NASA SP-7011(305)

AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 305)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in December 1987 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

NASA Scientific and Technical Information Division 1988
National Aeronautics and Space Administration
Washington, DC

INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 230 reports, articles and other documents announced during December 1987 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).* The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects of biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR,* including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

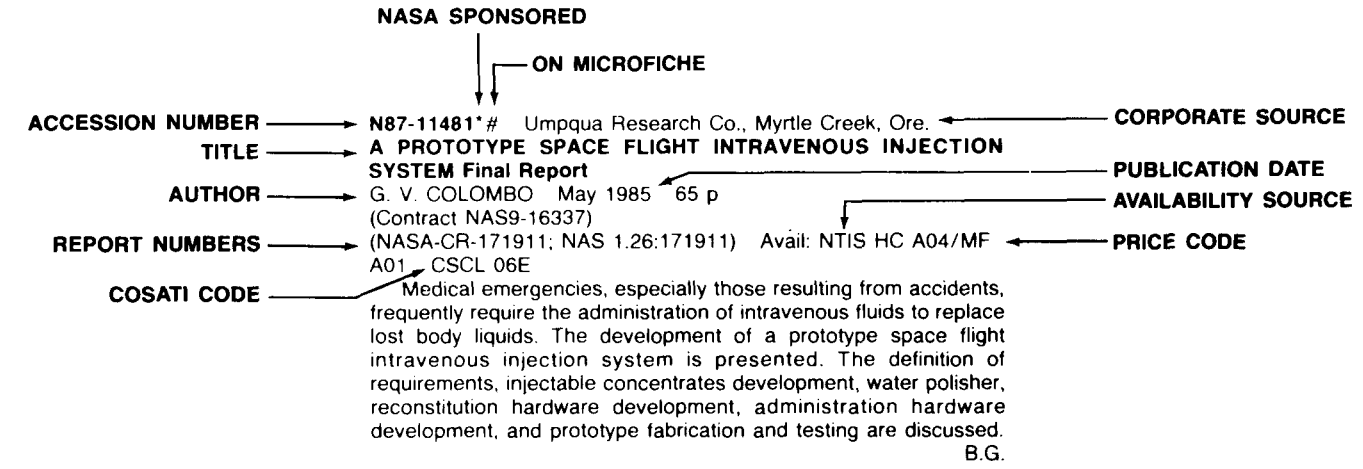
Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

An annual index will be prepared at the end of the calendar year covering all documents listed in the 1987 Supplements.

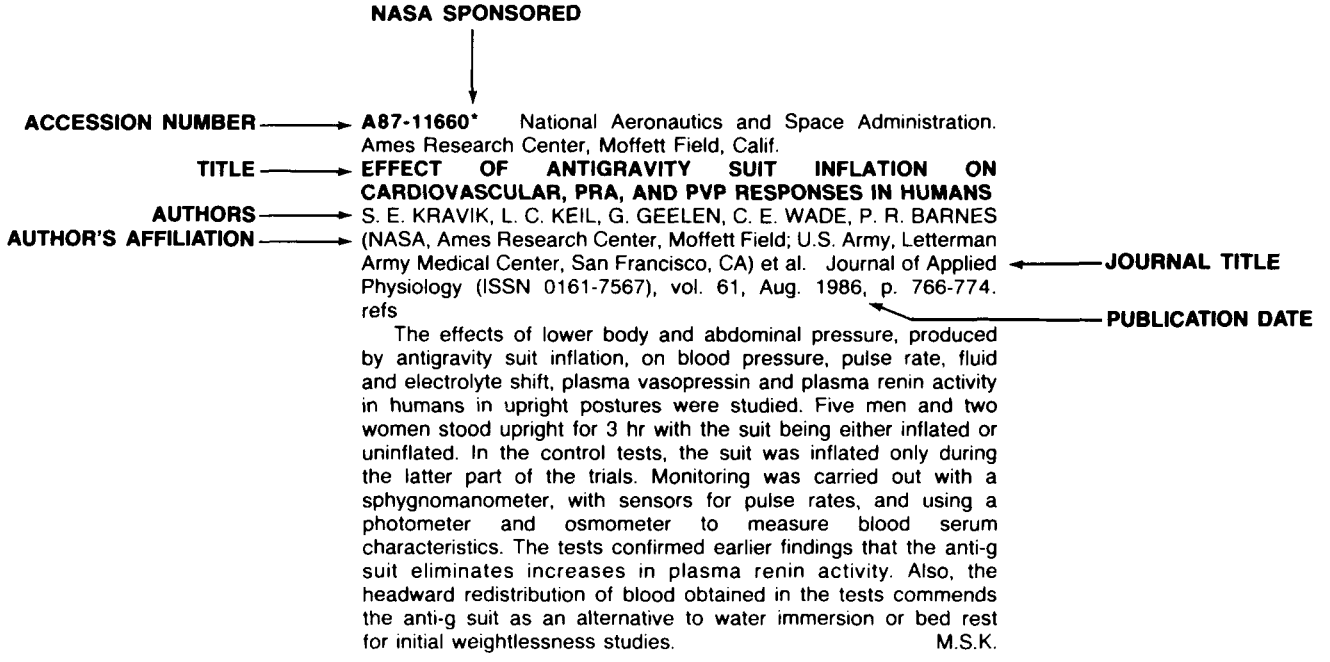
Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

TABLE OF CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 305)

JANUARY 1988

51

LIFE SCIENCES (GENERAL)

Includes genetics.

A87-51106
CHANGES IN BINDING BY THE CORTICOSTERONE RECEPTORS IN DIFFERENT BRAIN STRUCTURES OF RATS UNDER IMMOBILIZATION STRESS [IZMENENIIA SVIAZYVANIIA KORTIKOSTERONA RETSEPTORAMI V RAZLICHNYKH-STRUKTURAKH MOZGA KRYS PRI IMMOBILIZATSIONNOM-STRESSE]
D. A. ZHUKOV (AN SSSR, Institut Fiziologii, Leningrad, USSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 73, April 1987, p. 465-468. In Russian. refs

A87-51107
THE HORMONAL FUNCTION OF THE INSULIN APPARATUS AND THE INSULIN-BINDING CAPACITY OF ERYTHROCYTES IN ADAPTATION OF RATS TO HIGH ALTITUDE [GORMONAL'NAIA FUNKTSIIA INSULIARNOGO APPARATA I INSULINSVIAZUIUSHCHAIA SPOSOBNOST' ERITROTSITOV PRI ADAPTATSII KRYS K VYSOKOGOR'IU]
N. E. TIKHONOVA, E. M. KUCHUK, and V. G. SHALIAPINA (AN SSSR, Institut Fiziologii, Leningrad, USSR; Kirgizskii Gosudarstvennyi Meditsinkii Institut, Fru Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 73, April 1987, p. 469-474. In Russian. refs

Changes in the blood concentrations of glucose, glucagon, and insulin and in the binding capacity of insulin receptors on erythrocytes were monitored in rats during their adaptation to an altitude of 3200 m. During the first 14 days, the levels of insulin and glucagon decreased steadily, while the levels of glucose remained close to control (after a short-term decrease observed on the day 3). In the same period, the insulin-binding capacity of erythrocytes increased, with particularly sharp rises observed on days 3 and 14. These reactions are considered to be compensatory, effecting the maintenance of the glycolysis level in erythrocytes and thus the correction of tissue hypoxia. I.S.

A87-51108
THE EFFECT OF ADAPTATION TO COLD AND OF SHORT-TERM EXPOSURE TO COLD ON THE RESISTANCE OF ANIMALS TO HYPOXIC HYPOXIA [VLIIANIE KHOLODOVOI ADAPTATSII I KRATKOVREMENNOGO DEISTVIIA KHOLODA NA USTOICHIVOST' ZHIVOTNYKH K GIPOKSICHESKOI GIPOKSII]
I. A. GOROSHINSKAIA and G. M. RUDIK (Rostovskii Gosudarstvennyi Universitet, Rostov-on-Don, USSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 73, April 1987, p. 532-536. In Russian. refs

The effect of high-altitude (9000 and 12,000 m) hypoxia on rats adapted to cold (45 days at 2 C) and on unadapted rats subjected to cold-related stress (3 days at 2 C) was studied using the life duration, the frequency of seizures, and the activity and substrate specificity of brain mitochondrial monoamine oxidase to monitor the sensitivity to hypoxia. The animals adapted to cold were more resistant to hypoxia than controls; they exhibited an increase of life duration at 12,000 m, a decrease in seizure frequency, and showed no changes, typical for hypoxia, in the catalytic properties of brain mitochondrial monoamine oxidase. On the other hand, nonadapted cold-stressed rats exhibited reduced resistance to hypoxia, relative to controls. I.S.

A87-51109
THE DEPENDENCE OF THE VESTIBULAR REACTIONS OF CAT CORTICAL NEURONS ON THE DURATION AND DIRECTION OF SINUSOIDAL ROTATION [ZAVISIMOST' VESTIBULIARNYKH REAKTSII NEIRONOV KORY KOSHKI OT DLITEL'NOSTI I NAPRAVLENIIA SINUSOIDAL'NOGO VRASHCHENIIA]
V. S. DEM'IANENKO (AN SSSR, Institut Fiziologii, Leningrad, USSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 73, April 1987, p. 541-544. In Russian. refs

The effects of reversible and unidirectional sinusoidal rotations (2 h at 0.1-0.2 Hz) with continuously changing angular speed on the impulse activity of vestibular neurons were studied in cats fitted with electrodes that were implanted in the area of the suprasylvian sulcus. To determine the possibility of adaptation, the effect of prolonged rotations was also investigated. The poststimulus histograms revealed the presence of the directional dependence of vestibular neuronal reactions caused by angular acceleration. I.S.

A87-51110
REACTION OF THERMOREGULATORY NEURONS TO DIFFERENT TYPES OF SENSORY STIMULATION [REAKTSIIA NEIRONOV TSENTRA TERMOREGULIATSII NA VOZDEISTVIIA RAZLICHNOI SENSORNOI MODAL'NOSTI]
L. P. DYMNIKOVA (AN SSR, Institut Fiziologii, Leningrad, USSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 73, April 1987, p. 547-549. In Russian. refs

The responses of hypothalamic neurons to thermal, mechanical, acoustical, and light stimuli were studied in anesthetized rabbits fitted with electrodes in the medial preoptic region and the ventromedial and dorsomedial nuclei of the hypothalamus. The neuronal impulse activity was registered continually; an increase in the impulse frequency of a given neuron signified a reaction. It was found that, among hypothalamic neurons reacting to thermal stimuli, some were also responsive to nonspecific stimuli, such as a mechanical irritation of skin, light flashes, and sound signals. These polysensory neurons are believed to play a part in the behavioral reactions of an animal to cold. I.S.

A87-51125
FORMATION OF SINGLE-STRAND BREAKS IN DNA UNDER THE EFFECT OF HIGH-INTENSITY UV RADIATION [OBRAZOVANIE ODNONITEVYKH RAZRYVOV V DNK PRI DEISTVII UF IZLUCHENIIA VYSOKOI INTENSIVNOSTI]
T. G. BURCHULADZE (Tbilisskii Gosudarstvennyi Universitet, Tbilisi, Georgian SSR) Akademiia Nauk Gruzinskoi SSR, Soobshcheniia (ISSN 0132-1447), vol. 126, May 1987, p. 393-396. In Russian. refs

High-intensity UV-laser radiation at 266 nm was found to produce single-strand breaks in DNA due to two-photon photochemical reactions. It is noted that radiation-induced damage of this type makes an important contribution to the laser-induced inactivation of cells and provides for an increase in their sensitivity

as compared with the effect of low-intensity UV radiation from ordinary sources. B.J.

A87-51151* Maryland Univ., Baltimore.
A POSSIBLE ROLE FOR ENDOGENOUS GLUCOCORTICOIDS IN ORCHIECTOMY-INDUCED ATROPHY OF THE RAT LEVATOR ANI MUSCLE - STUDIES WITH RU 38486, A POTENT AND SELECTIVE ANTIGLUCOCORTICOID
MASAAKI KONAGAYA and STEPHEN R. MAX (Maryland, University, Baltimore) Journal of Steroid Biochemistry (ISSN 0022-4731), vol. 25, no. 3, 1986, p. 305-308. Previously announced in STAR as N86-30343. refs
(Contract NAG2-100)

RU38486, a potent and selective antiglucocorticoid, was employed to study a possible role for endogenous glucocorticoids in atrophy of the levator ani muscle secondary to castration of male rats. RU38486 was shown to block (3H) triamcinolone acetonide binding to cytosol from levator ani muscle. Daily oral administration of RU38486 to castrated rats partially prevented atrophy of the levator ani muscle, as well as a decrease in RNA concentration. In a control group receiving RU38486 alone, the levator ani underwent significant 20 percent hypertrophy. Administration of exogenous dexamethasone also caused pronounced atrophy of the levator ani muscle. This atrophy was prevented, to a significant degree, by simultaneous oral administration of Ru38486. It is concluded that endogenous glucocorticoids, the actions of which are blocked by RU38486, may be involved in regulation of the mass of the levator ani muscle in intact rats. Author

A87-51251
BACTERIAL ACTIVITY IN THE WARMER, SULPHATE-BEARING, ARCHAEAN OCEANS
HIROSHI OHMOTO and ROBERT P. FELDER (Pennsylvania State University, University Park) Nature (ISSN 0028-0836), vol. 328, July 16, 1987, p. 244-246. NSF-supported research. refs

In recent marine sediments, bacterial reduction of seawater sulfate is responsible for the formation of diagenetic sulfides, which are typically strongly depleted in S-34 relative to source sulfate and highly variable in delta S-34 values. In contrast, the delta S-34 values of Archaean sedimentary sulfides are generally less variable and nearly identical to those of sulfates in the same sedimentary units. Previous investigators have suggested that either sulfate-reducing bacteria had yet to develop in Archaean time and/or Archaean oceans contained much less sulfate and hence much less free oxygen than the present atmosphere. It is argued here that the sulfur isotope data on Archaean sediments from 2600 to 3500 Myr old can be better explained if sulfate-reducing bacteria were already active in oceans with temperatures of 30-50 C and containing appreciable amounts of sulfate, with delta S-34 values of about +3 per mil. C.D.

A87-51465
KINETICS OF THE O-PHOTOINTERMEDIATE OF BACTERIORHODOPSIN PHOTOCYCLE IN NATIVE AND ENZYME TREATED PURPLE MEMBRANE FRAGMENTS AS A FUNCTION OF PH
L. KESZTHELYI (Magyar Tudomanyos Akademiia, Biofizikai Intezet, Szeged, Hungary) and S. G. TANEVA (B'lgarska Akademiia na Naukite, Tsentralna Laboratoriia po Biofizika, Sofia, Bulgaria) Bolgarskaia Akademiia Nauk, Doklady (ISSN 0366-8681), vol. 40, no. 5, 1987, p. 127-130. refs

A87-51673
COMPARATIVE CHARACTERIZATION OF THE SLEEP-WAKEFULNESS CYCLE IN HIBERNATING AND NONHIBERNATING MAMMALS [SRAVNITEL'NAIA KHARAKTERISTIKA TSIKLA BODRSTVOVANIE-SON U ZIMOSPIASHCHIKH I NEZIMOSPIASHCHIKH MLEKOPITAIUSHCHIKH]
I. G. KARMANOVA, M. M. BOGOSLOVSKII, and L. V. ANDREEVA (AN SSSR, Institut Evoliutsionnoi Fiziologii i Biokhimii, Leningrad, USSR) Fiziologicheskii Zhurnal SSSR, (ISSN 0015-329X), vol. 73, May 1987, p. 595-601. In Russian. refs

A87-52215
HEAD-DOWN TILT AND RESTRAINT ON RENAL FUNCTION AND GLOMERULAR DYNAMICS IN THE RAT
B. J. TUCKER, C. A. MUNDY, M. G. ZIEGLER, C. BAYLIS, and R. C. BLANTZ (California, University, La Jolla; USVA, Medical Center, San Diego, CA) Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 505-513. USVA-supported research. refs
(Contract NIH-AM-28602; NIH-HL-31933)

The effect of 25-deg head-down tilt (HDT) on the extracellular fluid volume and the renal function of rat were studied using rats fitted with chronically indwelling cannulas in the femoral vein and artery and in the bladder. After 24 h of HDT, increases were observed in the values of the glomerular filtration rate (GFR), renal plasma flow (RPF), urine flow rate, and Na(+) and K(+) excretions, as well as in extracellular volume (whereas the nontilted suspended controls exhibited a decrease in extracellular volume). After 7 days of HDT, the GFR decreased (by 7 percent), while the RPF and the extracellular volume returned to the levels at day zero. By this time, the control rats exhibited increased levels of GFR and RPF. I.S.

A87-52216
STRUCTURAL AND FUNCTIONAL RESPONSES TO PROLONGED HINDLIMB SUSPENSION IN RAT MUSCLE
D. DESPLANCHES, M. H. MAYET, B. SEMPORE, and R. FLANDROIS (Lyon I, Universite, France) Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 558-563. refs

Changes effected in oxygen uptake, muscle capillarization, oxidative enzyme activities, and resting-muscle energy charge in the soleus (SOL) and extensor digitorum longus (EDL) muscles of rats after prolonged tail suspension were investigated. Tail suspension for 5 wks resulted in significant decreases in O2 uptake (19 percent) and muscle mass (63 in the SOl and 23 percent in EDL). No changes in fiber area, capillarization, and enzymatic activities occurred in EDL; in SOL, a decrease in the number of capillaries per fiber and in the activities of citrate synthase and 3-hydroxyacyl-CoA dehydrogenase were recorded. Tail suspension for 5 wks also caused transitions within the five histochemically identifiable muscle fiber types (I, IIa, and IIb and intermediate fiber types int I and int II): a reduction of type I distribution was accompanied by an increase of int I in SOL and int II in EDL. I.S.

A87-52217
SPECIES VARIATION IN LUNG ANTIOXIDANT ENZYME ACTIVITIES
CHARLES L. BRYAN and STEPHEN G. JENKINSON (Texas, University; USAF, Medical Center; Southwest Foundation for Biomedical Research; Audie Murphy Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 597-602. USVA-supported research. refs
(Contract NIH-HL-30556)

Lung antioxidant enzyme systems of rats, hamsters, baboons, and humans were compared by measuring the activities of glutathione peroxidase (GSH-Px), superoxide dismutase (SOD), catalase (CAT), and glutathione S-transferase (GSH S-trans) in the homogenates and/or extracts of the lung tissue of these animal groups. The results indicate that, among the animals studied, hamster is the best model for mimicking human lung with respect

to the antioxidant enzyme activities. On the other hand, rat lung antioxidant enxyme activities were markedly different from any of the other species examined. I.S.

A87-52220
TIME-DEPENDENT EFFECT OF HYPOXIA ON CAROTID BODY CHEMOSENSORY FUNCTION
P. BARNARD, S. ANDRONIKOU, M. POKORSKI, N. SMATRESK, A. MOKASHI (Pennsylvania, University, Philadelphia) et al. Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 685-691. refs
(Contract NIH-HL-19737-10; NIH-HL-07027)

The time-dependent effects of acute and chronic hypoxia on the function of the carotid chemoreceptors were investigated in cats after short (2-3 h) or prolonged (28 days) exposures to hypoxia. The chemoreceptor activity was measured as described by Lahiri et al. (1983). It was found that the response of the carotid chemoreceptor afferents to a given level of acute hypoxia (PaO2 = 30-40 Torr) did not significantly change within 2-3 h. In contrast, chronic hypoxia significantly increased the hypoxic responsiveness. It is suggested that this enhanced chemoreceptor activity may contribute to the ventilatory acclimatization in chronic hypoxia. I.S.

A87-52222
O2 DELIVERY TO CONTRACTING MUSCLE DURING HYPOXIC OR CO HYPOXIA
C. E. KING, S. L. DODD, and S. M. CAIN (Alabama, University, Birmingham) Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 726-732. Research supported by the Canadian Heart Foundation. refs
(Contract NIH-HL-14693; NIH-HL-26927)

The effects of hypoxic hypoxia (HH) or CO hypoxia (COH) on a contracting muscle were compared using canine gastrocnemius-plantaris preparations in which muscle O2 uptake, blood flow, oxygen extraction, and tension were measured at rest and at 1 twitch/s isometric contractions in normoxia and in HH and COH hypoxias (9 percent O2 in N2 or 1.0 percent CO in air, respectively). At rest, no difference was observed between HH and COH. During contractions during COH, the O2 uptake decreased from the normoxic level; the O2 uptake did not change in the HH group. Blood flow increased in both groups during hypoxia, but more so in the COH group. O2 extraction by the muscle increased with hypoxia in the HH group, but actually fell in the COH group. Thus, the O2 uptake limitation during COH contractions is associated with a lesser O2 extraction, suggesting that the leftward shift in the oxyhemoglobin dissociation curve during COH may have impeded tissue O2 extraction. I.S.

A87-52253* Bionetics Corp., Cocoa Beach, Fla.
POROUS MEMBRANE UTILIZATION IN PLANT NUTRIENT DELIVERY
T. W. DRESCHEL, C. R. HINKLE (Bionetics Corp., Cocoa Beach, FL), R. P. PRINCE, and W. M. KNOTT, III (NASA, Kennedy Space Center, Cocoa Beach, FL) American Society of Agricultural Engineers, Summer Meeting, Baltimore, MD, June 28-July 1, 1987. 9 p. refs
(ASAE PAPER 87-0425)

A spacecraft hydroponic plant growth unit of tubular configuration, employing a microporous membrane as a capilary interface between plant roots and a nutrient solution, is presented. All three of the experimental trials undertaken successfully grew wheat from seed to harvest. Attention is given to the mass/seed, number of seeds/head, ratio of seed dry mass to total plant dry mass, production of tillers, and mass of seed/plant. Dry matter production is found to be reduced with increasing suction pressure; this is true for both average seed and average total dry matter/plant. This may be due to a reduction in water and nutrient availability through the microporous membrane. O.C.

A87-52976
LIFE SCIENCES AND SPACE RESEARCH XXII(2); PROCEEDINGS OF THE TOPICAL MEETING AND WORKSHOP 4 OF THE 26TH COSPAR PLENARY MEETING, TOULOUSE, FRANCE, JUNE 30-JULY 11, 1986
G. M. MALACINSKI, ED. (Indiana University, Bloomington), H. OSER, ED. (ESA, Paris, France), G. HORNECK, ED. (DFVLR, Cologne, West Germany), K. DOSE, ED. (Mainz, Universitaet, West Germany), and H. HINGHOFER-SZALKAY, ED. (Graz, Universitaet, Austria) Meetings and Workshop sponsored by COSPAR. Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, 339 p. For individual items see A87-52977 to A87-53016.

The conference presents papers on gravitational biology, the results of space flight experiments, exobiology experiments in earth orbit, the limits of life, and the gravity response in man. Topics include the classification of gravity effects on 'free' cells, the effects of gravity perturbation on developing animal systems, the possible effects of organelle charge and density on cell metabolism, and investigations onboard the biosatellite Cosmos-1667. Consideration is also given to the application of the Space Station gas-grain simulation facility to exobiology, observational astrochemistry, molecular aspects of adaptation to extreme cold environments, the Antarctic cold desert and the search for traces of life on Mars, and system interrelations of gravity responses in the human organism and the use of modeling. K.K.

A87-52977
PHYSICAL PARAMETERS AFFECTING LIVING CELLS IN SPACE
DIETER LANGBEIN (Battelle-Institut, Frankfurt am Main, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 5-14. refs

Issues associated with biology in space are addressed and it is noted that the absence of gravity means constancy of the hydrostatic pressure and tbe absence of free convection and sedimentation. Examples are given which illustrate how significantly pressure and convection affect species arrangement, species transport, electric fields, and currents. The paper presents an order of magnitude analysis of the residual accelerations tolerable during materials sciences. K.K.

A87-52978
CLASSIFICATION OF GRAVITY EFFECTS ON 'FREE' CELLS
W. BRIEGLEB and I. BLOCK (DFVLR, Institut fuer Flugmedizin, Cologne, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 15-19. refs

A scheme is presented of the smallest functional units of organisms and their interaction with gravity. It is noted that a special approach is needed when free living cells with densities higher than that of the liquid medium, or even cells living on a free surface, are observed. In these two cases, allowance must be made for indirect effects as well; this is demonstrated using the slime mold Physarum polycephalum. K.K.

A87-52979* Indiana Univ., Bloomington.
AMPHIBIAN EGG CYTOPLASM RESPONSE TO ALTERED G-FORCES AND GRAVITY ORIENTATION
A. W. NEFF, R. C. SMITH, and G. M. MALACINSKI (Indiana University, Bloomington) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 21-28. refs
(Contract NAG2-323)

Elucidation of dorsal/ventral polarity and primary embryonic axis development in amphibian embryos requires an understanding of cytoplasmic rearrangements in fertile eggs at the biophysical, physiological, and biochemical levels. Evidence is presented that

amphibian egg cytoplasmic components are compartmentalized. The effects of altered orientation to the gravitational vector (i.e., egg inversion) and alterations in gravity force ranging from hypergravity (centrifugation) to simulated microgravity (i.e., horizontal clinostat rotation) on cytoplasmic compartment rearrangements are reviewed. The behavior of yolk compartments as well as a newly defined (with monoclonal antibody) nonyolk cytoplasmic compartment, in inverted eggs and in eggs rotated on horizontal clinostats at their buoyant density, is discussed.
Author

A87-52980* Indiana Univ., Bloomington.
EFFECTS OF GRAVITY PERTURBATION ON DEVELOPING ANIMAL SYSTEMS
G. M. MALACINSKI and A. W. NEFF (Indiana University, Bloomington) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 29-36. refs
(Contract NAG2-323)

The use of developing animal systems to analyze the effects of microgravity on animals is discussed. Some of the key features of developing systems, especially embryos, are reviewed and relevant space data are summarized. Issues to be addressed in the design of future space experiments are discussed. It is noted that an embryo which exhibits ground based gravity effects should be selected for use as a model system and individual variation in gravity response among batches of embryos should be taken into account.
K.K.

A87-52981
GEOTROPIC SENSITIVITY EXHIBITED BY SINGLE HORNETS - THE INFLUENCE OF CASTE, AGE, LIGHT AND TEMPERATURE
JACOB S. ISHAY, EYAL ROSENZWEIG, and IRIT ABIR (Tel Aviv University, Israel) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 37-40. refs

Hornet workers, queens, and males, aged 0-24 hours (i.e. juveniles) and 24 hours and more (i.e. adults) were tested for their responses to changes in the direction of the gravitational force while placed on a flat surface gradually tilted between 0.5 and 180 deg. The tests were run on nonblind and blind hornets, at temperatures ranging between 18 C and 35 C, in daylight as well as in the dark. Up to 18 hours of age, negative phototaxis prevailed among the hornets, which displayed a clear preference for remaining in the dark regardless of the geotropic position. Between 18-24 hours of age, there was gradual appearance of a sensitivity to change in the geotropic position. Above 24 hr of age, the hornets became sensitive to changes in their declinations, with workers becoming sensitive at a 3-5 deg declination, queens at 4-5 deg, and males at a declination of 8-19 deg from the horizontal.
Author

A87-52982
THE ORIGIN AND EVOLUTION AND COMPARATIVE PHYSIOLOGY OF GRAVITY SENSING ORGANS
ALLAN H. BROWN (Pennsylvania, University, Philadelphia) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 41-45. refs

The origin of bioaccelerometers is discussed and the question of whether animals or plants were the first to invent bioaccelerometers is addressed. It is noted that, although the earth's gravity has been essentially constant, the perfection of bioaccelerometers has been driven by evolutionary pressures. The comparative physiology of bioaccelerates is discussed as well as a navigational role for g sensing, biological memory, the reciprocity rule, and the use of variable gravity for producing unique test conditions.
K.K.

A87-52983* Michigan State Univ., East Lansing.
POSSIBLE EFFECTS OF ORGANELLE CHARGE AND DENSITY ON CELL METABOLISM
ROBERT S. BANDURSKI, AGA SCHULZE, and W. DOMAGALSKI (Michigan State University, East Lansing) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 47-54. refs
(Contract NAGW-97; NAG2-362; NSF DMB-85-04231)

A system of perception and transduction involving the gravity-induced asymmetric distribution of a plant growth hormone is studied. A theory is constructed which assumes that the perception of the gravitational stimulus involved a perturbation of the plant's bioelectric field and that the transduction of the stimulus involved voltage-gating of hormone movement from the plant's vascular tissue into the hormone responsive growing tissue. Particular attention is focused on the barriers to indole-3-acetic acid (IAA) transport from the seed to the mesocotyl cortex, the protoinhibition of IAA movement from the endosperm to the shoot, the effects of the gravitational stimulus on the movement of IAA from the kernel to the shoot, electrochemical gating as a target for the gravity stimulus, and the gravity sensing mechanism.
K.K.

