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AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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April 1995

AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Office
Washington, DC 1995

This publication was prepared by the NASA Center for AeroSpace Information,
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INTRODUCTION

This issue of *Aerospace Medicine and Biology* (NASA SP-7011) lists 397 reports, articles, and other documents recently announced in the NASA STI Database. The first issue of *Aerospace Medicine and Biology* was published in July 1964.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N95-15919 — N95-19505
Open Literature (A-60000 Series)	A95-62971 — A95-65815

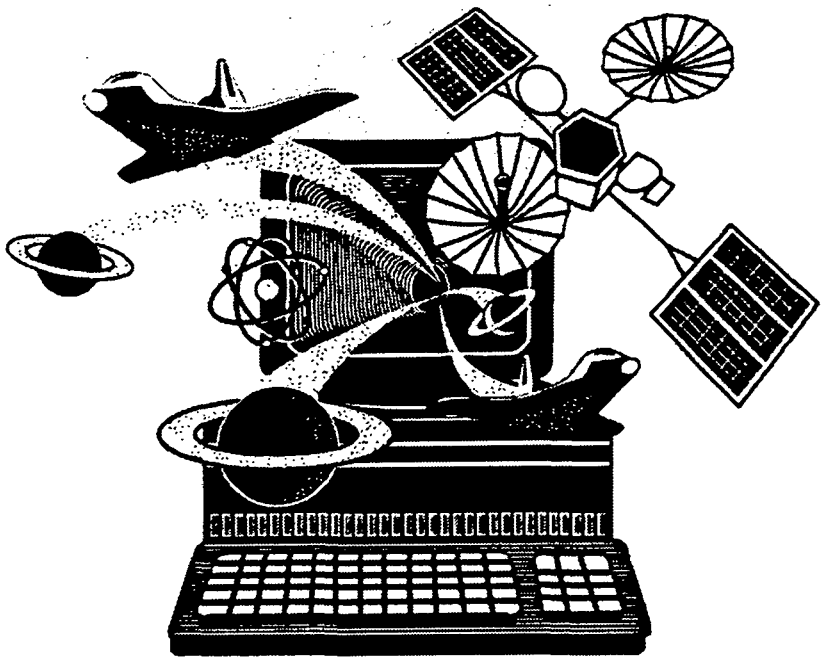
In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which humans are subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on 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. Applied research receives the most emphasis, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the publication consists of a standard 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 include the original accession numbers from the NASA STI Database.

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

A cumulative index for 1995 will be published in early 1996.

The NASA CASI price code table, addresses of organizations, and document availability information are located at the back of this issue.



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4/95

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Category 54 Man/System Technology and Life Support 175
Includes human engineering; biotechnology; and space suits and protective clothing.

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TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → N95-10863*# National Aeronautics and Space Administration. ← CORPORATE SOURCE
Ames Research Center, Moffett Field, CA.

TITLE → BIOTELEMETRY IMPLANT VOLUME AND WEIGHT IN RATS: A PILOT STUDY REPORT

AUTHOR → CHRIS J. SOMPS May 1994 19 p ← PUBLICATION DATE

CONTRACT NUMBER → (Contract RTOP 545-20-01)

REPORT NUMBERS → (NASA-TM-108812; A-94059; NAS 1.15:108812) Avail: CASI HC A03/MF A01 ← AVAILABILITY AND PRICE CODE

This paper reports the results of a pilot study in which a 240-gram rat was implanted for 41 days with biotelemetry devices weighing a total of 36 gm (18 cc). The implanted animal showed no differences in weight gain, food and water consumption, and postnecropsy organ weights when compared to both an unoperated control animal and an animal that underwent surgery but did not receive an implant. The implanted animal also had temperature and activity rhythms similar to those reported using much smaller implants. Thus, this pilot study showed that a 240-gm rat could be implanted with biotelemetry devices weighing nearly 15 percent of body weight without significant changes in health or behavior. A larger study involving more animals and similar implant sizes is recommended. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → A95-63745* National Aeronautics and Space Administration. John F. ← CORPORATE SOURCE
Kennedy Space Center, Cocoa Beach, FL.

TITLE → THE ORIGIN AND EARLY EVOLUTION OF ISSOL

AUTHOR → RICHARD S. YOUNG NASA. Kennedy Space Center, Cocoa Beach, ← AUTHORS' AFFILIATION
FL, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993.

PRIMARY DOCUMENT → A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169- ← JOURNAL TITLE
6149) vol. 24, no. 2-4. June 1994 p. 83 ← PUBLICATION DATE
Copyright

This is a discussion of the beginnings of the International Society for the Study of the Origin of Life (ISSOL)—how it came to be and the people responsible for it. It will include the early meetings on the subject of the Origin of Life which led to the formation of the Society. It will discuss the genesis of the interest of NASA in such a program and how the Exobiology Program got started, leading up to the Viking Program and the early exploration of Mars. Photographs of early meetings and the scientists involved will be included. Author (Herner)

AEROSPACE MEDICINE AND BIOLOGY

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April 1995

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LIFE SCIENCES (GENERAL)

A95-63321
ARE PERIODICITIES IN CRATER FORMATIONS AND MASS EXTINCTIONS RELATED?
S. YABUSHITA Kyoto Univ., Kyoto, Japan Earth, Moon, and Planets (ISSN 0167-9295) vol. 64, no. 3 March 1994 p. 207-216
(HTN-95-50109) Copyright

Periodicities in crater formation rate and mass-extinctions are reviewed. The former exhibits a period of 30 million yr, while the latter appear to have a periodicity at 26 myr. Results obtained earlier that small craters better satisfy the adopted criterion for statistical testing is shown due to the fact that there is a strong clustering of small craters in a recent past (less than 10 myr). On the basis of the dataset of craters compiled by Grieve, it is shown that there are several craters for which *no mass extinctions correspond. The difference in the periods of the* craters and of mass extinctions and the lack of mass extinctions that correspond to large craters appear to suggest that the two periodicities are not interrelated, and large impacts merely act as triggers for the mass-extinctions; the only exception being the K/T boundary.
Author (Herner)

A95-63478
PHOTOTAXIS IN THE FLAGELLATE, EUGLENA GRACILIS, UNDER THE EFFECT OF MICROGRAVITY
CH. KUHNEL-KRATZ Friedrich-Alexander-Universitat, Erlangen, Germany, J. SCHAFER Friedrich-Alexander-Universitat, Erlangen, Germany, and D.-P. HADER Friedrich-Alexander-Universitat, Erlangen, Germany Microgravity Science and Technology (ISSN 0938-0108) vol. 6, no. 3 September 1993 p. 188-193 Research sponsored by DARA and the Bundesminister fur Forschung und Technologie
(HTN-95-80092) Copyright

Positive phototaxis was analyzed in the unicellular photosynthetic flagellate, Euglena gracilis, under the conditions of microgravity during a parabolic rocket flight (TEXUS experiment). The fluence rate at which positive phototaxis changes to negative phototaxis was the same in a sample which had previously been exposed to microgravity as in a sample which had not been exposed to microgravity. During weightlessness the precision of positive phototaxis is higher than at 1g at the same fluence rate. The swimming velocity of the cells is higher at 0g than at 1g confirming previous results that under terrestrial conditions the cells are subject to simultaneous sedimentation while they swim upward. Tracks of organisms recorded at 0g show much more frequent deviations from the straight path than those at 1g. Author (Herner)

A95-63479
FUNGI IN SPACE - LITERATURE SURVEY ON FUNGI USED FOR SPACE RESEARCH
V. D. KERN Technical University of Munchen at Weilhenstephan, Freising, Germany and B. HOCK Technical University of Munchen at Weilhenstephan, Freising, Germany Microgravity Science and Technology (ISSN 0938-0108) vol. 6, no. 3 September 1993 p. 194-206 Research sponsored by DARA
(HTN-95-80093) Copyright

A complete review of the scientific literature on experiments involving fungi in space is presented. This review begins with balloon experiments around 1935 which carried fungal spores, rocket experiments in the 1950's and 60's, satellite and moon expeditions, long-time orbit experiments and Spacelab missions in the 1980's and 90's. All these missions were aimed at examining the influence of cosmic radiation and weightlessness on genetic, physiological, and morphogenetic processes. During the 2nd German Spacelab mission (D-2, April/May 1993), the experiment FUNGI provided the facilities to cultivate higher basidiomycetes over a period of 10d in orbit, document gravimorphogenesis and chemically fix fruiting bodies under weightlessness for subsequent ultrastructural analysis. This review shows the necessity of space travel for research on the graviperception of higher fungi and demonstrates the novelty of the experiment FUNGI performed within the framework of the D-2 mission. Author (Herner)

A95-63569
SMALL ANGLE NEUTRON SCATTERING FROM LYSOZYME IN UNSATURATED SOLUTIONS, TO CHARACTERIZE THE PRE-CRYSTALLIZATION PROCESS
N. NIIMURA Japan Atomic Energy Research Inst., Tokai (Japan), Y. MINEZAKI, M. ATAKA, and T. KATSURA Journal of Crystal Growth (ISSN 0022-0248) vol. 137, no. 3-4 April 1, 1994 p. 671-675 refs
(BTN-94-EIX94341340604) Copyright

The small angle neutron scattering (SANS) method was used to study the crystallization process of lysozyme from the microscopic molecular level. SANS was observed from unsaturated solutions of Lysozymes in D2O. By adding NaCl, Lysozyme molecules start to aggregate, and even when the NaCl concentration is increased to supersaturation SANS spectra show aggregation in the initial stage.
EI

A95-63744* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ISSOL MEETING, 7TH, BARCELONA, SPAIN, JULY 4-9, 1993
JAMES P. FERRIS, *editor* Rensselaer Polytechnic Institute, Troy, NY, US Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 386 p.
(HTN-95-40049) Copyright

The journal issue consists of abstracts presented at the International Society for the Study of the Origins of Life (ISSOL) conference. Topics include research on biological and chemical evolution including prebiotic evolution: cosmic and terrestrial; mechanisms of abiogenesis including synthesis and reactions of biomonomers; and analysis of cometary matter and its possible relationship to organic compounds on Earth. Theories and research on origins of ribonucleic acids (RNA), deoxyribonucleic acid (DNA), and other amino acids and complex proteins including their autocatalysis, replication, and translation are presented. Abiotic synthesis of biopolymers, mechanisms of the Genetic Code, precellular membrane systems and energetics are considered. Earth planetary evolution including early microfossils and geochemical conditions and simulations to study these conditions are discussed. The role of chirality in precellular evolution and the tax-

onomy and phylogeny of very simple organisms are reported. Past and future explorations in exobiology and space research directed toward study of the origins of life and solar system evolution are described. For individual titles, see A95-63745 through A95-63926. Herner

A95-63745* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
THE ORIGIN AND EARLY EVOLUTION OF ISSOL
RICHARD S. YOUNG NASA. Kennedy Space Center, Cocoa Beach, FL, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 *Origins of Life and Evolution of the Biosphere* (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 83
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This is a discussion of the beginnings of the International Society for the Study of the Origin of Life (ISSOL) — how it came to be and the people responsible for it. It will include the early meetings on the subject of the Origin of Life which led to the formation of the Society. It will discuss the genesis of the interest of NASA in such a program and how the Exobiology Program got started, leading up to the Viking Program and the early exploration of Mars. Photographs of early meetings and the scientists involved will be included. Author (Herner)

A95-63746
CHEMISTRY OF POTENTIALLY PREBIOLOGICAL NATURAL PRODUCTS
ALBERT ESCHENMOSER Eidgenoessische Technische Hochschule, Zuerich, Switzerland ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 84
Copyright

The lecture summarizes experimental contributions from the author's laboratory to the chemistry of classes of organic compounds which are commonly considered to be relevant to the problem of life's origin, e.g. alpha-aminonitriles, sugar phosphates and (certain) cofactors. One part of the investigation aims at an assessment of the potential for constitutional selfassembly of molecular structures by chemical synthetic analysis under reaction conditions whose choice is primarily determined by chemical criteria and is only loosely constrained by the requirement of prebiotic plausibility. Another part of the work refers to the chemistry of structural alternatives to biomolecules, alternatives which — by the criterion of constitutional selfassembly — could have been, but were not selected by Nature to become biomolecules. Results of an investigation on the chemistry of nucleic acids derived from hexose instead of pentose sugars will illustrate this approach of study. Author (Herner)

A95-63747
PREBIOTIC SYNTHESIS OF ORGANIC COMPOUNDS: A REVIEW AND NEW RESULTS
STANLEY L. MILLER University of California, San Diego, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 85-86
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There is a large literature on prebiotic synthesis under a variety of conditions. It is difficult to determine which of these are applicable to the primitive earth since the conditions on the primitive earth are not known and because the simulation experiments are usually run at concentrations far above those possible in the oceans of the primitive earth. It is important to determine how dilute the reactants can be for the reaction to still work. There are a number of concentration mechanisms, such as evaporation and freezing to get around this problem, but these processes may not work on an extensive scale. In the search for the precursor to RNA, as well as the other components of the first living organism, important constraints are the availability of robust prebiotic syntheses and the stability of the compounds after synthesis. It is also important to consider prebiotic compounds that do not occur presently in biology because they may have been important in the first organisms and subsequently removed. Author (revised by Herner)

A95-63748
DELIVERY OF INTERSTELLAR PREBIOTIC ORGANICS TO THE EARTH BY COMETS
J. MAYO GREENBERG Huygens Laboratory, Leiden, Netherlands ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 87
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The formation of prebiotic molecules in interstellar space is documented via studies of the chemical evolution of interstellar dust using infrared astronomy, theoretical interactions between gas and dust, and laboratory analog experiments. Molecular analyses of the composition of comets using in situ mass spectrometry of comet Halley, and of meteorites in the laboratory suggests a very high degree of preservation of the chemistry of interstellar dust in comets and to a lesser degree in meteorites. Experiments on the production of chiral molecules by circularly polarized ultraviolet radiation on cold interstellar dust have been performed. The frequency of the passage of interstellar clouds by neutron stars with significant circularly polarized ultraviolet radiation and the probability of the chirality of prestellar dust and of comets is calculated. The degree of preservation even in meteorites leads to the presumption that comets brought to the early earth interstellar organics which provided a major contribution to the prebiotic molecules required for life's origins some 4 thousand million years ago. Author (Herner)

A95-63749
THE COSMIC ORIGIN OF PREBIOTIC MOLECULES
A. H. DELSEMME University of Toledo, Toledo, OH, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 88-89
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Prebiotic molecules such as HCN, H2CO and H2, most purines, pyrimidines, and amino acids were probably first synthesized in interstellar space. During the formation of the Solar System, these molecules were carried on icy grains to the edge of the solar nebula and formed part of primeval comets. When comets penetrate the inner planetary system, they decay into gas and dust. This cosmic dust accumulates in planetary space and is collected by the upper atmosphere of the terrestrial planets. There is evidence of accretion disks of dust around young stars. Chondrites, primitive meteorites, are an assembly of sedimentary particles of different origins similar to that predicted. The role of temperature at dust sedimentation is confirmed by the observation that stony asteroids are found closer to the Sun and carbonaceous ones more distant. Due to a missing early atmosphere, only a cometary source explains early volatiles on Earth. The cratering impact record of other bodies along with known comet orbital patterns confirms to evidence of massive terrestrial cometary action. Finally, the deuterium-hydrogen ratio of Comet Halley is similar to modern oceans, also in support of a cometary origin. Herner

A95-63757* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AMMONIA ON THE PREBIOTIC EARTH: IRON(II) REDUCTION OF NITRITE
DAVID P. SUMMERS NASA. Ames Research Center, Moffett Field, CA, US and SHERWOOD CHANG NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 99-100
Copyright

Theories for the origin of life require the availability of reduced nitrogen. In the non-reducing atmosphere suggested by geochemical evidence, production in the atmosphere and survival of NH3 against photochemical destruction are problematic. Electric discharges and

impact shocks would produce NO rather than HCN or NH3. Conversion of NO to nitrous and nitric acid (by way of HNO) and precipitation in acid rain would provide a source of fixed nitrogen to the early ocean. One solution to the NH3 problem may have been the reduction of nitrite/nitrate in the ocean with aqueous ferrous iron, Fe(2+): 6Fe(+2) + 7 H2O + NO2(-) yields 3Fe2O3 + 11 H(+) + NH3. We have measured the kinetics of this reaction as a function of temperature, pH, and concentrations of salts, Fe(+2), and NO2(-). Cations (Na(+), Mg(2+), K(+)) and anions (Cl(-), Br(-), SO4(2-)) increase the rate by factors of 4 to 8. Although a competing pathway yields N2, the efficiency of the conversion of nitrite to ammonia ranges from 25% to 85%. Nitrate reduction was not consistently reproducible; however, when it was observed, its rate was slower by at least 8X than that of nitrite reduction. If the prebiotic atmosphere contained 0.2 to 10 atmospheres CO2 as suggested by Walker (1985), the Fe(+2) concentration and the rate would have been limited by siderite (FeCO3) solubility.

Author (revised by Herner)

A95-63758

SPECIFIC EFFECT OF MAGNESIUM ION ON AMP SYNTHESIS FROM ADENOSINE AND TRIMETAPHOSPHATE IN AQUEOUS SOLUTION

Y. YAMAGATA Kanazawa Institute of Technology, Ishikawa, Japan, H. INOUE Kanazawa Institute of Technology, Ishikawa, Japan, and K. INOMATA Kanazawa University, Kanazawa, Japan
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 101

Polyphosphates have been shown to be important substances in prebiotic evolution as well as in the present organisms. However, the spotaneous appearence of water-soluble polyphosphates on the primitive Earth has been a mystery for a long time. Recently, we have demonstrated that polyphosphates are produce by volcanic activity. Trimetaphosphate as one of the polyphosphates from volcanoes has been proved to be the most effective condensing and phosphorylating agent among polyphosphates. We present here the experimental results that magnesium ion works as an extremely effective catalyst for the synthesis of AMP from adenosine and trimetaphosphate in aqueous solution.

Author (Herner)

A95-63759* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A REDOX BEGINNING: WHICH CAME FIRST PHOSPHORYL, ACYL, OR ELECTRON TRANSFER ?

ARTHUR L. WEBER NASA. Ames Research Center, Moffett Field, CA, US
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 102

Thermodynamic and kinetic information available on the synthesis of prebiotic monomers and polymers will be examined in order to illuminate the prebiotic plausibility of polymer syntheses based on (a) phosphoryl transfer that yields phosphodiester polymers, (b) acyl transfer that gives polyamides, and (c) electron transfer that produces polydisulfide or poly(thio)ester polymers. New experimental results on the oxidative polymerization of 2,3-dimercaptopropanol by ferric ions on the surface of ferric hydroxide oxide will be discussed as a chemical model of polymerization by electron transfer. This redox polymerization that yields polymers with a polydisulfide backbone was found to give oligomers up to the 15-mer from 1 mM of 2,3-dimercaptopropanol after one day at 25 C. High pressure liquid chromatography (HPLC) analysis of the oligomers was carried out on an Alltech OH-100 column eluted with acetonitrile-water.

Author (Herner)

A95-63760

PREBIOTIC ORGANIC COMPOUNDS IN ANTARCTIC CARBONACEOUS CHONDRITES

AKIRA SHIMOYAMA University of Tsukuba, Tsukuba, Japan
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 103-104

We had analyzed Antarctic carbonaceous chondrites for carbon contents, amino acids, carboxylic acids, hydrocarbons, and nucleic acid-bases. These results were presented at the previous International Society for the Study of the Origin of Life (ISSOL) Meeting in Prague. We extended our analyses further to bulk carbon isotopic compositions, dicarboxylic acids, and insoluble organic matter. Here we summarize our new results on the chondrites.

Author (Herner)

A95-63761

INVESTIGATIONS ABOUT ALPHA-AMINOACID SYNTHESIS UNDER PREBIOTIC CONDITIONS

J. C. ROSSI Universite Montpellier II, Montpellier, France, S. BENEFICE-MALOUET Universite Montpellier II, Montpellier, France, J. TAILLADES Universite Montpellier II, Montpellier, France, L. MION Universite Montpellier II, Montpellier, France, and A. COMMEYRAS Universite Montpellier II, Montpellier, France
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 105-106

The synthesis of alpha-aminoacid under prebiotic conditions is of considerable interests, with respect to the origin of life. Since Miller's synthesis, in 1953, of alpha-aminoacids from a mixture of prebiotic compounds like CH4, NH3, H2 and H2O, it is more or less established that the synthesis of alpha-aminoacids could occur under prebiotic conditions. In 1987, Eschenmoser proved that the alpha-aminonitriles, involved in the Strecker alpha-aminoacid synthesis, could be considered as the central intermediates of potential prebiotic compounds in alpha-aminoacids synthesis, as they could be obtained from ammonia, hydrogen cyanide and carbonyl compounds at the prebiotic pH value of 9. Investigations about the next step involving the conversion of these alpha-aminonitriles into the corresponding alpha-aminoamides, which led to an industrial process, showed the formation of alpha-aminoamides in 100% yield, when the pH value was greater than 12 and in the presence of a carbonyl compound, used as a catalyst. So, for reasons to do with economics and in order to promote the alpha-aminoamide synthesis under prebiotic conditions, investigations were carried out about possibilities of synthezing alpha-aminoamides at pH 9. Here we report reactions performed in the presence of hydrogen peroxide. The hydration reaction of alpha-aminopropionitrile, used as a model, was firstly investigated in aqueous soda medium to determine the parameters, the mechanism and the kinetic rate of the reaction. Secondly, this reaction was performed in aqueous ammonia medium, according to prebiotic conditions.

Author (revised by Herner)

A95-63762

URAZOLE IS A POTENTIAL PRECURSOR TO URACIL

VERA M. KOLB University of California San Diego, La Jolla, CA, US, JASON P. DWORKIN University of California San Diego, La Jolla, CA, US, and STANLEY L. MILLER University of California San Diego, La Jolla, CA, US
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 107-108

Urazole is a five-membered heterocyclic compound that is isosteric in part to uracil. Because it is a potential prebiotic compound, we investigated urazole's reactivity with ribose. The high reactivity of urazole is attributed to the hydrazine moiety being an alpha-effect nucleophile and to its the low pKa (5.8). Urazole also reacts with ribose-5-phosphate and arabinose. A similar high reactivity of urazole relative to uracil would be expected for any electrophile, including the precursor to ribose in the first informational macromoleules. 1-Methyl urazole hydrogen-bonds to 9-ethyl adenine in Dimethyl Sulfoxide (DMSO) with a strength comparable to 1-methyl uracil. This suggests that urazole could replace uracil as a Watson-Crick base pair in RNA and its

prebiotic precursors. Uracil and cytosine appear to be less likely as prebiotic compounds than adenine and guanine because of their greater difficulty of synthesis, the lack of a prebiotic synthesis of the ribosides, and the inability of the activated pyrimidine ribosides to undergo template polymerizations. Our results suggest that urazole and cytozole are attractive replacements for uracil and cytosine in the earliest informational macromolecules.
Author (revised by Herner)

A95-63763
PREBIOTIC SYNTHESIS OF HYDROXYMETHYLURACIL AND SOME T-RNA BASES
MICHAEL P. ROBERTSON University of California San Diego, La Jolla, CA, US, JASON P. DWORKIN University of California San Diego, La Jolla, CA, US, and STANLEY L. MILLER University of California San Diego, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 109-110
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The difficulty of achieving template polymerizations using activated uridines and cytidines as well as their difficult prebiotic synthesis suggests that alternative bases were in the first informational macromolecules. A logical place to look for alternatives is in the 'minor' nucleosides of t-RNA. Many other minor nucleosides contain 5-substituted uracils which suggests a common pathway of prebiotic synthesis through hydroxy-methyluracil. This base occurs in the DNA of several phage and dinoflagellates. 5-Hydroxymethyluracil is synthesized very efficiently from uracil and HCHO. Cytosine, uridine, and 2-thiouracil also react with HCHO, but 20 times more slowly at pH 7. This reaction is so efficient that hydroxymethyluracil is likely to have been more abundant in the primitive ocean than uracil. Therefore, uracil is an unlikely constituent of the first informational macromolecules and suggests that hydroxymethyluracil and its derivatives may have been used instead. Author (revised by Herner)

A95-63764
THE BUBBLE-AEROSOL-DROPLET CYCLE AS A NATURAL REACTOR FOR PREBIOTIC ORGANIC CHEMISTRY (1)
LOUIS LERMAN University of California-Berkeley, Berkeley, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 111-112
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There is on the contemporary earth a primary and extensively observed geophysical/geochemical cycle: the bubble-aerosol-droplet ('bubblesol') cycle. It consists of a network of microenvironments which is almost certain to have existed on the early earth. This cycle's unique characteristics suggests that it played an important primordial role: providing consecutive cycles of selective chemical concentration, catalysis, and organization of increasingly complex organic molecules. The water based stages of this 'bubblesol' cycle are centered around the ubiquitous bubble. The air-based stages include the bubble-bursting creation of aerosols and their subsequent initiation of and participation in the atmospheric condensation processes. The sea-bottom based component of the cycle can (but need not) include the primordial chemical contributions of underwater hotspots. The entire network of processes outlined in this figure is coupled through the complex physical/chemical processes occurring at the air-sea interface. Organics of potentially increasing complexity (along with scavenged metals) would be rapidly cycled through the many (parallel) stages of this network in a manner akin to that of a modern chemical reactor. Taken together the entire bubblesol cycle samples a large volume of 'chemical phase space', and does so rapidly with respect to geological time-scales. This hypothesis is a new methodological approach, with a strong phenomenological basis in contemporary geophysics/geochemistry. In so doing, it provides a natural and robust macroscopic framework for many of the specific chemical models andenvironments developed by others. Author (revised by Herner)

A95-63765* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE STRECKER SYNTHESIS FROM INTERSTELLAR PRECURSORS AS A SOURCE OF AMINO ACIDS IN CARBONACEOUS CHONDRITES: DEUTERIUM RETENTION DURING SYNTHESIS
N. R. LERNER NASA. Ames Research Center, Moffett Field, CA, US, E. PETERSON NASA. Ames Research Center, Moffett Field, CA, US, and S. CHANG NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 113-114
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Amino acids in the Murchison carbonaceous chondrite are anomalously enriched in deuterium. Synthesis in Strecker reactions from D-enriched interstellar precursors during low temperature aqueous alteration of the parent body has been proposed by Cronin et al. (1988) to account for the isotopic observations. To test this hypothesis, we have measured the retention of deuterium in the glycine, alanine, and alpha-amino isobutyric acid produced, respectively, by reactions of formaldehyde-D2, acetaldehyde-D4, and acetone-D6 with HCN and NH3 in water. Author (revised by Herner)

A95-63766* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPUTER SIMULATION OF ASTROPHYSICAL ICES
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Understanding the physical chemical processes which affect the structure and composition of astrophysical ices is of central importance to our understanding of the early solar system and early earth. Laboratory experiments on amorphous ice analogues of cometary ices have shown that amorphous ices exhibit a rich and complex morphology. Computer simulation results for ice deposition with the solutes Ne, CH4, and CO are presented. The relative fraction of adsorbed solutes which are subsequently ejected from the growing ice has implications on the composition of comets relative to the composition of the primitive environment in which they formed. Author (revised by Herner)

A95-63767
ELEMENTAL AND ISOTOPIC COMPOSITION OF COMETARY GRAINS: IMPLICATIONS FOR ABIOTIC SYNTHESIS
FRANZ R. KRUEGER ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 117-118
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Spacecraft encounters with comet Halley raised interest in the existence of cometary organic particles. The question of whether such dust grains, in aqueous solution, may be precursors of prebiotic chemicals is considered and the distribution of elements and isotopes is reported. The following are found in such dust: Silicon, calcium, magnesium, are required for heterocatalysis; zinc, iron, and nickel are required for REDOX and other chemical reactions; sulfur is also involved in catalysis; and phosphorus is required for phosphates. It appears that the diversity of elements in cometary dust may have served as a necessary condition for chemical evolution. However, comparison of isotopic forms, especially analysis of carbon and silicon suggests that a non-cometary origin of terrestrial life. Herner

A95-63768
PREBIOTIC FORMATION OF BIOORGANIC COMPOUNDS BY COSMIC RADIATION UNDER TERRESTRIAL AND EXTRATERRESTRIAL CONDITIONS
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It has been controversy that bioorganic compounds were formed on primitive earth or formed in space and supplied to the earth before the origin of life on the earth. We experimentally verified the possibility of the formation of bioorganic compounds under both primitive terrestrial and extraterrestrial conditions. The present results show the possibility that there are 'amino acid precursors' (compounds which gave amino acids after acid hydrolysis) in such extraterrestrial environments as Jovian and Titan atmosphere and cometary coma and nucleis. It is plausible that amino acid precursors in comets were carried into the primitive earth. It was suggested that bioorganic compounds such as amino acids could be formed both in the primitive earth atmosphere and in extraterrestrial environments like comets, by the action of cosmic rays (including solar flare particles). It is now important to estimate the fractions of bioorganic compounds formed on the primitive earth and those extraterrestrially formed.

Author (revised by Herner)

A95-63769
CYANIDE POLYMERS IN THE SOLAR SYSTEM: MILLER-UREY REVISITED
CLIFFORD N. MATTHEWS University of Illinois at Chicago, Chicago, IL, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 121-122

Hydrogen cyanide polymers — heterogeneous solids ranging in color from yellow to orange to red to black — may be among the organic macromolecules most readily formed within the solar system. The nonvolatile black crust of comet Halley, for example, might consist largely of such polymers. It seems likely, too, that HCN polymers are a major constituent of the dark, O triple bond N bearing solids identified spectroscopically in the dust of some other comets, on the surfaces of several asteroids, within the rings of Uranus and covering the dark hemisphere of Saturn's satellite Iapetus. HCN polymerization could account also for the yellow-orange-red coloration of Jupiter and Saturn, as well as for the orange haze high in Titan's atmosphere.

Author (Herner)

A95-63770
CHARACTERIZATION OF HYDROGEN CYANIDE POLYMERS AND THE MURCHISON METEORITE: IMPLICATIONS FOR PREBIOTIC AND EXTRATERRESTRIAL CHEMISTRY
R. A. PESCE-RODRIGUEZ U.S. Army Research Laboratory, Aberdeen Proving Ground, MD, US, S. A. LIEBMAN CCS Instrument Systems, Inc., Avondale, PA, US, and C. N. MATTHEWS University of Illinois at Chicago, Chicago, IL, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 123-124

Hydrogen cyanide polymerizes readily to a black solid which yields a water soluble fraction that may be hydrolyzed to give alpha-amino acids. It is proposed that HCN polymers and their derivatives are major components of the dark matter observed on many bodies in the outer solar system, including comets and asteroids, and that primitive Earth might have been covered with HCN polymers through bolide bombardment or by terrestrial synthesis. Chemical characterization of HCN polymers and the Murchison meteorite shows many striking similarities. The most interesting results were obtained for sample fractions soluble in water and/or supercritical carbon dioxide (CO2). For example, analysis by pyrolysis-gas chromatography-Fourier Transform infrared (FTIR), and photoacoustic-FTIR spectroscopy indicated the presence of amide and peptide functional groups in both the HCN and meteorite samples; analysis by pyrolysis-mass spectroscopy (MS) revealed the presence of species with molecular weights as high as 500-600 daltons. For comparison, FTIR spectra of water soluble fractions of the Murchison meteorite and of an HCN polymer are shown together with the spectrum of a model compound, poly-alpha-cyanoglycine.

Author (Herner)

A95-63771
THE USE OF THE NINHYDRIN REACTION FOR THE ELIMINATION OF PROTEIN AMINO ACIDS IN COSMOGEOCHEMICAL SAMPLES
KAREN L. F. BRINTON University of California at San Diego, La Jolla, CA, US and JEFFREY L. BADA University of California at San Diego, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 125-126

Contamination has long proved a problem in the determination of amino acids from extraterrestrial sources. Many cosmogeochemical samples of interest have been extensively contaminated by biogenic amino acids, and these contaminants must be eliminated if a purely extraterrestrial component is to be measured. Several amino acids found in the terrestrial environment, such as alanine (ala) and glycine (gly), are also present in carbonaceous chondrites like the Murchison meteorite. These 'protein' amino acids may be due partly to abiotic synthesis and partly to terrestrial contamination; for chiral amino acids, the degree of contamination can be measured by the D/L ratio. Carbonaceous chondrites also contain alpha-dialkyl amino acids, such as alpha-amino-isobutyric acid (AIB), which are extremely rare on Earth. Thus, alpha-dialkyl amino acids are important indicators of extraterrestrial origin. Ninhydrin is a commonly used derivatizing agent in protein amino acid analysis. Alpha-hydrogen amino acids (all those found in proteins) are rapidly decarboxylated and deaminated, and ninhydrin reacts with the released ammonia to form a colored product which can be measured spectrophotometrically. Alpha-dialkyl amino acids reacts much more slowly with ninhydrin. Therefore, in a mixture of alpha-dialkyl and alpha-hydrogen amino acids reacted with ninhydrin for a short time, the alpha-hydrogen amino acids are selectively destroyed. The ninhydrin reaction can be used to determine AIB in samples known to be contaminated with biogenic amino acids. The results obtained from Orgueil, a meteorite that fell in France in 1864 (Lawless et al., 1972), and from other cosmogeochemical samples such as K-T boundary sediments, are presented.

Author (revised by Herner)

A95-63772
COMA A HIGH RESOLUTION TOF-SIMS FOR IN-SITU ANALYSIS OF COMETARY MATTER
P. BECK Max Planck Institute fuer Kernphysik, Heidelberg, Germany ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 127

Most information about comets has been gained through astronomical observation from Earth. Fly-by missions, the GIOTTO and VEGA probes, of comet Halley enabled collection of more direct data. A high resolution Time-of-Flight Secondary Ion Mass Spectrometer (TOF-SIMS) enables analysis of micrometer-sized cometary dust grains and gases and is used as a cometary matter analyzer (CoMA). Data about elements, isotopic and molecular composition are determined. The high mass resolution reduces the need for inferential projections and provides empirical data. With a high mass range,

detailed analysis of organic cometary constituents is possible and may lead to greater knowledge regarding the origin of life on Earth.
Herner

A95-63773* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMETARY COMA CHEMICAL COMPOSITION (C4) MISSION
G. C. CARLE NASA. Ames Research Center, Moffett Field, CA, US, B. C. CLARK Martin Marietta Civil Space & Communications, Denver, CO, US, H. B. NIEMANN NASA. Goddard Space Flight Center, Greenbelt, MD, US, M. ALEXANDER Baylor University, Waco, TX, US, P. C. KNOCKE Jet Propulsion Laboratory, Cal. Tech., Pasadena, CA, US, and B. J. O'HARA NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 128-129
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Cometary missions are of enormous fundamental importance for many different space science disciplines, including exobiology. Comets are presumed relics of the earliest, most primitive material in the solar nebula and are related to the planetesimals. They undoubtedly provided a general enrichment of volatiles to the inner solar system (contributing to atmospheres and oceans) and may have been key to the origin of life. A Discovery class, comet rendezvous mission, the Cometary Coma Chemical Composition (C4) Mission, was selected for further study by NASA earlier this year. The C4 Mission is a highly focused and usefully-limited subset of the Cometary Rendezvous Asteroid Flyby (CRAF) Mission, concentrating exclusively on measurements which will lead to an understanding of the chemical composition and make-up of the cometary nucleus. The scientific goals of the Cometary Coma Chemical Composition (C4) Mission are to rendezvous with a short-period comet and (1) to determine the elemental, chemical, and isotopic composition of the nucleus and (2) to characterize the chemical and isotopic nature of its atmosphere. Further, it is a goal to obtain preliminary data on the development of the coma (dust and gas composition) as a function of time and orbital position.
Author (Herner)

A95-63774* National Aeronautics and Space Administration, Washington, DC.
ULTRAVIOLET PHOTOCHEMISTRY OF CYANOACETYLENE: APPLICATION TO TITAN
D. W. CLARKE Rensselaer Polytechnic Institute, Troy, NY, US and J. P. FERRIS Rensselaer Polytechnic Institute, Troy, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 130 Research sponsored by NASA
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Cyanoacetylene is believed to have had a central role in the formation of the pyrimidines essential for RNA synthesis leading to the origin of life on Earth. Cyanoacetylene has also been detected on Titan, Saturn's largest moon, and the only moon in the solar system that possesses a dense atmosphere. It is generally accepted that photochemistry plays a major role in the formation of the complex organic molecules and aerosols found in Titan's atmosphere. Because of its long wavelength absorption and low dissociation threshold it is expected that cyanoacetylene is an important part of these photochemical processes. Since cyanoacetylene would also have been subject to ultraviolet light in the atmosphere of early Earth, an investigation of cyanoacetylene photochemistry on Titan might lead to a better understanding of both the photochemical reactions occurring on primitive earth and the processes of chemical evolution as they occur in planetary atmospheres. The effects of irradiation wavelength, mixing with Titan's atmospheric gases, reducing the temperature and lowering cyanoacetylene partial pressures on product formation and polymer composition have been determined with the ultimate goal of understanding the chemical transformations taking place in Titan's atmosphere. Author (revised by Herner)

A95-63776
ORGANIC SYNTHESIS INDUCED BY IONIZING RADIATION AND CAVITATION FROM CN-CONTAINING COMPOUNDS
A. NEGRON-MENDOZA Instituto de Ciencias Nucleares, Mexico, G. ALBARRAN Instituto de Ciencias Nucleares, Mexico, and E. CHACON Instituto de Ciencias Nucleares, Mexico ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 133-134
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As a part of our interest in the cyanide chemistry connected to cosmochemistry, we were prompted to do a systematic investigation on the gamma radiolysis and the sonolysis of CN-containing compounds, such as acetonitrile, hydrocyanic acid and its ammonium and potassium salts. In this paper we analyze the results of carboxylic acids formed from the nitriles under investigation. Among the acids detected in acetonitrile and hydrocyanic acid were malonic, oxalic, succinic, carboxysuccinic, tricarballylic and citric acids. Their concentration increased with the dose. The striking difference between sonolytic and radiolytic behavior was in the amount of products formed. Our aim has been to stress the relevance of ionizing radiation, and cavitation as tools for the study of compounds of potential interest in chemical evolution. In this way, the results obtained remark this aspect and act as a contributing factor toward the prebiotic synthesis of organic compounds. Author (revised by Herner)

A95-63777
FORMATION OF SUGAR-LIKE MATERIALS FROM FORMALDEHYDE OVER MORDENITE AND HYDROTALCITE CATALYST
TADASHI MIZUTANI Kyoto University, Kyoto, Japan, MOTOHIRO CHO Tottori University, Tottori, Japan, YUSHI WAKUMOTO Tottori University, Tottori, Japan, AKIRA KONDO Tottori University, Tottori, Japan, and RUKA NAKASHIMA Tottori University, Tottori, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 135-136
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The formose reactions afford sugar-like materials from formaldehyde under basic conditions (Shigemasa et al., 1978). Formation of sugar-like materials from formaldehyde under acidic or neutral conditions via completely different pathway from the formose reaction is of interest. We investigated the reaction of formaldehyde on the surface of minerals such as zeolite and hydrotalcite. We report herein that sugar-like materials are formed in neutral to acidic pH solution in the presence of zeolite or hydrotalcite containing transition metal ions.
Author (Herner)

A95-63778
PREBIOTIC SYNTHESIS OF PENTAERYTHRITOL FROM FORMALDEHYDE INVESTIGATION OF THE MECHANISM
ROB M. DE GRAAF University of Nijmegen, Nijmegen, Netherlands and ALAN W. SCHWARTZ University of Nijmegen, Nijmegen, Netherlands ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 137
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Recently we reported that UV-irradiation of diluted freshly distilled formaldehyde, in the presence of carbonate, leads to the synthesis of the reduced sugar pentaerythritol in high yield. This process differs strikingly from the formose reaction in which complex mixtures of carbohydrates are formed. During the irradiation, acetaldehyde is photochemically synthesized from aqueous formaldehyde. In a subsequent dark reaction acetaldehyde condenses with formaldehyde to form pentaerythritol. We will present the results of investigations of the photochemical and 'dark' reaction mechanisms. Author (Herner)

A95-63779
THE BUBBLE-AEROSOL-DROPLET CYCLE AS A NATURAL REACTOR FOR PREBIOTIC ORGANIC CHEMISTRY (2)
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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 138-139

This is a detailed overview of the phenomenological support for the prebiotic chemical evolution hypothesis first presented by Lerman (1986). This hypothesis suggests that the 'bubble-aerosol-droplet' (bubblesol) cycle on the primordial earth offered an integrated and cyclic network of microenvironments which strongly supported organic chemical self-organization. It offers the likelihood of the selective concentration of organics and metals in both the early atmosphere and oceans, the stabilization and possible coordination of these reactants, the availability of a range of usable energies as well as catalytic surfaces and possible templates, and a cycle continuity whereby 'useful' organics, once synthesized, are kept within this chemical 'reactor'. The nexus of this cycle is bubble formation which requires only the existence of a Raleigh-Taylor instability at an air-water interface (Sharp 1984). This is independent of any more detailed assumptions about the chemistry of the early earth (or indeed any planet with an atmosphere/'ocean'interface). Phenomenological support for these claims comes from the primary roles this cycle plays on the contemporary earth. This cycle involves the main mechanisms for the concentration and transport of dissolved organics and metal ions in the upper ocean — bubbles (MacIntyre 1974a), as well as those responsible for the scavenging of organics and metals in the atmosphere (Gill et al. 1983). Author (Herner)

A95-63780
CONTACT GLOW DISCHARGE ELECTROLYSIS AGAINST AQUEOUS SOLUTION CONTAINING AMINOACETONITRILE

TORATANE MUNEGUMI Oyama National College of Technology, Tochigi, Japan, AKIRA SHIMOYAMA University of Tsukaba, Ibaraki, Japan, and KAORU HARADA Shoin Women's University, Kobe, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 140-141

In this paper, we wish to report glycinamide formation from aminoacetonitrile in aqueous solution induced by Contact Glow Discharge Electrolysis (CGDE). Contact Glow Discharge Electrolysis (CGDE) was carried out against aqueous solutions (20 ml) containing aminoacetonitrile (20 mM) and inorganic salt buffers (pH1-10) at 10-20 C. A portion of the reaction solution was taken out by constant time and analyzed by means of an amino acid analyzer. The concentration changes of aminoacetonitrile and products during the CGDE reaction at pH 10 are plotted against the reaction time. After 60 min's reaction, aminoacetonitrile decreased to 42% (8.3 mM) compared with the initial concentration. And glycine (0.25 mM), ammonia (2.0 mM), and glycinamide (2.6 mM, 22%) were detected in the chromatogram of amino acid analysis. Under acidic or neutral pH conditions, CGDE reactions using aminoacetonitrile were also performed. However, glycinamide did not form or slightly formed under these conditions. Author (revised by Herner)

A95-63781
ION IRRADIATION OF ORGANIC AND BIOLOGICAL MATERIALS

G. STRAZZULLA Citta Universitaria, Catania, Italy, A. M. FOTI Citta Universitaria, Catania, Italy, and G. LETO Citta Universitaria, Catania, Italy ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 142

We review, and present new, experimental results obtained in the last years on the chemical and physical changes induced by ion irradiation of frozen hydrocarbons and other organic materials, including alanine and glycine, with a view to their astrophysical relevance. The presence in space of complex organic materials is widely accepted. Organic mantles built-up on grains of the general interstellar medium by ultraviolet photo processing and/or ion irradiation of simple ices, have been suggested to contain a fraction of interstellar carbon as large as 25%. The presence of organic material in the Solar System has been evidenced several times and is supported by both ground-based and space observations of objects in the Solar System including asteroids, comets, and satellites of the Saturnian and Uranian systems. Of particular relevance is the laboratory analysis of meteorite samples, also in view of their possible role in the development of life on Earth. Author (revised by Herner)

A95-63782
MECHANISM OF THE SELECTIVE RADIO DECOMPOSITION OF ALANINE IN THE GLYCINE-ALANINE MIXED SOLUTIONS

MITSUHIKO AKABOSHI Kyoto University, Osaka, Japan, KENICHI KAWAI Kyoto University, Osaka, Japan, and HIROTOSHI MAKI Kyoto University, Osaka, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 143-144

Interactions between different amino acids as demonstrated by their selective decomposition after irradiation are considered. Aqueous solutions of glycine and alanine were irradiated with CO-60 gamma rays. After irradiation, decomposition was determined using high pressure liquid chromatography (HPLC). The results indicate that OH radicals play an important role in the selective radiodecomposition by producing alpha-carbon radicals of glycine. These may be the initiators of the chain reaction to hydrogen. The study supports the molecular-molecular interaction as the cause of the observed selective decomposition. Herner

A95-63783
RADIATION EFFECTS IN ADSORBED NUCLEIC ACID BASES AND THEIR DERIVATIVES FROM K-40 IN CLAYS: A PREBIOTIC OVERVIEW

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Adsorption of nucleic bases and their derivatives on clay minerals may have played an important role in primordial organic chemistry. We review critically the extent of concentration effects on such molecules. In this paper an attempt is made to highlight the radiolytic properties and distribution of radionuclides that may have induced chemical changes of nucleic acid derivatives within the clay. In particular the effect of K-40 in clay and clay minerals is very important, since this element was homogeneously distributed in oceans and sediments. Several types of well documented reactions for the radiolysis of nucleic acids bases and their derivatives are analyzed. These reactions show that many changes take place, even at low doses, and may have induced diverse chemical changes within the clay that might not be directly relevant to chemical evolution. Author (revised by Herner)

A95-63784
THE PREBIOTIC ROLE OF ADENINE: A CRITICAL ANALYSIS

ROBERT SHAPIRO New York University, New York, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 147-148

The favorable signs concerning the prebiotic function of adenine are the following: (1) The published prebiotic syntheses of adenine, are the most successful of those for any nucleic acid component. (2) Adenine has been detected in meteorites, though in the parts per billion range. (3) Many present-day biological cofactors contain an adenylate residue, which has been explained as 'vestiges of an ancient metabolism based on RNA catalysis'. Many unfavorable indicators, however, shed doubt on the ability of adenine to function in a genetic role at the start of life: (1) The half life of adenine in neutral solution (where it is most stable) may be no more than a few hundred years at 37 deg, due to

hydrolytic deamination and ring-opening reactions. (2) Adenine supplies would be further depleted by reaction of with a variety of chemicals likely to be present in a prebiotic soup. Ribose also reacts primarily at the amino group of adenine. (4) The 2 H-bond interaction of A and U is not strong enough for their mutual recognition to act as an organizing force in a prebiotic mixture. No interaction can be detected between the monomers in aqueous solution. (5) Even in an RNA environment, adenine shows considerable infidelity in partner selection. For example, four distinct A-G mismatches are known; such mismatches are a common structural element in RNA folding. For the above reasons, it is difficult to visualize how adenine, if present as one component in a complex prebiotic mixture, could be incorporated into a functioning genetic system. This problem must be addressed experimentally, if the idea of RNA world, or an RNA-like world, is to be placed on a firm basis.
Author (revised by Herner)

A95-63785
SEPARATION AND CHARACTERIZATION OF HIGH MOLECULAR WEIGHT OLIGOMERS FROM IMPA AND VOLCLAY REACTION
KAMALUDDIN Rensselaer Polytechnic Institute, Troy, NY, US and JAMES P. FERRIS Rensselaer Polytechnic Institute, Troy, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 149
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The catalytic role of montmorillonite in the oligomerization of 5'-phosphorimidazolide of adenosine (ImpA) has recently been demonstrated in our laboratory (Ferris and Ertem, 1992). Oligomers of up to ten nucleotides in length are reported. Analysis of the trimers, tetramers, and pentamers formed from a 9:1 ImpA: diadenosine pyrophosphate (AppA) mixture showed 85% bonds as 3',5'-linked. In an extended program of research, large scale reaction of ImpA and volclay has been carried out and the products formed are separated by gel - filtration using G - 25 DNA grade Sephadex. High Pressure Liquid Chromatography (HPLC) analysis of the products showed formation of larger oligomers of up to eleven and twelve nucleotide units. Characterization of the structure of the oligomers and conditions for producing more longer oligomers is in progress. Author (Herner)

A95-63786
PHOSPHORYLATION OF GLYCERIC ACID
VERA KOLB The Salk Institute, San Diego, CA, US and LESLIE E. ORGEL The Salk Institute, San Diego, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 150
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The monophosphates of glyceric acid are central molecules in carbohydrate metabolism. It is therefore interesting to see how they might be formed under prebiotic conditions. Although it has not been identified in Urey-Miller experiments, it seems certain that glyceric acid would be formed along serine, particularly if the concentration of ammonia was reduced. We have therefore investigated the phosphorylation of glyceric acid. The trimetaphosphate anion is known to phosphorylate alcohols, particularly cis-glycols. We therefore treated glyceric acid with trimetaphosphate in alkaline solution and analyzed the phosphorylated products using Nuclear Magnetic Resonance spectroscopy. We obtained a 40% yield of mixed monophosphates. The yield of the 2-phosphate was in excess of that of the 3-phosphate at all times. Author (Herner)

A95-63787
OXIDATION OF ANILINE ON THE METAL FERROCYANIDES
SUSHAMA VILADKAR University of Roorkee, Roorkee, India, TANVEER ALAM University of Roorkee, Roorkee, India, and KAMALUDDIN University of Roorkee, Roorkee, India ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 151-152
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Clay and clay minerals are proposed to be the most suitable material which could have contributed towards certain reactions producing polymeric substances from which life has emerged. Clay minerals have also known to interact with certain organic compounds producing color derivatives. Insoluble metal ferrocyanides which form a special class of inorganic material due to their easy mode of formation have extensively been studied as ion exchangers. These metal ferrocyanides are also considered to be the active surface catalysts for many prebiotic reactions. Few oxidation reactions on the metal ferrocyanideswere therefore taken up for studies.
Author (Herner)

A95-63788
COOPERATIVE BINDING OF NUCLEOTIDES AND THEIR DERIVATIVES TO CLAY AND MINERAL SURFACES
D. WINTER Columbia University, New York, NY, US and G. ZUBAY Columbia University, New York, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 153
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It is our belief that chemical systems leading to the origin of life evolved on clay and/or mineral surfaces. The first phase of our research is concerned with studying the interaction between clay and mineral surfaces and molecules of possible importance in the evolution of prebiotic and biochemical systems. We have found that frequently the binding of small molecules to these surfaces shows an element of cooperativity. The most likely explanation for this cooperativity is that these small molecules not only bind to the solid surfaces but they bind to each other when attached to the solid surfaces. The extent of cooperative binding is a function of the clay or mineral, the small organic molecule being tested and the salt solution in which the experiment is done. We have studied the binding of 13 compounds to montmorillonite. In order of decreasing binding strength these are FMN thiamine hydrochloride, thiamine pyrophosphate, Flavin adenine dinucleotide (FAD) (cooperatively), hypoxanthine (cooperatively), adenine (cooperatively), nicotinamide adenine dinucleotide (NAD(+)), adenosine (cooperatively), uracil (cooperatively), inosine (cooperatively), ADP, ATP and AMP. On hydroxyapatite we have thus far studied the binding of 7 compounds. In order of decreasing binding strength these are ATP, ADP, FAD (cooperatively), AMP (cooperatively), thiamine pyrophosphate, UMP (cooperatively) and NAD(+).
Author (revised by Herner)

A95-63789
SITE OF ADSORPTION OF NUCLEIC BASES AND THEIR DERIVATIVES ON CLAY SURFACES
L. PEREZGASGA Ciudad Universitaria, Mexico, A. NEGRON-MENDOZA Ciudad Universitaria, Mexico, L. DE PABLO-GALAN Instituto de Geologia, Mexico, and F. G. MOSQUEIRA Centro Univ. de Comunicacion de la Ciencia, Mexico ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 154-155
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Experimental results are needed to test the feasibility of a proposed mathematical model (Mosqueira, 1979) in which it was first suggested the possibility of the polymerization of amino acids through the adsorption of small RNA molecules on clay surfaces and the connected participation of other RNA molecules charged with amino acids. As a first step we are now completing the study of the adsorption characteristics of their monomers. The results show that purines and its derivatives are adsorbed much more than its pyrimidines counterparts. In the case of adenine and its nucleotides, the adsorption is not dependent on the number of phosphate groups present in the organic phase. At pH 2 it was the largest adsorption, however it is not a relevant

pH value from the prebiotic standpoint. X-ray diffraction results lead us to conclude that the adsorption does not take place in the interlamellar space of clay, but it occurs mainly at the edges of the crystals.
Author (Herner)

A95-63790
A SIMPLE LABORATORY DEMONSTRATION OF PREBIOTIC SYNTHESIS. SYNTHESIS OF HYDROGEN CYANIDE IN A SIMULATED ATMOSPHERE
RAFAEL NAVARRO-GONZALEZ Instituto de Ciencias Nucleares, Mexico, EDUARDO MARAMBIO-DENNETT Universidad Nacional Autonoma de Mexico, Mexico, and SUSANA CASTILLO-ROJAS Instituto de Ciencias Nucleares, Mexico ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 156-157

We present a very simple, inexpensive and harmless experiment to illustrate the prebiotic synthesis of hydrogen cyanide. The experimental setup consists of a Pyrex glass tube with a tube opening in its center on which a natural latex rubber balloon is connected. The main ends of tube are closed with two rubber stoppers containing each an electrode in their centers made of iron wires. One end of the electrodes is grounded and the other is connected to a Tesla coil. An atmosphere composed of nitrogen and a mixture of alkanes (from a cigarette lighter) is used as a make-believe example of a 'primitive' atmosphere. The gas mixture is sparked for 30 min. At the completion of the sparking period, the student assays the formation of hydrogen cyanide.
Author (revised by Herner)

A95-63791
QUESTIONNAIRING UNIVERSITY STUDENTS IN BIOLOGY ON EMERGENCE AND EVOLUTION OF LIFE
ARISTOTEL PAPPELIS Southern Illinois University, Carbondale, IL, US and SIDNEY W. FOX Southern Illinois University, Carbondale, IL, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 158

We questionnaired (26 questions) students (n = 665) and found that about 60% recognized that protolife (protocells = microspheres of thermal proteins) has already been created in the laboratory. About 75% believe protocells are alive. About 70% believe that the Universe began from a determined bias. Additional results are: that the Universe is real (97%), everything in the Universe including life obeys physical and chemical laws (60%), in the 'fixity' of species (15%), that it is sacrilegious to try to solve the problems of emergence of life in the laboratory (23%), that both science and creation versions of the origin and evolution of life should be taught in public schools and universities (74%), in the concept of the miraculous origin of cellular life (60%), and that scientists who experiment with the synthetic retracement of the emergence of life will eventually contribute to identifying new biological processes and a new philosophy (84%). Author (revised by Herner)

A95-63792
APPROACHES TO THE SELECTION OF AN RNA REPLICASE
JACK W. SZOSTAK Massachusetts General Hospital, Boston, MA, US, RACHEL GREEN Massachusetts General Hospital, Boston, MA, US, DAVID P. BARTEL Massachusetts General Hospital, Boston, MA, US, ALICIA HAGER Massachusetts General Hospital, Boston, MA, US, and KAREN P. CHAPMAN Massachusetts General Hospital, Boston, MA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 159

We are attempting to build an RNA replicase, an RNA molecule with RNA polymerase activity that can also act as a template for RNA replication. Success in this endeavor would lend plausibility to the idea that early forms of life existed that relied upon RNA enzymes for catalysis. One approach that we have taken is to modify a self-splicing group I intron into an RNA polymerase. Both the Tetrahymena and the sun Y ribozymes can assemble a series of oligonucleotides aligned on a template strand, resulting in the synthesis of a fully complementary RNA strand. We have been trying to make the process of self-replication easier by minimizing the size of the replicase. Our smallest current version of the sun Y ribozyme has a catalytic domain of only 140 nucleotides. In vitro selection has been used to isolate a mutant form of this ribozyme with enhanced stability and activity. The selected ribozyme is also a better template for replication, apparently because of its decreased secondary structure. The selected ribozyme is able to generate a full length complementary strand to its own sequence when supplied with a series of complementary oligonucleotides 8-12 bases long. Additional selections are in progress with the goal of isolating mutations that improve the replicase-like properties of the ribozyme particularly improved substate binding and decreased sequence specificity.
Author (Herner)

A95-63793
DIRECTED EVOLUTION OF CATALYTIC RNA
N. LEHMAN The Scripps Research Institute, La Jolla, CA, US and G. JOYCE The Scripps Research Institute, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 160

According to the 'RNA World' hypothesis, there was a time during the early evolution of life on Earth when both biological information and catalytic capabilities resided in RNA molecules. We have been exploring the evolutionary aptitude of RNA through the use of an in vitro evolution system. With this system we have been able to alter the catalytic properites of the Tetrahymena ribozyme, and have carefully documented the progress of its evolution in the laboratory. RNA molecules with desired properties can be generated through a laboratory technique that mimics biological evolutionary processes. Considering the changes in the ribozyme that have accumulated over evolutionary time, one can infer sites within the molecule that are involved in divalent metal-ion interactions. More generally, it is apparent that in vitro systems validate the potential of RNA-driven catalysis to be responsive to evolutionary forces. Author (revised by Herner)

A95-63794
TEMPLATE-DIRECTED SYNTHESIS — A SUMMARY
LESLIE ORGEL The Salk Institute, San Diego, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 161

We summarize extensive studies on template-directed oligonucleotide synthesis. Poly(C) and C rich templates containing isolated A, T or G residues or short oligo(G) sequences can be copied effectively using nucleoside-5'-phosphoro(2-methyl)imidazolides as substrates. However, isolated A or T residues within an oligo(G) sequence are a complete block to copying and an isolated C residue within an oligo(G) sequence is copied inefficiently. Replication is possible only if there are two complementary oligo-nucleotides each of which acts as a template to facilitate the synthesis of the other. We emphasize the severity of the problems that need to be overcome to make possible non-enzymatic replication in homogeneous aqueous solution. We conclude that an efficient catalyst was involved in the origin of polynucleotide replication.
Author (Herner)

A95-63795
A NEW PERSPECTIVE FOR PREBIOTIC FORMATION OF ACHIRAL, NUCLEIC ACID-LIKE MOLECULES
ALAN W. SCHWARTZ University of Nijmegen, Nijmegen, Netherlands ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 162

It has been suggested that 'nucleic acid-like' molecules, in which the backbone was formed by a simpler unit than ribose, might have been evolutionary precursors of RNA. A glycerol-derived structural unit has been tested and shown to possess some of the desired properties, although these oligomers have proven to be only weak catalysts for the oligomerization of the complementary monomers. We have taken a fresh look at these problems. The following observations suggest a possible prebiotic scenario: Ultraviolet irradiation of aqueous formaldehyde in the presence of carbonate results in a highly selective synthesis of pentaerythritol. Pentaerythritol can be converted in a small number of chemical steps to a series of achiral derivatives of barbituric acid. Derivatives of barbituric acid are capable of forming hydrogen-bonded complementary pairs, and might form the basis for the synthesis of nucleic acid-like oligomers. Author (Herner)

A95-63796
MOLECULAR REPLICATION: FROM MINIMAL TO COMPLEX SYSTEMS

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Recent years have seen considerable progress in the development of chemical self-replicating systems. From a general point of view, self-replicating systems can be defined as autocatalytic reaction systems capable of passing on structural information. The latter requires a certain kind of autocatalyst, namely one which can act as a molecular template in the autocatalytic event. In all of these systems, the rate of autocatalytic template synthesis depends on the square-root of the template concentration. Thus, the autocatalytic growth observed is not exponential, but parabolic. We report on the peculiarities of parabolic growth, its sequence selectivity, its temperature response, and its implications for molecular evolution. We also report on more complex template directed reactions which allowed us to study information transfer under the condition of parabolic growth. Finally, possible experimental approaches towards the development of a minimal replicase are discussed. Author (revised by Herner)

A95-63797
AN APPROACH TO PREBIOTIC SYNTHESIS OF OLIGORIBONUCLEOTIDES

HIROAKI SAWAI Gunma University, Gunma, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 164-165

As a model process for the oligoribonucleotide synthesis without template, we have carried out oligomerization of nucleoside-5'-phosphorimidazolide by UO2(2+) ion catalyst in neutral aqueous solution. Adenosine-5'-phosphorimidazolide gave mainly 2'-5' linked oligoadenylates with chain length from 2 to 16. On the other hand, cytidine- and uridine-5'-phosphorimidazolide gave substantial amount of 3'-5' linked cyclic dimer and trimer, along with 2'-5' linked linear oligomers with chain length up to 12. Replacement of imidazole of nucleoside-5'-phosphorimidazolide by an other azole compound as an activated monomer also yielded 2'-5' linked oligoribonucleotides by UO2(2+) ion catalyst, though the yield and chain length of the resulting oligonucleotides varied with the type of the azole compound. However, UO2(2+) ion did not promote oligomerization of nucleoside-5'-polyphosphates. The hydrolyzed products, AMP and ADP were obtained from ATP by UO2(2+) ion catalyst, together with very small amount of diadenylate. Author (Herner)

A95-63798
ORIGIN OF PRIMITIVE TRANSLATING SYSTEMS

MASAHIRO ISHIGAMI University of Osaka Prefecture, Osaka, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 166-167

A theory for the origin of primitive gene translating systems is proposed. Various hydrophobic organic substances in droplets may have formed ribonucleotides (RNA) and oligoribonucleotides. Some RNA have been found to have enzyme-like activity. Among duplicating oligonucleotides, bound amino acids have been found. These are thought to be primitive tRNAs. Evolution of rRNA is seen to result in the establishment of a P-site and A-site of ribosome with amino acid-sequencing by RNA nucleotides. Herner

A95-63799
PEPTIDE NUCLEIC ACID (PNA): A MODEL STRUCTURE FOR THE PRIMORDIAL GENETIC MATERIAL?

