showed a symmetry from hyperreflexia when placed on their right side. Throughout this period, the cosmonauts were experiencing statokinetic disruptions in the form of instability in Romberg's station and swaying to the right when walking. The asymmetry was still present on the 4th-5th days; by the 12th-14th day postflight, the 30-day flight crew showed almost background otolith reflex values, while those who were in flight for 96 days still showed asymmetry on the 32nd day after return. The latter crew also continued to exhibit disrupted statokinetics.

Otolith functions of cosmonauts after short-term flight were either normal or only slightly changed. Statokinetic disruption experienced by two of the men had disappeared within the first week.

Kornilova et al. postulated a possible interdependence between statokinetic disorders with asymmetry of the otolith function and increased reflex, since the one was always seen in the presence of the others.

Space Biology

Metabolism

Key words: neurosecretion, posterior neurohypophysis, Cosmos 936, stress, rat

Savina and Alekseyev (1980) performed a comparative evaluation of some morphological indices of functional state of the posterior neurohypophysis in rats subjected to weightlessness or artificial gravity onboard the biosatellite Cosmos 936. The data obtained after the 18.5-day flight were compared with those from synchronous, ground-based test animals who experienced all factors of spaceflight except weightlessness. The analyses demonstrated that rats exposed to weightlessness have a considerable decrease in the number of neurosecretory cumulative corpuscles (Herring bodies), decreased nuclear volume, decreased pituicyte size, but increased content of neurosecretion in the neurosecretory fibers. Animals subjected to artificial gravity showed less pronounced changes and exhibited a higher level of neurosecretory function. Savina and Alekseyev believe the altered morphology in flight animals was the result of stress experienced during descent from orbit and landing, as well as readaptation to Earth's gravity.

Plant Research

Key words: tomato, Cosmos 1129, geotropism, morphology, spatial orientation

Platonova and coworkers (1980) reported the results of experimental tomato growth in the dark onboard the biosatellite Cosmos 1129. It was found that the spatial orientation the plants assumed in weightlessness depended upon the position of the seed with reference to the agar substrate. When the horseshoe-shaped embryo was oriented up or sideways, the root grew down and the shoot grew

into the atmosphere, although curved toward the growth medium (see diagram). Rotation on a horizontal clinostat produced plants with spatial orientations similar to those subjected to 0 G, except for a slight incline toward the rotational axis. The authors concluded that the geotropic reaction of tomato plants is indeed absent in weightless environments and that the orientation of plant organs is determined in the first stage of development by the germplasm morphology.

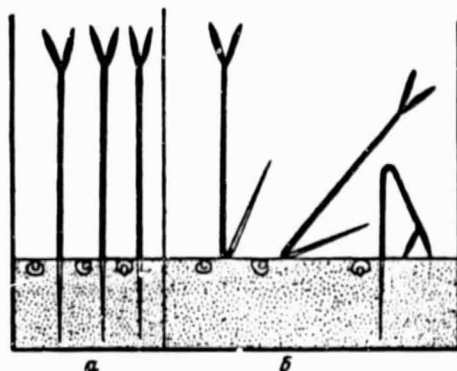


Diagram of orientation of overground and underground organs of tomatoes grown: (a) on Earth, (b) in weightlessness.

Key words: ion exchange, synthetic soil, Salyut, Oasis

An article by Chuba (1981) described the development, characteristics, and uses of a synthetic "ionite" soil. Initially manufactured as a granulated substance, it is reported to be similar to an ion exchange resin, discharging and absorbing mineral salts. As such, it is an adequate plant substrate on Earth. It has since been produced in the form of a synthetic fabric, upon which seeds can be sown during its manufacture and then stored. The article reports it was used in the Oasis space greenhouse in the Salyut orbital station where green plants were successfully grown.

Key words: plant development, embryogenesis, Arabidopsis, Cosmos 1129 biosatellite, weightlessness

Parfenov and Abramova (1981) described a plant of *Arabidopsis thaliana* which was flown on the Cosmos 1129 biosatellite. Prior to the 18-day flight, two buds had unfolded; at the end of the flight, 6 mature pods had formed. It was assumed that the first two pods were from the flowers that had bloomed before flight and the next two pods were from flowers that blossomed after placement aboard but before launching of the craft. The darkness the plant was subjected to before flight was believed responsible for the 3rd and 4th pods' possession of many sterile ovules and embryonal lethals. The last two buds opened in flight and fertilization, embryogenesis, and seed maturation also occurred in 0 G. The plant accumulated an increase in abortive generative formations in flight; there was a high variability of fertility indices in the pods. However, development from meiosis to seed maturation seemed to occur normally in weightless conditions.

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