A87-52984
POLARITY OF ROOT STATOCYTES - RELEVANCE FOR GRAVIPERCEPTION
W. HENSEL (Bonn, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 55-59. refs

During outgrowth of the radicle of cress (Lepidium sativum L.) the statocytes of the root cap develop a structural polarity with the nucleus at the proximal cell pole and a complex of endoplasmic reticulum (ER) at the distal cell pole. Amyloplasts sediment upon this complex of ER. During all stages of development the cytoskeleton (microtubules, microfilaments) is involved in positioning of the ER. The structural polarity of the statocytes develops independently of gravity, as indicated by corresponding results from fast and slow rotating clinostats and roots grown under microgravity in orbit. Disturbance of the structural polarity is possible by application of drugs, influencing microtubules and microfilaments. If, by rotation of roots on slow rotating clinostats or centrifugation, the structural polarity of the statocytes is changed, the ability of the roots to perceive gravity is affected also.
Author

A87-52985* Ohio State Univ., Columbus.
ROLE OF CALCIUM IN GRAVITY PERCEPTION OF PLANT ROOTS
MICHAEL L. EVANS (Ohio State University, Columbus) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 61-65. refs
(Contract NAGW-297; NSF PCM-83-05775)

Calcium ions may play a key role in linking graviperception by the root cap to the asymmetric growth which occurs in the elongation zone of gravistimulated roots. Application of calcium-chelating agents to the root cap inhibits gravitropic curvature without affecting growth. Asymmetric application of calcium to one side of the root cap induces curvature toward the calcium source, and gravistimulation induces polar movement of applied (Ca-45)(2+) across the root cap toward the lower side. The action of calcium may be linked to auxin movement in roots since: (1) auxin transport inhibitors interfere both with gravitropic curvature and graviinduced polar calcium movement and (2) asymmetric application of calcium enhances auxin movement across the elongation zone of gravistimulated roots. Indirect evidence indicates that the calcium-modulated regulator protein,

calmodulin, may be involved in either the transport or action of calcium in the gravitropic response mechanism of roots. Author

A87-52986* Texas Univ., Austin.
DISTRIBUTION OF CALMODULIN IN CORN SEEDLINGS - IMMUNOCYTOCHEMICAL LOCALIZATION IN COLEOPTILES AND ROOT APICES
M. DAUWALDER and S. J. ROUX (Texas, University, Austin) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 67-70. refs
(Contract NSG-7480)

Immunofluorescence techniques have been used to study the distribution of calmodulin in several tissues in etiolated corn (Zea mays, var. Bear Hybrid) seedlings. Uniform staining was seen in the background cytoplasm of most cell types. Cell walls and vacuoles were not stained. In coleoptile mesophyll cells the nucleoplasm of most nuclei was stained as was the stroma of most amyloplasts. The lumen border of mature tracheary elements in coleoptiles also stained. In the rootcap the most intensely stained regions were the cytoplasms of columella cells and of the outermost cells enmeshed in the layer of secreted slime. Nuclei in the rootcap cells did not stain distinctly, but those in all cell types of the root meristem did. Also in the root meristem, the cytoplasm of metaxylem elements stained brightly. These results are compared and contrasted with previous data on the localization of calmodulin in pea root apices and epicotyls and discussed in relation to current hypotheses on mechanisms of gravitropism. Author

A87-52987
INTERACTION OF GROWTH-DETERMINING SYSTEMS WITH GRAVITY
A. MERKYS, R. LAURINAVICIUS, D. BENDORAITYTE, D. SVEGZDIENE, and O. RUPAINIENE (AN LSSR, Institut Botaniki, Vilnius, Lithuanian SSR) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 71-80. refs

Results of experiments performed with lettuce shoots onboard the Salyut-7 orbital station, the Kosmos-1667 biosatellite, and under terrestrial conditions at 180-deg plant inversion are presented. By means of the centrifuge Biogravistat-1 M, the threshold value of the gravitational sensitivity of the lettuce shoots was determined on Salyut-7 to be equal to 0.0029 g for hypocotyls and 0.00015 g for roots. Kosmos-1667 results revealed that, under microgravity, the proliferation of the meristem cells and the growth of roots did not differ from the control and that the transverse growth of hypocotyls was significantly increased due to the enhancement of cortical parenchyma cell growth. K.K.

A87-52988
BIOSCIENCE EXPERIMENTS IN THE GERMAN SPACELAB MISSION D-1 - INTRODUCTION AND SUMMARY
G. HORNECK (DFVLR, Institut fuer Flugmedizin, Cologne, West Germany), G. GREGER (BMFT, Bonn, West Germany), and P. R. SAHM (Aachen, Rheinisch-Westfaelische Technische Hochschule, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 85-99. refs

Bioscience experiments performed during the German Spacelab mission D-1 (October 30-November 6, 1985) are reviewed. The role of gravity in the vital functions of biological systems was studied with emphasis placed on intra- and intercellular interactions, developmental processes, and regulation and adaptation in highly organized systems (including humans). Moreover, consideration was given to the effect of cosmic radiation. It is noted that The Bioscience Experiment Package and ESA's Vestibular Sled and Biorack were used for these experiments. K.K.

A87-52989
INVESTIGATIONS ONBOARD THE BIOSATELLITE COSMOS-1667
O. G. GAZENKO and E. A. IL'IN (Institut Mediko-Biologicheskikh Problem, USSR) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 101-106.

The program of the 7-day flight of the biosatellite Cosmos-1667 launched in July 1985 included experiments on two rhesus monkeys, ten Wistar SPF rats, ten newts, Drosophila flies, maize seedlings, lettuce sprouts, and unicellular organisms - Tetrahymena. The primate study demonstrated that transition to orbital flight was accompanied by a greater excitability of the vestibular apparatus and an increased linear blood flow velocity in the common carotid artery. The rat studies showed that atrophy of antigravity muscles and osteoporosis of limb bones developed even during short-term exposure to microgravity. The experiments on other living systems revealed no microgravity effects on the cell division rate, proliferative activity of cells of regenerating tissues and organs, energy metabolism of developing insects, structure or chemical composition of higher plant seedlings. Author

A87-52991
EMBRYOGENESIS AND ORGANOGENESIS OF CARAUSIUS MOROSUS UNDER SPACEFLIGHT CONDITIONS
H. BUECKER, R. FACIUS, G. HORNECK, G. REITZ (DFVLR, Institut fuer Flugmedizin, Cologne, West Germany), and E. H. GRAUL (Marburg, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 115-124. BMFT-supported research. refs

ESA's Biorack, flown on the German Spacelab D-1 mission, was used to study the influence of HZE particles of cosmic radiation and/or microgravity on the eggs of the stick insect Carausius morosus. Hatching rates, growth kinetics, and anomaly frequencies were determined. The early developmental stages were highly sensitive to single hits of cosmic ray particles as well as to microgravity. Hits by single HZE particles caused body anomalies and retarded growth after hatching. K.K.

A87-52993
GENETIC AND PHYSIOLOGICAL DAMAGE INDUCED BY COSMIC RADIATION ON DRY PLANT SEEDS DURING SPACE FLIGHT
A. R. KRANZ (Frankfurt, Universitaet, Frankfurt am Main, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 135-138. refs

Biostack experiments were performed to assess the role of cosmic HZE radiation in disturbing plants through their ontogenesis and mutation processes. Dry Arabidopsis seeds flown for 10 days on STS-9 experienced severe radiation damage in space. The lethality of seeds, the number of embryonic lethals, and the rate of form and leaf color mutants was highest for seeds exposed on the pallet inside the module. K.K.

A87-52995
CONFIRMATION OF GRAVISENSITIVITY IN THE SLIME MOLD PHYSARUM POLYCEPHALUM UNDER NEAR WEIGHTLESSNESS
I. BLOCK, W. BRIEGLEB, V. SOBICK (DFVLR, Institut fuer Flugmedizin, Cologne, West Germany), and K. E. WOHLFARTH-BOTTERMANN (Bonn, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 143-150. refs

Physarum polycephalum, a unicellular organism with no special gravity receptors, was studied with emphasis placed on its ability to react to gravity. Ground-based g-simulation experiments on the fast-rotating clinostat were conducted with the plasmodial strands of this slime mold. Among the parameters observed were the periodicity of the contractions and the dilations of the strand's ectoplasm. During 0 g-simulation, these parameters showed significant changes indicating that the slime mold is gravity-sensitive. It is noted that, under real near weightlessness (in the D1-Space Shuttle mission) the slime mold showed a transient frequency increase in its contraction rhythmicity and a steady increase in the streaming velocity of its endoplasm. K.K.

A87-52996
SURVEY OF THE VESTIBULUM, AND BEHAVIOR OF XENOPUS LAEVIS LARVAE DEVELOPED DURING A 7-DAYS SPACE FLIGHT
W. BRIEGLEB, J. NEUBERT, A. SCHATZ, T. KLEIN, and B. KRUSE (DFVLR, Institut fuer Flugmedizin, Cologne, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 151-156. refs

The paper describes the rough morphology of the vestibulum and the behavior of Shuttle-flown Xenopus laevis larvae. Experiments on the fast-running clinostat reveal that otolith formation is fairly autonomous with regard to gravity. It is noted that the loop swimming behavior of the larvae which was observed about 1 hr after the Space Shuttle landed was also observed in the case of larvae developed on the clinostat and fish flown aboard Apollo capsules. K.K.

A87-52997
CELLULAR DIFFERENTIATION AND PROLIFERATION IN CORN ROOTS GROWN IN MICROGAVITY (BIOCOSMOS 1985) [DIFFERENCIATION ET PROLIFERATION CELLULAIRES DANS DES RACINES DE MAIS CULTIVE EN MICROGRAVITE (BIOCOSMOS 1985)]
N. DARBELLEY, D. DRISS-ECOLE, and G. PERBAL (Paris VI, Universite, France) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 157-160. In French. refs

A cytological study of corn roots (Zea mays) grown aboard Biocosmos 1985 was performed to evaluate the effect of microgavity on cellular differentiation and proliferation, based on the criteria of cellular elongation in the cortical zone and mitotic activity of the meristem. A histological examination reveals differences in the functional root zones of corn roots grown in space and controls grown on earth. Cellular differentiation is found to begin closer to the root cap junction under microgravity conditions. Results also show a reduction by 1/3 in the meristem length, and a two-fold increase in mitotic activity, of the space-grown roots compared to the controls. R.R.

A87-53012
MICROBIAL LIFE AT EXTREMELY LOW NUTRIENT LEVELS
P. HIRSCH (Kiel, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 287-298. DFG-supported research. refs
(Contract NSF DPP-83-14180)

It is noted that many microorganisms (oligotrophs) and certain lower fungi grow in distilled water. In the laboratory, these organisms thrive on contaminations of the air. Oligotrophs found in natural locations with extremely low nutrient levels (snow, rainwater pools, springs, free ocean water, and Antarctic rocks and soils) are especially adapted to constant famine; they frequently live attached to surfaces, form polymers and storage products even while starving, and often aggregate. Extreme oliogotrophs also occur in generally nutrient-rich environments such as sewage aeration tanks and compost soil; they are thought to survive in nutrient-depauperate microhabitats. B.J.

A87-53013
SURVIVAL STRATEGIES OF MICROORGANISMS IN EXTREME SALINE ENVIRONMENTS
J. F. IMHOFF (Bonn, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 299-306. refs

Halophilic representatives are found in all main lines of evolutionary descendence of microbes: in archaebacteria, Gram-negative and Gram-positive eubacteria, and also in eucharyotes. In principle, all halophilic microoganisms have to adapt their surface and membrane structures to their highly ionic environments. Concerning their intracellular compartment, two different strategies have been developed: inorganic ions are largely excluded in some microoganisms while such ions are actively accumulated in others. In particular, the second group of organisms has to adapt the whole metabolic machinery to the highly ionic conditions of several molar salts, whereas in the first group only the outer surface of the cytoplasmic membrane and the extracytoplasmic structures that are in contact with high concentrations of inorganic ions. Author

A87-53533
CHANGES IN THE CARDIAC RHYTHM AND ITS REGULATION DURING ACUTE EXPOSURE TO HEAT [IZMENENIIA SERDECHNOGO RITMA I EGO REGULIATSII PRI OSTROM TEPLOVOM VOZDEISTVII]
T. A. MANSUROV and V. A. RAKHMATULLINA (AN USSR, Institut Fiziologii, Tashkent, Uzbek SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 33, July-Aug. 1987, p. 35-39. In Russian. refs

The effects of short exposures (1, 15, 30, and 45 min) to temperatures of 38-40 C and 48-50 C on the cardiac activity of rats were studied by measuring the EKG indices of cardiac rhythm, which were then statistically treated. At 38-40 C, two types of reaction were found to develop: (1) the relaxation of the vagal regulation and an increase of the hypophyseal-adrenal system influence on cardiac activity, and (2) a decrease of the sympathoadrenal effects on the sinus rhythm. At 48-50 C, a decrease of the vagal effects and an increase of the sympathetic ones on the cardiac activity were noted. The course of the development of the regulatory changes were found to depend on the individual rat. In one group, the intensification of the activity of the regulatory cardiac-rhythm mechanisms developed gradually, while in the other group, the intensification started at the beginning of the exposure. I.S.

A87-53534
THE ACTIVITIES OF ACID AND THE ALKALINE PHOSPHATASES IN TISSUES OF AN ORGANISM SUBJECTED TO COOLING OR OVERHEATING [AKTIVNOST' KISLOI I SHCHELOCHNOI FOSFATAZ TKANEI PRI OKHLAZHDENII I PEREGREVANII ORGANIZMA]
M. SH. USENOVA, Z. IA. DOLGOVA, and E. G. DOLGOV (Ust'-Kamenogorskii Pedagogicheskii Institut, Ust-Kamenogorsk, Kazakh SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 33, July-Aug. 1987, p. 39-43. In Russian. refs

The effects of 3-h exposures of rats to cold (+5 C) or elevated temperature (+41 C) on the activities of acid and the alkaline phosphatases in various tissues were studied using biochemical and histochemichal methods for enzyme analysis. The exposure of rats to +5 C resulted in increases of both enzymatic activities in the adrenal glands, but the activities of the brain, liver, myocardium, kidney, lung, and skeletal muscle phosphatases decreased. Overheating led to increases in lung and adrenal gland phosphatases but to decreases of both enzyme activities in all other tissues. I.S.

A87-53535
PEROXIDATION OF LIPIDS AND THE CONCENTRATION OF ALPHA-TOCOPHEROLS IN THE BLOOD OF RABBITS ADAPTED TO HYPOXIA AND SUBJECTED TO ACUTE DECOMPRESSION [PEREKISNOE OKISLENIE LIPIDOV I KONTSENTRATSIIA ALPHA-TOKOFEROLA V KROVI ADAPTIROVANNYKH K GIPOKSII KROLIKOV PRI OSTROI DEKOMPRESSII]
D. A. SUTKOVOI (AN USSR, Institut Fiziologii, Kiev, Ukrainian SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 33, July-Aug. 1987, p. 93-95. In Russian. refs

The effect of acute decompression (simulated by a rapid lowering of an animal) on the lipid peroxidation (LPO) indices and the enzymes of biooxidation systems was studied in rabbits adapted to moderate altitude (7500 m) hypoxia and in nonadapted rabbits. Nonadapted animals exposed repeatedly to decompression occurrences exhibited significant activation of LPO in blood; after the fourth exposure, the concentration of serum malonic dialdehyde (MDA) increased by 40-42 percent and the frequency of spontaneous chemoluminescence (SCL) increased by 177 percent. The concentration of tocopherol decreased to 44 percent after the fourth exposure. Animals adapted to hypoxia exhibited significantly lower LPO, MDA, and SCL increases. Tocopherol concentrations increased after the third and fourth decompression exposures, indicating increased stability of the antioxidation systems. I.S.

A87-53536
BIOCHEMICAL RECEPTION AND IONIZING IRRADIATION OF AN ORGANISM [BIOKHIMICHESKAIA RETSEPTSIIA I IONIZIRUIUSHCHEE OBLUCHENIE ORGANIZMA]
E. F. ROMANTSEV and E. N. PRIANISHNIKOVA (Ministerstvo Zdravookhraneniia SSSR, Institut Biofiziki, Moscow, USSR) Radiobiologiia (ISSN 0033-8192), vol. 27, May-June 1987, p. 291-296. In Russian. refs

The role of cellular receptors of biochemically active compounds (BAC) in the molecular mechanisms of radiation sickness is examined. Particular attention is given to radiation-induced changes in receptor binding of prostaglandins (PGs), leading to disruptions of cellular metabolism. The nature of potentially radioprotective drugs which would affect BAC receptors, particularly the receptors of PGs, is discussed. I.S.

A87-53537
CELLULAR MOLECULAR MECHANISMS OF THE BIOLOGICAL EFFECT OF LOW X-RAY DOSES ON ISOLATED MAMMALIAN CELLS [MOLEKULIARNO-KLETOCHNYE MEKHANIZMY BIOLOGICHESKOGO DEISTVIIA MALYKH DOZ RENTGENOVSKOGO IZLUCHENIIA NA IZOLIROVANNYE KLETKI MLEKOPITAIUSHCHIKH]
IU. B. KUDRIASHOV and I. M. PARKHOMENKO (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Radiobiologiia (ISSN 0033-8192), vol. 27, May-June 1987, p. 297-302. In Russian. refs

A87-53538
INVESTIGATION OF THE MECHANISM OF THYMOCYTE DEATH UNDER ULTRAHIGH GAMMA-RAY DOSES [ISSLEDOVANIE MECHANIZMA GIBELI TIMOTSITOV PRI VOZDEISTVII SVERKHVYSOKIKH DOZ GAMMA-IZLUCHENIIA]
N. B. ZVONAREVA, A. A. SEILIEV, S. N. KOLIUBAEVA, E. A. BORISOVA, B. D. ZHIVOTOVSKII (Tsentral'nyi Nauchno-Issledovatel'skii Rentgeno-Radiologicheskii Institut, Leningrad, USSR) et al. Radiobiologiia (ISSN 0033-8192), vol. 27, May-June 1987, p. 319-324. In Russian. refs

A87-53539
BIOLOGICAL EFFECTIVENESS OF HELIUM IONS AND PROTONS OF RELATIVISTIC ENERGIES [BIOLOGICHESKAIA EFFECTIVNOST' IONOV GELIIA I PROTONOV RELIATIVISTSKIKH ENERGII]
B. S. FEDORENKO, N. IA. SAVCHENKO, S. V. VOROZHTSOVA, V. N. GERASIMENKO, A. N. KABACHENKO (Institut Mediko-Biologicheskikh Problem, Moscow, USSR) et al. Radiobiologiia (ISSN 0033-8192), vol. 27, May-June 1987, p. 339-343. In Russian. refs

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

A87-53540
ANALYZING THE STRUCTURAL AND METABOLIC REACTIONS OF THE CENTRAL NERVOUS SYSTEM TO THE COMBINED EFFECTS OF MICROWAVE AND IONIZING RADIATION [STRUKTURNO-METABOLICHESKII ANALIZ REAKTSII TSENTRAL'NOI NERVNOI SISTEMY NA KOMBINIROVANNOE VOZDEISTVIE MIKROVOLNOVOGO I IONIZIRUIUSHCHEGO IZLUCHENII]
V. S. TIKHONCHUK, I. B. USHAKOV, and V. P. FEDOROV (Voronezhskii Gosudarstvennyi Meditsinskii Institut, Voronezh, USSR) Radiobiologiia (ISSN 0033-8192), vol. 27, May-June 1987, p. 361-365. In Russian. refs

The effects of microwaves and gamma rays on the structure and metabolism of the central nervous system (CNS) were studied in rats subjected to 20-s-long whole-body irradiation by microwaves and/or to Co-60 irradiation of the head area. Structural changes undergone by the brain cortex were evaluated by estimating changes in the numbers of mast cells and the volume of neurocyte nuclei in various regions of the brain. To assess metabolic changes, the enzymatic activity of acid phosphatase in the sensory-motor cortex and the plasma contents of Na, K, and water were measured. Both structural and functional changes in CNS were found to be the same after both microwave and gamma irradiation. When the two types of radiation were delivered in combination, the sequence of delivery was important: when gamma-rays were delivered prior to the microwave radiation, the effect was synergistic; when the exposure to gamma rays followed that by microwaves, some effects were antagonistic. I.S.

A87-53615* Pennsylvania State Univ., University Park.
AN ENZYME IMMUNOASSAY FOR RAT GROWTH HORMONE - APPLICATIONS TO THE STUDY OF GROWTH HORMONE VARIANTS
MARIANNE A. FARRINGTON and W. C. HYMER (Pennsylvania State University, University Park) Life Sciences (ISSN 0024-3205), vol. 40, 1987, p. 2479-2488. refs
(Contract NCC2-287; NAS9-17416)

A sensitive and specific competitive enzyme immunoassay for rat growth hormone (GH) is described and its use in the detection of GH variants is demonstrated. In the present assay, soluble GH and GH adsorbed to a solid-phase support compete for monkey anti-GH antibody binding sites. The immobilized antibody-GH complex is detected and quantified using goat antimonkey immunoglobin G covalently conjugated to horseradish peroxidase. It is noted that the assay can be performed in 27 hours and that sensitivities in the range of 0.19 to 25 ng can be obtained in the region of 10 to 90 percent binding. K.K.

A87-53619* Pennsylvania State Univ., University Park.
FLOW CYTOMETRIC IMMUNOFLUORESCENCE OF RAT ANTERIOR PITUITARY CELLS
J. MICHAEL HATFIELD and W. C. HYMER (Pennsylvania State University, University Park) Cytometry (ISSN 0196-4763), vol. 6, 1985, p. 137-142. refs
(Contract NIH-CA-23248; NAS9-15566)

A flow cytometric immunofluorescence technique was developed for the quantification of growth hormone, prolactin, and luteinizing hormone producing cells. The procedure is based on indirect-immunofluorescence of intracellular hormone using an EPICS V cell sorter and can objectively count 50,000 cells in about 3 minutes. It can be used to study the dynamics of pituitary cell populations under various physiological and pharmacological conditions. K.K.

A87-53624* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
IMMUNOCYTOCHEMICAL LOCALIZATION OF GLUTAMIC ACID DECARBOXYLASE (GAD) AND GLUTAMINE SYNTHETASE (GS) IN THE AREA POSTREMA OF THE CAT. LIGHT AND ELECTRON MICROSCOPY
FERNANDO E. D'AMELIO, WILLIAM R. MEHLER, MICHAEL A. GIBBS (NASA, Ames Research Center, Moffett Field, CA), LAWRENCE F. ENG (USVA, Medical Center, Palo Alto, CA), and JANG-YEN WU (Pennsylvania State University, Hershey) Brain Research (ISSN 0006-8993), vol. 410, 1987, p. 232-244. refs
(Contract NCC2-282; NCA2-OR-675-303; NIH-NS-11632; NIH-NS-20978)

Morphological evidence is presented of the existence of the putative neurotransmitter gamma-aminobutyric acid (GABA) in axon terminals and of glutamine synthetase (GS) in ependymoglial cells and astroglial components of the area postrema (AP) of the cat. Purified antiserum directed against the GABA biosynthetic enzyme glutamic acid decarboxylase (GAD) and GS antiserum were used. The results showed that punctate structures of variable size corresponding to axon terminals exhibited GAD-immunoreactivity and were distributed in varying densities. The greatest accumulation occurred in the caudal and middle segment of the AP and particularly in the area subpostrema, where the aggregation of terminals was extremely dense. The presence of both GAD-immunoreactive profiles and GS-immunostained ependymoglial cells and astrocytes in the AP provide further evidence of the functional correlation between the two enzymes. C.D.

A87-53629* Pennsylvania State Univ., University Park.
EFFECT OF PITUITARY HOLLOW FIBER UNITS AND THYROID SUPPLEMENTATION ON GROWTH IN THE LITTLE MOUSE (41949)
JOHN E. HARKNESS, W. C. HYMER, JAMES L. ROSENBERGER (Pennsylvania State University, University Park), and RICHARD E. GRINDELAND (NASA, Ames Research Center, Moffett Field, CA) Society for Experimental Biology and Medicine, Proceedings (ISSN 0037-9727), vol. 177, 1984, p. 312-317. Research supported by the Pennsylvania State University. refs
(Contract NCAZ-05-589-101)

It is shown that the implantation of encapsulated pituitary cells into heterozygous lit/+ mice inhibited the average percentage change in weight gain as compared to controls. However, homozygous lit/lit mice receiving cell-filled capsules consistently had higher percentage weight gains than their control counterparts. It was also found that thyroid-supplemented mutant mice with pituitary cell implants had significantly higher organ and carcass weights than other mutant groups. K.K.

A87-53649
FLOW CYTOMETRIC ANALYSIS AND SORTING OF LIVE MALE RAT ANTERIOR PITUITARY CELL TYPES BY FORWARD ANGLE AND PERPENDICULAR LIGHT SCATTER
J. MICHAEL HATFIELD and W. C. HYMER (Pennsylvania State University, University Park) Endocrinology (ISSN 0013-7227), vol. 119, no. 6, 1986, p. 2670-2682. refs
(Contract PHS-CA-23248)

The use of light scatter signals produced by live male rat anterior pituitary cells in the flow cytometer as markers to aid in the identification and separation of different hormone-containing cell types was investigated. The typical light scatter pattern had three ridges in the forward angle light scatter (FALS) perpendicular light scatter (PLS) bivariate cell distribution. FALS signals could be correlated with the size of different cell types and PLS signals with their content of cytoplasmic secretory granules. Agranular cells dominated the low PLS ridge while moderately granulated PRL cells and heavily granulated GH cells dominated the medium and high PLS ridges, respectively. Inclusion of dopamine in the pituitary gland dissociation medium increased the intensity of the PLS signals of a large population of cells. C.D.

A87-53650
FLOW CYTOMETRIC ANALYSIS AND SORTING OF LIVE FEMALE RAT ANTERIOR PITUITARY CELL TYPES BY FORWARD ANGLE AND PERPENDICULAR LIGHT SCATTER - EFFECT OF 17 BETA-ESTRADIOL
J. MICHAEL HATFIELD and W. C. HYMER (Pennsylvania State University, University Park) Endocrinology (ISSN 0013-7227), vol. 119, no. 6, 1986, p. 2683-2694. refs
(Contract PHS-CA-23248)

Studies were conducted to determine the extent of 17 beta-estradiol (E2)-induced changes in the laser light scatter signals of pituitary mammotrophs after the delivery of physiological concentrations of E2 to ovariectomized rats. Changes were found in the forward angle light scatter (FALS) and perpendicular light scatter signals of anterior pituitary lobe cells. The majority of the cells showing increased FALS signals were mammotrophs. It is noted that physiological levels of E2 produced small but consistent elevations in the percentage of somatotrophs at all treatment times tested. K.K.

A87-53828
POSSIBLE BIOLOGICAL ORIGIN OF BANDED IRON-FORMATIONS FROM HYDROTHERMAL SOLUTIONS
NILS G. HOLM (Stockholm, Universitet, Sweden) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 229-250. Research supported by the Naturvetenskapliga Forskningsradet. refs

The origin of banded Fe-formations is discussed in the framework of a combined hydrothermal/biogenic model which is based on the distribution of trace elements in modern biogenic

metalliferous sediments and Proterozoic banded Fe-formations (which are characteristically poor in trace elments), as well as on reduced carbon isotope data. On the basis of these data it is argued that the Fe banding was caused by periods of slow precipitations of oxidized iron from hot hydrothermal solutions alternating with periods of precipitation of silica from cool hydrothermal solutions. Slow oxidation of iron was brought about in low-oxygen hydrothermal environments by microaerophilic chemolithotrophic bacteria inhabiting these environments. I.S.

A87-53830* California Univ., La Jolla.
ENERGY YIELDS FOR HYDROGEN CYANIDE AND FORMALDEHYDE SYNTHESES - THE HCN AND AMINO ACID CONCENTRATIONS IN THE PRIMITIVE OCEAN
ROSCOE STRIBLING and STANLEY L. MILLER (California, University, La Jolla) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 261-273. refs
(Contract NAGW-20)

Simulated prebiotic atmospheres containing either CH4, CO, or CO2, in addition to N2, H2O, and variable amounts of H2, were subjected to the spark from a high-frequency Tesla coil, and the energy yields for the syntheses of HCN and H2CO were estimated from periodic (every two days) measurements of the compound concentrations. The mixtures with CH4 were found to yield the highest amounts of HCN, whereas the CO mixtures produced the highest yields of H2CO. These results model atmospheric corona discharges. From the yearly energy yields calculated and the corona discharge available on the earth, the yearly production rate of HCN was estimated; using data on the HCN production rates and the experimental rates of decomposition of amino acids through the submarine vents, the steady state amino acid production rate in the primitive ocean was calculated to be about 10 nmoles/sq cm per year. I.S.

A87-53841
ENERGY METABOLISM OF A THERMOACIDOPHILIC ARCHAEBACTERIUM, SULFOLOBUS ACIDOCALDARIUS
TAKAYOSHI WAKAGI and TAIRO OSHIMA (Tokyo Institute of Technology, Yokohama, Japan) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 391-399. refs

Membrane-bound factors of the oxidative phosphorylation system of Sulfolobus acidocaldarius archaebacterium were studied. Although cytochrome c was lacking in this organism, the respiratory poisons azide and cyanide killed the cells, suggesting the presence of a terminal oxidase (cytochrome a) of the electron transport system. NADH dehydrogenase was purified from the crude cell extracts; it was found to transfer electrons from NADH to caldariellaquinone (a unique quinone in the genus Sulfolobus) suggesting that this enzyme and the quinone are members of the S. acidocaldarius respiratory chain. Two types of ATPase were found in the membrane fraction: one is active at neutral pH and is slightly activated by sulfate; the other is an acid apyrase and is inhibited by sulfate. I.S.

A87-53843
ORIGIN AND EVOLUTION OF PHOTOSYNTHETIC REACTION CENTERS
JOHN M. OLSON (Odense Universitet, Denmark) and BEVERLY K. PIERSON (Puget Sound, University, Tacoma, WA) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 419-430. refs

The origin and the early evolution of photosynthetic reaction centers (RCs) are discussed. It is proposed that the prototype RC may have used a porphyrin molecule and a Fe-S center associated with small peptides to create a charge separation across the primitive cell membrane. The precursor of all contemporary RCs is considered to have contained chlorophyll a (Chl a), as both primary electron donor and initial electron acceptor, and a Fe-S center as a secondary acceptor (RC-1 type). The continued competition for light has stimulated the evolution of BChl g and, subsequently, of BChl a from Chl a; the competition for reductants for the CO2-fixation process has stimulated evolution of a second RC, RC-2. The organisms containing Chl a, RC-1, and RC-2 have added a water-splitting enzyme to RC-2 (between 3.0 and 2.5 Gyr ago) in order to use H2O in place of the ferrous hydroxide ion as an electron donor for autotrophic photosynthesis, thus completing the foundation for the contemporary oxygen-evolving photosynthesis by cyanobacteria and chloroplasts. I.S.