PETER EIGIL NIELSEN The Panum Institute, Copenhagen, Denmark ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 168-169

We recently described a novel DNA analog, PNA (peptide nucleic acid), which may be relevant for the discussion of the origin of life. PNA consists of a peptide (polyamide) backbone comprised of (2-aminoethyl)glycine units to which nucleobases are attached via carbonyl methylene linkers, and we have found that PNA binds to oligo(deoxy)-ribonucleotides obeying the Watson-Crick base pairing rules, i.e., A-T and G-C base pairs are highly preferred. Thus in a chemical sense (but not in a functional sense) PNA bridges the gap between proteins and nucleic acids, and the results obtained with PNA clearly show that molecules with the potential of carrying genetic information are not required to contain either phosphates or sugars but could be 'peptides'. Author (Herner)

A95-63800* National Aeronautics and Space Administration, Washington, DC.
A NOVEL COMPUTATIONAL METHOD TO SIMULATE NON-ENZYMATIC SELF-REPLICATION

RAFAEL NAVARRO-GONZALEZ Universidad Nacional Autonoma de Mexico, Mexico, JAMES A. REGGIA University of Maryland, College Park, MD, US, JAYOUNG WU University of Maryland, College Park, MD, US, and HUI-HSIEN CHOU University of Maryland, College Park, MD, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 170-171 Research sponsored by the University of Maryland (Contract(s)/Grant(s): NAGW-2805)

Non-enzymatic, template-directed synthesis of oligonucleotides has been extensively studied in the laboratory as a model to understand the kind of chemical processes that might have contributed to the origin of life on Earth. Several oligonucleotides have been shown to catalyze the synthesis of their complements from activated mononucleotides; however, a restricted number of them have been found to self-replicate. Recently we developed an efficient modified cellular automata method that supports the study of self-replicating oligonucleotides. With this method the oligonucleotide molecules are represented as active cells imbedded in a two-dimensional array of inactive cells symbolizing the environment. Random movements and probability-governed chemical reactions occurring in a cellular space can effectively simulate the experimental behavior observed in self-directed replication of oligonucleotides. Author (revised by Herner)

A95-63801
POLYPEPTIDE-ASSISTED OLIGOMERIZATION OF NUCLEOTIDE ANALOGS

BERNARD BARBIER C.N.R.S., Orleans, France, J. VISSCHER University of Nijmegen, Nijmegen, Netherlands, and ALAN W. SCHWARTZ University of Nijmegen, Nijmegen, Netherlands ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins

of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 172-173

As previously shown, simple polycationic polypeptides containing a regular distribution of hydrophobic and basic residues show an outstanding hydrolytic activity towards polyribonucleotides. Because of the principle of microscopic reversibility, such polypeptides, which are able to concentrate activated oligonucleotides, might therefore also favor their condensation. Poly (Leu-Lys) was chosen for its ability to form beta-sheet structures acting as template-like surfaces. Polypeptide-assisted polymerizations of ImpdGpIm were run at pH 6.5 and 0C during 2 weeks in the presence of Mn(2+). Activated nucleotides were used in 10 fold excess with regard to the fixation sites.

Author (Herner)

A95-63802* National Aeronautics and Space Administration, Washington, DC.

OLIGOMERIZATION OF MONONUCLEOTIDES ON MONTMORILLONITE: A POTENTIAL APPROACH TO THE PREBIOTIC SYNTHESIS OF RNA

JAMES P. FERRIS Rensselaer Polytechnic Institute, Troy, NY, US, GOEZEN ERTEM Rensselaer Polytechnic Institute, Troy, NY, US, ZI PING DING Rensselaer Polytechnic Institute, Troy, NY, US, and JOSEPH PRABAHAR Rensselaer Polytechnic Institute, Troy, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 174
(Contract(s)/Grant(s): NSF CHE-85-06377; NGR3-018-148)

The condensation of the 5'-phosphorimidazolide of adenosine (ImpA) on montmorillonite in a pH 8 aqueous solution yields oligomers containing up to 10 monomer units. The regiospecificity of 3',5'-phosphodiester bond formation is enhanced by addition of 10% diadenosine pyrophosphate (AppA) to the reaction mixture. A series of activated derivatives of 5'-AMP was prepared to investigate the effect of the leaving group on oligomer formation. The benzimidazole and p-dimethylamino-pyridine derivatives gave the best yields of oligomers. Factors important for oligomer formation is discussed.

Author (revised by Herner)

A95-63803

TEMPLATE-DIRECTED REACTIONS: KINETIC AND MECHANISTIC ANALYSIS

ANASTASSIA KANAVARIOTI Univeristy of California, Santa Cruz, CA, US, CLAUDE F. BERNASCONI Univeristy of California, Santa Cruz, CA, US, DIANN J. ALBERAS Univeristy of California, Santa Cruz, CA, US, and ELDON E. BAIRD Univeristy of California, Santa Cruz, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 175-176

We report a kinetic study of oligoguanylate synthesis on a polycytidylate template, poly(C), as a function of the concentration of the activated monomer, guanosine 5'-phosphate 2-methylimidazolide, 2-MeImpG. Reactions were run with 0.005 to 0.045 M 2-MeImpG, in the presence of 0.05 M poly(C) at 23 C. The kinetic results are consistent with a reaction scheme that consists of a series of consecutive steps, each step representing the addition of one molecule of 2-MeImpG (M) to the growing oligomer. This scheme allows the calculation of second order rate constants for every step by analyzing the time dependent growth of each oligomer. Computer simulations of the course of reaction based on the determined rate constants and the scheme are in excellent agreement with the product distributions seen in the HPLC profiles. Mechanistic models for the dimerization and elongation reactions are proposed that explain the monomer concentration dependence and take into account that the monomer associates with the template in a cooperative manner. Our kinetic analysis allowed the determination of rate constants for the elementary processes of covalent bond formation between two monomers (dimerization), and between an oligomer and a monomer on the template. A major conclusion from our study is that bond formation between two monomer units, or between a primer and a monomer, is assisted by the presence of additional next neighbor monomer units. This is consistent with recent findings with hairpin oligonucleotides. Our study is the first of its kind that shows the feasibility of a thorough kinetic analysis of a template-directed oligomerization and provides a detailed mechanistic model of these reactions. Preliminary results on the effect of the concentration of the template on the reaction rate based on a similar analysis is also discussed.

Author (revised by Herner)

A95-63804

OLIGOMERIZATION OF A NUCLEOTIDE ANALOG RELATED TO BARBITURIC ACID

MICHIEL J. VAN VLIET University of Nijmegen, Nijmegen, Netherlands, JOHNNY VISSCHER University of Nijmegen, Nijmegen, Netherlands, and ALAN W. SCHWARTZ University of Nijmegen, Nijmegen, Netherlands ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 177

We have studied some oligomerization reactions with a new, achiral nucleotide analog. The analog is based on barbituric acid, substituted with two functional groups at the 5-position, and has the capacity to form hydrogen bonds. Condensation of the activated compound, which has a plane of symmetry lying in the pyrimidine ring, would therefore result in the formation of pyrophosphate linked oligomers, capable of assuming an ordered stereo-chemical structure. A plausible prebiotic route for this type of analog has been suggested. The activated analog showed a surprisingly large tendency to oligomerize in aqueous solution. Although the two side groups are flexible, only a moderate degree of internal cyclization was found. The reaction is catalyzed more effectively by manganese than by magnesium ions.

Author (Herner)

A95-63805

IN VITRO SELECTION OF OPTIMAL DNA SUBSTRATES FOR LIGATION

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DNA or RNA sequences that have been brought together using a complementary template can be joined efficiently with chemical condensing agents. However, it is not known how extensive a region of complementarity is needed to ensure efficient ligation or how faithfully a given oligonucleotide can be replicated in this way. We have used an in vitro selection technique to isolate from large random populations and characterize DNA substrates that are ligated efficiently by a water-soluble carbodiimide. The same in vitro selection technique was used to analyze ligation of DNA substrates by T4 DNA ligase and T4 RNA ligase. A number of unexpected structural requirements were found.

Author (revised by Herner)

A95-63806

AN ASSEMBLAGE OF FREE AMINO ACIDS AS A POSSIBLE PREBIOTIC ENZYME

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The ways by which prebiotic enzymes could have been formed have been a major problem in our understanding of how life emerged on Earth. Once amino acids were formed the question arises as to how they polymerized to form non random polymers: peptides and proteins, which could act as catalysts. At this point the experimental difficulties increase considerably, because the interactions between polymer chains or between polymers and small molecules by hydrogen bonds or by Van der Waals interactions are much more subtle, of the order of

approximately 0.1-1 Kcal/mole. This bond energy is of the order of the thermal energy in a solution at room temperature (kT) and the bonds are short lived. The question then arises whether these weak interactions can attract free amino acids (AA) to a substrate and the resulting assemblages will induce the desired chemical reaction in the substrate. It was clearly demonstrated in three different and independent biochemical reactions that free AA can be attracted to substrates, probably through hydrogen bonds and Van der Waals forces, and catalyse these reactions. Some AA were shown to be more effective than others and an assemblage of several AA was even more effective. The activities of the AA were characterized as enzymatic by the same criteria as the biological enzymes (through concentration, temperature and acidity dependences). The activities, relative to the purified enzymes, were approximately 10(exp 7) times smaller for beta-galactosidase, approximately 2500 times smaller for carbonic anhydrase and approximately 1000 times smaller for catalase. The different activities found in our simple catalysts are not surprising. Even today's biological enzymes have very different turnover numbers, by up to seven orders of magnitude. Probably the size and complexity of the O-nitrophenyl-beta-d-galactopyranoside (ONPG) molecule, as compared with the small CO2 and H2O2 molecules, requires more organization of the AA molecules around it on a short time scale. Author (revised by Herner)

A95-63807
CATALYTIC STUDIES OF BIOMIMETIC MOLECULAR SYSTEMS AND ORIGIN OF LIFE
JEAN-LUC DECOUT Univ. J. Fourier, Grenoble, France, JACQUES VERGNE Institut Jacques Monod, Paris, France, DRAHOMIR ZIAK Institut Jacques Monod, Paris, France, and MARIE-CHRISTINE MAUREL Institut Jacques Monod, Paris, France ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 181-182

In our search for primitive catalysts, we have noticed that N6-ribosyl-adenine, a compound easily synthesized under presumed prebiotic conditions, has a free imidazole group and we have showed that it is as catalyst, a potential analog of histidine. Furthermore, among the chemical groups involved in protein catalysis, the imidazole ring of histidine has no equivalent in the RNA world. Modified nucleic acids, could be analogous to proteins in catalytic competence. In particular, the imidazole group could have been replaced by N6-substituted adenine derivatives in primitive catalysis. In order to study the catalysis by such analogs mimicking prebiotic structure, we have synthesized polymers containing aliphatic amino groups and adenine rings linked to macromolecules by their 6-amino group. The polymers prepared, in which nucleobases are linked to an aliphatic amino group can be related at once to the 'protein world' and/or to the 'nucleic acid world'. These polymers markedly enhanced the rate of cleavage of the nitrophenyl ester. A primary amino group can deprotonate the adenine ring and induces a proton transfer from a water molecule which leads to the hydrolysis. An adenylate ion formed can also react directly with the p-nitrophenyl substrate. We are now progressing in the determination of an appropriate kinetic model. Such knowledge will help us in designing further prebiotically primitive catalysts related to the structure of nucleic acids. Author (Herner)

A95-63808* National Aeronautics and Space Administration, Washington, DC.
TEMPLATE PROPERTIES OF OLIGOCYTIDYLATES FORMED IN THE MONTMORILLONITE CATALYZED CONDENSATION OF IMPC
JAMES P. FERRIS Rensselaer Polytechnic Institute, Troy, NY, US and GOEZEN ERTEM Rensselaer Polytechnic Institute, Troy, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 183-184
(Contract(s)/Grant(s): NSF CHE-85-06377; NGR3-018-148)

In an attempt to investigate the prebiotic formation of phosphodiester bond in RNA, we have studied the self condensation of 5'-phosphorimidazolide of adenosine (ImpA), in aqueous solutions containing 0.2 M sodium chloride and 0.075 M magnesium chloride at pH 8 using clay minerals as catalyst. In the presence of certain montmorillonites, oligomers containing up to ten monomer units in their chain were formed, while in control experiments, where no catalyst was added, the major product was 5',5'-diadenosine diphosphate, A(sup 5')ppA. In reactions carried out with ImpA: A(sup 5')ppA mixtures at 9:1 mole ratio, oligomers of the type A(sup 5')p(pA)(sub n) and (A(sup 5')p)(sub n)A(sup 5')ppA(pA)(sub n) formed at the expense of (pA)(sub n) type oligomers. Addition of A(sup 5')ppA to the reaction mixture increased the regiospecifity of 3',5'-link formation from 67% to 79%. The condensation of the 5'-phosphorimidazolide of cytidine, ImpC, was also carried out in the presence and absence of A(sup 5')ppA under the same conditions and oligomers containing up to twelve monomer units were obtained. Author (Herner)

A95-63809
EVOLUTION OF BIOCATALYSTS: RIBOZYMES MAY HAVE BEEN PRECEDED BY 'CHELAZYMES'
WILLIAM W.-C. CHAN McMaster University, Hamilton, Ontario, Canada ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 185-186

The structural complexity of RNA implies that its construction would probably require an earlier form of biocatalyst. By extrapolating the principles of enzyme action to primitive conditions, it is concluded that the earliest biocatalysts must have been essentially inorganic and must assemble spontaneously on the basis of non-covalent interactions. In order for specific catalysis to occur, the substrate must be immobilized by multiple attachment in a relatively rigid complex. The above requirements suggest metal coordination compounds with chelating ligands as the most logical biocatalyst to precede ribozymes. The term chelazyme is proposed for these ancient catalytic entities. Each chelazyme is assumed to contain one or more metal ions bound to a small number of inorganic or organic ligands. These auxiliary ligands may augment the catalytic potential of the metals, assist in substrate binding or act as structural components. The most attractive aspect of the chelazyme concept is the enormous evolutionary potential. As each new product is generated by chelazyme action it has the capability of being incorporated into a novel chelazyme. Components of chelazymes may be rearranged in various combinations as in exon shuffling to produce functional diversity. Analogous reaction schemes can also be formualted for the synthesis of NAD, FAD, pyridoxal phosphate and thiamine pyrophosphate. The participation of these cofactors in chelazymes should greatly facilitate the development of metabolic diversity. The synthesis of oligopeptides and oligonucleotides should also be feasible under chelazyme catalysis and these would be incorporated as components in other chelazymes. Thus metalloenzymes and metal-dependent ribozymes should be regarded as extensions of chelazymes. The concept of chelazymes therefore provides a smooth transition between the inorganic world and the RNA world. Because of the inherent chiral properties of peptides and nucleotides, their involvement in chelazyme action would also have implications on the appearance of homochirality in the biosphere. Author (revised by Herner)

A95-63810
2-AMINOPROPIONITRILE POLYMER
SHIRO MORIMOTO Tokushima University, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 187

The equilibrium liquid (2,2'-iminodipropionitrile (2,2'-IDPN) 38.2, 2-aminopropionitrile (2-APN) 35.6, NH3 8.9 wt %) obtained from acetoaldehyde, hydrogen cyanide, and ammonia increased its

viscosity and almost solidified (2,2'-IDPN 0.16, 2-APN 1.29, Ala 0.08, Ala-NH2 0.52, NH3 4.11 wt %), being standing for more than 8 years in a refrigerator (nearly 0 C). The raw polymerization product was completly soluble in water. The solid polymerization product was obtained after lyophilizing the aqueous solution. The solid polymerization product was fractionated into three kinds of fractions by use of weakly acidic ion-exchanger resin, Amberlite GC 50. The neutral-acidic fractions were obtained by elution with water. The weakly basic fractions were obtained by elution with aq. 1% AcOH. The basic fraction was obtained by elution with 1 % NH3. The one containing the largest amount of polymer constituents was acid hydrolyzed. The trimethylsilyl (TMS) derivative of this hydrolyzate was used for GC-MS to determine polymer structural units. Author (revised by Herner)

A95-63811
NONENZYMATIC PEPTIDE FORMATION AND AMINOACYLATION
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Gel electrophoresis was found to be a useful technique for analyzing the formation of oligopeptides attached to modified oligonucleotides that contain a free amino group. The longest peptides were formed with arginine, tryptophan and the two synthetic amino acids: alpha-amino-gamma-(N1-uridino)-propionic acid and alpha-amino-gamma-(N7-adenino)-propionic acid. Glutamine reacted better than asparagine. All remaining natural amino acids showed moderate reactivity except valine, isoleucine and lysine which reacted poorly. Proline, serine, threonine and cystine did not react. Tyrosine reacted also via the aromatic hydroxy group. In case of arginine the concentration-, pH-, and salt dependence were investigated.
Author (revised by Herner)

A95-63812
AN INFORMATION 'WORM HOLE' BETWEEN 20 AMINO ACIDS AND 64 TRIPLETS IS DUG THROUGH THE DECIMAL AND QUARTERNARY SYSTEMS
VLADIMIR SHCHERBAK Kazakh State University, Kazakhstan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 189-190

The number of nucleons serves as a parameter of the genetic code systematization principle (Shcherbak, 1988). Now it appears that their total sums in the side chains and boxes are precisely balanced and are multiples of the Prime Quantum (PQ) 37 — the degeneracy III-II-I Group, or give the squares of the first three Pithagorean numbers in the PQ dimensionality — Group IV (Shcherbak, 1993). In the case of Pro, the formal 'borrowing' of a proton makes those three numbers unique. Another balance of the same type (the sum of 814, i.e. 22 PQ) for amino acids having pyrimidines in the 5'-triplet position has been found by Verkhovod (1993). The unique quantitative regularities of the total nucleon numbers at the same time have a purely informational feature. The digital pattern of the nucleon sums notations (111 x 10, 222 x 10, 333), (925, 592) is noteworthy in this respect. In the first group, the numbers are written with the help of the same symbols; in the other, the numbers are arranged by cyclic permutation. The cause of the regularity lies in the properties of three-digit number notations in the decimal additive-position system, multiples of 37. Author (revised by Herner)

A95-63813
POLY-TRNA THEORY ON THE ORIGIN OF MRNA AND GENETIC CODES
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The 5'- and 3'halves (bases 1-36 and 37-76) of tRNA(sup Trp) (E. coli, EC) and tRNA(sup Phe) (Bacillus subtilis, BSU) were aligned with one another. The base match level is highest between the tRNA(sup Trp) 5'-half and the tRNA(sup Phe) 3'-half, giving a 51.4% match and a matching probability by chance, P(sub nuc) (18,35) = 0.70 x 10(exp -3). Therefore, tRNA first emerged by duplication of a ca.37-base 'semi-tRNA'. The anticodons at the 3'-termini of the 5'-halves are homologues of the 3'-terminal 'CCA' in this alignment. Therefore, the semi-tRNA probably had a 3'-terminal 'CCA', and the most primitive tRNA (proto-tRNA) had 'CCA' at its anticodon position. The peptidyltransferase (PT) region (2469-2589) of the EC 23S rRNA is highly homologous (54.4% match, P(sub nuc)(62,114) = 0.21 x 10(exp -10) to the entire EC 5S rRNA (bases 1-120). The PT region must have evolved from an ancestral 5S rRNA (Ohnishi, 1993). Author (Herner)

A95-63814
AMINO ACID DISTRIBUTION IN ACIENT AND DERIVED PROTEINS
ERIK SCHULTES University of California, Los Angeles, Los Angeles, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 193

The distribution of amino acid residues from existing protein sequences has been analyzed as a possible test of origin of life hypotheses that postulate a prebiotic synthesis of amino acids. Only a subset (e.g. G, A, V, E, D) of the 20 biological amino acids predominate in experimental prebiotic syntheses. Therefore, protoenzymes may have been built from, and might thus have reflected, this amino acid distribution. If these protoenzymes originated before amino acid biosynthetic pathways (i.e. if they mediated such pathways), and if these ancient sequences were incorporated into the enzymes of the last common ancestor of all living organisms, then owing to the highly conserved nature of functional sequences, existing proteins might be expected to contain small sequences or repeated sequences reflecting the prebiotic amino acid distribution. I have compared the amino acid distributions of various proteins. The potential influence of physiological biases in the amino acid distributions of contemporary sequences has been addressed by comparing sequences from what are presumed to be ancient, early-evolving proteins (ferredoxin, cytochrome c, nucleotide binding structure in dehydrogenase, kinase and flavodoxin enzymes, nitrogenase, RuBisCO, and amino acid biosynthetic enzymes) with sequences from more recently derived proteins (e.g. enzymes mediating the oxygen-dependent steps of sterol and fatty acid biosynthesis). Author (revised by Herner)

A95-63815
EVOLUTION OF THE TRNA CLOVERLEAF STRUCTURE
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It is supposed that several cloverleaf structure variations of the contemporary tRNAs represent different evolutionary stages of these molecules. The first (hypothetical) hairpin like tRNA probably had only anticodon loop and acceptor stem. It is possible that the latter contained in the central part an unpaired two-stranded region, from which gradually side (D-, T- and extra-) arms differentiated. A simple secondary structure of the (especially animal) mitochondrial tRNAs corresponds, in accordance to the author's archigenetic hypothesis, to a relatively primitive stage of the tRNA evolution. A well-differentiated cloverleaf structure with long extra-arm of contemporary pro- and eukaryotic leucine and serine tRNAs is apparently a most late and progressive stage of this molecule evolution. Author (Herner)

A95-63816* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SIZE ESTIMATION OF COMPLEXES CONSISTING OF HAIRPIN DNAS BOUND TO AN ASSEMBLER-STRAND
ULRICH BAUMANN NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 195
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In connection with a model of a primitive translation based entirely on nucleic acids the structural requirements and interactions of small nucleic acids were studied. As shown previously hairpins bind to a complementary single-strand by base pairs of their loop nucleotides if the loop contains at least five nucleotides (Baumann et al 1987). Here, the question is approached to which degree a single-strand, the assembler-strand, is occupied with hairpin molecules. A gapless occupation would allow the close proximity necessary for the assumed peptide bond formation by hairpins bearing an amino acid at their 3'-end. Oligo(dC)(sub n), n = 12, 15, 18, and the investigated hairpins form complexes which are detectable under nondenaturing electrophoretic conditions. The size range is estimated to be 3-4 hairpin molecules to one assembler molecule when oligo(dC)(sub n), n = 15, 18, is used. Due to the limitation of the method, dependence of the migration velocity on the shape which is unique and thus limits the use of marker nucleic acids, and due to the uncertainty if the ends of the assembler form base pairs, a gapless occupation of the assembler is conceivable but not proven. Author (revised by Herner)

A95-63817* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THREE STAGES DURING THE EVOLUTION OF THE GENETIC CODE
U. BAUMANN NASA. Ames Research Center, Moffett Field, CA, US and J. ORO University of Houston, Houston, TX, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 196
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A diversification of the genetic code based on the number of codons available for the proteinous amino acids is established. Three groups of amino acids during evolution of the code are distinguished. On the basis of their chemical complexity and a small codon number those amino acids emerging later in a translation process are derived. Both criteria indicate that His, Phe, Tyr, Cys and either Lys or Asn were introduced in the second stage, whereas the number of codons alone gives evidence that Trp and Met were introduced in the third stage. The amino acids of stage one use purines rich codons, thus purines have been retained in their third codon position. All the amino acids introduced in the second stage, in contrast, use pyrimidines in this codon position. A low abundance of pyrimidines during early translation is derived. This assumption is supported by experiments on non enzymatic replication and interactions of DNA hairpin loops with a complementary strand. A back extrapolation concludes a high purine content of the first nucleic acids which gradually decreased during their evolution. Amino acids independently available form prebiotic synthesis were thus correlated to purine rich codons. Conclusions on prebiotic replication are discussed also in the light of recent codon usage data. Author (Herner)

A95-63818
RECENT INVESTIGATIONS ON A PRIMITIVE TRNA MODEL
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With the discovery of ribozyme by Thomas Cech, the possibility that RNA molecules played a key role during the origin and evolution of early life has brightened. Molecular mechanics calculations showed that a pentanucleotide moiety having Uracil at the 5'-end and a purine at the 3'-end flanking any three bases in the middle has a U-turn conformation as one of its favored conformations, stabilized by hydrogen bonds. This pentanucleotide moiety is called a primitive tRNA (PIT) and the middle three bases are called the primitive anticodon (PAC). One side of the PAC can base pair with a triplet of codons on another long-chain RNA molecule (called primitive mRNA or PIM), while the other side can discriminate aminoacid side chains depending on the PAC sequences through specific interactions, mainly hydrogen bonds. Such a cognate aminoacid can be energetically docked into the cleft produced by the corresponding PIT and can be stabilized by specific interactions. Thus this model and theory provides a rationale for the origin of the primitive transcription and translation process. This theory has the potential for explaining the basis of chirality of amino acids, wobble behavior and the selection of proteinous aminoacids by the protein synthesizing machinery. Author (revised by Herner)

A95-63819
A MODEL FOR THE PREBIOTIC SYNTHESIS OF PROTEINS
A. R. MELLERSH DCGH, Derby, UK ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 199
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This describes a conformation of RNA attached to a solid phase. The RNA lies in a zig-zag, attached by the phosphates. It forms a series of clefts, each bounded by three bases. Reading 5'-3' the riboses are in 3'-endo, 3'-endo and 2'-endo. The conformation is stabilized by van der Waal's interactions between the first nucleoside and the 3rd nucleoside of the preceding cleft, and hydrogen bonds between 02' of each the first two nucleosides and the non-esterified oxygen of the following phosphate. Each cleft appears capable of selectively binding an alpha-amino acid. The alpha-amino group coordinates with the N3 (purines) or O2 (pyrimidines) of the first base, and the alpha-carboxylate with the 02' of the 3rd nucleoside. The R group of the amino acid projects up between the bases, to interact with the bases. This conformation of RNA selects for small L-alpha-amino acids, and appears to be consistent with the genetic code. Ribose is the only sugar which will allow this conformation and if the ribose is the D-enantiomer, then L-alpha-amino acids will be selected. This model suggests that the genetic code is an inherent chemical property of RNA and that adapter molecules may not be necessary for the selection, orientation and activation of amino acids. Author (revised by Herner)

A95-63820
ENZYMES, TURING MACHINES, METABOLIC PATHWAYS OR HOW TO COOK A NUTRITIOUS 'SOUP' INSIDE A CELL
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One enigma regarding the origin of life is to explain how metabolic pathways evolved defining metabolic trees and rings where molecular blocks are synthesized. A general hypothesis says that originally, when life began, cells could survive and grow on the molecules in their surroundings. As these resources were exhausted, 'starving' cells had to develop enzymes, emerging metabolic pathways ('soup'). Enzymes are very dynamic structures with conformational movements over a wide range of time scales and conformational transitions which are related to enzyme function. Conformational states at any given time may be triggered by factors including phosphorilation, ATP and GTP hydrolysis, ion fluxes, electric fields, pH, temperature, osmolality, binding of ligands, allosteric influences, etc. Thus an enzyme or protein may be viewed as a Turing 'Finite State Machine' with multiple inputs and two or more conformational output states. Author (Herner)

A95-63821
NANOBIOLOGICAL PRINCIPLES AND THE ORIGIN OF LIFE
P. A. HANSSON and S. SANTOLI ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 202
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One of the significant problems towards an understanding of the origin of life is the combination of chemistry with physics at what has recently been called the mesoscopic level. Historically, the physics contribution has been information theory. We suggest here that information is not in the form of a time series but in the form of a model. Thus, the material is a model of itself, in Chaitin's sense. Such mechanisms are outside the Bremermann's limit and their evolution is not based on a one-to-one information mapping, but on the compression possible in the material embediment of automatas, in a different physical environment. For example, low dimensional structures within proteins can have quantum dots and form layers of hierarchical dynamics in cells. We discuss how such structures could have appeared as thin films within solid matrices. Author (Hemer)

A95-63822
SELF-REPLICATING OLIGONUCLEOTIDES
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It is widely believed that life on earth originated before a coupled synthesis of proteins and nucleic acids i.e. translation was established. The earliest forms of life are conceived to depend solely on self-replicating RNA or related molecules. Self-replication necessitates a template-directed reaction which proceeds autocatalytically. The smallest conceivable representation of a self-replicating system consists of a self-complementary template T and two constituents A and B from which the template is built up. Template molecules are synthesized via an autocatalytic and a non-autocatalytic reaction pathway and the autocatalytic rate contribution follows the square-root of the template concentration. The initial growth of template concentration is not exponential but parabolic which in turn has profound consequences for molecular evolution. Author (revised by Hemer)

A95-63823
COMPLEXITY ACQUISITION DURING PREBIOTIC EVOLUTION
BRIAN K. DAVIS Research Foundation of Southern California, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 205-206
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Generalizing the fundamental theorem of natural selection from fitness-driven, Darwinian propagation (Fisher, 1930) to low fidelity processes, with significant cross-propagation, results in a covariance-error series representation of evolution. To accommodate prebiotic evolution, this series has been extended recently to include an error spectrum of arbitrary size. In addition, the fitness parameter was rescaled from polymer propagation to nucleotide condensation rate. Time variations with evolution in the mean condensation rate coefficient then specify changes in expected effective activation free energy. With improved copying efficiency, presumably facilitated by duplex avoidance strategies and the participation of early condensation catalysts, synthesis of a long sequence, with sufficient complexity to exceed the lower threshold for self-replication, then appears possible within a reasonable interval. Under these circumstances, however, the range of potential source replicators for a given polynucleotide species narrows sharply. This focussing action by a declining error rate follows from the exponential termwise fall off of the covariance-error series. Improving the fidelity of replication, consequently, clusters polymerization into ever smaller regions of the condensation potential energy surface (fitness terrain). Self-replication and Darwinian evolution are then seen as an end-result of the action of statistical thermodynamic forces.
Author (revised by Hemer)

A95-63824
EVOLUTION OF CATALYTIC NETWORKS FORMED BY SELF-REPLICATIVE SPECIES
MIGUEL ANGEL ANDRADE Universidad Complutense de Madrid, Madrid, Spain, PABLO CHACON Universidad Complutense de Madrid, Madrid, Spain, JUAN CARLOS NUNO Universidad Politecnica de Madrid, Madrid, Spain, and FRANCISCO MONTERO Universidad Complutense de Madrid, Madrid, Spain ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 207-208
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The formation of catalytic networks of self-replicative species has been postulated as a step towards more sophisticated biological systems. This kind of organization would be the object of evolutive and selective processes in the first steps of prebiotic evolution. Two evolutive levels can be distinguished in a catalytic network. On the one hand, the evolution of the concentration of the network species as a result of the network dynamics leading to quasistationary states with high average life times. On the other hand, a slower evolution of the network graph is a result of the appearing and disappearing of new species. The stochastic nature of the proccess of self-reproduction and mutation suggests its modeling by means of Monte Carlo methods, where the variables take discrete values. The simulation of this system shows that networks with high number of species evolve into states of low number of species and high catalytic and autocatalytic constant values. This fact indicates the low probability of the existence of catalytic networks with high number of species in advanced steps of the prebiotic evolution. Finally, the biological implications of these results are discussed. Author (revised by Hemer)

A95-63825
HYPERCYCLES VERSUS PARASITES IN THE ORIGIN OF LIFE: MODEL DEPENDENCE IN SPATIAL HYPERCYCLE SYSTEMS
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Hypercycles are suggested by Eigen and Schuster, (1979), as a way for a primitive self-replicating molecular system to increase its information contents beyond the restriction of the Eigen error catastrophe. The idea is that each of the molecular species catalyse the replication of an other molecular species, so as to form a closed loop. One major problem is that the evolutionary stability of hypercycles is not clear. In general hypercycles are vulnerable to so called parasites, i.e., molecular species that do not catalyse the replication of any other species but still receive catalytic support from a species of the hypercycle. The parasites can arise by mutations within the hypercycle and may be common in a system of low replication accuracy. A parasite is formed every time a molecular domain, which is essential for the ability to give catalytic support, is damaged, as long as the previous catalysing molecule is still able to recognise the molecule as something to be replicated. In models without spatial organisation parasites with higher replication rate or lower decay rate are fatal to the hypercycle system. Such parasites may arise by a length reduction of a molecule of the hypercycle. Author (Hemer)

A95-63826
THE ORIGIN OF THE GENETIC CODE: AN APPROACH ON THE BASE OF THE PROGENE HYPOTHESIS
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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 211-212

To explain the origin of the simplest bimolecular genetic system, consisting of a polynucleotide gene and its polypeptide product (enzyme), the progene hypothesis has been proposed (Altstein, 1987, 1992). The progene is a mixed anhydride between non-occasional amino acid and a trinucleotide at 3'-gamma-phosphate (NpNpNppp-AA, where N is a nucleoside, p is phosphate, AA is an amino acid). The progenes are a sole substrate for the origin and the reproduction of the first genetic system. The hypothesis and a stereochemical analysis made on its basis allow to explain the simultaneous synthesis the polynucletide and the polypeptide with interdependent order of nucleotides and amino acids, a principle of selection of substances for the first genetic system, including appearance of chirality, the main characteristics of the modern genetic code. The central postulate of the hypothesis is a mechanism of progene formation. Three components are needed for the progene formation: dinucleotides (DN, NpNppp), 3'-gamma-aminoacyl nucleotides (AAN, Nppp-AA) and oligonucleotide templates (greater than 3 bases). The first step is the formation of an unstable triplet: DN and AAN are united due to stacking and specific interaction between the amino acid of AAN and the dinucleotide. Then the unstable triplet is stabilized by complementary pairing with the oligonucleotide template (other unstable complementary triplet also can be used as the template). This interaction increases a chance for the phosphodiester bond formation between DN and AAN. In this complex the negative charge beta-phosphate group of AAN is approached to 5'-OH group of AAN and can catalyse the phosphodiester bond formation (the intracomplex basic catalysis). Thus the progene (the mixed anhydride of the trinucleotide and the specific amino acid on 3'-gamma-phosphate) is synthesized. The progene formation is the specific and the autocatalytic process. Author (Hemer)

A95-63827
TRANSFER RNAS WITH COMPLEMENTARY ANTICODONS COULD SHOW THE MOST RARSIMONIOUS WAY TOWARDS GENETIC CODE ORIGIN
SERGEY RODIN UNAM, Mexico, SUSUMU OHNO Beckman Research Institute of the City of Hope, Duarte, CA, US, and ANDREY RODIN UNAM, Mexico ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 213-214

Primordial tRNAs appear to have emerged concertedly as replicating plus- and minus-chains with complementary anticodons. This conclusion is based upon results of comparative sequence analysis of the 17-base-Inog anticodon loop and stem of modern tRNAs, totaling 896, and especially of 22 pairs of consensus tRNAs with complementary anticodons. More variable acceptor stem sequences served as an internal control region. Such pairs of consensus tRNAs anti-parallelly oriented to each other display surprisingly small number of mismatches (complementary distances); standard comparisons showing in contrast considerably larger direct distances. Furthermore, smallest complementary distances were detected for quasi-complementary anticodons, i.e. those with irregular G-U base partnership. Their pre-tRNAs could generate by replication new codon-synonyms for the same pair of amino acids. Author (Hemer)

A95-63828
CORRELATIONS BETWEEN STRUCTURAL AND CHEMICAL PROPERTIES OF AMINO ACIDS AND THEIR PLACE IN THE GENETIC CODE TABLE
G. COCHO UNAM, Mexico and A. RODIN UNAM, Mexico ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 215

We present a statistical mechanics formalism using the propensity parameters of Goldstein et al. and define an ordering parameter. The ordered state corresponds to helix or sheet and the disordered one to turn or loop. Amino acids coded by the first (NUN) and third (NAN) columns of the genetic code have in general larger values than amino acids of the other two columns and therefore, will belong to more 'crystaline' proteins. NUN and NAN form a rather complete set, as in addition of initiation and stop codons, they code nonpolar and strongly polar, basic and acid amino acids. There is no such a complete set for NCN and NGN. We show that proteins with a low mutation rate have in general large sigma and are dominated by NUN and NAN codons. We discuss different scenarios and suggest that a 'cold scenario' for the origin of the genetic code seems to be consistent with our findings. Author (revised by Hemer)

A95-63829
THE REVERSE GENETIC CODE AND THE CENTRAL DOGMA OF MOLECULAR BIOLOGY
O. V. DAVYDOV Byelorussian Research Inst. for Epidem & Microbi, Minsk, Rep. of Belarus ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 216-217

The 'central dogma' of molecular biology postulates possible and impossible directions of information flow between main types of biological macromolecules. That is information transfer is possible between nucleic acids and from them to protein, and is forbidden from protein to nucleic acids and between proteins. Information means here the precise determination of monomer (base and amino acid) sequence. It is clear that elementary structural units of this information system, bases (nucleotides) and amino acids have a molecular nature. A new biological information system, called the reverse genetic code, has been described. It demonstrates that each protein amino acid is a carrier of complete structurochemical information about own codons. Two atom clusters of definite localization in amino acid formula are equivalents of nucleotides of appropriate doublet according to the vocabulary: CCH = SCH = SH = 'U', NCCH = 'C', NH = O = OH = 'A', and CNH = 'G'. These clusters and adjacent atoms provide additionally information about positions (1' or 2') of deciphered nucleotides in doublet and the group characteristic of appropriate 3' nucleotides (purine, pyrimidine, mixed). The reverse code is based on information conception which is wider than the monomer sequence principle used in the central dogma. Its minimal structural units are single non-hydrogenic atoms while functional units include mainly clusters of such atoms. Author (revised by Hemer)

A95-63830
PHYLOGENETIC EVIDENCE SUPPORTS THE CONCEPT THAT VIROID AND VIROIDLIKE SATELLITE RNAS ARE RELICS OF THE RNA WORLD
SANTIAGO F. ELENA Universitat de Valencia, Valencia, Spain, RICARDO FLORES IATA/CSIC, Valencia, Spain, and ANDRES MOYA Universitat de Valencia, Valencia, Spain ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 218-219

A phylogenetic reconstruction of the evolution of some representative viroid and viroidlike plant satellite RNAs, as well as the viroidlike domain of human hepatitis delta virus (HDV) RNA, indicates that these RNAs represent a monophyletic group. We have re-elaborated this phylogenetic reconstruction to include some additional members of this group of infectious RNA whose sequences have been reported recently. The new consensus phylogenetic tree obtained forms three branches: (1) typical viroids that replicate autonomously, but apparently lack the capacity to self-cleave (requiring a host trans-acting factor

for the processing of oligomeric replication intermediates to monomeric progeny molecules); (2) two self-cleaving plant satellite RNAs and HDV RNA; and (3) two atypical viroids and most plant satellite RNAs, all of which self-cleave via hammerhead structures. The present phylogenetic analysis further supports the concept that these small plant pathogenic RNAs have evolved from initially self-replicating molecules in the RNA world by becoming dependent for their replication on specific cells or viruses. Author (revised by Herner)

A95-63831
AMINO-ACYL-T-RNA SYNTHETASES AND THE EVOLUTION OF THE GENETIC CODE
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There has been a new development in our understanding of the amino-acyl-t-RNA synthetases. A rough classification into two classes has been made. The two classes are: (1) Class 1 which include Valine, Leucine, Isoleucine, Methionine, Tyrosine, Tryptophane, Glutamic, Glutamine and Arginine (Cysteine) (2) Class 2 which includes Proline, Threonine, Serine, Phenylalanine, Aspartic, Asparagine, Histidine, and Lysine and Class 2a which includes Glycine and Alanine. There has been some speculation that Class 2 is the more primitive of the synthetases and in fact it is the class 2a which seems the most primitive. These observations are consistent with my proposal that the first code was a (G,C) code coding for Glycine, Proline, Alanine, and a positively charged amino-acid. Three of these amino acids belong to class 2 (Glycine, and Alanine belong to class 2a) and Proline to class 2. The positively charged amino acid must have been simpler than arginine. The evolution of the genetic code from a (GC) code to a (GCAU) code is still to be found in the amino-acyl-t-RNA-synthetases.
Author (revised by Herner)

A95-63832
MECHANISMS FOR THE POLYMERIZATION OF NUCLEOTIDES BY ALPHA-PARTICLE RADIOLYSIS IN AQUEOUS SOLUTION
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The possibility that DNA evolved selectively under the influence of radiation interactions in artesian aquifers is discussed by Martell (1992). That the ability of DNA to direct enzymatic repair of radiation damage was an important selection factor in DNA evolution is reinforced by conclusive evidence that DNA replication synthesis and DNA repair synthesis are carried out by the same enzymes and that inhibition of DNA repair and DNA replication are attributable to the same agents and mechanisms (Collins and Johnson, 1984), clearly indicating that replication and repair processes must have evolved together. Initiation of polymerization with ionizing radiation has a number of important advantages over its initiation by chemical and thermal energy sources. In particular, initiation by ionizing radiation has essentially zero activation energy, provides for a wide range of initiation rates, produces fewer interfering chemical decomposition products, gives rise to a minimum of adverse temperature effects, and is highly effective in dilute aqueous solution of monomers due to the indirect action of water radiolysis products. Author (revised by Herner)

A95-63833
OLIGONUCLEOTIDES AS PROBES FOR STUDYING POLYMERIZATION REACTIONS UNDER PREBIOTIC CONDITIONS
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It is well known that regularly structured water-soluble polymers can exhibit a myriad of biological activities. Thus, it seems worthwhile to investigate the outcome of polymerization reactions under prebiotic conditions, that is in aqueous solution. Under such conditions isolation and characterization of polymers by traditional means (e.g. viscosity and spectroscopic measurements, MW determination) are not feasible. We developed a probe which will make study of polymerizations under prebiotic conditions possible. The probe consists of an oligonucleotide (synthesized on a DNA synthesizer) which has a p-32 tag at the 5' position (introduced by kinasing with gamma-ATP). At the 3' position a reactive group is attached (e.g. NH2, by using 3'-modifier column) which initiates the polymerization (such as a nucleophilic ring opening) and gets incorporated into the growing polymer chain. The success and extent of polymerization are measured by gel electrophoresis, an extremely sensitive method well suited for observing the oligonucleotide tag and sensitive to both molecular weight and charge of the attached polymer chain. We have synthesized T8 oligonucleotide labeled with P-32 at the 5' terminus and with a primary amine at the 3' end. This probe was used to study polymerization of ethylene imine (aziridine). Author (Herner)

A95-63834* National Aeronautics and Space Administration, Washington, DC.
EFFECT OF LEAVING GROUP ON THE OLIGOMERIZATION OF 5'-AMP ON MONTMORILLONITE
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The oligomerization of imidazole derivative of 5'-AMP (ImpA) in the presence of montmorillonite clay yields oligomers containing up to 10 monomer units. In these reactions, the heterocyclic base, imidazole is the leaving group. In our present study, we synthesized a series of activated nucleotides of 5'AMP using other leaving groups such as pyrazole, 1,2,4-triazole, piperidine, morpholine, 4-aminopyridine, 4-methylaminopyridine, 4-dimethylaminopyridine, 2-aminobenzimidazole etc. to determine the effect of amine leaving group on the products of the oligomerization reaction. Earlier results from our laboratory showed that the presence AppA in the clay reaction of ImpA enhances the oligomerization reaction to yield higher oligomers. We also studied the effect of AppA in the clay mediated oligomerization reaction of the activated nucleotides. Oligomerization of 2-amino-benzimidazole derivative of 5'-AMP gave higher oligomers containing up to nine monomer units in the presence of AppA. Author (revised by Herner)

A95-63835
KINETICS OF DIMERIZATION AND OLIGOMERIZATION OF THE 5'-PHOSPHORIMIDAZOLIDE OF ADENOSINE ON NA(+)-MONTMORILLONITE
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The reaction of 5'-phosphorimidazolide of adenosine (ImpA) in the presence of Na(+)-VolClay (a Na(+)-montmorillonite) yields oligoadenylates of up to ten nucleotides in length. The scope of the ImpA reaction was investigated using a Wyoming, a Japanese, and an Otay Na(+)-montmorillonite. The Wyoming and Japanese clays facilitated the formation of oligoadenylates 1oligo(A)1 as efficiently as does VolClay. However oligomerization did not proceed in the presence of the Otay clay. The logarithmic value of the yield of each oligomeric fraction (eg. trimer, tetramer, pentamer) is inversely proportional to the

length of oligomer (eg. 3, 4, 5 respectively) in those reactions where oligomers are formed. This relationship can be demonstrated by the kinetic computer simulation KINSIM (Barshop et al. 1983). The reaction of ImpA on VolClay was investigated by the rate of loss of ImpA and the rate of formation of oligomer. The percent binding of ImpA and each oligomeric fractions to VolClay was measured. The data fitting program FITSIM was used to calculate the rate constants for each step in the oligomerization reaction. They are higher than that determined for the rate of 2-MeImpG oligomerization from 8-mer to 10-mer on poly(C) which is 12.8/h/m. Author (revised by Herner)

A95-63836
OLIGOMERIZATION OF NUCLEOTIDE IMIDAZOLIDES ON NA(+)-MONTMORILLONITE CLAY: A MODEL FOR THE PREBIOTIC SYNTHESIS OF RNA
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Activated nucleotides, typically the imidazolides (ImpN) oligomerize on Na(+)-montmorillonite clay in aqueous solution. The P(sub 1), P(sub 2)-dinucleoside-5',5'-pyrophosphate (NppN) is the major product formed from ImpN in the absence of montmorillonite. Symmetric (UppU) and unsymmetric (AppU) pyrophosphates were synthesized and their role in the oligomer formation was investigated. The products of the condensation of purine and pyrimidine nucleotide imidazolides (ImpA and ImpU) by themselves and with pyrophosphates (AppA, UppU and AppU) were investigated and isomeric oligomers of chain length up to 10 were detected. The percent of pyrophosphate incorporation and the regiospecificity of 3', 5'-phosphodiester bond formation was determined by selective enzymatic hydrolyses and HPLC analysis of the products. The products of the reaction of ImpU with AppA do not contain the AppU grouping. This eliminates a mechanistic scheme in which a triphosphate intermediate undergoes intramolecular rearrangement to a UppApA. This finding suggests that the enhanced reactivity of AppA is due to a specific interaction of ImpU and AppA on the mineral surface. Author (revised by Herner)

A95-63837
ASSOCIATIVE BEHAVIOR OF THE 'POSSIBLY PREBIOTIC' ACYCLIC OLIGONUCLEOTIDES
L. MERLE CNRS, Mont-Saint, France, Y. MERLE CNRS, Mont-Saint, France, A. SZEMZO Hungarian Academy of Sciences, Budapest, Hungary, and J. SAGI Hungarian Academy of Sciences, Budapest, Hungary ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 230-231
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The acyclic oligonucleotides / or nucleotides were not found or even looked for in prebiotic experiments, they could be potential candidates for a primitive form of Nucleic Acids as suggested theoretically and experimentally in enzymatic systems. As example, the modified dodecathymidilate (GlyT)12, acyclic analogue of the normal (dT)12, has proved to be an efficient primer for TdT transferase and DNA polymerase. That means the acyclic analogue is partially recognized by the enzymes, in the normal triphosphate and template/enzyme/acyclic primer quaternary complex with Klenow DNA polymerase, suggested an hybridation between the acyclic and normal oligonucleotides. The lack of the sugar moiety induces a destabilisation of the helix duplex and reduces the thermal melting (Tm) of the duplex when the acyclic unit is incorporated into natural short fragments. No real transition is observed between the acyclic oligothymidilate (GlyT)12 and its complementary oligomer (pA)12 or polynucleotides poly(A) or poly(dA). Only, a small slope change of the melting temperature profiles appears. The presence of spermine or spermidine, polyamine of low molecular weight considered as possibly prebiotic, known to stabilize the helical duplex in some natural systems higher than the Mg(++) cation, do not affect the very weak associations. In conclusion, the high asymmetry of the ribose or deoxyribose plays a fundamental role in the stability of the double helix of the Nucleic acid as shown many times. The greater simplicity of the acyclic oligonucleotides, but not the synthesis, is a stimulating hypothesis to explain the prebiotic origin of the Nucleic Acids. Their properties related to their role as 'primer' and their associative power are very moderate. For that, they were discarded in the primitive soup when the sugar molecule appears. Nevertheless, it does not mean, that for example, a cytosine/guanine acyclic oligonucleotide could not be a more plausible candidate. Author (revised by Herner)

A95-63838
COPPER COMPLEXES: MODEL FOR EARLY ENZYMES
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The development of catalytic and autocatalytic functions is an important feature of biochemical evolution. However, actual information about the pathways of synthesis of biocatalysts is rather random. In view of this, transition metal ions and transition metal complexes are presumed to have played a significant role. Excellent catalytic nature and large number of catalytic properties of transition metal compounds can represent the role of such coordination compounds in the evolutionary processes. It is assumed that transition metal ions which were abundant in the primeval sea might have formed complexes with simple organic ligands readily available to them. Moreover, these complexes could have catalysed number of biologically important reactions. However, all metal complexes formed during early period of chemical evolution may not have acted as catalysts for all reactions but only few effective combination of metal ions and ligand must have served as catalysts for certain class of reactions. Here, we have extended our previous investigations of evolution of metalloenzymes. Simple complexes of imidazole with copper, cobalt, nickel, zinc and manganese were prepared as described by Goodgame et al (1968) and Eilbeck et al (1967). The catalytic activity of each complex was tested towards decomposition of hydrogen peroxide at 40 C and pH range of 5.0-11.0. Among the above synthesized complexes, only copper and cobalt imidazole complexes have shown catalytic activity towards decomposition of hydrogen peroxide and copper imidazole complex was found to be much more active than cobalt imidazole. Imidazole complexes of nickel, zinc and manganese were absolutely inactive. The results indicate that copper complexes are more effective catalysts for oxidoreductase type of reactions and thus might have selected naturally by eliminating others. The reactivity of copper complexes towards decomposition of hydrogen peroxide varied depending upon nature of ligands and probably in next stage still more effective combination of metal ion ligands selected naturally for a particular class reactions. Author (revised by Herner)

A95-63839
THERMAL HETERCOMPLEX MOLECULES FROM AMINO ACIDS AND THEIR CATALYTIC CAPABILITIES
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We examined the catalytic capabilities exhibited by thermal heterocomplex molecules made by heating a mixture of aspartic acid and proline as model polymeric molecules of prebiotic significance. The model molecules of molecular weight of roughly 4000 daltons (hereafter called DP1 molecules) were shown to exhibit ion association when they

aggregated into microspherical structures in their aqueous suspension. The rate of dissociation increased in proportion to the square of the total surface area of the then available microspherical sediments in the suspension. The process of ion association points to that free DP1 molecules in the aqueous suspension aggregate into the microspherical sediments already made in a pairwise manner. Likewise, the dissociation of aggregated DP1 molecules was found to proceed in a pairwise manner through hydration. We examined whether microspherical structures made of DP1 molecules could maintain the capacity of attracting monomeric amino acids. Among the twenty different kinds of amino acids of biological relevance we tried, it has been identified that histidine can adhere on the microspherical structures made of DP1 molecules. The characteristic time for adhesion was found to be roughly a hundred minutes. Our present observation supports that thermal heterocomplex molecules from amino acids could have various catalytic capabilities of potentially biological significance. Author (revised by Herner)

A95-63840
CELLULAR STRUCTURES FROM AMINO ACID THERMOLYSATES

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A cellular system produced abiogenetically from lyophilized amino acid thermolysates is offered as a model for prebiotic molecular self-assembly and membrane transport systems. The hexagonically shaped cellular aggregates contain the photoactive chromophores (pteridines, flavins, acridines, deazaflavins and melanoidal pigments) within the interfaces of the boundary structures. The photoreceptor molecules that are conjugated to the peptides within the membrane offer a template for interaction with a variety of different molecules such as nucleic acids. The thermolysates show similarities to flavo-proteins that are membrane oriented enzymes. Anisotropic orientation of the flavin photoreceptors within the membrane allows for selective absorption of horizontally polarized light. This special alignment of the chromospheres could have implications for chiral amplification.

Author (revised by Herner)

A95-63841
SYNTHESES OF PROTEIN-LIKE COPOLY (AMINO ACIDS) — A POSSIBLE ROUTE FOR THE FORMATION OF PHOTOPROTEIN

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In the present study, a hypothetical reaction pathway for the formation of protein-like copoly (amino acids) from gaseous starting materials is proposed. The sequence of the chemical reactions in the pathway is composed of four steps. These are (1) formation of fumaronitrile from cyanoacetylene, (2) hydrolysis of fumaronitrile to thermal precursors of aspartic acid such as ammonium salts of fumalic acid and malic acid, (3) thermal copolycondensation of the thermal precursors of aspartic acid with amino acids, and (4) formation of microspheres from the resulting copoly (amino acids). Most of the reaction pathway was supported experimentally. The materials and the reaction conditions used in this reaction could be regarded as prebiological for the formation of protoprotein on the primordial earth. The copolycondensation is also interesting as a simple and convenient way to prepare copolyamino acids including aspartic acid.