A87-54091
A SMALL CATALYTIC OLIGORIBONUCLEOTIDE
OLKE C. UHLENBECK (Colorado, University, Boulder) Nature (ISSN 0028-0836), vol. 328, Aug. 13, 1987, p. 596-600. NIH-supported research. refs

A 19-nucleotide RNA fragment can cause rapid, highly specific cleavage of a 24-nucleotide RNA fragment under physiological conditions. Because each 19-mer can participate in many cleavage reactions, this molecule has all the properties associated with an RNA enzyme. Author

N87-29077*# Santa Clara Univ., Calif. Dept. of Biology.
GROWTH HORMONE SECRETION DURING SPACE FLIGHT AND EVALUATION OF THE PHYSIOLOGICAL RESPONSES OF ANIMALS HELD IN THE RESEARCH ANIMAL HOLDING FACILITY Final Report, Mar. 1982 - Jul. 1986
THOMAS N. FAST, RICHARD GRINDELAND, WILLIAM MEHLER, and JIRO OYAMA Sep. 1987 6 p
(Contract NCC2-180)
(NASA-CR-181344; NAS 1.26:181344) Avail: NTIS HC A02/MF A01 CSCL 06C

The spaceflight of the Research Animal Holding Facility (RAHF) on the Space Laboratory 3 (SL 3) provided the opportunity to evaluate the suitability of the RAHF for housing and maintaining experimental animals during spaceflight, and to determine changes in the secretion of growth hormone during spaceflight. Using ground-based studies the following were investigated: the optimum conditions for creating gravitational force on space flight animals; neural pathways that may play a role in the space flight syndrome; and the time course of muscle atrophy due to hypodynamia and hypokenesia in hindlimb-suspended animals and the role of growth hormone in these processes. B.G.

N87-29078# Los Alamos National Lab., N. Mex.
WORK PERFORMANCE EVALUATION USING THE EXERCISING RAT MODEL
D. M. STAVERT and B. E. LEHNERT 1987 5 p Presented at the 6th Medical Chemical Defense Bioscience Review, Baltimore, Md., 1 Aug. 1987
(Contract W-7405-ENG-36)
(DE87-010131; LA-UR-87-1748; CONF-870887-1) Avail: NTIS HC A02/MF A01

A treadmill-metabolic chamber system and a stress testing protocol have been developed to evaluate aerobic work performance on exercising rats that have inhaled toxic substances. The chamber with an enclosed treadmill provides the means to measure the physiologic status of rats during maximal work intensities in terms of O2 consumption (V sub O2) and CO2 production (V sub CO2). The metabolic chamber can also accommodate instrumented rats for more detailed analyses of their cardiopulmonary status, e.g., ECG, cardiac output, arterial blood gases and pH, and arterial and venous blood pressures. For such studies, an arterial/venous catheter preparation is required. Because of the severe metabolic alterations after such surgery, a post surgical recovery strategy using hyperalimentation was developed to ensure maximal performance of instrumented animals during stress testing. Actual work performance studies are conducted using an eight minute stress test protocol in which the rat is subjected to increasing external work. The metabolic state of the animal is measured from resting levels to maximum oxygen consumption (V sub O2 max). The V sub O2 max has been shown

to be reproducible in individual rats and is a sensitive indicator of oxidant gas-induced pulmonary damage. DOE

N87-29079*# RCA Government Services, Washington, D.C.
USSR SPACE LIFE SCIENCES DIGEST, ISSUE 13
LYDIA RAZRAN HOOKE, ed., VICTORIA GARSHNEK, ed., RONALD TEETER, ed., MIKE RADTKE, ed., and JOSEPH ROWE, ed. (Library of Congress, Washington, D. C.) Washington NASA Sep. 1987 122 p
(Contract NASW-3676)
(NASA-CR-3922(15); NAS 1.26:3922(15)) Avail: NTIS HC A06/MF A01 CSCL 06C

This is the thirteenth issue of NASA's USSR Space Life Sciences Digest. It contains abstracts of 39 papers recently published in Russian-language periodicals and bound collections, two papers delivered at an international life sciences symposium, and three new Soviet monographs. Selected abstracts are illustrated with figures and tables from the original. Also included is a review of a recent Soviet-French symposium on Space Cytology. Current Soviet Life Sciences titles available in English are cited. The materials included in this issue have been identified as relevant to 31 areas of aerospace medicine and space biology. These areas are: adaptation, biological rhythms, body fluids, botany, cardiovascular and respiratory systems, cosmonaut training, cytology, developmental biology, endocrinology, enzymology, equipment and instrumentation, gastrointestinal systems, genetics, habitability and environment effects, hematology, human performance, immunology, life support systems, mathematical modeling, metabolism, microbiology, musculoskeletal system, neurophysiology, nutrition, operational medicine, perception, personnel selection, psychology, radiobiology, space biology, and space medicine. Author

N87-29087# Joint Publications Research Service, Arlington, Va.
ADAPTIVE AND CUMULATIVE EFFECTS ON DOGS OF REGULAR EXPOSURE TO +GZ ACCELERATIONS
R. A. VARTBARONOV, G. D. GLOD, N. N. UGLOVA, I. S. ROLIK, I. G. KRASNYKH, V. G. NOVIKOV, and N. A. GAYDAMAKIN *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 51-56 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 37-40
Avail: NTIS HC A08/MF A01

The development of adaptive and cumulative effects was investigated in 13 noninbred dogs regularly exposed to plus Gz acceleration. Group 1 dogs were exposed 3 to 4 times a week for 2 months and Group 2 dogs were exposed 1 to 2 times a week for 5 months. The tolerance threshold was evaluated with respect to ECG abnormalities. The study of circulation reactions and acceleration tolerance threshold revealed the predominant development of adaptive changes that were more distinct in Group 2 dogs. Cumulative effects in the form of functional disorders of pulmonary vessels occurred in all experimental dogs, but less frequently in Group 2 dogs. Morphological lesions of the lung tissue developed in Group 1 animals after 2 to 3 exposures and in Group 2 animals after 2 to 3 months, the incidence rate being lower in the latter group. These findings suggest that adaptive and cumulative effects in response to regular exposures to threshold plus Gz acceleration develop more or less in parallel. Author

N87-29091# Joint Publications Research Service, Arlington, Va.
STATUS OF ALPHA 1-ADRENERGIC REGULATION OF STROKE VOLUME IN HYPOKINETIC RATS
A. S. CHINKIN *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 75-80 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 52-55
Avail: NTIS HC A08/MF A01

The positive effect of phenylephrine (PE) on stroke volume was 3 to 5 times weaker in the rats exposed to hypokinesia for 30 days as compared to the controls. An investigation suggested that the activity of alpha 1-adrenoreceptors involved in the actualization of positive effects of agonists on stroke volume is considerably lower during hypokinesia. Author

N87-29092# Joint Publications Research Service, Arlington, Va.
ADAPTABILITY OF THE RAT HYPOKINETIC HEART TO AFTERLOAD, AND THE ROLE OF NERVOUS REGULATION
V. I. KUZNETSOV and G. M. PRUSS *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 81-85 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, Mar. - Apr. 1987 p 55-58
Avail: NTIS HC A08/MF A01

Adaptation of the heart of hypokinetic rats to sustained afterload and the role of nervous regulation in this process is investigated. It was concluded that cardiac resistance of the hypokinetic rats to afterload is higher than in the intact rats with coarctation of the aorta. On the other hand, afterload reduces the hypokinesia induced increase in the contractility function. In addition to the nervous influences (sympathic), intracardiac factors play an important role in the mechanisms of adaptation of the heart to hypokinesia and of the hypokinetic heart to afterload. Author

N87-29095# Joint Publications Research Service, Arlington, Va.
DYNAMICS OF NONCOLLAGEN PROTEIN METABOLISM IN DOGS EXPOSED TO LOW DOSES OF CHRONIC GAMMA RADIATION FOR 6 YEARS
Z. A. VINOGRADOVA *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 97-101 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 66-69
Avail: NTIS HC A08/MF A01

The effect of chronic and acute (as compared to the total dose) gamma irradiation in the range 2.5 to 7.5 Gy on metabolism of noncollagen proteins (NCP) in various tissues and peripheral blood of dogs was investigated. Metabolic disorders of NCPs in tissues were found. Their high level was indicative of enhanced collagen formation in the irradiated animals. With respect to the NCP content, 3 to 14 days after acute irradiation in the dose of 0.42 Gy there was a change in the body which was independent of the total irradiation dose. Author

N87-29101# Joint Publications Research Service, Arlington, Va.
CHANGES IN RAT HEMOPOIESIS AS A RESULT OF THE COMBINED EFFECT OF ACCELERATIONS, RADIATION AND RADIATION-MODIFYING AGENTS
V. B. TENCHOVA and T. P. PANTEV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 129-131 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 85-86
Avail: NTIS HC A08/MF A01

Spaceflight factors lead to a number of changes in hemopoiesis, the severity of which depends on the nature, duration and order of exposure to such factors. Accelerations, weightlessness, vibration and certain other factors can modify not only radiation

lesions, but pharmacotoxic and protective properties of radioprotective agents and substances for biological protection. Cellularity of bone marrow and the spleen is one of the indicators of the radiation-protective effect of chemical agents and substances that enhance natural resistance. The objective here is to investigate changes in overall cellularity of bone marrow, weight and cellularity of the spleen of rats subjected to the combination of acceleration and radiation, as well as the possibility of modifying these changes with eleuterococcus and the radioprotective agent adeturon.
Author

N87-29103# Joint Publications Research Service, Arlington, Va.
EFFECT OF COOLING AND FREEZING ON MICROFLORA IN WATER REGENERATED FROM ATMOSPHERIC MOISTURE CONDENSATE
M. I. SHIKINA, S. V. CHIZHOV, and N. B. KOLESINA *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 135-138 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), no. 21, no. 2, Mar. - Apr. 1987 p 87-89
Avail: NTIS HC A08/MF A01

The objective was to test the effect of low temperature on the growth and development of microflora in a condensate of atmospheric moisture and regenerated water. The findings were indicative of instability of microflora in a condensate of atmospheric moisture and regenerated water at low temperatures in a closed environment.
Author

N87-30022# Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
BIOLOGICAL EFFECTS OF MILLIMETER-WAVE IRRADIATION Final Report, 15 Apr. 1984 - 31 Mar. 1986
OM P. GANDHI, DOUGLAS W. HILL, LUCIANO FURIA, MAGDY F. ISKANDER, and DEEPAK GHODGAONKAR Apr. 1987 93 p
(Contract F33615-84-K-0610)
(AD-A182890; UTEC-86-095; USAFSAM-TR-86-44) Avail: NTIS HC A05/MF A01 CSCL 06G

Experiments were conducted to verify the reported high degree of sensitivity of growth rates of yeast cultures to millimeter-wave irradiation in the band 41.650 to 41.798 GHz. A new irradiation chamber was designed and built to allow simultaneous irradiation and sham irradiation of recirculating suspension of saccharomyces cerevisiae maintained with a temperature difference of less than 0.01 C. No difference larger than plus or minus 4% was ever detected in the growth rates at any of the highly stabilized (within plus or minus 50 Hz) irradiation frequencies for which the effects had been reported by earlier workers. Experiments were also performed to determine the Raman Spectra of cultures of bacillus megaterium to investigate if these are dependent on the stage of their life cycle. The results were negative. A further study to investigate the ability of millimeter waves to induce conformational changes in lipid bilayers of dipalmitoyl phosphatidycholine (DPPC) liposomes below and above the transition temperature of 41 C also gave negative results. For these experiments the conformational characteristics of the liposomes were evaluated using Raman spectra with and without mm-wave irradiation at 41.650 GHz.
GRA

N87-30023# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
AN ELECTRICAL CIRCUIT MODEL OF THE INTERFACE BETWEEN AN ELECTRODE AND THE ELECTROLYTIC MEDIUM OF THE CORTEX M.S. Thesis
JEFFREY M. SEDLAK 31 Jul. 1987 383 p
(AD-A183204; AFIT/GE/EE/86D-48) Avail: NTIS HC A17/MF A01 CSCL 09A

Former research of the visual processes that occur at the cortex of mammals concentrated on the task of the design and implantation of a multielectrode array, the AFIT brain chip. Despite the importance of refining these activities, questions were generated from data collected during the first implant that need to be resolved before the next implant into a higher-level primate is attempted. The specific nature of the interface between the electrodes and the electrolytic medium at the cortex is critical to understanding and interpreting data collected during an implantation. The primary thrust of this research is to propose a qualitative model of the electrode/electrolyte interface and then to calculate the quantitative parameters of that model by immersing brain chips into a simulated electrolyte and recording empirical data. The secondary focus of this research is to investigate the limiting effect of the electrode/electrolyte interface upon the maximal scan rate or the multielectrode array.
GRA

N87-30024# Washington Univ., Seattle. Bioelectromagnetics Research Lab.
AFFERENT MECHANISMS OF MICROWAVE-INDUCED BIOLOGICAL EFFECTS Final Report, Jun. 1980 - Aug. 1987
H. LAI, A. HORITA, C. K. CHOU, and A. W. GUY 12 Aug. 1987 14 p
(Contract N00014-80-C-0354; DA PROJ. RR0-4108)
(AD-A183562) Avail: NTIS HC A02/MF A01 CSCL 06G

Effects of low-level microwave irradiation on neurological function were investigated in the rat. Results can be summarized in the following statements: (1) acute exposure effects the response of an animal to psychoactive drugs and changes cholinergic activity in the brain; (2) effects of microwaves are classically conditionable to environmental cues after repeated exposure. Tolerance can also develop after repeated exposure; and (3) endogenous opioids play a mediating role in certain neurological effects of microwaves. These data further our understanding on the neurological effects of microwave exposure and may have important implications in certain occupational situations in which repeated exposure to low-level microwaves is unavoidable.
GRA

52

AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and weightlessness.

A87-50948
THE EFFECT OF HIGH TEMPERATURE ON THE FUNCTIONAL CONDITION AND WORK CAPACITY OF AN ORGANISM [VLIIANIE VYSOKOI TEMPERATURY NA FUNKTSIONAL'NOE SOSTOIANIE ORGANIZMA I RABOTOSPOSOBNOST']
N. D. BAGROVA and V. P. KOVALENKO Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), April 1987, p. 35, 36. In Russian.

Evidence demonstrating the deleterious effects of high temperature, especially in combination with high humidity, on the physiological state of an organism and on the ability to do mental and physical work is discussed. The capacity for mental work begins to deteriorate already at 27-31 C, whereas the decrease in the capacity for physical work appears to begin at 35-36 deg. The effect of high temperature (40-70 C) and humidity (45-50 percent) on work capacity was studied. It was found that even insignificant physical loads lead to large increases in heart rate (to 170-190 beats/min) and rectal temperature (to 38.3-38.6 C) and to a rapid drop of work capacity. The use of pulse rate as an monitor of physiological condition is suggested; workers performing physical assignments in hot environments should stop working when the pulse rate reaches 140 counts/min. At 100 counts/min, the work can be resumed.
I.S.

A87-50950
THE EFFECT OF ELEVATED OXYGEN AND CARBON DIOXIDE CONTENTS IN AIR ON THE CONDITION OF THE CARDIORESPIRATORY SYSTEM [VLIIANIE POVYSHENNOGO SODERZHANIIA V VOZDUSHNOI SREDE KISLORODA I UGLEKISLOGO GAZA NA SOSTOIANIE KARDIORESPIRATORNOI SISTEMY]
V. G. ALTUKHOV, M. A. GREBENIK, and A. A. SHAPOVOLOV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), April 1987, p. 39, 40. In Russian.

The effect of prolonged (up to 4 months) breathing of an artificial atmosphere (AA) containing 21.3-26.3 kPa O2 and 0.1-0.4 kPa CO2 on the parameters of the cardiorespiratory system was studied in 20 volunteers, divided into two equal groups: an experimental group, which exercised on a bicycle ergometer three times a week, and a nonexercising control group. With increasing time in the AA, the subjects of both groups exhibited symptoms typical of moderate hyperoxia: decreases in pulse rate and minute blood volume, O2 intake and CO2 elimination, respiratory coefficient, and energy consumption at rest. At the same time, the coefficient of O2 utilization, the minimal arterial pressure, and the peripheral vessel resistance increased. Exercise decreased these deleterious effects. I.S.

A87-51163
IMPROVING VISUAL PERFORMANCE THROUGH VOLITIONAL FOCUS CONTROL
STANLEY N. ROSCOE and DONALD H. COUCHMAN (Illiana Aviation Sciences, Las Cruces, NM) Human Factors (ISSN 0018-7208), vol. 29, June 1987, p. 311-325. USAF-sponsored research. refs

Nine undergraduate students were trained to control eye accommodation volitionally and, by exercising that acquired ability, to improve by varying amounts their visual acuity, contrast sensitivity, and flash target resolution. Six of the nine received auditory biofeedback of focusing responses measured automatically by a complex infrared tracking optometer and monocular focus stimulator, whereas the remaining three used a relatively simple polarized Vernier optometer that provides visual feedback of eye accommodation, and an even simpler binocular focus stimulator. Performance improvements were elicited by both methods, but larger gains were attained in far less time with the simpler approach, in which training is mainly self-administered. Author

A87-51178
SOME CHARACTERISTICS OF PERIPHERAL VISION
TADAHIKO FUKUDA (Japan Broadcasting Corp., Visual Science Research Div., Tokyo) NHK Technical Monograph (ISSN 0077-2631), Jan. 1987, p. 3-38. refs

Some of the characteristics of peripheral vision were investigated not only as a pure way of understanding the visual system but also as a basis for wide angle display and other technical applications. Flicker perimetry and flicker perception are dealt with, and relationship between the conditions under which motion and retinal location can be perceived is given. The function of the visual field in figure perception and character recognition, and the relationship between recognition of character string and the lateral interference effect are also dealt with. Finally, information capacity for various characters is given with the discussion on lateral interference effect. Author

A87-52086
DOES CONE POSITIONAL DISORDER LIMIT RESOLUTION?
JOY HIRSCH and W. H. MILLER (Yale University, New Haven, CT) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1481-1492. Research supported by the Connecticut Lions Eye Research Foundation Association. refs
(Contract F49620-83-C-0026; NIH-EY-00785; NIH-EY-03196; NIH-EY-00167)

The retinal sampling mosaic for a monkey eye is determined. Consideration is given to the possible consequences of both cone spacing and positional jitter on visual resolution. It is found that the sampling theorem based on average spacing overestimates the pooled estimate of visual acuity from the foveal edge to about 5 deg; this is probably due to the sampling noise caused by orientation and spacing disorder combined with demodulation as a result of the optics of the eye. K.K.

A87-52087* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONE SAMPLING ARRAY MODELS
ALBERT J. AHUMADA, JR. (NASA, Ames Research Center, Moffett Field, CA) and ALLEN POIRSON (Stanford University, CA) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1493-1502. refs

A model is described for positioning cones in the retina. Each cone has a circular disk of influence, and the disks are tightly packed outward from the center. This model has three parameters that can vary with eccentricity: the mean radius of the cone disk, the standard deviation of the cone disk radius, and the standard deviation of postpacking jitter. Estimates for these parameters out to 1.6 deg are found by using measurements reported by Hirsch and Hylton (1985) and Hirsch and Miller (1987) of the positions of the cone inner segments of an adult macaque. The estimation is based on fitting measures of variation in local intercone distances, and the fit to these measures is good. Author

A87-52088
PSYCHOPHYSICAL ESTIMATE OF EXTRAFOVEAL CONE SPACING
NANCY J. COLETTA and DAVID R. WILLIAMS (Rochester, University, NY) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1503-1513. refs
(Contract AF-AFOSR-85-0019; NIH-EY-04367; NIH-EY-01319; NIH-EY-00269)

In the extrafoveal retina, interference fringes at spatial frequencies higher than the resolution limit look like two-dimensional spatial noise, the origin of which has not been firmly established. It is shown that over a limited range of high spatial frequencies this noise takes on a striated appearance, with the striations running perpendicular to the true fringe orientation. A model of cone aliasing based on anatomical measurements of extrafoveal cone position predicts that this orientation reversal should occur when the period of the interference fringe roughly equals the spacing between cones, i.e., when the fringe spatial frequency is about twice the cone Nyquist frequency. Psychophysical measurements of the orientation reversal at retinal eccentricities from 0.75 to 10 deg are in quantitative agreement with this prediction. This agreement implies that at least part of the spatial noise observed under these conditions results from aliasing by the cone mosaic. The orientation reversal provides a psychophysical method for estimating spacing in less regular mosaics, complementing another psychophysical technique for measuring spacing in the more regular mosaic of foveal cones (Williams, 1985). Author

A87-52089
CONE SPACING AND THE VISUAL RESOLUTION LIMIT
DAVID R. WILLIAMS and NANCY J. COLETTA (Rochester, University, NY) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1514-1523. refs
(Contract AF-AFOSR-85-0019; NIH-EY-04367; NIH-EY-00269; NIH-EY-01319)

It is commonly assumed that the visual resolution limit must be equal to or less than the Nyquist frequency of the cone mosaic. However, under some conditions, observers can see fine patterns at the correct orientation when viewing interference fringes with spatial frequencies that are as much as about 1.5 times higher than the nominal Nyquist frequency of the underlying cone mosaic. The existence of this visual ability demands a closer scrutiny of the sampling effects of the cone mosaic and the information that is sufficient for an observer to resolve a sinusoidal grating. The Nyquist frequency specifies which images can be reconstructured

without aliasing by an imaging system that samples discretely. However, it is not a theoretical upper bound for psychophysical measures of visual resolution because the observer's criteria for resolving sinusoidal gratings are less stringent than the criteria specified by the sampling theorem for perfect, alias-free image reconstruction. Author

A87-52090
PERIPHERAL HYPERACUITY - ISOECCENTRIC BISECTION IS BETTER THAN RADIAL BISECTION
YEN L. YAP, DENNIS M. LEVI, and STANLEY A. KLEIN (Houston, University, TX) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1562-1567. Research supported by the American Optometric Foundation. refs
(Contract NIH-R01-EY-01728; NIH-R01-EY-04776)

Performance of three-dot bisection was determined as a function of orientation for a variety of feature separations and field meridians at eccentricities of 0-10 deg for two observers. The dot stimuli and separations were scaled in size to compensate for eccentricity. The precision of three-dot bisection was found to depend on the direction of test-feature offset. In the fovea, horizontal and vertical bisections were better than oblique bisections, while at eccentricities of 5-20 deg, isoeccentric (on a tangent to a circle of a given eccentricity) bisection was better than radial bisection. The direction of offset was more important than the orientation of the stimulus. Large separations showed a stronger effect than small separations. The anisotropy of bisection appears different from the meridional effect for resolution and is unlikely to be simply related to a local anisotropy of the cortical magnification factor. Author

A87-52091
CORTICAL MAGNIFICATION AND PERIPHERAL VISION
VEIJO VIRSU, RISTO NASANEN, and KARI OSMOVIITA (Helsinki, University, Finland) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1568-1578. Research supported by the Academy of Finland. refs

In a generalized form, the cortical magnification theory of peripheral vision predicts that the thresholds of any visual stimuli are similar across the whole visual field if the cortical stimulus representations calculated by means of the cortical magnification factor are similar independently of eccentricity. Failures of the theory in spatial vision were analyzed, and the theory was tested with five visual acuity tasks and two hyperacuity tasks. Almost all increases in thresholds with eccentricity were explained by the theory in five of these tasks, which included the two-dot Vernier hyperacuity test, the measurement of visual acuities with gratings, the Snellen E test, and two acuity tests that required either separation between dots or discrimination between two mirror-symmetric forms. The two-dot Vernier thresholds could be explained as a special case of orientation discrimination, and orientation discrimination at different eccentricities was in agreement with the cortical magnification theory. The increase of thresholds in peripheral vision was larger than predicted by the theory in the Landolt visual acuity and bisection hyperacuity tests, possibly because of retinal undersampling. Author

A87-52093
CONTRAST DISCRIMINATION IN PERIPHERAL VISION
GORDON E. LEGGE (Minnesota, University, Minneapolis) and DANIEL KERSTEN (Brown University, Providence, RI) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1594-1598. refs
(Contract NIH-EY-02857)

Properties of contrast discrimination in central and peripheral vision are determined. Forced-choice procedures were used to measure contrast-increment thresholds as a fuction of pedestal contrast. Two-cycle/deg Gaussian-windowed sine-wave grating patches centered at retinal loci ranging from 10 deg nasal to 20 deg temporal on the horizontal meridian are used as stimuli. It is found that, after scaling by the local contrast sensitivity, properties of contrast discrimination are qualitatively and quantitatively similar in the range of 0 to 20 deg on the retina. It is concluded that contrast coding mechanisms are similar in central and periperal vision. K.K.

A87-52094
SPATIOTEMPORAL PROPERTIES OF GRATING MOTION DETECTION IN THE CENTER AND THE PERIPHERY OF THE VISUAL FIELD
M. J. WRIGHT (Brunel University, Uxbridge, England) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1627-1633. refs

A87-52095
ACCOMMODATION TO STIMULI IN PERIPHERAL VISION
YUANCHAO GU and GORDON E. LEGGE (Minnesota, University, Minneapolis) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1681-1687. refs
(Contract NIH-EY-02857)

Can targets in peripheral vision elicit accommodation responses? A laser optometer was used to measure monocular steady-state accommodation for stimuli at retinal eccentricities ranging from 1 to 30 deg. The optical distance from the eye to the stimulus was varied from 0 to -6 D by introducing lenses in front of the eye. The accommodative response was plotted as a function of optical distance to produce an accommodative stimulus-response function. The magnitude of accommodative response was defined as the difference between the maximum and minimum values of this function. The magnitude declined from 4 D at 1 deg to 1-2 D at 30 deg eccentricity. The relation of the magnitude of accomodative response in peripheral vision to changes in acuity, contrast sensitivity, and depth of focus are considered. The role played by convergence accommodation is also discussed. Author

A87-52218
NEUROMUSCULAR AND MECHANICAL RESPONSES TO INSPIRATORY RESISTIVE LOADING DURING SLEEP
DAVID W. HUDGEL, MARIBETH MULHOLLAND, and CURTIS HENDRICKS (Case Western Reserve University; Cleveland Metropolitan General Hospital, OH) Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 603-608. refs
(Contract NIH-HL-33712)

The neuromuscular and mechanical responses of healthy humans to resistive loading were determined in healthy humans during wakefulness and sleep. Ventilation variables, the changes in the chest wall and upper-airway inspiratory muscle electromyograms (EMGs), and the upper-airway resistance were measured for two breaths immediately preceding and immediately following six applications of an inspiratory resistive load of 15 cm/l s H2O during wakefulness and stage-two sleep. During wakefulness, there was an enhanced chest-wall inspiratory muscle activity in response to loading, but it was accompanied by a proportional increase in inspiratory time, so that rate of rise did not significantly increase. These responses were absent during sleep. Significant upper-airway inspiratory muscle activation with inspiratory resistive loading was not found during wakefulness or sleep. I.S.

A87-52219
HYPOXIA AND MONOSYNAPTIC REFLEXES IN HUMANS
J. C. WILLER, G. MISEROCCHI, and H. GAUTIER (Paris V, Universite, France; Milano, Universita, Milan, Italy) Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 639-645. refs

The effect of hypoxia on the monosynaptic reflexes in humans was investigated by studying the recruitment curves of the Hoffman (H) reflex and the direct motor (M) response as a function of stimulus intensity, in both normoxic and hypoxic conditions at sea level. Electromyographic sygnals were derived from surface electrodes placed over the soleus muscle. Exposure to hypoxia did not affect the maximal M response but decreased maximal H

response by 7 percent; there was a decrease of 6 percent in the threshold of both the H and M responses with no change in slope of the recruitment curves. At a constant stimulus eliciting a half-maximal H response, hypoxia caused a 50-percent increase in the amplitude of the H response within 12 min. The results suggest that the effects of hypoxia on the nervous system consist of a direct depolarizing action on the peripheral alpha-fibers and the 1A sensory fibers and of a central effect on supraspinal structures affecting the spinal alpha-motoneurons. I.S.

A87-52221* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
HYSTERESIS IN RESPONSE TO DESCENDING AND ASCENDING LOWER-BODY NEGATIVE PRESSURE
CLARE MARIE TOMASELLI, MARY ANNE BASSETT FREY, RICHARD A. KENNEY, and G. WYCKLIFFE HOFFLER (NASA, Kennedy Space Center; Bionetics Corp., Cocoa Beach, FL; George Washington University, Washing Journal of Applied Physiology (ISSN 0161-7567), vol. 63, Aug. 1987, p. 719-725. refs

Changes in the indices of fluid redistribution and cardiovascular responses during graduated orthostatic stress were measured in 12 men subjected for 25 min to lower-body negative pressure (LBNP) test protocol that involved stepwise decreases (from the starting pressure of -8 to the final -50 mm Hg), followed by stepwise increases (back to -8 mm Hg) of LBNP. The values of many variables measured during the descending phase of LBNP were significantly different from the respective values measured during the ascending phase. These differences appear to be caused by a component of fluid translocation that occurs during LBNP and cannot be reversed within the duration of the procedure. It is hypothesized that this slowly-reversed component is the sequestration of fluid in the interstitial and the lymphatic compartments. I.S.

A87-52994
THE EFFECT OF MICROGRAVITY ON PLASMA-OSTEOCALCIN
C. VERMEER and M. M. W. ULRICH (Limburg, Rijksuniversiteit, Netherlands) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1987, p. 139-142. Research supported by the Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart and the Praeventiefonds. refs

Investigations are described which explore whether the bone loss in astronauts as well as in osteoporotic patients may be related to abnormalities in a recently discovered calcium-binding protein, named osteocalcin. It was observed that in all subjects of a limited number of osteoporotic patients, the amount of calcium-binding groups (Gla-residues) in the circulating osteocalcin was substantially reduced. The Gla-content could be normalized, however, by the oral administration of vitamin K (1 mg/day). The Gla-content of plasma-osteocalcin from four astronauts before and after the D-1 mission was also analyzed. The amount of Gla-residues was reduced by more than 50 percent in the post-flight samples. It seems probable that an increased vitamin K-intake by the astronauts will correct the observed abnormality, but whether this will lead to a decrease of the microgravity-induced bone-loss remains to be seen. Author

A87-52998
EFFECTS OF RECTILINEAR ACCELERATION, CALORIC AND OPTOKINETIC STIMULATION OF HUMAN SUBJECTS IN THE SPACELAB D-1 MISSION
J. WETZIG and R. VON BAUMGARTEN (Mainz, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 161-170. refs

Vestibular experiments performed during the German Spacelab D-1 mission (October 30-November 6, 1985) are described. Related hardware included the Space Sled and the vestibular helmet, the latter being used for air-colorization of the ears, optokinetic stimulation pattern presentation, and optical and nystagmographic recording of eye movements. It was found that the threshold for the perception of the linear acceleration direction was only slightly lowered while the gain of ocular counterrotation was significantly lowered after the mission as compared to preflight measurements. Optokinetic and caloric nystagmus were enhanced with free-floating. K.K.