Author (Herner)

A95-63842
AUTOCATALYTIC ACCRETION OF PREBIOTIC MOLECULES IN AQUEOUS ENVIRONMENTS

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We chose thermal heterocomplex molecules made by heating amino acids as model polymeric molecules and investigated their catalytic capabilities that they exhibit in aqueous environments. Our thermal heterocomplex molecules of amino acids were made by heating a mixture of aspartic acid and proline. The resulting heterocomplex molecules of molecular weight of roughly 4000 daltons were shown to exhibit a cooperativity in the process of aggregation into microspherical structures in their aqueous suspension. The observed cooperativity suggests that our model polymeric molecules participating in the aggregation also serve as a form of a catalyst for the very aggregation process. That molecules to be aggregated serve as catalysts for the aggregation implies that the accretion of our model molecules into microspherical structures is autocatalytic. The order of autocatalysis measuring the number of molecules to help transferring one molecule of the same kind into the aggregate state was found to be unity in the case of our molecules in their aqueous suspension. When the suspension was shifted into alkaline conditions, the order of autocatalysis was found to become greater than unity. Our demonstration of autocatalytic accretion of model prebiotic molecules in their aqueous suspension shows that thermal heterocomplex molecules from amino acids would satisfy a necessary condition that they may become precursor molecules having the capacity of autocatalytic synthesis. Author (revised by Herner)

A95-63843
THE ORIGIN OF GENETIC INFORMATION

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A living entity can be described as a complex adaptive system which differs from any, however complex, chemical structure by its capability of functional self-organization based on processing of information. If one asks where does this information come from and what is its primary semantics the answer is: information generates itself in feed back loops via replication and selection, the object being 'to be or not to be'. We describe the theoretical frame work of information-generating systems and provide experimental clues for some basic forms of genetic organization, such as molecular quasispecies, hypercyclic and compartmentalized RNA-protein assemblies. The results are primarily obtained with RNA-viruses and virus-like systems. The experiments are carried out with automated, computer-controlled bioreactors, called 'evolution machines', that may form the basis of a new 'evolutionary biotechnology'. Author (Herner)

A95-63844
PHOSPHATE COMPOUNDS IN PRECELLULAR AND EARLY CELLULAR ENERGY CONVERSION

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Among the energy-rich phosphate compounds of a non-nucleotide nature, which may have been actively involved in energy conversion during chemical evolution preceding the origin of life on earth, inorganic pyrophosphate (PPi), higher inorganic polyphosphates, acetyl phosphate, carbamyl phosphate and 1,3-diphosphoglyceric acid (DPGA) have been found in living cells. Of these, PPi has been shown to be

involved both at the substrate and the electron transport levels of biological energy conversion, and acetyl phosphate, carbamyl phosphate and DPGA only at the substrate level. Lipmann (1965) suggested that PPi may have been a predecessor of ATP as an early energy carrier. We discovered in bacterial chromatophores the first alternative photophosphorylation system, giving, at the expense of light energy, PPi instead of ATP. That PPi also was shown to function in chromatophores as an alternative energy donor in several energy requiring reactions seemed to strengthen the position of PPi as a possible early energy carrier. Recent geochemical support for the idea that PPi may have been continuously produced on the primordial earth was obtained in experiments with volcanic magma. Biochemical and other support for a possible role of PPi in precellular and early cellular energy conversion has been reviewed recently. Author (Herner)

A95-63845
PHYLOGENY OF PROTON PUMPING ATPASES: IMPLICATION FOR THE EARLY EVOLUTION OF LIFE
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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 244-245

Ion transporting ATPases are found in all extant organisms. These enzymes link the formation (or dissipation) of transmembrane gradients of ions (usually H(+)) to the hydrolysis (or synthesis) of ATP. Those enzymes that utilize the transmembrane proton motive force for the synthesis of ATP are also termed coupling factor ATPases. In bacteria the reaction catalyzed by these coupling factor ATPases is reversible. Depending on the conditions, these coupling factor ATPases can either use the energized membrane to synthesize ATP or they can use ATP generated by substrate level phosphorylation to energize the membrane. The discovery of the homology between the eukaryotic vacuolar type ATPase, i.e., the ATPase that energizes the eukaryotic endomembrane system (V-ATPase), and the eubacterial coupling factor ATPase (F-ATPase), made another marker molecule available for the study of the evolution of -and relations between-the three domains of life. Both the bacterial coupling factor ATPases and the eukaryotic vacuolar type ATPases contain two paralogous subunit types, a catalytic and a non-catalytic subunit. The catalytic subunit binds and hydrolyzes ATP; the non-catalytic subunit (also termed regulatory subunit) also binds ATP, but it does not hydrolyze ATP. Sequence comparisons suggest that the gene duplication that gave rise to these two subunits had already occurred in the last common ancestor of eukaryotes, eubacteria and archaebacteria. Different scenarios can account for the fact that only two known lineages survived from the lower half of the tree: (A) Random multiple and independent death of lineages (unlikely). (B) Speciation of the early life forms was fundamentally different from that of present day organisms (i.e., there never were many more than the two existing lineages); this scenario is in contradiction to the inferred properties of the last common ancestor. (C) A late, nearly ocean boiling impact destroyed most species living at that time. Following this nearly complete annihilation of life on earth, two surviving extreme thermophilic species in the radiations that accompanyed the colonization of the re-emerging ecological niches gave rise to the now existing eu- and archaebacterial groups. Author (revised by Herner)

A95-63846
CHEMICAL AUTOPOIESIS: SELF-REPLICATING MICELLES AND VESICLES
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In one set of experiments, reverse and aqueous octanoate micelles have been brought to replication by oxidizing octanol with sodium permanganate. In another approach the self-replicating micelles are initially not present in the system, but first created by a simple chemical reaction. For this an aqueous phase containing 3 N NaOH and a supernatant phase of octanoic acid ethyl ester are heated to almost 100 C for several hours. As time progresses the ester molecules are hydrolyzed to octanoate and ethanol. Initially, the rate of hydrolysis is rather slow until the first micelles are formed in the aqueous phase. These micelles are getting self-replicating by taking up ester molecules which are then hydrolysed at the micellar boundary in an autocatalytic process. Recently, we have extended the self-reproduction studies to vesicles since these double-layered structures in water represent more closely models for a minimal cell. At this aim, we have modified the two-phase reaction system to the hydrolysis of octanoic anhydride. As time progresses, anhydride molecules are hydrolyzed, leading to a decrease in the pH of the aqueous phase and to the formation of octanoate molecules which spontaneously assemble into micelles as soon as the critical concentration of micelle formation is reached. The hydrolysis reaction is then accelerated by the presence of micelles, and as a consequence of the continuous drop in pH, the octanoate micelles are transformed into bilayer structures (polydisperse vesicles), as soon as the pH of the aqueous phase is approaching the pK value of octanoic acid in the bilayer (pH-6.8). The vesicles themselves catalyze the hydrolysis reaction, which leads to an increase in the concentration of vesicles, until all anhydride molecules initially present in the system are consumed. Author (Herner)

A95-63847
SPONTANEOUS FORMATION OF HELICAL STRANDS FROM PHOSPHOLIPID-NUCLEOSIDE CONJUGATES AND THEIR REPLICATING SYSTEMS
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A mononucleotide unit covalently linked to hydrophobic groups of phospholipids should be capable of self-assembly in aqueous solution to form helical strands as in the case of DNA and RNA. A great interest in the construction of a superstructure similar to DNA and RNA by self-assembly of the mononucleotide unit has stimulated us to provide phospholipid-nucleoside conjugates such as 5'-phosphatidylnucleosides having two long alkyl chains and a nucleotidyl group in a molecule. 5'-Phosphatidylnucleosides could be enzymatically synthesized from 1, 2-diacyl-sn-glycero 3-phosphocholine and the corresponding nucleoside using Streptomyces phospholipase D. The phospholipid-nucleoside conjugate, dipalmitoyl-5' phosphatidylcytidine, was recently found to spontaneously assemble to form linear and circular helical strands and the phospholipid-deoxynucleoside conjugate, dimyristoyl-5' phosphatidyldeoxycytidine, to form superhelical strands each consisting of a double and double duplex. We concluded that stacking and hydrogen bonding between bases, and hydrophobic interactions between the long alkyl chain moieties of phospholipid-nucleoside conjugates are necessary for the formation of the helical strands. It should thus be possible to construct different types of higher helical structures through a hydrogen bonding and stacking between nucleic acid base moieties of phospholipid-nucleoside conjugates. Dimyristoyl-5' phosphatidylnucleosides with different nucleic acid bases such as adenine, guanine, cytosine, and uracil have already been successfully produced. The spontaneous formation of different helical structures from dimyristoyl-5' phosphatidylnucleosides in alkaline and acidic solution was furthermore examined. Author (revised by Herner)

A95-63848* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STRUCTURE AND FUNCTIONS OF SIMPLE MEMBRANE-WATER INTERFACES
A. POHORILLE NASA. Ames Research Center, Moffett Field, CA, US and M. A. WILSON NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 250-251
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The structure and functions of the earliest ancestors of contemporary cells are focal points in studies of the origin of life. Probably the first cell-like structures were vesicles - closed, spheroidal structures with aqueous medium trapped inside. The membranous walls of vesicles were most likely bilayers composed of simple amphiphilic material available on early earth. The membrane studied was composed of glycerol 1-monooleate (GMO). Glycerol forms the polar head group and the oily tail contains 18 carbon atoms. All head groups have been found to be located in two narrow regions at the interfaces with water. The membrane interior, formed by the hydrophobic tails, is quite fluid with chain disorder increasing towards the center of the bilayer. These results are in agreement with x-ray and neutron scattering data from related bilayers. The width of the membrane is not constant, but fluctuates in time and space. Occasional thinning defects in the membrane, observed during the course of the simulations, may have a significant influence on rates of passive transport of small molecules across membranes. It has been found that water penetrates the head group region but not the oily interior of the membrane. Water molecules near the interface are oriented by dipoles of the head groups. The resulting electrostatic potential across the interface, determined in our simulations, has been found to be markedly larger than across the water-oil interface. This quantity has been implicated as the source of selectivity, with respect to the sign of the charge, as an ion approaches the interface and during transport of hydrophobic ions across membranes. Author (revised by Herner)

A95-63849
MOLECULAR MODELLING OF CELLULAR AND PRECELLULAR MEMBRANE SYSTEMS
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A novel biomembrane lipid bilayer imitation has been built, using new Tartu precision space-filling atomic-molecular models. According to this model, the membrane contains trimeric hexagonal-prismatic lipid units, composing a dynamic honeycomb-like general structure. These units consist of three peripherically placed molecules of fundamental lipids (two-tailed glycero- and sphingolipids) and centrally localized molecules of assistant lipids (sterols, hopanoids, carotinoids, terpenes, etc.) or ice-like water. There are significant differences of biomembrane lipid complexes between archaebacteria and eubacteria+eukaryotes. The archebacterial lipids may be considered more primitive. The relations of these lipids to precellular membrane systems will be discussed. Author (Herner)

A95-63850
A MODEL FOR BIOGENESIS BASED ON THERMOSYNTHESIS
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A biological heat engine could consist of (1) an asymmetric biomembrane in which the surface dipole potential changes with the temperature during a thermotropic phase transition, and (2) an aptly regulated ATPsynthase that charges and discharges the membrane at different H(+)/ATP-stoichiometries. Net ATP is synthesized during thermal cycling around the phase transition temperature. The process is named membrane-associated thermosynthesis (MTS). In the model, the first organisms were essentially heat engines, the required thermal cycling originating from the cells being suspended in a solution subject to convection. MTS evolved as follows: during primeval wet/dry cycling many biochemical (including ribose, the presence of which is postulated) were phosphorylated and/or condensed; the process is named wet/dry thermosynthesis (WDTS). The resulting polymers formed protocells identical to Fox's proteinoid microspheres. Thermal cycling of such protocells during circulation in a convection cell permitted one protein formed by chance, 'pF(sub 1)' (precursor of the F(sub 1) of ATPsynthase) to phosphorylate and/or condense substrates while the protein remained immersed in water. pF(sub 1) used the binding change mechanism to synthesize tightly-bound ATP at one temperature; it released this ATP after unfolding at another temperature. Presence of pF(sub 1) gave a selective advantage to a protocell, as phosphorylation of cell membrane constituents stabilized the cell. The synthesized ATP permitted the synthesis of new proteins, of which a very small fraction were pF(sub 1)s themselves, and permitted, using a synthesized Q(sub beta) replicase-like enzyme, RNA synthesis, which in turn accelerated and directed protein synthesis. By natural selection, RNA was obtained that increased the fraction of pF(sub 1)s in newly synthesized proteins from almost nil to almost 100%: in the process a genetic apparatus and a mRNA coding for pF(sub 1) emerged. pF(sub 1) is assumed to have been the first enzyme, the ancestor of all enzymes; gene duplication and mutation lead to a genome coding for other enzymes that also utilized thermal cycling. Addition of a F(sub 0) protein, capable of translocating a variable amount of protons across the protocell membrane, to the pF(sub 1)-now active as an F(sub 1)-resulted in a membrane-bound ATPsynthase with a variable stoichiometry that permitted MTS.
Author (revised by Herner)

A95-63851
THE FORMATION OF "MINIMAL PROTOCELL": THERMODYNAMICAL AND MECHANICAL ASPECTS
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It is well known that such compounds as long-chain fatty acids and lipids are disposed at the air/water or oil/water interface as monomolecular layer with polar heads oriented in water phase. Lateral mechanical stress of monolayer or/and fluctuations of surface concentration are followed by augmentation of monolayer surface pressure. This pressure, nevertheless, can not exceed some critical level which is named as the pressure of collapse. On the basis of thermodynamic theory it was shown that during the collapse process chemical potential of lipid component of monolayer becomes equal to the same chemical potential of nonstretched bilayer membrane. As the result, when collapse pressure is achived, further subtraction of monolayer is followed by not further augmentation of surface pressure, but formation bilayer ripples directed in subphase. By this way most advantageous contact of polar head with water is reserved, and simultaneously diminution of surface energy of the monolayer by subtraction of its free surface during ripples formation is achived. In conclusion, the formation of closed bilayer membrane systems has very clear physical-chemical reason. It could take place at earliest stages of biogenesis and serve as the basis for the origin of most (or all) biological processes and structures. By this reason it could be in fact the crucial point of 'minimal protocell' (Morowitz et al., 1988) formation, and hence, this system could be the precoursor of contemporal cell. Author (revised by Herner)

A95-63852
EMERGENCE OF BIOLOGICAL FUNCTIONALITY AS CONSEQUENCE OF COOPERATIVE AND COLLECTIVE PHENOMENA IN PROTEINS
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7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 257
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Absence of a formal definition of life, decisive data about its origin and extent make this problem more difficult to solve. Modern knowledge of biological systems generally describe adaptation to the environment over many generations in term of Darwinian natural selection. In 'real-time' the adaptive behavior of ancient living systems may have depended on polymer structures with different degrees of complexity and functionality. We describe how polymerization bias could influence protein subunits to behave collectively and cooperative during assembly. The concept of cooperativity is used here in according to the definition given by Adey (1988) as ways in which components of a macromolecule, or a system of macromolecules, act together to switch from one stable state to another. We suggest protein cooperative phenomena might have been critical during the origin of life, allowing a prebiotic system to become a coherent living system. Coherence is considered a consequence of cooperative phenomena, defined by us as the tuning of a group of subunits (i.e. proteins) yielding a logical (Lahoz-Beltra et al., 1993), consistent and ordered or algorithmic behavior (i.e. tobacco mosaic virus self-assembly) in the system. We propose that the emergence of biological functionality could be a spontaneous consequence of this coherent behavior.

Author (Hemer)

A95-63853
NMR STUDIES ON THE WEAK INTERACTIONS BETWEEN AMINO ACIDS AND NUCLEOTIDES
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Nuclear Magnetic Resonance (NMR) Spectroscopy analysis was employed to investigate the weak interactions of amino acids with nucleotides, the strength of which was quantitatively defined as the association constant that was calculated through the chemical shift change (CSC) data of base protons. The data analysis demonstrated that the interaction of tryptamide, leucinamide and lysine with four 5'-mononucleotides observed the 1:1 complex formation mode. The association affinity of four mononucleotides with tryptamide decreased in the order of G greater than A greater than C greater than U, with leucinamide G greater than C greater than A = U, and with lysine C greater than U greater than G = A. It seemed to indicate that association strength was determined by the combined effects of amino acid-anticodonic preferential interaction and hydrophobic interaction, and may be some other forces. Neither of them was deterministic, at least at the level of monomers. Author (Hemer)

A95-63854 National Aeronautics and Space Administration, Washington, DC.
EVIDENCE THAT THE PROTOCELL WAS ALSO A PROTONEURON
YU BI, ARISTOTEL PAPPELIS, C. STEVEN SIKES, and SIDNEY W. FOX ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 261 Research sponsored by NASA
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A blueprint for a protocell was presented in 1960 (Fox) as a consequence of the newly discovered self-ordering of amino acids and the self-organization of the resultant thermal proteins into cellular structures. The biofunctions of the laboratory protocells (proteinoid microspheres) have since been cataloged; they display roots of many phenomena of modern cells, e.g. synthesis of internucleotide and peptide bonds in aqueous media. These results are inconsistent with a popular assumption that DNA/RNA preceded protein in earliest molecular evolution. The necessity for synthetic research on molecules and cells to 'begin at the beginning' is being realized. Ivanov and Fortsch (1986) have described by analysis how the self-ordering mechanism of amino acids into informed thermal proteins was conserved in evolution from the earliest stage as modern (reverse) mechanisms assumed control. Tyagi and Ponnamperuma (1990) have negated assumptions corollary to DNA/RNA. Ponnamperuma has demonstrated the powerful effect of self-ordering of amino acids in polymerization of aminoacyl nucleotides and the irrelevance of mononucleotide residues. Excitable thermal proteins (Vaughan et al, 1987) are neurotrophic and antiaging when added to cultures of real neurons (Hefti et al, 1991) and are memory enhancers in mice (Fox and Flood, 1992). Proteinoid microspheres of dominant hydrophobic constitution form 'gap junctions', sprout axon-like outgrowths, and form dendritic networks spontaneously. In the latest studies, phenylalanine-rich equimolar proteinoid or the leucine analog (Ishima et al 1981), is found to produce electrical signals for several days when lecithin is included in the assembly with the thermal polymer. Author (revised by Hemer)

A95-63855
NEW EVIDENCE OF THE ANTIQUITY OF LIFE
J. WILLIAM SCHOPF Univ. of California, Los Angeles, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 263-264
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Eleven species of cellularly preserved filamentous microbes, comprising the oldest diverse microbial assemblage now known in the geologic record, have been discovered in shallow water cherts interbedded with lava flows of the Early Archean Apex Basalt of northwestern Western Australia. This prokaryotic assemblage establishes that trichomic cyanobacterium-like microorganisms were extant and both morphologically and taxonomically diverse at least as early as approximately 3,465 million years ago, thus suggesting that oxygen-producing photoautotrophy may have already evolved by this early stage in biotic history. The existence of the Apex microfossils demonstrates that the paleobiologically neglected Archean rock record is a fruitful if largely untapped source of direct evidence regarding the earliest history of life. Like many younger Precambrian and modern filamentous prokaryotes, the Apex filaments are uniseriate and unbranched; exhibit morphologically distinctive (flat, rounded, globose, or conical) end cells; and are composed of spheroidal, disc-shaped, or quadrate medial cells that divided via formation of intracellular partial septations. Several of the Apex taxa are morphologically similar in considerable detail to younger prokaryotic species, both fossil and modern. Although this newly discovered assemblage is more than 1,300 million years older than any other comparable suite of fossil microorganisms now known, it thus seems evident that the Apex microfossils are part of an evolutionary continuum that extends from the Early Archean to the present. Author (Hemer)

A95-63856
EARTH'S EARLY ATMOSPHERE: HOW REDUCING WAS IT?
JAMES F. KASTING Penn State University, University Park, PA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 265-266
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Most recent models of the prebiotic atmosphere suggest that it consisted of a weakly reduced mixture of CO2, N2, and H2O, along with traces of H2, CO, and reduced sulfur gases. This is an acceptable environment for generating formaldehyde (H2CO), but it is not suitable for generating hydrogen cyanide (HCN). Both of these molecules are needed to originate life from organic compounds synthesized within the atmosphere. Perhaps the most plausible mechanism for forming HCN in the prebiotic atmosphere is the one suggested by Zahnle (1986).

Nitrogen atoms formed by dissociative recombination of N2(+) in the ionosphere could have flowed downward and recombined with the by-products of methane photolysis in the lower atmosphere. To make this mechanism work at a reasonable rate, methane must have been present in the lower atmosphere at a concentration of at least several parts per million. Where might this methane have come from? One possible source for methane on the primitive Earth is volcanic outgassing. Today, methane is a negligible component of volcanic gases released either at the surface or from submarine hydrothermal vents. This reflects the generally oxidizing state of the present upper mantle, which has an oxygen fugacity near that of the quartz-fayalite-magnetite (QFM) synthetic buffer. Volcanic gases released from a more reduced mantle would have higher concentrations of methane and other highly reduced gases. In particular, if the oxygen fugacity of the upper mantle was originally near the iron-wustite (IW) buffer, methane might have been a significant component of at least the relatively low-temperature gases emitted from hydrothermal vents. So, the question of interest is: Could the mantle oxygen fugacity have been lower in the past?

Author (Herner)

A95-63857

LIFE IN ISUA TIMES? A FRONTIER REVISITED

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Since the unmetamorphosed geological record fades 3.5 Gyr ago, the oldest Archean sediments bear a metamorphic overprint that blurs, but never completely obliterates, the biogeochemical and paleontological information encoded in these rocks. This holds particularly for the 3.76 Gyr-old Isua metasedimentary suite of West Greenland that preserves the potentially oldest empirical evidence of an involvement of life processes in the exogenic cycle of the ancient Earth. While sedimentological features give unequivocal proof for the presence of an early Archean hydrosphere, and sedimentary carbonate beds attest to the operation of the CO2-HCO3-CO3(2-)-equilibrium system during Isua times, the occurrence in the Isua suite of organic carbon in the form of kerogen and its graphitic derivatives (up to 0.6%) can be best explained as a result of life processes. If allowance is made for a high-temperature isotopic reequilibration between reduced and oxidized (carbonate) carbon under conditions of amphibolite facies metamorphism, the isotopic signature of these organics is decidedly consistent with a biogenic derivation. Therefore, a reasonable case can be made for a biological modulation of the terrestrial carbon cycle since early Archean times, with the ancient carbon isotope record primarily reflecting the isotope-selecting properties of the principal CO2-fixing enzyme of the Calvin cycle (RuBP carboxylase). Ever since Isua times, carbon transformations in the Earth's exogenic system have, accordingly, proceeded in the form of a biogeochemical cycle comprising an organic (reduced) and an inorganic (oxidized) carbon branch. The occurrence in the Isua suite of sedimentary apatite as a potential "biomarker" mineral has been interpreted as indirect evidence of microbial life in the primary depositional and/or diagenetic environments of the Isua sediments. Author (revised by Herner)

A95-63858

CHROOCOCCIDIOPSIS, THE MOST PRIMITIVE LIVING CYANOBACTERIUM?

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Cyanobacteria are an ancient group of organisms; their modern representatives are the product of an evolutionary process over 3 billion years long. In the course of this process, some present-day cyanobacteria have undergone more profound evolutionary changes than others, and the question of the 'most primitive' cyanobacterial type is a tempting problem. Morphology, given the limited range of complexity in cyanobacteria, is not a reliable guide to phylogenetic relationships. Biochemical characteristics in cyanobacteria are also remarkably uniform, but ecological characters may be more revealing. Schopf (1992), in commenting on the nature of Proterozoic evolution, highlights three ecological characteristics of cyanobacteria: they are (1) 'unexcelled ecologic generalists,' (2) neither fast growers nor the most prolific reproducers, and (3) at disadvantage in competition with eukaryotes. Among living cyanobacteria, the coccoid genus Chroococcidiopsis seems to fit best Schopf's postulates for a 'primitive' Proterozoic cyanobacterium. The morphology and development of Chroococcidiopsis are variable and, compared with the strictly geometric structure of some cyanobacteria, appear undefined and undifferentiated. This lack of definition is arguably a primitive character, and strictly defined types with a rigid geometry probably represent more specialized and derived forms, presumably an expression of narrower ecological adaptation. There are indications in the fossil record that Chroococcidiopsis was common on Proterozoic earth. Several Proterozoic fossil taxa of solitary or colonial coccoid forms fall within the range of morphological variability of Modern Chroococcidiopsis. Its unparalleled environmental versatility, low growth rate, lack of competitive vigor, lack of N-fixing ability, and undifferentiated morphology, supported by the fossil record, indicate that Chroococcidiopsis is a phylogenetically primitive cyanobacterium, possibly the most primitive living representative of this group. Author (revised by Herner)

A95-63861

NITROGEN ISOTOPIC COMPOSITION OF ORGANIC MATTER: CHEMICAL FOSSILS IN PRECAMBRIAN CHERTS

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Stable nitrogen isotope compositions have been investigated in kerogen from Precambrian rocks. Because of experimental difficulties, few nitrogen analyses have been published. Part of the problem is that relatively unaltered and syngenetic kerogen appears to be rare; however one rock type for which the organic matter may be reliable is chert (Kolodny & Epstein, 1976). In addition, the state of preservation of cherts can be checked via their bulk oxygen isotopic compositions (Robert, 1988). Working with carefully selected Archean and Proterozoic chert samples, we concentrated the acid-insoluble organic matter by an HF-HCl treatment. The carbon isotopic compositions of these resulting residues (delta C-13 = -31.3%) are typical of preserved Precambrian kerogen. Preliminary analysis of the residues of early Archean cherts (i.e. 3.5 Ga) yielded delta N-15 values from -4 to +8%. This scattering of the values is similar to modern marine sedimentary organic matter. However the rather common negative delta N-15 values (less than or equal to -2%) which are rare in modern ecosystems, could be an evidence of changes in the relative contribution of biological processes involving nitrogen. In modern ecosystems, the nitrogen isotopic composition is buffered by the atmospheric reservoir and N2 fixing organisms furnish biological nitrogen with delta N-15 values close to the atmospheric value (-2 to +2%). Further fractionation leading to higher delta N-15 values is principally controlled by the availability of oxygen in the marine environment. In this respect, the similarity of the Precambrian and modern organic matter nitrogen isotopic compositions suggests that the ecosystem complexity recognised for the modern biological nitrogen cycle were established at a very early stage in Earth's history. Author (revised by Herner)

A95-63862* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MAGNETITE: WHAT IT REVEALS ABOUT THE ORIGIN OF THE BANDED IRON FORMATIONS
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Magnetite, Fe3O4 is produced abiotically and biotically. Abiotically, magnetite is a late magmatic mineral and forms as a consequence of the cooling of iron rich magma. Biotically, magnetite is produced by several organisms, including magnetotactic bacteria. Hematite, Fe2O3, is also produced abiotically and biotically. Abiotically, hematite rarely occurs as a primary mineral in igneous rocks, but is common as an alteration product, fumarole deposit, and in some metamorphosed Fe-rich rocks. Biotically, hematite is produced by several types of microorganisms. Biologically-produced magnetite and hematite are formed under the control of the host organism, and consequently, have characteristics not found in abiotically produced magnetite and hematite crystals. To determine if the magnetite and hematite in the Banded Iron Formation was biologically or abiotically produced, the characteristics of biologically-produced magnetite and hematite (concentrated from Aquaspirillum magnetotacticum) and abiotically-produced magnetite and hematite obtained from Wards Scientific Supply Company, were compared with characteristics of magnetite and hematite concentrated from the Gunflint Banded Iron Formation (Ontario, Canada) using thermal and crystallographic analytical techniques. Whole rock analysis of the Gunflint Banded Iron Formation by x-ray diffraction (XRD) and differential thermal analysis (DTA) revealed the presence of quartz, hematite, siderite and dolomite as the major minerals, and magnetite, greenalite, pyrite, pyrrhotite and apatite as the minor minerals. Analysis of a crude magnetic fraction of the Gunflint showed the minerals quartz, hematite, siderite, dolomite, and magnetite. Analysis of the crude magnetic fraction from Aquaspirillum magnetotacticum revealed organic compounds plus hematite and magnetite. The mineral identification and particle size distribution data obtained from the DTA along with XRD data indicate that the magnetite and hematite from the Gunflint BIF share some similarities with biologically formed magnetite and hematite.

Author (revised by Herner)

A95-63863
BIOCHEMICAL MARKERS IN PRECAMBRIAN SEDIMENTS - INDIAN SUBCONTINENT
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Studies on some ancient rock samples from Southern India have revealed the presence of microbiota. It was therefore of interest to explore the presence of biochemical remains in such rock samples. Precambrian samples from the Cuddapah and Sandur Basins of India with an age of 1.5 Ga were analaysed. These were supplied by National Geophysical Research Institute (NGRI), Hyderabad. Of the nine samples examined, none of them showed the presenced of extractable organics on Gas Chromatography. However, kerogenic residues obtained from these after exhaustive acid treatment were submitted to elemental analysis. Of these, four samples gave a high percentage of C and an H/C ratio which warranted further investigation. These were subjected to pyrolysis combined with Gas Chromatography, Gas Chromatography - Mass Spectrometry and X-ray diffraction studies. The absence of any identifiable organic components from pyrolysis GC and GC-MS examination indicated virtually complete graphitization of these samples. The X-ray diffraction patterns were identical to standard graphite samples thus confirming the observation of nearly complete graphitization of carbon material in 4 samples examined in detail.

Author (Herner)

A95-63864
STROMATOLITC MICROBIAL MATS IN PERENNIALLY ICE-COVERED ANTARCTIC LAKES
ROBERT A. WHARTON, JR. Desert Research Institute, Reno, NV, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 281-282

Stromatolitic microbial mats composed primarily of bacteria, cyanobacteria, and eukaryotic algae are found in the cold, dimly-lit, perennially ice-covered lakes of the McMurdo Dry Valleys in southern Victoria Land, Antarctica (77 deg 32 min to 77 deg 43 min S 161 deg 33 min to 163 deg 7 min E). Four mat morphologies have been reported: prostrate, lift-off, columnar, and pinnacle. The morphology of a particular mat results from a combination of biological, geochemical, and sedimentological processes, some of which may be unique to the ice-covered antarctic lakes. The mats are trapping and binding sediment, precipitating minerals, and remaining undisturbed on the lake bottom forming laminated, organosedimentary structures. Using the definition of Awramik et al. (1976), these structures can be classified as modern stromatolites. The discovery of modern stromatolitic microbial mats in the lakes of Antarctica may provide a new approach for understanding the distant past. As pointed out by Walter and Bauld (1983), there has been a misconception that Precambrian stromatolites and their associated carbonates, sulphates and chloride evaporites were formed in warm climates. It is well known that several periods of major glaciation occurred during the Precambrian. Based upon studies in the cold antarctic lakes, it is apparent that stromatolites, carbonates, and various evaporites may be components of frigid lake facies, and do not necessarily reflect warm climates. Studies of antarctic microbial mats and their development into stromatolites may play an important role in the reinterpretation of stromatolite occurrence in Precambrian polar environments.

Author (revised by Herner)

A95-63865
REVIVAL OF THE CONCEPT OF COLD PREHISTORY OF LIFE
VITALII I. GOLDANSKII Russian Academy of Sciences, Moscow, Russia ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 283

The extraterrestrial scenario of the origin of life suggested by Svante Arrhenius (1908) as the 'panspermia' hypothesis was revived by the discovery of low-temperature quantum limit of a chemical reaction rate (1973). Entropy factors play no role near absolute zero, and show molecular tunneling can lead to the exothermic formation of quite complex molecules. Interstellar grains or particles of cometary tails could serve as possible cold seeds of life, with acetic acid, urea and products of their polycondensation as quasiequilibrium intermediates. The scenario of the origin of life should consider the appearance of typical feature of living species - chiral purity of their amino acids and sugars. Very cold solid environment hinders tunneling racemization under the conditions typical for outer space. However the decisive problem of the origin of chiral purity of Earth's biosphere is the mechanism of spontaneous breaking of mirror symmetry rather than the search for some 'advantage factors' which can promote gradual accumulation of enantiomeric excess. An extraterrestrial (cold, solid phase) scenario of the origin of life seems to be more promising from that point of view than terrestrial (warm) scenarios. In connection with the scheme of five main stages of prebiological evolution there

are a number of important problems which require further detailed discussion. Author (revised by Herner)

A95-63866
DID THE VERY FIRST SELF-REPLICATING CHEMICAL SYSTEMS NEED HOMOCHIRALITY?
ANDRE BRACK CNRS, Orleans, France ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 284-285
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Amino acids were most likely available on the primitive Earth from a reducing atmosphere or/and hydrothermal vents. Import of extraterrestrial amino acids via cometary and meteoritic grains may represent an alternative supply. They can be selectively condensed in liquid water. When hydrophobic and hydrophilic amino acids alternate within the same chain, stereoselective and thermostable beta-pleated sheet structures are formed made exclusively of homochiral strands. Polycationic alternating peptides strongly accelerate the hydrolysis of oligoribonucleotides. The chemical activity is directly related to the beta-sheet geometry, thus to homochirality. Such a behavior suggests that early peptides already required homochirality to display an efficient structure-function relationship. The prebiotic synthesis of informative molecules based on nucleotide or nucleotide analogs appears to be too difficult to be considered as primitive. The formation of oligonucleotides is much more efficient in the presence of a performed polynucleotide acting as a matrix. However, in template-directed condensation of racemic nucleotides, monomers of the opposite handedness to the template are incorporated and inhibit the polymerization reaction. Chemists have failed to demonstrate that accumulation of substancial amounts of oligonucleotides has a counterpart in prebiotic reality. They are more and more convinced that the first living systems did not arise as a cell-like system or even as an RNA system but as a simple self-sustaining chemical system able to undergo self-replication, mutation and selection. If the first replicator did not use oligonucleotides or peptides, then homochirality was perhaps not needed at that time. For instance, life started perhaps with mutating autocatalytic chemical systems using racemic molecules. Such autocatalytic sytems could have generated homochiral molecules through random fluctuations.
Author (revised by Herner)

A95-63867
AMINO ACID STEREOCHEMISTRY IN COSMOGEOCHEMICAL SAMPLES AND THE ORIGIN OF AMINO ACID CHIRALITY ON EARTH
JEFFREY L. BADA Univ. of California at San Diego, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 286, 288
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It is not known whether the origin of amino acid chirality in living organisms took place before or after the origin of life on Earth. In fact, whether the first self-replicating systems even required amino acids in unknown. Amino acid chirality is important because proteins cannot fold into bioactive configurations such as the alpha-helix if the amino acids are racemic. Enzymes could not have been efficient catalysts in early organisms if they were composed of racemic amino acids. Most recent scenarios concerning the origin of amino acid chirality have focused on chiral enrichment and amplification processes favoring the L-amino acids which took place before the origin of life. Any prebiotic amino acid chiral resolution process faces the severe problem of maintaining chirality because of racemization. Racemic amino acids probably existed on the prebiotic Earth. It is likely that only after biotic protein synthesis become an efficient process in the evolution of early life could the chirality of amino acids be maintained in proteins. Thus, instead of amino acid chirality proceeding the origin of life, it only developed after life was well established and possibly was closely associated with the origin of protein biosynthesis. As to why the protein amino acids today consist of only the L-enantiomers, it is likely simply a matter of chance. Life based on D-amino acids would function just as effectively as the L-amino acid system on which life is now based. However, D- and L-amino acid based systems operating simultaneously would be redundant and require duplicate and separate sets of mRNA and enzymes. During the evolution of early life on Earth, this redundance was eliminated and the L-amino acid based system eventually dominated.
Author (revised by Herner)

A95-63868
CHIRALITY, COSMOCHEMISTRY AND LIFE
WILLIAM A. BONNER Stanford University, Stanford, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 287
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The important biopolymers are made up of monomer units having unique chiralities, with L-amino acid units in proteins and D-sugar units in DNA and RNA. These biopolymers are also homochiral, i.e., they contain none of the 'unnatural' enantiomeric monomers. It is now believed that such homochirality is necessary for efficient self-replication, and that the enantiomeric homogeneity of monomers was essential for the development of self-replicating prebiotic polymers. While thus crucial, the prebiotic origin of chirality is generally ignored in theories of the origin of life, even though considerable experimental and theoretical effort has been devoted to the subject. While certain amplification mechanisms appear viable, a critical evolution of the theories and experiments involving terrestrial mechanisms for the origin of chiral molecules suggests these mechanisms all to be either intrinsically impossible or highly improbable in the chaotic and turbulent environment of Earth's ca. 0.9 Gyr prebiotic era. To circumvent these difficulties we have suggested an extraterrestrial scenario for the production of chiral molecules. We propose that circularly polarized ultraviolet synchrotron radiation from the neutron star remnants of supernovae interacts with the organic mantles on interstellar grains in molecular clouds, thus producing chiral molecules of low e.e. in the mantles by partial asymmetric photolysis of racemic mantle constituents. Earth subsequently captures these grains with their chiral molecules during passage of the Solar System through the clouds, or by prior coalescence of the grains into comets or asteroids, which ultimately collide with Earth. Author (revised by Herner)

A95-63869
SETTING THE STAGE FOR THE EMERGENCE OF THE CONFIGURATIONALLY ONE-SIDED BIOSPHERE
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Because we wanted to extend our earlier studies of peptide stereoselectivity to an experimental model which would simulate the ribosomal process, we chose amino acid esters of ethylene glycol to represent the aminoacyl adenylate terminus of tRNA. But first it was necessary to determine which of the two mechanisms, PATHWAY A or PATHWAY B actually represented the ribosomal process, for both mechanisms satisfied the experimental evidence, which required the presence of the 2'-hydroxyl group in the peptidyl-tRNA terminus. The evidence indicating the incorrectness of PATHWAY A rested upon the observation that the intramolecular ester aminolysis was found experimentally to be so difficult to achieve that its reality in ribosomal peptide synthesis is extremely unlikely. On the other hand, the intermolecular process which represented PATHWAY B, occurred rapidly. While the function of the essential 2'-hydroxyl group of the adenylate-tRNA terminus is not that depicted in PATHWAY A, additional kinetic studies carried out in this laboratory on the series of substrates represented by 3 (X = H, a; OH, b; OMe, c; and F, d) indicates that the purpose of the 2'-hydroxyl group is at least to

provide an electronic effect which contributes to the observed fast rate of ribosomal peptide elongation. Author (revised by Herner)

A95-63870
ELECTROWEAK ENANTIOSELECTION AND THE ORIGIN OF LIFE
ALEXANDRA J. MACDERMOTT Oxford Brookes Univ., Oxford, England ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 291

A homochiral pre-biotic chemistry is increasingly viewed as a pre-condition for life because polymerization to form long-chain biopolymers proceeds efficiently only in optically pure monomer solutions. We argue here that the weak force is probably the only universal truly chiral influence that could provide the necessary symmetry-breaking. The weak force, mediated by the Z boson, is the only one of the four forces that can distinguish left and right. It produces a slight energy difference between left and right-handed molecules called the parity-violating energy difference or 'PVED'. This results in a slight enantiomeric excess, typically about 10(exp -17), of the more stable enantiomer, which can be amplified to homochirality through preferential crystallization (Yamagata mechanism) or autocatalytic reactions (Kondepudi mechanism). Kondepudi has estimated that typical PVEDs of 10(exp -17) kT can be amplified in just 10(exp 4) years - relatively fast on an evolutionary timescale. We argue that thiosubstituted ancestral replicators are highly plausible and would greatly facilitate attainment of the homochirality which appears necessary for life to emerge. New results on the effect of the DNA bases are presented. L-quartz is PVED-stabilized by 10(exp -17) kT per SiO2 unit, which reproduces the reported 1% excess of L-quartz in nature. This chiral bias could be transferred to biology by surface catalysis, resulting - through the 1% enantioselectivity of L-amino acid absorption on the 1% excess of L-quartz - in an enantiomeric excess of 10(exp -4) which is much more easily amplified than the 10(exp -17) excess from the PVED of individual molecules. Chiral 'buckyballs' could provide an extraterrestrial enantioselective surface, and we present some new computations of their PVED. Author (revised by Herner)

A95-63871
CAN BIOLOGICAL HOMOCHIRALITY RESULT FROM A PHASE TRANSITION?
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The origin of homochirality of biological molecules has been a constant problem since this phenomenon was unraveled by Pasteur. Recently, Salam (1991) proposed that, due to the attractive character of the parity violating force in electro-weak interactions, a phase transition at low temperature could eventually lead to enantiomeric purity. A simple signature for this process would then be obtained if an optically inactive sample turned into an active one when the temperature is lowered sufficiently. A series of experimental tests has been undertaken this year in Lyon: our first measurements indicated no sizeable change in the optical activity of cystine molecules down to the liquid helium temperature. This negative result suggests that the homochirality of biomolecules is not directly obtained when cooling a racemic mixture as we did to reproduce simply the plausible conditions in space. The tunneling effect at the root of the chirality change is a reality however, and the discussion must bear on the effectiveness of its enhancement: the excess of one enantiomer population over the other being of the order of 10(exp -17) in normal conditions, how can this minuscule amount be transformed into a measurable one? The proposed phase transition implies collective phenomena which might overcome the potential barrier, but its parameters are completely unknown. Author (revised by Herner)

A95-63872
ON THE POSSIBLE PATHS OF OPTICAL (PHOTOCHEMICAL) ACTIVATION OF LIVING MATTER
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The origin of optical activity in Nature remains one of important question of problem of origin of life. Up to now we know several paths of optical activation of organic substances. That are: (1) Fluctuations from exact equality in enantiomers during reactions; (2) Inequivalence due to violence of symmetry in weak interactions of free energies of both enantiomers that automatically results in predomination of one of enantiomers of product especially in reactions connecting with the amplification of asymmetric effect; (3) Kinetical splitting of racemate and asymmetric synthesis under action of elemental particles, circular polarized light, selective adsorption and asymmetric catalysis on inorganic and organic matrixes (liquid crystals etc.), dissymmetric catalysts with chiral ligands. We studied experimentally two cases. It was shown the revealing of induced circular dichroism in system; chiral matrix 'Tween-80' (polyoxyethylene-sorbitanmonooleate, n = 20, MW 1300) as liquid crystal mesophase and anthracene resulting induced circular dichroism effect at 360-380nm. Then we have found that cholesteryltridecanoate liquid crystal mesophase induces Cotton effect in system: (RhCl (PPh3)3) -acetylaminocinnamic acid - hydrogen and results in (S)-acetylphenylalanine only in the range 62-64 C -the temperature interval of stability of chiral mesophase. These experiments show the possibilities of optical activation of organic substances by means of contacts with chiral matrixes. Author (Herner)

A95-63873
TAXONOMY AND PHILOGENY: PALAEOMYCOLOGY
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The objective of this work is to approach the study of the evolution and philogeny of fungi on the basis of their distinctive characteristics for adapting to the habitat in wich they develop, in addition to the characteristics features of molds and yeasts. Fungi fossils have been taxonomically acknowledged because of the sufix '-ites' used in their nomenclature. Ibrahim (1933) grouped the Paleozoic species under the category of Sporonites. However, the name Solerotinites was adopted after the Petrology Conference of 1951. Van der Hammen distinguished several types of shapes among the fungi fossils according to the number of cells per spore, and the number and position of spores. This system was accepted by Clark in 1965. In 1976, Elsik divided fungi fossils into two main categories of shapes: Fungi sporse dispersae and Mycelia sterilia. The first included the Sporae, Monocellae, Monodicellae and Dicellae Families; while the second included the Cellae, Hyphae, Peltae and Indeterminatae families. Lutrell (1973) mentioned the Locuascomycetes Class, which included the species of the Phragmothyrites genus. Certain authors have stressed the fundamental need to relate fungi fossils to present-day fungi in order to classify them. According to Smith, they must be classified on the basis of their physical appearance, shape and size, and given a generic category according to the present binomial system of nomenclature. In the case of fungi fossils, it is almost impossible to determine the age of the conidii, which makes the classification of the fungus into a particular type difficult. Author (revised by Herner)

A95-63874
URANIUM DEPOSITS AND THE ORIGIN OF LIFE
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The hypothesis I propose is that the existing U-deposits in the remote past were the most favorable environments for the occurrence of life or, at least, to cause to shift to the right. Uranium of the remote past possessed an enrichment, r, in the fissionable isotope U-235 significantly greater than the actual. This explains the phenomenon of Oklo (Gabon), a U-deposits which behaved as a nuclear reactor 1.8 x 10(exp 9) years ago, and was in operation for 6 x 10(exp 5) years. The other deposits spread throughout the planet should certainly have behaved, at least, as subcritical assembles, due to the neutron sources in the deposits (reactions (alpha, n) with light elements in the ore; spontaneous fission of the U-238 and, specially, neutrons from cosmic radiation). It is very probable that the water worked as control element, as other alternatives are much less likely to occur, let's see what the mechanism could have been. Starting with a determined value of K, we are going to see how the system is stable (irrespective if K less than 1 or K greater than 1). In fact, actually if K increased, the released heat would also increase, with the result of some water being evaporated and/or migrated, thus worsening the moderation (submoderate system), which would then lessen K. The released heat would also decrease, condensing and/or returning the water to its original place, which, by improving the moderation, would cause the value of K to rise. In this way, there would be a series of oscillations round the initial value. Radioactivity and nuclear fission supplied the necessary energy for the diverse reactions involved in the chemical evolution. The radiation field favoured the abiotic synthesis of monomers by ionizing the molecules of the primitive atmosphere. The multiplicative systems, subcritical or critical, provided the alternation of dry and wet periods for the synthesis of proteins. Perhaps, radiation helped the diversification of the most evolutioned molecules. Consequently, it seems reasonable to assume that these environments were suitable for the origin of life, although they were possibly not the only ones. Perhaps the most significant feature of presently known U-deposits is their association with precambrian rocks, which is where most microfossils know till now have been found.

Author (revised by Herner)

A95-63875
SILICA BIOMORPHS: AN ALTERNATIVE EXPLANATION OF SOME PUTATIVE PRECAMBRIAN MICROFOSSILS
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I propose silica biomorphs as a plausible alternative interpretation when deciphering the biogenicity of the putative Precambrian microbiota. Silica biomorphs are inorganic self-organized precipitates made of a metal silicate hydrate membrane that show an amazing morphological convergence with living organisms within the range of size from micron to millimetre. Its formation is unavoidable under the physico-chemical conditions assumed to produce the chemical precipitation of Precambrian chert precursors, which are the rocks where most of Precambrian microfossils are preserved. The silica biomorphs alternative to Precambrian microstructures will be evaluate considering the following points: Geochemical conditions leading to the formation of Precambrian chert precursors and the formation of silica biomorphs; explanation of highly complex Precambrian structures and the general morphogenetical processes working in the formation of silica biomorphs; explanation of the hollow character of the Precambrian microstructures; cellular elaboration and chemical composition of silica biomorphs and the plausibility of an organic-rich silica gel; size and size distribution of silica biomorphs; and conditions for laminar arrangement of silica biomorphs and Precambrian microbiota.

Author (revised by Herner)

A95-63876
INHIBITION OF AMINO ACID METABOLIC ENZYMES BY ALPHA-AMINOISOBUTYRIC ACID
GENE D. MCDONALD Univ. of California at San Diego, La Jolla, CA, US and JEFFREY L. BADA Univ. of California at San Diego, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 301-302

Alpha-aminoisobutyric acid (AIB) is one of the major amino acids in carbonaceous chondrites and has been identified in early Earth spark discharge experiments. In addition, AIB has been detected in Cretaceous-Tertiary boundary sediments, indicating that it can be supplied to the Earth by bolide impacts although in limited amounts. On the early Earth, interplanetary dust particles may have been an important extraterrestrial source of organics such as AIB. Thus, it is reasonable to assume that AIB was a component of the organic material on the early Earth both before and after the origin of life. We have measured the inhibition by AIB of the activity of the L- and D-amino acid oxidases (AAO) toward L- and D-alanine. The results indicate that AIB inhibits amino acid oxidases when the AIB/Ala ratio is significantly greater than 1. Marked inhibition of L-AAO is observed at high AIB/L-Ala ratios, while only minor inhibition of D-AAO is observed even at high AIB/D-Ala ratios. The inhibition of amino acid metabolic enzymes by AIB suggests that sufficiently large AIB concentrations in the environment might reduce the efficiency of amino acid metabolism. This inhibition could be especially pronounced immediately following impact delivery of AIB, and could play a role in organismic survivability in a global impact scenario. The greater AIB inhibition of L-AAO relative to D-AAO suggests that in a system where both enzymes are present along with an initially racemic mixture of alanine, progressive enrichment in the L-enantiomer would occur. If proto-amino acid oxidases were present in primitive biological systems prior to the exclusive use of L-amino acids, this differential inhibition could have produced an enrichment in the L-enantiomers of at least some amino acids.

Author (revised by Herner)

A95-63877
POSSIBILITIES OF SPONTANEOUS GENERATION OF OPTICAL (PHOTOCHEMICAL) ACTIVITY THROUGH AUTOCATALYSIS
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Few experiments have shown a spontaneous generation of optically active compounds in laboratory, which could elucidate the evolution of an homo-chiral biosphere which we experience today on Earth. In this paper we want to present a novel approach to the problem that makes use of an autocatalytically proceeding mechanism in an homogeneous phase. To this aim we investigate the behavior of the tetralin system which is oxidized in an autocatalytical way via radical active intermediates of the hydroperoxytetralin compound in solution, yielding ultimately chiral alpha-tetralol. In the first attempts we did not succeed in getting the desired optically active end product in experiments performed in our laboratory, however we could show in a systematic computer simulation study that the system is principally capable to produce the desired result, given that very specific constraints are well defined and pre-set accordingly. The main constraint lies in the high degree of stereospecificity, which must exceed values of at least 95%, i.e. preserving the chiral information through the various intermediate stereospecific chemical reactions involved.

Author (Herner)

A95-63878
DEVELOPMENT AND DIVERSIFICATION OF THE LAST UNIVERSAL ANCESTOR
ARTHUR L. KOCH Indiana University, Bloomington, IN, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 304

The majority of evolutionary steps in the development of basic cellular processes took place in the time interval after the 'First Cell' arose until the time of the 'Last Universal Ancestor'. During this period life evolved in a monophyletic way in which no stable diversity arose; i.e., although side branches developed, only one branch survived because of simple 'survival of the fittest'. The myriad of enzymes and processes developed in this time interval can be grouped in eight qualitatively different categories. In many case, the evolution of a particular gene was dependent on the concomitant improvement of the cellular machinery generally, including developments in other categories. Eventually several individuals arose (the immediate descendants of the Last Universal Ancestor) that made stable diversity possible because they developed alternative non-competing strategies. These diverse strategies subsequently led to eubacteria, archaebacteria, and eukaryotes (and viruses, plasmids, etc.). This paper considers the evolutionary developments in this monophyletic epoch. It depends on three assertions: firstly, that there is no trivial spontaneous mechanism for the introduction of polynucleotides into a living cell and thus transfer of genes from organism to organism did not occur; secondly, that the number of accessible habitats and niches was very limited; and thirdly, that the major factor that led to stable diversity was the development of two radically different and independent solutions to the problem of overcoming cellular osmotic stress. Sufficient osmotic pressure could create a high turgor pressure and destructive tension in the wall.
Author (Herner)

A95-63879
EVOLUTION OF BIOSYNTHESIS OF HYDROPHOBIC AMINO ACIDS
ANTHONY D. KEEFE Univ. of California, San Diego, La Jolla, CA, US and STANLEY L. MILLER Univ. of California, San Diego, La Jolla, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 305-306

Horowitz (1945) proposed that biosynthetic pathways arose by the backwards development of the contemporary biosynthetic pathways, utilizing organic compounds available from the prebiotic environment. As a compound was depleted from the environment, organisms which acquired the capability of synthesizing it from its immediate precursor would gain a competitive advantage. Therefore biochemical pathways evolved backwards in a stepwise fashion. This hypothesis cannot apply to the hydrophobic amino acids valine, isoleucine and leucine because their biosynthetic precursors are unstable, e.g. alpha-acetolactate decarboxylates readily. Also, acetolactate mutase, which converts alpha-acetolactate to alpha, beta-dihydroxyisovalerate by a pinacol-type rearrangement, is unlikely to be an early enzyme. An alternative approach is to examine the degraditive pathways of the hydrophobic amino acids where the Horowitz principle could equally apply. The next step is a transamination or a reductive amination to the amino acid. This pathway is used by some bacteria for isoleucine synthesis from alpha-methylbutyric acid (Robinson et al., 1969). If the fatty acid synthesis and degraditive pathways were developed early, then n-valeric, n-butyric and propionic acids might have been depleted early from the environment. This would have prevented the synthesis of norleucine, norvaline and alpha-amino-n-butyric acid by the reductive carboxylation process. This might account for the absence of these straight chain amino acids from proteins. The aromatic amino acids phenylalanine, tyrosine, tryptophan and histidine may have first been synthesized by this reductive carboxylation pathway from phenyl acetic acid, 4-hydroxyphenyl acetic acid, indole acetic acid and imidazole acetic acid. These precursors may have been available in the prebiotic environment. Some modern bacteria synthesize phenylalanine, and tyrosine by this pathway (Sauer et al. 1975). Once these precursors were exhausted from the environment the development of the complex shikimic acid aromatic biosynthetic pathway would have been necessary.
Author (revised by Herner)

A95-63880
THE EARLY EVOLUTION OF METABOLIC PATHWAYS
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Both sequence analysis and experimental studies on enzyme substrate specificity support the patchwork assembly of at least some primordial metabolic pathways. Evidence of the patchwork assembly of metabolic pathways is provided by a number of reports showing that (a) the two different carbamoyl transferases involved in the biosynthesis of arginine and pyrimidines are homologous (Van Vliet et al., 1984); (b) the cubacterial flavin-dependent acetohydroxy acid synthase and pyruvate oxidase have evolved from a common ancestor (Chang and Cronan, 1988); (c) site-specific amino acid substitution experiments can change a NAD-dependent lactate dehydrogenase into a specific, highly active malate dehydrogenase (Wilks et al., 1988); and (d) experiments on the lack of high levels of substrate discrimination in polymerases (Lazcano et al., 1992). Results on the monophylogenetic analysis of amide transferases involved in different anabolic routes such as tryptophan and folate biosynthesis will also be presented, which suggest that 'subunit shuffling' in the evolution of oligomeric enzymes has also taken place. The available evidence suggests that although exon shuffling has played an important role in the emergence of enzymes endowed with novel catalytic abilities, gene duplication events followed by a gradual neoDarwinian accumulation of mutations and other minute genetic changes also led to the narrowing and modification of enzyme function.
Author (revised by Herner)

A95-63881
DIRECTED EVOLUTION OF NOVEL BIOSYNTHETIC PATHWAYS TO PROLINE
JOHN D. SUTHERLAND The Dyson Perrins Laboratory, Oxford, UK, ESTHER J. WILSON The Dyson Perrins Laboratory, Oxford, UK, and MARTIN C. WRIGHT The Dyson Perrins Laboratory, Oxford, UK ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 309-310

Retroevolution, as described by Horowitz, bears a striking resemblance to the approach of retrosynthetic analysis used by organic chemists (complex molecules are broken up by a series of disconnections yielding simpler precursors). Applied to an appropriate auxotrophic strain, a biosynthetic pathway could be built up in the reverse direction by repeated mutagenesis and growth on successive chemical precursors. Given such a scheme, the theories of Jensen and Ycas would predict a background growth on each of the percursors without mutagenesis and subsequent improvement by gene doubling and mutagenesis. We have recently initiated an experimental program aimed at simulating an early evolutionary agenda and investigating the ways in which biosynthetic pathways evolve in the laboratory. We have selected proline as a biosynthetic target and proline auxotrophs of Escherichia coli as models for a primitive organism. To mimic the scenario of gene amplification and mutagenesis, we have constructed strains which carry the highly mutagenic mut D5 allele and harbor a high copy number plasmid library of the host chromosome.
Author (Herner)

A95-63882
EARLY GENE DUPLICATION AND THE ORIGIN OF BIOCHEMICAL REGULATION
E. HILARIO Univ. of Connecticut, Storrs, CT, US, J. P. GOGARTEN Univ. of Connecticut, Storrs, CT, US, A. SOSA-PEINADO UNAM, Mexico, E. SILVA UNAM, Mexico, and A. LAZCANO UNAM, Mexico ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 311-312

Although the nature of the first biological catalysts is a matter of debate, it is has been argued that the first proteinic enzymes were endowed with broad substrate specificity and lacked regulatory mechanisms. The diversity of regulatory and control mechanisms found in different but closely related microbial lineages suggests that many of them may be of polyphyletic origin. However, the universal distribution of some regulatory processes among eubacteria, archaebacteria and the eukaryotic nucleocytoplasm, implies that some of these control mechanisms had a single origin that predated the evolutionary divergence of the last common ancestor into the three extant cellular lineages. Enzymes having a single catalytic site usually follow Michaelis-Menten kinetics. However, the interactions between metabolic pathways and the homeostasis of key metabolites requires enzymes whose activity rapidly increases only above a certain substrate concentration. This sigmoid substrate dependence is due to cooperativity between multiple substrate binding sites. In many cases these binding sites are located in different subunits; the interacting subunits can be either identical to each other (homomers), or they can be different from each other (heteromers). In the latter case, these subunits are often paralogous to each other (hemoglobin family, lactate dehydrogenase, F-ATPases and homologues, etc.). Initially the duplication of a gene encoding a homomultimeric enzyme might convey a selective advantage because of the need of large amounts of the encoded product. If the duplicated genes escape gene conversion mechanisms, they begin to rapidly accumulate sequence differences (Ohta, 1991). An extreme case is exemplified by the alpha subunit of F-ATPases. One of the paralogous subunits lost its catalytic activity and turned into a regulatory subunit that influences the kinetic mechanism; however, this non-catalytic subunit still retains substrate binding ability and cooperativity for catalysis. How other different regulatory mechanisms evolved is still an open question that deserves further investigation.

Author (revised by Herner)

A95-63883
THE ROLE OF ACCURACY FOR EARLY COOPERATIVE STAGES OF THE ORIGIN OF LIFE
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It is normally believed that the path to living organisms started by the occurrence of some polymers with the possibilities of self-reproduction. At this stage there was no cooperation, but the polymers used the same monomers. This gave a possibility of selection, and it is clear at that stage that polymers with high reproduction rate and low decay rate are favored. There is a well-defined 'fitness measure' for this stage, and the evolution is purely Darwinian with simple selection rules. The effect of accuracy in the polymer synthesis in this stage has been thoroughly investigated by Swetina and Schuster (1982). What is important here is that the main effect of accuracy is to limit the possibility of complexity and of attaining any considerable length. The system can not within itself be destroyed by errors in replication, although errors may make the system susceptible to the change of external influences. There are essentially two severe effects that also may be combined. One is the parasite effect: by errors (mutations) in reproduction. An efficient polymer with catalytic properties may give rise to an erroneous one that lacks the catalytic activity but can be efficiently reproduced by the same molecular mechanisms that reproduce the proper molecules. If the parasites are reproduced as efficiently as others or are as stable, they may decrease the monomer resources, so that the original, efficient polymers decay. There is no obvious way to avoid the occurrence of such parasites, and they would be quite disastrous in for instance a 'RNA world' with the same type of RNA-molecules acting as information carriers and catalysts. Another fatal error possibility is that of error propagation (Kirkwood and Holliday, 1975) which is particularly harmful in a more developed system with separate genomes and catalytic enzymes, and with some kind of transfer molecule (adaptor). If the enzymes have evolved a certain efficiency and accuracy, there may occur erroneous ones with lower accuracy but still significant activity. These may then lead to the occurrence of more erroneous molecules, eventually leading to a catastrophic situation. This situation is stabilized if the erroneous enzymes that provide a bad accuracy also have a low catalytic activity and/or are less stable than the proper enzymes. But there are again no obvious ways to avoid a fatal situation in a primitive system.

Author (revised by Herner)

A95-63884
PURINES: THEIR ROLE IN BIOPOIESIS, BIOLOGICAL EVOLUTION AND ONCOGENESIS
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Purines are among the oldest biogenic substances in existence on Earth; their prebiotic synthesis from components which existed in the primitive Earth environment is extremely facile and is carried out with a low amount of energy and in a short period of time as compared with the prebiotic synthesis of other biogenic compounds. Purines possess an extraordinary reactivity which enable them to fulfill a plurivalent biological role. In addition, adenine and guanine in their nucleotide form, due to their remarkable biochemical reactivity, are the main targets of the nucleophilic attack on the DNA molecule by a great number of oncogenic agents. The purines constitute at the different N- and C-8 positions, the main loci for the initiation of the mutagenic and neoplastic transformation. The extraordinary reactivity of purines is also manifested by their behavior towards oxidation and nitrosation. One of us has investigated a series of purine N-oxides resulting from the mild oxidation of adenine, guanine, and purine base itself, as well as the N-6 hydroxylation of adenine, resulting in molecules with an oncogenic activity some of which is equal to those of the most potent polycyclic aromatic hydrocarbons. Adenine was thus converted into adenine N-1 oxide and N-3 oxide, and upon hydroxylation into N-6-hydroxyadenine; guanine is transformed into guanine N-3 oxide and purine base into purine N-3 oxide. On the basis of the above and other related research work, we discuss the possible role of intermediates and derivatives of purines, not only in biopoiesis, but also in early biological evolution and the early emergence of oncogenesis.

Author (revised by Herner)

A95-63885
ORIGIN OF EUKARYOTIC CELL -AUTOGENOUS PROCESS FROM CYANOBACTERIAL WORLD-
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The most primitive photosystem can be seen in the anaerobic photosynthetic bacteria, which possess the systems separated in the ATP and NADH productions. However, in cyanobacteria, both the photosystems are connected to a single reaction line and it has been maintained till the higher land plants. In this evolutional course, it is interesting that a sequence of electron carriers, ubiquinone-cytochrome b-cytochrome c, has been inherited through the primitive and evolved photosynthetic bacteria, cyanobacteria, chloroplasts in the phototrophs and aerobic bacteria and mitochondria in the O2-respiratory organisms. It has been demonstrated that amino acid sequences of the cytochromes b and c are highly homologous between the

chloroplast and mitochondrial organelles. Therefore, it is apparent that the electron transfer system of the organelles has been derived from a common ancestor of the prokaryotes. Especially, certain species of the cyanobacteria Chlorogloea fritchii possess O2-evolved photosynthesis and O2-respiration, which are typical in the eukaryotes though they belong to the prokaryotes. Author (Herner)

A95-63886
CILIUM (UNDULIPODIUM): ORIGIN AND GEOMETRY
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How the cilium (or undulipodium) appeared is still such a poorly defined problem that current hypotheses range from a symbiotic spirochete to a cellular eye. The most recent endogenous hypothesis states that the centriole arose as a cellular eye (Albrecht-Buehler, 1992). The main objection here is the lack of any experimental evidence. Such an eye presupposes the presence of a blind and a photosensor. Both these structures require pigments, which have never been reported for centrioles or basal bodies (kinetosomes). Perhaps the most important missing point in the hypotheses put forward so far is a rationale for the always astonishing geometry of the cilium. What can explain a 9+0 or 9+2 arrangement of microtubules? If microtubules had already been present, the idea that ancient eukaryotes reinforced some of their extroversions by means of bundles of microtubules could be accepted. Among the different kinds of extroversions, a peduncle had greater mechanical needs, as it had to support a whole albeit tiny cell. A tight bundle could be 6+1, according to a commonly found hexagonal geometry. But if the swinging angle had to be restricted, an easy solution was to double the inner microtubule and surround it with a relatively tight belt of 9 microtubules. Thus, the 9+2 arrangement may have initiated from a reinforced swinging peduncle. The advantage of active swinging may have led to an enhancement of the motility of the structure. The cilium may thus have derived from a mobile peduncle loosely attached to the substrate. As a consequence, the 9+0 arrangement of centrioles appeared later, and there is no reason for the presence of DNA or pigments in them.
Author (revised by Herner)

A95-63887
ARCHIGENETIC HYPOTHESIS OF THE EARLY CELLULAR EVOLUTION
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Recent data on mitochondria question their place on the phylogenetic tree. A hypothesis is presented, which generally agrees with Woese-Fox's concept of the common origin of eubacteria, archaebacteria, and eukaryotic hosts. However, a case is made for the evolution of mitochondria from the ancient predecessors of pro- and eukaryotes (protobionts), not from eubacteria. Animal, fungal, and plant mitochondria are considered to be endosymbionts derived from independent free-living cells (mitobionts), which, having arisen at different developmental stages of protobionts, retained some of their ancient primitive features of the genetic code and the transcription-translation systems. The molecular—biological, bioenergetic, and paleontological aspects of this new concept of cellular evolution are discussed.
Author (Herner)

A95-63888
THERMODYNAMICS OF STRECKER SYNTHESIS IN HYDROTHERMAL SYSTEMS
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Theoretical studies of abiotic organic synthesis in hydrothermal systems indicate that the highest potential occurs at temperatures from 100 to 250 C at oxidation states controlled by mineral/fluid reactions. Recent experimental results have shown that synthesis of amino acids from formaldehyde, cyanide, and ammonia occurs at 150 C at redox conditions similar to those of submarine hydrothermal systems. These results suggest that the amino acids could be produced by a mechanism like Strecker synthesis, which takes place in aqueous solution and that such reactions may be favored by the higher temperatures and pressures which characterize hydrothermal systems. In one path of Strecker synthesis, aldehydes or ketones react with HCN and ammonia in aqueous solution to produce amino acids. In the absence of sufficient ammonia in the initial reaction step, Strecker synthesis will produce hydroxy acids. Thermodynamic calculations for Strecker synthesis reactions are facilitated with the revised Helgeson-Kirkham-Flowers equation of state for aqueous species. These results are encouraging for the hydrothermal compatibility of Strecker synthesis. Additional geochemical constraints on the availability of aldehydes, ketones, and HCN in hydrothermal fluids may limit conditions in which such mechanisms apply to natural systems. One set of geochemical constraints comes from studies of hydrothermal systems and abiotic synthesis in volcanic gases. Another set of constraints applies to the possibility of hydrothermal processing of cometary material. Owing to the violence of cometary impacts on the early Earth, the latter scenario may apply more directly to meteorite parent bodies and icy satellites in the outer solar system. In any event, hydrothermal systems would have been more abundant on the early Earth than at present, and the results of this study support the hypothesis that Strecker synthesis could be one of the pathways to abiotic synthesis of amino acids in hydrothermal systems.
Author (revised by Herner)

A95-63889
FORMATION AND ALTERATION OF ORGANIC COMPOUNDS UNDER SUBMARINE HYDROTHERMAL VENT ENVIRONMENTS
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There have been many studies on the roles of submarine hydrothermal vent systems in chemical evolution. Yanagawa and Kobayashi (1992) reported that amino acids, peptide-like polymers and cell-like structures were formed abiotically under simulated hydrothermal vent environments. It was also pointed out that organic compounds such as free amino acids are quite unstable under hydrothermal vent conditions since free amino acids were easily decomposed by heating above 523K in aqueous solution. The following aqueous solutions containing 50 mM ammonium chloride (pH 3.6) were put into Pyrex glass tubes, which were placed in a 100-mL autoclave which, and they were pressurized with nitrogen gas and heated at 573K for 2h (the pressure raised to ca. 200 atm): (1) various amino acids (0.05 mM ea.); (2) various amino acid amides (0.05 mM ea.); and (3) products by proton irradiation of a mixture of carbon monoxide, nitrogen and water, in aqueous solution. After heating, the samples were cooled to room temperature, and filtered through membrane filters. The filtrates were analyzed with an amino acid analyzer before and after acid-hydrolysis. The residues on membrane filters were also analyzed after acid-hydrolysis. When the aqueous solution of free amino acids was heated at 573K, less than 1% of each amino acid was recovered in the resulting filtrate before hydrolysis, but 18% of glutamic acid and 1.4% of aspartic acid were found in the acid-hydrolysate. On the other hand, 1.3% of glycinamide

converted to free glycine, and 0.15% of alaninamide converted to free alanine before acid-hydrolysis: The hydrolysate contained 5.3% of glutamic acid, 5.8% of glycine and 1.0% of alanine (the percentage stands for the ratio of resulting amino acid to initial amino acid amide). These results suggested that some diketopiperazines and pyroglutamate, were performed. In most of the reported experiments on thermal stability of amino acids, the following conditions have been ignored: (1) the fugacity of oxygen and hydrogen of the solution; (2) coexisting metal ions; (3) chemical forms of amino acid precursors; and (4) heating system (continuos heating or rapid quenching). We found that chemical forms of amino acid precursors are very important in their stability in hydrothermal systems. The further investigations are planned concerning the other factors in order to study the roles of submarine hydrothermal vents in chemical evolution.

Author (revised by Herner)

A95-63894
THE STABILITY OF DNA IN EXTREME DRYNESS

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A wide variety of terrestrial organisms, the so-called "anhydrobiotes", has learned to survive in a state of extreme dehydration in dry environments. Strategies of survival include the accumulation of certain polyols and non-reducing sugars, which help to prevent damages to membranes and proteins. However, also the longevity of dormant life in dry environments is limited. We have accumulated evidence indicating that DNA in dry environments is progressively damaged by various lesions, especially strand breaks and cross-linking to other cellular constituents, especially reducing sugars and proteins. These lesions, if they are not too numerous, can often be repaired immediately after dehydration. Long-term exposure to dry conditions, however, diminishes the chances of survival as DNA damages accumulate. We have exposed a variety of anhydrobiotic organisms (spores of Bacillus subtilis, cells of Deinococcus radiodurans, conidia of Aspergillus species and plasmid pBr 322) to dry Argon and (simulated) space vacuum for days to several months at room temperature. Our data allow the following conclusions: DNA-strand breaks are produced during an initial phase of a few days by physical stress. After longer exposure also substantial amounts of DNA-protein cross-links, DNA-DNA cross-links and other DNA adducts are produced by condensation reactions. The formation of DNA double-strand breaks largely depends on the repair capacity of the strains: Repair deficient strains show fewer DNA double-strand breaks, but more DNA adducts than wild strains. These results indicate that DNA double-strand breaks are chiefly produced by repair enzymes in secondary reactions. Control experiments with free cellular DNA (above 3.5 Mbp) and plasmid DNA moreover showed that native DNA is not measurably degraded if stored in a sterile aqueous environment at about 4 C for years. In aerobic and humid environments (above 80% relative humidity), however, lyophilized DNA is significantly degraded by oxidative reactions within a few weeks. Our data permit the following conclusions: half-lives of dormant life forms in extremely dry environments at about 20 C cannot exceed a few decades because the cellular DNA is progressively damaged by chemical and physical processes. DNA fragments, however, may 'survive' in cool, non-oxidizing and dark environments for geological periods of time. Author (Herner)

A95-63895
THE ROLE OF POLYPHOSPHATES AT DIFFERENT STAGES OF LIFE EVOLUTION ON EARTH

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The role of polyphosphates has been significantly changing in the process of life evolution on Earth. During abiogenesis the polyphosphates were, apparently, involved as energy donors into the biosynthesis of Adenosine Triphosphate (ATP), nucleic acids and, possibly, other biopolymers. The major function of polyphosphates in procaryotes was their participation in bioenergetic processes in which they could perform functions analogous with ATP. As for lower eucaryotes (yeasts, fungi), the bioenergetic processes primarily occur at the expense of ATP and other nucleoside triphosphates. In higher eucaryotes, first of all animals, whose biochemical processes are regulated very precisely by the hormonal and nervous systems, the polyphosphates lose the function of a phosphate deposit though they are also available and, apparently, play some role in the functioning of chromatin as well as in the traffic of substances and ions across the membrane. Author (Herner)

A95-63896* National Aeronautics and Space Administration, Washington, DC.
DOUBLE LAYER HYDROXIDE MINERALS AS HOST STRUCTURES FOR BIOORGANIC MOLECULES

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(Contract(s)/Grant(s): NSF EAR-89-16467; NAGW-1031; NAGW-2881)

A central problem in molecular evolution concerns the selective concentration from dilute, multicomponent solution of source molecules into a reactive environment, where formation of larger molecular assemblages can take place. Minerals consisting of positively charged, separable metal hydroxide sheets have proven capable of these functions. This common structural type is represented by minerals such as pyroaurite (Mg-Fe(3+) hydroxide), hydrotalcite (Mg-Al), green rust Fe(2+)-Fe(3+) and others. Effective interlayer sorption is demonstrated for orthophosphate and condensed phosphates, anionic alkyl compounds, polypeptides, nucleic acids, cyanide complexes and glycolaldehyde phosphate, the latter shown to readily oligomerize to form and selectively retain racemic hexose -2, 4, 6-phosphates, preferentially of altrose (Pitsch, et al, 1993). The selective aldomerization and retention effects correlate with the charge distribution in the host mineral structure and the stereochemistry of the substrate molecules. Interaction between nucleic acid bases, and between the cyanide groups of glycolaldehyde phosphate nitrile at the low water activity in the mineral interlayer is indicated by doubling of the monomeric separation of the hydroxide mineral sheets. Author (Herner)

A95-63897* National Aeronautics and Space Administration, Washington, DC.
PHOSPHATE MICROAGGREGATES IN ARCHEAN SEDIMENTS

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(Contract(s)/Grant(s): NAGW-1031; NAGW-2881; NSF EAR-89-16467)

Light microscopy conducted on samples of Archean sediments reveals phosphate microaggregates which are suggestive of a biotic origin (Arrhenius et al., 1993). These aggregates, typically 15 micrometers wide and 50 micrometers long, are thought to be the mineral remains of colonies of microorganisms that lived during the late Archean Eon (greater than or equal to 2.5 Ga). Confocal microscopy was used to study the structures of these microaggregates in three dimensions. Samples used in this study are from the lowermost section of drill core taken from the Dales Gorge Member of the Brockman Iron-Formation (Hamersley Basin) in Western Australia. These sediments are well-preserved and escaped extensive metamorphism typically experienced by older rocks of this type. Two types of samples were prepared for study under the microscope: thin sections (30 micrometers) for transmitted light microscopy to study the general rock texture and to locate the grains of interest, and thick sections (3mm) for confocal microscopy to determine the 3-D structure of the aggregates in situ. The samples have been carefully polished so that they may be directly placed on the oil-immersion lens without the use of a cover slip. No chemical treatments of the surfaces have been performed. The aggregates often form clusters, although isolated aggregates have also been found. The clusters tend to distribute along microbands in the rocks. Electron microprobe analyses show that the phosphate grains and their inclusions, besides calcium and phosphorus, contain no major elements heavier than sodium. The proportions of calcium to phosphorus, the absence of stoichiometric amounts of other cations such as magnesium and iron, as well as optical properties suggest apatite as the mineral form. Author (Herner)

A95-63904

FROM PROTOMETABOLISM TO METABOLISM

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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 346

According to a widely held assumption, RNA molecules preceded proteins in the emergence of life on Earth and proteins first arose as products of an all-RNA machinery that progressively acquired the means of coded translation. Only after this system was established did the first peptide enzymes arise as the selected translation products of RNA genes and were the corresponding reactions incorporated into metabolism. This hypothesis raises two questions. I have proposed a model of a protometabolism supported energetically by thioesters and catalytically by multimers assembled from thioesters. I have also followed pathways not too different from present-day metabolic pathways. Author (revised by Herner)

A95-63905

RELATIONSHIPS OF ESSENCE AND FORM IN THE ORIGIN OF THE GENETIC SYSTEM

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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 347-348

Recent data show that stereoselective reactions between amino acids and nucleosides, and which model various aspects of contemporary protein synthesis, are effective at the monomer level and are quite precisely reversed when switching from D-adenosine to L-adenosine. These combined data have convinced us that the general features of the genetic code and the use of L-amino acids and D-nucleotides were inevitable. However, living systems based on the coupling of D-amino acids and L-nucleotides must have been equally likely. That is, either hetero-pairing of amino acids and nucleotides seems likely, however, life based on L-L and D-D combinations of amino acids and nucleotides must not have been very likely. Author (Herner)

A95-63906

EQUALLY PARSIMONIOUS PATHWAYS OF RNA EVOLUTION MAY NOT BE EQUALLY VALID

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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 349-350

The relative merits of ostensibly equally likely alternative pathways associated with two possible evolutionary transitions were examined. The first pathway would allow transition between the 5S rRNAs of Vibrio proteolyticus and Vibrio alginolyticus. These 5S rRNAs differ in four positions, one of which requires a single point insertion/deletion event. There are thus 24 equally parsimonious four event pathways by which one could change one of these sequences to the other. These 24 pathways are comprised of various combinations of 14 intermediate sequences. All the intermediate sequences were made and their validity as 5S rRNAs determined. Of these, 9 were valid sequences and 4 of the pathways consisted of only valid sequences. Similarly, all six equally parsimonious three change pathways between V. alginolyticus and Vibrio nereis were examined. In this case, 3 of 6 intermediate sequences were valid and two of the six pathways included only valid sequences. Overall 60% of the intermediates sequences generated were valid and 27% of the pathways contained exclusively valid sequences. In both pathways a base pair is converted. In the V. alginolyticus/V. nereis pathway this occurs as expected via a G-U wobble intermediate. In the V. proteolyticus/V. alginolyticus case an intermediate wobble pair is not possible. All possible routes thus require acceptance of a mispair and hence one might anticipate that all of the pathways would contain an invalid sequence, necessitating a less parsimonious route. Indeed, one can not immediately make either mispair. However, it turns out that if either of the changes not associated with the pair occur first then at least one of the mispair conditions becomes valid. These results demonstrate that equally parsimonious pathways of evolutionary transition may not be equally valid. Presumably efforts to generate phylogenetic trees by parsimony approaches would thus be more realistic if they imposed a validity requirement on hypothetical ancestral sequence nodes. It is not obvious at this stage to what extent an evolutionary construction could be improved or how validity would be determined. The latter point is especially bothersome because the validity of a particular sequence may be interdependent with the status of the sequence of one or more other molecules. The approach described here provides the basis for a detailed characterization of a portion of the sequence space available to 5S rRNA. Such a characterization will provide considerable insight to RNA evolution in general. Author (revised by Herner)

A95-63907

SYMBIOGENESIS AND SPECIES ORIGIN

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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 351

Bacteria, although distinguishable physiologically and genetically, are single genomic systems capable of reversible DNA exchange. Genetic material recombines but cytoplasmic fusion does not occur. Because bacteria (prokaryotes, homogenomic systems) engage in reversible gene flow, unlike eukaryotes, they do not form species. Eukaryotes originated symbiogenetically; nucleated organisms (protoctista, animals, fungi and plants) evolved from genetic integration of former microbial symbionts. Eukaryotic individuals are made of irreversibly integrated heterologous genomes. Members of the same

species share in common the same set of integrated heterologous genomes. If these postulates are correct speciation is a phenomenon limited to eukaryotes and involves the aquisition and integration of symbionts to form composite new 'individuals'. These new individuals function as single entities and go on to reproduce as a single integrated complex. Author (Hemer)

A95-63908
HOW COMPLEX WAS THE LAST COMMON ANCESTOR?
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Although the hypothesis that all extant life forms are descendants of a primordial cellular system based solely on catalytic and replicative RNA molecules is still a matter of debate, there is considerable evidence suggesting that RNA molecules played a major role during the early stages of biological evolution. The RNA world was probably a short-lived stage of biological evolution, but it left major marks in contemporary cells: RNA molecules play a central role in protein synthesis and other biological processes, and ribonucleotides (a) are universal precursors in the biosynthesis of deoxyribonucleotides; (b) are an essential moeity of a large number of coenzymes; and (c) modified ribonucleotides such as cAMP, ppGpp, pppGpp, and ApppA, form part of a cellular system of distress signals or alarmones. However, there is a huge gap in our current descriptions of the evolutionary events leading from the RNA world to the last common ancestor of eubacteria, archaebacteria, and the eukaryotic nucleocytoplasm. Based on the phylogenetic analysis of ribosomal RNA molecules, it was hypothesized that these three cellular lineages diverged simultaneously from a progenote, i.e., a biological entity having a rudimentary linkage between their genotype and phenotype, with inaccurate mechanisms for replicating and translating genetic information (cf. Woese, 1987). The comparison of traits common to the three cellular lineages does not support this possibility, and suggests instead that their last common ancestor was a cell endowed at least with (a) a complex translation apparatus with an oligomeric RNA polymerase and ribosome-mediated protein synthesis; (b) membrane-associated ATP production; (c) a DNA genome; (d) polynucleotide phosphorylase, ribonuclease P, and other RNA-processing enzymes; (e) major metabolic abilities such as amino acid and purine biosynthesis; (f) heat shock response; and (g) insulin-like proteins that may have allowed cell-to-cell communication in colonies. Author (Hemer)

A95-63909
THE USE OF FUNCTIONAL INHIBITORS IN THE STUDY OF RIBOSOMAL EVOLUTION
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The functional evolution of ribosomes can be studied using antibiotics which interfere with the highly cooperative ribonucleoprotein structures responsible for protein synthesis. The functional dissection of ribosomes belonging to the three domains has been accomplished using 26 antibiotics with different structural, functional and domain specificity. The data bank constructed using in vitro protein synthesis systems to avoid problems related with transport and/or antibiotic inactivation has been analyzed using different statistical methods in order to prove the consistency of the results. The phenograms obtained using ribosomal functional inhibition are consistent with the phylogenetic relationships obtained using rRNA sequence comparison. Our data shows that Archaeal ribosomes are relatively homogeneous with respect to their functional characteristics. This is revealed by their antibiotic sensitivity profiles as demonstrated by their clustering regardless of differences in their sensitivity, when they are analyzed with members of the other domains. Discriminant analysis of the ribosomal sensitivity data offers some clues about the evolution of the protein synthesis machinery which can be tested by complementary structural analysis. Author (Hemer)

A95-63910
STRUCTURE AND EVOLUTION OF AN RNA ENZYME: RIBONUCLEASE P.
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The RNase P enzymes of the Archaea (formerly archaebacteria) contain RNA components with striking similarity to those of the Bacteria. In contrast to their bacterial homlogs, the archaeal RNase P RNAs are dependent on the protein components of the enzyme for activity in vitro. Although the RNase P RNA gene sequences are so far only available from extreme halophiles and Sulfolobus solfataricus, the emerging secondary structures of these RNAs are remarkably similar to those of the Bacteria. The archaeal RNAs contain all of the structural elements found in the bacterial minimum consensus model, including even the identities of the majority of invariant bacterial nucleotides. The reason for the dependence of the archaeal RNase P activity on protein components is therefore unclear. It appears that in contrast to the bacterial enzyme, at least in the case of S. solfataricus, the enzyme is predominantly protein rather than RNA. These protein components have yet to be examined. RNase P may therefore serve as a model for the aquisition of RNA function by protein, a process demanded by the RNA world hypothesis about which little is known. The tertiary structure of RNase P RNA is being examined by a combination of comparative and experimental methods. Co-axial stacking of helices in the secondary structure have been identified by comparative analysis; the relative positions and orientations of these stacks are being determined in photoaffinity crosslinking experiments. Models for the three-dimensional structure of the RNA are being constructed by a combination of molecular mechanics and manual methods, which are evaluated on the basis of known phylogenetic variation in RNase P RNA structure. Author (Hemer)

A95-63911
ON THE MONOPHYLETIC ORIGIN OF EUBACTERIAL, ARCHAEBACTERIAL AND EUKARYOTIC POLYNUCLEOTIDE PHOSPHORYLASE
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Cross-reactivity immunological studies and molecular phylogenetic analysis have been used to infer that the last common ancestor of the three extant cellular lineages was a complex cell comparable in many ways to extant prokaryotes (Lazcano et al., 1992). The distribution of traits present in eubacteria, archaebacteria and eukaryotes has shown that they are descended from a common ancestor endowed with a modern-type translational apparatus, membrane-associated F-type ATPases, different biosynthetic abilities and a complex set of enzymes including those involved in mainstream metabolic pathways. The complexity of this common ancestor suggests that it was not a direct, immediate descendant of earlier biological systems in which it is assumed that RNA played a much more important role (Lazcano, 1993). However, the last common ancestor of the three extant cellular lineages must have inherited from its evolutionary predecessors a number of enzymes involved in RNA metabolism. Author (Hemer)

A95-63912
SELECTIVE MUTATIONS IN MOLECULAR EVOLUTION
M. ANGELICA SOTO Universidad de Chile, Santiago, Chile and JOSE TOHA Universidad de Chile, Santiago, Chile ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 359-360

Most of the relevant knowledge of molecular evolution corresponds to comparisons between homologous proteins, which permits a quantitative analysis of evolutionary changes. Nevertheless, all these changes probably do not have the same significance, considering the position in the protein and the physical, chemical and structural properties of the amino acids involved in the mutation, in such a way that, in general, some of them can be considered as selectives and others as neutral changes. With the aim to establish the role of selective mutations in molecular evolution, we have defined as neutral change that involving amino acids with similar properties and selective mutation, the substitution of an amino acid by another with very different properties. We have used the well known classification employed by Dickerson (1972) who distributes the 20 amino acids into 6 groups: Hydrophobic, aromatic rings: Phe, Trp, Tyr; Hydrophobic, not aromatic: Ile, Leu, Met, Val; Hydrophilic, basic: His, Lys, Arg; Hydrophilic, acidic: Asp, Glu; Ambivalent: Ala, Asn, Cys, Pro, Gln, Ser, Thr and No side chain: Gly. We analyze the evolution of Fibrinopeptides A, comparing two evolutionary trees, one of them constructed from the table of total distances between species and the other from a table of selective distances, that is, the change of an amino acid to another of a different group. Table corresponding to neutral mutations is also studied and analyzed. Author (Hemer)

A95-63913
ISOPRANYLGLYCEROL DIETHERS IN NON-ALKALINE RECENT AND MIOCENE EVAPORITIC ENVIRONMENTS
PILAR TEIXIDOR Univ. of Barcelona, Catalonia, Spain, JOAN O. GRIMALT Dept. of Environmental Chemistry (CID-CSIC), Catalonia, Spain, JUAN J. PUEYO Univ. of Barcelona, Catalonia, Spain, and FRANCISCO RODRIGUEZ-VALERA Univ. of Alicante, Alicante, Spain ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 361

Gas chromatographic-mass spectrometric analyses of Miocene and recent halite samples using high temperature gas chromatographic columns have shown that O-sesterpanyl-O-phytanylglycerol and bis-O-phytanylglycerol are common constituents of halites deposited in non-alkaliphilic systems. These isopranylglycerol diether distributions differ from those found in carbonates and most sulphates deposited in solar salterns or in sediments of mesohaline lagoons which only contain the C20-C20 homolog. The investigation of the distributions of these compounds in thirteen species of non-alkaliphilic halobacteria has revealed that bis-O-phytanylglycerol occurs as the single homolog in most cases, namely Halobacterium, Haloferax and Haloarcula spp., whereas O-sesterpanyl-O-phytanylglycerol has been found in one Halococcus species. The presence of this C20-C25 diether in this genus of extremely halophilic archaebacterial cocci expands the limited number of organisms previously known as potential precursors of this isopranylglycerol, alkaliphilic halobacteria and Methanosarcina spp., and indicates that its widespread occurrence in recent and Miocene halites is related to contributions from non-alkaliphilic halobacteria. Author (Hemer)

A95-63914
ARCHAEBACTERIAL RIBULOSE BISPHOSPHATE CARBOXYLASE
WIJAYA ALTEKAR Bhabha Atomic Research Centre, Bombay, India and REMA RAJAGOPALAN Bhabha Atomic Research Centre, Bombay, India ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 362

The CO2 fixing enzyme of Calvin Cycle ribulose 1.5-bisphosphate carboxylase/oxygenase (E.C. 4.1.1.39) has been isolated for the first time from a halophilic bacterium Haloferax mediterranei grown heterotrophically (Altekar, W. and Rajagopalan, R). A homogeneous preparation was obtained from sonic extract of the cells by ammonium sulphate precipitation, salt mediated chromatography on Blue Sepharose CL-6B and molecular exclusion chromatography on Sepharose CL-6B. The physicochemical and catalytic properties of the enzyme were studied. The halobacterial ribulose bisphosphate carboxylase is an oligomer of large and small subunits of greatly differing molecular masses viz. 54 kDa and 14 kDa respectively as detected by polyacrylamide gel electrophoresis under denaturing conditions. By sucrose density gradient centrifugation, the molecular mass of the enzyme was estimated as 520 kDa indicating a hexadecameric nature. No evidence for additional form of the enzyme devoid of small subunits was obtained. The requirement of Mg(++) for the activity of archaebacterial enzyme was 12.5 mM. pH optimum of halobacterial ribulose bisphosphate carboxylase is 7.8 at 30 C. The halobacterial enzyme is also halophilic and requires KCl for activity and stability. In contrast to many halophilic proteins, ribulose bisphosphate carboxylase from H. mediterranei is not an acidic protein. Author (Hemer)

A95-63915* National Aeronautics and Space Administration, Washington, DC.
THE POTENTIAL FOR PREBIOTIC SYNTHESIS IN HYDROTHERMAL SYSTEMS
JAMES P. FERRIS Rensselaer Polytechnic Institute, Troy, NY, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 363
(Contract(s)/Grant(s): NGR3-018-148)

Contemporary hydrothermal systems provide a reducing environment where organic compounds are formed and may react to generate the molecules used in the first living systems. The organic compounds percolate through mineral assemblages at a variety of temperatures so the proposed synthetic reactions are driven by heat and catalyzed by minerals (Ferris, 1992). Some examples of potential prebiotic reactions are discussed. Author (Hemer)

A95-63916
AMINO ACID STABILITY IN HYDROTHERMAL VENTS
JEFFREY L. BADA Scripps Institution of Oceanography, San Diego, CA, US, STANLEY L. MILLER Univ. of California, La Jolla, CA, US, and MEIXUN ZHAO Univ. of Bristol, UK ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 364-365

Laboratory investigations have shown that amino acids should be rapidly and irreversibly destroyed at the greater than 350 C temperatures characteristic of hydrothermal vents at oceanic spreading centers. The instability of amino acids at high temperatures is consistent with observations that there are no detectable amounts (less than 10(exp -7)M) of amino acids in 319 C Guaymas Basin hydrothermal vent waters (Haberstroch and Karl, 1989). Theoretical calculations have suggested that significant concentrations of amino acids could persist in hydrothermal vents because amino acid stability in geochemical systems is not determined by kinetics but rather by metastable thermodynamic equilibria (MTE) governed by redox conditions (Shock 1990a,b). MTE calculations have been used as 'evidence' that the organics on the early Earth could have been supplied by hydrothermal vents, and to bolster earlier claims that the origin of life took place in hydrothermal environments. Author (revised by Hemer)

A95-63917
CAN HYPERTHERMOPHILIC PROCARYOTES TELL US ANYTHING ABOUT THE PRIMITIVE EARTH?
ROBERT HUBER Univ. of Regensburg, Regensburg, Germany and KARL O. STETTER Univ. of Regensburg, Regensburg, Germany
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 366-367

Recently, we have isolated the hyperthermophilic archaeon Pyrobaculum aerophilum and the hyperthermophilic bacterium Aquifex pyrophilus. They grow both microaerophilic by hydrogen oxidation, using traces of oxygen as electron acceptor. Alternatively, they grow strictly anaerobic by dissimilatory nitrate reduction. Phylogenetically, both organisms represent deep-branching and short evolution lineages within their domains. Therefore, they may be still rather primitive and similar to their archaean ancestors. Both metabolic types may have therefore evolved well before transition of earth to a stable aerobic hydrosphere and atmosphere had ocurred, but where nitrate and traces of oxygen were already available on this primitive archaeon earth.

Author (Herner)

A95-63918
THE REVERSE GYRASE OF HYPERTHERMOPHILIC ARCHAEBACTERIA - ORIGIN OF LIFE AND THERMOPHILY
P. FORTERRE Universite Paris-Sud, Orsay, France, F. CONFALONIERI Universite Paris-Sud, Orsay, France, F. CHARBONNIER Universite Paris-Sud, Orsay, France, C. BOUTHIER DE LA TOUR Universite Paris-Sud, Orsay, France, and M. DUGUET Universite Paris-Sud, Orsay, France ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 368-369

We have recently cloned and sequenced the gene encoding reverse gyrase from the sulfothermophilic archaebacterium Sulfolobus acidocaldarius (Confalonieri et al. 1993). This sequence turns out to be a combination of an helicase and a DNA topoisomerase gene. This unique structure suggests that reverse gyrase originated after the appearance of helicases and topoisomerases, i.e. by the fusion of a DNA helicase gene and a DNA topoisomerase gene. This implies that reverse gyrase only appeared after a first round of evolution in the DNA world. Phylogenetic analyses of DNA polymerases and topoisomerases I and II amino-acid sequences indeed suggest the existence of a specific evolutionary period comprised between the first organism with a DNA genome and the last common ancestor of eubacteria, archaebacteria and eukaryotes, a first age of the DNA world.

Author (Herner)

A95-63919
EVIDENCE AND CONDITIONS FOR SYNTHESIS OF ORGANIC COMPOUNDS IN HYDROTHERMAL SYSTEMS
BERND R. T. SIMONEIT Oregon State Univ., Corvallis, OR, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 370-371

The reactivity of organic compounds in hot water (200-350 C, in auto-claves) has been studied to model the geochemical and technological implications of this chemistry. The potential of supercritical water as a medium for chemistry has also been reviewed. However, none of these studies were carried out under mineral buffered conditions nor with the aid of catalysts. The aim was solely to observe the stability of organic compounds and elucidate their decomposition products. For the documentation of organic compound synthesis in hydrothermal systems it will be necessary to understand the chemistry of condensation, autocatalysis, catalysis and hydrolysis reactions in aqueous mineral buffered systems over a range of temperatures from warm to greater than 400 C.

Author (Herner)

A95-63920
GEOCHEMICAL CONSTRAINTS ON CHEMOLITHOAUTOTROPHIC REACTIONS IN HYDROTHERMAL SYSTEMS
EVERETT L. SHOCK Washington Univ., St. Louis, MO, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 372-373

Hyperthermophilic organisms are the closest-known living relatives of a common ancestor of all life on Earth. Current speculation by microbiologists suggests that life may thrive to temperatures as high as 150 C. Many of the well-studied organisms are found in hydrothermal systems in which pH, oxidation states and concentrations of dissolved chemical species are controlled, or strongly influenced, by fluid/rock reactions. Therefore, a useful method to evaluate the bioenergetics of such organisms can be developed within a geochemical reference frame. This reference frame can be adopted in preference to the highly restrictive, 25 C and pH=7, set of reference conditions used in traditional studies of bioenergetics. Shifts of several kilocalories in standard partial molal Gibbs energies of formation for aqueous organic compounds with increasing temperature serve to illustrate the usefulness of a geochemical reference frame. Modern primary producers among the archeae employ sulfur, sulfide, S4O6(-2), and Fe(+2) oxidation reactions, as well as sulfur reduction reactions, as energy sources for organic synthesis using CO2 as the source of carbon. Considerable insight can be gained into hyperthermophilic bioenergetics by placing chemolithoautotrophic reactions in a geochemical context.

Author (revised by Herner)

A95-63921
EVOLUTION OF THE GENETIC CODE
L. J. BOYA Universidad de Zaragoza, Zaragoza, Spain ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 374

The genetic code has evolved after the first interactions between RNA and aminoacids (aa), once the RNA world was well established, and there were abundant aminoacids in the pool of organic matter. We propose a 3-stage procedure to produce the actual code. First, there is a two-letter code with a third meaningless letter (N) and four combinations are selected, namely GGN (Gly), GCN (Ala), CGN (Arg) and CCN (Pro), based in the robust union C(triple bond)G; these aa's are either the most simple (Gly, Ala), or essential for neutralization (Arg) or chain bending (Pro). Secondly, the nucleotides A and U enter, still in the two-letter mode; the union A=U is weaker. Most of aa's are thus selected, such as UUN (Phe), etc. Third, in a few cases there is a distinction between Pyrimidyne or Purine bases in the third letter; as a final modification, Met and Trp ara coded by a single triplet; in fact, these two aa's are very rare, Met being connected within the 'start' signal. It is argued that anomalies in the universal code, as they happen in cilliates, mitochondriae, etc., are 'reversions' to primitive forms of the code.

Author (Herner)

A95-63922
REDOX RIBONUCLEOSIDES: ISOLATION AND CHARACTERIZATION OF 5-HYDROXYCYTIDINE, 5-HYDROXYURIDINE, 8-HYDROXYGUANOSINE AND 8-HYDROXYADENOSINE FROM TORULA YEAST RNA
HIROSHI YANAGAWA Mitsubishi Kasei Institute of Life Sciences, Tokyo, Japan and YOKO OGAWA Mitsubishi Kasei Institute of Life Sciences, Tokyo, Japan ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 375-376

The hypothesis that DNA-based genetic mechanisms arose in nearly all organisms from an ancient 'RNA World' has found recent support in the notions that RNA, not DNA, was the first transmitter of genetic information and that it was capable of replicating itself without

a protein catalyst. If RNA functioned as both a genetic information store and a replicative enzyme with splicing and phosphodiester cleavage activities, it represents a strong candidate molecule for the earliest genetic material. Currently known catalytic RNAs called ribozymes may be likened to molecular fossils whose history predates that of primordial cellular life forms. Ribozymes have a number of enzymatic activities including RNA endonuclease, nucleotidyl transferase, phosphotransferase, phosphatase, ligase, and kinase activity. These, however, are limited to sequence- and structure-specific cleavage and ligation of RNA phosphodiester bonds. It can be speculated that hydroxy ribonucleosides, free or tightly bound to RNAs, may have originally functioned as oxidoreduction catalysts in primordial early life forms. In addition, ferricyanide and ferrocyanide ions together with these hydroxy ribonucleosides may have had important roles in biological redox reactions, since transition elements such as iron, molybdenum, and zinc, and ligands such as CN(-), NH3, and H2O were relatively abundant in the primeval sea. Author (revised by Herner)

A95-63924
LIPIDS OF ARCHAEBACTERIA
T. G. TORNABENE Georgia Institute of Technology, Atlanta, GA, US and G. HOLZER Georgia Institute of Technology, Atlanta, GA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 379
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The principal membranal components of all of the archaebacteria are the lipids which are constructed from isopranyl hydrocarbons and isopranyl ether glycerols. These lipids and/or its derivatives are sufficiently stable to survive geological time and conditions. Using these lipid biomarkers it is possible to draw a correlation between geological evolution and ecological niches. Author (revised by Herner)

A95-63925
INFORMATION, ENTROPY, THERMODYNAMICS AND THE ORIGIN OF LIFE
W. L. BRADLEY Texas A & M University, TX, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 380
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The relationship between entropy and information will be considered. Recent contention that the Second Law of Thermodynamics provides a 'driving force' for chemical and biological evolution will be critiqued and illustrated with calculations. The critical steps in chemical evolution are analyzed in light of the information/complexity issue, and the relationship of the information problem to thermodynamics will be considered. Author (Herner)

A95-63926
BIOLOGICAL SAMPLES IN COMET SIMULATION EXPERIMENT (KOSI-11)
K. ROESSLER Institut fuer Nuklearchemie, Germany, G. HORNECK Institut fuer Luft- und Raumfahrtmedizin, Koln, Germany, and U. ESCHWEILER Institut fuer Luft- und Raumfahrtmedizin, Koln, Germany ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 381
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The comet simulation experiment KOSI-11 in the space simulator chamber of Institut fuer Raumsimulation of DLR-Koln was dedicated to chemical and biological problems. The analog consisted of 40 weight % mineral dust (olivine, montmorillonite), 45% water-ice, 6% CO2 ice, 6% frozen formaldehyde, 2% methanol, and 1% ammonia. The biological samples were dry spores of Bacillus Subtilis HA 101 on quartz substrates. Two of them were positioned at the surface, one in about 3 mm depth. Starting temperature was about 100 K. During 12 h insolation in vacuum with light from Xe-lamps of 1.3 SC intensity the surface temperature reached approx. 345 K. CH2O and NH3 partially evaporated or reacted chemically and polymerized. Even the spores were covered at the end of the experiment by a dry dust mantle, the survival rates of all three samples were below 10(exp -4). This very preliminary experiment seems to indicate terrestrial biological species cannot survive in the upper layers of typical cometary material, be it by the action of UV-light, temperature or poisonous gases. In the interior of icy samples, however, at temperatures below 100 K biological species show an increased stability versus radiation due to the immobilization of OH radicals as has been demonstrated for gamma-rays, UV-photons, and 20 MeV protons and alphas. Author (Herner)

A95-64050
CHEMISTRY OF POTENTIALLY PREBIOLOGICAL NATURAL PRODUCTS
ALBERT ESCHENMOSER Swiss Federal Institute of Technology, Zurich, Switzerland Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 5 September 1994 p. 389-423 Research sponsored by the Swiss National Science Foundation, Ciba-Geigy AG, Basel, Firmenich & Cie., Geneva, and the ETH Zurich (HTN-95-10288) Copyright

A relationship between what might be called a kinetic version of Le Chatelier's principle and chemical self-organization is considered. Some aspects of the search for a pre-RNA genetic system are discussed. Results of an experimental investigation on the pairing properties of alternative nucleic acid systems-including those of pyranosyl-RNA ('p-RNA'), a constitutional isomer of RNA-are summarized. Author (Herner)

A95-64051
THE PHYLOGENY OF TRNA MOLECULES AND THE ORIGIN OF THE GENETIC CODE
MASSIMO DI GIULIO International Inst. of Genetics and Biophysics, Naples, Napoli, Italy Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 5 September 1994 p. 425-434 (HTN-95-10289) Copyright

The evolutionary relationships between transfer RNA (tRNA) molecules are analyzed by parsimony algorithms. The position of the topologies expected on the basis of the hypotheses made to explain the origin of the genetic code, on the frequency distribution of all the possible tree topologies of the evolutionary relationships between tRNAs seems to lead to the following conclusion: The hypothesis that sees the genetic code as a map of the biosynthetic relationships between amino acids seems to occupy a statistically significant position on these frequency distributions, thus reflecting a significant part of the tRNA phylogeny. Author (Herner)

A95-64053
INORGANIC SELF-ORGANISATION IN PRECAMBRIAN CHERTS
JUAN MANUEL GARCIA-RUIZ CSIC-Universidad de Granada, Granada, Spain Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 6 November 1994 p. 451-467 Research sponsored by CICYT and Autonomous Government of Andalucia (HTN-95-10291) Copyright

Silica biomorphs are inorganic self-organized precipitates resulting from a crystal aggregation process controlled by a metal silicate membrane. They display morphological and symmetric properties of living organisms and form under physico-chemical conditions similar to some geochemical conditions suggested for the chemical precipitation of Precambrian chert precursors. In consequence, these inorganic precipitates are proposed as an alternative interpretation to be considered when trying to decipher the biogenicity of putative Precambrian microbiotas. Author (Herner)

A95-64054
ROLE OF METAL FERROCYANIDES IN CHEMICAL EVOLUTION
KAMALUDDIN Univ. of Roorkee, Roorkee, India, MALA NATH Univ. of Roorkee, Roorkee, India, and ARCHANA SHARMA Univ. of Roorkee, Roorkee, India Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 6 November 1994 p. 469-477

Research sponsored by Department of Science and Technology, New Dehli
(HTN-95-10292) Copyright

Adsorption of several ribose and 2'-deoxyribose 5'-nucleotides on zinc- and copper ferrocyanides has been studied at a neutral pH of 7.01. The Langmuir adsorption isotherm was used to determine the values of K(sub L) and X(sub m). Both types of nucleotides, ribose and 2'-deoxyribose, showed similar adsorption behavior on zinc- and copper ferrocyanides. Zinc ferrocyanide showed larger adsorption as compared to copper ferrocyanide. Purine nucleotides adsorbed more than pyrimidine nucleotides on both the metal ferrocyanides probably because of an additional binding site in the imidazole ring in purines. Results of the present study suggest the importance of metal ferrocyanides and metal ions in stabilization of nucleotides during processes of prebiotic condensation reactions. Author (Herner)

A95-64055* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TEMPLATE-DIRECTED CHEMISTRY AND THE ORIGINS OF THE RNA WORLD
ANASTASSIA KANAVARIOTI Univ. of California, Santa Cruz, CA, US Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 6 November 1994 p. 479-494
(Contract(s)/Grant(s): NCC2-534)
(HTN-95-10293) Copyright

Prompted by the growing number of reports about reactions catalyzed by ribozymes, this paper summarizes mechanistic and kinetic aspects of template-directed (TD) chemistry important for the synthesis of a diverse population of polynucleotides and analogues possibly up to 100 units long. Assuming that this chemistry takes place in a microenvironment conducive to life under the constant influx of mM concentrations of activated monomeric building blocks, the proposed scenario represents a working hypothesis for the prebiotic synthesis of the RNA world. Author (Herner)

A95-64056
A HYPOTHESIS: RECIPROCAL INFORMATION TRANSFER BETWEEN OLIGORIBONUCLEOTIDES AND OLIGOPEPTIDES IN PREBIOTIC MOLECULAR EVOLUTION
SHUGUANG ZHANG Massachusetts Institute of Technology, Cambridge, MA, US and MARTIN EGLI ETH-Swiss Federal Inst. of Technology, Zurich, Switzerland Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 6 November 1994 p. 495-505
(HTN-95-10294) Copyright

We wish to propose a mechanism for reciprocal information transfer in prebiotic molecular evolution, based on heterologous pairing complex formation between oligoribonucleotides and oligopeptides. In this proposed pairing complex, the bases of the oligoribonucleotide and the side chains of the oligopeptide may form three types of complementary Watson-Crick-type hydrogen bonds. The structural basis for the pairing is the close correspondence of the distances between the side chains in the two molecules. Both the inter-nucleotide spacing of the RNA and the inter-side-chain spacing of the peptide are approximately 3.4 A. The proposed pairing mode would allow both specific and nonspecific interactions required for reciprocal information transfer. Thus, it represents a simple and versatile coding system that could have had significant implications in prebiotic molecular selection and evolution. In addition, we propose several testable experimental approaches based on the pairing mode of oligoribonucleotides and oligopeptides to verify our hypothesis. Author (Herner)

A95-64529
COMPETITION FOR A SINGLE LIMITING RESOURCE IN CONTINUOUS CULTURE: THE VARIABLE-YIELD MODEL
HAL L. SMITH Arizona State Univ., Tempe, AZ and PAUL WALTMAN SIAM Journal on Applied Mathematics (ISSN 0036-1399) vol. 54, no. 4 August 1994 p. 1113-1131 refs
(BTN-94-EIX94501431532) Copyright

The global asymptotic behavior of solutions of the so-called variable yield model of competition between two microbial populations for a single growth-limiting nutrient is determined. This model, also referred to as the variable-internal stores or Caperon-Droop model, is a generalization of the classical Monod model. It assumes that the growth rate of a population depends on the amount of nutrient stored by the organism, taken to be the same for all organisms, rather than the concentration of ambient nutrient in the culture. It is shown that competitive exclusion holds, the winner being the organism that can grow at the lower ambient nutrient concentration. Author (EI)

A95-65315
MECHANICS AND FORM OF THE MAIZE LEAF: IN VIVO QUALIFICATION OF FLEXURAL BEHAVIOR
B. MOULIA Univ de Bordeaux, Cestas-Gazinet (France), M. FOURNIER, and D. GUITARD Journal of Materials Science (ISSN 0022-2461) vol. 29, no. 9 May 1, 1994 p. 2359-2356 refs
(BTN-94-EIX94461400303) Copyright

An in vivo flexural test is designed and conducted on maize leaves. Data processing is based on a local structural definition of longitudinal leaf suppleness, which originates in the theory of pure plane bending of initially curved beams, in large displacements. A specific procedure for curvature and suppleness computation is methodologically discussed. The results presented concern only the elastic flexural behavior of the leaf (which could be characterized in 59% of the tested leaves). A quasi-exponential increase in suppleness, from the base to the tip of the leaf, was always experienced. It is demonstrated that the midrib plays a major part in bending stiffness. Going up the longitudinal leaf form, it is shown that self weight related elastic bending strain only account for one-third of the actual curvature. Author (EI)

N95-15961*# North Carolina Univ., Raleigh, NC. Dept. of Soil Science.
REGULATION OF NITROGEN UPTAKE AND ASSIMILATION: EFFECTS OF NITROGEN SOURCE AND ROOT-ZONE AND AERIAL ENVIRONMENT ON GROWTH AND PRODUCTIVITY OF SOYBEAN Final Technical Report
C. DAVID RAPER, JR. 1 Oct. 1994 20 p
(Contract(s)/Grant(s): NCC2-101)
(NASA-CR-197098; NAS 1.26:197098) Avail: CASI HC A03/MF A01

The interdependence of root and shoot growth produces a functional equilibrium as described in quantitative terms by numerous authors. It was noted that bean seedlings grown in a constant environment tended to have a constant distribution pattern of dry matter between roots and leaves characteristic of the set of environmental conditions. Disturbing equilibrium resulted in a change in relative growth of roots and leaves until the original ratio was restored. To define a physiological basis for regulation of nitrogen uptake within the balance between root and shoot activities, the authors combined a partioning scheme and a utilization priority assumption in which: (1) all carbon enters the plant through photosynthesis in leaves and all nitrogen enters the plant through active uptake by roots, (2) nitrogen uptake by roots and secretion into the xylem for transport to the shoots are active processes, (3) availability of exogenous nitrogen determines concentration of soluble carbohydrates within the roots, (4) leaves are a source and a sink for carbohydrates, and (5) the requirement for nitrogen by leaf growth is proportionally greater during initiation and early expansion than during later expansion. Derived from text

N95-16034*# Colorado Univ., Boulder, CO. Dept. of Aerospace Engineering Sciences.
BIOSERVE SPACE TECHNOLOGIES: A NASA CENTER FOR THE COMMERCIAL DEVELOPMENT OF SPACE Annual Report
1992 55 p Prepared in cooperation with Kansas State Univ., Manhattan, KS

(Contract(s)/Grant(s): NAGW-1197)
(NASA-CR-196983; NAS 1.26:196983) Avail: CASI HC A04/MF A01

BioServe Space Technologies, a NASA Center for the Commercial Development of Space (CCDS), was established in 1987. As is characteristic of each CCDS designated by NASA, the goals of this commercial center are aimed at stimulating high technology research that takes advantage of the space environment and at leading in the development of new products and services which have commercial potential or that contribute to possible new commercial ventures. BioServe's efforts in these areas focus upon space life science studies and the development of enabling devices that will facilitate ground-based experiments as well as the conversion of such to the microgravity environment. A direct result of BioServe's hardware development and life sciences studies is the training of the next generation of bioengineers who will be knowledgeable and comfortable working with the challenges of the space frontier.

Derived from text

N95-16164# Pittsburgh Univ., Pittsburgh, PA.
INVESTIGATION OF PRESSURE REGULATION IN AN ARCHAEBACTERIAL ENZYME Final Report, 1 Feb. 1991 - 31 Jan. 1994
ALAN J. RUSSELL 25 Mar. 1994 8 p
(Contract(s)/Grant(s): DAAL03-91-G-0034)
(AD-A281413; ARO-28011.2-LS) Avail: CASI HC A02/MF A01

Initial studies focused on the purification of the hydrogenase from Methanococcus jannaschii. The hydrogenase was characterized, N-terminal sequenced, and its amino acid content was compared to other hydrogenases. Researchers then constructed a library of genomic DNA from Methanococcus jannaschii. The genomic library, with over 1 million independent representatives, was cloned into bacteriophage lambda. The DNA from the organism has been found to be methylated, preventing classic enzyme treatments for gene library synthesis. A gene library has been synthesized by mechanical shearing, and the fragment size is approximately 8-15 kb. Another driving force for the production of the library was the independent discovery of a remarkably thermostable protease which retains activity at 135 C. The protease was partially purified. The partially purified sample was used for the studies to determine which class of protease it may be. DTIC

N95-16429*# Old Dominion Univ., Norfolk, VA. Dept. of Biological Sciences.
ROOT GROWTH AND DEVELOPMENT IN RESPONSE TO CO2 ENRICHMENT Final Report, 2 Jul. 1992 - 15 Oct. 1994
FRANK P. DAY, JR. 15 Oct. 1994 5 p
(Contract(s)/Grant(s): NAG10-0110)
(NASA-CR-196154; NAS 1.26:196154) Avail: CASI HC A01/MF A01

A non-destructive technique (minirhizotron observation tubes) was used to assess the effects of CO2 enrichment on root growth and development in experimental plots in a scrub oak-palmetto community at the Kennedy Space Center. Potential effects of CO2 enrichment on plants have a global significance in light of concerns over increasing CO2 concentrations in the Earth's atmosphere. The study at Kennedy Space Center focused on aboveground physiological responses (photosynthetic efficiency and water use efficiency), effects on process rates (litter decomposition and nutrient turnover), and belowground responses of the plants. Belowground dynamics are an exceptionally important component of total plant response but are frequently ignored due to methodological difficulties. Most methods used to examine root growth and development are destructive and, therefore, severely compromise results. Minirhizotrons allow nondestructive observation and quantification of the same soil volume and roots through time. Root length density and root phenology were evaluated for CO2 effects with this nondestructive technique. Derived from text

N95-16599# Virginia Univ., Charlottesville, VA. Dept. of Biology.
CONTROL OF CIRCADIAN BEHAVIOR BY TRANSPLANTED SUPRACHIASMATIC NUCLEI Final Report, 1 Mar. 1993 - 28 Feb. 1994
MICHAEL MENAKER 2 Sep. 1994 15 p
(Contract(s)/Grant(s): F49620-93-1-0185)
(AD-A285233; AFOSR-94-0588TR) Avail: CASI HC A03/MF A01

Over the past three years we have focused our research efforts on the study of the properties of the suprachiasmatic nucleus (SCN) of the tau mutant hamster. In general we have sought to understand how this mutation, which changes the period of circadian rhythmicity from about 2.4 hours in wild-type animals to near 20 hours in homozygous mutants, affects the SCN itself and how it affects the locomotor behavior which is driven by the SCN. Specifically we have used SCN lesions, which abolish behavioral rhythmicity, followed by transplantation of fetal or neonatal donor SCN, which restores rhythmicity, to ask which components of rhythmic behavior are intrinsic to the SCN and which may depend on its interaction with other structures. We have also studied the free running locomotor rhythms of mutant and wild-type hamsters and compared their responses to constant darkness, constant light and to phase shifting light pulses as a first step toward discovering whether the profound differences that exist in the parameters can all be accounted for by changes in the SCN. DTIC

N95-16737# Aerospace Medical Association, Alexandria, VA.
AEROSPACE MEDICAL ASSOCIATION 63RD ANNUAL SCIENTI FIC MEETING PROGRAM Abstracts Only
14 May 1992 132 p *Meeting held in Miami Beach, FL, 10-14 May 1992*
Avail: CASI HC A07/MF A02

Abstracts submitted by the authors of slide, poster, and panel sessions are presented. They cover aerospace medicine topics in the following areas: gravitaional physiology related to space flight; simulation of microgravity using centrifuges and parabolic flight; motion sickness and space adaptation syndrome; medical techniques in microgravity; medical hardware developed for use in space flight environments; physiological constraints on aerobraking; aircraft control and navigation; anti gravity suits; pilot aging; the effect of long missions on flight crews; and psychological aspects of personnel selection and training. For individual titles, see N95-16738 through N95-16782.