A87-52999
SUBJECTIVE VERTICAL BEFORE AND AFTER SPACE FLIGHT
J. R. KASS and H. VOGEL (Mainz, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 171-174. BMFT-supported research.

Three astronauts of the D1 Spacelab mission were involved in orientation experiments performed before and after exposure to orbital weightlessness. An attempt was made to determine whether the signals from the otoliths to the CNS are effectively inhibited or enhanced as a result of exposure to O g. Each subject was tilted about a roll axis at 15-deg intervals up to +/- 90 deg and, at each angle, the subject set a luminous line to what he perceived to be vertical. The error in setting the vertical for the high-tilt range was greater during the early postflight period. K.K.

A87-53015
SYSTEMS INTERRELATIONS OF GRAVITY RESPONSES IN THE HUMAN ORGANISM, AND THE USE OF MODELLING
H. HINGHOFER-SZALKAY (Graz, Universitaet, Austria) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 315-321. refs

The application of mathematical modeling techiques to biological systems is considered with emphasis on the question of systems interrelations in the adaptation to weightlessness. Particular attention is given to the regulation of cardiovascular volumes and pressures, the influence of space flight on interstitial and vascular emptying, and the removal of forces to which the musculoskeletal system is subjected. B.J.

A87-53016
THE MUSCULO-SKELETAL SYSTEM IN MAN - DEVELOPMENT STRUCTURE AND FUNCTION IN DEPENDENCE ON GRAVITY, AND POTENTIAL LIMITATIONS FOR LONG TERM SPACE FLIGHTS
B. KUMMER (Koeln, Universitaet, Cologne, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 323-330. refs

A87-53090
MEDICAL PROBLEMS ASSOCIATED WITH LONG-DURATION SPACE FLIGHTS
WILLIAM M. DECAMPLI (Stanford University, Medical Center, CA) IN: The human quest in space; Proceedings of the Twenty-fourth Goddard Memorial Symposium, Greenbelt, MD, Mar. 20, 21, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 197-220.
(AAS PAPER 86-115)

Potential medical problems related to a 3-year duration mission to Mars are discussed. The microgravity effects of cardiovascular and muscular deconditioning, bone resorption, and sensorimotor maladaptation are examined. The effects of hostile external (radiation) and internal (infectious disease, psychological isolation and confinement, trauma, and airborne toxins) environments on the crew are studied. Consideration is given to endogenous medical problems (such as gastrointestinal and respiratory diseases and cancer) not detectable prior to the mission and to potential surgical emergencies. I.F.

A87-53620
EXECUTION OF 'ARC' EXPERIMENT ON SPACE SHUTTLE 'DISCOVERY' STS 51-C - SOME RESULTS ON AGGREGATION OF RED BLOOD CELLS UNDER ZERO GRAVITY
L. DINTENFASS (Sydney, University, Australia) Biorheology (ISSN 0006-355X), vol. 23, no. 4, 1986, p. 331-347. Research supported by the Australian Department of Science and Technology, Philip Bushell Foundations, CIBA-GEIGY AG, CSIRO, and USRA. refs

Data from an experiment conducted on the Space Shuttle from January 24-25, 1985 to define the kinetics and morphology of aggregation of red blood cells under zero gravity and under normal gravity are presented. Blood samples from healthy donors and donors with a history of ischaemic heart disease, colon cancer, juvenile-onset diabetes, and hyperlipidaemia were processed using an automated slit-capillary photoviscometer. The design and operation of the photoviscometer, which is composed of an optical, blood metering, and thermal electronic subsystems, is described. Analysis of micro- and macrophotographs of the red blood cell samples reveal that the red blood cells do not change shape under zero gravity; however, aggregation does occur. In the pathologic blood, it is observed that the aggregates show a morphology of normal rouleaux under zero gravity; however, on the ground, clumps of red cells are detected. It is suggested that zero gravity may affect cell-to-cell interaction and the microstructure of the cell membrane. I.F.

N87-29080# Joint Publications Research Service, Arlington, Va.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: SPACE BIOLOGY AND AEROSPACE MEDICINE, VOLUME 21, NO. 2, MARCH - APRIL 1987
O. G. GAZENKO, ed. 15 Jun. 1987 157 p Transl. into ENGLISH of Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), Mar.-Apr. 1987 407 p
(JPRS-USB-87-004) Avail: NTIS HC A08/MF A01

Various topics in space biology and aerospace medicine are discussed. Sociopsychological screening of flight personnel; the effects of alcohol, emotions and stress on performance; hypokinesis; radiation damage; pilot head kinematics during ejection into air flow; and the efficiency of anti-gravity suits with exposure to continuously increasing accelerations are among the topics covered.

N87-29082# Joint Publications Research Service, Arlington, Va.
FORMATION OF SPATIAL POSITION IMAGE WITH ONSET OF ILLUSIONS OF VESTIBULAR ORIGIN
O. A. VOROBYEV and V. V. IVANOV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 7-13 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 7-12
Avail: NTIS HC A08/MF A01

Specific features of a pilot's spatial orientation in response to spatial illusions of vestibular origin associated with their recognition and management are discussed. Analysis of data in the literature and observations by the present authors allow the conclusion that the pilot's spatial orientation, once spatial illusions have emerged, makes him assess not only the instrumental information, but also the pattern of his own controlling movements. As a consequence, it is suggested that in relation to the formation of a correct image of spatial position (particularly in the case of spatial illusions), the pilot's controlling movements act as part of instrumental information concerning the spatial position of the flying vehicle. Author

N87-29088# Joint Publications Research Service, Arlington, Va.
DYNAMICS OF FLUID TURNOVER IN HUMAN EXTREMITIES AS RELATED TO DIFFERENT BODY POSITIONS
N. YE. PANFEROVA and T. A. KABESHEVA *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 57-64 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 40-45
Avail: NTIS HC A08/MF A01

Anthropometric measurements and occlusion venous plethysmography were used to investigate fluid inflow and outflow in the limbs of human subjects who kept normal motor activity for 4 hours, remained in recumbency or were in the head down position at an angle of -12 degrees and -22 degrees (to simulate effects of zero gravity). During these exposures diuresis, heart rate and blood pressure were measured. In the horizontal and, to a greater extent, the head down position, when motor activity was diminished, volume blood flow velocity in the limbs decreased, i.e., blood inflow to them became smaller. Arm volume varied insignificantly since inflow and outflow were in balance, whereas leg volume decreased because fluid outflow was larger than inflow. In the head down position, the tone of the leg veins also declined. The data obtained indicate an active involvement of the peripheral vascular bed in the adaptation to diminished motor activity in the horizontal and head down position of human bodies. Author

N87-29089# Joint Publications Research Service, Arlington, Va.
FUNCTIONAL STATE OF THE HUMAN CARDIORESPIRATORY SYSTEM FOLLOWING 30-DAY ANTIORTHOSTATIC HYPOKINESIA
G. V. MACHINSKIY, V. P. BUZULINA, V. M. MIKHAYLOV, and E. I. NECHAYEVA *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 65-68 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 46-48
Avail: NTIS HC A08/MF A01

Before and after 30 day head down tilt (-8 degrees), the cardiorespiratory function of six healthy volunteers was assessed using an exercise test (aerobic workload on the treadmill that grew to the maximal level). After hypokinesia the maximal oxygen consumption decreased by 9.9 percent and total oxygen debt by 23 percent. The bioelectric activity of the heart showed a decrease of the T sub A wave by 34 percent and the T sub D by 30 percent. These changes are evidence that the cardiorespiratory system declined and as a consequence the ability of the subjects to perform sustained physical work of an aerobic character also declined. Author

N87-29090# Joint Publications Research Service, Arlington, Va.
VARIANT OF QUANTITATIVE EVALUATION OF MECHANISMS OF CENTRAL HEMODYNAMIC ORTHOSTATIC REACTIONS
P. A. TITUNIN, M. L. SVESHCHINSKIY, V. F. CHUDIMOV, and S. F. ZEROV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 69-74 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 48-52
Avail: NTIS HC A08/MF A01

An approach that can help clarify mechanisms of central circulation of orthostatic men using a mathematical model and noninvasive methods of examination is described. Circulation parameters such as peripheral resistance, arterial compliance, and ratio of vein compliance to the pump coefficient of the heart were determined by the partial identification method of the two component circulation model with the aid of cardiac output and arterial blood pressure measured by tetrapolar thoracic rheography and tachooscillography. A physiological interpretation of the above parameters, as related to the upright posture of man, is also given. Author

N87-29099# Joint Publications Research Service, Arlington, Va.
AUTOMATED ANALYSIS OF VECTORCARDIOGRAMS IN SPACE MEDICINE
N. I. VIKHROV, L. S. SOLOVYEVA, V. D. TURBASOV, V. K. VASILYEV, B. R. S. REDDI, and R. S. CHATTERJEE *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 120-124 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 79-82
Avail: NTIS HC A08/MF A01

An system of automated processing of vectorcardiographic (VCG) data is discussed. The spatial characteristics of the heart's electric field were measured in cosmonauts on the ground, in weightlessness at rest (5 minutes), during exercise (power of 130 W, 5 minutes) on a cycle ergometer, and during the recovery period (5 minutes). On the whole, the changes in VCG parameters under the influence of spaceflight factors were moderate. The parameters reverted to the preflight range within 4 days. Author

N87-29100# Joint Publications Research Service, Arlington, Va.
EFFECT OF VESTIBULAR STIMULATION ON STATIC PHYSICAL WORK CAPACITY
A. A. PODSHIVALOV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 125-128 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 83-84
Avail: NTIS HC A08/MF A01

A study of the static physical work capacity (SPW) of cervical extensors revealed that SPW diminishes after stimulation of the vestibular system and development of motion sickness reactions. The reliable decline of SPW of cervical extensors with vestibular stimulation confirms the close connection between propriocepters of cervical muscles and the vestibular system. Passive vestibular conditioning with prolonged, contrived displacement of the head enhances SPW of cervical muscles and prevents its decline following vestibular stimulation. Author

N87-29102# Joint Publications Research Service, Arlington, Va.
EFFECT OF VOLUNTARY CONTROL OF RESPIRATION ON FUNCTIONAL STATE OF THE CARDIORESPIRATORY SYSTEM IN THE PRESENCE OF HYPOXIC HYPOXIA
YE. P. GORA *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 132-134 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskay Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 86-87
Avail: NTIS HC A08/MF A01

At the present time there are no clearcut ideas about the effect of the modification of voluntary breathing on the functional state of the body in the presence of acute hypoxia. The objective was to test the influence of some modes of voluntary respiration on the cardiorespiratory system function in the presence of different degrees of acute hypoxia. Author

N87-29104# Joint Publications Research Service, Arlington, Va.
EVALUATION OF PSYCHOLOGICAL FITNESS FOR FLIGHT WORK
V. I. YEVDOKIMOV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 139-144 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, Mar. - Apr. 1987 p 89-92
Avail: NTIS HC A08/MF A01

In order to assess the the qualitative and quantitative aspects of psychological fitness for flying, a flight variant of the Thematic Apperception Test (TAT) was used. The flight variant of the TAT consisted of microsocial topics (intimate, family relations) and pictures on aviation subjects. It was concluded that by using the flight variant of the TAT one can detect psychological traits that are important to successful performance of flight assignments, which cannot be assessed by other methods in a number of cases. Author

N87-29105# Joint Publications Research Service, Arlington, Va.
SYMPOSIUM ON SPACE GASTROENTEROLOGY
K. V. SMIRNOV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 145-147 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 93-94
Avail: NTIS HC A08/MF A01

Eight papers on the topic of space gastroenterology are briefly discussed. The phenomenology of changes in the digestive system; adaptive changes in hydrolysis, transport and utilization of carbohydrates in hypogravity and hypokinetic conditions; the role of digestive organs in lipid metabolism under hypokinetic conditions; intestinal microecology during spaceflight; human bile and pancreatic secretions in the presence of emotional stress caused by taking state tests or first parachute jumps; the effect of hypokinesia on parameters of liver function; and changes in the fatty acid composition of human blood serum during 120 day hypokinesia are among the topics discussed. R.J.F.

N87-29108# Defence Research Information Centre, Orpington (England).
TREATMENT OF DEGENERATIVE DISEASES OF THE SPINE BY PHYSIOTHERAPY
W. KOCH and A. LYNN Dec. 1985 11 p Transl. into ENGLISH from Orthop. Praxis (West Germany), no. 9, 1982 p 690-695
(DRIC-T-7613) Avail: NTIS HC A02/MF A01

Three methods of treating degenerative diseases of the spine by physiotherapy are reviewed. Specific examples involving patients are discussed which demonstrate the effectiveness of different heat, physiotherapy, and exercise treatments. The uses of physiotherapy for differing degrees of disorders and backache are also considered, from its use in post-operative therapy to simple self-help ergotherapy exercise treatments. Author

N87-29109# Universal Energy Systems, Inc., Dayton, Ohio.
OPTIMIZATION OF PERIPHERAL VISION Final Report, Apr. - Sep. 1985
JULIEN M. CHRISTENSEN, ROBERT D. ODONNELL, CLARK A. SHINGLEDECKER, CONRAD L. KRAFT, and GARY WILLIAMSON Nov. 1986 82 p
(Contract F33615-84-D-0658)
(AD-A182438; USAFSAM-TR-85-96) Avail: NTIS HC A05/MF A01 CSCL 06D

One of the most exciting ideas that has emerged fairly recently in the time-honored area of visual research is that of a system that consists of the central (also foveal or focal) and the peripheral (also ambient) subsystems. The subsystems functions are roughly described as what and where. Such broad assignment of function is acceptable as long as we don't forget that some of each function (i.e., location and identification) is subserved by both subsystems and that there is significant interaction between the two. In the past, the overwhelming amount of scientific attention has been toward the central subsystem; relatively speaking, the peripheral subsystem has been seriously neglected. This report should stimulate renewed interest within the U.S. Air Force in discovering more about the capabilities and limitations, both inherited and acquired, of the peripheral subsystem. The reports include sections on anatomical foundations; functional performance characteristics; improvement through training; history of peripheral vision displays; and experimental occlusion techniques. GRA

N87-29110# Yale Univ., New Haven, Conn. Dept. of Psychology.
LEVELS OF ANALYSIS OF COMPLEX AUDITORY STIMULI Final Report, 1 Sep. 1984 - 31 Aug. 1986
ARTHUR G. SAMUEL 16 Jan. 1987 50 p
(Contract AF-AFOSR-0324-84)
(AD-A182699; AFOSR-87-0861TR) Avail: NTIS HC A03/MF A01 CSCL 06D

The two-year project (AFOSR 84-0324) called for work in several areas of complex auditory pattern perception. Our first annual report summarized research in two of these areas. This report summarizes our efforts in four other areas. The most detailed section of this report covers work on the perception of normal and whispered speech. Using the selective adaptation paradigm, this study examined the representation of stops and continuants. The results supported the existence of a simple acoustic, peripheral level of representation, and a complex acoustic, central level of representation. Three other lines of research are briefly summarized in this report. First, several experiments tested the putative role of the syllable in the disruption of perception under conditions of signal ear-alternation. The second brief report covers work on timbre perception. A trumpet - cello continuum of tokens was synthesized, and used in various speech perception paradigms. The final brief summary reports work on the perceptual restoration of musical notes. Those experiments were designed to explore possible commonalities in the use of expectations in the perception of complex auditory patterns. The data suggest that music perception does make use of expectations, and that aspects of such perception are analagous to the use of lexical and sentential information in speech. GRA

N87-29111# Systems Science and Software, La Jolla, Calif.
CHARGING OF A MAN IN THE WAKE OF THE SHUTTLE
G. A. JONGEWARD, I. KATZ, M. J. MANDELL, and J. R. LILLEY, JR. Jul. 1986 69 p
(Contract F19628-82-C-0081)
(AD-A182789; SSS-R-86-8064; AFGL-TR-86-0139; SR-5) Avail: NTIS HC A04/MF A01 CSCL 20C

Charging of the DMSP F6 and F7 satellites is shown to result from the combined effects of high flux of high energy auroral electrons and low ambient background ion density. POLAR computer code calculations are presented which show that a shuttle size object will charge more than 3000 volts negative under these charging conditions. The highly charged shuttle accelerates ions to the shuttle potential producing a high energy mono-energetic plasma environment near the shuttle. During these charging events, an astronaut performing EVA will charge with its ion collection orbit limited. Material secondary properties will produce differential charging on the astronaut of the same magnitude as the shuttle charging potential. NASCAP computer code calculations of EMU charging in the near shuttle environment show differential voltage of 2600 volts and overall charging 1000 volts more negative than the shuttle will occur. GRA

N87-29112# National Aerospace Medical Centre, Soesterberg (Netherlands).
ACTIVITIES REPORT IN AEROSPACE MEDICINE Annual Report, 1985 [STICHTING NATIONAAL LUCHT-ENRUIMTE-VAARTGENEESKUNDIG CENTRUM]
1985 42 p In DUTCH
(ETN-87-90153) Avail: NTIS HC A03/MF A01

Research in X-ray recording, electroencephalograms, military activities, airline operations, certificates, and ophthalmology are described. ESA

N87-29113 California Univ., Los Angeles.
CAROTID BODY CONTRIBUTIONS TO THE EXERCISE HYPERNEA IN MAN Ph.D. Thesis
JOHN WILLIAM MACDONALD, II 1987 212 p
Avail: Univ. Microfilms Order No. DA8711689

Evidence suggests that the carotid bodies contribute to hypernea during steady-state exercise. There is little systematic investigation of how work-rate influences their proportional contribution. The purpose of this investigation was to explore this issue, by application of the Dejours' O2-switching technique, in healthy subjects at moderate and heavy work-rates. Based upon the assumption that 100 percent O2 silences the carotid body chemoreflex, Dejours devised a scheme to estimate the magnitude of the carotid body drive. Hence, switching a subject's inspirate from air to O2 caused ventilation (VE) to fall after 2 to 3 breaths reflecting the vascular transit delay from the lungs to carotid bodies; the VE decay is assumed to represent the effect of turning off the carotid bodies. Recognizing that secondary factors might influence VE prior to the carotid chemoreflex being completely suppressed, a technique was developed for predicting the full magnitude of this suppression. This technique was based on evidence which shows that the carotid chemoreceptor and ventilatory response dynamics to primary changes in alveolar and arterial PO2 appear to be first-order. It is suggested that the proportional contribution of the carotid bodies to the hypernea of steady-state exercise is independent of work-rate. The predicted data led to the same conclusion as the observed data with a proportional VE fall of 26.9 percent. Dissert. Abstr.

N87-29114*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
EMPIRICAL MODELS FOR USE IN DESIGNING DECOMPRESSION PROCEDURES FOR SPACE OPERATIONS
JOHNNY CONKIN, BENJAMIN F. EDWARDS (Krug International, Houston, Tex.), JAMES M. WALIGORA, and DAVID J. HORRIGAN, JR. Jun. 1987 52 p
(NASA-TM-100456; S-562; NAS 1.15:100456) Avail: NTIS HC A04/MF A01 CSCL 06P

Empirical models for predicting the incidence of Type 1 altitude decompression sickness (DCS) and venous gas emboli (VGE) during space extravehicular activity (EVA), and for use in designing safe denitrogenation decompression procedures are developed. The models are parameterized using DCS and VGE incidence data from NASA and USAF manned altitude chamber decompression tests using 607 male and female subject tests. These models, and procedures for their use, consist of: (1) an exponential relaxation model and procedure for computing tissue nitrogen partial pressure resulting from a specified prebreathing and stepped decompression sequence; (2) a formula for calculating Tissue Ratio (TR), a tissue decompression stress index; (3) linear and Hill equation models for predicting the total incidence of VGE and DCS attendant with a particular TR; (4) graphs of cumulative DCS and VGE incidence (risk) versus EVA exposure time at any specified TR; and (5) two equations for calculating the average delay period for the initial detection of VGE or indication of Type 1 DCS in a group after a specific denitrogenation decompression procedure. Several examples of realistic EVA preparations are provided. Author

N87-30025*# Brown Univ., Providence, R. I. Dept. of Lab. Medicine.
GROWTH FACTOR INVOLVEMENT IN TENSION-INDUCED SKELETAL MUSCLE GROWTH Semiannual Status Report, 1 Apr. - 31 Sep. 1987
H. H. VANDENBURGH 1987 8 p
(Contract NAG2-414)
(NASA-CR-181349; NAS 1.26:181349) Avail: NTIS HC A02/MF A01 CSCL 06P

Muscle tissue culture techniques were developed to grow skeletal myofibers which differentiate into more adult-like myofibers. Mechanical simulation studies of these muscle cells in a newly developed mechanical cell simulator can now be performed to study growth processes in skeletal muscle. Conditions in the mechanical cell simulator were defined where mechanical activity can either prevent muscle wasting or stimulate muscle growth. The role of endogenous and exogenous growth factors in tension-induced muscle growth is being investigated under the defined conditions of tissue culture. M.G.

N87-30026# School of Aerospace Medicine, Brooks AFB, Tex. Radiation Physics Branch.
PROCEEDINGS OF A WORKSHOP ON RADIOFREQUENCY RADIATION BIOEFFECTS Final Report
JOHN C. MITCHELL, ed. Apr. 1985 242 p Workshop held in Wachtberg-Werthhoven, West Germany, 11-13 Sep. 1984; sponsored by NATO
(Contract AF PROJ. 7757)
(AD-A157090; USAFSAM-TP-85-14) Avail: NTIS HC A11/MF A01 CSCL 06R

The workshop addressed new developments in the field of Radio Frequency Radiation (RFR). Safety standards, assessment of RFR levels in the military environment, RFR instrumentation and dosimetry, biological effects of long-term low-level RFR exposures and pulsed versus continuous wave effects are among the topics discussed.

N87-30027# Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
PHYSICAL INTERACTIONS OF RADIOFREQUENCY RADIATION FIELDS AND BIOLOGICAL SYSTEMS
CARL H. DURNEY *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 5-36 Apr. 1985 Previously announced as N85-27129
Avail: NTIS HC A11/MF A01 CSCL 06R

A biological system irradiated by radiofrequency radiation (RFR) responds to the internal RFR fields produced by that irradiation. The measurement and calculation of the internal fields is called dosimetry. The internal fields are often described in terms of the specific absorption rate (SAR) in watts/kilogram. A combination of techniques, each valid for a particular model and in a particular frequency range, are used to calculate average whole body SAR's for models of human beings and other animals over a wide frequency range for plane wave irradiation. Calculating SAR's for near field irradiation is much more difficult than for plane wave irradiation; thus, fewer near field SAR data are available. To calculate spatial distribution of SAR's is still more difficult (especially at higher frequencies); this problem in dosimetry is yet to be solved satisfactorily, although significant progress has recently been made in this area. Author

N87-30028# Yale Univ., New Haven, Conn.
THERMAL PHYSIOLOGY OF RFR INTERACTIONS IN ANIMALS AND HUMANS
ELEANOR R. ADAIR *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 37-54 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

The description of thermoregulation in any endotherm involves detailed knowledge of thermoregulatory behavior, both instinctive and learned, as well as knowledge of autonomic processes of heat production and heat loss. It is shown that the particular autonomic response that may be ongoing at any given time is dictated by the prevailing environmental temperature. In other words, endotherms shiver in the cold and pant or sweat in the heat, but not the reverse, and they will avoid doing either if an efficient behavioral maneuver is available to them. Radiofrequency radiation (RFR) may be regarded as part of the thermal environment to which man and other endotherms may be exposed. The maintenance of heat balance in a body exposed to radiofrequency radiation is discussed. Author

N87-30029# School of Aerospace Medicine, Brooks AFB, Tex.
CRITICAL REVIEW OF SELECTED TOPICS ON BIOLOGICAL EFFECTS OF RADIOFREQUENCY RADIATION
JEROME H. KRUPP, LOUIS N. HEYNICK, and PETER POLSON (SRI International Corp., Menlo Park, Calif.) *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 55-84 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

Several selected reports regarding radio frequency radiation (RFR) bioeffects that were considered important with regard to possible hazards to human beings were critically reviewed. Researchers concluded that no reliable evidence indicates that chronic exposure to RFR at incident average power densities below 1 mW/square cm or at SAR's below 0.4 W/kg are hazardous to human health. Important uncertainties are reviewed. Author

N87-30030# School of Aerospace Medicine, Brooks AFB, Tex.
RADIOFREQUENCY RADIATION SAFETY STANDARDS
JOHN C. MITCHELL *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 85-102 Apr. 1985 Previously announced as N85-27137
Avail: NTIS HC A11/MF A01 CSCL 06R

Using a safety factor of 10, the American Standards Institute developed radio frequency radiation (RFR) protection guides that will limit all human whole body exposures to incident energy that results in a specific absorption rate (SAR) no greater than 0.4 W/kg. This allows incident average power densities from 1 to 100 mW/square cm depending upon the frequency of the radiation. New safety guidelines are compared with many other RFR standards used throughout the world. Author

N87-30031# Office of Naval Research, Arlington, Va.
RFR RESEARCH PROJECTIONS FOR THE FUTURE
MICHAEL T. MARRON *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 103-119 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

A review is given of where we are going in the field of bioelectromagnetics. It is concluded that research into the mechanisms by which electromagnetic fields interact with biological tissue will assume increasing importance ir the next few years. The major new impetus for mechanism research will be derived from beneficial applications of electromagnetic fields to biological tissue. Use of electric and magnetic fields to promote healing is already widespread and will continue to increase. Author

N87-30032# School of Aerospace Medicine, Brooks AFB, Tex.
THE CUMULATIVE EFFECTS OF LONG-TERM EXPOSURE TO LOW LEVELS OF RADIOFREQUENCY RADIATION (RFR)
JEROME H. KRUPP *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 121-133 Apr. 1985 Previously announced as N85-27132
Avail: NTIS HC A11/MF A01 CSCL 06R

Over a four-year period of planning, pilot study, and definitive experiment, a lifetime exposure is given to a population of test animals (100) whose state of health, growth, and cause of death are closely monitored. An equal number of sham expected animals served as a comparison population. After 25 months of exposure, at the point where there is 90 percent mortality in both groups, the remaining subjects are sacrificed and assayed. The overall conclusion is that no cumulative ill effects could be attributed to the life-long exposure at absorption rates of 0.4 W/kg or less. Author

N87-30033# School of Aerospace Medicine, Brooks AFB, Tex.
HUMAN EXPOSURES TO RADIOFREQUENCY RADIATION (RFR). A REVIEW OF RFR ACCIDENTS
JOHN C. MITCHELL *In its* Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 135-141 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

A review and analysis of Air Force radio frequency radiation (RFR) accident files were performed. The following conclusions are evident: (1) of the 296 suspected overexposures, only 58 (approx. 20 percent) were confirmed, the other 80 percent being within the permissible exposure limit; (2) about half of the overexposures were detected because the individual(s) felt a warming sensation; (3) essentially all of the exposures were partial body exposures; (4) actual exposure times were most often less than 6 minutes; and (5) most of these exposures occurred at frequencies between 1 and 10 GHz. Medical review of the physical examinations following RFR overexposure revealed few consistent clinical patterns. Erythema and/or edema were rare findings at the time of the examination. Lenticular findings such as vacuoles and opacities were noted in some overexposed individuals receiving radiation to the head. None of these findings, however, were

deemed clinically significant since there was no concomitant visual impairment. Author

N87-30034# Defence Research Establishment, Ottawa. (Ontario).
APPLICATION OF HUMAN WHOLE-BODY RF ABSORPTION MEASUREMENTS TO RFR SAFETY STANDARDS
DOUGLAS A. HILL *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 143-161 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

Human whole-body radiofrequency (RF) absorption rates were measured as a function of body orientation, wave impedance, separation from ground, and frequency (from 3 to 40 MHz). Results applicable to RF radiation protection are summarized. The worst-case radiation exposure situation is taken to be the far-field whole-body exposure of a man wearing footgear and standing on the ground plane. Assuming that 0.4 W/kg is a safe whole-body specific absorption rate (SAR), the permitted exposure levels (PEL's) set by the 1982 ANSI standard are well supported by researchers' results. On the other hand, PEL's set by NATO STANAG 2345 are unsafe at most frequencies from 5 to 40 MHz. RF currents through the feet of grounded subjects were also measured. For the maximum exposures permitted by the ANSI standard, the RF currents cause a localized SAR in the ankle region of 16 W/kg. Author

N87-30035# Laboratory for Electronic Development of the Armed Forces, Oegstgeest (Netherlands).
EXPOSURE TO RADIOFREQUENCY FIELDS IN THE NETHERLANDS: MEASUREMENTS AND EVALUATION
AUGUSTINUS B. WOLTERING *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 163-177 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

The activities carried out on behalf of the inventory of the power flux density (PFD) in the vicinity of civil radio frequency (RF) sources in the frequency band of 0.5 MHz to 18 GHz are discussed. A computer program that gives a general (theoretical) impression of the RF environment was developed. Information about civil transmitters was collected and relevant technical parameters to be used as input data for this computer program were deduced. Measurements in the vicinity of RF emitting equipment such as seal machines that are too complex to model theoretically were carried out. Author

N87-30036# London Univ. (England). Dept. of Physics.
DIELECTRIC BEHAVIOUR OF WATER IN BIOLOGICAL MATERIAL WITH PARTICULAR REFERENCE TO BRAIN TISSUE
EDWARD H. GRANT *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 179-186 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

The absorption of microwave energy by biological material at frequencies in excess of 1 GHz is due mainly to the water content. Knowledge of the dielectric properties of water in biological material is therefore a necessary prerequisite for the calculation of energy deposition. However, the water of hydration immediately adjacent to biological macromolecules is subject to chemical forces different from those in bulk water and must in consequence exhibit different dielectric properties. The nature and proportion of this water vary considerably from one tissue to another and therefore need to be evaluated for each specific case. For adult rabbit brain material, dielectric measurements show that the water of hydration constitutes about 20 percent of the total while the remainer has dielectric properties similar to those of pure water. With brain tissue from recently born rabbits, the proportion of water of hydration is indistinguishable from zero. Author

N87-30037# Bundesgesundheitsamt, Neuherberg (West Germany). Inst. for Radiation Hygiene.
EVALUATION OF HUMAN EXPOSURE TO LOW FREQUENCY FIELDS
JURGEN H. BERNHARDT *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 187-202 Apr. 1985
Previously announced as N85-27135
Avail: NTIS HC A11/MF A01 CSCL 06R

Threshold values of field strength or current density, inducing biological effects are compiled from experimental and theoretical studies. On the basis of these data it is possible to establish safe, dangerous and hazardous current density curves as a function of frequency. The criterion for the definition of injury is the elicitation of ventricular fibrillation which must be avoided. To define exposure limits, the field strength or current density causing injury should be reduced by a factor exceeding 100. The arguments supporting this wide safety margin are discussed. The electric and magnetic field strength in the human environment is correlated with the corresponding electric current density induced in the human body. This enables safe, dangerous and hazardous levels of current density in the human body to be correlated with the external electric or magnetic field strength. Author

N87-30038# Forschungsinstitut fuer Hochfrequenzphysik, Werthhoven (West Germany).
RADIOFREQUENCY RADIATION SAFETY GUIDELINES IN THE FEDERAL REPUBLIC OF GERMANY
KLAUS W. HOFMANN *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 203-216 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

The German safety rules in the fields of electronics and electricity are summarized. Part 1 of the standard includes instructions on how to take measurements and how to do calculations so as to get comparable results. Part 2 is concerned mainly with direct effects of electric shock. Part 3, which exists only in draft form, includes guidelines for the protection against explosive gas-air mixtures. Part 4, which is still under consideration, deals with electroexplosive devices. Author

N87-30039# Defence Research Establishment, Ottawa. (Ontario).
RADIOFREQUENCY RADIATION SAFETY OF TWO MANPACK TRANSCEIVERS (AN/PRC-515 AND AN/PRC-77)
DOUGLAS A. HILL *In* SAM, Proceedings of a Workshop on Radiofrequency Radiation Bioeffects p 217-223 Apr. 1985
Avail: NTIS HC A11/MF A01 CSCL 06R

The radiofrequency radiation (RFR) safety of two Canadian Forces manpack transceivers (AN/PRC-515 and AN/PRC-77) was studied by a university contractor. The relationship of his study to current thinking in the field of RFR safety is explained. The main findings are summarized and applied to operations. It is concluded that both transceivers are safe under all practical operating conditions. Author

N87-30040# Ottawa Univ. (Ontario). Dept. of Electrical Engineering.
SPECIFIC ABSORPTION RATE DISTRIBUTIONS IN A HETEROGENEOUS MODEL OF THE HUMAN BODY AT RADIOFREQUENCIES
S. S. STUCHLY Jun. 1987 102 p
(Contract EPA-R-812156)
(PB87-201356; EPA/600/1-87/003) Avail: NTIS HC A06/MF A01 CSCL 06R

The electric field distribution of the rate of energy absorption referred to as the specific absorption rate (SAR) in a biological body is a complex function of several exposure parameters such as frequency, intensity of the incident field, polarization, source to object configuration (near field vs far field), and the body characteristics such as size, shape, and dielectric properties. An experimental approach was employed to determine SAR patterns in a full scale heterogeneous model of man exposed to radiofrequency fields at 160, 350, and 914 MHz in the far and near fields for two polarizations. The model had an anatomically

correct shape and contained a skull, spinal cord, rib cage, and all major bones (except those in the feet and hands), brains, lungs, and muscle tissue. The square of the electric field inside the model was measured by a small diameter electric field probe. Data acquisition, exposure conditions, and data processing were under computer control. Specific circuitry including an optical link was used to interface the electric field probe with the computer. Extensive data were obtained, analyzed, and compared with the data for a homogeneous model. GRA

N87-30041* National Aeronautics and Space Administration, Washington, D.C.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 302)
Oct. 1987 55 p
(NASA-SP-7011(302); NAS 1.21:7011(302)) Avail: HC A04 CSCL 06E

This bibliography lists 131 reports, articles, and other documents introduced into the NASA scientific and technical information system in September, 1987. Author

N87-30042# Joint Publications Research Service, Arlington, Va.
USSR REPORT: LIFE SCIENCES. BIOMEDICAL AND BEHAVIORAL SCIENCES
29 Apr. 1987 93 p Transl. into ENGLISH from various Russian articles
(JPRS-UBB-87-009) Avail: NTIS HC A05/MF A01

Topics addressed include: aerospace medicine, agrotechnology; biochemistry; biophysics; immunology; pharmacology and toxicology; physiology; public health; radiation biology; nonionizing electromagnetic radiation; military medicine; laser bioeffects; epidemiology; and genetics.

N87-30043# Joint Publications Research Service, Arlington, Va.
CIRCULATORY CHANGES IN CAROTID ARTERY BASIN IN RESPONSE TO ANTIORTHOSTASIS AND ANTIORTHOSTATIC BED REST Abstract Only
B. M. FEDOROV, YE. N. STRELTSOVA, and T. V. SEBEKINA *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences p 1 29 Apr. 1987 Transl. into ENGLISH from Fiziologiya Cheloveka (Moscow, USSR), v. 11, no. 5, Sep. - Oct. 1985 p 755-762 Original language document was announced in IAA as A86-15513
Avail: NTIS HC A05/MF A01

The effect of antiorthostasis (AO) on circulation in the carotid pool was studied in healthy men placed in -8 deg head-down tilt, and in anesthesized dogs subjected to -45 or -90 deg AO. The 5-day-long antiorthostatic hypokinesia in men led to a decreased blood flow in the carotid and orbital arteries, an increase in the peripheral resistance index, a decreased reactivity to the compression test, and a decreased functioning of the flow along the anterior communicating artery when the common carotid was compressed. During the later phases of the 30-day long AO, these blood flow indices tended to return to normal. In dogs, the AO led to a sharp increase in pressure in the jugular veins and in peripherals of the carotid pool, and to a decrease of blood flow rate in the carotid arteries. IAA

N87-30044# Joint Publications Research Service, Arlington, Va.
HEMODYNAMIC EFFECTS OF NEGATIVE PRESSURE IN LOWER BODY Abstract Only
M. M. MIRRAKHIMOV, T. A. AZHIMAMATOV, and T. B. BALTABAYEV *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences p 2 29 Apr. 1987 Transl. into ENGLISH from Fiziologiya Cheloveka (Moscow, USSR), v. 11, no. 5, Sep. - Oct. 1985 p 763-769 Original language document was announced in IAA asA86-15514
Avail: NTIS HC A05/MF A01

The effect of lower body negative pressure (LBNP) on the cardiovascular functions was studied in 42 normal male subjects aged 31-64 yrs, using noninvasive methods of electrocardiography, phonocardiography, and tetrapolar thoracic rheography. The responses to the LBNP included increases in heart rate and in systemic vascular pressure, decreases in the heart rate and the cardiac indices as well as in the volumes of the cardiac chambers, caused by partial detainment of blood in the large-capacity blood vessels of the lower body. The degree of these changes depended on the magnitude of applied LBNP, which was in the range of 20-60 mm. Rapid (2-3 sec) decompression caused the temporarily detained blood to enter the circulation, leading to short-term increases of the cardiac volume load and to reversal of the hemodynamic effects caused by the LBNP. IAA

N87-30045# Joint Publications Research Service, Arlington, Va.
INTERACTION OF MACULA AND SEMICIRCULAR CANALS IN ANGULAR STABILIZATION OF MAN IN SPACE Abstract Only
V. M. GUSEV and V. A. KISLYAKOV *In its* USSR Report: Life Sciences. Biomedical and Behavioral Sciences p 2-3 29 Apr. 1987 Transl. into ENGLISH from Biofizika (Moscow, USSR), v. 31, no. 1, Jan. - Feb. 1986 p 123-127 Original language document was announced in IAA as A86-27474
Avail: NTIS HC A05/MF A01

A mathematical model is developed for spatial angular stabilization in which the fixed and variable space coordinates are related to the coordinates of the semicircular canals and the otolithic organ during spatial displacement. The equations describing the interrelationship of both vestibular systems are solved for the case of abrupt displacement of angular vectors, and for the case of slow periodic variations of the same angles, approximating the pitching and rocking motion of a medium-size fishing trawler. The results indicate a need for integrated activity of both the semicircular canals and the otolithic organ for an acceptable stabilization: the canals insure short-term stabilization and stabilization during the abrupt changes of spatial orientation, while the otolithic organ plays a dominant role during long-term slowly occurring changes. IAA

N87-30046# Ministry of Defence, Tel-Aviv (Israel). Directorate of Defence R and D.
ADJUSTMENT AND VALIDATION OF THE MATHEMATICAL PREDICTION MODEL FOR SWEAT RATE, HEART RATE AND BODY TEMPERATURE UNDER OUTDOOR CONDITIONS Annual Report, 7 Oct. 1985 - 6 Oct. 1986
Y. SHAPIRO, R. BURSTEIN, and Y. EPSTEIN 1 Nov. 1986 17 p
(Contract DAMD17-85-G-5044)
(AD-A183109) Avail: NTIS HC A02/MF A01 CSCL 06J

This study is conducted in order to validate under outdoor conditions, and if necessary, to adjust the mathematical models to predict physiological tolerance under different environmental conditions, solar loads, clothing ensembles, and metabolic rates. Different physiological parameters were carefully monitored. The results show that the prediction models, which were developed from laboratory studies, are conservative and overestimate the physiological responses under outdoor conditions. It is hypothesized that a factor related to long wave radiations should be included in the equations. GRA

N87-30047# School of Aerospace Medicine, Brooks AFB, Tex.
SPATIAL ORIENTATION IN FLIGHT Final Report, Jan. 1982 - Jan. 1985
KENT K. GILLINGHAM and JAMES W. WOLFE Dec. 1986 133 p
(AD-A183431; USAFSAM-TR-85-31) Avail: NTIS HC A07/MF A01 CSCL 06J

Man's orientational mechanisms, and how those mechanisms fail in flight, are discussed in this comprehensive review. Specific topics include: Mechanics and associated physiologic nomenclature; visual orientation; vestibular function and information processing; other senses of motion and position; spatial disorientation, including causes, types, examples, statistics, and methods of preventing orientation mishaps; and the significance, etiology, and therapy of motion sickness. Forty-three figures are included, many illustrating vestibular anatomy and physiology, and others depicting the more common visual and vestibular illusions

in flight. Sixty-five classic references and a recommended reading list are also provided. GRA

N87-30048# Naval Aerospace Medical Research Lab., Pensacola, Fla.
NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY BIBLIOGRAPHY, 1981-1986 Interim Report, 1 Jan. 1981 - 31 Dec. 1986
KATHLEEN S. MAYER Jun. 1987 21 p
(AD-A183837) Avail: NTIS HC A02/MF A01 CSCL 06E

This report lists citations of all unclassified research reports, special reports, monographs, journal articles, and proceedings that were published by the Naval Aerospace Medical Research Laboratory during calendar years 1981 through 1986. Requests for numbered reports (AD XXX XXX) should be directed to DTIC, Cameron Station, Alexandria, Virginia 22314. Requests for articles that were published in the open literature should be addressed to the author, NAMRL, NAS, Pensacola, Florida 32508-5700. GRA

N87-30049*# Good Samaritan Hospital and Medical Center, Portland, Oreg. Neurological Sciences Inst.
ROLE OF ORIENTATION REFERENCE SELECTION IN MOTION SICKNESS, SUPPLEMENT 2S Semiannual Status Report
ROBERT J. PETERKA and F. OWEN BLACK Oct. 1987 16 p
(Contract NAG9-117)
(NASA-CR-181393; NAS 1.26:181393) Avail: NTIS HC A02/MF A01 CSCL 06P

Previous experiments with moving platform posturography have shown that different people have varying abilities to resolve conflicts among vestibular, visual, and proprioceptive sensory signals. The conceptual basis of the present proposal hinges on the similarities between the space motion sickness problem and the sensory orientation reference selection problems associated with benign paroxysmal positional vertigo (BPPV) syndrome. These similarities include both etiology related to abnormal vertical canal-otolith function, and motion sickness initiating events provoked by pitch and roll head movements. The objectives are to explore and quantify the orientation reference selection abilities of subjects and the relation of this selection to motion sickness in humans. The overall objectives are to determine: if motion sickness susceptibility is related to sensory orientation reference selection abilities of subjects; if abnormal vertical canal-otolith function is the source of abnormal posture control strategies and if it can be quantified by vestibular and oculomotor reflex measurements, and if it can be quantified by vestibular and oculomotor reflex measurements; and quantifiable measures of perception of vestibular and visual motion cues can be related to motion sickness susceptibility and to orientation reference selection ability. B.G.

N87-30065# Britannia Airways Ltd., Luton (England).
IN-FLIGHT ASSESSMENT OF WORKLOAD USING PILOT RATINGS AND HEART RATE
ALAN H. ROSCOE *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 78-82 Jun. 1987
Avail: NTIS HC A07/MF A01

At present the most used and probably the most reliable methods for assessing pilot workload in flight are based on some form of subjective reporting by experienced test pilots. Subjective opinions are susceptible to bias and preconcieved ideas and so may occasionally result in false estimates of workload. For more than 15 years subjective reporting at RAE Bedford has been augmented by recording their heart rates. At first pilots described workload in a relatively unstructured manner but the need for some form of rating scale was soon apparent. After much trial and error, a 10 point rating scale using the concept of spare capacity was developed. The overall design is based on the Handling Qualities Rating Scale of Cooper and Harper. During the past 8 year a number of flight trials have used pilot ratings and heart rate responses to assess workload. The rationale for using heart rate in assessing pilot workload is based on the concept of neurological arousal. The technique is described and examples of its use are given. Also listed and briefly discussed are limitations and pitfalls of the technique. Author

53

BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

A87-50947
THE DEVELOPMENT OF AN ALGORITHM FOR PREDICTING THE SUCCESS OF AN OPERATOR'S ACTIVITY ON THE BASIS OF A SMALL LEARNING SAMPLE [RAZRABOTKA ALGORITMA PROGNOZIROVANIIA USPESHNOSTI DEIATEL'NOSTI OPERATOROV PRI MALOI OBUCHAIUSHCHEI VYBORKE]
A. I. KHORISHKO, IU. V. GORSKII, IU. V. ASTAPOV, and V. V. KORMACHEV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), April 1987, p. 33-35. In Russian.

A87-51162
PART-TASK TRAINING STRATEGIES IN SIMULATED CARRIER LANDING FINAL-APPROACH TRAINING
DENNIS C. WIGHTMAN (U.S. Navy, Naval Training Systems Center, Orlando, FL) and FRANK SISTRUNK (South Florida, University, Tampa, FL) Human Factors (ISSN 0018-7208), vol. 29, June 1987, p. 245-254. refs

The effect of selected part-task training strategies on transfer to simulated carrier landing is investigated. Fourty male students ranging in age from 18-28 years were taught the final approach phase of the carrier landing tasks using a conventional takeoff and landing simulator. The students were tested for four training conditions: (1) whole task with normal lag; (2) whole task with progressively increased lag; (3) segmented task with normal lag; and (4) segmented task with progressively increased lag. The motor-skill aptitudes of the subjects are also assessed. It is observed that training under the task segmentation strategy produces better transfer to the task than does the whole approach training strategy. The relation between aptitude and training strategy is examined, and it is determined that the segmentation training is more useful for low-aptitude subjects. I.F.

A87-51164* California State Univ., Hayward.
HESITATIONS IN CONTINUOUS TRACKING INDUCED BY A CONCURRENT DISCRETE TASK
STUART T. KLAPP, PATRICIA A. KELLY, and ALLAN NETICK (California State University, Hayward) Human Factors (ISSN 0018-7208), vol. 29, June 1987, p. 327-337. Previously announced in STAR as N86-29503. refs
(Contract NCC2-223)

Subjects performed a continuous visually-guided pursuit tracking task with the right hand. From time to time (intervals averaging 30 sec) an auditory tone appeared signaling the subjects to perform a discrete response with the left hand. The presence of this tone was frequently associated with a hesitation in right-hand tracking which lasted 1/3 sec or longer. The rate of occurrence of these hesitations was about the same when the left-hand response involved a choice between competing responses as when the left hand responded in a predetermined direction. Hesitations occurred for three different mechanical tracking manipulanda using different controlling muscles, and appeared to be due to freezing rather than to relaxation of muscular action. The rate of occurrence of hesitations declined with practice, and this improvement in right-hand performance was accompanied by an improvement in performance of the concurrent left-hand response. The presence of hesitations, and their reduction with practice, can be interpreted within several viewpoints. Author

A87-51165* Toronto Univ. (Ontario).
A CLOSED-LOOP CAUSAL MODEL OF WORKLOAD BASED ON A COMPARISON OF FUZZY AND CRISP MEASUREMENTS TECHNIQUES
NEVILLE MORAY, BARBARA KING, BURHAN TURKSEN, and KEITH WATERTON (Toronto, University, Canada) Human Factors (ISSN 0018-7208), vol. 29, June 1987, p. 339-348.
(Contract NAGW-429)

Fuzzy and crisp measurements of workload are compared for a tracking task that varied in bandwidth and order of control. Fuzzy measures are as powerful as crisp measures, and can under certain conditions give extra insights into workload causality. Both methods suggest that workload arises in a system in which effort, performance, difficulty, and task variables are linked in a closed loop. Marked individual differences were found. Future work on the fuzzy measurement of workload is justified. Author

A87-52092* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ESTIMATION OF LOCAL SPATIAL SCALE
ANDREW B. WATSON (NASA, Ames Research Center, Moffett Field, CA) Optical Society of America, Journal, A: Optics and Image Science (ISSN 0740-3232), vol. 4, Aug. 1987, p. 1579-1582. refs

The concept of local scale asserts that for a given class of psychophysical measurements, performance at any two visual field locations is equated by magnifying the targets by the local scale associated with each location. Local scale has been hypothesized to be equal to cortical magnification or alternatively to the linear density of receptors or ganglion cells. Here, it is shown that it is possible to estimate local scale without prior knowledge about the scale or its physiological basis. Author

A87-54098
INTERACTION BETWEEN COLOUR AND MOTION IN HUMAN VISION
V. S. RAMACHANDRAN (California, University, La Jolla) Nature (ISSN 0028-0836), vol. 328, Aug. 13, 1987, p. 645-647. Research supported by the University of California. refs

Evidence is presented that suggests that the human visual system extracts certain conspicuous image features based on luminance constrast, and that the signals derived from these are then attributed to other features on the object. Specifically, it is found that when either illusory contours or random-dot patterns are moved in the vicinity of a color-border, the color border will also seem to move in the same direction even though it is physically stationary. C.D.

A87-54099
PARALLEL PROCESSING OF MOTION AND COLOUR INFORMATION
THOM CARNEY (California, University, Berkeley), MICHAEL SHADLEN (Brown University, Providence, RI), and EUGENE SWITKES (California, University, Santa Cruz) Nature (ISSN 0028-0836), vol. 328, Aug. 13, 1987, p. 647-649. NIH-supported research. refs

A novel example is described in which the visual system simultaneously exhibits binocular rivalry and vision that integrates signals from both eyes. This apparent contradiction is resolved by postulating parallel visual processes devoted to the analyses of color and motion information. Counterphased gratings are viewed dichoptically such that for one eye the grating is composed of alternating yellow and black stripes (luminance) while for the other it is composed of alternating red and green stripes (chrominance). When the gratings are fused, a moving grating is perceived. A consistent direction of motion can only be achieved if left and right monocular signals are integrated by the nervous system. Yet the apparent color of the binocular percept alternates between red-green and yellow-black. These observations demonstrate the segregation of processing by the early motion system from that affording the perception of color. C.D.

N87-29081# Joint Publications Research Service, Arlington, Va.
SCIENTIFIC THEORETICAL PROBLEMS OF VALIDATING THE SYSTEM FOR SOCIOPSYCHOLOGICAL SCREENING OF FLIGHT PERSONNEL
V. L. MARISHCHUK and V. I. YEVDOKIMOV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, no. 2, March - April 1987 p 1-6 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 4-7
Avail: NTIS HC A08/MF A01

Basic psychoprophylactic measures of medical expertise, professional training and psychological selection are given. Proper development of these measures will contribute to flight safety and pilot longevity. Author

N87-29083# Joint Publications Research Service, Arlington, Va.
ALCOHOL, EMOTIONS, STRESS AND PERFORMANCE
L. G. POLEVOY and L. L. STAZHADZE *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 14-27 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 12-21
Avail: NTIS HC A08/MF A01

A survey is given of the history of alcohol consumption and of the effects of alcohol on stress, the emotions, and performance. It is concluded, based on the experience accumulated from Canadian and American pilots, that treatment and rehabilitation of alcoholoc pilots should be based on modern concepts of stable pathological systems and their elimination by the production of stable, functional antagonistic anti-systems. Author

N87-29086# Joint Publications Research Service, Arlington, Va.
EFFECT OF LINEAR, IMPACT AND VIBRATION ACCELERATIONS ON ACCURACY OF OPERATOR IMPLEMENTATION OF STRENGTH LOAD PROGRAMS
I. N. KOROLEVA, S. V. PETUKHOV, and YU. O. BULAYEV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 46-50 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 34-37
Avail: NTIS HC A08/MF A01

The factors which influence the accuracy with which motor commands are actualized were investigated. The study concentrated on linear acceleration, vibration at a frequency of about 23 Hz, and impact acceleration. The force applied to hand sticks or foot levers was recorded by means of electromechanical sensors. It was demonstrated that impact acceleration caused normal men to underestimate their own muscle efforts. As a rule, this led to a greater than prescribed application of strength. It is very important to note that acceleration acting from right to left or left to right (in the frontal plane) produced nonsymmetric pressure by the right and left limbs. Author

N87-29093# Joint Publications Research Service, Arlington, Va.
DISTINCTIONS OF PSYCHOSOMATIC CORRECTION OF PERFORMANCE DURING CONTINUOUS LONG-TERM WORK
A. I. SKRYPNIKOV and A. K. YEPISHKIN *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 86-90 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, Mar. - Apr. 19887 p 59-62
Avail: NTIS HC A08/MF A01

It has been shown by experiment that autogenic training exerts a positive effect on the performance of operators working continuously for a long time. Their efficiency depends on their skill, current health state, and the time of the day. Depending on these factors, autogenic training may increase the quality of operator's work bt 7 to 49 percent. Author

N87-29094# Joint Publications Research Service, Arlington, Va.
INVESTIGATION OF CRITICAL FUSION FREQUENCY IN MAN DURING EXPOSURE TO NOISE
I. N. DANTSIG and A. V. DIYEV *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 91-96 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 62-66
Avail: NTIS HC A08/MF A01

The critical frequency of flicker fusion in the central and four peripheral points of the retina was investigated in twelve test subjects, during and after 1 hour exposure to wide band noise of 95 dBA. The subjects showed two types of response: three displayed an increase and nine a decrease of the flicker fusion critical frequency as compared to the control level. The changes showed individual variations. No correlation was found between the sign of changes in the parameter and its pretest level or the retinal site of registration. Author

N87-29098# Joint Publications Research Service, Arlington, Va.
METHOD OF ENHANCING INTERFERENCE RESISTANCE OF OPERATOR PERFORMANCE
YE. T. PETRENKO and L. A. YERMUKHAMETOVA *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 117-119 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 78-79
Avail: NTIS HC A08/MF A01

A method was developed to improve man's work capacity by conditioning motor resistance to interference. The method is based on the effect on man of photic and acoustic signals in the rhythm of the basic frequency of his electroencephalogram. The Alpha-rhythm 2 unit, training routines, and results are described. Author

N87-29106# Joint Publications Research Service, Arlington, Va.
REVIEW OF POTEGAL BOOK ON SPATIAL ABILITIES OF MAN
A. A. GYURDZHIYAN and M. POTEGAL, ed. *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 148-152 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, Mar. - Apr. 1987 p 94-96
Avail: NTIS HC A08/MF A01

The views of representatives of different specialities about the problem of spatial orientation are reviewed. The role of sensory systems, age-related aspects, the role of heredity, the involvment of cerebral sensory systems, age-related aspects, the role of heredity, and the involvement of the cerebral cortex and subcortical structures in the formation of human spatial orientation are the main areas discussed. Author

N87-29107# Joint Publications Research Service, Arlington, Va.
PSYCHOLOGICAL CONTROL OF HEALTH STATUS DURING LONG-TERM EXPOSURE TO LONGITUDINAL ACCELERATIONS
V. A. PONOMARENKO, A. A. OBOZNOV, and D. YU. ARKHANGELSKIY *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 32-36 15 Jun. 1987 Transl. into ENGISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 24-27
Avail: NTIS HC A08/MF A01

It was demonstrated by centrifugal studies that, from the psychological point of view, an operator's activities when exposed to acceleration are complex and require continuous mental regulation of the health state. During exposure to acceleration, it is important to develop in the operator a specific mental property - the skill to distribute attention between the operator's tasks and the mental regulation of his own health. Author

N87-29115# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Anthropotechnik und Simulation.
REFINEMENT OF THE EYE-POINT-OF-REGARD MEASUREMENTS WITH HELICOPTER PILOTS IN A FLIGHT EXPERIMENT
RAINER UCKERMANN, HANS RADKE, and KLAUS WENDIGGENSEN Nov. 1986 54 p In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-1073)
(DFVLR-FB-86-61; ISSN-0171-1342; ETN-87-90049) Avail: NTIS HC A04/MF A01; DFVLR, Cologne, West Germany DM 23

The NAC-4 Eye Mark Recorder was tested in flight in order to make eye-point-of-regard measurements in helicopters simple and accurate. Twelve pilots served as subjects. It was tested whether a helmet mounting of the apparatus improves the wearing quality without deteriorating the accuracy of the measurements. The results show that the helmet-mounted apparatus can work much better, while the quality of the measurements is as good as with the original equipment. The new configuration is especially suitable for use in long duration experiments. ESA

N87-29116 Toronto Univ. (Ontario). Inst. for Aerospace Studies.
FLIGHT SIMULATION MOTION-BASE DRIVE ALGORITHMS. PART 3: PILOT EVALUATIONS
L. D. REID and M. A. NAHON Dec. 1986 194 p
(UTIAS-319; ISSN-0082-5255) Avail: Issuing Activity

Full six degrees-of-freedom of motion of a synergistic motion-base was studied. Three forms for these algorithms were considered: classical linear washout, optimal control, and coordinated adaptive washout. It was felt that the latter two techniques might provide some advantages over the classical, which is currently employed in most commercial flight simulators. The goals were to: develop the necessary equations, implement the necessary real-time software, and evaluate the performance of the software with the help of airline pilots in a complete flight simulation. The simulated aircraft and the flight scenarios employed during the evaluation process are described. The experimental plan and data gathering process are outlined fully. Both subjective pilot ratings and objective performance measures were obtained from seven pilots who evaluated ten different motion-base drive algorithm cases. In addition to using a direct pilot rating technique, about half of the experimental trials were used to obtain paired comparison results for four of the ten algorithm cases. The pilot ratings, pilot comments, and objective measures were analyzed and conclusions are presented based on this. The results highlight both pilot preferences in motion-base drive algorithms and the nature of the pilot variability in assessing motion quality. Author

N87-29505# Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
STUDY OF ANTICIPATION MECHANISMS IN THE AERONAUTICAL ENVIRONMENT [ETUDE DES MECANISMES D'ANTICIPATION EN AERONAUTIQUE]
R. AMALBERTI, CL. VALOT, and J.-P. MENU *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 14 p Feb. 1987 In FRENCH
Avail: NTIS HC A14/MF A01

Pilot behavior during anticipation activities is discussed. These types of activities make use of the ability to mentally represent the result of changes produced in a given situation, allowing for related events and real action potentials. Anticipation activities may take place at various levels including initial mission planning and necessitated in-flight changes thereto, during the use of standard procedures to accomplish various flight maneuvers and other highly routine acts, and during the acquisition and transfer of information to and from the hardware system using its displays and controls. Both behavioral observation and interview techniques with experienced and inexperienced pilots were used to reveal

the rules by which these anticipation activities are carried out and how they differ as a function of the specific knowledge of the pilot at a given point in time and the available time to consider alternate responses. M.G.