N95-16801 California Univ., Davis, CA. Dept. of Veterinary Pharmacology.
FAILURE OF OZONE AND NITROGEN DIOXIDE TO ENHANCE LUNG TUMOR DEVELOPMENT IN HAMSTERS
H. WITSCHI, M. A. BREIDER, and H. M. SCHULLER *Sep. 1993*
43 p Prepared in cooperation with Tennessee Univ., Knoxville, TN
(Contract(s)/Grant(s): HEI-RFPA-87-4)
(PB94-182854; HEI/RR-60/93) Copyright Avail: Issuing Activity

The authors tested the hypothesis that ozone and nitrogen dioxide modulate the development of respiratory tract tumors, in particular neuroendocrine cell tumors, in Syrian golden hamsters. The animals received subcutaneous injections of the carcinogen N-diethylnitrosamine (20 mg/kg) twice a week while being exposed continuously to an atmosphere of 0.8 parts per million (ppm) of ozone or 15 ppm nitrogen dioxide. Animals were killed 16 weeks or 24 to 32 weeks after the beginning of the treatment. For positive controls, animals were treated with N-diethylnitrosamine and exposed to 65 percent oxygen. Ozone delayed the incidence of tumors in the lung periphery. Ozone also seemed to mitigate development of hepatoxic lesions mediated by N-diethylnitrosamine. The role of ozone and nitrogen dioxide as possible additional risks in the pathogenesis of lung cancer in animals continues to remain uncertain. Derived from text

N95-17666 Army Medical Research Inst. of Chemical Defense, Aberdeen Proving Ground, MD.
A STUDY TO DETERMINE THE CRITICAL CHARACTERISTICS FOR MICE IN A NEWLY DESIGNED WHOLE BODY TOXIC GAS EXPOSURE MODULE Final Technical Report, 8 Mar. - 18 Jul. 1993
HOLCOMBE H. HURT, ALFRED M. SCIUTO, and RICHARD R. STOTTS Dec. 1993 21 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A285085; USAMRICD-TR-93-04) Avail: CASI HC A03

This project was undertaken to answer questions involved in optimizing the use of a newly designed whole body exposure chamber. To accomplish these objectives, individual groups were given 10-, 20-, and 30-minute whole body exposures to moderate concentrations (near LCT 50 concentrations) of phosgene. Survival rates were recorded at 24 hours. Pertinent conclusions were based on the survival rates and were as follows: (1) The LC50 for 20-minute exposures was found to be in the range of 21 to 27 mg per cubic meter; (2) Spatial homogeneity of the chamber gas concentration was satisfactory; and (3) Ten-minute exposures at higher concentrations of phosgene resulted in survival rates which were consistently reproducible as thirty minute exposures at lower concentrations. Author

N95-17714# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
CARBON MONOXIDE DOES NOT MODULATE PULMONARY VASCULAR REACTIVITY IN ISOLATED RAT LUNGS M.S. Thesis
JAMES M. CANTRELL Jul. 1994 62 p
(AD-A283190; AFIT/CI/CIA-94-108) Avail: CASI HC A04/MF A01

Recent studies have demonstrated that the gas nitric oxide (NO), when inhaled in low concentrations, acts as a vasodilator in the pulmonary vasculature. Due to the physical and chemical similarities between NO and carbon monoxide (CO), we speculated that acute, low concentration exposure to CO would have similar effects in the isolated rat lung. Therefore, the purpose of this study was to determine the role of CO (200 and 1000 ppm) in modulating hypoxia and angiotensin 2 induced pulmonary vasoconstriction, using isolated salt-perfused (Earle's salt solution; + 4 g% Ficoll) lungs of male Sprague Dawley rats (CON). Pulmonary hypertensive rats (ALT), induced by simulated altitude exposure (15,000 ft; 4572 m; 430 mm Hg for 32-48 days), were also used to determine the effects of CO in a remodeled pulmonary vascular bed. DTIC

N95-18173*# Maryland Univ., College Park, MD. Dept. of Horticulture.
PHYSIOLOGICAL AND GENETIC CHARACTERIZATION OF PLANT GROWTH AND GRAVITROPISM IN LED LIGHT SOURCES
GERALD F. DEITZER *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program. 1994 Research Reports p 159-203 Oct. 1994
Avail: CASI HC A03/MF A04

Among the many problems of growing plants in completely controlled environments, such as those anticipated for the space station and the CELSS program, is the need to provide light that is both adequate for photosynthesis and of proper quality for normal growth and development. NASA scientists and engineers have recently become interested in the possibility of utilizing densely packed, solid state, light emitting diodes (LED's) as a source for this light. Unlike more conventional incandescent or electrical discharge lamps, these sources are highly monochromatic and lack energy in spectral regions thought to be important for normal plant development. In addition, a recent observation by NASA scientist has suggested that infra-red LED's, that are routinely used as photographic safelights for plants grown in darkness, may interact with the ability of plants to detect gravity. In order to establish how plants respond to light from these LED light sources we carried out a series of experiments with known pigment mutants of the model mustard plant, Arabidopsis thaliana, growing in either a gravity field or on a clinostat to simulate a micro-gravity environment. Results indicate that only red light from the 665 nm LED's disrupts the ability of normal wildtype seedlings to detect a gravity stimulus. There was no consistent effect found for the far-red (735 nm) LED's or either of the infrared (880 nm or 935 nm) LED sources but both showed some effect in one or more of the genotypes tested. Of these five members of the phytochrome multigene family in Arabidopsis, only the phytochrome B pigment mutant (hy3) lacked the ability to detect gravity under all conditions. There was no effect of either micro-gravity (clinostat) or the infra-red LED's on the light induced inhibition of hypocotyl elongation. Measurements of the pigment phytochrome in oats also showed no photoconversion by 15 min irradiations with the infra-red LED's. We conclude that phytochrome B is required for the perception of gravity and that only red light is able to disrupt this perception. The infra-red LED's also do not appear to interact with gravity perception in Arabidopsis, but caution should be exercised if infra-red LED's are to be used as photographic safelights for these types of experiments. Author

N95-18179*# Colorado State Univ., Fort Collins, CO. Dept. of Agricultural and Chemical Engineering.
ETHYLENE DYNAMICS IN THE CELSS BIOMASS PRODUCTION CHAMBER
ALLEN L. RAKOW *In* Univ. of Central Florida, NASA/ASEE Summer Faculty Fellowship Program. 1994 Research Reports p 349-378 Oct. 1994
Avail: CASI HC A03/MF A04

A material balance model for ethylene was developed and applied retrospectively to data obtained in the Biomass Production Chamber of CELSS in order to calculate true plant production rates of ethylene. Four crops were analyzed: wheat, lettuce, soybean, and potato. The model represents an effort to account for each and every source and sink for ethylene in the system. The major source of ethylene is the plant biomass and the major sink is leakage to the surroundings. The result, expressed in the units of ppd/day, were converted to nl of ethylene per gram of plant dry mass per hour and compare favorably with recent glasshouse to belljar experiments. Author

N95-18371# Pacific Northwest Lab., Richland, WA.
MECHANISMS OF INTERACTION AND BIOLOGICAL EFFECTS OF EXTREMELY-LOW-FREQUENCY ELECTROMAGNETIC FIELDS
T. S. TENFORDE 1994 10 p Presented at the US-Japan Science Seminar, Sapporo, Japan, 28 Jun. - 1 Jul. 1994
(Contract(s)/Grant(s): DE-AC06-76RL-01830)
(DE94-015200; PNL-SA-24287; CONF-9406207-1) Avail: CASI HC A02/MF A01

Evidence is mounting, that environmental electric and magnetic fields in the extremely-low-frequency (ELF) band below 300 Hz can influence biological functions by mechanisms that are only poorly understood at the present time. The primary objectives of this paper are to review the physical properties of ELF fields, their interactions with living systems at the tissue, cellular, and subcellular levels, and the key role of cell membranes in the transduction of signals from imposed ELF fields. Topics of discussion include signal-to-noise ratios for single cells and cell aggregates, resonance phenomena involving a combination of static and ELF magnetic fields, and the possible influence of ELF fields on molecular signaling pathways that involve membrane receptors and cytoplasmic second messengers. The implications of these findings for promotion of tumor growth by ELF fields are also reviewed. DOE

N95-18439 Colorado State Univ., Fort Collins, CO. Dept. of Anatomy and Neurobiology.
CELLULAR NEUROPHYSIOLOGY OF THE RAT SUPRACHIASMATIC NUCLEUS: ELECTRICAL PROPERTIES, NEUROTRANSMISSION, AND MECHANISMS OF SYNCHRONIZATION Annual Report, 1 Jul. 1993 - 30 Jun. 1994

F. E. DUDEK 29 Jul. 1994 108 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-93-1-0302)
(AD-A284111; AFOSR-94-0513TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The general aim of this research has been to understand the electrophysiological properties and synaptic mechanisms of suprachiasmatic nucleus (SCN) neurons. Our earlier experiments included sharp-intracellular-electrode analyses of amino-acid-mediated synaptic transmission and intrinsic membrane properties, focussing on the degree to which SCN neurons are homogenous or heterogenous. This work showed that GABA (in addition to glutamate) plays a critical role in fast synaptic transmission in the SCN, and that SCN neurons are not homogenous in terms of their electrophysiological properties, although they could not be grouped into distinct neuron classes. More recently, multiple-unit extracellular recordings have shown synchronous bursts of action potentials in the SCN in low (Ca(2+)) solutions containing amino-acid-receptor antagonists demonstrated to block chemical synapses, thus suggesting that SCN neurons can communicate through nonsynaptic mechanisms. Our more recent studies using whole-cell patch-clamp techniques in the thin-slice preparation have shown evidence for local GABA-ergic communication among SCN neurons, and have begun to define the different types of K(+) currents present in SCN neurons. DTIC

N95-18734*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECT OF HEAT ACCLIMATION ON SITTING ORTHOSTATIC TOLERANCE IN THE HEAT AFTER 48 AND 96 HOUR BED REST IN MEN
J. E. GREENLEAF and M. MATTER, JR. Jan. 1995 10 p
(Contract(s)/Grant(s): RTOP 199-18-12-07)
(NASA-TM-108861; A-95026; NAS 1.15:108861) Avail: CASI HC A02/MF A01

The purpose of this pilot study was to investigate sitting orthostatic tolerance and determine potentially adverse signs and symptoms that would incapacitate subjects in a hot environment (Gemini reentry cabin temperature profile) after 48 hr and 96 hr of horizontal bed rest (BR), which simulated microgravity deconditioning. Six college men (23-29 yr) were allocated into two groups: heat acclimated (three subjects: No. 1- control, No. 2- 48 hr BR, and No. 3- 96 hr BR) and nonheat acclimated (three subjects: No. 4- control, No. 5- 48 hr BR, and No. 6- 96 hr BR). After BR they sat in an ambient temperature of 57 C (135 F) for 30 min which then was decreased to 49 C (120 F) for up to 480 min. Tolerance time in the heat with seated orthostatic stress was 480 min (subject No. 1) and 180 min (subject No. 4) in the two ambulatory men, but was reduced to 22-150 min in the four bed-rested men irrespective of their heat acclimation status. Although heat acclimation appeared to enhance tolerance and attenuate accompanying physiological responses, as well as ameliorate the frequency and intensity of adverse signs and symptoms at termination of exposure, tolerance was reduced in the bed-rest deconditioned subjects regardless of their acclimation level. Thus, these few collective findings do not indicate an unequivocal positive effect of acute heat acclimation on sitting orthostatic tolerance in acute bed-rest deconditioned subjects.
Author (revised)

N95-18997*# Alabama Univ., Huntsville, AL. Dept. of Biological Sciences.
CONCENTRATION AND TEMPERATURE EFFECTS ON OVOSTATIN ACTIVITY
DEBRA M. MORIARITY *In* Alabama Univ., Research Reports: 1994 NASA/ASEE Summer Faculty Fellowship Program 6 p Oct. 1994
Avail: CASI HC A02/MF A03

Light scattering experiments performed at Mississippi State University using MSFC ovostatin preparations indicated that at low ovostatin concentrations, below 0.2 mg/ml, the protein was dissociating from a tetramer into dimers. Since the proposed mechanism of action involved the tetrameric form of the protein, we hypothesized that perhaps under the conditions of our assays at various O/T ratios the ovostatin was becoming dissociated into an inactive dimer. To examine this possibility we assayed the ovostatin activity as a function of ovostatin concentration and of temperature of the assay. Data are presented that show the results of these assays at 23 C, 30 C, 37 C and 42 C respectively. The data are highly suggestive that there is a decrease in ovostatin activity as the concentration of the protein falls below 0.06 mg/ml. This may not be of any physiological importance, however, since the concentration of ovostatin in the egg is about 0.5 mg/ml. Curiously, the dissociation of the tetramer into dimers does not show a significant temperature dependence as would be expected for an equilibrium reaction. Whether this is in fact the case, or whether the differences are so small as to not be discerned from the current data remains to be seen. Another aspect to consider is that in the egg the primary role of the ovostatin may or may not be as a protease inhibitor. Although the inhibition of collagenase by ovostatin may be an important aspect of embryogenesis, it is also possible that it functions as a binding protein for some substance. In this regard, all ovostatin preparations from MSFC have shown an approximately 88,000 MW protein associated with the ovostatin. The identity of this protein is not currently known and may be the subject of future studies. Author

N95-19014*# Calhoun Community Coll., Decatur, AL. Dept. of Natural Sciences.
CAPILLARY ELECTROPHORESIS: BIOTECHNOLOGY FOR SEPARATION OF DNA AND CHROMOSOMES
GEORGE O. WILLIAMS, JR. *In* Alabama Univ., Research Reports: 1994 NASA/ASEE Summer Faculty Fellowship Program 5 p Oct. 1994
Avail: CASI HC A01/MF A03

Electrophoresis has been used for the separation of particles, ions, and molecules for a number of years. The technology for separation and detection of the results has many applications in the life sciences. One of the major goals of the scientific community is to separate DNA molecules and intact chromosomes based upon their different lengths or number of base pairs. This may be achieved by using some of the commercially available and widely used methods, but these processes require a considerable amount of time. The challenge is to achieve separation of intact chromosomes in a short time, preferably in a matter of minutes.
Derived from text

N95-19140*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DRINK COMPOSITION AND CYCLE-ERGOMETER ENDURANCE IN MEN: CARBOHYDRATE, NA(+), OSMOLALITY
J. E. GREENLEAF, R. LOOFT-WILSON, J. L. WISHERD, N. MARCHMAN, T. WELLS, P. R. BARNES, and L. G. WONG (Shaklee US, Inc., San Francisco, CA.) Dec. 1994 16 p
(Contract(s)/Grant(s): RTOP 199-18-12-07)
(NASA-TM-4650; A-94137; NAS 1.15:4650) Avail: CASI HC A03/MF A01

Cycle-ergometer endurance performance was determined in 5 untrained men (22-39 yr, 62.4-100.5 kg, 29-55 mL x min(exp -1) x kg(exp -1) peak oxygen uptake) after consuming Nothing (N) or two fluid formulations (10 mL x kg(exp -1), 555-998 mL). Performance 1 (P1), a multi-ionic-glucose rehydration drink, contains 55 mEq/L Na(exp +), 416 mg/dL citrate, 2,049 mg/dL glucose, and 365 mOsm/kgH2O. HyperAde (HA), a sodium chloride-citrate hyperhydration drink, contains 164 mEq/L Na(exp +), 854 mg/dL citrate, less than 0.5 mg/dL glucose, and 253 mOsm/kgH2O. Endurance at a load of 87-91 percent of peak VO2 was 30.50 +/- SE 3.44 min with HA; 24.55 +/- 1.09 min with P1 (p greater than 0.10 from HA); and 24.68 +/- 1.50 min with N (p less than 0.05 from HA). The attenuated endurance performance with P1 and N could not be attributed to differences in exercise metabolism, change or absolute level of rectal and mean skin tempera-

ture, or change in perceived exertion. The greater increase in resting plasma volume with HA, compared with P1 or N, probably contributed to the greater endurance with HA. ARC

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AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

A95-63898
BIO-REGENERATIVE LIFE SUPPORT SYSTEMS FOR HUMAN PLANETARY MISSIONS
RICHARD S. YOUNG ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 338
Copyright

Human missions to the moon and Mars seem likely prospects for future exploration. Such missions, particularly long term stays will include the establishment of habitations enabling support for stays of a year of more. Techniques for in situ production of food, air and water are currently being studied in several laboratories in the U.S., France, Russia, and probably elsewhere. Author (Hemer)

A95-65124
CALCULATION OF CHARACTERISTIC X RAYS IN DIAGNOSTIC D-RAY SPECTRUM
NOBUYUK NAKAMORI Kyoto Inst. of Technology, Kyoto (Japan), KANAME YAMANO, MASAYOSHI YAMADA, and HITOSHI KANAMORI Japanese Journal of Applied Physics, Part 1: Regul ar Papers and Short Notes and Review Papers (ISSN 0021-4922) vol. 33, no. 1A January 1994 p. 347-352 refs
(BTN-94-EIX94341341389) Copyright

The purpose of this work is to develop a new method of calculating the intensity of the characteristic radiation of the electron energy used in medical diagnosis and to compare the results in detail with the experimental data for a wide variety of radiographic conditions. EI

A95-65203
FIELD ANALYSIS OF DIELECTRIC-LOADED LENS APPLICATOR FOR MICROWAVE HYPERTHERMIA
PHILIP H. ALEXANDER Univ of Windsor, Windsor (Ontario) and JIANFEN LIU IEEE Transactions on Microwave Theory and Techniques (ISSN 0018-9480) vol. 41, no. 5 May 1993 p. 792-796 refs
(BTN-94-EIX94361134953) Copyright

A dielectric-loaded waveguide applicator for microwave hyperthermia is analyzed. The phase constant in the waveguide is determined from the numerical solution of the characteristic equation. The field pattern in human muscle which is produced by the applicator is determined by using the Kirchhoff-Huygens principle. The field focusing effect is dependent on the properties of the low permittivity dielectric slab centered in the water-filled waveguide. The greatest field enhancement is found to occur when the slab is 75 mm wide for a 150 mm x 100 mm waveguide at 430 MHz.
Author (EI)

N95-15975*# Alaska Univ., Fairbanks, AK. Arctic Region Supercomputing Center.
SIMULATION OF ARTHROSCOPIC SURGERY USING MRI DATA
GEOFFREY HELLER and JON GENETTI *In* NASA. Johnson Space Center, ISMCR 1994: Topical Workshop on Virtual Reality. Proceedings of the Fourth International Symposium on Measurement and Control in Robotics p 21-26 Nov. 1994 Sponsored by Cray Research Inc. and Corps of Engineers
Avail: CASI HC A02/MF A02

With the availability of Magnetic Resonance Imaging (MRI) technology in the medical field and the development of powerful graphics engines in the computer world the possibility now exists for the simulation of surgery using data obtained from an actual patient. This paper describes a surgical simulation system which will allow a physician or a medical student to practice surgery on a patient without ever entering an operating room. This could substantially lower the cost of medial training by providing an alternative to the use of cadavers. This project involves the use of volume data acquired by MRI which are converted to polygonal form using a corrected marching cubes algorithm. The data are then colored and a simulation of surface response based on springy structures is performed in real time. Control for the system is obtained through the use of an attached analog-to-digital unit. A remote electronic device is described which simulates an imaginary tool having features in common with both arthroscope and laparoscope. Author

N95-15976*# Padua Univ. (Italy). Dept. of Innovation in Mechanics and Management.
MULTIMODAL CORRELATION AND INTRAOPERATIVE MATCHING OF VIRTUAL MODELS IN NEUROSURGERY
ENRICO CERESOLE, MICHELE DALSASSO, and ALDO ROSSI *In* NASA. Johnson Space Center, ISMCR 1994: Topical Workshop on Virtual Reality. Proceedings of the Fourth International Symposium on Measurement and Control in Robotics p 27-30 Nov. 1994
Avail: CASI HC A01/MF A02

The multimodal correlation between different diagnostic exams, the intraoperative calibration of pointing tools and the correlation of the patient's virtual models with the patient himself, are some examples, taken from the biomedical field, of a unique problem: determine the relationship linking representation of the same object in different reference frames. Several methods have been developed in order to determine this relationship, among them, the surface matching method is one that gives the patient minimum discomfort and the errors occurring are compatible with the required precision. The surface matching method has been successfully applied to the multimodal correlation of diagnostic exams such as CT, MR, PET and SPECT. Algorithms for automatic segmentation of diagnostic images have been developed to extract the reference surfaces from the diagnostic exams, whereas the surface of the patient's skull has been monitored, in our approach, by means of a laser sensor mounted on the end effector of an industrial robot. An integrated system for virtual planning and real time execution of surgical procedures has been realized. Author (revised)

N95-16105# Naval Health Research Center, San Diego, CA. Physiological Performance and Operational Medicine.
AN ANNOTATED BIBLIOGRAPHY OF HEAT TOLERANCE: REGARDING GENDER DIFFERENCES
M. KATHERINE CANINE (Geo-Centers, Inc., Fort Washington, MD.), TONIANN DERION (Public Health Service, Washington, DC.), JAY H. HEANEY (San Diego State Univ., CA.), and ROBERT POZOS 15 Mar. 1994 52 p
(Contract(s)/Grant(s): PROJ. M00-96)
(AD-A280755; NHRC-TD-93-1A) Avail: CASI HC A04/MF A01

The purpose of this technical report is to provide an overview of the literature on the similarities and differences between men and women in their physiological responses to heat stress. Studies that compare thermoregulation in physically fit and sedentary females, as well as research examining the effect of the menstrual cycle on thermal physiology, are included. For each study review, a brief synopsis of the methodology and a summary of relevant results are provided. It was the intent of this report to provide a literature resource, not a review paper, regarding gender differences in thermoregulation during heat exposure. DTIC

N95-16112# North Carolina Univ., Chapel Hill, NC. Dept. of Chemistry.
EXTRACELLULAR IONIC COMPOSITION ALTERS KINETICS OF VESICULAR RELEASE OF CATECHOLAMINES AND QUANTAL SIZE DURING EXOCYTOSIS AT ADRENAL MEDULLARY CELLS Technical Report, Jun. 1993 - Jun. 1994
JEFFREY A. JANKOWSKI, JENNIFER M. FINNEGAN, and R. M. WIGHTMAN 5 Jul. 1994 33 p
(Contract(s)/Grant(s): N00014-91-J-1784)
(AD-A281613; TR-4) Avail: CASI HC A03/MF A01

The temporal resolution of carbon-fiber microelectrodes has been exploited to examine the plasticity of quantal secretory events at individual adrenal medullary cells. The size of individual quantal events monitored by amperometric oxidation of released catecholamines was found to be dependent on the extracellular ionic composition, the secretagogue, and the order of depolarization delivery. Release was observed with either exposure to 60 mM K+ in the presence of Ca2+ or exposure to 3 mM Ba2+ in the solutions of different pH, and without external Ca2+. Ba2+ was demonstrated to induce Ca2+ independent exocytotic release for an extended period of time (greater than 4 min) relative to release induced by K+ (approximately 30 s), which is Ca2+ dependent. In all cases, simultaneous changes of intracellular divalent cations, monitored by fura-2 fluorescence, accompanied quantal release and had a similar time course. Exocytosis caused by Ba2+ in Ca2+ free medium had a large mean spike area at pH 8.2 than at pH 7.4. When Ba2+ induced spikes measured at pH 7.4 were compared, the spikes in Ca2+ free medium were found to be broader and shorter, but had the same area. Release induced by K+ after exposure to Ba2+ was comprised of larger quantal events when compared to preceding K+ stimulations. Finally, spikes obtained with Ba2+ exposure at an extracellular pH of 5.5 had a different shape than those obtained in more basic solutions. These changes in spike size and shape are consistent with the interactions between catecholamines and other intravesicular components. DTIC

N95-16132# Army Aeromedical Research Lab., Fort Rucker, AL.
AVIATION EPIDEMIOLOGY DATA REGISTER: AGE-SPECIFIC MEDICAL AND NONMEDICAL ATTRITION RATES AMONG FORT RUCKER CIVILIAN AVIATORS Final Report
KEVIN T. MASON and SAMUEL G. SHANNON Jul. 1994 19 p
(Contract(s)/Grant(s): DA PROJ. 301-62787-A-878)
(AD-A284970; USAARL-94-35) Avail: CASI HC A03/MF A01

An epidemiological analysis of the coronary angiography outcomes of Fort Rucker civilian aviators could not be completed without first conducting an analysis of attrition from aviation service due to medical and nonmedical causes. Longitudinal data on flying duty medical examinations and aeromedical boards conducted on Fort Rucker area civilian aviators was reviewed using the U.S. Army Aviation Epidemiology Data Register (AEDR). The AEDR records of 847 Fort Rucker civilian aviators were reviewed over nine calendar years from 1985 to 1993. By the end of 1992, 528 (62.3 percent) remained in aviation service, 251 (29.6 percent) were lost to nonmedical attrition, and 68 (8.1 percent) were lost to medical attrition. Of the 847, 196 (23.14 percent) had operational military affiliation (dual-status service as civilians and reserve component aviators), while 651 (76.86 percent) did not. Controlling for age, there was a higher risk for nonmedical and medical attrition among those without operational military affiliation (chi(exp 2, sub Mantel-Haenszel), p less than 0.0001). Medical attrition was uncommon up to 50 years of age. Cardiovascular disease accounted for three-fourths of the cases of medical attrition. Overall, there was a threefold higher rate of medical attrition among those without operational military affiliation. DTIC

N95-16135# International Society for Optical Engineering, Bellingham, WA.
COMPUTATIONAL VISION BASED ON NEUROBIOLOGY Final Report, Jun. 1993 - Jun. 1994
TERI B. LAWTON, ed. 10 Aug. 1994 254 p Conference held at Pacific Grove, CA, 6-9 Jul. 1993
(Contract(s)/Grant(s): F49620-93-1-0274)
(AD-A284472; AFOSR-94-0523TR) Avail: CASI HC A12/MF A03

Biological systems use multiple object attributes to construct a 3D perception from an initial 2D representation. This report explores computational vision models that are based on neurobiology. Each of the fundamental levels of analysis needed for high level pattern recognition are addressed to provide new insights into the different processing modules. Papers detail methods for reconstructing 3D images from partial information, for correcting image defects, or for effectively extracting/analyzing/interpreting images of neurobiological and biomedical interest. DTIC

N95-16151# Naval Aerospace Medical Research Lab., Pensacola, FL.
MATHEMATICAL MODEL FOR INTERACTION OF CANALS AND OTOLITHS IN PERCEPTION OF ORIENTATION, TRANSLATION, AND ROTATION Final Report
JAMES D. GRISSETT Dec. 1993 23 p
(Contract(s)/Grant(s): PROJ. MR0-4101)
(AD-A280897; NAMRL-SR-93-5) Avail: CASI HC A03/MF A01

A computer model with six degrees of freedom was developed in which linear acceleration along each axis is detected and directed along two channels. Output of one channel is perceived as a signal that was generated by gravity, produces no perception of translation, and is used to determine body orientation with respect to earth-vertical. Output of the other channel is perceived as a signal generated by transient linear acceleration and produces a perception of translational motion. Attenuation of signals in these channels is controlled by computations that compare the angular velocity signal generated by the canals with the angular velocity of the input linear acceleration vector. The difference between these velocities serves as an error signal that increases the attenuation of the orientation channel and decreases the attenuation of the translation channel. Orientation channel outputs attenuate orthogonal canal signals that provide angular sensation and ocular reflexes. The model computes the following results that are consistent with empirical data reported in the literature: (1) For off-vertical rotation: bias and modulation components of nystagmus, faster decay of postrotatory nystagmus, attenuation of postrotatory turning sensations, and perceived conical translation; (2) For pendular centrifuge: vertical ascent and tumbling during deceleration; (3) For nonpendular centrifuge: delay in perception of roll; and (4) For passive roll: no delay in perception. DTIC

N95-16152# Naval Health Research Center, San Diego, CA.
EVENT-RELATED BRAIN POTENTIALS AS PREDICTORS OF TARGET DETECTION PERFORMANCE IN A MOVING WATERFALL DISPLAY SIMULATING PASSIVE BROAD-BAND SONAR MONITORING
S. HILLYARD, P. JOHNSTON, and SCOTT MAKEIG Mar. 1994 41 p
(AD-A280900; NHRC-93-33) Avail: CASI HC A03/MF A01

Fifteen subjects performed in a visual target detection task that took place in a simulated broad-band, sonar monitoring display. Over a one-hour test session, subjects attempted to detect two types of targets presented at an average rate of three/minute on a continuously updated waterfall display. Event-related brain potentials were recorded in response to the two classes of targets (growing lines of lighted pixels that simulated an acoustic source in the surroundings and briefly flashed vertical lines) as well as to two types of irrelevant 'probe' stimuli (occasional tone pips and diffuse flashes of the video screen). ERP amplitudes were significantly related to target detection performance in several ways. A late positive component (P300) was enlarged in response to correctly detected targets, particularly in subjects who were performing with a high level of accuracy. Specific ERP components elicited by both targets and irrelevant probes during the first 6 minutes of the session were found to be predictive of subsequent performance accuracy during the hour-long session in subjects studied under alert and drowsy conditions. These findings suggest the application of ERP measures to evaluate fitness for duty of operators in task situations

requiring a high level of vigilance, such as radar and sonar operators, air traffic controllers, etc. DTIC

N95-16228# Army Research Inst. of Environmental Medicine, Natick, MA. Altitude Physiology and Medicine Div.
EVALUATION OF A NEWLY-DESIGNED, DYNAMIC KNEE EXTENSION DEVICE FOR THE STUDY OF MUSCLE FATIGUE IN HUMANS Final Report, 1 Sep. 1993 - 2 Sep. 1994
CHARLES S. FULCO, STEVEN F. LEWIS, PETER N. FRYKMAN, ROBERT BOUSHEL, SINCLAIR SMITH, LINDSAY GIBSON, ALLEN CYMERMAN, and KENT B. PANDOLF 2 Sep. 1994 40 p
(AD-A284974; USARIEM-TR-94-18) Avail: CASI HC A03/MF A01

A device utilizing a simple pulley system was developed to study muscle fatigue during dynamic, submaximal exercise isolated to the knee-extensor muscles of one or both legs. The purposes of this study were to determine the following: (1) oxygen consumption requirements for various submaximal and maximal power outputs and to compare these data to values obtained from published reports using modified bicycle ergometers (criterion devices), (2) intraindividual test-retest variability, and (3) muscle fatigability during exercise. On each of 2 separate days, 8 male volunteers (mean age 18.6 + or - 0.3 yr (SE), weight 79.5 + or 5.1 kg, and height 179.1 + or - 2.0 cm) performed a graded, intermittent (4 min bouts) exercise test using the knee-extensor muscles of one leg to determine one-legged peak oxygen consumption. Maximal voluntary contractions (MVC) were obtained at the beginning, at 2 min, and at the end of each exercise bout as a means to monitor rate of muscle fatigue. The slope and intercept of the relationship of the increase in power output and oxygen consumption were 13.80 ml O2/watt and 470 ml/min, respectively, with r2 = 0.96. These values for slope and intercept are similar to those reported previously: slopes 13.10 and 14.70 ml O2/watt; intercepts, 400 and 471 ml/min; and r2 = 0.99. Also, there was minimal intra-individual variation (r2 = 0.90) in oxygen consumption values for identical power outputs. Test-retest oxygen consumption values did not differ from a line of identity. Stepwise accelerations in muscle fatigability were discernable with small increments in exercise intensity and elapsed exercise time. Our device represents a low-cost, expanded capability alternative compared to previous units utilizing modified bicycle ergometers as a testing mode.
DTIC

N95-16297# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
A PROPOSAL TO STUDY GENDER DIFFERENCES IN THE RATES OF DECOMPRESSION SICKNESS M.S. Thesis
GREGG A. BENDRICK May 1994 50 p
(AD-A281854; AFIT/CI/CIA-94-049) Avail: CASI HC A03/MF A01

Decompression sickness is the clinical syndrome associated with evolution of nitrogen bubbles in the blood and body tissues upon exposure to an acute reduction in barometric pressure. Because nitrogen is more soluble in fatty substances than in water, adiposity has long been considered a risk factor for the development of decompression sickness. Due to the physiologic differences between the sexes, women have an average eight percent more body fat than men, so it is possible that women have a greater likelihood of developing decompression sickness. Several studies in the scientific literature seem to support this hypothesis, but they have been associated with such drawbacks as selection and reporting bias, retrospective approach, and the lack of an objective diagnostic modality for the syndrome of decompression sickness. DTIC

N95-16360# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
CHARACTERIZATION OF THE FAST-PHASE COMPONENT OF THE VESTIBULO-OCULAR RESPONSE M.S. Thesis
REBECCA SCHULTZ May 1994 52 p
(AD-A281830; AFIT/CI/CIA-94-043) Avail: CASI HC A04/MF A01

The vestibular system can be tested by recording eye-movement responses to whole-body angular acceleration. The resulting vestibulo-ocular reflex (VOR) has two components. The slow-phase component is a compensating movement in the same direction as the stimulus, while the fast-phase component is a refixation movement usually in the opposite direction of the stimulus. The slow-phase signal is extracted and evaluated to determine the condition of the vestibular system. Currently the fast-phase component is not used for diagnostic purposes. Normal subjects were tested and the extracted fast-phase signal was characterized using parameters such as amplitude, velocity and duration of each fast eye movement.
Derived from text

N95-16378 Michigan State Univ., East Lansing, MI. Dept. of Pediatrics and Human Development.
THE ROLE OF CHEMICAL INHIBITION OF GAP JUNCTIONAL INTERCELLULAR COMMUNICATION IN TOXICOLOGY Annual Technical Report, 14 May 1993 - 15 May 1994
JAMES E. TROSKO 14 Jun. 1994 206 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-92-J-0293)
(AD-A282452; AFOSR-94-0421TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Gap junctional intercellular communication (GJIC) is the biological process which regulates homostatic control of cell proliferation, differentiation, and adaptive functions of differentiated cells. Disruption of GJIC by toxic chemicals, either at the level of gene expression or protein function, has been correlated with teratogenesis, tumor promotion, reproductive and neurotoxicities. The mechanisms by which various epigenetic toxicants or oncogenes inhibit GJIC have been studied. Modulation of phosphorylation of one gap junction protein (cx43) by two different tumor promoters (phorbol esters, DDT) has been shown to be different, yet the end result (inhibition of GJIC) is the common end point. Preliminary evidence has linked the toxic-chemical modification of the gap junction protein phosphorylation paths with altered trafficking of the protein within the cell. DTIC

N95-16405# Army Aeromedical Research Lab., Fort Rucker, AL.
AVIATION EPIDEMIOLOGY DATA REGISTER: CORONARY ANGIOGRAPHY OUTCOMES OF CIVILIAN AVIATORS FLYING US AIRCRAFT
KEVIN T. MASON and SAMUEL G. SHANNON Aug. 1994 26 p
(AD-A285191) Avail: CASI HC A03/MF A01

All Army aviators participate in a cardiovascular disease screening program. Five percent of Army aviators are civilian. The U.S. Army Aviation Center requested a review of cardiovascular disease screening outcomes among this subgroup of aviators. The AEDR was queried to determine the coronary angiography outcomes of civilian aviators who failed levels 1 and 2 of cardiovascular disease screening program during the period 1988 to 1992. Among 847 civilian aviators, 364 failed level 1 cardiovascular disease screening due to elevated risk factors for coronary artery disease. Among the 364, 289 passed level 2 screening with a normal exercise treadmill tent and a normal cardiac fluoroscopy. The remaining 75 failed level 2 by having an abnormal exercise treadmill tent and/or an abnormal cardiac fluoroscopy. These 75 were referred for further diagnostic testing in levels 3 and 4. Of the 55 aviators undergoing coronary angiography, 17 had normal coronary arteries, 14 had uncomplicated minimal coronary artery disease, 3 had complicated minimal coronary artery disease, and 21 had significant coronary artery occlusions. Eight other aviators had advanced heart conditions other than coronary artery disease, such as cardiomyopathy. Of 36 aviators with documented significant cardiovascular disease, 32 (88.9 percent) denied symptoms when their disease was detected by the screening program. They were referred for clinical, and in some cases, emergent care. DTIC

N95-16412*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
KINETICS MODEL FOR INITIATION AND PROMOTION FOR DESCRIBING TUMOR PREVALENCE FROM HZE RADIATION
FRANCIS A. CUCINOTTA and JOHN W. WILSON Dec. 1994 19 p
(Contract(s)/Grant(s): RTOP 199-45-16-11)
(NASA-TP-3479; L-17404; NAS 1.60:3479) Avail: CASI HC A03/MF A01

A kinetics model for cellular repair and misrepair for multiple radiation-induced lesions (mutation-inactivation) is coupled to a two-mutation model of initiation and promotion in tissue to provide a parametric description of tumor prevalence in the Harderian gland in a mouse. Dose-response curves are described for gamma-rays and relativistic ions. The effects of nuclear fragmentation are also considered for high-energy proton and alpha particle exposures The model described provides a parametric description of age-dependent cancer induction for a wide range of radiation fields. We also consider the two hypotheses that radiation acts either solely as an initiator or as both initiator and promoter and make model calculations for fractionation exposures from gamma-rays and relativistic Fe ions. For fractionated Fe exposures, an inverse dose-rate effect is provided by a promotion hypothesis using a mutation rate for promotion typical of single-gene mutations. Author

N95-16423# Puerto Rico Univ., San Juan. Inst. of Neurobiology.
CHARACTERIZATION OF NEUROTROPHIC AND NEUROTROPIC INTERACTIONS BETWEEN NEURONS AND THEIR MUSCLE AND NERVE TARGETS Final Report, 1 Sep. 1990 - 30 Nov. 1993
DAMIEN KUFFLER 14 Feb. 1994 12 p
(Contract(s)/Grant(s): DAAL03-90-G-0189)
(AD-A281846; ARO-28095.4-LS-SAH) Avail: CASI HC A03/MF A01

The broad aim of the work carried out under the support of this grant was to examine the factors involved in promoting and directing axon regeneration. How do injured nerves find and recognize their targets and reestablish the correct types of synaptic contacts with them? Cultures have been established of adult sensory and motor neurons, as well as intact muscle fibers. These cells survive for weeks in vitro and the neurons extend processes. In electrophysiological experiments we have characterized several membrane properties of the neurons. The peripheral nerve tube, as well as isolated intact muscle fibers, have been shown to release trophic factors that promote and modify process outgrowth from the sensory neurons, and one of the trophic factors is being characterized. An extracellular matrix molecule that independently also promote process outgrowth has been isolated and characterized. A novel role of macrophages, as directors of process growth, has been shown. Preliminary experiments demonstrate that factors released from peripheral nerve can direct process outgrowth by means of diffusible concentration gradients. DTIC

N95-16444# Minnesota Univ., Minneapolis, MN.
HEMOGLOBIN-BASED BLOOD SUBSTITUTES AND ENHANCED SUSCEPTIBILITY TO BACTERIAL INFECTIONS Final Report, 17 Jan. 1991 - 9 Feb. 1994
JOHN R. MAHONEY and JOHN W. EATON 8 Mar. 1994 26 p
(Contract(s)/Grant(s): DAMD17-91-Z-1009)
(AD-A281023) Avail: CASI HC A03/MF A01

Chemically modified human hemoglobin is currently being studied as a potential blood substitute for use in military and emergency medical applications. We have tested one form of modified hemoglobin, DBBF-Hb, against normal Hb in order to determine its ability to promote hemoglobin-driven bacterial infections. Using an experimental model of E. coli peritonitis we have determined that DBBF-Hb is equally likely as unmodified Hb (on a mole to mole basis) to lead to a fatal outcome in this model. Further investigations were undertaken to elucidate the molecular mechanism of these hemoglobin-driven bacterial infections. The strains of E. coli that exhibit the hemoglobin-adjuvant effect are resistant to phagocytosis by peritoneal macrophages. This feature may explain why hemoglobin is necessary (nutritional iron) but not sufficient for the promotion of E. coli infections. We are currently examining the composition of the outer membrane proteins in the hemoglobin-adjuvant strains. In addition, using a molecular biological approach, we are attempting to clone the gene(s) responsible for the hemoglobin adjuvant phenotype in E. coli. Further understanding of the mechanism of hemoglobin driven bacterial infections may enable the rational design of a safe blood substitute. DTIC

N95-16481# Toronto Univ. (Ontario). Dept. of Psychology.
CELL CULTURE AND TRANSPLANTATION OF THE SUPRACHIASMATIC CIRCADIAN PACEMAKER Annual Report, 30 Sep. 1992 - 29 Sep. 1993
MARTIN R. RALPH 29 Sep. 1993 5 p
(Contract(s)/Grant(s): F49620-92-J-0517)
(AD-A280977; AFOSR-94-0374TR) Avail: CASI HC A01/MF A01

The general aim of the research supported by AFOSR is to understand how circadian rhythms in mammals are generated and controlled. We have used a variety of techniques to ask such questions as: (1) How does photic information reach and affect the clock? (2) What is the nature of the electrical events in pacemaker cells responsible for the generation and expression of rhythmicity? (3) What are the biochemical components of the pacemaker system? In particular, we have used the tau (period) mutation in the golden hamster, to pursue experiments designed to eventually identify mammalian circadian pacemaker cells. DTIC

N95-16484# Dalhousie Univ., Halifax (Nova Scotia). Dept. of Psychology.
NEUROPHYSIOLOGICAL ANALYSIS OF CIRCADIAN RHYTHM ENTRAINMENT Annual Technical Report, 1 Jun. - 31 Dec. 1993
BENJAMIN RUSAK 24 May 1994 9 p
(Contract(s)/Grant(s): F49620-93-1-0089)
(AD-A280981; AFOSR-94-0372TR) Avail: CASI HC A02/MF A01

Loss of melatonin secretion in hamsters can alter the rhythm of melatonin sensitivity in the suprachiasmatic nuclei (SCN) as tested in an in-vitro slice preparation. The effect on melatonin sensitivity depended on whether pinealectomy or brief constant light exposure was used to reduce melatonin levels, with constant light increasing sensitivity and pinealectomy decreasing it. The same treatments also eliminated or reduced the amplitude of the firing-rate rhythms monitored in the SCN slice preparation. These results imply a role for pineal melatonin in the maintenance of the normal amplitude of the SCN pacemaker's output rhythms. Serotonin and melatonin were determined to suppress photic responses of SCN cells and intergeniculate leaflet cells studied in vivo. Serotonin appears to act at both targets via a receptor that is similar to the serotonin-1A receptor type, while melatonin acts via a non-serotonergic receptor. Gastrin-releasing peptide (GRP) causes increased firing of about 50% of SCN cells tested in a slice preparation; the proportion of responsive cells depends on the circadian phase tested. GRB injected into the SCN in vivo causes phase-dependent phase shifts that resemble those caused by light pulses. DTIC

N95-16491# Army Medical Research Inst. of Chemical Defense, Aberdeen Proving Ground, MD.
DEVELOPMENT OF AN IN VITRO MODEL ASSAY SYSTEM FOR THE EVALUATION OF THE EFFECTS OF TOXIC CHEMICALS ON HUMAN AIRWAYS Final Report, 1988 - 1993
JAMES L. ELLIS and MARGARET G. FILBERT Mar. 1994 16 p
(AD-A285074; USAMRICD-TR-94-02) Avail: CASI HC A02/MF A01

The ability of the anticholinesterase agent soman to contract human bronchi was examined. Soman (1-2 uM) had variable effects on human bronchi that had not been stimulated with an electric field stimulator (EFS). In bronchi continuously stimulated by EFS (0.5 Hz, 1 ms, 12 V), soman produced contractions in all tissues examined (12 preparations from 9 humans). In tissues stimulated by EFS, the

beta-adrenoreceptor agonist isoproterenol produced relaxations that were greater in magnitude than the contractions produced by soman. The duration of the isoproterenol induced relaxations was variable. Of 12 preparations studied, 3 showed no reversal of the relaxation within 120 min, 6 showed a slow reversal with a reversal time of 106 +/- 6 min and 3 showed rapid reversal with a 50 percent reversal time of 14 min. In the latter group the duration of the relaxation produced by isoproterenol was doubled (28 +/- 2 min) by the M2 muscarinic receptor antagonist AFDX 116 (10 uM). These results show that the isolated human bronchus is a useful model for studying the effects of toxic chemical agents such as soman on the airways. The data obtained with isoproterenol suggest that beta-2 agonists may be useful adjuncts for treating the effects of anticholinesterase agents. DTIC

N95-16515# Arizona Univ., Tucson, AZ.
THE CHRONIC EFFECTS ON JP-8 JET FUEL EXPOSURE ON THE LUNGS Final Technical Report, 1 Apr. 1991 - 31 Mar. 1994
MARK L. WITTEN 2 Jun. 1994 12 p
(Contract(s)/Grant(s): AF-AFOSR-0199-91)
(AD-A280982; AFOSR-94-0382TR) Avail: CASI HC A03/MF A01

There are four major findings from the three years of work devoted to the effects of chronic JP-8 jet fuel exposure on the lungs and secondary organs. These findings are the following chronic exposure to JP-8 jet fuel alters pulmonary function and lung structures with an acute response with as little as seven days of low dose, approximately 500 mg/m3, exposure to JP-8 jet fuel; chronic exposure to JP-8 jet fuel increased liver, spleen, and kidney weights compared to controls. Microscopic evaluation of liver sections were normal; however, kidney and spleen had histological changes consistent with organic solvent exposure. There is a correlation between JP-8 jet fuel exposure-induced decreases in lung Substance P levels and lung neutral endopeptidase levels. Chronic exposure to JP-8 jet fuel caused a decrease in lung Substance P levels with a corresponding increase in lung neutral endopeptidase levels; and, there is a recovery process in the 56 day low dose JP-8 jet fuel-exposed lungs as marked by a return to baseline and longitudinal control 99mTcDTPA values. The 99mTcDTPA data was very consistent with our pathologic findings of very little lung injury in the 56 day low dose JP-8 jet fuel-exposed rats. We speculate that this finding indicates that there is a 'threshold' level of JP-8 jet fuel exposure that the lungs' defense mechanism(s) can tolerate. DTIC

N95-16619# Naval Health Research Center, San Diego, CA.
SKIN BLOOD FLOW AND BIOELECTRICAL IMPEDANCE Final Report, Jul. 1989 - Sep. 1990
MARCIE B. BECKETT, JAMES A. HODGDON, WANDA WOODS, and BRIAN W. APPLETON 14 Jun. 1994 20 p
(Contract(s)/Grant(s): NR PROJ. M00-001)
(AD-A285475; NHRC-94-17) Avail: CASI HC A03/MF A01

This study was performed to determine the effect of changes in skin blood flow (SBF) on bioelectrical resistance (RES). Twenty-three men had their left hand repeatedly immersed (1 min) and removed from water (3 min) for a total of 12 min in order to manipulate SBF in the contralateral (right) limbs where RES electrodes were located. Tests were completed at three water temperatures (5, 15, and 350C) in constant ambient air temperature (25 +/ - 1 deg C). SBF was monitored on the middle finger of the right hand using a laser-Doppler flowmeter, and skin temperature on the dorsal right hand (Th) and foot (Tf). Time series analysis revealed cyclic SBF and RES responses were inversely correlated at all water temperatures (r = -0.38 to -0.64; p less than 0.05). Tb and Tf were not correlated with SBF for any test. During hand immersion in 5, 15, and 350C water, SBF decreased by 36, 20, and 4%, respectively, while RES increased by 3.5, 2.0, and 0.7 ohms, respectively. When incorporated into existing bioimpedance (BIA) prediction equations, the largest RES difference observed (3.5 ohms) translated into a difference of 0.4% body fat and 0.4 L body water. Changes in SBF of the magnitude observed in this study appear to have a relatively small impact on BIA prediction of body water and composition. DTIC

N95-16738*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THE EFFECT OF DIFFERENCES IN TIME TO DETECTION OF CIRCULATING MICROBUBBLES ON THE RISK OF DECOMPRESSION SICKNESS Abstract Only
K. V. KUMAR (Krug Life Sciences, Inc., Houston, TX.), J. H. GILBERT (Krug Life Sciences, Inc., Houston, TX.), M. R. POWELL, and J. M. WALIGORA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Circulating microbubbles (CMB) are frequently detected prior to the appearance of symptoms of Decompression Sickness (DCS). It is difficult to analyze the effect of CMB on symptoms due to differences in the time to detection of CMB. This paper uses survival analysis models to evaluate the risk of symptoms in the presence of CMB. Methods: Information on 81 exposures to an altitude of 6,400 m (6.5 psi) for a period of three hours, with simulated extravehicular activities, was examined. The presence or absence of CMB was included as a time dependent covariate of the Cox proportional hazards regression model. Using this technique, the subgroup of exposures with CMB was analyzed further. Mean (S.D.) time in minutes to onset of CMB and symptoms were 125 (63) and 165 (33) respectively, following the three hours exposure. The risk of symptoms (17/81) increased 14 times in the presence of CMB, after controlling for variations in time to detection of CMB. Further, the risk was lower when time to detection of CMB was greater than 60 minutes (risk ratio = 0.96; 95 percent confidence intervals = 0.94 - 0.99 0.99 P less than 0.01) compared to CMB before 60 minutes at altitude. Conclusions: Survival analysis showed that individual risk of DCS changes significantly due to variations in time to detection of CMB. This information is important in evaluating the risk of DCS in the presence of CMB. Author

N95-16739*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
VARIABILITY IN HOFFMANN AND TENDON REFLEXES IN HEALTHY MALE SUBJECTS Abstract Only
E. GOOD (Humana Hospital, Webster, TX.), S. DO (Baylor Coll. of Medicine, Houston, TX.), and M. JAWEED *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

There is a time dependent decrease in amplitude of H- and T-reflexes during Zero-G exposure and subsequently an increase in the amplitude of the H-reflex 2-4 hours after return to a 1-G environment. These alterations have been attributed to the adaptation of the human neurosensory system to gravity. The Hoffman reflex (H-reflex) is an acknowledged method to determine the integrity of the monosynaptic reflex arc. However deep tendon reflexes (DTR's or T-reflexes), elicited by striking the tendon also utilize the entire reflex arc. The objective of this study was to compare the variability in latency and amplitude of the two reflexes in healthy subjects. Methods: Nine healthy male subjects, 27-43 years in age, 161-175 cm in height plus 60-86 Kg in weight, underwent weekly testing for four weeks with a Dan-Tec EMG counterpoint EMG system. Subjects were studied prone and surface EMG electrodes were placed on the right and left soleus muscles. The H-reflex was obtained by stimulating the tibial nerve in the politeal fossa with a 0.2 msec square wave pulse delivered at 2 Hz until the maximum H-reflex was obtained. The T-reflex was invoked by tapping the achilles tendon with a self triggering reflex hammer connected to the EMG system. The latencies and amplitudes for the H- and T-reflexes were measured. Results: These data indicate that the amplitudes of these reflexes varied considerably. However, latencies to invoked responses were consistent. The latency of the T-reflex was approximately 3-5 msec longer than the H-reflex.

Conclusion: The T-reflex is easily obtained, requires less time, and is more comfortable to perform. Qualitative data can be obtained by deploying self triggering, force plated reflex hammers both in the 1--G and Zero-G environment. Author

N95-16740*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE PSYCHOPHYSICAL FUNCTION FOR PERCEIVED GRAVITATIONAL-INERTIAL FORCE DOES NOT DEPEND ON THE ORIENTATION OF THE OTOLITH ORGANS Abstract Only
M. COHEN, R. WELCH, and C. DEROSHIA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

It has generally been believed that the perceived intensity of a gravitational-inertial force depends on both the magnitude and orientation of the force with respect to the otolith organs, as does the elevator illusion. In this study, we examine the perceived intensity of Gz force and the elevator illusion as a function of the applied force and the orientation of the subject's head. Methods: Each of 7 male subjects was seated upright in a swinging chair mounted in the Ames 20-G Human Centrifuge while he set a visual target to his apparent horizon and judged the perceived intensity of Gz forces by cross-modal matches on a hand dynamometer. Plateau Gz levels were 1.00 1.25, 1.50, 2.00, 2.25, and 2.50; a 30 second ramp to plateau was used in all cases, and the duration of exposure at each plateau was 120 seconds. All measures were obtained both with the subject's head erect and pitched forward 30 degrees. Results: Although the elevator illusion changed with head orientation ($F(6,60) = 7.56$; p less than 0.001) the perceived intensity of Gz was essentially the same for both orientations of the head ($F(6,60) = 0.61$; p greater than 50). Conclusions: The results of this experiment suggest that the perceived intensity of gravitational-inertial force does not depend on otolith mechanisms in the same way as does the elevator illusion and that somesthetic, tactile, and other proprioceptive inputs are important for the psychophysical function. Author

N95-16741*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
USE OF INJECTABLE PROMETHAZINE TO DECREASE SYMPTOM SCORES OF SPACE MOTION SICKNESS Abstract Only
B. G. BECK and A. E. NICOGOSSIAN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Space motion sickness (SMS) has been a problem affecting approximately 74 percent of first time shuttle flyers. Promethazine injections have been used for 29 cases of SMS to decrease the severity of their illness. Although reported to be effective in reducing symptoms in 27 of the 29 cases, there has been no proof of its efficacy. Methods: Retrospective analysis of medical debriefs examining the symptom scores for nausea, vomiting, decreased appetite, and stomach awareness were performed. Each symptom is rated on a mild = 1, moderate = 2, severe = 3 system for each flight day. Crewmember scores for the first three flight days on an initial flight in which injectable promethazine had not been used were compared to scores in a later flight in which the promethazine was utilized. Scores were also compared in a similar group of crewmembers who did not use promethazine. Results: There was a decrease in median scores for all symptoms except nausea, however, it was significant ($p = 0.14$) only for the vomiting scores. This significant decrease was not seen in the control group. Conclusions: Injectable promethazine has been associated with a significant decrease in vomiting compared to earlier flights in which injectable promethazine was not used. Author

N95-16742*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPARISON OF SALINE AND FLUDROCORTISONE AS FLUID-LOADING COUNTERMEASURES FOLLOWING EXPOSURE TO SIMULATED MICROGRAVITY Abstract Only
J. VERNIKOS, D. A. LUDWIG, and V. A. CONVERTINO *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Saline loading (SL) within hours of reentry is currently used as a countermeasure against postflight orthostatic hypotension in astronauts. However, its effects on blood volume expansion is not quantified and its effectiveness has proved marginal at best. The purposes of the present study were: (1) to quantify the effects of SL on plasma volume and orthostatic tolerance following exposure to simulated microgravity and (2) to compare these effects with the use of a pharacological fluid expander, fludrcortisone (F). Method: Eleven men (30-45 yr.) underwent a 15-minute stand test before and immediately after 7 days of head-down bedrest (BR). Five subjects ingested SL (8 g salt tablets with 1 liter of water) 2 hours before standing at the end of BR while the other 6 subjects received 0.2 mg oral doses of F at 0800 and 2200 hours the day before and 0800 hours the day the subjects got out of bed (i.e., 2 hours before standing). Plasma volume (PV) was measured before BR on day 7 of BR and after the final SL and F treatments just before the post-BR stand test. Blood pressure and heart rate were measured continuously during the stand tests. Results: BR decreased PV from 40.7 plus or minus 1.9 mml/kg to 35.9 plus or minus 1.1 ml/kg (minus 11.8 percent P less than 0.05). Following SL, PV remained at 36.4 plus or minus 1.5 ml/kg while F returned PV to 39.1 plus or minus 1.8 ml/kg. The post BR stand test was completed without syncopal symptoms by 5 of 6 F subjects but only 2 of 5 SL subjects. Conclusions: SL may be ineffective in restoring PV to preflight levels and may provide inadequate protection against postflight orthostatic hypotension. In contrast, F may provide a promising countermeasure since it restored PV and reduced the incidence of syncope following exposure to simulated microgravity in the present study. Author

N95-16743*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
SKELETAL MUSCLE RESPONSES TO UNLOADING IN HUMANS Abstract Only
G. DUDLEY (Bionetics Corp., Cocoa Beach, FL.), P. TESCH, B. HATHER, G. ADAMS, and P. BUCHANAN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Prepared in cooperation with Karolinska Inst., Stockholm, Sweden
(Contract(s)/Grant(s): NAS10-11624)
Avail: CASI HC A01/MF A02

This study examined the effects of unloading on skeletal muscle structure. Method: Eight subjects walked on crutches for six weeks with a 110 cm elevated sole on the right shoe. This removed weight bearing by the left lower limb. Magnetic resonance imaging of both lower limbs and biopsies of the left m. vastus laterallis (VL) were used to study muscle structure. Results: Unloading decreased (P less than 0.05) muscle cross-sectional areas (CSA) of the knee extensors 16 percent. The knee flexors showed about 1/2 of this response (-7 percent, P less than 0.05). The three vasti muscles each showed decreases (P less than 0.05) of about 15 percent. M. rectus femoris did not change. Mean fiber CSA in VL decreased (P less than 0.05) 14 percent with type 2 and type 1 fibers showing reductions of 15 and 11 percent respectively. The ankle extensors showed a 20 percent decrease (P less than 0.05) in CSA. The reduction for the 'fast' m. gastrocnemius was 27 percent compared to the 18 percent decrease for the 'slow' soleus. Summary: The results suggest that decreases in muscle CSA are determined by the relative change in impact loading history because atrophy was (1) greater in extensor than flexor muscles, (2) at least as great in fast as compared to slow muscles or fibers, and (3) not dependent on single or multi-joint function. They also suggest that the atrophic responses to unloading reported for lower mammals are quantitatively but not qualitatively similar to those of humans. Author

N95-16744*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INTRAMUSCULAR PRESSURE: A BETTER TOOL THAN EMG TO OPTIMIZE EXERCISE FOR LONG-DURATION SPACE FLIGHT Abstract Only
A. R. HARGENS, R. E. BALLARD, M. ARATOW, A. CRENSHAW, J. STYF, N. KAHAN, and D. E. WATENPAUGH *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

A serious problem experienced by astronauts during long-duration space flight is muscle atrophy. In order to develop countermeasures for this problem, a simple method for monitoring in vivo function of specific muscles is needed. Previous studies document that both intramuscular pressure (IMP) and electromyography (EMG) provide quantitative indices of muscle contraction force during isometric exercise. However, at present there are no data available concerning the usefulness of IMP versus EMG during dynamic exercise. Methods: IMP (Myopress catheter) and surface EMG activity were measured continuously and simultaneously in the tibalis anterior (TA) and soleus (SOL) muscles of 9 normal male volunteers (28-54 years). These parameters were recorded during both concentric and eccentric exercises which consisted of plantarflexon and dorsiflexon of the ankle joint. A Lido Active Isokinetic Dynamometer concurrently recorded ankle joint torque and position. Results: Intramuscular pressure correlated linearly with contraction force for both SOL (r exp 2 = 0.037) and TA (R exp 2 = 0.716 and r exp 2 = 0.802, respectively). During eccentric exercises, SOL and TA IMP also correlated linearly with contraction force (r(exp 2) = 0.883 and r(exp 2) = 0.904 respectively), but SOL and TA EMG correlated poorly with force (r(exp 2) = 0.489 and r(exp 2) = 0.702 respectively). Conclusion: IMP measurement provides a better index of muscle contraction force than EMG during concentric and eccentric exercise. IMP reflects intrinsic mechanical properties of individual muscles, such as length tension relationships. Although invasive, IMP provides a more powerful tool and EMG for developing exercise hardware and protocols for astronauts exposed to long-duration space flight. Author

N95-16745*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
CATECHOLAMINERGIC RESPONSES TO STRESSFUL MOTION STIMULI, SCOPOLAMINE PLUS AMPHETAMINE, AND DEXAMETHASONE Abstract Only
R. L. KOHL and W. E. CHELEN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Prepared in cooperation with National Academy of Sciences - National Research Council, Houston, TX
(Contract(s)/Grant(s): NAS9-17267; RTOP 199-16-11-08)
Avail: CASI HC A01/MF A02

Peripheral levels of epinephrine (EPI) and neoepinephrine (NE) generally rise following stressful motion stimuli. Effective anti-motion sickness drugs, scopolamine plus, d-amphetamine (S/D) and dexamthasone (DEX) modulate release of EPI and NE. This modulation may be of etiological relevance. Methods: Severe nausea was induced by exposure to coriolis simulation using a rotating chair. Chronic administration of S/D (0.4 and 5 mg/da) DEX (3 mg/day) and placebo preceded coriolis simulation. EPI and NE were measured immediately before and after simulation. A double-blind crossover design was used. Results: Nausea-induced elevations of EPI (2.5 fold, p less than. 01) and NE were not diminished upon repeated exposure and adaptation to the stressor. Subjects with more pronounced elevations of EPI following simulation displayed higher resistance to stressful motion (p less. 05). Alteration of peripheral catechlomaine levels following drug suggested that motion sickness was not mediated by peripheral catechlolamine receptor simulation. EPI and NE levels were 2.8 and 3.6-fold higher (p less than. 03 and. 01) after nausea without DEX treatment. DEX loading halved pre-stress levels of EPI and NE (p less than. 05). Conclusions: Marked differences were noted in individual responses to drug and systematic responses of EPI and NE. It is possible that the responses of EPI to motion sickness may predict resistance to stressful motion and represent a peripheral manifestation of some as yet unknown central event of etiologic relevance.
Author

N95-16746*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
HEAT STRESS AND A COUNTERMEASURE IN THE SHUTTLE RESCUEMAN'S SUIT Abstract Only
D. F. DOERR, H. REED, and V. A. CONVERTINO *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Rescue of the astronaut flight crew from a contingency landing may risk exposure of the rescue crew to toxic propellants spilling from potentially ruptured tanks in the crew module area. An Aquala dry diver's suit has been in service by the rescue team to preclude exposure, especially in the water rescue scenario. Heat stress has become a factor of concern in recent years when older and less physically-fit team members work in this suit. Methods: Field testing was initiated using fully instrumented rescue men in a simulated scenario to determine the extent of heat stress. Two tests were accomplished, one in the normal (N) configuration and one with a proposed cooling countermeasure, the Steele vest (S). Results: Heat stress was high as indicated by average rectal temperatures (Tre) of 38.28 degrees C(100.9 degrees F) after the 45 minute protocol. Slopes of the regression equations describing the increase in Tre with time were greater (P less than 0.05) with N (0.073 plus or minus. 008) compared to S (0.060 plus or minus. 007). Projection of time to the 38.89 degree C (102 degree F) limit was increased by 15.3 percent with the vest. Mean skin temperature (Tsk) was higher (P less than 0.05) in N (38.33 plus or minus. 11 degrees C) compared to S (34.33 plus or minus. 39 degrees C). Average heart rate was higher (P less than 0.05 in N than S. Sweat loss, as measured by weight loss, was more (P less than 0.05) for N (1.09 plus or minus. 09 kg versus 0.77 plus or minus. 06 kg). Air usage, while slightly less for S, was not statistically different. Conclusion: The use of the cool vest provided significant relief from thermal stress in spite of the addition of 3.4 kg (7.5 pounds) weight and some loss in mobility.
Author

N95-16747*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A NEW MODEL FOR ESTIMATING TOTAL BODY WATER FROM BIOELECTRICAL RESISTANCE Abstract Only
S. F. SICONOLFI and K. T. KEAR *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Estimation of total body water (T) from bioelectrical resistance (R) is commonly done by stepwise regression models with height squared over R, H(exp 2)/R, age, sex, and weight (W). Polynomials of H(exp 2)/R have not been included in these models. We examined the validity of a model with third order polynomials and W. Methods: T was measured with oxygen-18 labled water in 27 subjects. R at 50 kHz was obtained from electrodes placed on the hand and foot while subjects were in the supine position. A stepwise regression equation was developed with 13 subjects (age 31.5 plus or minus 6.2 years, T 38.2 plus or minus 6.6 L, W 65.2 plus or minus 12.0 kg). Correlations, standard error of estimates and mean differences were computed between T and estimated T's from the new (N) model and other models. Evaluations were completed with the remaining 14 subjects (age 32.4 plus or minus 6.3 years, T 40.3 plus or minus 8 L, W 70.2 plus or minus 12.3 kg) and two of its subgroups (high and low) Results: A regression equation was developed from the model. The only significant mean difference was between T and one of the earlier models. Conclusion: Third order polynomials in regression models may increase the accuracy of estimating total body water. Evaluating the model with a larger population is needed.
Author (revised)

N95-16748*# Kentucky Univ., Lexington, KY. Center for Biomedical Engineering.
SPECTRAL COMPONENTS OF HUMAN CARDIOVASCULAR RESPONSES TO STEP CHANGES IN LOWER BODY NEGATIVE PRESSURE (LBNP) BEFORE AND AFTER 22 HOUR OF 6 DEG HEAD DOWN BED REST Abstract Only
C. F. KNAPP, J. M. EVANS, K. J. GRANDE, C. D. MURPHY, and A. R. PATWARDHAN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
(Contract(s)/Grant(s): NAG9-298)
Avail: CASI HC A01/MF A02

Changes in autonomic outflow to peripheral organs during the development of bedrest induced orthostatic intolerance have not been determined. Recent studies have indicated that spectral analysis provides an indirect assessment of these changes. Eight male subjects were studied before and after 22 hours of 6 degree head down bedrest plus Lasix (40 mg. P.P.). Cardiovascular spectra (using an autoregressive technique) were determined for heart rate (HR, ECG), arterial pressure (AP, Finapres), radial artery flow (RF, Hokansen) and respiration rate (RR, BoMed). Spectra were obtained from 2.5 minute segments during control, lower body negative pressure (minus 10, 20, 30, 40, 50 mmHg) and recovery. Bedrest increased HR spectra power in the low frequency (.001 to. 041 Hz) range, increased RF power in the low and mid (.04 to. 18 Hz) range and increased AP power in the high (.18 to. 50 Hz) frequency range. Increasing levels of lower body negative pressure decreased HR power and increased RF power in the high frequency range and decreased AP power in the low frequency range. Since spectral power of HR in the high frequency range has been shown to indicate parasympathetically mediated regulation and power in the low and mid frequency ranges indicates a sympathetic / parasympathetic mixture, then both bedrest and lower body negative pressure appeared to shift sympathetic / parasympathetic balance toward sympathetic regulation of HR. The interpretation of the spectral content of AP and RF with respect to their autonomic origins remains unclear. Author

N95-16749*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MAGNETIC RESONANCE IMAGING (MRI) OF SKELETAL MUSCLES IN ASTRONAUTS AFTER 9 DAYS OF SPACE FLIGHT Abstract Only
M. JAWEED, P. NARAYANA, J. SLOPIS, I. BUTLER, V. SCHNEIDER, A. LEBLANC, L. FOTEDAR, and D. BACON *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Skylab data indicated that prolonged exposure of human subjects to microgravity environment causes significant muscle atrophy accompanied by reduced muscle strength and fatigue resistance. The objective of this study was to determine decrements in muscle size, if any, in the soleus and gastrocnemius muscles of male and female astronauts after 9 days of space flight. Methods: Eight astronauts, one female and seven male, between the ages of 31 and 59 years 59-84 kg in body weight were examined by MRI 2-3 times preflight within 16 days before launch, and 2 days, (n=6) and seven days (n=3) after landing. The right leg muscles (gastroc-soleus) were imaged with a lower extremity coil in magnets operating at 1.0 or 1.5 Tsela. The imaging protocol consisted of spin echo with a Tr of 0.70 - 1.5 sec. Thirty to forty 3-5 mm thick slices were acquired in 256 x 128 or 256 x 256 matrices. Acquisition time lasted 20-40 minutes. Multiple slices were measured by computerized planimetry. Results: Compared to the preflight, the cross-sectoral areas (CSA) of the soleus, gastrocnemius, and the leg, at 2 days after landing were reduced (at least p less than 0.05) 8.9 percent, 13.2 percent, and 9.5 percent respectively. The soleus and the leg of three astronauts evaluated at 7 days postflight did not show full recovery compared to the preflight values. Conclusions: It is concluded that 19-days of space flight may cause significant decreases in CSA of the leg muscles. The factors responsible for this loss need further determination. Author

N95-16750*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
RESULTS OF AN INTERNATIONAL SPACE CREW DEBRIEF Abstract Only
P. A. SANTY (Texas Univ., Galveston, TX.), A. W. HOLLAND, L. LOOPER, and R. MARCONDES-NORTH *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

In order to identify potential multi-cultural and multinational problems for future International Space Station Freedom crew, a crew debrief questionnaire was developed for U.S. astronauts who flew on shuttle missions with one or more crew members from other countries. Methods: From 1981-90, a total of 20 U.S. astronauts flew on international space missions. Debriefs were mailed to all 20 with instructions not to identify themselves or their specific mission. The debrief focused primarily on preflight training and post flight incidents of misunderstanding, miscommunication, and interpersonal friction among crewmembers. Astronauts were also asked to rate the impact of the incident to the mission (low, medium, high). Results: Ten astronauts responded, but only nine responses were able to be scored, for a return rate of 45 percent. 42 incidents were reported, 9 in the preflight period, 26 inflight, and 7 in the postflight period. Most of the incidents were rated at a low or medium impact, but 5 of the inflight incidents were rated at a 'high' mission impact. A number of causes for the problems were listed, and are discussed. Conclusions: The debrief respondents provide useful and timely recommendations on preflight training which might help facilitate the integration of multinational crews and prevent multicultural or multinational factors from interfering with mission operations. Author

N95-16751*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PHYSIOLOGICAL CONSTRAINTS ON DECELERATION DURING THE AEROCAPTURE OF MANNED VEHICLES Abstract Only
J. E. LYNE *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

The peak deceleration load allowed for aerobraking of manned vehicles is a critical parameter in planning future excursions to Mars. However, considerable variation exists in the limits used by various investigators. The goal of this study was to determine the most appropriate level for this limit. Methods: Since previous U.S. space flights have been limited to 84 days duration, Soviet flight results were examined. Published details of Soviet entry trajectories were not available. However, personal communication with Soviet cosmonauts suggested that peak entry loads of 5-6 G had been encountered upon return from 8 months in orbit. Soyuz entry capsule's characteristics were established and the capsule's entry trajectory was numerically calculated. The results confirm a peak load of 5 to 6 G. Results: Although the Soviet flights were of shorter duration than expected Mars missions, evidence exists that the deceleration experience is applicable. G tolerance has been shown to stabilize after 1 to 3 months in space if adequate countermeasures are used. The calculated Soyuz deceleration histories are graphically compared with those expected for Mars aerobraking. Conclusions: Previous spaceflight experience supports the use of a 5 G limit for the aerocapture of a manned vehicle at Mars. Author

N95-16752*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
BLOOD VOLUME AND ORTHOSTATIC RESPONSES OF MEN AND WOMEN TO A 13-DAY BEDREST Abstract Only
S. FORTNEY, T. DRISCOLL, L. STEINMANN, and C. ALFREY *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Prepared in cooperation with Krug Life Sciences, Inc., Houston, TX

Avail: CASI HC A01/MF A02

Changes in blood volume during space flight are thought to contribute to decrements in postflight orthostatic function. The purpose of this study was to determine whether gender affects red cell mass and plasma volume during a short exposure to simulated microgravity, and whether gender differences in orthostatic tolerance ensure. Methods: Ten men (31.5 plus or minus 5.2 years, STD) and eleven normally menstruating women (33.3) plus or minus 6.0 STD) underwent 13 days of 6 degree head-down bedrest. Plasma volume (Iodine 125 labeled human serum albumin) and red cell mass (Carbon 51 labeled red blood cells) were measured before bedrest and on bedrest day 13. On the same days, orthostatic tolerance (OT) was determined as the maximal pressure during a presyncopalimited lower body negative pressure test. Results: Plasma volume (PV) and red cell mass (RCM) decreased in both groups with a greater PV decrease (P less than 0.05) in men (6.3 plus or minus 0.7 ml/kg) than in women (4.1 plus or minus 0.6 ml/kg). Decreases in red cell mass were similar (1.7 plus or minus 0.2 ml/kg in men and 1.7 plus or minus 0.2 ml/kg in women). OT was similar for men and women before bedrest (minus 78 plus or minus 6 mmHg in men versus minus 70 plus or minus 4 mmHg in women) and decreased by a similar degree (by an average of 11 mmHg in both groups) after bedrest. The changes in OT did not correlate with changes in plasma volume during bedrest (r(exp 2) = 0.002). Conclusion: Thus, although female hormones may protect PV during bedrest, they do no appear to offer an advantage in terms of loss of orthostatic function. Author

N95-16753*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

EFFECT OF ANTIORTHOSTATIC BEDREST (BR) ON GASTROINTESTINAL MOTILITY (GIM) OF NORMAL SUBJECTS Abstract Only

L. PUTCHA, R. P. HUNTER, K. J. TIETZE, and N. M. CINTRON *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

The combined effects of postural changes, fluid shifts and diuresis associated with the absence of the gravity vector may decrease gastrointestinal motility (GIM) during space flight. GIM can be estimated from the mouth to cecum transit time (MCTT) of orally administered lactulose (LAC); this test is used to assess changes in GIM in normal subjects and in patients with GI pathology and related disease conditions. Since bedrest (BR) mimics some of the physiological changes that occur during space flight, the effect of ten days of BR on GIM was evaluated from the MCTT of LAC. Methods: Subjects were 12 nonsmoking males between the ages of 35 and 50. After an 8-10 hour fast, subjects ingested Cephulac (registered) (20 g solution) with a low-fiber breakfast on four different days (45, 30, 25, and 20) before BR and on three separate days (4, 7, and 10) during BR. Breath-H2 concentrations were measured before and at 10 minute intervals for 4 hours after breakfast using a Quintron breathalyzer and MCTT was determined from these data. Results: MCTT ranged between 10 and 122 minutes during ambulation and 80 to 120 minutes during BR with means of 79 minutes and 122 minutes respectively. Conclusion: Mean MCTT during BR was 54 percent longer than during ambulation, suggesting that absorption and availability of orally administered medications and nutrients may be delayed or impaired as a result of decreased GIM during bedrest. Author

N95-16754*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

CHANGES IN LEFT VENTRICULAR FUNCTION AS DETERMINED BY THE MULTI-WIRE GAMMA CAMERA AT NEAR PRESYNCOPAL LEVELS OF LOWER BODY NEGATIVE PRESSURE Abstract Only

R. PINTNER (Krug Life Sciences, Inc., Houston, TX.), S. FORTNEY, S. MULVAGH, and J. LACY *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

At presyncopal levels of lower body negative pressure (LBNP), we have frequently observed electrocardiographic responses that may be due to changes in cardiac position and/or shape, but could be indicative of altered myocardial function. To further investigate this, we evaluated cardiac function using a nuclear imaging technique in 21 healthy subjects (17 men and 4 women) after 30 minutes of supine rest and near the end of a presyncopal-limited LBNP exposure (LBNP averaged 65 plus or minus 3 mmHg at injection). Cardiac first pass images were obtained with a Multi-Wire Gamma Camera following an intravenous bolus injection of 30-50 millicurries of Tantalum-178. Manual blood pressures and electrocardiograms were obtained throughout the 3 minute graded LBNP protocol. Between rest and injection during LBNP, heart rate increased (P less than 0.01) from 67 plus or minus 3 beats per minute to 99 plus or minus beats per minute, systolic blood pressure decreased (P less than 0.01) from 110 plus or minus 3 mmHg to 107 plus or minus 3 mmHg and left ventricular ejection fraction (EF) decreased (P less than 0.01) from 0.57 plus or minus 0.02 to 0.48 plus or minus 0.02. During LBNP, ST segment depression of at least 0.5 mm occurred in 7 subjects. Subjects with ST depression had greater reductions (P = 0.05) in EF than subjects without ST depression (0.15 plus or minus 0.07 versus 0.005 plus or minus 0.03), but also tolerated greater levels (P less than 0.05) of negative pressure (88 plus or minus mmHg versus 69 plus or minus 5 mmHg). There was a significant relationship between presyncopal LBNP level and EF (R(exp 2) = 0.50, P less than 0.05). Our findings suggest there may be a decrease in systolic myocardial function at high levels of LBNP. Author

N95-16756*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

ACHILLES TENDON REFLEX (ATR) IN RESPONSE TO SHORT EXPOSURES OF MICROGRAVITY AND HYPERGRAVITY Abstract Only

M. FUJII and M. JAWEED *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

Previous studies indicate that latency and amplitude of the Achilles tendon reflex (ATR) are reduced after exposure to microgravity for 28 days. The objective of this study was to quantitatively measure the latency of ATR during brief (20 sec) exposure to microgravity in KC-135 parabolic flights. Methods: The ATR was elicited in ten men during parabolic flight with the ankle held neutrally, planarflexed, and dorsiflexed. During flight, the ATR was elicited during the zero G and 1.8 G phases. Postflight testing was performed flying back to the airfield. Latencies to onset of the ATR were calculated and analyses of variance were performed to determine the effect of gravity and ankle position on latency. Result: The mean latencies for zero-G, 1.8-G and postflight with the ankle in the neutral position were 32.7 plus or minus 0.5 ms, and 33.1 plus or minus 0.7 ms respectively, which were not significantly different. There was a trend toward prolongation of latencies postflight. The mean latency for those who were motion sick was 32.1 plus or minus 0.1 ms compared to 34.0 plus or minus 0.3 ms for those who were not sick. Conclusions: These studies indicate that neither the level of gravity nor ankle position significantly affected the latency of the ATR.Author

N95-16757*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

PREDICTION OF SPACE SICKNESS IN ASTRONAUTS FROM PREFLIGHT FLUID, ELECTROLYTE, AND CARDIOVASCULAR VARIABLES AND WEIGHTLESS ENVIRONMENTAL TRAINING FACILITY (WETF) TRAINING Abstract Only

K. SIMANONOK, E. MOSELY, and J. CHARLES *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

Nine preflight variables related to fluid, electrolyte, and cardiovascular status from 64 first-time Shuttle crewmembers were differentially weighted by discrimination analysis to predict the incidence and severity of each crewmember's space sickness as rated by NASA flight surgeons. The nine variables are serum uric acid, red cell count, environmental temperature at the launch site, serum phosphate, urine osmolality, serum thyroxine, sitting systolic blood pressure, calculated blood volume, and serum chloride. Using two methods of cross-validation on the original samples (jackknife and a stratefied random subsample), these variables enable the prediction of space sickness incidence (NONE or SICK) with 80 percent sickness and space severity (NONE, MILD, MODERATE, of SEVERE) with 59 percent success by one method of cross-validation and 67 percent by another method. Addition of a tenth variable, hours spent in the Weightlessness Environment Training Facility (WETF) did not improve the prediction of space sickness incidences but did improve the prediction of space sickness severity to 66 percent success by the first method of cross-validation of original samples and to 71 percent by the second method. Results to date suggest the presence of predisposing physiologic factors to space sickness that implicate fluid shift etiology. The data also suggest that prior exposure to fluid shift during WETF training may produce some circulatory pre-adaption to fluid shifts in weightlessness that results in a reduction of space sickness severity. Author

N95-16758*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

DARK FOCUS OF ACCOMMODATION AS DEPENDENT AND INDEPENDENT VARIABLES IN VISUAL DISPLAY TECHNOLOGY Abstract Only

SHERRIE JONES (Naval Training Systems Center, Orlando, FL.), ROBERT KENNEDY (Essex Corp., Orlando, FL.), and DEBORAH HARM *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

When independent stimuli are available for accommodation, as in the dark or under low contrast conditions, the lens seeks its resting position. Individual differences in resting positions are reliable, under autonomic control, and can change with visual task demands. We hypothesized that motion sickness in a flight simulator might result in dark focus changes. Method: Subjects received training flights in three different Navy flight simulators. Two were helicopter simulators entailed CRT presentation using infinity optics, one involved a dome presentation of a computer graphic visual projection system. Results: In all three experiments there were significant differences between dark focus activity before and after simulator exposure when comparisons were made between sick and not-sick pilot subjects. In two of these experiments, the average shift in dark focus for the sick subjects was toward increased myopia when each subject was compared to his own baseline. In the third experiment, the group showed an average shift outward of small amount and the subjects who were sick showed significantly less outward movement than those who were symptom free. Conclusions: Although the relationship is not a simple one, dark focus changes in simulator sickness imply parasympathetic activity. Because changes can occur in relation to endogenous and exogenous events, such measurement may have useful applications as dependent measures in studies of visually coupled systems, virtual reality systems, and space adaptation syndrome. Author

N95-16759*# National Aeronautics and Space Administration, Washington, DC.

REVIEW OF PERFORMANCE, MEDICAL, AND OPERATIONAL DATA ON PILOT AGING ISSUES Abstract Only

J. H. STOKLOSA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

An extensive review of the literature and studies relating to performance, medical, operational, and legal data regarding pilot aging issues was performed in order to determine what evidence there is, if any, to support mandatory pilot retirement. Popular misconceptions about aging, including the failure to distinguish between the normal aging process and disease processes that occur more frequently in older individuals, continue to contribute to much of the misunderstanding and controversy that surround this issue. Results: Review of medical data related to the pilot aging issue indicate that recent improvement in medical diagnostics and treatment technology have made it possible to identify to a high degree individuals who are at risk for developing sudden incapacitating illness and for treating those with disqualifying medical conditions. Performance studies revealed that after controlling for the presence of disease states, older pilots are able to perform as well as younger pilots on many performance tasks. Review of accident data showed that older, healthy pilots do not have higher accident rates than younger pilots, and indeeed, evidence suggests that older pilots have an advantage in the cockpit due to higher experience levels. The Man-Machine-Mission-Environment interface of factors can be managed through structured, supervised, and enhanced operations, maintenance, flight reviews, and safety procedures in order to ensure safe and productive operations by reducing the margin of error and by increasing the margin of safety. Conclusions: There is no evidence indicating any specific age as an arbitrary cut-off point for pilots to perform their fight duties. A combination of regular medical screening, performance evaluation, enhanced operational maintenance, and safety procedures can most effectively ensure a safe pilot population than can a mandatory retirement policy based on arbitrary age restrictions. Author

N95-16768*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

SPACE MEDICINE RESEARCH: NEEDS FOR THE 21ST CENTURY Abstract Only

L. J. PEPPER *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

Space medicine research in the 21st century will continue to focus on the four major areas including: (1) expansion of the current incomplete knowledge base of clinical and subclinical physiological changes due to microgravity; (2) development of countermeasures to extend the capabilities of the human performance envelope in extended duration flights; (3) development of novel methods for delivering all aspects of a comprehensive health care system in extreme remote conditions: and (4) further research and application of systems for biological materials processing. New space transportation vehicles will place unique physiologic and human factors demands on the human system, while providing better access to platforms for materials processing. Success in meeting the demands in each of the noted research areas will require an extensive, interactive team approach. Personnel from the medical research,operational, developmental, and basic science communities will be essential to success. Author

N95-16770*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

EFFECTS OF WEIGHTLESSNESS ON HUMAN BAROREFLEX FUNCTION Abstract Only

JANICE M. FRITSCH and DWAIN L. ECKBERG *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Prepared in cooperation with Veterans Administration Hospital, Richmond, VA

Avail: CASI HC A01/MF A02

Impaired cardiovascular function, characterized by orthostatic intolerance and reduced exercise capacity, is a result of space travel. We hypothesized that postflight baroreflex dysfunction may contribute. We studied the vagally mediated carotid baroreceptor-cardiac reflex response of 6 astronauts before, during, and after the ten day SLS-I mission. A series of R-waves triggered pressure and suction steps (from 40 to minus 65 mmHg) were delivered to a neck chamber during held expirtation. Resulting R-R interval changes were plotted against

carotid distending pressure (systolic - neck pressure), and curve parameters calculated. After an initial rise, the operational point declined consistently during the flight and reached a nadir on landing day, but had recovered to preflight levels by L + 4. Slope and range of the response declined throughout the flight, were slightly recovered by the time measurements were made on landing day, but still were reduced on L + 4. These data indicate that space flight results in a significant impairment of the carotid baroreceptor cardiac reflex response.
Author

N95-16771*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DYNAMICS OF THE G-EXCESS ILLUSION Abstract Only
K. A. BAYLOR (Naval Aerospace Medical Research Lab., Pensacola, FL.), M. RESCHKE, F. E. GUEDRY, B. J. MCGRATH, and A. H. RUPERT *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

The G-excess illusion is increasingly recognized as a cause of aviation mishaps especially when pilots perform high-speed, steeply banked turns at low altitudes. Centrifuge studies of this illusion have examined the perception of subject orientation and/or target displacement during maintained hypergravity with the subject's head held stationary. The transient illusory perceptions produced by moving the head in hypergravity are difficult to study onboard centrifuges because the high angular velocity ensures the presence of strong Coriolis cross-coupled semicircular canal effects that mask immediate transient otolith-organ effects. The present study reports perceptions following head movements in hypergravity produced by high-speed aircraft maintaining a banked attitude with low angular velocity to minimize cross-coupled effects. Methods: Fourteen subjects flew on the NASA KC-135 and were exposed to resultant gravity forces of 1.3, 1.5, and 1.8 G for 3 minute periods. On command, seated subjects made controlled head movements in roll, pitch, and yaw at 30 second intervals both in the dark and with faint targets at a distance of 5 feet. Results: head movement produced transient perception of target displacement and velocity at levels as low as 1.3 G. Reports of target velocity without appropriate corresponding displacement were common. At 1.8 G when yaw head movements were made from a face down position, 4 subjects reported oscillatory rotational target displacement with fast and slow alternating components suggestive of torsional nystagmus. Head movements evoked symptoms of nausea in most subjects, with 2 subjects and 1 observer vomiting. Conclusions: The transient percepts present conflicting signals, which introduced confusion in target and subject orientation. Repeated head movements in hypergravity generate nausea by mechanisms distinct from cross-coupled Coriolis effects.
Author

N95-16774*# Krug Life Sciences, Inc., Houston, TX.
DELIVERY OF CARDIOPULMONARY RESUSCITATION IN THE MICROGRAVITY ENVIRONMENT Abstract Only
M. R. BARRATT and R. D. BILLICA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Sponsored by NASA. Lyndon B. Johnson Space Center, Houston, TX
Avail: CASI HC A01/MF A02

The microgravity environment presents several challenges for delivering effective cardiopulmonary resuscitation (CPR). Chest compressions must be driven by muscular force rather than by the weight of the rescuer's upper torso. Airway stabilization is influenced by the neutral body posture. Rescuers will consist of crew members of varying sizes and degrees of physical deconditioning from space flight. Several methods of CPR designed to accommodate these factors were tested in the one G environment, in parabolic flight, and on a recent shuttle flight. Methods: Utilizing study participants of varying sizes, different techniques of CPR delivery were evaluated using a recording CPR manikin to assess adequacy of compressive force and frequency. Under conditions of parabolic flight, methods tested included conventional positioning of rescuer and victim, free floating 'Heimlich type' compressions, straddling the patient with active and passive restraints, and utilizing a mechanical cardiac compression assist device (CCAD). Multiple restrain systems and ventilation methods were also assessed. Results: Delivery of effective CPR was possible in all configurations tested. Reliance on muscular force alone was quickly fatiguing to the rescuer. Effectiveness of CPR was dependent on technique, adequate restraint of the rescuer and patient, and rescuer size and preference. Free floating CPR was adequate but rapidly fatiguing. The CCAD was able to provide adequate compressive force but positioning was problematic. Conclusions: Delivery of effective CPR in microgravity will be dependent on adequate resuer and patient restraint, technique, and rescuer size and preference. Free floating CPR may be employed as a stop gap method until patient restraint is available. Development of an adequate CCAD would be desirable to compensate for the effects of deconditioning.
Author

N95-16777*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MEDICINE ON MARS: REMOTE MEDICAL CARE AND THE SPACE EXPLORATION INITIATIVE Abstract Only
S. C. SIMMONS and R. D. BILLICA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 14 May 1992 Prepared in cooperation with Krug Life Sciences, Inc., Houston, TX
Avail: CASI HC A01/MF A02

Mars exploration missions as described in the Synthesis Group report will involve extended exposures of crew members to remote, hazardous environments for up to 100 days. Maintenance of crew health and performance will be critical to ensure mission success. Because of the great distances between the Earth and Mars, round trip telecommunication will take from seven to forty minutes and immediate return to Earth will not be feasible: an autonomous medical care system that integrates preventive, occupational, and environmental aspects of health care and provides diagnostic and treatment capabilities will be necessary. Providing medical care for Mars explorers will pose some unique technical and engineering challenges. Medical care equipment will need to be designed to be modular and portable to ensure that it is interchangeable between vehicle and planetary surface elements. Miniaturization will be necessary to reduce mass and volume. Computerized systems that automatically acquire and manage medical information and provide medical references (literature), decision support, and automated medical record keeping will be a crucial part of a Martian medical care system. Medical care will also rely on remote consultation with Earth-based specialists. This presentation will provide an overview of the health and medical concerns associated with Mars exploration missions and will describe some specific concepts for Mars medical care systems.
Author

N95-16779*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE EFFECT OF INTERMITTENT STANDING OR WALKING DURING HEAD DOWN TILT BEDREST ON PEAK O2 CONSUMPTION Abstract Only
A. C. ERTL, A. S. DEARBORN, and J. VERNIKOS *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

The cardiovascular aspect of bedrest deconditioning is manifested by decreases in peak O2 uptake (VO(sub 2 peak)) during minimal exercise. The effect of intermittent standing (+G(z)) or walking (+G(z)W) during 4 days of 7 degree Head Down Tilt bedrest (HDT) on VO(sub 2 peak) was evaluated. Methods: Five protocols were performed by eight male subjects; control (C) consisting of complete bedrest, and 15 minute periods to total 2 or 4 hours daily of standing (+G(z)(exp 2) and +G(z)(exp 4) respectively) or walking at 3.0 MPH (+G(z)W2 and +G(z)W4 respectively). Subjects performed VO(sub 2 peak) tests prior to and on the final day of HDT. VO(sub 2 peak) was determined using open circuit indirect calorimetry during supine leg cycling ergometry. After a 5 minute warmup, three 2 minute incremental

loads of 33 W previously determined to elicit VO(sub 2 peak) were given and the subject cycled to volitional fatigue. Results: The C protocol VO(sub 2 peak) decreased by 16 percent (2.71 plus or minus 0.16 to 2.27 plus or minus 0.14 L/min) and 11 percent in +G(z)(exp 4) (2.72 plus or minus 0.15 to 2.43 plus or minus 0.14 L/min). With +G(z)W2 VO(sub 2 peak) decreased by 9 percent (2.71 plus or minus 0.17 to 2.46 plus or minus 0.14 L/min) and with +G(z)W4, VO(sub 2 peak) decreased by 10 percent (2.71 plus or minus 0.14 to 2.43 plus or minus 0.14 L/min). VO(sub 2 peak) in all protocols decreased with HDT (P less than 0.05). The decrease in C VO(sub 2 peak) was significantly greater (P less than 0.05) than the decreases in either +G(z) or +G(z)W protocols. Conclusion: The deconditioning that occurs after only 4 days of HDT was demonstrated by decreases in VO(sub 2 peak). Intermittent +G(z) or +G(z)W attenuated, but did not prevent, the decrease in VO(sub 2 peak) with HDT. Author

N95-16780*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERIODIC UPRIGHT POSTURE NEGATES THE SUPPRESSION OF NEUROENDOCRINE RESPONSE TO HEAD DOWN BEDREST Abstract Only
C. E. WADE, J. VERNIKOS, J. EVANS, and D. OHARA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Head down bedrest (HDT) decreases plasma neurohormone levels, attaining a nadir within four hours. The present study evaluates the effect of periodic standing or exercises (+G(z)) on this acute suppression of plasma neurohormones. Methods: Nine male subjects (mean plus or minus SE age 37 plus or minus 2 yr; height 182 plus or minus 2 cm; weight 83 plus or minus 3 kg) were admitted to the Human Research Facility on three occasions separated by one month. Subjects were assigned to head down tilt (minus 6 degrees) or 15-minutes of standing or moderate exercise at the end of each hour. Initially during an ambulatory period, subjects were placed in a supine position for 45-min and a control blood sample obtained. The next day following 4 hours of HDT with or without standing or exercise a blood sample was taken 45-min (3 3/4 hours into HDT) after the preceding stand or exercise. Blood was withdrawn and all plasma samples frozen for determination of neurohormone levels within the same assay. Plasma aldosterone, Plasma Renin Activity (PRA) vasopressin (AVP) and cortisol levels were measured by radioimmunoassay. Norepinephrine (NE) and epinephrine (E) levels were measured by electrochemical detection following HPLC. Values were compared by ANOVA, P less than 0.05. Results: Control levels following 45-min supine were not different between treatments. HDT suppressed plasma aldosterone (13.9 plus or minus 3.7 to 6.6 plus or minus 0.7 ng/dl) and NE levels (299 plus or minus 35 to 217 plus or minus 23 pg/dl), E (69 plus or minus 15 to 65 plus or minus 21 pg/ml), and PRA (0.64 plus or minus 0.13 to 0.58 plus or minus 0.17 ngAl/m/hr) were not significantly altered. Standing or exercise negated the decrease in aldosterone and NE levels due to HDT. Conclusions: Periodic upright posture (+G(z)) with or without exercise for 15-min out of each hour negates the acute suppression of aldosterone and NE associated with HDT. Author

N95-16781*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE EFFICACY OF PERIODIC +GZ EXPOSURE IN THE PREVENTION OF BEDREST INDUCED ORTHOSTATIC INTOLERANCE Abstract Only
D. A. LUDWIG (North Carolina Univ., Greensboro, NC.), J. VERNIKOS, M. R DUVOISIN, and J. L. STINN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

What is the most efficient dosage of periodic exposure to positive 1G(z) during microgravity to maintain a functional upright position after returning to a positive 1G(z) environment? The answer has implications for the type of countermeasures astronauts will be required to perform during long term space flight. Methods: Nine males were subjected to four different positive 1G exposure protocols plus a control protocol ('zero G(z)') during four days of continuous bedrest. The four positive 1G(z) exposures consisted of periodic standing or walking, each for a total period of two or four hours. Each subject was returned for bedrest on five different occasions over a period of approximately one year to obtain data on each of the nine subjects across all four positive 1G(z) treatments and the control. A 30 min tilt test was used to measure orthostatic response during pre and post bedrest. Results: In terms of survival rate (percentage of subjects who did not faint after 30 sec of tilt), four hours of intermittent standing was the only protocol that maintained a rate comparable to pre bedrest levels (87.5 percent). Although the other three positive 1G(z) protocols performed better than the 'zero G(z) control (22.2 percent), only the four hour standing returned post bedrest survival rates to pre bedrest levels. Conclusions: The results will need to be evaluated with regards to a variety of other physiological systems which are known to decondition during microgravitry. Author

N95-16782*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE VALUE OF THE 4-DAY HEADDOWN BEDREST MODEL FOR SCREENING COUNTERMEASURES Abstract Only
J. VERNIKOS, L. KEIL, A. C. ERTL, C. E. WADE, J. E. GREENLEAF, D. OHARA, and D. LUDWIG *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

In order to evaluate the benefits of periodic exposure to the +G(z) vector as a countermeasure to the physiological responses to minus 6 degree head down bedrest (HDT), we considered a two-tiered approach: (a) to use 4 days HDT as a quick and inexpensive means of screening countermeasures, (b) to use a 60 day HDT to validate the most promising candidates. The approach and results of a 4 day study are described here. Methods: Nine males were admitted to our Human Research Facility for one ambulatory control day followed by 4 days HDT and were released on the next day after completion of a peak oxygen consumption test (VO(sub 2 peak)). A battery of tests was selected and standardized to evaluate the known early effects of HDT on plasma volume, early bone markers, orthostatic tolerance, physical performance, and fluid and electrolytes and their hormone regulation. Fluid sodium (Na) and potassium (K) intake and output in the urine were monitored throughout. Plasma volume was determined with a modified Evans Blue method and orthostatic tolerance with a 60 degree head-up tilt test for 30 minutes - both of which were determined on the ambulatory control day and on day 4 of HDT. Immediately after completion of the tilt test subjects were returned to the minus 6 degree position until the next morning when a VO(sub 2 peak) (horizontal ergometer) was done. This was compared to a similar control test determined on 2 separate occasions before subject admission. Results: Four hours after going HDT produced significant decreases (p less than 0.05) in the circulating concentration of fluid and electrolyte regulating hormones. Plasma volume, orthostatic tolerance and VO(sub 2 peak) changed significantly after 4 days HDT. There was also the expected natriuresis on day 1 of HDT but no significant diuresis. The consistency of the pre-bedrest VO(sub 2 peak) tilt tests and plasma volumes was remarkable. Conclusions: The 4 day HDT model seems highly promising for screening a variety of countermeasures alone and in combination before validating their benefits in extended bedrest or flight experiments. Author

N95-16796# Chicago Univ., Chicago, IL. Dept. of Medicine.
PHASE-SHIFTING EFFECTS OF LIGHT AND ACTIVITY ON THE HUMAN CIRCADIAN CLOCK Final Report, 1 Mar. 1993 - 28 Feb. 1994
EVE VANCAUTER 28 Feb. 1994 19 p
(Contract(s)/Grant(s): F49620-93-1-0188)
(AD-A281204; AFOSR-94-0399TR) Avail: CASI HC A03/MF A01

While still preliminary, the findings from this study have provided

two important novel observations (1) an overall elevation of TSH levels is a biological concomitant of the 'jet lag syndrome'; (2) exposure to dark/sleep is capable of exerting immediate phase-shifting effects of human rhythms. DTIC

N95-16809# Army Research Inst. of Environmental Medicine, Natick, MA.
INCREASED SKIN BLOOD FLOW AND ENHANCED HEAT LOSS IN HUMANS AFTER NIACIN INGESTION
LOU A. STEPHENSON and MARGARET A. KOLKA Jun. 1994 52 p
(AD-A281124; USARIEM-T94-16) Avail: CASI HC A04/MF A01

Healthy, young subjects were studied in three separate series of studies characterizing nicotinic acid (NA) ingestion (5 mg/kg): (1) at rest, seated (T sub a = 30 C, rh = 23%) at 0800 h and again between 1800 and 2100 h; (2) at rest (R) and during seated exercise (X, T sub a = 29 C, rh = 30%); and (3) during upright exercise when wearing a protective clothing system (T sub a = 28 C, rh = 30%). NA treatment resulted in decreased T sub es, bar-T su b sk, SkBF, FBF, heart rate, and cutaneous vascular conductance (CVC) (P less than or equal to 0.05). NA decreased mean arterial pressure at rest. Subjects had no difficulty completing seated or upright exercise in either control or NA experiments. The pharmacological manipulation of skin blood flow at rest and during moderate exercise effectively increased sensible heat flux during seated as well as upright exercise. NA ingestion also increased sensible heat flux from individuals dressed in chemical protective clothing. These experiments show that pharmacologic manipulation of skin blood flow by NA ingestion should be done cautiously, especially when NA will be used repeatedly or in novel circumstances. DTIC

N95-16847# Virginia Univ., Charlottesville, VA. Dept. of Biology.
PHOTORECEPTORS REGULATING CIRCADIAN BEHAVIOR: A MOUSE MODEL Annual Report, 15 Mar. 1993 - 14 Mar. 1994
RUSSELL G. FOSTER 14 Mar. 1994 15 p
(Contract(s)/Grant(s): F49620-92-J-0205)
(AD-A285157; AFOSR-94-0605TR) Avail: CASI HC A03/MF A01

In the rd mouse the absence of rod cells and the progressive loss of cones does not result in a decrease in circadian phase shifting responses to light. By contrast, rd mice are unable to perform simple visual tasks. In addition, rodless transgenic mice, and mice homozygous for the rds mutation, show unattenuated circadian responses to light. Collectively these data suggest that cone cells lacking outer segments are sufficient to maintain normal circadian responses to light, or there may be some unidentified photoreceptor within the retina. An action spectrum for circadian responses to light in rd mice, and molecular analysis of retinally degenerate mice and blind mole rat eyes, suggests the involvement of a green cone opsin in mammalian photoentrainment. DTIC

N95-16851# Scripps Clinic and Research Foundation, La Jolla, CA.
MOLECULAR APPROACH TO HYPOTHALAMIC RHYTHMS Annual Report, 15 Mar. 1993 - 14 Mar. 1994
J. G. SUTCLIFFE 14 Mar. 1994 41 p
(Contract(s)/Grant(s): F49620-92-J-0188)
(AD-A285164; AFOSR-94-0606TR) Avail: CASI HC A03/MF A01

The suprachiasmatic nucleus (SCN) of the hypothalamus is the anatomical seat of the mammalian endogenous biological clock which regulates the temporal expression of hormonal and behavioral circadian rhythms. Light, serotonin and melatonin are the dominant stimuli which affect the phase of the endogenous clock. The grantee has devised strategies to identify molecules that mediate the action of these stimuli within the SCN. The grantee has identified a novel receptor for serotonin, the 5-HT7 receptor, and determined its amino acid structure. Its pharmacological ligand binding properties have been measured and a unique profile of agonists and antagonists defined. These allowed demonstration that the 5-HT7 receptor mediated circadian activity of cultured SCN. The receptor has been shown to couple to activation of adenylyl cyclase and to be synthesized by neurons of the subparaventricular zone immediately dorsal to the SCN. Molecules whose expression within the SCN is activated by light entraining cues have also beenidentified. DTIC

N95-16871# Texas Univ. Health Science Center, Houston, TX.
INVESTIGATION OF LASER-INDUCED RETINAL DAMAGE: WAVELENGTH AND PULSEWIDTH DEPENDENT MECHANISMS Final Technical Report, 1 Apr. 1991 - 31 Mar. 1994
RANDOLPH D. GLICKMAN 31 Aug. 1994 20 p
(Contract(s)/Grant(s): AF-AFOSR-0208-91)
(AD-A285186; UTHSCSA-OPH-94-01; AFOSR-94-0621TR) Avail: CASI HC A03/MF A01

This research was initiated to develop biochemical and cellular assays of laser damage in ocular tissue. Photochemical damage was identified by evidence of oxidative reactions resulting from free radicals generated by the interaction of laser and incoherent light with ocular tissue components. Melanin contained in retinal pigment epithelial (RPE) cells formed a free radical during illumination and rapidly oxidized ascorbic acid (AA). RPE cells have a high capacity for utilizing AA; the cells have different transporters for AA and its oxidized form, dehydro-L-ascorbic acid (DHA), and efficiently reduce DHA to AA. The kinetics and specificity of these transporters were measured in these studies. In the absence of AA or other antioxidants, light-activated melanin promoted the formation of hydroperoxides of the fatty acid, linoleic acid. Thus, if intracellular antioxidants become depleted, the melanin radical may mediate some aspects of photochemical damage such as lipid peroxidation. Other assays of laser damage were investigated. Following laser exposure, release of K+ ions from RPE cells could be demonstrated, but the measured changes were small and inconsistent. Efflux of the cytoplasmic enzyme, lactate dehydrogenase, showed more promise as an assay for thermal or photodisruptive laser bioeffects. DTIC

N95-17174# Walter Reed Army Medical Center, Washington, DC.
COMPARISON OF WORK OF BREATHING DURING MECHANICAL VENTILATION USING ASSIST CONTROL AND INTERMITTENT MANDATORY VENTILATION Final Report, 15 Mar. 1992 - 30 Sep. 1993
RONALD K. POROPATICH 19 Jul. 1994 6 p
(Contract(s)/Grant(s): MIPR-92MM2539)
(AD-A285516) Avail: CASI HC A02/MF A01

Request termination of MIPR 92MM2539, titled: Comparison of Work of Breathing During Mechanical Ventilation Using Assist Control and Intermittent Mandatory Ventilation. Since initiation of the above study in March 1992, only 2 patients have been enrolled. Difficulties in enrollment has been due to patients not tolerating the various ventilatory settings, as well as the metabolic cart (which measures the exhaled carbon dioxide and oxygen consumption) having too large a range in measured variables. This latter fact may be related to the difficulties encountered in tolerating the ventilator changes. DTIC

N95-17300 National Defence Research Establishment, Stockholm (Sweden). Huvudavdelning foer Maensklig Prestation och Funktion.
MENTAL EFFECTS OF CAFFEINE IN FATIGUED MEN AND WOMEN [KOFFEIN SOM ETT MEDEL MOT TROETTHET]
L. LINDE Jan. 1994 29 p In SWEDISH
(PB94-190683; FOA-C-50105-5.1) Avail: Issuing Activity

The purpose of the present experiments was to investigate the effect of caffeine in subjective experience and in performance of cognitive tasks among men and women during vigil. In experiment 1: eight male and eight female subjects were randomly assigned to either a caffeine or a placebo condition. 150 mg caffeine was given at midnight and at 4 p.m. In experiment 2: nine female and nine male subjects were assigned randomly to either a placebo or caffeine treatment. 200 mg caffeine was given at 5 a.m. It is suggested (1) that effects of caffeine in fatigued subjects may not be revealed directly in the level of performance but in the experienced effort of performing a task, and (2) that there might be sex differences in the reaction to caffeine possibly

due to different arousal patterns in men and women. It is also suggested that the results may be interpreted in terms of compensatory arousal mechanism. NTIS

N95-17342# Chicago Univ., Chicago, IL. Dept. of Medicine.
BASIC MECHANISMS AND IMPLICATIONS OF NON-PHOTIC ENTRAINMENT OF CIRCADIAN RHYTHMICITY Annual Report, 1 Sep. 1992 - 31 Aug. 1993
EVE VANCAUTER 30 Aug. 1993 5 p
(Contract(s)/Grant(s): F49620-92-J-0347)
(AD-A283180; AFOSR-94-0451TR) Avail: CASI HC A01/MF A01

The studies showed that afternoon exposure to exercise increases TSH levels and tends to delay the onset of nocturnal TSH secretion on the following night. Analysis of the melatonin levels is under progress. Studies examining the effects of carbohydrate intake on vigilance and performance were performed. A new computerized data collection and analysis system was used to determine the phase shifting effects of light pulses of varying intensity on the free-running circadian rhythm of locomotor activity in both young and old hamsters. It was demonstrated that old hamsters are about 20 times less sensitive to the effects of light on the circadian clock, despite there being little if any effect of age on the amount of light being transmitted through the eyes. DTIC

N95-17703* National Aeronautics and Space Administration, Washington, DC.
AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 396)
Jan. 1995 187 p
(NASA-SP-7011(396); NAS 1.21:7011(396)) Avail: CASI HC A09

This publication is a cumulative index to the abstracts contained in the Supplements 385 through 395 of Aerospace Medicine and Biology: A Continuing Bibliography. It includes seven indexes: subject, personal author, corporate source, foreign technology, contract number, report number, and accession number. Author

N95-17949# National Library of Medicine, Bethesda, MD. Office of the Director.
NATIONAL LIBRARY OF MEDICINE PROGRAMS AND SERVICES, FISCAL YEAR 1991 Final Annual Report, 1 Oct. 1990 - 30 Sep. 1991
Mar. 1992 80 p
(PB94-188026; NLM/OD-94/01) Avail: CASI HC A05/MF A01

The report provides statistical and narrative information regarding the National Library of Medicine's (NLM's) activities during FY 1990. Coverage includes information on: library operations, specialized information services, the Lister Hill National Center for Biomedical Communications, the National Center for Biotechnology Information, extramural programs, the Office of Computer and Communications Systems, international programs, and the administration. In addition, there is information about NLM special initiatives, including outreach, the unified medical language system, paper preservation, and high performance computing and communications. Appendices include a staff bibliography; extramural-supported publications; lists of members of various NLM advisory bodies including the Board of Regents, Board of Scientific Counselors, Biomedical Library Review Committee, and the Literature Selection Technical Review Committee; and a list of acronyms, abbreviations, and initialisms. NTIS

N95-17950# National Library of Medicine, Bethesda, MD. Office of the Director.
NATIONAL LIBRARY OF MEDICINE PROGRAMS AND SERVICES, FISCAL YEAR 1992 Final Annual Report, 1 Oct. 1991 - 30 Sep. 1992
Mar. 1993 84 p
(PB94-188034) Avail: CASI HC A05/MF A01

The report provides statistical and narrative information regarding the National Library of Medicine's (NLM's) activities during FY 1990. Coverage includes information on: library operations, specialized information services, the Lister Hill National Center for Biomedical Communications, the National Center for Biotechnology Information, extramural programs, the Office of Computer and Communications Systems, international programs, and the administration. In addition, there is information about NLM special initiatives, including outreach, health services research, and high performance computing and communications. Appendices include a staff bibliography; extramural-supported publications; lists of members of various NLM advisory bodies including the Board of Regents, Board of Scientific Counselors, Biomedical Library Review Committee, and the Literature Selection Technical Review Committee; and a list of acronyms, abbreviations, and initialisms. NTIS

N95-17998# JAYCOR, San Diego, CA.
HEALTH HAZARDS ASSESSMENT FOR BLAST OVERPRESSURE EXPOSURES Report, 2 Nov. 1992 - 31 May 1994
JAMES H. STUHMILLER 1 Jun. 1994 49 p
(Contract(s)/Grant(s): DAMD17-93-C-3005)
(AD-A283352) Avail: CASI HC A03/MF A01

The Army needs to set blast overpressure exposure standards that will protect soldiers in training against adverse effects from blast coming from a variety of weapons in a variety of surroundings. JAYCOR is developing biomechanical models that compute the tissues level response due to external blast loading and correlations of that response to pathology and lethality. To validate the models, animal test data has been organized into a database. Trends in the data have been determined that are independent of the models and agreement between the correlations and observations have been good for all level of blasts and animal species. The future work will refine the pathology prediction by location and provide a probabilistically-based methodology for making health hazards assessment. DTIC

N95-18138 Naval Aerospace Medical Research Lab., Pensacola, FL.
EFFECTS OF WEIGHT LIFTING ON INTRATHORACIC PRESSURES GENERATED BY ANTI-G STRAINING MANEUVERS
L. G. MEYER, J. D. GRISSETT, and J. G. LAMBERTH 1994 19 p
Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): DA PROJ. M00-96)
(AD-A283651; NAMRL-1393) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of this study was to assess the effects of physical fitness program on the ability to perform an anti-G straining maneuver (AGSM). We used mouth-generated intrathoracic pressure (IP) as an index of effectiveness of the AGSM. We compared changes in IP in experimental subjects who performed the AGSM 5 times per week and participated in a weight lifting exercise program to IP's in control subjects who performed the AGSM 10 times per week and did not participate in a weight training program. Initial mean IP's were 169 mmHg and 167 mmHg for the experimental and control groups respectively. After 6 weeks of exercise and AGSM training, mean IP for the experimental subjects was 213 mmHg (26% increase). After 3 weeks of AGSM training, mean IP for the control group was 202 mmHg (21% increase). The difference in pre- and post-IP's between groups was not significant, but both groups significantly increased their IP's with training. Multiple linear regression analysis showed that pulmonary vital capacity and the strength of several muscle groups were significant predictors of IP in the experimental group. We conclude that strength and anaerobic fitness may be important for the performance of an effective AGSM. However, the AGSM training alone appeared to improve the performance of the AGSM as indicated by the increased IP's. DTIC

N95-18400 California Univ., San Diego, La Jolla, CA. Dept. of Psychiatry.
EXTRATHALAMIC MODULATION OF CORTICAL RESPONSIVENESS Annual Report, 1 Jul. 1993 - 30 Jun. 1994
STEPHEN L. FOOTE 1 Aug. 1994 23 p Limited Reproducibility:

More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-93-1-0402)
(AD-A284100; AFOSR-94-0514TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The overall goal of the proposed studies is to further elucidate the mechanisms by which the brainstem noradrenergic (NA) nucleus, locus coeruleus (LC), is capable of altering forebrain electrophysiological activity. The proposed studies have the following Specific Aims: (1) To examine the relationship between the intensity of LC neuronal activity, forebrain EEG activation, and rates of NA release in neocortex and hippocampus using microdialysis; (2) To test the hypothesis that LC-induced activation of forebrain EEG is mediated by LC/NA actions on septal and basal forebrain neurons; (3) To examine, in unanesthetized monkey, the effects of activating or inactivating the LC/NA system on forebrain EEG and on dialysis measures of NA and acetylcholine release in neocortex and hippocampus. The effects on these dialysis measures of systemic adrenergic drugs that alter cognitive performance will also be determined; (4) To examine, in monkey, the effects of activating or inactivating the LC/NA system on cortical and hippocampal EEG measures and on complex, bimanual motor behavior.
DTIC

N95-18512 Massachusetts General Hospital, Boston, MA.
CELLULAR ANALYSIS OF CIRCADIAN RHYTHMICITY IN CULTURED SCN NEURONS Annual Report, 1 Jul. 1993 - 31 Jul. 1994
STEVEN M. REPPERT and DAVID K. WELSH 28 Jul. 1994 4 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-93-1-0434)
(AD-A284167; AFOSR-94-0495TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Circadian rhythms are generated by brain cells located in the suprachiasmatic nuclei (SCN) of the mammalian hypothalamus, but it is not clear how individual cells contribute to the operation of the circadian clock. SCN neurons dissociated from newborn rat SCN were characterized by immunocytochemistry and by patch recording of spontaneous action potentials and synaptic currents. Inhibitory synaptic interactions were prevalent among neurons, increasing progressively with time in culture. Evidence was found for presence of gap junctions between glial cells but not between neurons. To assess circadian rhythmicity, long-term multielectrode recordings of spontaneous action potentials were obtained from neurons cultured for 1-6 weeks on Glass plates containing a flat array of 61 microelectrodes. Firing rates of some but not all individual neurons exhibited clear circadian rhythms with periods of nearly 24 hrs. Within a culture, cells expressing circadian rhythms showed no short-term firing synchrony. The phase of the circadian rhythm varied among cultures and, in most cases, among different cells within the same culture. With the ability to record circadian rhythms from individual SCN neurons, experimental analysis can now proceed to detailed study of circadian pacemaker neurons and their interactions.
DTIC

N95-18515 New England Medical Center Hospitals, Boston, MA.
RETINAL INJURIES FROM SINGLE AND MULTIPLE PICOSECOND LASER PULSES Annual Report, 1 May 1993 - 30 Apr. 1994
CARMEN A. PULIAFITO 30 Apr. 1994 10 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-93-1-0337)
(AD-A284173) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

We investigate laser-induced shock waves from melanin particles as a possible cause of retinal injury from ultrashort pulse laser exposures. Melanin granules were isolated from calf retina and suspended in gels. The melanin particles were irradiated with 100 psec laser pulses from an amplified, mode-locked Nd:YAG laser and shock waves were observed under a microscope using a time-delayed strobe pulse. Spherical shock fronts were observed at incident laser fluences 4J/sq cm and were imaged as close as 20 micrometers from the melanin particles. Multiple shock fronts were resolved when several melanin particles were irradiated simultaneously. Shock front radii were measured as a function of photographic delay time and laser fluence. Average shock from velocities during the first 10 nsec ranged from 2500 to 4000 m/sec. A velocity of 3000 m/sec corresponds to a shock pressure of 11 kbars. These results indicate that shock wave emission from melanin particles in the retinal pigment epithelium is a potential cause of retinal injury from ultrashort laser pulses.
DTIC

N95-18518 SRI International Corp., Menlo Park, CA.
IN VITRO SYSTEM FOR STUDYING METABOLISM OF ENVIRONMENTAL CHEMICALS IN HUMAN CELLS Annual Report, 30 Apr. 1993 - 29 Apr. 1994
CAROL E. GREEN 25 Jul. 1994 24 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-91-C-0050)
(AD-A284174; AFOSR-94-0508TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The objective of the project is to establish and use an in vitro liver model from rodents and humans to develop quantitative data on the metabolism of toxic chemicals. In the third year of the project, liver slices from rat and human liver were compared to evaluate their capacity for chloroform metabolism. It was observed that the weight (an indication of the slice thickness) of the liver slices was inversely related to the rate of chloroform metabolism, suggesting that metabolism was limited by diffusion into the tissue in the thicker slices. Using the thinnest slices possible, the kinetic constants for chloroform metabolism by rat and human liver slices were determined. The V max values for chloriform in metabolism were 2.82 +/- 0.79 nmol/mi n/g tissue and 2.91 + or 0. 99 nmol/min/g tissue, with rat and human liver, respectively and the K values were 25.5 +/- 18.4 nmol/flask and 8.33 +/- 1.9 nmol/flask, rat and human liver, respectively. Rat hepatocytes incubated under similar conditions metabolized chloroform with a V max of 10 nmol/min/g and a K m of 93 nmol/flask. In summary, the liver slice system was readily adaptable to investigation of the metabolism of volatile chemicals.
DTIC

N95-18618# Army Research Inst. of Environmental Medicine, Natick, MA.
DESIGN CONCEPTS FOR AN INTEGRATED ENVIRONMENTAL MEDICINE WORKSTATION FOR PREDICTION, SIMULATION AND TRAINING
MATTHEW J. REARDON Dec. 1993 53 p
(AD-A283686) Avail: CASI HC A04/MF A01

A design concept is developed for a comprehensive multimedia software-based environmental medicine and physiology workstation for military health care planners and providers for use in both operational and training settings. This will be based on integrating a core of predictive models for soldier responses to hot, cold, and high altitude stress. Overlying this core is a layer of on-line documentation to provide assistance and guidance as well as support training modes. The user interactive information resource will incorporate USARIEM's cumulative database in hot, cold, and altitude stress as well as nutrition, human performance, and injury prevention. The outer layer of the workstation is a flexible, user friendly, graphical interface. It may also be tailored as an environmental medicine computer-based training module for medical students and residents.
DTIC

N95-18626 Indiana Univ., Bloomington, IN. Hearing and Communication Lab.
PERCEPTION OF COMPLEX AUDITORY PATTERNS Annual Report, 15 Sep. 1992 - 14 Sep. 1993
CHARLES S. WATSON 14 Sep. 1993 16 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-92-J-0506)
(AD-A284189; AFOSR-94-0503TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

This report describes research progress in three areas: the

perception of complex sounds, including tonal sequences and bursts of frozen Gaussian noise; models for the discrimination of complex sounds; and the perception of speech sounds, under various degrees of stimulus uncertainty and levels of training. Major accomplishments during this period include: the finding that the ability to detect very small frequency changes in single components of tonal sequences, previously assumed to be accomplished only after lengthy training on the specific discrimination task in question, is largely the result of familiarity with the stimulus and is relatively independent of the manner in which that familiarity was acquired; the previously described PTD rule for auditory pattern discrimination predicts the discrimination of changes in temporal as well as spectral properties of patterns, and a new model of auditory pattern discrimination that combines elements of Jeffress leaky integrator and the Durlach-Braida equalization-cancellation models is quite successful in describing the results of noise-burst discrimination experiments, including the PTD phenomena mentioned above. DTIC

N95-18656 Hahnemann Medical Coll. and Hospital, Philadelphia, PA.