N87-29506# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany). Helicopter and Military Aircraft Group.
THE TASK TAXONOMY METHOD: A BASIS FOR AN EXPERT SYSTEM ON HUMAN RELIABILITY
R. SEIFERT and K. BRAUSER *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 8 p Feb. 1987
Avail: NTIS HC A14/MF A01

A survey of human error (HE), its definition, nature of HE and the categorization of HE's, causes and prevention measures is described. Then a HE rating scale is introduced, which allows the assignment of HE probability (HEP) values measured into 10 reliability classes (RC). Based on HEP values measured for a number of human performances, a Task Taxonomy Method is developed. This method allows the assignment of a relative weight to all task factors and to all performance shaping factors involved in the task performance. The task taxonomy method is a tool to predict the HEP and RC of tasks allocated to man. Such a predictive tool is used for analysis, definition and design of man machine systems. Rules of an Expert System are described which facilitates the application and use of the task taxonomy method. Author

N87-30050# Air Force Human Resources Lab., Brooks AFB, Tex.
SPATIAL ABILITY AS A PREDICTOR OF FLIGHT TRAINING PERFORMANCE Interim Report, Jan. 1982 - Sep. 1986
THOMAS R. CARRETTA Jul. 1987 15 p
(AD-A183141; AFHRL-TP-86-70) Avail: NTIS HC A02/MF A01 CSCL 05I

Spatial ability has been demonstrated to be related to performance of a variety of tasks including several military enlisted jobs and piloting aircraft. This paper examined the relationship between performance on spatial ability task (i.e., the Mental Rotation Test) and flight training performance for 1,939 United States Air Force Undergraduate Pilot Training (UPT) candidates. Performance on the Mental Rotation Test was not related to completion of training, but was related to a recommendation for specialized training after UPT. Pilot candidates who made quick, consistent, and accurate judgements were more likely to be recommended for fast-jet training (Fighter-Attack-Reconnaissance or FAR). This was consistent with the current practice of selecting the best-performing student pilots for follow-on training in FAR aircraft. GRA

N87-30051# Naval Aerospace Medical Research Lab., Pensacola, Fla.
TRACKING A LASER-PROJECTED HORIZON INDICATOR Interim Report
J. M. LENTZ, G. T. TURNIPSEED, and W. C. HIXSON May 1987 20 p
(AD-A183384; NAMRL-1330) Avail: NTIS HC A02/MF A01 CSCL 01D

We did not evolve in motion and acceleration environments typical of military aviation, and we lack sense organs to cope with these environments. Even though the vestibular and visual system function properly in these environments, the brain accurately interprets them without visual or tactile contact with some fixed spatial reference point such as the Earth's horizon. In the airplane, this reference is provided by a gyro-stabilized artificial horizon instrument. Individuals differ widely in their ability to extract visual information from this attitude indicator and mentally integrate it with information from other body sensors. Consequently, failure to assimilate all of this information can result in disorientation, erratic motor performance, or intuitively correct but grossly incorrect control decisions. One of the more promising recent attempts to combat inflight spatial disorientation has focused on the development of Peripheral Vision Horizon Devices (PVHD) suitable for installation in operational aircraft. This paper describes a series of laboratory experiments directed at explaining some of the psychophysiological characteristics of the PVHD significant to its operational application. GRA

N87-30052# Letterman Army Inst. of Research, San Francisco, Calif.
VISUAL INPUT REQUIREMENTS RELATING TO PURSUIT TRACKING ACCURACY Report, Feb. 1985 - Jun. 1986
KENNETH R. BLOOM and HARRY ZWICK Jun. 1987 23 p
(AD-A183445; LAIR-241) Avail: NTIS HC A02/MF A01 CSCL 05A

The interaction between visual function and pursuit tracking performance was measured in 10 human volunteers who participated in three daily 1-hr sessions involving two target sizes (18 min arc and 6 min arc - 1 min arc = 0.28 mrad), two target intensities (photopic = 25 cd/sq m, mesopic = .76 cd/sq m, and two directions of horizontal target motion. Pursuit tracking performance was measured by a computerized video digitizing system, developed at LAIR, during 20-sec tracking trials. Analysis of variance showed significant main effects for target luminance and under mesopic target conditions, target size on pursuit tracking accuracy, pointing to the need to delineate the visual requirements of visual motor tasks to assess the effects of battlefield laser exposure. GRA

N87-30053# Georgia Inst. of Tech., Atlanta. Systems Engineering Lab.
ENHANCEMENT OF HUMAN PERFORMANCE IN MANUAL TARGET ACQUISITION AND TRACKING Final Report, Dec. 1984 - Feb. 1986
DENNIS J. FOLDS, JEFFREY M. GERTH, and WILLIAM R. ENGELMAN May 1987 48 p
(Contract F33615-83-D-0601)
(AD-A183549; USAFSAM-TR-86-18) Avail: NTIS HC A03/MF A01 CSCL 05I

A review and analysis of the literature pertaining to human performance in manual target acquisition and tracking tasks is presented. The emphasis is on the identification of factors which enhance performance, particularly those related to training and practice. Three major areas are reviewed: (1) typical patterns of performance in simple target acquisition and tracking tasks; (2) the effects of various training and practice regiments on the development of tracking proficiency; and (3) the impact of dual-task conditions on performance of tracking tasks. A framework for interpreting the various theoretical constructs and empirical findings covered in the literature is offered. This framework is based on the general notion of response organization, and embraces both the process of organization and the result of that process. A major issue which has not been addressed in the literature is how the impact of dual-task conditions on response organization may be lessened (or recovery hastened) by appropriate training. An experiment was conducted to address this issue. GRA

N87-30060# McDonnell-Douglas Corp., Long Beach, Calif.
MENTAL WORKLOAD MEASUREMENT IN OPERATIONAL AIRCRAFT SYSTEMS: TWO PROMISING APPROACHES
MICHAEL BIFERNO *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 44-51 Jun. 1987
Avail: NTIS HC A07/MF A01

When evaluating aircraft systems, the most useful mental workload (MWL) measures are those which can be employed inflight or full mission simulations. This requires measures to be noninterfering, relatively unobtrusive, and provide estimates of operationally relevant MWL while maintaining high levels of validity and reliability. In the context of automated systems, the strategy was to define MWL as language based mental activity and to develop subjective ratings (opinion scale) in the short term and event related brain potential (ERP) measures in the long term. Subjective ratings are being employed to estimate the required degree of attention to perform: information processing, mental operations, and actions. This organization aids in the identification of undesirable MWL levels associated with system displays, logic,

and controls. In addition to providing a quantitative workload rating, this technique elicits verbal explanations if high MWL levels are reported. Author

54

MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

A87-50949
THE PROBLEMS OF AIRCRAFT MICROCLIMATE (REVIEW OF THE LITERATURE) [PROBLEMY MIKROKLIMATA V SAMOLETAKH /OBZOR LITERATURY/]
A. N. AZHAEV, I. D. MALININ, and E. A. LUSHCHIKOV Voenno-Meditsinskii Zhurnal (ISSN 0026-9050), April 1987, p. 37, 38. In Russian. refs

The changes of temperature inside the front and back compartments of an aircraft during different stages of flight are discussed with emphasis on low-altitude flights in hot environments, which pose the particular danger of heat stress to aircraft personnel. Consideration is given to the ranges of ambient temperature necessary for the maintenance of comfort and of the ability to safely operate an aircraft during normal flight as well as during high-speed maneuvers. Special attention is given to preventive measures, such as air-conditioned clothing and clothing equipped with a portable water-cooling system. I.S.

A87-51979#
DEVELOPMENT OF A SMALL-SIZED SPACE MANIPULATOR
YOSHITUGU TODA, KAZUO MACHIDA, TOSHIAKI IWATA, MASAO INOUE, KATSUHIKO YAMADA et al. Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 35, no. 401, 1987, p. 294-302. In Japanese, with abstract in English. refs

Future space stations and space factories which require many types of manipulators or robots for assembling and servicing in space, especially demand small-sized manipulators for dexterous tasks. A 1-meter class articulated manipulator with space environment durability and light weight has been developed. This paper presents the system design of the manipulator and development efforts of its components. The design of actuators and a hand, a tribological investigation of mechanical elements in the vacuum environment, the multiprocessor control system, and the dynamic control algorithm of the arm, are described. Author

A87-52827
ESTIMATING THE OPERATIONAL QUALITY OF MAN-MACHINE SYSTEMS WITH BIMODAL AND MONOMODAL PRESENTATION OF INFORMATION [OTSENKA KACHESTVA FUNKTSIONIROVANIIA ERGATICHESKIKH SISTEM PRI BIMODAL'NOM I MONOMODAL'NOM PRED'IAVLENII INFORMATSII]
G. V. LOZHKIN and V. V. SPASENNIKOV (Kievskoe Vysshee Inzhenernoe Radiotekhnicheskoe Uchilishche, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 72, 1986, p. 33-38. In Russian. refs

The paper presents a comparative characterization of the semiautomated radar tracking of aerial targets for bimodal and monomodal presentation of information. Results of full-scale experiments are presented, and it is shown that the bimodal approach leads to significant accuracy gains in the extraction of plane coordinates: a 15 percent gain in range and a 20 percent gain in azimuth. B.J.

A87-52828
THE HUMAN STRATEGIES IN THE FORMATION OF SUBJECTIVE CONSTRAINTS ON MANUAL-CONTROL PARAMETERS [STRATEGII CHELOVEKA PRI FORMIROVANII SUB'EKTIVNYKH OGRANICHENII NA PARAMETRY RUCHNOGO UPRAVLENIIA]
V. A. CHERNOMORETS (AN USSR, Institut Kibernetiki, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 72, 1986, p. 59-64. In Russian. refs

Consideration is given to the use of the integrality principle to identify a system of subjective constraints used by a human operator in the formation of manual-control parameters. This approach makes it possible to identify the optimal control duration toward which the operator unconsciously strives. B.J.

A87-52829
TAKING ACCOUNT OF RULES IN THE PREDICTION OF THE POSSIBLE STRATEGIES OF ACTIVE PARTNERS [UCHET PRAVIL PRI PROGNOZIROVANII VOZMOZHNYKH STRATEGII AKTIVNYKH PARTNEROV]
V. D. SIABRO (AN USSR, Institut Kibernetiki, Kiev, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 72, 1986, p. 74-77. In Russian.

The formalization of rules presented to a human operator in a man-machine system is considered. A procedure of automatically taking account of the rules is used to predict possible control straegies for active partners and to choose one's own strategy. B.J.

A87-52830
ALGORITHM AND PROGRAM SOFTWARE OF AN INFORMATION/MEASUREMENT SYSTEM FOR EVALUATING THE STATE OF AN OPERATOR [ALGORITMICHESKOE I PROGRAMMNOE OBESPECHENIE INFORMATSIONNO-IZMERITEL'NOI SISTEMY OTSENKI SOSTOIANIIA OPERATORA]
A. P. GRISHANOVICH and V. V. DMITRIEVA (Belorusskii Gosudarstvennyi Universitet, Minsk, Belorussian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 72, 1986, p. 77-80. In Russian. refs

A system for the processing of physiological data has been developed with the aim of investigating the functional states of an operator. The processing involves a set of indices that reflect the various vital functions. The software engineering is described, and it is noted that results of operator-state evaluation are presented in clear tabular and graphic forms. B.J.

A87-52831
THE SIMULATION OF FLEXIBLE ACTIVITY ALGORITHMS (FOR THE EXAMPLE OF AN OPERATOR-DISPLAY SYSTEM) [MODELIROVANIE GIBKIKH ALGORITMOV DEIATEL'NOSTI /NA PRIMERE SISTEMY OPERATOR-DISPLEI/]
A. P. ROTSHTEIN (Tsentral'noe Konstruktorskoe Biuro Informatsionnoi Tekhniki, Vinnitsa, Ukrainian SSR) Kibernetika i Vychislitel'naia Tekhnika (ISSN 0454-9910), no. 72, 1986, p. 87-92. In Russian. refs

An analytical model for evaluating the error performance and implementation time of a flexible model of display-operator activity is examined. The possibility of the interconnected analysis, identification, and optimization of flexible activity algorithms is illustrated by the example of an operator inputting alphanumeric messages from a display into a computer. A general approach to the simulation of flexible algorithms is proposed. B.J.

A87-52990
DOSIMETRIC MAPPING INSIDE BIORACK
G. REITZ, H. BUECKER, R. FACIUS (DFVLR, Institut fuer Flugmedizin, Cologne, West Germany), R. BEAUJEAN, W. ENGE (Kiel, Universitaet, West Germany) et al. (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 107-113. BMFT-supported research. refs

Dosimetric results from dosimeters at various locations inside ESA's Biorack are presented. Flown on the D-1 mission, the present experiment used different plastic detectors and emulsions to measure the high linear energy transfer (LET) components of the radiation environment; thermoluminescence dosimeters (LiF) were used for low LET measurements. Data are presented on the total dose, charge, energy, and LET spectra obtained and comparisons are made with the results of previous missions. The necessity of measuring the radiation field as close as possible to the biological system under investigation is demonstrated. K.K.

A87-52992* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE MEASURED RADIATION ENVIRONMENT WITHIN SPACELABS 1 AND 2 AND COMPARISON WITH PREDICTIONS
T. A. PARNELL, J. W. WATTS, JR., G. J. FISHMAN (NASA, Marshall Space Flight Center, Huntsville, AL), E. V. BENTON, A. L. FRANK (San Francisco, University, CA) et al. (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 125-134. refs
(Contract NAS8-34354; NAS8-34340; NAS9-17389)

A set of passive and active radiation detectors was flown as part of the verification flight instrumentation (VFI) in an attempt to measure the radiation environment in the Spacelab (SL) module and on the pallet. SL 1 carried 4 passive and 2 active detector packages which were used to evaluate the radiation environment within the spacecraft and SL 2 carried 2 passive VFI units on the pallet. Dose equivalents of 330 + or - 70 mrem and 537 + or - 37 mrem were measured in the SL 1 module and SL 2 pallet, respectively. K.K.

A87-53063#
THE USE OF INDIVIDUAL DIFFERENCES IN INFERRING HUMAN OPERATOR INTENTIONS
NORMAN D. GEDDES (Georgia Institute of Technology, Atlanta) IN: AAAIC '86 - Aerospace Applications of Artificial Intelligence; Proceedings of the Second Annual Conference, Dayton, OH, Oct. 14-17, 1986. Volume 1 . Dayton, OH, AAAIC Conference Secretariat, 1986, p. 31-41. Research sponsored by Lockheed-Georgia Co. refs

Past experiences in the development of human-machine system models have repeatedly shown that while good agreement between the model and human operators in terms of performance statistics could be obtained, the detailed behavior of the model rarely agreed with the observed human behavior. In fact, the behavior of well-trained human operators often shows large variability. As a result of these observations, it is reasonable to suspect that a model of human intentions which attempts to observe a human operator's actions and infer his goals and methods must also consider the role of individual differences in shaping behavior. This paper addresses a number of the issues underlying the concept of using individual differences as a consideration in inferring operator intentions from observed actions. Author

A87-53089
HUMAN CAPABILITIES IN SPACE
BYRON K. LICHTENBERG (Payload Systems, Inc., Wellesley, MA) IN: The human quest in space; Proceedings of the Twenty-fourth Goddard Memorial Symposium, Greenbelt, MD, Mar. 20, 21, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 183-194.
(AAS PAPER 86-114)

The role of humans in space is discussed. The crew is concerned with flying the vehicle, operating experiments, participating in biomedical studies, and exploring outside the spacecraft. The use of the crew to construct large structures, such as the Space Station, in space and the functions of the crew on the Space Station are examined. I.F.

A87-53092
BIOSPHERE II - THE CLOSED ECOLOGY PROJECT
MARGRET AUGUSTINE (Space Biospheres Ventures, Oracle, AZ) IN: The human quest in space; Proceedings of the Twenty-fourth Goddard Memorial Symposium, Greenbelt, MD, Mar. 20, 21, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 243-254. refs
(AAS PAPER 86-119)

Biosphere II is a proposed stable, complex, evolving, materially closed, life closed, and energetically open system. The system is to be located at a 2500-acre facility near Tucson, Arizona and it is to contain seven biomes: a tropical rain forest, tropical savannah, marsh, marine, desert, intensive agriculture, and human habitat. The Greenhouse and Tissue Culture complex, which is a model for the Biosphere II, is described, and a model of the system is provided. Applications for the biospheric system include: scientific and ecological management research, refuges for endangered species, and life habitats for manned stations on spacecraft or on other planets. I.F.

A87-53093
THE CLOSED ECOLOGY PROJECT - AGRICULTURAL AND LIFE SCIENCES BACKGROUND
CARL N. HODGES (Arizona, University, Tucson) IN: The human quest in space; Proceedings of the Twenty-fourth Goddard Memorial Symposium, Greenbelt, MD, Mar. 20, 21, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 255-271.
(AAS PAPER 86-120)

Some of the research that was applied to the development of Biosphere II is discussed. Consideration is given to the use of solar energy to desalt sea water; a desert agricultural environment; animal production inside a controlled environment; and the Land Pavilion project depicting the history of agriculture. Attention is also given to temperature control for the agricultural area of the greenhouse, recycling, and maintaining a clean atmosphere. I.F.

A87-53921#
ROBOT MANIPULATORS FOR SAMPLE HANDLING IN SPACE
N. E. CABLE (ESA, Mechanical Systems Dept., Noordwijk, Netherlands) ESA Bulletin (ISSN 0376-4265), no. 50, May 1987, p. 73-79.

The application of a robot-manipulator to transport tasks in space is evaluated by designing a robot-manipulator for the Automatic Mirror Furnace Facility of Eureca; skeleton and advanced manipulator designs are proposed. The design of the end-effector devices, grapple fixtures, and process-transport mechanism is examined; a tetrahedral wedge joint has been selected for these devices. The main design requirements for the manipulator involve fitting the manipulator in the limited space of the payload module. Consideration is given to the sensors for the basic operation of the manipulator; the ground testing of the equipment; the use of CAD in the development of the manipulator; the need for processors for each facility; and the electronics and software used to control the manipulator's operation. Computer-graphics generated images of the skeleton and advanced manipulator design are provided. I.F.

A87-53979* Vigyan Research Associates, Inc., Hampton, Va.
A SIMULATION MODEL FOR THE ANALYSIS OF SPACE STATION GAS-PHASE TRACE CONTAMINANTS
DANA A. BREWER (Vigyan Research Associates, Inc., Hampton, VA) and JOHN B. HALL, JR. (NASA, Langley Research Center, Hampton, VA) Acta Astronautica (ISSN 0094-5765), vol. 15, Aug. 1987, p. 527-543. refs
(Contract NAS1-550; NAS1-17919)

A simulation model for the analysis of gas-phase trace contaminants in the cabin air of the NASA Space Station Reference Configuration was developed at the NASA Langley Research Center. The model predicts changes in trace contaminant concentrations from both physical and chemical sources and sinks as a function of time. Simulations were performed in which values for relative humidity, temperature, radiation intensity, pressure, and initial species concentrations were constrained to values for these parameters measured and modeled in the continental tropics at the earth's surface. Species concentrations simulated using the model compared favorably with concentrations in the continental tropics which demonstrated that the chemical mechanism in the trace contaminant model approximates changes in atmospheric species concentrations. The sensitivity of initial species concentrations to producing changes in additional species concentrations was also assessed. Results from the model indicated that chemical reactions will be important in determining the composition of cabin air in the Space Station. It is anticipated that the trace contaminant model will be useful in assessing the impact of experiments and commercial operations on the composition of the cabin air in the Space Station. Author

N87-29084# Joint Publications Research Service, Arlington, Va.
CONCEPT OF FUNCTIONAL STRENGTH IN THE PROBLEM OF OBJECTIVIZATION OF BIOMECHANICAL SPECIFICATIONS FOR PROTECTIVE AND RESCUE GEAR FOR AIRCRAFT CREWS
A. S. BARER and YU. G. KONAKHEVICH *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 28-31 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 21-24
Avail: NTIS HC A08/MF A01

Problems related to the ambiguous formulation of biomedical requirements pertaining to the quality of protection and rescue gear used by aircraft crews are discussed. In order to objectify these requirements, the use of the functional strength concept which reflects both mechanical and functional results of adverse effects is recommended. The potential use of this parameter in developing complex requirements for various programmed and contingent situations and the probability aspects of the problem of evaluating protection and rescue gear is described. Author

N87-29085# Joint Publications Research Service, Arlington, Va.
THEORETICAL ANALYSIS OF EFFICACY OF G SUITS WITH EXPOSURE TO CONTINUOUSLY INCREASING ACCELERATIONS
B. L. PALETS, M. A. TIKHONOV, A. A. POPOV, D. YU. ARKHANGELSKIY, L. D. PALETS, and R. A. BONDARENKO *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 37-45 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 27-33
Avail: NTIS HC A08/MF A01

A mathematical model of circulation was employed to examine circulation responses to plus Gz acceleration (the value of which increases linearly at the rate of 1.0 G/sec) using subjects wearing an anti-gravity suit and sitting in a relaxed posture. It was calculated that the anti-gravity suit could compensate for as much as 83 percent of the increment of hydrostatic pressure in leg vessels and as much as 57 percent in abdominal vessels. The suit makes an approximately equal contribution to an increase of the acceleration tolerance threshold. However, the occlusion effect of the anti-gravity suit causes a significant increase of afterload. Author

N87-29097# Joint Publications Research Service, Arlington, Va.
MATHEMATICAL MODEL OF PILOT HEAD KINEMATICS DURING EJECTION INTO AIR FLOW
V. I. KHARCHENKO, N. V. GOLOVLEVA, YU. G. KONAKHEVICH, V. A. LYAPIN, A. V. MARYIN, V. KH. PETLYUK, and L. N. SHOLLO *In its* JPRS Report: Science and Technology. USSR: Space Biology and Aerospace Medicine, Volume 21, No. 2, March - April 1987 p 110-116 15 Jun. 1987 Transl. into ENGLISH from Kosmicheskaya Biologiya i Aviakosmicheskaya Meditsina (Moscow, USSR), v. 21, no. 2, Mar. - Apr. 1987 p 73-78
Avail: NTIS HC A08/MF A01

The trajectories of head movements in a helmet and velocities of impact contact with the seat and interior of the cockpit were calculated as applied to every stage of the catapulting process, with mass-inertia parameters of the helmets taken into account. Kinematic models were used to describe biomechanic parameters of the head-neck system. Special attention was given to the case of catapulting to the air flow. The effect upon the nod of aerodynamic forces acting on the human body and the catapult ejection seat at air flow velocities of 700 to 800 and 1300 km/h was calculated. Author

N87-29117*# Honeywell, Inc., Clearwater, Fla. Space and Strategic Avionics Div.
AUTOMATED SUBSYSTEM CONTROL FOR LIFE SUPPORT SYSTEM (ASCLSS) Final Report
ROGER F. BLOCK 15 Jul. 1987 65 p
(Contract NAS9-16895)
(NASA-CR-172003; NAS 1.26:172003) Avail: NTIS HC A04/MF A01 CSCL 06K

The Automated Subsystem Control for Life Support Systems (ASCLSS) program has successfully developed and demonstrated a generic approach to the automation and control of space station subsystems. The automation system features a hierarchical and distributed real-time control architecture which places maximum controls authority at the lowest or process control level which enhances system autonomy. The ASCLSS demonstration system pioneered many automation and control concepts currently being considered in the space station data management system (DMS). Heavy emphasis is placed on controls hardware and software commonality implemented in accepted standards. The approach demonstrates successfully the application of real-time process and accountability with the subsystem or process developer. The ASCLSS system completely automates a space station subsystem (air revitalization group of the ASCLSS) which moves the crew/operator into a role of supervisory control authority. The ASCLSS program developed over 50 lessons learned which will aide future space station developers in the area of automation and controls.. Author

N87-29118* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MOBILE REMOTE MANIPULATOR VEHICLE SYSTEM Patent
HAROLD G. BUSH, inventor (to NASA), MARTIN M. MIKULAS, JR., inventor (to NASA), RICHARD E. WALLSOM, inventor (to NASA), and J. KERMIT JENSEN, inventor (to NASA) (Kentron International, Inc., Hampton, Va.) 11 Aug. 1987 17 p Filed 31 Jul. 1985 Supersedes N86-21147 (24 - 11, p 1842)
(NASA-CASE-LAR-13393-1; US-PATENT-4,685,535; US-PATENT-APPL-SN-760799; US-PATENT-CLASS-182-63; US-PATENT-CLASS-182-82; US-PATENT-CLASS-182-223)
Avail: US Patent and Trademark Office CSCL 05H

A mobile remote manipulator system is disclosed for assembly, repair and logistics transport on, around and about a space station square bay truss structure. The vehicle is supported by a square track arrangement supported by guide pins integral with the space station truss structure and located at each truss node. Propulsion is provided by a central push-pull drive mechanism that extends out from the vehicle one full structural bay over the truss and locks drive rods into the guide pins. The draw bar is now retracted

and the mobile remote manipulator system is pulled onto the next adjacent structural bay. Thus, translation of the vehicle is inchworm style. The drive bar can be locked onto two guide pins while the extendable draw bar is within the vehicle and then push the vehicle away one bay providing bidirectional push-pull drive. The track switches allow the vehicle to travel in two orthogonal directions over the truss structure which coupled with the bidirectional drive, allow movement in four directions on one plane. The top layer of this trilayered vehicle is a logistics platform. This platform is capable of 369 degees of rotation and will have two astronaut foot restraint platforms and a space crane integral. NASA

N87-29504# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
AUTOMATION AT THE MAN-MACHINE INTERFACE
WALTER M. HOLLISTER *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 10 p Feb. 1987
Avail: NTIS HC A14/MF A01

There is a recognized need for automation. However, detailed analysis shows that the term automation is too broad for making specific research recommendations. The specific characteristics vary in kind and degree as a function of the piloting tasks. In some cases, the task should be left entirely to the pilot. In many cases, computer aiding is the best choice. A method for allocating functions between automated systems and the pilot is presented using the theory of divided attention. It describes a structured approach for reducing the control dwell fraction with improved flying qualities. There is a need for fundamental research into the understanding of how the human pilot operates as part of the aircraft and weapons control system. Author

N87-29507# Washington Univ., St. Louis, Mo.
CLOSING THE MAN-MACHINE LOOP: ON THE USE OF PHYSIOLOGICAL MEASURES TO AFFECT COMPUTER-CONTROLLED DEVICES
J. A. STERN, G. F. WILSON, and M. THEISSEN (General Dynamics Corp., Fort Worth, Tex.) *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 5 p Feb. 1987
Avail: NTIS HC A14/MF A01

Results suggest that physiological information: heart rate, eye blink, etc., as well as information about operator performance and system characteristics, could be used to alert the operator, change displays, or permit the hardware to take over certain functions. Utilization of physiological data from the operator must be used with certain cautions in mind. For example, physical exertion causes changes in heart rate. The system would have to be provided with information concerning physical exertion, so that the heart rate data could be appropriately interpreted in a larger context. This is true of the information concerning aircraft performance as well, where the pattern of inputs from various sensors is analyzed in order to make a decision about an action to be taken. Author

N87-29508*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE EFFECTS OF DISPLAY-CONTROL I/O, COMPATIBILITY, AND INTEGRALITY ON DUAL-TASK PERFORMANCE AND SUBJECTIVE WORKLOAD
PAMELA S. TSANG (Illinois Univ., Savoy.), SANDRA G. HART, and MICHAEL A. VIDULICH *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 9 p Feb. 1987
Avail: NTIS HC A14/MF A01 CSCL 05H

The utility of speech technology was evaluated in terms of three dual task principles: resource competition between the time shared tasks, stimulus central processing response compatibility, and task integrality. Empirical support for these prinicples was reviewed. Two studies investigating the interactive effects of the three principles were described. Objective performance and subjective workload ratings for both single and dual tasks were examined. It was found that the single task measures were not necessarily good predictors for the dual task measures. It was shown that all three principles played an important role in determining an optimal task configuration. This was reflected in both the performance measures and the subjective measures. Therefore, consideration of all three principles is required to insure proper use of speech technology in a complex environment. Author

N87-29509# Royal Air Force, London (England).
A STUDY OF PILOT FLIGHT INFORMATION CROSSMONITORING PERFORMANCE
V. P. SCHMIT *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 12 p Feb. 1987
Avail: NTIS HC A14/MF A01

A experiment is discussed which investigated the ability of the pilot to crossmonitor between Head Up display and Head Down instruments. In a situation with high error rates, no subsidiary tasks and with explicit exclusion of troubleshooting (i.e., a best case), results show a low error detection rate, long detection times and significant flying performance decrements while crossmonitoring. Error detection performance is correlated not with the amount of time spent crossmonitoring, but with the frequency at which the pilot chooses to crossmonitor. Extrapolation from the results suggests that, at least for the conditions of this experiment, crossmonitoring should occur every 22 to 23 sec to ensure acceptable error detection. The evidence points clearly to the need to remove the crossmonitoring task from the pilot and make it an automated function for future aircraft. Author

N87-29510# Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France).
SOPHISTICATED INTEGRAL CONTROL METHODS FOR USE IN FLIGHT [LES MOYENS DE COMMANDE INTEGRES SOPHISTIQUES SERONT-ILS CONCUS POUR ETRE UTILISABLES EN VOL]
J.-P. MENU, G. SANTUCCI, and R. AMALBERTI *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 6 p Feb. 1987 In FRENCH
Avail: NTIS HC A14/MF A01

The changing nature of display and control requirements for modern aircraft and the various means by which information is transferred to and from the pilot are reviewed. Some of the known factors affecting human performance are discussed including: (1) desaturation and contrast loss in electronically generated information during high illumination inflight conditions; (2) the effects of high acceleration on both foveal and peripheral presentations of information; (3) manual control designs which obscure some settings when engaged; and (4) the improper labelling of display and control devices. The potential use of voice interactive control devices, especially in overcoming problems inherent in multitask situations, is also discussed. Finally, the relative merits of dedicated and multifunctional displays and controls are examined along with the theoretical causes of increased higher cognitive workloads required by multifunction devices. M.G.

N87-29516# Centre d'Etudes et de Recherches de Medecine Aerospatiale, Paris (France). Lab. Central de Biologie Aerospatiale.
ORGANIZATION OF DISPLAYS IN THE VISUAL SPACE OF THE COMBAT AIRCRAFT PILOT [ORGANISATION DES VISUALISATIONS DANS L'ESPACE VISUEL DU PILOTE D'AVION DE COMBAT]
J.-P. MENU and R. AMALBERTI *In* AGARD, Information Management and Decision Making in Advanced Airborne Weapon Systems 12 p Feb. 1987 In FRENCH
Avail: NTIS HC A14/MF A01

The psychophysiological problems associated with the specific organization of cockpit displays were examined through laboratory studies and pilot surveys. The response time associated with the transition between head-up and head-down displays was measured under various conditions. It was found that reduced transition times could be obtained through the use of intermediate display concepts. Illumination level and visual adaptation were identified as important factors in the optimal integration of displays. M.G.

N87-29865*# Rockwell International Corp., Downey, Calif. Space Station Systems Div.
THE DESIGN AND DEVELOPMENT OF A MOBILE TRANSPORTER SYSTEM FOR THE SPACE STATION REMOTE MANIPULATOR SYSTEM
THOMAS W. CARROLL *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium p 93-101 May 1987
Avail: NTIS HC A16/MF A01 CSCL 05H

The analyses, selection process, and conceptual design of potential candidate Mobile Transporter (MT) systems to move the Space Station Remote Manipulator System (SSRMS) about the exposed faces of the Space Station truss structure are described. The actual requirements for a manipulator system on the space station are discussed, including potential tasks to be performed. The SSRMS operating environment and control methods are analyzed with potential design solutions highlighted. Three general categories of transporter systems are identified and analyzed. Several design solution have emerged that will satisfy these requirements. Their relative merits are discussed, and unique variations in each system are rated for functionality. Author

N87-29866*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
TELEROBOTIC WORK SYSTEM: CONCEPT DEVELOPMENT AND EVOLUTION
LYLE M. JENKINS *In its* The 21st Aerospace Mechanisms Symposium p 103-110 May 1987
Avail: NTIS HC A16/MF A01 CSCL 05H

The basic concept of a telerobotic work system (TWS) consists of two dexterous manipulator arms controlled from a remote station. The term telerobotic describes a system that is a combination of teleoperator control and robotic operation. Work represents the function of producing physical changes. System describes the integration of components and subsystems to effectively accomplish the needed mission. Telerobotics reduces exposure to hazards for flight crewmembers and increases their productivity. The requirements for the TWS are derived from both the mission needs and the functional capabilities of existing hardware and software to meet those needs. The development of the TWS is discussed. Author

N87-29867*# Martin Marietta Energy Systems, Inc., Oak Ridge, Tenn.
TRACTION-DRIVE, SEVEN-DEGREE-OF-FREEDOM TELEROBOT ARM: A CONCEPT FOR MANIPULATION IN SPACE
D. P. KUBAN and D. M. WILLIAMS *In* NASA-Lyndon B. Johnson Space Center, The 21st Aerospace Mechanisms Symposium p 111-130 May 1987
Avail: NTIS HC A16/MF A01 CSCL 05H

As man seeks to expand his dominion into new environments, the demand increases for machines that perform useful functions in remote locations. This new concept for manipulation in space is based on knowledge and experience gained from manipulator systems developed to meet the needs of remote nuclear applications. It merges the best characteristics of teleoperation and robotic technologies. The design goals for the telerobot, a mechanical description, and technology areas that must be addressed for successful implementation are presented and discussed. The concept incorporates mechanical traction drives, redundant kinematics, and modular arm subelements to provide a backlash-free manipulator capable of obstacle avoidance. Author

N87-30054# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
THE PRACTICAL ASSESSMENT OF PILOT WORKLOAD
ALAN H. ROSCOE, ed. (Britannia Airways Ltd., Luton, England) Jun. 1987 141 p
(AGARD-AG-282; ISBN-92-835-1546-3) Avail: NTIS HC A07/MF A01

Whether one is attempting to reduce workload in the cockpit of a combat aircraft to improve mission effectiveness, or to optimise workload levels on the flight deck of a civil airliner to improve safety, it is important to be able to assess workload in practical terms. In the case of the civil transport aircraft the findings of the President's Task Force on Crew Complement have underlined the need to assess workload in flight reliably in order to satisfy certification requirements for new aircraft. The main purpose of this report is to provide guidance for the assessment of pilot workload in practical situations. The various techniques available for assessing pilot workload are introduced and briefly reviewed. Some techniques that have been successful inflight are presented along with techniques for assessing workload for the purpose of aircraft certification.