CEREBELLAR CIRCUIT MECHANISMS WHICH ACCOMPANY COORDINATED LIMB TRAJECTORY PATTERNS IN THE RAT: USE OF A MODEL OF SPONTANEOUS CHANGES IN LIMB COORDINATION Annual Report, Feb. 1993 - Mar. 1994

SHERYL S. SMITH 1 Aug. 1994 7 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality (Contract(s)/Grant(s): F49620-93-1-0136)
(AD-A284023; AFOSR-94-0542TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The olivo-cerebellar circuit plays a role in the coordination of the distal limbs. The present study was proposed to determine the behavior of individual neurons in this circuit, recorded chronically as ensembles of 10-20 during tests of limb coordination across spontaneous changes in limb coordination. Hormone (estrous) and circadian cycles are known to be associated with improvements in the speed and accuracy of limb trajectory, and will be used in this study as a model of changes in performance. Underlying circuit properties which accompany changes in performance will be assessed during performance paradigms. Rats, chronically implanted with microwires in the dorsal accessory olive and arrays of Purkinje cells in the paravermal cerebellum will be monitored during treadmill paradigms employing constant speed, variable acceleration and perturbed gait. Single unit discharge will then be analyzed and correlated with changes in performance associated with hormone state. The following parameters will be assessed: (1) step-cycle correlated discharge; (2) the strength of olivo-cerebellar connections, using cross-correlation techniques; (3) the degree of synchronized olivary oscillatory discharge, a putative timing mechanism for rapid movements; and (4) changes in center-surround properties of adjacent arrays of Purkinje cells. DTIC

N95-18661 Southeastern Center for Electrical Engineering Education, Inc., Saint Cloud, FL.

THE CROSS-VALIDATION OF THE UNITED STATES AIR FORCE SUBMAXIMAL CYCLE ERGOMETER TEST TO ESTIMATE AEROBIC CAPACITY Interim Report, Jun. 1993 - Jun. 1994

MICHAEL L. POLLOCK, LINDA GARZARELLA, DIEGO DEHOYOS, WILLIAM BRECHUE, and MATT BEEKLEY Jun. 1994 157 p Prepared in cooperation with Florida Univ., Gainesville, FL Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F33615-90-D-0606; AF PROJ. 7930)
(AD-A284055; AL/CF-TR-1994-0046) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Two hundred and seven subjects (males, n=103; females, n=104) between the ages of 18 and 54 volunteered for this study to determine the accuracy of the USAF submaximal cycle ergometry (SCE) test versus treadmill (TM). The analysis shows that USAF SCE VO(sub 2max) estimates are valid for males and females in this age range. For males, baseline SCE underpredicted VO(sub 2max) by 2.2 ml/kg/min, had a moderately high correlation (r=0.85), and acceptably low standard error of the estimate (SEE, 6.7 ml/kg/min). For females, baseline SCE overestimated VO(sub 2max) by 2.2 ml/kg/min. For females, correlation was moderately high (r=0.85) with a relatively low SEE (5.5 ml/kg/min, 16.6%). Repeat SCE did not increase accuracy. Adjusting power output to achieve higher steady state heart rates improved correlations and lowered SEE. SCE was more closely related to TM VO(sub 2max) than to maximal cycle measures. Finally, 102 subjects completed a YMCA SCE test. For males, the YMCA test overpredicted VO(sub max). Correlation and SEE were not satisfactory (r=0.63 and SEE=9.8 ml/kg/min). For females, the YMCA test was equally good or slightly better than the USAF SCE in estimating VO sub 2max. USAF SCE sensitivity was 75%. Specificity was 96%. Suggestions to further improve USAF SCE validity and accuracy are offered. DTIC

N95-18971*# Oakwood Coll., Huntsville, AL. Dept.of Chemistry, Biochemistry and Allied Health.

THE ASSESSMENT OF VIRTUAL REALITY FOR HUMAN ANATOMY INSTRUCTION

KAREN P. BENN *In* Alabama Univ., Research Reports: 1994 NASA/ASEE Summer Faculty Fellowship Program 6 p Oct. 1994
Avail: CASI HC A01/MF A03

This research project seeks to meet the objective of science training by developing, assessing, and validating virtual reality as a human anatomy training medium. In ideal situations, anatomic models, computer-based instruction, and cadaver dissection are utilized to augment the traditional methods of instruction. At many institutions, lack of financial resources limits anatomy instruction to textbooks and lectures. However, human anatomy is three dimensional, unlike the one dimensional depiction found in textbooks and the two dimensional depiction found on the computer. Virtual reality is a breakthrough technology that allows one to step through the computer screen into a three dimensional world. This technology offers many opportunities to enhance science education. Therefore, a virtual testing environment of the abdominopelvic region of a human cadaver was created to study the placement of body parts within the nine anatomical divisions of the abdominopelvic region and the four abdominal quadrants. Derived from text

N95-19239* National Aeronautics and Space Administration, Washington, DC.

AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 398)

Feb. 1995 41 p
(NASA-SP-7011(398); NAS 1.21:7011(398)) Avail: CASI HC A03

This bibliography lists 66 reports, articles and other documents introduced into the NASA Scientific and Technical Information System during Feb. 1995. Subject coverage includes: aerospace medicine, life sciences, behavioral sciences, man/system technology and life support, and space biology. Author

N95-19244# Oak Ridge National Lab., TN.

NUCLEAR MEDICINE PROGRAM Quarterly Progress Report, period ending 30 Jun. 1994

F. F. KNAPP, JR., K. R. AMBROSE, A. L. BEETS, C. R. LAMBERT, D. W. MCPHERSON, S. MIRZADEH, and H. LUO Aug. 1994 17 p
(Contract(s)/Grant(s): DE-AC05-84OR-21400)
(DE94-017530; ORNL/TM-12789) Avail: CASI HC A03/MF A01

We describe the first successful synthesis and in vivo evaluation of a fluorinated analog of the IQNP muscarinic-cholinergic receptor ligand. Unanticipated synthetic hurdles lead to several unsuccessful approaches before the synthesis of a model compound was achieved. The successful route involved introduction of the fluoroethyl moiety at an early stage of the synthesis by alkylation of ethyl 1,3-dithiane-2-carboxylate with 1-fluoro-2-bromoethane. Subsequent unmasking of the carbonyl, followed by introduction of the phenyl group with phenylmagnesium bromide and subsequent

transesterification with racemic quinuclidinol afforded the target compound, 1-azabi-cyclo-(2.2.2)oct-3-yl alpha-(1-fluoroethan-2-yl)-alpha-hydroxy- alpha-phenylacetate (QNF). Pretreatment of Fisher rats with QNF one hour prior to the intravenous administration of the (I-131)-Z-(R,R) IQNP isomer demonstrated that the new fluoro analog blocked uptake of iodine-131 in those regions of the brain rich in muscarinic-cholinergic receptors measured three hours after injection. As an example, the control values for group of nontreated animals were (5 animals; mean +/- SD): cortex, 1.20 +/- 0.27; striatum, 0.73 +/- 0.19; pons, 0.70 +/- 0.20; cerebellum, 0.43 +/- 0.114. Brains from animals pretreated with the fluoro analogue had the following values (mean +/ - SD; % decrease): cortex, 0.67 +/- 0.15 (65%); striatum, 0.35 +/- 0.114 (52%); pons, 0.40 +/- 0.08 (43%); cerebellum, 0.16 +/- 0.09 (63%). Also during this period several tungsten-188/rhenium-188 generators and tin-117m samples were provided for collaborative studies. DOE

N95-19384# Hilton Systems, Inc., Cherry Hill, NJ.
AGE 60 STUDY. PART 3: CONSOLIDATED DATABASE EXPERIMENTS Final Report
EDWIN J. KAY (Lehigh Univ., Bethlehem, PA.), DONALD J. HILLMAN (Lehigh Univ., Bethlehem, PA.), DIANE T. HYLAND (Lehigh Univ., Bethlehem, PA.), ROBERT S. VOROS (Lehigh Univ., Bethlehem, PA.), REGINA M. HARRIS, and JIM D. DEIMLER Oct. 1994 99 p
(Contract(s)/Grant(s): DTFA02-90-C-90125)
(AD-A286247; RN-8025-3C(R2)-PT-3; DOT/FAA/AM-94/22-PT-3) Avail: CASI HC A05/MF A02

This report was a primary deliverable from the research contract with Hilton Systems, Inc. on the FAA's mandatory retirement for pilots operating under Federal Aviation Regulations Part 121, the Age 60 Rule. The purpose of this study was to examine existing data to assess the relationship between pilot age, accident rate, and experience. Three existing data bases were integrated on a single computer platform: (1) the FAA Airmen Certification file, (2) the FAA Medical History file, and (3) the National Transportation Safety Board (NTSB) Accident data base. The report presents a discussion of the methodological issues with studies in aging and reviews prior research. Limitations of utilizing these data sets are discussed. The methodological approach was developed from these considerations. Hilton Systems replicated and extended analyses from previous studies, including statistical analyses. The report describes outcomes from analyses conducted to answer a series of questions examining the relationship between age and accident rates for pilots holding Class 1, Class 2, and Class 3 medical certificates. Recent and total flight time are utilized as a measure of risk exposure. The results present a converging body of evidence which fail to support a hypothesis that accident rates increase at or about the age of 60 years. DTIC

N95-19385# Hilton Systems, Inc., Cherry Hill, NJ.
AGE 60 STUDY. PART 4: EXPERIMENTAL EVALUATION OF PILOT PERFORMANCE Final Report
DIANE T. HYLAND, EDWIN J. KAY, and JIM D. DEIMLER Oct. 1994 66 p
(Contract(s)/Grant(s): DTFA02-90-C-90125)
(AD-A286248; RN-8025-4B-PT-4; DOT/FAA/AM-94/23-PT-4) Avail: CASI HC A04/MF A01

This report was a deliverable from the research contract with Hilton Systems, Inc. on the FAA's mandatory retirement for pilots operating under Federal Aviation Regulations Part 121, the Age 60 Rule. The purpose of this study was to examine the feasibility of developing an individually-based pilot performance assessment, as well as design an experimental methodology to empirically examine the relationship between pilot aging and performance. Pilot performance was measured with both domain-dependent as well as domain-independent assessments to test a decrement with compensation model of expertise and aging. Computerized cognitive test batteries, COGSREEN and WOMBAT, were selected as the domain-independent measures. Flitescript and whole task performance in the B-727 simulator were domain-dependent measures. Forty B-727-rated pilots were recruited from air carriers and the FAA. Pilots were males between the ages of 41 and 71 years (M=53.9, sd=8.1). DTIC

N95-19413# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.
THE CLINICAL BASIS FOR AEROMEDICAL DECISION MAKING [LES BASES CLINIQUES POUR LA PRISE DE DECISION DANS LE DOMAINE AEROMEDICAL]
Sep. 1994 257 p In ENGLISH and FRENCH Symposium held in Palma de Mallorca, Spain, Apr. 1994
(AGARD-CP-553; ISBN-92-836-0003-7) Copyright Avail: CASI HC A12/MF A03

This symposium addressed the rationale behind aeromedical decisions. Lack of available data required decision-makers to be conservative when deciding who should fly or not. Papers in this symposium updated available data and provided a focal point for discussion and re-evaluation of aeromedical selection and retention standards. Discussion periods allowed for open exchange on particular topics of concern, i.e., cardiovascular and neurological problems and HIV. Our purpose was to exchange data, experience, and management rationales dealing with the very difficult task of aeromedical decision-making. Information sharing would enable nations to update management protocols based upon experience and collectively more powerful data. The elimination of costly redundant research, the focusing of future research, and collaborative efforts between AGARD member nations is the hope of this exchange. For individual titles, see N95-19414 through N95-19443.

N95-19414# Air Force Systems Command, Bolling AFB, Washington, DC. Medical Operations Agency.
AEROMEDICAL RISK MANAGEMENT FOR AIRCREW
T. M. GIBSON (Royal Air Force, Farnborough, England.) and P. M. GIOVANETTI *In* AGARD, The Clinical Basis for Aeromedical Decision Making 8 p Sep. 1994
Copyright Avail: CASI HC A02/MF A03

Medical waivers for aircrew are exceptions to aeromedical standards which have operational justification. The goal of the waiver process is to preserve flying experience to the fullest extent while preserving flight safety, individual health and mission completion. Unfortunately, the flight surgeon has historically been forced to be conservative in deciding who was or who was not fit to fly because of a paucity of relevant scientific data. Moreover, the waiver process has not always been applied logically or consistently. The US Air Force has recently applied the philosophy of aeromedical risk management to produce a waiver guide for flight surgeons. The guide lists the aeromedical concerns for selected chronic conditions met by the flight surgeon. Advice is given on the workup required for each waiver request and a discussion section examine the rationale for the aeromedical disposition. For each condition, an indication is given of the US Air Force waiver experience over the last few years. This paper examines the basic philosophy and describes the use of the waiver guide. Author

N95-19415# Belgian Air Force, Brussels (Belgium).
THE WAY TO WAIVERS IN THE BAF
J. P. VASTESAEGER and P. VANDENBOSCH *In* AGARD, The Clinical Basis for Aeromedical Decision Making 4 p Sep. 1994
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The medical and physical examinations our pilots go in for at recruiting and during their annual revision become more extended and accurate thanks to new medical techniques. On the other hand we notice that the importance of human factors as a cause of flight accidents increases. Therefore, the medical Commission (GCGLUD) responsible for declaring pilots fit to fly has to describe the affections regarding to risks and prognosis in more detail, and has to impose flight restrictions adapted to the type of airplane and the function of the pilot involved. The medical Commission for suitability to fly's decision thus has an important influence on the further career of the pilot in question and on flight safety in common. The Commission has to find a balance

between common and personal interest. The main intention of this study was to critically evaluate the procedures followed by the Commission, based on an investigation on the cases of all pilots, in the Belgian Airforce, who were restricted definitely during the year of 1992. The population, the different kinds of affections and the resulting flight restrictions were studied. These data will be followed by a critical view on the method of procedure of the Commission. Author

N95-19416# Naval Aerospace Medical Inst., Pensacola, FL.
THE WAIVER PROCESS AND DISQUALIFYING MEDICAL CONDITIONS IN US NAVAL AVIATION PERSONNEL
DEAN A. BAILEY, LOUIS G. GILLERAN, and P. GLENN MERCHANT *In* AGARD, The Clinical Basis for Aeromedical Decision Making 11 p Sep. 1994
Copyright Avail: CASI HC A03/MF A03

In the United States Navy, many diagnoses are considered disqualifying for aviation duty but may be 'waived' to return to flight duties after resolution of the disease or appropriate treatment of the condition. Personnel with waivers are usually subject to more frequent physical examinations and/or special diagnostic procedures. Although the Naval Aerospace and Operational Medical Institute promulgates written aeromedical guidelines that delineate which disease conditions may be waived and which may not, waivers are granted on a case-by-case basis considering not only the diagnosis, but the age, experience, and type of aviation duty of the individual in question. This study was undertaken to determine which conditions were most and least likely to be waived. We reviewed all cases entered in the Naval Aviation Medical Data Bank who had been diagnosed with a condition considered disqualifying for aviation duty, totaling over 39,000 records. Cases were stratified by diagnosis and aviation duty and the percentage waived was calculated for major diagnostic groups. Approximately 66% of all cases with a disqualifying diagnosis were recommended for a waiver. Otolaryngologic, ophthalmologic and musculoskeletal disorders accounted for over 50% of diagnoses in personnel recommended for a waiver. Fear of flying, personality disorders and adjustment disorders were the three diagnoses least likely to be granted a waiver. The most common disqualifying diagnoses of aviation personnel not recommended for waiver were disorders of refraction and accommodation, obesity, allergic rhinitis, alcohol dependence, and hypertension. Designated aviation personnel were significantly more likely to be waived than students. Author

N95-19417# Naval Aerospace Medical Inst., Pensacola, FL.
THE EFFECT OF SPECIAL BOARDS OF FLIGHT SURGEONS ON THE EVOLUTION OF US NAVAL FLIGHT STANDARDS
K. L. GALLAGHER and E. A. BOWER *In* AGARD, The Clinical Basis for Aeromedical Decision Making 5 p Sep. 1994
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The flight surgeon is frequently asked to make a determination on the 'fitness to fly' of a member of his or her squadron. Common medical conditions that are transient, unlikely to progress in the operational environment, and have no sequelae that could compromise safety of flight do not result in the physical disqualification of the aviator. These simple cases lend themselves to a prompt aeromedical disposition and are routinely handled by the squadron flight surgeon through the issuance of temporary grounding notices. Following resolution of the acute illness, the aviator can immediately return to full flight status. If any of these prerequisites are not met, however, the aeromedical disposition becomes more complex. Medical conditions that may have significant sequeale, require long term follow up, or those that require chronic medication are not compatible with existing Naval aviation physical standards. If the aviator's career is to be preserved, a waiver of physical standards must be obtained. These challenging cases are generally handled by the squadron flight surgeon, with input from higher medical authorities. These recommendations are forwarded to the Bureau of Personnel for final action. The line community is the final arbiter of standards, and will issue a waiver for flight status based on the needs of the service. Since 1956, the U.S. Navy aeromedical community has officially recognized the need for an approach to evaluate aviators with significant fitness for flight questions. In 1957, the Chief of Naval Air Training established a reviewing body of speciality trained flight surgeons at the Naval Aviation Medical Center in Pensacola, Florida. This group became known as the Special Board of Flight Surgeons. The Senior Board of Flight Surgeons can make recommendations that supersede the recommendations of the Special Board of Flight Surgeons, and in effect can serve as the court of last resort for aviators seeking another hearing of their case prior to final recommendation. A Special Board of Flight Surgeons is requested by an aviator's commanding officer. Medical information is supplied to the clinical departments at the Naval Aerospace and Operational Medical Institute (NAMI) and a recommendation on the merits of hearing the case is then made to the commanding officer of NAMI. All special board cases presented at NAMI from 1 January 1984 until 31 December 1993 were reviewed. There were 119 special board cases involving 116 individuals. These individuals appeared before the board on two separate occasions. Pertinent demographic data were entered into a computerized database program (dBase III, Ashton-Tate Inc.) for trend analysis. The rationale for the aeromedical conclusions reached in each of the 119 cases presented in the past ten years was explored in detail. No statistical analyses were attempted on the data. The effect of sex and race on board outcome were considered, however, there were only two females and few minorities during the time frame considered negating any statistical significance. Author

N95-19418# Centro de Instruccion de Medicina Aeroespatial, Madrid (Spain).
FIT TO FLY: ANALYSIS OF THE AEROMEDICAL DISPOSITION IN AIRCREWMEMBERS OF THE SPANISH ARMED FORCES
FRANCISCO RIOS, JOSE A. AZOFRA, PATRICK P. MILES, JUAN J. CANTON, VICENTE VELAMAZAN, and JOSE B. DELVALLE *In* AGARD, The Clinical Basis for Aeromedical Decision Making 14 p Sep. 1994
Copyright Avail: CASI HC A03/MF A03

Medical fitness is an essential part of air safety. Aircrews undergo their regular medical review to ensure their physical and mental status will enable them to carry out their onboard functions in both normal and exceptional circumstances. Medical screening during the selection process followed by continued medical vigilance over the health of aircrews has been the major contributor to air safety by reducing the risk of potential incapacitation during flying duty. Because preexisting disease has been described as a contributor to aircraft mishaps military aviators undergo detailed initial flying physical examinations designed to find those with physical defects or disabilities that could potentially compromise flying safety. Another major objective of the physical examination is to periodically reevaluate conditions already known to the pilot and flight surgeon which may or may not have required the granting of a waiver previously, as there are many medical problems or conditions which are not static but may become improved or worsened over the time interval since the last periodic check up. The decision whether to let a pilot fly again is always a difficult one, especially since the airman involved is usually very keen to return to duty and will do his utmost to convince those who make these decisions that he is capable of flying. Flight surgeons have the responsibility to confirm this capability prior to putting a pilot back in the cockpit. The purpose of this study was: (1) to review the aeromedical disposition of Spanish military personnel through the first half of 1993 and identify the major reasons for permanent or temporary disqualification; (2) to determine the incidence or various medical causes for permanent or restricted status; and (3) to determine the incidence and reasons for restrictions or temporary disqualification among aviators who, after appropriate follow-up were returned to flying duties. ESDU

N95-19419# Naval Aerospace Medical Inst., Pensacola, FL.
AMDRS: A RESOURCE FOR INTELLIGENT AEROMEDICAL DECISION-MAKING
C. J. NICKLE *In* AGARD, The Clinical Basis for Aeromedical Decision

Making 6 p Sep. 1994
Copyright Avail: CASI HC A02/MF A03

The Aviation Medical Data Retrieval System (AMDRS) is a dynamic, expanding database that currently contains information on 150,000 individuals, and approximately 75,000 separate complete examinations. The Naval Aerospace and Operational Medical Institute (NAMI) developed AMDRS in March 1989. The Aviation Epidemiological Data Register (AEDR), developed by the US Army Aeromedical Research Laboratory, is the temporary repository of information from which the AMDRS develops. After the medical record is completed by reviewers, information is transferred for permanent storage in the Aviation Medical Data Base (AMDB). The purpose of this paper will be to provide detail about the information available in the database, examples of previous studies completed, and propose specific areas for future study. Author

N95-19420# Institute of Aviation Medicine, Fuerstenfeldbruck (Germany).
RELEVANCE OF LABORATORY TESTS IN AEROMEDICAL DECISIONS
K. REICHENBACH-KLINKE *In* AGARD, The Clinical Basis for Aeromedical Decision Making 3 p Sep. 1994
Copyright Avail: CASI HC A01/MF A03

Laboratory tests in body fluids are an essential part of the aeromedical examination. It helps to find objective data in a poor anamnesis. Nearly all pilots tell us they feel healthy and fit for flying duty. The chemical finding sometimes give surprising results. Measurements are of a high technical standard, quality control guarantees reliability. So no-one can ignore an abnormal laboratory measure, the range of test profiles in aeromedical examination in civil and military regulations is different. Our laboratory program for pilots is now reformed and will be part of the regulations for the aeromedical examination. The selection of laboratory screening test follows some criteria: (1) relevance for a safety relevant disorder; (2) test is sufficient specific and sensitive; and (3) test can be automated and economically performed. Specials in military duty asymptomatic chronic diseases, which may be aggravated in extreme climate, must be excluded. Author

N95-19421# Italian Air Force Forensic Medical Inst., Rome (Italy).
TSH DETERMINATION IN SUBJECTS WITH MEDIUM-LOW LEVELS OF SERUM THYROXINE
D. DANESE, F. VIAGGI, and O. SARLO *In* AGARD, The Clinical Basis for Aeromedical Decision Making 13 p Sep. 1994
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The prevalence of thyroid diseases is almost 5 to 7%. Hypothyroidism, whether primary (thyroidal) or secondary (hypothyrotropic and, rarely, hypothalamic) occurs at all ages and is more common in women. Its frequency varies depending on the population studied. The prevalence of overt hypothyroidism is 0.5 to 2%. Even though hypothyroidism is an uncommon cause of disease, it nevertheless decreases psychological and physiological efficiency, modifying the aeromedical standards. Hypothyroidism is an involved clinical, metabolic condition supported by inadequate thyroid function. Elevation of thyrotropin blood levels is a sensitive indicator of decreased thyroid gland function (primary hypothyroidism). In this study we evaluated the prevalence of subclinical hypothyroidism, characterized by an elevation of TSH levels with low levels of serum thyoxine and medium-low levels of free tiroxine, in subjects examined at the Forensic Medical Institute of IAF, during ordinary checkups. Author

N95-19422# Service de Medecine Aeronautique, Versailles (France).
EKG IN FLIGHT: USEFULNESS AND LIMITS FOR AIRCREW REHABILITATION
A. SEIGNEURIC, J. P. BURLATON, F. DIDELOT, R. CARLIOZ, and P. E. BERTRAN *In* AGARD, The Clinical Basis for Aeromedical Decision Making 5 p Sep. 1994
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During the last 16 years, we have performed 86 in-flight EKG's on french aircrew members in order to have additional arguments for fitness decisions. Fighter pilots were the most important group (39%) followed by helicopter pilots (27%), transport pilots (13%) and student pilots (9%). The most important reasons were EKG disturbances and in particular excitability disorders. Cardiac troubles like coronary or valvular disease were more rare. This examination provided positive indication of flying fitness in 70% of cases, negative indications in 15% and no indication in 15% of cases. It is a useful complement to conventional cardiac investigations before medical decision in certain cases. Author

N95-19423# Centro de Instruccion de Medicina Aeroespatial, Madrid (Spain).
EVALUATION OF THE EKG'S ISOELECTRIC T WAVE IN AIR FORCE PILOTS
M. A. GOMEZ-MARINO, F. RIOS-TEJADA, and V. VELAMAZANPERDOMO *In* AGARD, The Clinical Basis for Aeromedical Decision Making 7 p Sep. 1994
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171 out of 5126 performed EKG's from aircrew members (3.33%), showed some ST-T wave abnormalities. We studied 23 out of the 171 with isoelectric (low amplitude or moderate inversion, but less than 1 mm) in all leads but not in V2-V3 where the T wave were normal. Six of those, had T wave inversion in III and avF leads. All 23 are healthy males, between 30-55 years old (43.6 plus or minus. 3), without associated EKG disorders, ionic alterations, and no one regularly practiced heavy exercise. Each one had had between 3 and 21 (11.5 plus or minus 6.5) EKG recordings along a following period of 3 to 20 years (13.0 plus or minus 6.3). All of them has been evaluated through treadmill test (Bruce protocol, submaximal greater than 90%), Doppler-Echocardiography and 24 hours Holter monitoring. We found in 22 cases (95.6%), echocardiographic criteria of left ventricular hypertrophy (IV septum more than 13 mm). 15 out of 15 were symmetric and 6 were asymmetric. 19 cases (86.4%) had a mitral filling flow pattern typical of left ventricular compliance disorder, with atrial wave (A) bigger than fast filling wave (E). Only 3 cases (13.6%) had normal mitral flow Doppler pattern. Valvular or subvalvular aortic gradient was not found in any case. Bruce test results were negative in all cases, but in 21 of those (91.3%), during exercise or the first minute of recovery, T waves became normal, returning to be isoelectrics before 10 minutes. We conclude that asymptomatic flyers without coronary risk factors with isoelectric T waves in all EKG leads (but normals T waves in V2-V3), with or without T inversion in III and avF leads, should be adequately tested in order to rule-out mild hypertrophic myocardiopathy, by Doppler-Echocardiography, and not focus attention in trying to find coronary artery diseases. Author

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CENTRIFUGE TESTS OF THE MEDICAL CONDITION OF FRENCH FIGHTER PILOTS [EPREUVE EN CENTRIFUGEUSE DANS LE CADRE DE L'APTITUDE MEDICALE DES PILOTES DE CHASSE FRANCAIS]
G. OSSARD, A. SEIGNEURIC (Service de Medecine Aeronautique, Versailles, France.), J. M. CLERE, and J. P. BURLATON (Service de Medecine Aeronautique, Versailles, France.) *In* AGARD, The Clinical Basis for Aeromedical Decision Making 8 p Sep. 1994 In FRENCH
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The performance of piloting may be involved with processes of which the etiology is not well known today. In the French Air Force, after a serious illness, the pilots undergo a medical examination of their condition to resume flying. Therefore, in order to insure that no risk remains due to accelerations, the pilots undergo a standardized centrifuge test in the Aerospace Medicine Laboratory. From 1983 to 1993, 112 centrifuge tests were conducted. The requirement for having a centrifuge test is largely predominated by illness of loss of consciousness and cardio-vadcular disturbances which are essentially transitory electrocardiograph anomalies. In certain cases, the disorders have been reproduced and analyzed. The centrifuge test

frequently permit avoidance of a disqualification which would have grave consequences for the pilot, based on physiological findings, and for the savings to the Air Force of an investment in operational status. Author

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IS THE PILOT FIT FOR FLYING AFTER AN ACCIDENT?
GRETE MYHRE *In* AGARD, The Clinical Basis for Aeromedical Decision Making 3 p Sep. 1994
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It has been recommended that a pilot should fly as soon as possible after an aviation accident or incident, provided he is medically fit. This tradition has been successful in many cases and has therefore been accepted as the right thing to do in the flying society. New knowledge about post traumatic reactions related to accidents has led to new procedures in the Royal Norwegian Air Force in the wake of a crash. Since an accident necessarily affects many persons, much like rings in the water after throwing a pebble, the new post accident debriefing procedures cover the involved parts after a survivable accident in addition to the rest of the squadron. A considerable problem with post traumatic emotional reactions are that they are not usually detected right after the accident, but are elements in a process rather than immediate results of the acute event. So far this program has demonstrated two effects: (1) maintaining the confidence level the aviator had prior to the accident, and (2) demystifying normal emotional reactions in flying personnel, which in itself is a very important accomplishment. In conclusion, the pilot is fit for flying when he has been made aware of the emotions connected with an accident and what to do if and when they appear. The pilot will be able to continue his duties if he has a supportive team that he can lean on in the first period of time after his traumatic experience. For most people it is an advantage to get back to work and resume the normal activities as soon as possible. The aviator will be able to execute his duties without limitations, knowing that the emotions he has gone through are normal and expected, provided the flight surgeon has performed this part of his job carefully. Author

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THE CONCEPT OF AERONAUTICAL ADAPTABILITY AS DEVELOPED BY THE US NAVY
P. G. MERCHANT and J. C. BAGGETT *In* AGARD, The Clinical Basis for Aeromedical Decision Making 7 p Sep. 1994
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Physicians working in the field of aviation medicine have known from the earliest days of the specialty that the psychological fitness of aviators was a critical element in minimizing aircraft accidents. Studies, spanning 8 decades of aviation, have demonstrated that the majority of aviation accidents have been the result of human factors. Selection of psychologically fit candidates and monitoring the status of designated Naval Aviation personnel has thus been one of the major tasks performed by Naval Flight Surgeons. To guide them, the concept of Aeronautical Adaptability has been developed. Composed of two similar but separate concepts, the first one requires the flight surgeon to evaluate the motivation, temperment, flexibility, and appropriate psychological defense mechanisms of aviation candidates. The second concept accepts that once designated, an aviator has proven his ability to adapt to the rigors of aviation. Still, it requires monitoring of the experienced aviator's pattern of coping with the stresses of aviation, and provides the means to find designated personnel not Aeronautically Adaptable should maladaptive behavior affect the safety of flight. This paper will explore the early psychological standards in the U.S. Navy, then discuss Aeronautical Adaptability as it evolved over the last 15 years. It will discuss the rational behind the current concept and show how Aeronautical Adaptability provides a fair, timely system of review to help the U.S. Naval Flight Surgeon process difficult cases that could present an unacceptable safety risk in Naval Aviation. Author

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VESTIBULAR EXAMINATION IN PILOTS SUSCEPTIBLE TO MOTION SICKNESS
WILLEM BLES, BERND DEGRAAF, and JELTE E. BOS *In* AGARD, The Clinical Basis for Aeromedical Decision Making 8 p Sep. 1994
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An analysis is presented of data obtained from vestibular examinations on student pilots prone to airsickness. It is shown that those pilots who were most susceptible during the initial flight training course, in the laboratory even suffered from mild conditions of the Coriolis test. Abnormal postural behavior in the tilting room test, or long time constants of the nystagmus decay after sudden stops from constant velocity rotation, do not contra-indicate a successful desensitization program. A Practical Flying Selection considerably diminishes the number of student pilots suffering from airsickness. Those who pass this test, but got nevertheless into motion sickness trouble during the pilot training, were successfully treated with a desensitization program. Author

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THE NAMI SYNCOPE TEST BATTERY AND CLINICAL DECISION-MAKING IN AVIATORS WITH SYNCOPE
J. R. DEVOLL and E. W. HOPKINS *In* AGARD, The Clinical Basis for Aeromedical Decision Making 9 p Sep. 1994
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The Syncope Test Battery (STB) was adopted in 1988 at the Naval Aerospace and Operational Medicine Institute (NAMI) to provide a coherent and consistent methodology for the evaluation of physiologic or secondary syncope. Records from 1988-1992 that utilized the STB were reviewed, and STB results were compared against final diagnostic categories of physiologic or secondary syncope (n=55). Analysis of the STB showed a sensitivity of 20.6 percent, specificity 100 percent, predictive value positive 100 percent, predictive value negative 43.8 percent, and concordance 50.9 percent. These results failed to support the effectiveness of the STB, and the STB did not result in any change between the preliminary and final diagnoses as made on other clinical bases. The evaluation and disposition of syncopal aviators is reviewed in the light of general and aerospace medical literature. It is concluded that the STB is not a useful tool in evaluating syncope in the US Navy aviation population. A step-wise algorithmic approach is recommended for the evaluation of syncopal aviators, but the eventual disposition must still be individualized and remains problematic for the flight surgeon. Author

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THINK HEALTH NOT DISEASE
HARALD T. ANDERSEN *In* AGARD, The Clinical Basis for Aeromedical Decision Making 5 p Sep. 1994
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At air crew selection time many important medical decisions are made, most of them relying on simple clinical methods such as preliminary case history and physical examination. Information obtained using sophisticated laboratory methods may give crucial information when results are evaluated against occupational hazards, but it is important to keep in mind that such procedures are not clinically indicated. Health management of those successfully trained is not performed towards a background of disease but to the contrary, in order to promote health. Retention of those treated for illness is a decision of fitness to fly after evaluation of treatment. Clinicians may be satisfied with the treatment of a patient, flight surgeons may or may not be happy with the result considering the occupational hazards of military aviation. It follows that selection, health management and retention of aviators are in principle considerations of health not of disease. Examinations performed on asymptomatic military aviators using diagnostic high technology instrumentation may not contribute essentially to medical decision making. Author

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NEUROPSYCHOPHYSIOLOGIC SEQUELAE OF MILD HEAD INJURY
ANTONIO BELLI, SILVIO PORCU, and ANDREA BELLATRECCIA *In* AGARD, The Clinical Basis for Aeromedical Decision Making 11 p Sep. 1994
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Psychologic or neuropsychologic consequences of severe closed head injury have received much attention in both clinical and experimental studies. Nevertheless, it has been clearly established that even mild closed head-injured patients may develop psychologic or even psychiatric sequelae of clinical relevance, including poor social adjustments as well as cognitive impairment. Symptoms such as dizziness, fatigue, irritability, headaches, insomnia, anxiety, and amnesia are also frequently reported, these being usually the major features of post-concussion syndrome. Cognitive impairment is responsible of attention and concentration capability disorders, with consequent difficulty in retrieving acquired information and performing usual tasks. Full or satisfactory recovery from such symptoms is normally achieved in few months, with persistence in a minority of cases with distinct risk factors (age, gender, multiple trauma, history of previous head injuries). Such manifestations of head trauma are satisfactorily detected and followed up by means of specific neuropsychologic tests in several studies, while CT-scan fails to provide but scarce prognostic reliability. The role of neurophysiology is controversial, although opinions are that it should be referred to in selected cases and in a multidisciplinary approach. Finally, an interesting and significant correspondence of neuropsychologic tests, behavioral data and MRI or SPECT findings casts a new light on both clinical and research aspects of the question. Making a decision whether returning a head-injured pilot to flight activity or not certainly constitutes an additional problem for the risk of epilepsy and of other neurological or neurosurgical complications is to be considered of primary importance even for mild head trauma (which accounts 75 percent or more of the total, with an annual incidence of about 150 per 100,000 population). Neuropsychologic sequelae themselves do require a restriction from flying duties for months or years. It is advisable to await normalization of neuropsychologic and neurophysiologic parameters, in absence of neuroimaging (i.e. MRI) signs, before returning the patient to flight activity. Neurophysiology (EEG, evoked potentials) provides cost-effective, sensible and reproducible means for diagnosis and follow-up and its value could be boosted by the implantation of an individual neurophysiological database for all the flying personnel. Author

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NEUROLOGICAL DECISION MAKING IN AVIATION MEDICINE BASED ON ELECTROPHYSIOLOGICAL METHODS
H. GLASER and W. FREUND *In* AGARD, The Clinical Basis for Aeromedical Decision Making 7 p Sep. 1994
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The task of neurology in aviation medicine is to determine whether a person is without disturbances of the nervous system's function and without elevated probability to show relevant disturbances in future. Besides medical history and clinical examination, decisions are based on technical methods. Concerning image generating methods, testing of higher brain functions, and sonotopographic methods neurology for the most part utilizes the service of the specialities radiology, psychology, and angiology, while application of electro-physiological methods like electroencephalography, electromyography, neurography or examination of evoked potentials are the neurological specialities own methods. The main task of electroence-phalography in aviation medicine in our opinion is to identify persons with an individually higher electrophysiological lability, which is a lower threshold for abnormal activity of the brain. These persons under conditions of military duty bear a higher risk of developing epileptic phenomena, even if they stay asymptomatic under conditions of everyday life. Author

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THE EEG IN THE EVALUATION OF APPLICANTS TO AIRCREW MEMBERS
NUNO PEDRO RIBEIRO *In* AGARD, The Clinical Basis for Aeromedical Decision Making 4 p Sep. 1994
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The E.E.G. has been used since its beginning as a tool in selection of aircrew personnel. Knowing that even in epileptic patients the E.E.G. in a great majority of cases doesn't show abnormalities, the problem is raised on the meaning of such method in the selection of aircrew candidates. On the other hand we must agree in the definition of a 'normal' E.E.G., and what are the meanings of certain abnormalities in an individual that says that he/she is healthy and denies in his/her clinical history, epilepsy, febrile convulsions, headaches and head traumas. Acording to Niedermeyer and Lops da Silva, the usefulness of the E.E.G. in aircrew selection is that we'll have a record to compare in case of need of repetition of E.E.G. In the Portuguese Air Force the selection is seriated, the neurological observation being one of the last ones and only one small part of all applicants submitted to it. The evaluation consists on a clinical history, in which the denial of all pathology is the rule (they are all voluntary), neurological examination and an E.E.G., 30 minutes duration, in the 10-20 system (since 1990), with two hyperventilations and one photic stimulation.
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CLINICAL BASIS FOR AEROMEDICAL DECISION-MAKING: THE EEG EXAMPLE
J. L. FIRTH *In* AGARD, The Clinical Basis for Aeromedical Decision Making 8 p Sep. 1994
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The EEG, electroencephalogram, is used as a test in aircrew selection. Given that the natural history of the seizure disorders has been described, the validity of this practice is questioned and potentially more rewarding applications of the EEG suggested. System reliability is a major component of aircraft system performance. In military aviation both are central nervous system dependent. In aircrew assessment and management the EEG, electroencephalogram, has traditionally played a major role. Advances in technology, data retrieval, storage, presentation, processing, interpretation and assessment make this an appropriate time to review the place of the EEG in aeromedical decision-making and research. Author

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SPINE INJURIES: UP TO DATE EVALUATION IN AIRCRAFT EJECTIONS
FRANCISCO RIOS, JOSE A. AZOFRA, PATRICK P. MILES, CARLOS VELASCO, JUAN SIEIRO, and ALFREDO CUEVAS *In* AGARD, The Clinical Basis for Aeromedical Decision Making 6 p Sep. 1994
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Spinal injury during aircraft egress has been a well known phenomenon since the early days of flying, though at that time usually secondary to ground impact. However, the development of High Performance Aircraft (HPA) has forced the consequent development of high performance ejection mechanisms. These modern ejection systems have functioned superbly with the latest generation mechanism allowing 91.1 percent survivability when egress takes place above 500 ft from ground level and 79.2 percent pilot survival rate when egress is undertaken at flying level less than 500 ft. However, while the overall success rate of 88 percent has resulted in many more pilots surviving an egress experience, 21 percent of these flyers have been shown to suffer some degree of significant spinal injury (vertebral compression-fracture) during egress, potentially threatening their ability to return to the cockpit. Modern HPA, with their ability to inflict immediate and sustained high +Gz forces to the cockpit environment challenge the flight surgeon now as never before to carefully and successfully evaluate the pilot who has suffered egress-related spinal injury in order

to determine whether it will be safe for the flyer to return to such an environment. This challenge is made even more pressing by the fact that pilots who eject are often well-trained, experienced flyers whose potential lost services, either due to permanent disqualification from flying duties or due to further, additional spinal injury, represent a significant potential loss of valuable human resources to NATO Air Forces, already facing the loss of key personnel and resources due to today's economic pressures. These factors make it imperative that all of the modern medical means at hand be utilized in the analysis of post-ejection spinal injuries. Author

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CLINICAL PRACTICE, DIAGNOSIS AND THERAPY OF INTERVERTEBRAL DISK LESION: IMPORTANCE TO FITNESS FOR MILITARY FLYING DUTIES

T. PIPPIG *In* AGARD, The Clinical Basis for Aeromedical Decision Making 6 p Sep. 1994

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The intervertebral disk, central element of the motion segment, may be exposed to high strains which occur when piloting a jet aircraft or a helicopter. Isolated traumatic ID lesions due to flying strains do probably not come into existence neither ID degeneration according to our actual findings and knowledge of the matter. When there is an accurate diagnosis as to ID prolapse considering clinical and radiological findings, ability for military flying duties is exempted for the next six months. Adequate therapy, either by conservative or surgical treatment, is to be initiated. In the case of cervical ID prolapse however, we do not recognize ability for military flying duties for pilots of jet aircraft seated on an ejection seat and for helicopter pilots, even after good results of treatment. After lumbar ID prolapse and good results of treatment we consider the ability for military flying duties as being restored. Thereafter and when the first flying strains set in, the responsible flight surgeon should examine the pilot regularly, at least in the beginning. Author

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SPINAL NERVE SYNDROMES: THE NEED TO CONFIRM THE DIAGNOSIS WITH NEUROPHYSIOLOGICAL EXAMINATIONS

WOLFGANG FREUND and H.-J. GLASER *In* AGARD, The Clinical Basis for Aeromedical Decision Making 8 p Sep. 1994

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Because even the normally healthy pilots suffer from the usual aging and degeneration of the spine, sudden g-stress may lead to compressions of spinal nerves if degenerated intervertebral discs protrude into the intraspinal space. To avoid risks to general flight-safety as well as to the pilot's health, back-pain and sciadic syndromes have to be evaluated aeromedically. The common methods to investigate the cause of spinal-nerve affections can be divided into three steps: first the intensified interrogation and clinical examination of the pilot, which usually leads to the rough specification of the location of the lesion as well as a first hypothesis of the cause (e.g.: A probably traumatic lesion of the left first thoracal nerve). Second usually come radiological methods such as X-ray of the spine and, more promising, a X-ray computer-tomography (CT) and in difficult cases magnetic-resonance-imaging (MRI), which can differentiate between tumors and protusions of intervertebral discs. In the third step the extent of the damage is evaluated by neurophysiological methods. From the viewpoint of aeromedical decision-making this step is the most critical. Of the suitable methods there are the following used the GAF Institute of Aviation-Medicine (GAFIAM): Electromyography: Fast, rather accurate and reliable, though it covers only the motorical part of the nerve-root); Neurography (F-wave measurements can detect lesions in the motorical part of the nerve-root); Somatosensory Evoked Potentials (SEP) (though time-consuming and demanding they offer the only way to measure sensory deficits); and Magnetically Evoked Potentials. To illustrate the decision-making process, examples are demonstrated.

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THE AEROMEDICAL IMPLICATIONS OF SUPRAVENTRICULAR TACHYCARDIA

LONDE A. RICHARDSON and PAUL V. CELIO *In* AGARD, The Clinical Basis for Aeromedical Decision Making 5 p Sep. 1994

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Supraventricular tachycardia (SVT) is uncommon in healthy screened populations and has an overall prevalence of 0.02 percent and a maximal prevalence 0f 0.1 percent on routine screening electrocardiograms (2-8), 4.6 percent on Holter monitors (9-12) and approximately 0.6 percent on treadmills (13, 14). A review of the clinical literature reveals that occupational and aeromedical risks for aviators with SVT remains inadequately addressed. Long term follow-up data in aviators with SVT is limited to a single small series by Matthewson and Varnam who followed four aviators for 14 years and found no deaths or coronary events. The Aeromedical Consultation Service (ACS) is a centralized United States Air Force (USAF) referral center which performs aeromedical evaluations in aviators to determine their fitness for flying. The ACS has evaluated aviators with SVT since 1955. In 1973, the ACS developed a protocol permitting resumption of flying duties in aviators with SVT; waivers were granted in selected low aeromedical risk cases. We have continued to provide clinical follow-up of aviators with SVT to insure that waivers for SVT are recommended only in low aeromedical risk cases. Although uncommon, SVT can present suddenly with presyncope, syncope or sudden death with potentially catastrophic results during flying duties. Aviators with SVT were disqualified historically because of these risks. Medical standards must be conservative to insure that USAF aviators are free of such conditions. However, this conservative approach has disqualified many asymptomatic aviators who may have safety flown if data had been available demonstrating that certain subsets had an acceptably low aeromedical risk. When evaluating an aviator with SVT, waiver authorities must determine the extent of aeromedical risk, the level of risk acceptable for continued flying duties and which waiver restrictions should be applied. This paper provides outcome data, acquired from aviators with various SVT presentation profiles to assist in that risk stratification. With these data, a safe return to flying duties for those aviators with acceptably low levels of aeromedical risk can be achieved. Author

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SARCOIDOSIS IN US MILITARY AVIATORS

ROBERT MUNSON, B. TUOMALA, PAUL V. CELIO, and LONDE A. RICHARDSON *In* AGARD, The Clinical Basis for Aeromedical Decision Making 3 p Sep. 1994

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Sarcoidosis is a systemic granulomatous disease of unknown etiology and is generally a benign, self-limiting disorder. Myocardial involvement has been known since 1929, but several articles published in the early 1970's indicated that myocardial involvement was a more common and serious problem. In 1974, Fleming reported on 50 cases of myocardial sarcoidosis with cardiac involvement confirmed in 20 cases by necropsy. He suggested that myocardial sarcoid was probably underdiagnosed and was not a rare condition. In 1984, he also suggested that sarcoidosis was frequently overlooked until sudden death occurs, often in relatively young people, 25-54 years of age. In 1976, Matsui, et al., reported in a Japanese population on 72 individuals with sarcoidosis at autopsy. Fifty-eight percent of these individuals died because of myocardial involvement. Most of these deaths were sudden and the diagnosis was generally not suspected during life. In addition, myocardial involvement was apparently a late complication and was not predicted by progressive pulmonary involvement. In 1977, Roberts et al., reported on 113 patients found to have myocardial sarcoidosos at autopsy. Seventy-nine percent had cardiac dysfunction due to myocardial involvement, 67 percent experienced sudden

death, and 23 percent developed congestive heart failure. Most patients with myocardial sarcoid presented initially with cardiac symptoms and most had little or no evidence of other organ involvement. In 16 percent sudden death was the initial manifestation of sarcoidosos. In view of the possible catastrophic consequences of sudden unexpected death or sudden incapacitation of a military aviator, the United States Air Force (USAF) became concerned about the implication of myocardial sarcoidosis. Prior to 1978, all USAF flyers with sarcoidosis were evaluated at the local flight surgeon's office. After they became stable and the findings of sarcoid resolved, they were returned to flying duties with a local waiver. The details of the local evaluation were not prescribed by protocol and were based solely on the judgment of the local physician. In 1978, the USAF initiated the sarcoidosis study group. This program was initiated to solve 2 basic problems. First clinical studies indicated that a more thorough evaluation was required to examine the possibility that an individual with a history of pulmonary sarcoidosis may have asymptomatic butsignificant myocardial granulomas. This program also provided a mechanism for recurrent periodic evaluations to ensure the aviator's continued fitness for flying. The second objective of the sarcoid study group was to perform these evaluations in a systematic fashion with periodic review to determine the outcome of individuals with a history of sarcoidosis to insure that the prognosis of this group was consistent with continued flying duties. Author

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THE AEROMEDICAL RISK ASSOCIATED WITH ASYMPTOMATIC CHOLELITHIASIS IN USAF PILOTS AND NAVIGATORS

G. W. SABOE, J. W. SLAUSON, R. JOHNSON, and T. H. LOECKER *In* AGARD, The Clinical Basis for Aeromedical Decision Making 6 p Sep. 1994

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The USAF aeromedical policy regarding incidentially discovered, asymptomatic cholelithiasis requires the aircrew to undergo cholecystectomy prior to being considered for return to flying duties. The merit of continuing this USAF policy was evaluated at the request of the USAF Surgeon General. A review of the medical literature predicted a 1 percent to 4 percent annual event rate of acute cholecystitis in individuals with previous asymptomatic cholelithiasis. The prevalence of asymptomatic cholelithiasis in USAF pilots and navigators was determined to be 2 percent to 3 percent, based on data acquired at the Ellingson Aerospace Medicine Consultation Service (ACS). Of 11.685 pilots and navigators evaluated at the ACS, 0.7 percent (n = 880) were diagnosed with cholelithiasis or previous cholecystectomy. Between 1972 to 1992, 16,232 man years of pilot and navigator exposure to asymptomatic cholelithiasis was estimated to have occurred; however, only 50 cases with a diagnosis of cholecystectomy or cholelithiasis were reported in the USAF Surgeon General waiver file. Mortality and morbidity associated with cholecystectomy by either open or laparoscopic technique were reported as 0.2 percent and 5 percent, respectively. Using 1994 USAF pilot and navigator manpower data and the worse case scenario of a 0.7 percent occurrence for the onset of acute symptoms associated with previously asymptomatic cholelithiasis, up to five aircrew would be expected to experience acute symptomatology at some time during 1994. However, if every pilot and navigator flew 200 to 1,000 flying hours during 1994, 0.1 to 0.6 individuals, or essentially none, would be predicted to experience acute symptoms related to gallstones inflight. The natural history of cholelithiasis in USAF pilots and navigators is more favorable than suggested by the clinical literature. The inflight risk of experiencing acute symptoms associated with previously asymptomatic cholelithiasis is essentially nonexistent in USAF aircrew. Author

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CLINICAL BASIS FOR AEROMEDICAL DECISIONS IN AIRCREW HIV POSITIVE

JOSE A. AZOFRA, FRANCISCO RIOS, JUAN J. CANTON, PATRICK P. MILES, CARLOS VELASCO, and V. VELAMAZAN *In* AGARD, The Clinical Basis for Aeromedical Decision Making 3 p Sep. 1994

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There has been appropriate concern regarding HIV infection and its effect on aviation safety. Among reasons cited is the consideration that the nervous system is involved early in HIV infection and that dementia in its early stages may be subtle and difficult to detect, on opinion not currently supported by the medical literature. Others have felt that seropositivity alone did not constitute an unacceptable risk to aviation safety, suggesting that other criteria be used, such as the development of AIDS related symptoms, or laboratory abnormalities, prior to grounding a flyer. Discussion and controversy will continue in this area until specific studies of asymptomatic seropositive individuals' performance in real and simulated flying environments are carried out by the aeromedical community. As the prevalence of this disease continues to grow exponentially in the general population the answers to these questions will become increasingly more important. Author

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COLOR VISION ISSUES IN MODERN MILITARY AVIATION OR THE SEARCH FOR THE ABOMINABLE CONEMAN

DOUGLAS J. IVAN, J. TERRY YATES, THOMAS J. TREDICI, and JOHN M. GOOCH *In* AGARD, The Clinical Basis for Aeromedical Decision Making 17 p Sep. 1994

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Visual information provided to the modern military aircrew member accounts for the preponderance of data contributing to situational awareness. Although long recognized as a critical factor in aviation, as a result of advancing technological developments, color vision is emerging as an ever-increasing critical requirement in modern and future cockpits. Despite that premise, the modern battlefield is characterized by a vast array of technological weaponry that increases the threat to the visual system and dictates effective countermeasures that compromise visual performance in general and color perception in specific. This paper will review the aeromedical basis of color testing developments and issues that effect aeromedical decisions in color standards and performance as they relate to the modern military aircrew member. It will include an update on color vision issues raised by protective equipment such as selective waveband filters that include sunglass materials and laser protective eyewear/visors. Color-related aircraft accident issues will be addressed. Author

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PHOTOREFRACTIVE KERATECTOMY (PRK) IN THE MILITARY AVIATOR: AN AEROMEDICAL EXPOSE

DOUGLAS J. IVAN *In* AGARD, The Clinical Basis for Aeromedical Decision Making 18 p Sep. 1994

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Refractive surgery to correct rehabilitate refractive errors of the eye continues to evolve at a significant pace and is here to stay. The surgical manipulation of the cornea by carefully planned incisions, as in radial keratotomy, represented the first technological procedure to evolve for the correction of ametropia and is an area of continued active development and improvement. More recently, photorefractive keratectomy (PRK) using laser technology to ablate and recon-tour the corneal surface has emerged as a viable modality. This paper explores the aeromedical factors surrounding this new revolutionary procedure and discusses the issues relevant to evaluating its applicability to the modern aviator as well as reviewing results of the latest clinical trials currently in progress. The goal is to provide the aeromedical community with the fundamental information required to formulate aeromedical decision- and policy-making in regard to a new procedure that is certain to have tremendous impact on future aircrew candidates. Author

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MEDICATION IN THE COURSE OF ACTIVE FLYING DUTY
M. RADA, A. DVORAK, and J. SULC *In* AGARD, The Clinical Basis for Aeromedical Decision Making 8 p Sep. 1994
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The Czech Institute of Aviation Medicine deals with the practice of medication of airmen without the prohibition of active flying over 25 years. The experience with medical treatment of 420 airmen during the 1982-1993 period is presented in details. Main reason for employment of this policy follows from the successful management of initial stages of primary hypertension as well as of other health disturbances. Hypertension counts for 57.9 percent of all cases liable to medication, being most often started in the second half of the fifth and first half of the sixth decade. Mean duration of medication took 3, 4 years leading to the overall prolongation of active flying for 2, 9 years. A combination of two antihypertensive agents, viz. the diuretic and the beta-blocking agent appears to be the most effective method. Among other frequently applied pharmaceuticals hypolipidaemic and hepato-protective agents along with vitamin compound remedies should be included. The introduction of medication must precede a thorough medical and psychological examination, repeated prior to waivered certification. Regular observation performed by a flight surgeon or a licensed aeromedical examiner is mandatory. With observance of responsible policy the preservation of an airman in active duty despite his/her medication brings significant economic as well as social benefits without the flight safety impairment. Author

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BEHAVIORAL SCIENCES

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

A95-65503* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
OPTICAL SPECIFICATION OF TIME-TO-PASSAGE: OBSERVERS' SENSITIVITY TO GLOBAL TAU
MARY K. KAISER NASA. Ames Research Center, Moffett Field, CA, US and LYN MOWAFY Journal of Experimental Psychology: Human Perception and Performance (ISSN 0096-1523) vol. 19, no. 5 1993 p. 1028-1040
(HTN-95-10448) Copyright

Despite its general mathematical formulation, most empirical work on the visual perception of tau (defined as a quantity divided by its temporal derivative) has focused on the case of direct approach, with tau defined as image angle/rate of expansion. Empirical investigators tend to generalize image size analyses to off-axis approaches. However, this generalization is inappropriate for all but a few classes of objects. After mathematically reestablishing the appropriate optical cues specifying time to passage for noncollision cases, we report a series of studies in which we examined observers' sensitivities to this information in both relative- and absolute-judgment paradigms. In general, we found observers' judgments to be accurate and robust. Author (Hemer)