N87-30055# Ergometrics Technology, Inc., Dayton, Ohio.
IN-FLIGHT WORKLOAD ASSESSMENT USING EMBEDDED SECONDARY RADIO COMMUNICATIONS TASKS
CLARK A. SHINGLEDECKER *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload p 11-14 Jun. 1987
Avail: NTIS HC A07/MF A01

The embedded secondary task methodology was developed to improve the practical utility of dual task measures for inflight workload assessment, while retaining many of the scientific advantages associated with traditional laboratory secondary tasks. The concept of the embedded secondary task is based on the hypothesis that instrumentation limitations, task intrusion, and poor operator acceptance can be minimized by designing secondary tasks which are fully integrated with system hardware and with the crewmember's conception of the mission environment. By their nature, such tasks are realistic components of crewstation activity, yet their performance can be manipulated and measured independently of the primary activities of interest. While several classes of aircrew activity are potential candidates for isolation and use as embedded tasks, radio communication tasks are particularly suitable for this purpose. Such tasks closely resemble the nonadaptive discrete secondary tasks used in numerous workload studies and have many properties of good measurement tasks. Measurement techniques are described and examples of use are given along with limitations. Author

N87-30056# Douglas Aircraft Co., Inc., Long Beach, Calif.
USE OF TASK TIMELINE ANALYSIS TO ASSESS CREW WORKLOAD
G. STONE, R. K. GULICK, and R. F. GABRIEL *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload p 15-31 Jun. 1987
Avail: NTIS HC A07/MF A01

As systems have become more sophisticated, the role of humans in operating and maintaining them has grown more complex. There has been a steadily growing recognition that human characteristics, particularly limitations and abilities, must be considered in some depth in system design if design objectives are to be met. The size and role of the crew represent critical decisions. Mission performance has a direct relationship to the ability of the crew to carry out all of the required functions. The use of workload measures to assess the viability of a selected crew complement as well as other crew interfaces was considered. Several techniques are listed which are used to assess workload including task/timeline analysis measures. It appears to be the most easily implemented and could meet most of the established criteria. A model was developed to utilize this workload measure in the design, verification of design improvements, and certification

of recent aircraft. This approach is presented and discussed in detail. E.R.

N87-30057# Boeing Co., Seattle, Wash.
PILOT SUBJECTIVE EVALUATION OF WORKLOAD DURING A FLIGHT TEST CERTIFICATION PROGRAMME
FRANK T. RUGGIERO and DELMAR M. FADDEN *In* advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload p 32-36 Jun. 1987
Avail: NTIS HC A07/MF A01

To date there is no agreed upon definition of mental workload and therefore there is no agreement on how it should be measured. Three aspects of mental workload are agreed upon: it is a multidimensional construct, a clear distinction must be maintained between imposed mental load (task load) and the mental load as experienced (subjective load), and the use of subjective ratings should be central to any investigation of workload. The Pilot Subjective Evaluation (PSE) process developed in conjunction with the FAA is outlined which supplements the analytical, simulator, and flight test crew workload evaluation techniques used to demonstrate compliance with the minimum crew size requirement regulations. Author

N87-30058# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. for Flight Guidance.
THE USE OF SUBJECTIVE WORKLOAD ASSESSMENT TECHNIQUE IN A COMPLEX FLIGHT TASK
F. V. SCHICK and R. L. HANN (Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.) *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 37-41 Jun. 1987
Avail: NTIS HC A07/MF A01

Techniques for measuring mental workload can be divided into three basic categories: physiological, behavioral, and subjective. One particular technique belonging to the subjective group of methods, which always use some form of operator self-report (e.g., rating scales or questionnaires) is discussed. In order to deal with the undesirable properties of subjective methods, a procedure known as the Subjective Workload Assessment Technique (SWAT) was developed. In SWAT, subjective workload is defined as being composed of three dimensions: time load, mental effort load, and psychological stress load. This method is introduced and discussed. E.R.

N87-30059# Illinois Univ., Urbana-Champaign. Dept. of Psychology.
WORKLOAD METHODOLOGY
EMANUEL DONCHIN and CHRISTOPHER D. WICKENS *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 42-43 Jun. 1987
Avail: NTIS HC A07/MF A01

The goal of the proposed technique is to employ two converging methodologies to track the workload changes during the ILS approach to landing. The two methodologies, based upon the Event Related Brain Potential (ERP) and the Sternberg Memory Search task, provides information that is both sensitive, detecting variations in resource demand when they occur, and diagnostic, localizing these changes within the multidimensional space underlying human processing resources. Each of these techniqes are briefly described. The ERP is a transient series of voltage oscillations in the brain that can be recorded from the scalp in response to the occurrence of a discrete event. The Sternberg Memory Search requires the pilot to identify whether or not a displayed character is one of a set of characters that is held in short term memory. Author

N87-30061# Ergometrics Technology, Inc., Dayton, Ohio.
CORTICAL EVOKED RESPONSE AND EYEBLINK MEASURES IN THE WORKLOAD EVALUATION OF ALTERNATIVE LANDING SYSTEM DISPLAYS
R. D. ODONNELL and GLENN WILSON *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload p 52-55 Jun. 1987 Prepared in cooperation with Aerospace Research Labs., Wright-Patterson AFB, Ohio
Avail: NTIS HC A07/MF A01

Based on the results of a number of studies, it was decided to construct a battery of physiological tests, each of which had shown some promise in laboratory studies of being sensitive to various aspects of workload. This Neuropsychological Workload Test Battery (NWTB) is undergoing validation testing in several simulator environments. Two of the most promising measures from this battery are the transient cortical evoked response and several analyses of eyeblink behavior. It is becoming clear that these techniques can contribute complementary types of information on the amount of workload being experienced by the operator, and could form the basis of a measurement system which would tap both global and specific aspects. Rationales are given for these techniques along with a description and examples of their use. E.R.

N87-30062*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IN-FLIGHT ASSESSMENT OF WORKLOAD USING INSTRUMENT SCAN
J. R. TOLE (Digital Analysis Corp., Reston, Va.) and R. L. HARRIS, SR. *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 56-59 Jun. 1987
Avail: NTIS HC A07/MF A01

During instrument flight, the pilot obtains information concerning aircraft state by cross checking or scanning the flight instruments. The exact method of scanning the instrument panel varies from pilot to pilot but there are some basic features common to a good scan pattern. The method discussed may be considered a candidate for workload studies with piloting tasks which will invoke a regular visual scan (spatial/temporal pattern of eye movements) during instrument flight. It is important to point out that instrument scan by itself is not a complete indicator of workload nor is task attention necessarily associated with where the pilot happens to be looking at a particular instant. However, whenever instrument scan is required in a piloting task, analysis of scanning behavior may yield important direct or indirect information concerning workload. Author

N87-30063# British Aerospace Dynamics Group, Hatfield (England). Test Pilots Office.
FLIGHT TEST EVALUATION OF CREW WORKLOAD. PART 1: AIRCRAFT CERTIFICATION FOR A MINIMUM CREW OF TWO PILOTS
W. A. WAINWRIGHT *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 60-68 Jun. 1987
Avail: NTIS HC A07/MF A01

The method developed to certificate the BAe 146 for operation by a minimum crew of two pilots to regulations is described. The method is based primarily on subjective assessment of workload but employs objective data to support that assessment. All the data were collected from one flying phase and no flight or ground simulator assessments were performed, neither were the results correlated with any previous evaluation. The flight test evaluation used a variety of assessment methods, including practical demonstration, qualitative and quantative subjective evaluation, subjective comparison with similar aircraft types, and objective physiological evaluation. All confirmed that the crew workload on the BAe 146 was compatible with operation by a minimum crew of 2 pilots. This method is briefly discussed. Author

N87-30064# Royal Air Force Strike Command, High Wycombe (England).
MEASUREMENT OF AIRCREW WORKLOAD DURING LOW-LEVEL FLIGHT. PART 1: A COMPARISON BETWEEN IN-FLIGHT AND POST FLIGHT ASSESSMENT METHODS
I. GAVIN LIDDERDALE *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 69-77 Jun. 1987
Avail: NTIS HC A07/MF A01

The results of a comparative study of the use of inflight and postflight methods of subjective workload assessments in a modern military combat aircraft are presented. The assessments were made during a demanding low level flight task which was undertaken to assess workload and define crew cooperation procedures for pilot and navigators during terrain following flight. The inflight workload assessments were made using a modified version of the Cooper-Harper scale which is referred to as the Bedford Scale. Postflight ratings were made using a method of pairwise comparisons based on a method reported by Saaty. Other measures, including physiological recordings and voice tapes were also taken during the trials to provide additional data. From the results of the trials, it was found that both methods of subjective workload assessment produced similar results and a rank order analysis gave high correlations. A hypothetical Recce/Attack task for fast jet aircraft was chosen to illustrate the application of the workload measurement techniques described. The technique relies on the use of subjective ratings scales and physiological measures supported by voice recordings and flight data recordings. Author

N87-30066# Cranfield Inst. of Tech., Bedford (England). Applied Psychology Unit.
THE ASSESSMENT OF WORKLOAD IN HELICOPTERS
HELEN C. MUIR and ROBERT ELWELL *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 83-89 Jun. 1987
Avail: NTIS HC A07/MF A01

In aviation an assessment of workload is often used as one component in a program of research. The objective of the research may vary from an assessment of the activities of the crew to an evaluation of either cockpit modifications or operational changes. Thus workload assessments will form one of a series of stages in the research. A model is presented in which the stages of the investigation which will proceed and follow the workload assessment are described. An application of this approach to the assessment of workload in helicopters is used to illustrate the practical implications of the model. Author

N87-30067# Airbus Industrie, Blagnac (France).
ASSESSING WORKLOAD FOR MINIMUM CREW CERTIFICATION. PART 1: STATIC WORKLOAD ANALYSIS AND PERFORMANCE ANALYSIS
J. J. SPEYER, A. FORT, J. P. FOUILLOT, and R. D. BLOMBERG *In* Advisory Group for Aerospace Research and the Practical Assessment of Pilot Workload p 90-115 Jun. 1987 Prepared in cooperation with Centre de Recherches de Medecine Aeronautique, Paris (France) and Dunlap and Associates, Inc., Norwalk, Conn.
Avail: NTIS HC A07/MF A01

The critical importance of man machine interaction has been recognized in the field of aircraft handling qualities. The recognition that man machine interaction is part of a complex information transfer process between pilots, the aircraft and ground facilities is relatively new. Classical are the systematic methods for assessing aircraft handling qualities, which inspired the approach to workload assessment presented. Also classical topics in flight test are the determination of static and dynamic stability, the former indicating the tendency of an aircraft to return to its equilibrium position, the latter indicating the way an aircraft returns to its equilibrium position. Analogous to the complementarity of these evaluations, the Static Taskload and the Dynamic Workload Methods were developed. Both methods address particular workload functions and factors. These methods are briefly described and discussed. Author

N87-30068*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MEASUREMENT OF PILOT WORKLOAD
SANDRA G. HART *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 116-122 Jun. 1987
Avail: NTIS HC A07/MF A01

A multistage process for evaluating the workload of a five-minute segment of flight including approach and landing for a typical transport aircraft was described. The goal of the analysis was to compare the workload of the two pilots. Four types of measurement techniques were suggested: Analytic (a preliminary task and time line analysis identified task requirements and target performance levels); Performance (flight path control, communications, and interval production); Physiological (heart rate and heart rate variability); and Subjective ratings (a multidimensional technique developed at NASA Ames). Author

N87-30069# National Aerospace Lab., Amsterdam (Netherlands).
INVESTIGATION OF WORKLOAD MEASURING TECHNIQUES: A THEORETICAL AND PRACTICAL FRAMEWORK
RENE C. VANDEGRAAFF *In* Advisory Group for Aerospace Research and The Practical Assessment of Pilot Workload p 123-130 Jun. 1987
Avail: NTIS HC A07/MF A01

A number of considerations involved in the setting up of an investigation dealing with the problem of being able to draw conclusions from a variety of experimental measures in a complex task situation are discussed. Several implications are pointed out, such as the problem of dealing with contradictory outcomes, the designating of artefacts, and the problem of formulating final conclusions with the (a priori) availability of a superior method for evaluating other methods. An experimental program is outlined which is based on (normal) approach conditions for civil fixed wing aircraft. The task conditions in this experiment are selected to serve as an operationally based framework for comparing different workload evaluation methods, for evaluating the effects of specific task conditions and for investigating the strategies needed for drawing final conclusions from a variety of outcomes. Author

N87-30070# Oak Ridge National Lab., Tenn.
DYNAMIC TASK ALLOCATION FOR A MAN-MACHINE SYMBIOTIC SYSTEM
L. E. PARKER and F. G. PIN Jun. 1987 55 p
(Contract DE-AC05-84OR-21400)
(DE87-011950; ORNL/TM-10397; CESAR-87/08) Avail: NTIS HC A04/MF A01

This report presents a methodological approach to the dynamic allocation of tasks in a man-machine symbiotic system in the context of dexterous manipulation and teleoperation. This report addresses a symbiotic system containing two symbiotic partners which work toward controlling a single manipulator arm for the execution of a series of sequential manipulation tasks. It is proposed that an automated task allocator use knowledge about the constraints/criteria of the problem, the available resources, the tasks to be performed, and the environment to dynamically allocate task recommendations for the man and the machine. The presentation of the methodology includes discussions concerning the interaction of the knowledge areas, the flow of control, the necessary communication links, and the replanning of the task allocation. Examples of task allocation are presented to illustrate the results of this methodology. DOE

N87-30071# Army Research Inst. of Environmental Medicine, Natick, Mass.
EFFECTIVENESS OF AN AIR COOLED VEST USING SELECTED AIR TEMPERATURE, HUMIDITY AND AIR FLOW RATE, COMBINATIONS
STEPHEN R. MUZA, NANCY A. PIMENTAL, and HENRY M. COSIMINI Jun. 1987 36 p
(AD-A183298; USARIEM-T-22-87) Avail: NTIS HC A03/MF A01 CSCL 05H

The effectiveness of reducing thermal strain in soldiers by supplying an air-cooled vest with each of four different dry bulb (db) and dew point (dp) temperatures and air combinations is evaluated. The four combinations were selected to determine minimal air conditioning requirements for several military vehicles. Six male soldiers attempted four, 300-min heat exposures (49 C db, 20 C dp) at metabolic rates of either 175 and 315 W. The soldiers wore chemical protective clothing over the combat vehicle crewman uniform and the air-cooled vest. Air supplied to the vest ranged from 22.5 to 27.5 C db, 15.5 to 21.1 dp at flow rates of either 10 or 14.5 cfm. Endurance times with the vest were 272 to 300 min (175 W) and 159 to 220 min (315 W). In summary, at the 175 W metabolic rate the vest condition which provided the 10 cfm air flow was effective in reducing thermal strain and extending endurance time. At the 315 W metabolic rate, typical of a tank commander or loader, either vest condition would extend endurance time, but would not be as effective in reducing thermal strain as the vest combinations tested in an earlier study. GRA

N87-30072# Naval Aerospace Medical Research Lab., Pensacola, Fla.
INCOMPATIBILITY OF THE M-1 MANEUVER WITH US NAVY TACTICAL AIRCRAFT OXYGEN SYSTEMS Final Report
J. T. WHITE and L. M. MORIN Sep. 1986 9 p
(AD-A183731; NAMRL-TM-86-1) Avail: NTIS HC A02/MF A01 CSCL 06J

A spectrum of clinical symptoms consisting of grey-out, black-out, and G-induced loss of consciousness has been identified in pilots of high performance aircraft. The M-1 maneuver used in conjunction with reclined seats and inflated G-suit provides significant protection against these symptoms. Centrifuge-trained United States Navy tactical aircraft pilots have recently reported a decreased ability to perform the M-1 maneuver while using the MBU-12P oxygen mask and CRU-79/P oxygen regulator. This report reviewed the performance specifications of these devices and compared them with published pulmonary flow rates. We found this oxygen system to interfere with the performance of the M-1 and other anti-G maneuvers. Further research is needed to characterize pulmonary flow rates during the performance of the M-1 maneuver in order to make recommendations for breathing system standards aboard high performance aircraft. GRA

55

PLANETARY BIOLOGY

Includes exobiology; and extraterrestrial life.

A87-53000
HYPOTHESES ON THE APPEARANCE OF LIFE ON EARTH (REVIEW)
K. DOSE (Mainz, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 181-186. refs

Past theories on the origin and evolution of life (until about 1865) are discussed as well as contemporary hypotheses. Particular attention is given to the self-organization of spontaneously formed biomolecules into early precursors of life, their stepwise evolution via (postulated) protocells to (postulated) progenotes, and the Darwinian evolution from progenotes to the three kingdoms of contemporary organisms (archaebacteria, eubacteria, and eukaryotes). The hypothesis that life came to earth from a remote place in the universe (panspermia) has been reconsidered but there is evidence indicating that spores can survive only a relatively short journey within the solar system. K.K.

A87-53001
EXOBIOLOGY REVISITED
H. P. KLEIN (Santa Clara, University, CA) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 187-192. refs

The early history and recent progress in exobiology is reviewed. Tables are presented listing important questions concerning the early history of the 'biogenic' elements, the environment of the primordial earth, and the early and late stages of biological evolution. Finally, a general conceptual summary of the content of and the philosophy behind modern exobiology is given in a figure, including some of the space missions or activities that have contributed to the clarification of the first-order biological questions. B.J.

A87-53002* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SPACE STATION GAS-GRAIN SIMULATION FACILITY - APPLICATION TO EXOBIOLOGY
C. P. MCKAY, C. R. STOKER (NASA, Ames Research Center, Moffett Field CA), J. MORRIS, G. CONLEY (Colorado, University, Boulder), and D. SCHWARTZ (SETI Institute, Los Altos, CA) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 195-206. refs

The technical issues involved in performing experiments on the behavior and properties of aerosols in a microgravity environment provided by the Space Station are reviewed. The displacement of a particle resulting from g-jitter for ballistic, Knudsen, and Stokes flow regimes is examined in detail, and the radiation, acoustic, electrostatic, and electromagnetic mechanisms for the control of this motion are described. The simulation of organic haze production on Titan has been selected as an example experiment for detailed study. The purpose of this experiment was to simulate the photolysis of methane and the subsequent formation of the organic haze particles in the Titan upper atmosphere. B.J.

A87-53003
RADIATION STABILITY OF ORGANIC MATTER IN LIQUID AND FROZEN H2O, NH3 AND WATER-AMMONIA MIXTURES
B. NEBELING, K. ROESSLER, and G. SCHMITZ (Kernforschungsanlage Juelich, GmbH, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 207-210. refs

The redox properties of irradiated liquid and frozen H2O, NH3, and H2O/NH3 mixtures at 298 and 77 K towards some simple organic molecules have been checked by injecting carrier-free C-11 atoms and analyzing their chemical state by means of radiochromatography. The reactions and the stability of organic products versus radiation dose depend on temperature, phase state, mobility of radicals, their concentration, and reactivity. Especially dangerous are the reactive OH and O2H radicals which oxidize organic material to inorganic CO2. Highest stability has been found at low temperatures and for systems containing H-donors, which reduce the concentration of oxidizing radicals. The fact that many bodies in space consist of H2O-ice with NH3 and CH4 additives at temperatures between 10 and 150 K is promising in view of the survival of organic matter under high doses of radiation. Author

A87-53005* California Univ., Berkeley.
SURVEY OF EARTH ORBITAL TELESCOPES AND THEIR POTENTIAL FOR EXOBIOLOGY
JILL C. TARTER (California, University, Berkeley; SETI Institute, Los Altos) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 219-226.
(Contract NCC2-36)

The opportunities that exist for observational exobiology (OE) are examined. The potential uses of free-flying spacecraft, the Space Shuttle, and the Space Station for OE are considered. Proposed experiments are summarized, including research on extrasolar planetary systems, the solar nebula and its analogs, the solar system, giant-planet atmospheres, Titan, comets and asteroids, and molecules in space. A table listing appropriate NASA and ESA telescopes is given. B.J.

A87-53007
SEARCH FOR ORGANIC MOLECULES IN THE OUTER SOLAR SYSTEM
TH. ENCRENAZ (Paris, Observatoire, Meudon, France) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 237-246. refs

Published data from ground and space observations revealing the presence of complex organic molecules in the outer solar system are compiled in tables and spectra and discussed. Detections of IR lines of organic species are reported for the atmospheres of Titan, Jupiter, Saturn, Uranus, and Neptune, and near the nucleus of Comet Halley. Consideration is given to plans for further research, including larger antennae and interferometers on the ground; advanced space observatories such as ISO, SIRTF, Caesar, Vesta, and CRAF; and the ESA Comet Nucleus Sample Return mission. T.K.

A87-53008
PHYSICAL-CHEMICAL LIMITS FOR THE STABILITY OF BIOMOLECULES
E. W. LANG (Regensburg, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 251-255. refs

The effects of temperature (T) and pressure (p) on reactions among biopolymers and between biopolymers and water (and hence on the effective stability of the biomolecules) are discussed, summarizing the results of published experimental investigations. Consideration is given to the reversible undercooling of aqueous solutions of some biomolecules, the cold lability of proteins, the self-dissociation of water and the weakening of hydrogen bonds at high T and p (leading to accelerated hydrolysis of biomolecules), and increases in hydrophobic reactions at high T. Results for the t-butanol/water system (Woznyj et al., 1984; Woznyj, 1985) are examined in more detail. The upper stability limit on T is estimated at about 400 K, but the p values encountered on earth (up to about 120 MPa) are found to have little effect on biomolecule stability at T less than 400 K. T.K.

A87-53009* Drexel Univ., Philadelphia, Pa.
MOLECULAR ASPECTS OF ADAPTATION TO EXTREME COLD ENVIRONMENTS
LEONARD FINEGOLD (Drexel University, Philadelphia, PA) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 257-264. Research supported by the American Philosophical Society. refs
(Contract NATO-84/0667; NSF DPP-83-14180; NSG-7337)

Some of the various strategies adopted by living organisms for survival at low temperatures are discussed from the molecular and membrane points of view. Two examples of connections between biological cold adaptation and the molecular level are considered: (1) antifreeze proteins in fish from cold sea water and (2) the fluidity characteristics of cell membranes in a wide variety of organisms. Emphasis is placed on the occurrence of s-phases. B.J.

A87-53010* Florida State Univ., Tallahassee.
THE ANTARCTIC COLD DESERT AND THE SEARCH FOR TRACES OF LIFE ON MARS
E. I. FRIEDMANN (Florida State University, Tallahassee) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 265-268. refs
(Contract NSG-7337; NSF DPP-83-14180)

The cryptoendolithic microoganisms that live inside rocks in the frigid Ross Desert of Antarctica can serve as a terrestrial model for what may have happened to life forms on Mars when the planet became dry and cold. Trace fossils of microbial rock colonization exist in Antarctica, and similar structures could have formed on Mars. In some respects, such trace fossils could be an easier target for life-detection systems than fossils of cellular structures. Author

A87-53011* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EXOBIOLOGY AND FUTURE MARS MISSIONS - THE SEARCH FOR MARS' EARLIEST BIOSPHERE
CHRISTOPHER P. MCKAY (NASA, Ames Research Center, Moffett Field, CA) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 6, no. 12, 1986, p. 269-285. NASA-supported research. refs

The primordial Mars may have possessed a thick carbon dioxide atmosphere, with liquid water common on the surface, similar in many ways to the primordial earth. During this epoch, billions of years ago, the surface of Mars could have been conducive to the origin of life. It is possible that life evolved on Mars to be later eliminated as the atmospheric pressure dropped. Analysis of the surface of Mars for the traces of this early Martian biota could provide many insights into the phenomenon of life and its coupling to planetary evolution. Author

A87-53014
SURVIVAL UNDER SPACE VACUUM - BIOCHEMICAL ASPECTS
K. DOSE (Mainz, Universitaet, West Germany) (COSPAR, Plenary Meeting, 26th, Topical Meeting and Workshop 4 on Life Sciences and Space Research XXII/2/, Toulouse, France, June 30-July 11, 1986) Advances in Space Research (ISSN 0273-1177), vol. 16, no. 12, 1986, p. 307-312. refs
(Contract BMFT-01-QV-179/13)

It is suggested that a number of biophysical and chemical effects have a crucial function in the inactivation of biological systems induced by long-term exposure to vacuum. These effects include the disruption of hydrophobic bonds (e.g., in membranes and proteins), the induction of conformational changes by removal of hydrate water (particularly in DNA and proteins), and the formation of new covalent bonds by condensation and elimination reactions (the formation of DNA-protein crosslinks). B.J.

A87-53551
CLAY MINERALS AND THE ORIGIN OF LIFE
A. GRAHAM CAIRNS-SMITH, ED. (Glasgow, University, Scotland) and HYMAN HARTMAN, ED. (MIT, Cambridge, MA) Cambridge and New York, Cambridge University Press, 1986, 204 p. No individual items are abstracted in this volume.

The role of clays in the origins of life is examined in papers presented at a workshop held at Glasgow University on July 18-24, 1983. Topics addressed include protoplasm and the gene theory, the clay hypothesis, and the use of SEM to analyze clay minerals. Consideration is given to layer silicate structures, cation patterns

and information storage, interstratified clays, flocculation/deflocculation, the hydrothermal strategy, clay synthesis using hydroxide silica gels, and the role of organic complexing agents in the synthesis of clay. Also discussed are the origin of clays on earth, Precambrian clays, the synthesis of iron-rich clays in an anaerobic environment, dysoxic environments as models for primordial mineralization, clays on Mars and in meteorites, clay catalysis, the essential conditions for life, four crystal genes, and the pedigree principle. I.F.

A87-53826
1986 ISSOL MEETING, 5TH, BERKELEY, CA, JULY 21-25, 1986, PROCEEDINGS
JAMES P. FERRIS, ED. (Rensselaer Polytechnic Institute, Troy, NY) Meeting sponsored by the International Society for the Study of the Origin of Life. Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, 238 p. For individual items see A87-53827 to A87-53845.

The volume includes papers on the quantitative aspects of photoprecipitation and the banded iron-formations, the possible biological origin of banded iron-formations from hydrothermal solutions, the formation of amino acid precursors in the reaction of atomic carbon with water and ammonia at 77K, and the prebiotic synthesis of imidazole-4-acetaldehyde and histidine. Consideration is given to the nonenzymatic synthesis of coenzymes uridine diphosphate glucose and cytidine diphosphate choline and other phosphorylated metabolic intermediates, kinetic analysis of the template effect in ribooligoguanylate elongation, selective emergence and survival of early polypeptides in water, and the energy metabolism of a thermoacidophilic archaebacterium, Sulfolobus acidocaldarius. Special attention is given to the origin and evolution of photosynthetic reaction centers, and the structural elements and organization of the ancestral translational machinery. I.S.

A87-53831
THE FORMATION OF AMINO ACID PRECURSORS IN THE REACTION OF ATOMIC CARBON WITH WATER AND AMMONIA AT 77 K
DANIEL W. MCPHERSON, KAZI RAHMAN, IRIS MARTINEZ, and PHILIP B. SHEVLIN (Auburn University, AL) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 275-282. refs
(Contract NSF CHE-84-01198)

When atomic carbon is condensed on a surface at 77 K containing ammonia and water, glycine, N-methylglycine, alanine, beta-alanine, aspartic acid, and serine are generated. It is postulated that these reactions may mimic those which occur when an extraterrestrial carbon atom condenses on a frozen surface coated with water and ammonia and may provide a route to extraterrestrial amino acids. Experiments designed to elucidate the mechanisms of amino acid formation under these conditions have been carried out. Author

A87-53832
STUDIES ON THE STRUCTURE OF HCN OLIGOMERS
KIMIKO UMEMOTO, MAKOTO TAKAHASI, and KATSUYUKI YOKOTA (International Christian University, Mitaka, Japan) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 283-293. refs

Infrared, NMR, and chemical analyses were used to study the structure of the water-insoluble fraction of HCN oligomers prepared by introducing HCN gas into concentrated aqueous ammonia. After four days, the precipitated solid oligomers were washed with water and dryed in vacuo before analyses. It was found that nearly half of the nitrogen atoms contained in the oligomers are of the primary amino type, and the other half are involved in the -C=N- type bonding. The oligomers contain about 0.2 atom of oxygen per atom of nitrogen; it is suggested that oxygen is introduced into the oligomers from the solvent water through a hydrolytic process to form a C=O bond in place of the C=NH. Acetylated oligomers show IR absorption and NMR spectra characteristic for acetyl amide. The molecular weights of acetylated oligomers, estimated by gel permeation chromatography, ranged from 300 to 900. I.S.

A87-53833* Houston Univ., Tex.
PREBIOTIC SYNTHESIS OF IMIDAZOLE-4-ACETALDEHYDE AND HISTIDINE
CHUN SHEN, J. ORO, LILY YANG (Houston, University, TX), and STANLEY L. MILLER (California, University, La Jolla) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 295-305. refs
(Contract NGR-44-005-002; NAGW-20)

The prebiotic synthesis of imidazole-4-acetaldehyde and imidazole-4-glycol from erythrose and formamidine has been demonstrated as well as the prebiotic synthesis of imidazole-4-ethanol and imidazole-4-glycol from erythrose, formaldehyde, and ammonia. The maximum yields of imidazole-4-acetaldehyde, imidazole-4-ethanol, and imidazole-4-glycol obtained in these reactions are 1.6, 5.4 and 6.8 percent respectively, based on the erythrose. Imidazole-4-acetaldehyde would have been converted to histidine on the primitive earth by a Strecker synthesis, and several prebiotic reactions would convert imidazole-4-glycol and imidazole-4-ethanol to imidazole-4-acetaldehyde. Author

A87-53834* Houston Univ., Tex.
NON-ENZYMATIC SYNTHESIS OF THE COENZYMES, URIDINE DIPHOSPHATE GLUCOSE AND CYTIDINE DIPHOSPHATE CHOLINE, AND OTHER PHOSPHORYLATED METABOLIC INTERMEDIATES
A. MAR, J. DWORKIN, and J. ORO (Houston, University, TX) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 307-319. refs
(Contract NGR-44-005-002)

Using urea and cyanamide, the two condensing agents considered to have been present on the primitive earth, uridine diphosphate glucose (UDPG), cytidine diphosphate choline (CDP-choline), glucose-1-phosphate (G1P), and glucose-6-phosphate (G6P) were synthesized under simulated prebiotic conditions. The reaction products were separated and identified using paper chromatography, thin layer chromatography, enzymatic analyses, and ion-pair reverse-phase high performance liquid chromatography. The possibility of nonenzymatic synthesis of metabolic intermediates on the primitive earth from simple precursors was thus demonstrated. I.S.

A87-53835* Instituto Politecnico Nacional, Mexico City.
LIPOSOMES WITH POLYRIBONUCLEOTIDES AS MODEL OF PRECELLULAR SYSTEMS
ISABEL BAEZA, MIGUEL IBANEZ, CARLOS SANTIAGO, ANTONIO LAZCANO, CARLOS ARGUELLO (Instituto Politecnico Nacional, Mexico City, Mexico) et al. (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 321-331. Research supported by the Instituto Politecnico Nacional. refs
(Contract NGR-44-005-002)

Three types of liposomes were prepared under anoxic conditions: from dipalmitoyl phosphatidyl choline (DPPC), from egg yolk phosphatidyl choline (PC), and from PC with cholesterol (PC:Chol). These were used for encapsulation of poly(U) and poly(C). It was found that 36 to 70 percent of the available liposome lipids and 2 to 5 percent of the polyribonucleotides could be entrapped. An enhanced encapsulation of poly(U) and poly(C) by all three types of liposomes was observed in the presence of 0.001 to 0.01 M Zn(2+), with the effect being greatest with DPPC. The presence of 1.0 M urea inhibited the formation of PC liposomes. I.S.

A87-53836* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
KINETIC ANALYSIS OF THE TEMPLATE EFFECT IN RIBOOLIGOGUANYLATE ELONGATION
ANASTASSIA KANAVARIOTI (Nasa, Ames Research Center, Moffett Field, CA) and DAVID H. WHITE (Santa Clara, University, CA) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 333-349. Research supported by the U.S. National Research Council. refs
(Contract NCC2-166)

The paper presents kinetic studies on the reaction of elongation of the 3-prime-5-prime-linked ribooligoguanylates with guanosine 5-prime-phospho-2-methylimidazolide (2-MeImpG) in the presence or absence of a complementary template, the polycytidylic acid. In the absence of poly(C), the reaction leads to three isomeric oligomers that are elongated by one monomer unit: the 3-prime-5-prime linked, the 2-prime-5-prime linked, and the pyrophosphate, formed in a ratio of 1:2:5. In the presence of the template, the reaction is 20-fold faster and yields products (n + 1), (n + 2), (n + 3), etc., as long as 2-MeImpG is available. The formation of the natural, 3-prime-5-prime-linked isomer, is enhanced selectively by 140-fold at 37 C, and its relative yield increases with decreasing temperature. I.S.

A87-53837* Nijmegen Univ. (Netherlands).
NUCLEIC ACID-LIKE STRUCTURES. II - POLYNUCLEOTIDE ANALOGUES AS POSSIBLE PRIMITIVE PRECURSORS OF NUCLEIC ACIDS
ALAN W. SCHWARTZ, J. VISSCHER, C. G. BAKKER, and J. NIESSEN (Nijmegen, Katholieke Universiteit, Netherlands) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 351-357. refs
(Contract NGR-05-067-001)

Activated derivatives of purine-containing deoxynucleoside-diphosphates spontaneously oligomerize to produce pyrophosphate- linked oligodeoxynucleotide analogs. These analogs are of potential interest as models of primitive, polynucleotide precursors. The efficiency of oligomerization (ImpdGpIm and ImpdApIm much greater than ImpdIpIm) appears to reflect a combination of stacking forces and the specific geometric orientations of the stacked units. Under favorable conditions, chain lengths greater than 20 have been obtained for oligomers containing pdGp in the absence of a template. In the presence of a complementary template, the activated derivatives of pdGp and pdAp oligomerize much more extensively. An acyclo-analog of G has also been shown to undergo template-directed oligomerization on poly(C). These observations suggest the possibility that primitive information transfer might have evolved in much simpler systems and that this function was taken over by polynucleotides at a later stage in evolution. Author

A87-53838
BINDING OF DNA HAIRPINS TO AN ASSEMBLER-STRAND AS PART OF A PRIMORDIAL TRANSLATION DEVICE
ULRICH BAUMANN (Max-Planck-Institut fuer biophysikalische Chemie, Goettingen, West Germany) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 359-366. refs

A crucial event in the process leading to the origin of life is the emergence of a simple translation device. To approach experimental realization of this device the binding ability of short DNA hairpins to complementary oligonucleotides fixed on a solid support was investigated. The binding is achieved by base pairing between the loop nucleotides of the hairpins containing different numbers of adenosine residues and oligothymidylates covalently linked to cellulose. The loop has to consist of at least five nucleotides to achieve binding. The exact number of established base pairs was determined in two ways. First, the elution temperatures of hairpins and those of oligoadenylates which had the length of the loop were compared. Secondly, the architecture of the loop was analyzed by means of the single-strand-specific nuclease from mung bean acting as structural probe. Only n-2 of n loop nucleotides of a hairpin are able to form base pairs. Therefore, a strong evidence for the formation of a triplet of base pairs between primeval tRNA and mRNA sufficient to stabilize the complex enzyme-free is given. Author

A87-53839
SELECTIVE EMERGENCE AND SURVIVAL OF EARLY POLYPEPTIDES IN WATER
ANDRE BRACK (CNRS, Centre de Biophysique Moleculaire, Orleans, France) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 367-379. refs

Evidence is presented for the selective condensation of amino acids in water, as well as for the selective resistance of condensation products to degradation, indicating that oligopeptides essential to primitive cells could be formed in the environment of primitive earth. It is shown that N-carboxyanhydrides (formed when active esters of amino acids are left in the presence of bicarbonate ions or when N,N-prime-carbonyldiimidazole is used as the condensing agent) are good candidates for chemical selection in water. The specific stability of water-soluble beta-pleated sheet conformation against chemical degradation suggests a possible way to accumulate homochiral sequences made of hydrophilic and hydrophobic residues; amino acids with branched aliphatiac side-chains are selected but those with short linear aliphatic side-chains are not. I.S.

A87-53840
SEARCH FOR CATALYTIC PROPERTIES OF SIMPLE POLYPEPTIDES
B. BARBIER and A. BRACK (CNRS, Centre de Biophysique Moleculaire, Orleans, France) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 381-390. refs

The catalytic effects of polypeptides on the nucleotide polymerization (in the absence of any preformed polynucleotide template) and/or degradation were investigated by testing sequential copolymers of Ala and Glu, water-soluble polypeptides based on Arg, and poly(Glu-Ser-Glu). No catalytic effect was observed with any of these, although poly(Glu-Ser-Glu) was found to modify the course of nucleotide polymerization by favoring the 2-prime-5-prime internucleotide linkage. On the other hand, the polypeptides containing Arg were found to significantly enhance the hydrolysis of oligoadenylates at pH values between 7.5 and 12 and at temperatures below 40 C. I.S.

A87-53842
THE RELATIONSHIP BETWEEN THE BIOSYNTHETIC PATHS TO THE AMINO ACIDS AND THEIR CODING. I - THE ALIPHATIC AMINO ACIDS AND PROLINE
JOHN H. MCCLENDON (Nebraska, University, Lincoln) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 401-417. refs

The genetic code could not have been fixed until the means for biosynthesis of the amino acids was at hand. The biosynthetic enzymes could not be optimized until the genetic code ceased to be rearranged. Therefore the development of the code and the development of the biosynthesis of the amino acids occurred concurrently. The present day biosynthetic pathways of amino acids, examined from this point of view, help to explain the present set of coded amino acids, in particular the absence of norvaline, norleucine, homoserine, ornithine, and alpha-aminobutyric acid. An order of development of biosyntheses is also proposed. Lysine was first, followed by valine and isoleucine. The more common primordial amino acids did not need biosyntheses so early. The central pathways of metabolism probably developed in response to a need for amino acid biosynthesis. Author

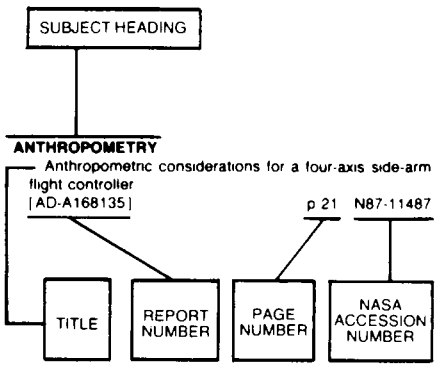
A87-53844* Roswell Park Memorial Inst., Buffalo, N. Y.
STRUCTURAL ELEMENTS AND ORGANIZATION OF THE ANCESTRAL TRANSLATIONAL MACHINERY
R. REIN, S. SRINIVASAN, J. MCDONALD, G. RAGHUNATHAN, and M. SHIBATA (Roswell Park Memorial Institute, Buffalo, NY) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 431-438. refs
(Contract NSG-7305)

The molecular mechanisms of the primitive translational apparatus are discussed in the framework of present-day protein biosynthesis. The structural necessities of an early adaptor and the multipoint recognition properties of such an adaptor are investigated on the basis of structure/function relationships found in a contemporary system and a molecular model of the contemporary transpeptidation complex. A model of the tRNA(Tyr)-tyrosyl tRNA synthetase complex including the positioning of the disordered region is proposed; the model is used to illustrate the required recognition properties of the ancestor aminoacyl synthetase. I.S.

A87-53845
INFORMATION THEORY AND THE GENETIC CODE
A. FIGUREAU (Lyon I, Universite, Villeurbanne, France) (International Society for the Study of the Origin of Life, Meeting, 5th, Berkeley, CA, July 21-25, 1986) Origins of Life (ISSN 0302-1688), vol. 17, no. 3-4, 1987, p. 439-449. refs

The key processes involved in the functioning of the genetic code as an information system in the replication, transcription, and translation processes are examined. A systematic approach is devised, which makes it possible to integrate the most fundamental characteristics of the code in a theoretical scheme in which many features of the code table can be interpreted as resulting from a unique principle of best resistance against the effects of mutations. Some consequences of this new principle are explored in the most simple models that can be built for the origin and evolution of the genetic code. I.S.

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, the title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

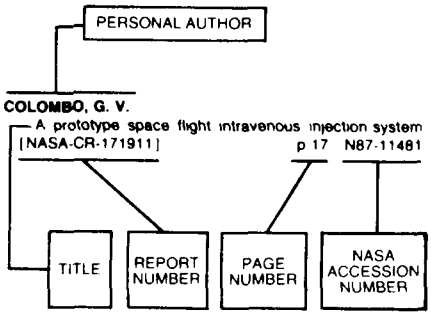
R

S

T

X

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

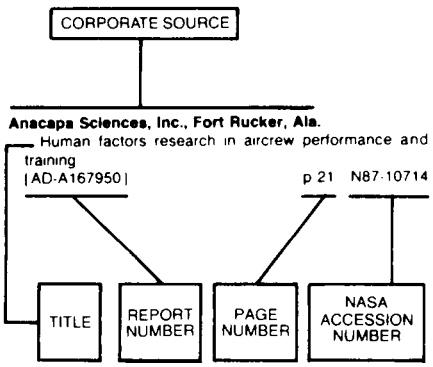
W

Y

Z

CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

R

S

T

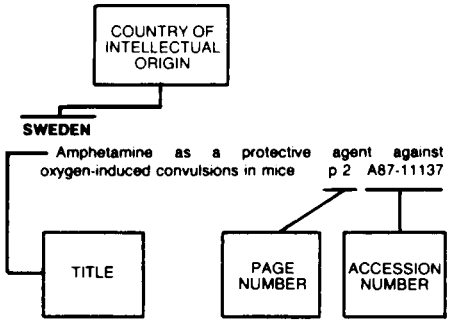
U

V

W

Y

Typical Foreign Technology Index Listing



Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section.

A

AUSTRALIA
Execution of 'ARC' experiment on Space Shuttle 'Discovery' STS 51-C - Some results on aggregation of red blood cells under zero gravity p 309 A87-53620

AUSTRIA
Systems interrelations of gravity responses in the human organism, and the use of modelling p 308 A87-53015

C

CANADA
A closed-loop causal model of workload based on a comparison of fuzzy and crisp measurements techniques p 316 A87-51165
Flight simulation motion-base drive algorithms. Part 3: Pilot evaluations [UTIAS-319] p 317 N87-29116
Application of human whole-body RF absorption measurements to RFR safety standards p 313 N87-30034
Radiofrequency radiation safety of two manpack transceivers (AN/PRC-515 and AN/PRC-77) p 313 N87-30039
Specific absorption rate distributions in a heterogeneous model of the human body at radiofrequencies [PB87-201356] p 313 N87-30040

D

DENMARK
Origin and evolution of photosynthetic reaction centers p 303 A87-53843

F

FINLAND
Cortical magnification and peripheral vision p 307 A87-52091

FRANCE
Structural and functional responses to prolonged hindlimb suspension in rat muscle p 296 A87-52216
Hypoxia and monosynaptic reflexes in humans p 307 A87-52219
Cellular differentiation and proliferation in corn roots grown in microgavity (Biocosmos 1985) p 300 A87-52997
Search for organic molecules in the outer solar system p 327 A87-53007
Selective emergence and survival of early polypeptides in water p 329 A87-53839
Search for catalytic properties of simple polypeptides p 329 A87-53840
Information theory and the genetic code p 330 A87-53845
Study of anticipation mechanisms in the aeronautical environment p 317 N87-29505
Sophisticated integral control methods for use in flight p 322 N87-29510
Organization of displays in the visual space of the combat aircraft pilot p 322 N87-29516
The practical assessment of pilot workload [AGARD-AG-282] p 323 N87-30054
Assessing workload for minimum crew certification. Part 1: Static workload analysis and performance analysis p 325 N87-30067

G

GERMANY,FEDERAL REPUBLIC OF
Physical parameters affecting living cells in space p 297 A87-52977
Classification of gravity effects on 'free' cells p 297 A87-52978
Polarity of root statocytes - Relevance for graviperception p 298 A87-52984
Bioscience experiments in the German Spacelab mission D-1 - Introduction and summary p 299 A87-52988
Dosimetric mapping inside Biorack p 320 A87-52990
Embryogenesis and organogenesis of Carausius morosus under spaceflight conditions p 299 A87-52991
Genetic and physiological damage induced by cosmic radiation on dry plant seeds during space flight p 299 A87-52993
Confirmation of gravisensitivity in the slime mold Physarum polycephalum under near weightlessness p 300 A87-52995
Survey of the vestibulum, and behavior of Xenopus laevis larvae developed during a 7-days space flight p 300 A87-52996
Effects of rectilinear acceleration, caloric and optokinetic stimulation of human subjects in the Spacelab D-1 mission p 308 A87-52998
Subjective vertical before and after space flight p 308 A87-52999
Hypotheses on the appearance of life on earth (Review) p 326 A87-53000
Radiation stability of organic matter in liquid and frozen H2O, NH3 and water-ammonia mixtures p 326 A87-53003
Physical-chemical limits for the stability of biomolecules p 327 A87-53008
Microbial life at extremely low nutrient levels p 300 A87-53012
Survival strategies of microorganisms in extreme saline environments p 300 A87-53013
Survival under space vacuum - Biochemical aspects p 327 A87-53014
The musculo-skeletal system in man - Development structure and function in dependence on gravity, and potential limitations for long term space flights p 308 A87-53016
Binding of DNA hairpins to an assembler-strand as part of a primordial translation device p 329 A87-53838
Treatment of degenerative diseases of the spine by physiotherapy [DRIC-T-7613] p 310 N87-29108
Refinement of the eye-point-of-regard measurements with helicopter pilots in a flight experiment [DFVLR-FB-86-61] p 317 N87-29115
The task taxonomy method: A basis for an expert system on human reliability p 318 N87-29506
Evaluation of human exposure to low frequency fields p 313 N87-30037
Radiofrequency radiation safety guidelines in the Federal Republic of Germany p 313 N87-30038
The use of subjective workload assessment technique in a complex flight task p 324 N87-30058

H

HUNGARY
Kinetics of the O-photointermediate of bacteriorhodopsin photocycle in native and enzyme treated purple membrane fragments as a function of pH p 296 A87-51465

I

INTERNATIONAL ORGANIZATION
Robot manipulators for sample handling in space p 320 A87-53921

ISRAEL
Geotropic sensitivity exhibited by single hornets - The influence of caste, age, light and temperature p 298 A87-52981
Adjustment and validation of the mathematical prediction model for sweat rate, heart rate and body temperature under outdoor conditions [AD-A183109] p 314 N87-30046

J

JAPAN
Some characteristics of peripheral vision p 306 A87-51178
Development of a small-sized space manipulator p 319 A87-51979
Studies on the structure of HCN oligomers p 328 A87-53832
Energy metabolism of a thermoacidophilic archaebacterium, Sulfolobus acidocaldarius p 303 A87-53841

L

LITHUANIA
Interaction of growth-determining systems with gravity p 299 A87-52987

M

MEXICO
Liposomes with polyribonucleotides as model of precellular systems p 328 A87-53835

N

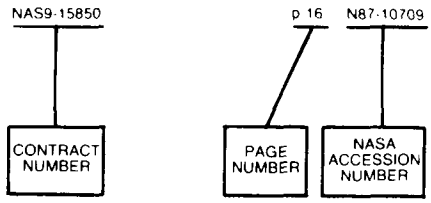
NETHERLANDS
The effect of microgravity on plasma-osteocalcin p 308 A87-52994
Nucleic acid-like structures. II - Polynucleotide analogues as possible primitive precursors of nucleic acids p 329 A87-53837
Activities report in aerospace medicine [ETN-87-90153] p 311 N87-29112
Exposure to radiofrequency fields in the Netherlands: Measurements and evaluation p 313 N87-30035
Investigation of workload measuring techniques: A theoretical and practical framework p 325 N87-30069

FOREIGN

S

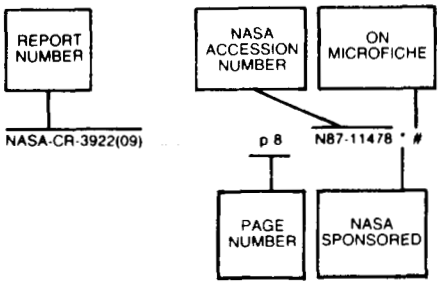
U

Typical Contract Number Index Listing



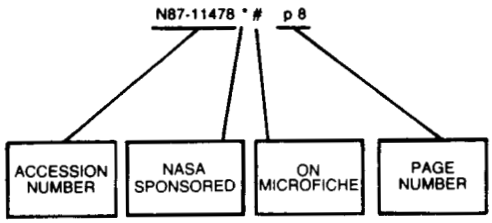
Listings in this index are arranged alpha-numerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the AIAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

Typical Report Number Index Listing



Listings in this index are arranged alpha-numerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

Typical Accession Number Index Listing



Listings in this index are arranged alpha-numerically by accession number. The page number listed to the right indicates the page on which the citation is located. An asterisk (*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

AVAILABILITY OF CITED PUBLICATIONS

IAA ENTRIES (A87-10000 Series)

Publications announced in *IAA* are available from the AIAA Technical Information Service as follows: Paper copies of accessions are available at $10.00 per document (up to 50 pages), additional pages $0.25 each. Microfiche[1] of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand. Standing order microfiche are available at the rate of $1.45 per microfiche for *IAA* source documents and $1.75 per microfiche for AIAA meeting papers.

Minimum air-mail postage to foreign countries is $2.50. All foreign orders are shipped on payment of pro-forma invoices.

All inquiries and requests should be addressed to: Technical Information Service, American Institute of Aeronautics and Astronautics, 555 West 57th Street, New York, NY 10019. Please refer to the accession number when requesting publications.

STAR ENTRIES (N87-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation. The most commonly indicated sources and their acronyms or abbreviations are listed below. If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line.

Avail: NTIS. Sold by the National Technical Information Service. Prices for hard copy (HC) and microfiche (MF) are indicated by a price code preceded by the letters HC or MF in the *STAR* citation. Current values for the price codes are given in the tables on NTIS PRICE SCHEDULES.

Documents on microfiche are designated by a pound sign (#) following the accession number. The pound sign is used without regard to the source or quality of the microfiche.

Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices. For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Section, Springfield, Va. 22161.

NOTE ON ORDERING DOCUMENTS: When ordering NASA publications (those followed by the * symbol), use the N accession number. NASA patent applications (only the specifications are offered) should be ordered by the US-Patent-Appl-SN number. Non-NASA publications (no asterisk) should be ordered by the AD, PB, or other *report* number shown on the last line of the citation, not by the N accession number. It is also advisable to cite the title and other bibliographic identification.

Avail: SOD (or GPO). Sold by the Superintendent of Documents, U.S. Government Printing Office, in hard copy. The current price and order number are given following the availability line. (NTIS will fill microfiche requests, as indicated above, for those documents identified by a # symbol.)

(1) A microfiche is a transparent sheet of film, 105 by 148 mm in size containing as many as 60 to 98 pages of information reduced to micro images (not to exceed 26.1 reduction).

Avail: BLL (formerly NLL): British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. Photocopies available from this organization at the price shown. (If none is given, inquiry should be addressed to the BLL.)

Avail: DOE Depository Libraries. Organizations in U.S. cities and abroad that maintain collections of Department of Energy reports, usually in microfiche form, are listed in *Energy Research Abstracts.* Services available from the DOE and its depositories are described in a booklet, *DOE Technical Information Center - Its Functions and Services* (TID-4660), which may be obtained without charge from the DOE Technical Information Center.

Avail: ESDU. Pricing information on specific data, computer programs, and details on ESDU topic categories can be obtained from ESDU International Ltd. Requesters in North America should use the Virginia address while all other requesters should use the London address, both of which are on the page titled ADDRESSES OF ORGANIZATIONS.

Avail: Fachinformationszentrum, Karlsruhe. Sold by the Fachinformationszentrum Energie, Physik, Mathematik GMBH, Eggenstein Leopoldshafen, Federal Republic of Germany, at the price shown in deutschmarks (DM).

Avail: HMSO. Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, California. The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI.

Avail: NASA Public Document Rooms. Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration, Public Documents Room (Room 126), 600 Independence Ave., S.W., Washington, D.C. 20546, or public document rooms located at each of the NASA research centers, the NASA Space Technology Laboratories, and the NASA Pasadena Office at the Jet Propulsion Laboratory.

Avail: Univ. Microfilms. Documents so indicated are dissertations selected from *Dissertation Abstracts* and are sold by University Microfilms as xerographic copy (HC) and microfilm. All requests should cite the author and the Order Number as they appear in the citation.

Avail: US Patent and Trademark Office. Sold by Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, at the standard price of $1.50 each, postage free. (See discussion of NASA patents and patent applications below.)

Avail: (US Sales Only). These foreign documents are available to users within the United States from the National Technical Information Service (NTIS). They are available to users outside the United States through the International Nuclear Information Service (INIS) representative in their country, or by applying directly to the issuing organization.

Avail: USGS. Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed in this Introduction. The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction.

Avail: Issuing Activity, or Corporate Author, or no indication of availability. Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document.

PUBLIC COLLECTIONS OF NASA DOCUMENTS

DOMESTIC: NASA and NASA-sponsored documents and a large number of aerospace publications are available to the public for reference purposes at the library maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 555 West 57th Street, 12th Floor, New York, New York 10019.

EUROPEAN: An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England for public access. The British Library Lending Division also has available many of the non-NASA publications cited in *STAR*. European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols # and * from ESA – Information Retrieval Service European Space Agency, 8-10 rue Mario-Nikis, 75738 CEDEX 15, France.

FEDERAL DEPOSITORY LIBRARY PROGRAM

In order to provide the general public with greater access to U.S. Government publications, Congress established the Federal Depository Library Program under the Government Printing Office (GPO), with 50 regional depositories responsible for permanent retention of material, inter-library loan, and reference services. At least one copy of nearly every NASA and NASA-sponsored publication, either in printed or microfiche format, is received and retained by the 50 regional depositories. A list of the regional GPO libraries, arranged alphabetically by state, appears on the inside back cover. These libraries are *not* sales outlets. A local library can contact a Regional Depository to help locate specific reports, or direct contact may be made by an individual.

STANDING ORDER SUBSCRIPTIONS

NASA SP-7011 and its supplements are available from the National Technical Information Service (NTIS) on standing order subscription as PB 86-912300 at the price of $8.00 domestic and $16.00 foreign, and at $14.00 domestic and $28.00 foreign for the annual index. Standing order subscriptions do not terminate at the end of a year, as do regular subscriptions, but continue indefinitely unless specifically terminated by the subscriber. Questions on the availability of the predecessor publications, *Aerospace Medicine and Biology* (Volumes I-XI), should be directed to NTIS.

ADDRESSES OF ORGANIZATIONS

American Institute of Aeronautics and Astronautics
Technical Information Service
555 West 57th Street, 12th Floor
New York, New York 10019

British Library Lending Division,
Boston Spa, Wetherby, Yorkshire,
England

Commissioner of Patents and Trademarks
U.S. Patent and Trademark Office
Washington, D.C. 20231

Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

ESA-Information Retrieval Service
ESRIN
Via Galileo Galilei
00044 Frascati (Rome) Italy

ESDU International, Ltd.
1495 Chain Bridge Road
McLean, Virginia 22101

ESDU International, Ltd.
251-259 Regent Street
London, W1R 7AD, England

Fachinformationszentrum Energie, Physik, Mathematik GMBH
7514 Eggenstein Leopoldshafen
Federal Republic of Germany

Her Majesty's Stationery Office
P.O. Box 569, S.E. 1
London, England

NASA Scientific and Technical Information Facility
P.O. Box 8757
B.W.I. Airport, Maryland 21240

National Aeronautics and Space Administration
Scientific and Technical Information Division (NTT-1)
Washington, D.C. 20546

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Pendragon House, Inc.
899 Broadway Avenue
Redwood City, California 94063

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, Michigan 48106

University Microfilms, Ltd.
Tylers Green
London, England

U.S. Geological Survey Library
National Center - MS 950
12201 Sunrise Valley Drive
Reston, Virginia 22092

U.S. Geological Survey Library
2255 North Gemini Drive
Flagstaff, Arizona 86001

U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025

U.S. Geological Survey Library
Box 25046
Denver Federal Center, MS914
Denver, Colorado 80225

NTIS PRICE SCHEDULES

(Effective January 1, 1988)

Schedule A
STANDARD PRICE DOCUMENTS AND MICROFICHE

PRICE CODE	PAGE RANGE	NORTH AMERICAN PRICE	FOREIGN PRICE
A01	Microfiche	$ 6.95	$13.90
A02	001-010	9.95	19.90
A03	011-050	12.95	25.90
A04-A05	051-100	14.95	29.90
A06-A09	101-200	19.95	39.90
A10-A13	201-300	25.95	51.90
A14-A17	301-400	32.95	65.90
A18-A21	401-500	38.95	77.90
A22-A25	501-600	44.95	89.90
A99	601-up	*	*
NO1		49.50	89.90
NO2		48.00	80.00

Schedule E
EXCEPTION PRICE DOCUMENTS AND MICROFICHE

PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
E01	$ 8.50	17.00
E02	11.00	22.00
E03	12.00	24.00
E04	14.50	29.00
E05	16.50	33.00
E06	19.00	38.00
E07	21.50	43.00
E08	24.00	48.00
E09	26.50	53.00
E10	29.00	58.00
E11	31.50	63.00
E12	34.00	68.00
E13	36.50	73.00
E14	39.50	79.00
E15	43.00	86.00
E16	47.00	94.00
E17	51.00	102.00
E18	55.00	110.00
E19	61.00	122.00
E20	71.00	142.00
E99	*	*

*Contact NTIS for price quote.

IMPORTANT NOTICE

NTIS Shipping and Handling Charges

U.S., Canada, Mexico — ADD $3.00 per TOTAL ORDER

All Other Countries — ADD $4.00 per TOTAL ORDER

Exceptions — Does NOT apply to:

ORDERS REQUESTING NTIS RUSH HANDLING

ORDERS FOR SUBSCRIPTION OR STANDING ORDER PRODUCTS *ONLY*

NOTE: Each additional delivery address on an order requires a separate shipping and handling charge.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7011 (305)		

4. Title and Subtitle	5. Report Date
Aerospace Medicine and Biology A Continuing Bibliography (Supplement 305)	January, 1988
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, DC 20546	11. Contract or Grant No.
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This bibliography lists 230 reports, articles and other documents introduced into the NASA scientific and technical information system in December, 1987.

17. Key Words (Suggested by Authors(s))	18. Distribution Statement
Aerospace Medicine Bibliographies Biological Effects	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	82	A05/HC

*For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1988