N95-15959 University of Central Florida, Orlando, FL.
SITUATIONAL AWARENESS IN COMPLEX SYSTEMS Final Report, 1 Feb. 1993 - 31 Jan. 1994
RICHARD D. GILSON 31 Jan. 1994 336 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-93-1-0132)
(AD-A281448; AFOSR-94-0418TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Decisions, whose appropriateness depends on knowledge and rules, are expected more or less effectively depending on the psychomotor skills of the operator. If these are sequential rather than parallel processes, and it seems to me that they must be even though they may be carried out very quickly, then in some cases we may be able to infer decision from action, and gestalt from decision, as long as we understand that the cognitive centroid of the individual operator is idiosyncratic and unknowable to some degree. Training can help to improve perception: it can also help to standardize the decisions taken in a given situation. The comprehension and integration of sensed data can also be improved by training, practice and criticism. The changes brought about by carefully targeted training can be observed and can also help us to underlying processes. DTIC

N95-16010# Yale Univ., New Haven, CT.
PRESENTATIONS OF SHAPE IN OBJECT RECOGNITION AND LONG-TERM VISUAL MEMORY Annual Report, 15 Jan. 1993 - 14 Jan. 1994
MICHAEL J. TARR 5 Apr. 1994 22 p
(Contract(s)/Grant(s): F49620-92-J-0169)
(AD-A281336; AFOSR-94-0413TR) Avail: CASI HC A03/MF A01

A wide range of psychophysical experiments investigating the mechanisms and representations underlying human object recognition have been conducted. In particular, the focus of this research has been an approach in which object recognition is mediated by at least two systems, one based on an explicit qualitative encoding of viewpoint-invariant features and one based on a metrically specific encoding of shape. Within the literature, this dichotomy has been most often associated with measures of the effect of viewpoint on recognition performance. For the most part, the common assumption has been that viewpoint-dependent patterns of performance are the signature of one recognition mechanism, while viewpoint-invariant patterns of performance are the signature of another recognition mechanism. Reinforcing this distinction, viewpoint-dependent mechanisms have been more broadly associated with metrically specific representations sensitive to a range of image-based properties, for example, size, handedness, color, or illumination, while viewpoint invariant mechanisms have been more broadly associated with coarsely-coded representations insensitive to image based properties. To this point, the majority of work on this project has focused only on the former in recognition tasks where perceivers must discriminate between visually similar objects (e.g., a within-category or subordinate-level judgment). During the past year we have continued this line of research, but have extended our approach to include recognition tasks using objects that are relatively dissimilar in that they may be differentiated by a small number of quantitatively different parts (e.g., a between-category or entry-level judgment). DTIC

N95-16138# California Univ., Irvine, CA. Center for the Neurobiology of Learning and Memory.
SYNAPTIC PLASTICITY AND MEMORY FORMATION Annual Report, 1 Jun. 1993 - 31 May 1994
GARY LYNCH 31 May 1994 5 p
(Contract(s)/Grant(s): F49620-92-J-0307)
(AD-A284926; AFOSR-94-0619TR) Avail: CASI HC A01/MF A01

Work described in past progress reports led to the conclusion that the postsynaptic glutamate receptors which mediate fast, excitatory transmission in mammalian brain are the sites at which the changes responsible for LTP occur. Moreover, pharmacological and physiological experiments indicated that the nature of the change involved a modification of receptor channel kinetics. Modelling studies, incorporating this information into a biologically realistic simulation of the receptor, resulted in a specific hypothesis about which the channel opens and closes (see Progress Report, 1992-1993). During the past year, experimental work was carried out to test this hypothesis. This involved hippocampal slices in which fast, excitatory responses were isolated by pharmacologically blocking inhibitory conductances and post-synaptic spiking. The synaptic responses in those 'disinhibited' slices are simple reflections, modified by dendritic filtering, of AMPA receptor mediated currents. DTIC

N95-16140# Navy Computer and Telecommunications Station, Pensacola, FL.
DEVELOPMENT OF THE OMPAT NEUROPSYCHOLOGICAL/ PSYCHOMOTOR PERFORMANCE EVALUATION AND OMPAT DATA AND TIMING SUPPORT PROGRAMS Final Report, 15 Nov. 1990 - 31 Dec. 1993
KATHRYN P. WINTER and DENNIS L. REEVES 31 Dec. 1993 42 p
(Contract(s)/Grant(s): MIPR91-MM-1504)
(AD-A284928) Avail: CASI HC A03/MF A01

The objectives of this project have been: (1) to create a millisecond accuracy software timer module that could be incorporated into OMPAT and other testing programs; (2) to construct a set of automated, i.e., 'computerized' OMPAT Level I neuropsychological and psychomotor tests with documentation that provide a standardized, clinically relevant, and rapid method for assessment of nervous system integrity; and (3) to construct a version of UTCPAB that incorporates the software timer. DTIC

N95-16244# Utah Univ., Salt Lake City, UT. Dept. of Psychology.
STUDIES OF NOVEL POPOUT Annual Report, 15 Aug. 1992 - 14 Aug. 1994
WILLIAM A. JOHNSTON, IRENE S. SCHWARTING, and KEVIN J. HAWLEY 5 Aug. 1994 22 p
(Contract(s)/Grant(s): F49620-92-J-0473)
(AD-A285237; AFOSR-94-0590TR) Avail: CASI HC A03/MF A01

Familiar arrays of objects are perceived better than novel arrays, indicating a perceptual bias toward expected inputs. Yet a novel object in an otherwise familiar array attracts attention, indicating a perceptual bias toward unexpected inputs. These phenomena describe a highly adaptive system but pose a paradox: How can the mind be biased simultaneously toward both what it most expects and what it least expects? Our research on novel popout illuminates the empirical boundaries of this stability/plasticity dilemma, and our computational model, called mismatch theory, provides a resolution. In this report we summarize the last two years of research on novel popout and the evolution of mismatch theory. Among other findings, we cite evidence that novel popout represents an automatic and conceptually-driven form of attention capture and that it is not attributable exclusively to simple feature analysis. We argue that the data undermine certain widespread concepts of attention but are in accord with mismatch theory. The general idea behind mismatch theory is that because the processing of expected inputs can be knowledge-based or conceptually-driven data-driven processing can be inhibited for expected inputs and thereby dedicated to any unexpected inputs. Mismatch theory accommodates our findings and resolves the stability/plasticity dilemma without appealing to the concept of attention as a special gate-keeping device between preattentive and post-attentive processing. Instead, no distinction is drawn between pre-attention and post-attention, and attention is viewed as an emergent phenomenon of ordinary perceptual processes. DTIC

N95-16298# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
THE EFFECTS OF TARGET ORIENTATION ON THE DYNAMIC CONTRAST SENSITIVITY FUNCTION M.S. Thesis
CRAIG A. CROXTON 1994 122 p
(AD-A281855; AFIT/CI/CIA-94-035) Avail: CASI HC A06/MF A02

Much research has been accomplished on the effects of target motion on visual acuity. Research has also been accomplished on the effects of target orientation on visual acuity. The contrast sensitivity function (CSF) also had been studied as a predictor of visual performance under dynamic conditions. However, no previous studies have combined these areas of research and examined the effect of target orientation on the Dynamic Contrast Sensitivity Function (DCSF). DTIC

N95-16299# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
TRAINING VISUAL PATTERN RECOGNITION: USING WORKED EXAMPLES TO AID SCHEMA ACQUISITION M.S. Thesis
KARIN L. NAGEL Aug. 1993 97 p
(AD-A281859; AFIT/CI/CIA-94-013) Avail: CASI HC A05/MF A02

One challenge faced by those involved in the provision of training is to find methods of instruction which retain flexibility, and therefore provide efficient transfer of skills and the ability to adapt to similiar situations in the future. A goal of this thesis is to provoke the reader to think about the learner's mental software when faced with a task requiring recognition in a dynamic, cluttered visual domain that demands flexibility. For example, how does a quarterback learn to recognize and react appropriately to so many defensive patterns, even ones that he has not seen before? This paper briefly reviews some of the literature pertaining to vision research which illustrates how quickly one can recognize features in a scene. Next, this paper addresses features of perceptual learning, specifically Treisman's feature integration theory, and also reviews the cognitive literature relevant to training for transfer, flexibility and adaptability and applies it to the domain of visual pattern recognition. Particular attention will be given to the role of models, schema or principles in transfer, as well as the role of examples in facilitating schema acquisition and hence transfer. The current study investigated whether the use of worked examples aids in schema development, which is believed to be one possible explanation for flexibility in novel situations. DTIC

N95-16301# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
MENTAL ROTATION WITH AND WITHOUT A CONCURRENT TASK: MODERATING EFFECTS OF VISUOSPATIAL ABILITY M.S. Thesis
PAUL K. DALY Apr. 1994 119 p
(AD-A281866; AFIT/CI/CIA-94-074) Avail: CASI HC A06/MF A02

Men (N = 25) and women (N = 27) rated as either high or low in visuospatial ability as assessed on a battery of visuospatial tests (Card Rotations, Mental Rotations, Minnesota Paper Form Board), performed a computer-administered task requiring the mental rotation of abstract geometric shapes presented sequentially, either alone or with a concurrent task of repeating sets of six random digits. Gender and skill-level effects were found. Men were faster than women, and high visuospatial subjects were faster than low. Individual performance did not significantly differ between the single- and dual-task conditions, either in terms of mean response time or rate of mental rotation. DTIC

N95-16368# New York Univ., New York, NY. Dept. of Psychology.
VISUAL NEURAL DEVELOPMENT AND CHROMATIC ABERRATION Final Report, 15 Mar. 1992 - 14 Mar. 1994
LAURENCE T. MALONEY 14 Mar. 1994 4 p
(Contract(s)/Grant(s): F49620-92-J-0187)
(AD-A285064; AFOSR-94-0562TR) Avail: CASI HC A01/MF A01

The purpose of the research undertaken was to develop computational techniques and psychophysical methods for investigating the internal representation of visual information (shape, depth and color) in human observers. Some of the equipment needed was not available in Summer 1992. A no-cost one-year extension was requested and granted, and work on the project continued through March 1994. The following is a list of publications and presentations supported in whole or in part by the grant. A list of personnel is also included. DTIC

N95-16377 Hahnemann Medical Coll. and Hospital, Philadelphia, PA. Dept. of Mental Health Sciences.
LOCUS COERULEUS, VIGILANCE AND STRESS: BRAIN MECHANISMS OF ADAPTIVE BEHAVIORAL RESPONSIVENESS Annual Technical Report, 31 Dec. 1992 - 30 Dec. 1993

GARY ASTON-JONES 8 Jul. 1994 9 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): F49620-93-1-0099)
(AD-A282450; AFOSR-94-0471TR) Avail: CASI HC A02

We have recorded electrical activity from more than 200 neurons in the locus coeruleus (LC) in two behaving monkeys during the last year. We have made significant technical advances (e.g., use of 10 micrometers-diameter microwires for recordings, increased accuracy of electrode penetrations) which have increased the quality and quantity of data obtained. Results confirm our preliminary findings of the last period, i.e., LC neurons vary activity physically and tonically during a vigilance task indicating a role for the LC system in regulating attentional lability and adaptive responsiveness to urgent stimuli. Moreover, extensive analysis of reversal performance reveals that LC neurons may have a close relationship with cognitive processes underlying stimulus analysis and decision making. Finally, this analysis also reveals that LC neurons alter their responsiveness to stimuli after reversal of cue meaning in advance of corresponding alterations in behavioral responsiveness, indicating that LC neurons may play an important role in early learning processes, helping to 'entrain' other brain systems to respond adaptively to new significant stimuli. DTIC

N95-16433# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
AVIATION SPATIAL ORIENTATION IN RELATIONSHIP TO HEAD POSITION, ATTITUDE INTERPRETATION, AND CONTROL M.S. Thesis
DARYL R. SMITH 16 Jun. 1994 112 p
(AD-A281869; AFIT/CI/CIA-94-087) Avail: CASI HC A06/MF A02

Aircraft instrument design theory assumes pilots maintain head alignment with the aircraft during turn and bank maneuvers. As a result, the outside view through the windscreen is thought to be of a moving horizon. The attitude indicator used in today's aircraft displays moving horizon symbology thought to accurately represent pilot spatial orientation. Recently, an optokinetic collic neck reflex was documented which indicates that pilots align their heads with the horizon rather than the axis of the aircraft while manually flying the aircraft. If this is the case, then pilots orient about a fixed rather than moving horizon, implying current attitude instruments inaccurately present spatial information. The purpose of this study was to determine if the optokinetic collic neck reflex has an affect upon pilots while monitoring the autopilot and if so, what that affect is in relation to manual flight. Findings will help determine if the optokinetic collic reflex is transferrable to other flight crewmembers. DTIC

N95-16518# Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.
THE GOMS FAMILY OF ANALYSIS TECHNIQUES: TOOLS FOR DESIGN AND EVALUATION
BONNIE E. JOHN and DAVID E. KIERAS 24 Aug. 1994 53 p
(Contract(s)/Grant(s): N00014-89-J-1975; N00014-92-J-1173)
(AD-A285211; CMU-CS-94-181) Avail: CASI HC A04/MF A01

Since the seminal Card, Moran, & Newell (1983) book, 'The Psychology of Human-Computer Interaction,' the concept of the GOMS model has been one of the few widely known theoretical concepts in human-computer interaction. This concept has spawned much research to verify and extend the original concept and has been used in real-world design and evaluation situations. The original presentation of the GOMS concept left substantial room for interpretation and subsequent researchers and practitioners have applied the idea in a variety of ways. While this variety shows that the GOMS concept is fruitful, there is some confusion about the GOMS concept and the various approaches that share this label yet appear to be radically different. This paper synthesizes the previous work on GOMS to provide an integrated view of GOMS models and how they can be used in design. The major variants of GOMS that have matured sufficiently to be used in real-world design and evaluation situations are described and related to the original GOMS proposal and to each other. A single example is used to illustrate all of the techniques. Guidance is provided to practitioners who wish to use GOMS for their design and evaluation problems, and examples of actual applications of GOMS techniques are presented. DTIC

N95-16520# Army Aeromedical Research Lab., Fort Rucker, AL.
VISUAL PERCEPTION IN THE FIELD-OF-VIEW OF PARTIAL BINOCULAR OVERLAP HELMET-MOUNTED DISPLAYS Final Report
VICTOR KLYMENKO, ROBERT W. VERONA, HOWARD H. BEASLEY, JOHN S. MARTIN, and WILLIAM E. MCLEAN Aug. 1994 26 p
(Contract(s)/Grant(s): DA PROJ. 3M1-62787-A-879)
(AD-A285213; USAARL-94-40) Avail: CASI HC A03/MF A01

Because of limitations in the size of the field-of-view (FOV) available in helmet-mounted displays (HMD) using the full overlap display mode, where the entire FOV is binocular, partial binocular overlaps displays, which can be convergent or divergent, have been proposed. One consequence of this is a perceptual effect known as luning, which is a subjective darkening in the monocular regions of the FOV, which can in some cases cause fragmentation of the FOV into three regions. A concern is, the possible effect on target identification in the monocular regions, particularly in areas affected by luning. We review data we have collected in our binocular vision lab on the effect of display mode one aspects of visual perception. DTIC

N95-16615# *Institute for Human Factors TNO, Soesterberg* (Netherlands).
SUBSET-SELECTIVITY AND DISTRACTOR MATCHING IN VISUAL CONJUNCTION SEARCH
N. A. KAPTEIN and J. THEEUWES 25 Apr. 1994 49 p
(AD-A285137; IZF-1994-B-9; TDCK-94-0049) Avail: CASI HC A03/MF A01

In search for a conjunction of color and orientation, Theeuwes, Kaptein and Van der Heijden obtained target absent responses that were in some conditions faster and in other conditions slower than target present responses. In addition, target absent search function slopes were shallower than target present slopes. These findings cannot be explained by present conjunction search theories. Since in the same study Theeuwes et al. demonstrated subset-selectivity in conjunction search, the interdependence of the fast absent responses and subset-selective search needed to be assessed. The present study shows that subset-selective search is independent of the occurrence of fast absent responses. Experiment 1 replicated the findings of Theeuwes et al. Experiment 2 showed that the fast absents were not the result of a response bias. The results of Experiments 3 and 4 showed that the fast absents can be explained by a weak, parallel distractor matching process that enables responding 'target absent' if all relevant distractor elements are similar. Since this process is easily disturbed, the absence of a sameness-signal can not be used for 'target present' decisions. It is argued that both subset-selective search and distractor matching may have occurred unnoticed in previously reported experiments. DTIC

N95-16760*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ALERTNESS MANAGEMENT IN TWO-PERSON LONG-HAUL FLIGHT OPERATIONS Abstract Only
M. R. ROSEKIND and P. H. GANDER *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Long-haul flight operations involve cumulative sleep loss, circadian disruption, and extended and irregular duty schedules. These factors reduce pilot alertness and performance on the flightdeck. Conceptually and operationally, alertness management in flight operations can be divided into preventive strategies and operational countermeasures. Preventive strategies are utilized prior to a duty period to mitigate or reduce the effects of sleep loss, circadian disruption and fatigue during subsequent flight operations. Operational countermea-

sures are used during operations as acute techniques for maintaining performance and alertness. Results from previous NASA Ames field studies document the sleep loss and circadian disruption in three-person long-haul flying and illustrate the application of preventive strategies and operational countermeasures. One strategy that can be used in both a preventive and operational manner is strategic napping. The application and effectiveness of strategic napping in long-haul operations will be discussed. Finally, long-haul flying in two-person highly automated aircraft capable of extended range operations will create new challenges to maintaining pilot alertness and performance. Alertness management issues in this flight environment will be explored. Author

N95-16761*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
RESULTS OF THE PSYCHIATRIC, SELECT-OUT EVALUATION OF US ASTRONAUT APPLICATIONS Abstract Only
D. M. FAULK (Texas Univ., Galveston, TX.), P. A. SANTY (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), A. W. HOLLAND (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), and R. MARSH (Texas Univ., Galveston, TX.) *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

The psychiatric exclusion criteria for astronauts are based on NASA Medical Psychiatric Standards for space flight. Until recently, there were no standardized methods to evaluate disqualifying psychopathology in astronaut applicants. Method: One hundred and six astronaut applicants who had passed the intitial screening were evaluated for Axis 1 and Axis 2 DSM-3-R diagnoses using the NASA structured psychiatric interview. The interview consisted of three parts: (1) an unstructured portion for obtaining biographical and historical information, (2) the schedule for effective disorders-lifetime version (SASDL), specially modified to include all disqualifying Axis 1 mental disorders; and, (3) the personality assessment schedule (PAS) also modified to evaluate for Axis 2 disorders. Results: Nine of 106 candidates (8.5 percent) met diagnostic criteria for six Axis 1 disorders (including V code) or Axis 2 disorders. Two of these disorders were disqualifying for the applicants. 'Near' diagnoses (where applicants met at least 50 percent of the listed criteria) were assessed to demonstrate that clinicians using the interview were able to overcome applicants' reluctance to report symptomatomatology. Conclusion: The use of the NASA structured interview was effective in identifying past and present psychopathology in a group of highly motivated astronaut applicants. This was the first time a structured psychiatric interview had been used in such a setting for this purpose. Author

N95-16762*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
VALIDATION OF ASTRONAUT PSYCHOLOGICAL SELECT-IN CRITERIA Abstract Only
R. M. ROSE (Texas Univ., Galveston, TX.), R. L. HELMREICH (Texas Univ., Austin, TX.), T. MCFADDEN, P. A. SANTY, and A. W. HOLLAND *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

An optional astronaut selection strategy would select-in individuals on the basis of personality attributes associated with superior performance. Method: A test battery, the Astronaut Personal Characteristics Inventory (ASTROPCI) was developed which assesses positive and negative components of achievement, motivation, and interpersonal orientations and skills. The battery was administered to one hundred three astronaut candidates and sixty-six current U.S. Shuttle astronauts. To determine performance, a series of conceptual areas related to space flight performance were defined. Astronauts rated their peers on each of these dimensions. Ratings were obtained on all eighty-four current astronauts (excluding those selected in 1990). In addition to peer ratings, supervisor assessments of the same dimensions were obtained for each astronaut. Results: Cluster and factor analysis techniques were employed to isolate subgroups of astronauts. Those astronauts with both high achievement needs and interpersonal skills were most often rated among the top five by their peers and least often rated among the lowest five. A number of scales discriminated between astronauts rated high and low on one or more performance dimensions. Conclusions: The results parallel findings from the personality assessment of individuals in other demanding professions, including aircraft pilots and research scientists, suggesting that personality factors are significant determinants to performance in the space environment. Author

N95-16763*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PSYCHOLOGICAL TRAINING OF NASA ASTRONAUTS FOR EXTENDED MISSIONS Abstract Only
A. W. HOLLAND *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

The success of operational teams working in remote and hostile environments rests in large part on adequate preparation of those teams prior to emplacement in field settings. Psychological training, directed at the maintenance of crew health and performance becomes increasingly important as space missions grow in duration and complexity. Methods: Topics to be discussed include: the conceptual framework of psychological training; needs analysis; content and delivery options; methods of assessing training efficacy; use of testbeds and analogies and the relationship of training to crew selection and real-time support activities. Results and Conclusions: This paper will discuss the psychological training approach being developed at the NASA/JSC Behavior and Performance Laboratory. This approach will be compared and contrasted with those underway in the U.S. Department of Defense and in other space agencies. Author

N95-16764*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HUMAN PERFORMANCE IN THE MODERN COCKPIT Abstract Only
R. K. DISMUKES and M. M. COHEN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

This panel was organized by the Aerospace Human Factors Committee to illustrate behavioral research on the perceptual, cognitive, and group processes that determine crew effectiveness in modern cockpits. Crew reactions to the introduction of highly automated systems in the cockpit will be reported on. Automation can improve operational capabilities and efficiency and can reduce some types of human error, but may also introduce entirely new opportunities for error. The problem solving and decision making strategies used by crews led by captains with various personality profiles will be discussed. Also presented will be computational approaches to modeling the cognitive demands of cockpit operations and the cognitive capabilities and limitations of crew members. Factors contributing to aircrew deviations from standard operating procedures and misuse of checklist, often leading to violations, incidents, or accidents will be examined. The mechanisms of visual perception pilots use in aircraft control and the implications of these mechanisms for effective design of visual displays will be discussed. Author (revised)

N95-16765*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CREW DECISION MAKING UNDER STRESS Abstract Only
J. ORASANU *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992
Avail: CASI HC A01/MF A02

Flight crews must make decisions and take action when systems fail or emergencies arise during flight. These situations may involve high stress. Full-missiion flight simulation studies have shown that

crews differ in how effectively they cope in these circumstances, judged by operational errors and crew coordination. The present study analyzed the problem solving and decision making strategies used by crews led by captains fitting three different personality profiles. Our goal was to identify more and less effective strategies that could serve as the basis for crew selection or training. Methods: Twelve 3-member B-727 crews flew a 5-leg mission simulated flight over 1 1/2 days. Two legs included 4 abnormal events that required decisions during high workload periods. Transcripts of videotapes were analyzed to describe decision making strategies. Crew performance (errors and coordination) was judged on-line and from videotapes by check airmen. Results: Based on a median split of crew performance errors, analyses to date indicate a difference in general strategy between crews who make more or less errors. Higher performance crews showed greater situational awareness - they responded quickly to cues and interpreted them appropriately. They requested more decision relevant information and took into account more constraints. Lower performing crews showed poorer situational awareness, planning, constraint sensitivity, and coordination. The major difference between higher and lower performing crews was that poorer crews made quick decisions and then collected information to confirm their decision. Conclusion: Differences in overall crew performance were associated with differences in situational awareness, information management, and decision strategy. Captain personality profiles were associated with these differences, a finding with implications for crew selection and training. Author

N95-16766*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COGNITION AND PROCEDURE REPRESENTATIONAL REQUIREMENTS FOR PREDICTIVE HUMAN PERFORMANCE MODELS Abstract Only

K. CORKER *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Avail: CASI HC A01/MF A02

Models and modeling environments for human performance are becoming significant contributors to early system design and analysis procedures. Issues of levels of automation, physical environment, informational environment, and manning requirements are being addressed by such man/machine analysis systems. The research reported here investigates the close interaction between models of human cognition and models that described procedural performance. We describe a methodology for the decomposition of aircrew procedures that supports interaction with models of cognition on the basis of procedures observed; that serves to identify cockpit/avionics information sources and crew information requirements; and that provides the structure to support methods for function allocation among crew and aiding systems. Our approach is to develop an object-oriented, modular, executable software representation of the aircrew, the aircraft, and the procedures necessary to satisfy flight-phase goals. We then encode in a time-based language, taxonomies of the conceptual, relational, and procedural constraints among the cockpit avionics and control system and the aircrew. We have designed and implemented a goals/procedures hierarchic representation sufficient to describe procedural flow in the cockpit. We then execute the procedural representation in simulation software and calculate the values of the flight instruments, aircraft state variables and crew resources using the constraints available from the relationship taxonomies. The system provides a flexible, extensible, manipulative and executable representation of aircrew and procedures that is generally applicable to crew/procedure task-analysis. The representation supports developed methods of intent inference, and is extensible to include issues of information requirements and functional allocation. We are attempting to link the procedural representation to models of cognitive functions to establish several intent inference methods including procedural backtracking with concurrent search, temporal reasoning, and constraint checking for partial ordering of procedures. Finally, the representation is being linked to models of human decision making processes that include heuristic, propositional and prescriptive judgement models that are sensitive to the procedural content in which the valuative functions are being performed. Author

N95-16817# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Soesterberg (Netherlands). Human Factors Research Inst.

PERCEPTUAL SELECTIVITY FOR COLOR AND FORM: ON THE NATURE OF THE INTERFERENCE EFFECT Interim Report

J. THEEUWES 10 May 1994 23 p

(AD-A285338; TNO-TM-1994-B-11; TDCK-94-0053) Avail: CASI HC A03/MF A01

Previous research has shown that search for a shape singleton is disrupted by the presence of an irrelevant color singleton (Theeuwes, 1991b, 1992). These findings have been treated as evidence for the hypothesis that, irrespective of a goal-directed attentional set on part of the observer, attention is unintentionally captured by the most salient singleton. This hypothesis was tested in two experiments in which subjects searched multi-element displays for a shape singleton. Subjects reported the Letter that always appeared inside the target shape singleton (a green diamond). On some trials an irrelevant color singleton was present which contained a Letter that was compatible or incompatible with the Letter inside the target shape. As reported earlier, the presence of an irrelevant color singleton distracted goal-directed search for the shape singleton. The finding that the identity of the Letter inside the distractor affected responding to the Letter inside the target shape, provides support for the hypothesis that attention is captured by the most salient singleton. The identity of the Letter inside the distractor can only affect responding when it is assumed that attention is involuntarily drawn to the Location of the distracting singleton. DTIC

N95-16822# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). Hoofdgroep Maatschappelijke Technologie.

PARALLEL SEARCH FOR A CONJUNCTION OF SHAPE AND CONTRAST POLARITY

J. THEEUWES and F. L. KOOI 1994 15 p

(AD-A285344; TNO-TM-1994-B-6; TDCK-94-0045) Avail: CASI HC A03/MF A01

When a target object embedded in an array of other objects can be distinguished along a single feature dimension (e.g., colour or shape), it can be detected in parallel. When a target object is defined by a conjunction of stimulus features, search has to be conducted serially, indicating that the visual system is incapable of conducting a parallel search over two stimulus dimensions simultaneously. Earlier research has shown that there are two exceptions to this finding. one dimension can be searched in parallel if the other dimension is stereoscopic depth (Nakayama & Silverman, 1986), or relative motion (McLeod, Driver & Crisp, 1988). We report a third exception: if one dimension involves contrast polarity, another dimension (shape) can be searched inparallel. The neurophysiological implications are discussed. DTIC

N95-16835# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). Hoofdgroep Maatschappelijke Technologie.

A FRAMEWORK FOR THE ANALYSIS OF COGNITIVE TASKS

E. J. MERKELBACK and J. M. SCHRAAGEN 1994 38 p

(AD-A285345; TNO-TM-1994-B-13; TDCK-94-0063) Avail: CASI HC A03/MF A01

The goal of this study was to examine similarities and differences between various types of cognitive task analysis and, if possible, to infer some framework in which the areas for further research should become clear. The result of this study is a framework which integrates three views on cognitive task analysis: task, knowledge and cognitive modelling. For each view, prototypical task analysis techniques are presented respectively: Hierarchical Task Analysis (HTA), Knowledge Analysis and Documentation System (KADS) and Goals Operators

Methods and Selection rules (GOMS). The task modelling view and the cognitive modelling view are already known in the cognitive task analysis domain. The task modelling view concentrates on the decomposition of tasks into goals and subgoals. The cognitive modelling view concentrates on the cognitive performance of the task. The knowledge modelling view, however, is a relativeLy new element in the research area of cognitive task analysis. Within the knowledge modelling view, it is recommended by the framework to gain information about the requirements of the task. Those requirements can have a strong influence on the cognitive performance of the task and, therefore, within the framework of cognitive task analysis, it is advised to examine task requirements before starting to analyze the cognitive performance of the task. Further research in this area is therefore necessary to bridge the gap between one sight of the camp, the task modelling view, and the other side of the camp, the cognitive modelling view. An interesting work of research could be to invent a way in which task requirements are acquired in such a way that they, together with the task's goals, can easily be used to make predictions about cognitive performance. DTIC

N95-17175# Michigan Univ., Ann Arbor, MI. Intense Energy Beam Interaction Lab.

ESTIMATING THE BENEFITS OF PERSONNEL SELECTION AND CLASSIFICATION: AN EXTENSION OF THE BROGDEN TABLE Interim Technical Paper, Apr. 1993 - Mar. 1994

WILLIAM E. ALLEY and MELODY M. DARBY Oct. 1994 25 p
(Contract(s)/Grant(s): AF PROJ. 7719)
(AD-A285674; AL/HR-TP-1994-0010) Avail: CASI HC A03/MF A01

A Monte Carlo study was done to estimate the standardized performance gain (Sigma units) for personnel who have been optimally selected and classified as a function of the number of alternative job assignments, the applicant rejection rate, the validity of the performance estimates, and the intercorrelation among the estimates. The study extended the number of job assignment categories considered to 500 based on a general solution provided by Brogden for up to 10 jobs. Results indicated that adding job categories with zero applicant rejection improved expected performance from 0.0 Sigma units with 1 job to 3.03 Sigma units with 500 jobs. For the highest level of applicant rejection (90%), corresponding gains were 1.75 a units and 3.78 or units respectively. Implications for use of the table were discussed. DTIC

N95-17447 Air Force Inst. of Tech., Wright-Patterson AFB, OH.

CAFFEINE'S INFLUENCE ON CRITICAL FREQUENCY THRESHOLDS M.S. Thesis

JOHN P. SIMEROTH 11 May 1994 120 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A282005; AFIT/CI/CIA-94-069) Avail: CASI HC A06

Caffeine's effect on the visual system was investigated. Twelve male and twelve female subjects (aged 18- 25 years) were measured for Critical Flicker Frequency (CFF) thresholds at 15 levels of retinal illuminance (-1.0 to 3.0 log trolands) in each of four caffeine dosage conditions (0, 200mg, 400mg, 600mg). Variables of interest included dosage, gender, left and right eye differences and time after ingestion. Significant results were found for dosage ($p=.000$), gender ($p=.001$) and eye differences ($p=.000$). Interactions were found for gender and dosage ($p=.000$), and gender and eye differences ($p=.043$). DTIC

N95-17530# Washington Univ., Saint Louis, MO. Dept. of Psychology.

BLINKS, SACCADES, AND FIXATION PAUSES DURING VIGILANCE TASK PERFORMANCE. 1: TIME ON TASK Final Report

JOHN A. STERN, DONNA BOYER, DAVID SCHROEDER (Civil Aeromedical Inst., Oklahoma City, OK.), MARK TOUCHSTONE (Civil Aeromedical Inst., Oklahoma City, OK.), and NIKOLAI STOLIAROV (State Scientific Research Inst. for Civil Aviation, Moscow, Russia.) Washington Dec. 1994 44 p
(Contract(s)/Grant(s): DTFA02-91-C-91056)
(DOT/FAA/AM-94/26) Avail: CASI HC A03/MF A01

In the future, operators of complex equipment will spend more time monitoring computer controlled devices rather than having hands-on control of such equipment. The operator intervenes in system operation under 'unusual' conditions or when there is a computer malfunction. The latter occurs relatively seldom. The operator's task thus becomes a 'vigilance' task, one requiring attention to monitoring equipment with little need for action. An individual's ability to maintain vigilance is easily compromised, with time-on-task (TOT) a major detractor of performance. The question asked in this research was: Can gaze control measures be used to reflect, and hopefully to predict, periods of impaired vigilance? The results of this study clearly demonstrate that a number of aspects of eye movements and eye blinks show significant TOT effects. These effects are, we believe, more likely to be associated with short periods of attentional lapses or 'microsleep'; than with more tonic changes in alertness level. The literature dealing with such measures as indicants of 'fatigue' and/or 'time-on-task' effects is reviewed in considerable detail. The study evaluated aspects of blinking and eye movements in subjects performing the Thackray and Touchstone ATC simulation task. Subjects performed the task for a 2-hour period on 3 separate occasions. Significant increases in blink frequency, blink closing duration, blink flurries, eye closures and fixation pause were obtained as well as similar effects for derivative measures. Though the current data was collected through electrodes attached to the participant, much of the information can be acquired with remote monitoring technologies. This makes possible the application of such measures in a field setting where subjects are required to work on a display terminal. Additional exploration of this approach and the new technologies should provide the information needed to develop strategies and approaches that will enhance operator reliability. Author

N95-17655# Texas Technological Univ., Lubbock, TX. Dept. of Industrial Engineering.

SITUATION AWARENESS INFORMATION REQUIREMENTS FOR EN ROUTE AIR TRAFFIC CONTROL Final Report

MICA R. ENDSLEY and MARK D. RODGERS (Civil Aeromedical Inst., Oklahoma City, OK.) Washington Dec. 1994 37 p Sponsored by FAA
(DOT/FAA/AM-94/27) Avail: CASI HC A03/MF A01

Situation awareness is presented as a fundamental requirement for effective air traffic control, forming the basis for controller decision making and performance. To develop a better understanding of the role of situation awareness in air traffic control, an analysis was performed to determine the specific situation awareness information requirements for air traffic control. This was conducted as a goal-directed task analysis in which the major goals, subgoals, decisions, and associated situation awareness information requirements for enroute air traffic control (ATC) were delineated based on elicitation from eight experienced air traffic control specialists (ATCS's). This effort was supported by available task analyses and video-tapes of simulated ATC tasks. A determination of the major situation awareness information requirements for enroute ATC was developed from this analysis, providing a foundation for future system development which seeks to enhance controller situation awareness and provides a basis for the development of situation awareness measures for air traffic control. Author

N95-18084 Air Force Materials Lab., Wright-Patterson AFB, OH. Crew Systems Directorate.

SITUATION AWARENESS: PAPERS AND ANNOTATED BIBLIOGRAPHY Interim Report, 15 Jan. 1992 - 6 Jun. 1994

MICHAEL VIDULICH, CYNTHIA DOMINGUEZ, ERIC VOGEL, and GRANT MCMILLAN Jun. 1994 167 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): AF PROJ. 7184)
(AD-A284752; AL/CF-TR-1994-0085) Avail: CASI HC A08

This report combines an annotated bibliography about situation

awareness (SA) with four papers that discuss central issues for SA research. The report was compiled to support the Armstrong Laboratory's Situation Awareness Integration (SAINT) team. The annotated bibliography includes the citations and reviews of over 200 articles that discuss SA research or the role of SA in operational systems. These articles are indexed by keyword and author(s). The four papers address the definition of SA, the cognitive processes involved in SA, the operational role of SA, and the initial results of the SA research program conducted by the SAINT team. DTIC

N95-18094 Maryland Univ., College Park, MD. Computer Vision Lab.

THE SYNTHESIS OF VISION AND ACTION

CORNELIA FERMUELLER and YIANNIS ALOIMONOS 1993 40 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): N00014-93-1-0257)

(AD-A285453) Avail: CASI HC A03

Our efforts to reconstruct the world using visual information have led to the insight that the study of Vision should not be separated from the study of a system's actions and purposes. In computational terms this relates to approaching the analysis of perceptual information processing systems through the modelling of the observer and world in a synergistic manner, not through the isolated modelling of observer and world as closed systems. The question still remains: how should such a synergistic modelling be realized? This chapter addresses the question by providing a methodology for synthesizing vision systems and integrating perception and action. In particular, we outline an architecture for purposive vision systems and present a hierarchy of navigational competences based on computational models of increasing complexity, employing representations of motion, shape, form and space. Pure computational considerations will not tell us what visual competences and representations are important to vision systems performing a set of tasks. Interaction, however, with empirical sciences such as Neurobiology, Physiology, Psychology, Ethology, etc., can give us inspiration about the visual categories relevant to systems existing in real world environments. Throughout the chapter, we describe biological findings and how they affect the choice of computational models and representations needed for the synthesis of a hierarchy of navigational competences in a working system. DTIC

N95-18095# Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA.

CREATION OF NEW ITEMS AND FORMS FOR THE PROJECT A ASSEMBLING OBJECTS TEST Final Report, Oct. 1990 - Jan. 1994

HENRY H. BUSCIGLIO, DALE R. PALMER, IVEY H. KING, and CLINTON B. WALKER Aug. 1994 48 p

(AD-A285522; ARI-TR-1004) Avail: CASI HC A03/MF A01

The Army's Project A was a comprehensive effort to improve the selection and classification of enlisted personnel. The Assembling Objects (AO) test was a major product of this effort. Previous research has shown AO to be an excellent measure of both overall spatial ability and complex, g-loaded problem-solving skills. In view of the great potential usefulness of the AO measure, researchers from the U.S. Army Research Institute for the Behavioral and Social Sciences examined the original test to develop precise, comprehensive item specifications. Using these specifications, they developed new draft items that were psychometrically tested in a field setting. The researchers then chose the best of the new items and combined them into three complete new forms that were further tested. Analyses showed that all three new forms displayed acceptable (or better) psychometric properties, at both the item and total score level, thus supporting the usefulness of the item specifications for creating new AO items and forms. These efforts should help to make the Assembling Objects test a valuable addition to the testing programs of the Army and the other armed services. DTIC

N95-18151# Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).

IMPLEMENTATION OF A HUMAN INFORMATION PROCESSING MODEL FOR TASK NETWORK SIMULATION

KEITH C. HENDY May 1994 47 p

(AD-A283903; DCIEM-94-40) Avail: CASI HC A03/MF A01

Task network simulation is an analytical technique that is widely used to predict operator performance and/or workload during early stages of systems design. Task network simulation is based on traditional time-line analysis methods, but allows possibility of non-deterministic task characteristics such as completion times, sequences, outcomes etc. Many simulation environments allow task parameters to vary with various network states, which supports complex logical relationships, and the varying network behaviors. This report outlines the implementation of a theoretical framework for a new model of the human information processor for using task network simulation. The development and validation of the Information Processing (IP) Model is described in detail elsewhere. This report deals only with those aspects that are necessary to take the ideas of the IP Model and adapt them for direct application task network simulation. The material contained in this report provides the bridge between the conceptual descriptions of the Model, and the software requirements necessary to put that concept into practice. As part of this process, many parameters are defined and assigned tentative values so that the model can be run within the task network simulation environment. DTIC

N95-18401 Yale Univ., New Haven, CT. Dept. of Psychology.

A PARALLEL PROCESSING HYPOTHESIS FOR SHORT-TERM AND LONG-TERM MEMORY IN APLYSIA Annual Report, 1 May 1993 - 30 Apr. 1994

THOMAS J. CAREW 30 Apr. 1994 7 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): F49620-93-1-0273)

(AD-A284101; AFOSR-94-0499TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The primary focus of this program of research is a mechanistic analysis of the relationship between short-term and long-term information processing in central neural circuits of the marine mollucs Aplysia. During the last year we have completed several projects in this program; these projects fall into two broad classes which focus on facilitatory and, more recently, inhibitory information processing. We have identified several forms of behaviorally relevant cellular and circuit modifications which involve both facilitatory and inhibitory information processing. Our goal for the current year is to analyze each of these processes mechanistically, and determine their interaction in both short-term and long-term storage of information in identified neural networks. DTIC

N95-18403 Pittsburgh Univ., Pittsburgh, PA.

VISUO-OCULAR PERFORMANCE DURING VESTIBULAR STIMULATION Annual Report, 1 Jul. 1993 - 30 Jun. 1994

JOSEPH M. FURMAN and JAMES A. CARL 30 Jun. 1994 6 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract(s)/Grant(s): F49620-93-1-0261)

(AD-A284103; AFOSR-94-0510TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The objective of this study is to enhance knowledge regarding spatial orientation and disorientation in environments characterized by combined stress, namely simultaneous visual and vestibular stimulation. This study will test the hypothesis that target acquisition, ocular tracking, and visual search are degraded by vestibular stimulation using off-vertical axis rotation. Target acquisition stimuli will consist of a spot moving suddenly to a new location in a pseudo-random fashion; ocular tracking stimuli will consist of constant velocity target motion. Visual search will combine these stimuli. Eye movements will be recorded using the magnetic scleral search coil method. Analysis of the data will

yield measures of saccadic latency and accuracy, and ocular pursuit gain. Calculated performance measures will be compared across visual and vestibular stimulus conditions with analysis of variance. The goal of the first year of research was to develop protocols and assess visual-vestibular interaction. As proposed for the first year, 15 normal subjects (8F, 7M) have been tested with the entire protocol of vestibular, visual, and visual-vestibular stimuli. With these first year studies completed, studies for the second year have begun. DTIC

N95-18414 Naval Aerospace Medical Research Lab., Pensacola, FL.
COMPUTER-BASED PSYCHOMOTOR TESTS IN OPTIMAL TRAINING TRACK ASSIGNMENT OF STUDENT NAVAL AVIATORS
D. R. STREET, JR. and D. L. DOLGIN Feb. 1994 18 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): DA PROJ. M00-96)
(AD-A283720; NAMRL-1391) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The purpose of our investigation was to determine if computer-based selection tests could predict training track assignment for student naval aviators. This study evaluated the predictive efficacy of an experimental battery of computer-based pilot selection tests for training classification. Student naval aviators are currently assigned to an aircraft training track based primarily on performance in primary training. Students were tested on the experimental test battery and classified into one of three aircraft training tracks based on their test scores. The resulting classifications were compared to actual selections made as the students progressed through naval aviation training. Using a sample of 237 students, linear analyses were conducted to evaluate the efficacy of predicted decisions. The unique contribution of the experimental battery was determined by comparing scores on the experimental battery to scores on the Navy/Marine Corps Aviation Selection Test Battery, a paper-and-pencil pilot selection test used by the United States Navy and Marine Corps, and student primary flight training grades. A significant classification model including one of the experimental selection tests was derived. The model was able to significantly predict fast attack pipeline selections before flight training. DTIC

N95-18440 Naval Biodynamics Lab., New Orleans, LA.
NAVAL BIODYNAMICS LABORATORY 1993 COMMAND HISTORY
1993 58 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A284358) Avail: CASI HC A04

The Naval Biodynamics Laboratory (NBDL) was established as the Naval Aerospace Medical Research Laboratory Detachment (NAMRLD) in April 1971 by the Bureau of Medicine and Surgery. NAMRLD was a detachment of the Naval Aerospace Medical Research Laboratory which is located at the Naval Air Station, Pensacola, Florida. The initial purpose of the Detachment was to study human response to impact acceleration. In 1975, the mission was expanded to include human response to vibration, ship motion, and to study human performance. NBDL was designated a separate command by the Secretary of the Navy in February, 1980, and officially established on 28 February 1980. NBDL is under the command of Naval Medical Research and Development Command (NMRDC) and receives primary support from the Chief, Bureau of Medicine and Surgery, Washington, DC. DTIC

N95-18530# Michigan State Univ., East Lansing, MI.
EFFECTIVE TEAM PERFORMANCE UNDER STRESS AND NORMAL CONDITIONS: AN EXPERIMENTAL PARADIGM, THEORY AND DATA FOR STUDYING TEAM DECISION MAKING IN HIERARCHICAL TEAMS WITH DISTRIBUTED EXPERTISE Final Report, 15 Mar. 1990 - 31 Aug. 1993
DANIEL R. ILGEN and JOHN R. HOLLENBECK Aug. 1993 85 p
(Contract(s)/Grant(s): N00014-90-J-1786)
(AD-A284683) Avail: CASI HC A05/MF A01

The report describes a program of research addressing decision making in hierarchical teams with distributed expertise. A theory of such decision making is presented along with empirical research related to the theory. Then a team simulation exercise was developed to address team decision for four person teams. This exercise presents teams with problems that require gathering and sharing information prior to reaching a team decision and also allow for the assignment of team members to roles that differ in areas of expertise. This exercise, performed on four networked computers, allows for the assessment of a large number of team behaviors. Along with the exercise, repeated measures regression is used as a means of analyzing team data by taking advantage of the statistical power available at various levels of analysis. Several studies were conducted to assess the viability of theory and to look at a number of other issues of decision making. DTIC

N95-19068 Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Computer Science.
ASSESSMENT OF THE ACSE SCIENCE LEARNING ENVIRONMENT AND THE IMPACT OF MOVIES AND SIMULATIONS
JOHN F. PANE 1 Jun. 1994 21 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): NSF MDR-91-50211)
(AD-A284071; CMU-CS-94-162) Avail: CASI HC A03

This paper describes an empirical study that assesses a multimedia science learning environment, and the impact on student learning of movies and simulations as lesson components. The study measures summative effects on student performance and satisfaction, and gathers formative data about student use of the environment for iterative improvement to the system and lessons. Two lessons containing movies and simulations were compared with lessons that used static graphics to present the same material. Preliminary results show that participants using the lesson with movies and simulations spend significantly more time working through the material, and score higher on questions that target material that is presented with simulation. Analysis of usage patterns identifies features of the system that are effective, underutilized, misunderstood or problematic. DTIC

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MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

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

A95-64205
HT-7 MACHINE CONTROL SYSTEM
J. PANG Academia Sinica, Hefei (China), C. CHEN, C. WANG, Y. WANG, and Y. SHU IEEE Transactions on Nuclear Science (ISSN 0018-9499) vol. 41, no. 1, pt. 1 February 1994 p. 181-183 Proceedings of the 1993 IEEE 8th Conference on Real-Time Computer Applications in Nuclear, Particle, and Plasma Physics (RT 1993), Vancouver, British Columbia, 8-11 Jun. 1993 refs
(BTN-94-EIX94301313413) Copyright

The paper deals with the design and implementation of the machine control system for the HT-7 tokamak, at present under construction in Hefei, China. This is a distributed system which achieves a balance between performance and cost. A powerful UNIX workstation with a CAMAC serial highway serves as the system supervisor. Man-machine interface is based on the industry standard X Window system. Programmable logical controllers are used for subsystem.
Author (EI)

N95-15984*# Tokyo Metropolitan Univ. (Japan). Precision and Intelligence Lab.
A VIRTUAL WORK SPACE FOR BOTH HANDS MANIPULATION WITH COHERENCY BETWEEN KINESTHETIC AND VISUAL SENSATION
MASAHIRO ISHII, P. SUKANYA, and MAKOTO SATO *In* NASA. Johnson Space Center, ISMCR 1994: Topical Workshop on Virtual Reality. Proceedings of the Fourth International Symposium on Measurement and Control in Robotics p 84-90 Nov. 1994
Avail: CASI HC A02/MF A02

This paper describes the construction of a virtual work space for tasks performed by two handed manipulation. We intend to provide a virtual environment that encourages users to accomplish tasks as they usually act in a real environment. Our approach uses a three dimensional spatial interface device that allows the user to handle virtual objects by hand and be able to feel some physical properties such as contact, weight, etc. We investigated suitable conditions for constructing our virtual work space by simulating some basic assembly work, a face and fit task. We then selected the conditions under which the subjects felt most comfortable in performing this task and set up our virtual work space. Finally, we verified the possibility of performing more complex tasks in this virtual work space by providing simple virtual models and then let the subjects create new models by assembling these components. The subjects can naturally perform assembly operations and accomplish the task. Our evaluation shows that this virtual work space has the potential to be used for performing tasks that require two-handed manipulation or cooperation between both hands in a natural manner. Author (revised)

N95-16119# Michigan Univ., Ann Arbor, MI. Div. of Research Development and Administration.
THE EPIC ARCHITECTURE FOR MODELING HUMAN INFORMATION-PROCESSING AND PERFORMANCE: A BRIEF INTRODUCTION Interim Report, 1 Jan. 1992 - 1 Apr. 1994
DAVID E. KIERAS and DAVID E. MEYER 1 Apr. 1994 21 p
(Contract(s)/Grant(s): N00014-92-J-1173)
(AD-A280762; DRDA-TR-94/ONR-EPIC-1) Avail: CASI HC A03/MF A01

EPIC (Executive Process-Interactive Control) is a human information-processing architecture that is especially suited for modeling multiple-task performance. The EPIC architecture includes peripheral sensory-motor processors surrounding a production-rule cognitive processor, and is being used to construct precise computational models for basic multiple-task situations. Some of these models are briefly illustrated here to demonstrate how EPIC applies to multiple-task performance, and helps clarify some basic properties of human performance. Additional applications of EPIC to modeling human-computer interaction are briefly summarized. DTIC

N95-16145# Army Aeromedical Research Lab., Fort Rucker, AL.
WHOLE-BODY VIBRATION ASSESSMENT OF THE PALLETIZED LOAD SYSTEM Final Report
AL W. MORAN, BRADLEY S. ERICKSON, TAMMY L. SIMMONS, and BARCLAY P. BUTLER Jul. 1994 105 p
(AD-A285181; USAARL-94-33) Avail: CASI HC A06/MF A02

An evaluation of all new tactical vehicles and aircraft is required to assess potential whole-body vibration (WBV) health hazards to crewmembers. As requested by the U.S. Army Environmental Hygiene Agency, a health hazard assessment (HHA) was performed by the U.S. Army Aeromedical Research Laboratory (USAARL) on the Palletized Load System (PLS) truck. The PLS was tested on five cross-country courses at Aberdeen Proving Ground, MD, by the U.S. Army Combat System Test Activity in coordination with the Response and Tolerance Branch of USAARL. The PLS was tested with speeds ranging from 3 to 20 mph. The results of these tests show that, for the worst-case scenario for each course, the lowest tolerances for WBV were on course 5. Less severe WBV occurred on courses 1 and 3, which had near equal tolerances, followed by course 4. Finally, the highest tolerances for WBV exposure were on course 2. The results also show that both driver and passenger were exposed to a Hazard Severity-Category III (marginal), with a Hazard Probability-Level C (occasional). DTIC

N95-16147# Army Aeromedical Research Lab., Fort Rucker, AL.
WHOLE-BODY VIBRATION ASSESSMENT OF THE M1070 HEAVY EQUIPMENT TRANSPORTER, VOLUME 1
TAMMY L. SIMMONS, BARCLAY P. BUTLER, NABIH M. ALEM, and BRADLEY S. ERICKSON Aug. 1994 29 p
(AD-A285199; USAARL-94-41-VOL-1) Avail: CASI HC A03/MF A01

An evaluation of all new tactical vehicles and aircraft is required to assess potential whole-body vibration (WBV) health hazards to crewmembers. As requested by the U.S. Army Environmental Hygiene Agency (USAEHA), a health hazard assessment (HHA) was performed by the U.S. Army Aeromedical Research Laboratory (USAARL) on the M1070 Heavy Equipment Transporter System (HETS). The HETS was tested on three cross-country courses at Aberdeen Proving Ground (APG), MD, by the U.S. Army Combat Systems Test Activity (USACSTA), in coordination with the Response and Tolerance Branch of USAARL. The M1070 HETS was tested with a M1000 trailer in a loaded and unloaded configuration. The loaded configuration was obtained by placing an M1 tank on the bed of the M1000 trailer. The unloaded configuration consisted of a M1070 tractor with an empty M1000 trailer. While operating the HETS in its intended operational environment, the front passenger was exposed to an overall risk assessment code of 5. This consisted of an overall assignment of hazard severity category IV and hazard probability level D. DTIC

N95-16418*# Arizona Univ., Tucson, AZ. Dept. of Aerospace and Mechanical Engineering.
THERMAL CONTROL SYSTEMS FOR LOW-TEMPERATURE HEAT REJECTION ON A LUNAR BASE Annual Progress Report
K. R. SRIDHAR, MATTHIAS GOTTMANN, and ASHOK NANJUNDAN Nov. 1993 80 p
(Contract(s)/Grant(s): NAG5-1572)
(NASA-CR-197486; NAS 1.26:197486) Avail: CASI HC A05/MF A01

One of the important issues in the design of a lunar base is the thermal control system (TCS) used to reject low-temperature heat from the base. The TCS ensures that the base and the components inside are maintained within an acceptable temperature range. The temperature of the lunar surface peaks at 400 K during the 336-hour lunar day. Under these circumstances, direct dissipation of waste heat from the lunar base using passive radiators would be impractical. Thermal control systems based on thermal storage, shaded radiators, and heat pumps have been proposed. Based on proven technology, innovation, realistic complexity, reliability, and near-term applicability, a heat pump-based TCS was selected as a candidate for early missions. In this report, Rankine-cycle heat pumps and absorption heat pumps (ammonia water and lithium bromide-water) have been analyzed and optimized for a lunar base cooling load of 100 kW. Author

N95-16553 Logicon Technical Services, Inc., Dayton, OH.
VISUAL ACUITY VERSUS FIELD-OF-VIEW AND LIGHT LEVEL FOR NIGHT VISION GOGGLES (NVG) Final Report, Nov. 1993 - Apr. 1994
HARRY L. TASK, MARY M. DONOHUE-PERRY, and SHARON A. DAVIS May 1994 18 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(Contract(s)/Grant(s): AF PROJ. 7184)
(AD-A284750; AL/CF-TR-1994-0076) Avail: CASI HC A03

Parameters typically used to characterize night vision goggles (NVG) are visual acuity (resolution) and field-of-view (FOV). An increase in FOV is accomplished by providing higher magnification of the image intensifier tube. However, increased magnification means that the pixels will subtend a larger angle, thus leading to lower NVG visual acuity. An inverse relationship between visual acuity and field-of-view

is expected based upon this optical/geometrical relationship. This relationship should be examined as production of NVG resolution quality increases. A trade-off study examining FOV and resolution was conducted with three observers having 20/20 corrected Snellen acuity. The NVGs had fields-of-view of 40, 47, and 52 degrees, respectively. Five levels of ambient scene illumination (corresponding to output luminance levels of 0.01, 0.03, 0.08, 0.26, and 1.4 ft-L) were provided by a 2856K light source. The targets used in the study were 95+% contrast square wave targets ranging in size from 45 cycles/degree to 5 cycles/degree. A walk-back method of adjustment was employed. The results indicate that the geometric relationship between field-of-view and visual acuity is valid. DTIC

N95-16755*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

COMPARISONS OF THREE ANTI-G SUIT CONFIGURATIONS DURING LONG DURATION, LOW ONSET, +GZ Abstract Only

B. J. STEGMANN (Krug Life Sciences, Inc., San Antonio, TX.), R. W. KRUTZ (Krug Life Sciences, Inc., San Antonio, TX.), R. R. BURTON (Air Force Systems Command, Brooks AFB, TX.), and C. F. SAWIN *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

Little physiologic data exist on the effects of long duration, low onset, hypergravity (+G). Space shuttle crewmembers are subjected to low +G forces (less than +3G) for upwards of 30 minutes during reentry. A similar reentry profile is predicted for the National Aerospace Plane (NASP). The physiologic effects of this acceleration stress are compounded by the loss of body water experienced during microgravity. Currently, a standard 5 bladder anti-G suit is being used during shuttle reentry. There have been complaints of discomfort using this suit, mainly due to the abdominal bladder. This study compared the effectiveness of three anti-G suit configurations in volume depleted subjects during a simulated space shuttle reentry profile. Methods: Seven male subjects were given intravenous Lasix in a dose from 20-40 mg to induce a total body weight loss of 3 plus or minus 1.5 percent. Approximately six hours after the injection, the subjects donned one of three anti-G suits - a standard 5 bladder anti-G suit, an extended coverage anti-G suit (the advanced technology anti-G suit or ATAGS), or an extended coverage anti-G suit without an abdominal bladder (the reentry anti-G suit or REAGS). All subjects were exposed to a simulated space shuttle reentry profile. Non-invasive eye-level blood pressure (ELBP) was monitored throughout the +G exposure. When systolic ELBP dropped below 70 mmHg, the anti-G suit was inflated in 0.5 psig increments to the pressure required to maintain 70 mmHg ELBP. Each subject rode with all three suits. Comparisons were made between the final pressure required in each suit to maintain ELBP and subjective reports of comfort. Results: The mean final suit pressure required to maintain ELBP was 1.1 psi, in both the ATAGS and REAGS versus 1.8 psi in the standard suit. In addition, the subjects rated the REAGS suit highest on the comfort scale, citing the absence of the abdominal bladder as the main reason. Conclusions: Overall, the REAGS suit was the superior anti-G suit during long duration, low onset +G. This is based on its ability to maintain ELBP and still remain comfortable when inflated for prolonged periods of time. Author

N95-16767*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

BEYOND THE COCKPIT: THE VISUAL WORLD AS A FLIGHT INSTRUMENT Abstract Only

W. W. JOHNSON, M. K. KAISER, and D. C. FOYLE *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992

Avail: CASI HC A01/MF A02

The use of cockpit instruments to guide flight control is not always an option (e.g., low level rotorcraft flight). Under such circumstances the pilot must use out-the-window information for control and navigation. Thus it is important to determine the basis of visually guided flight for several reasons: (1) to guide the design and construction of the visual displays used in training simulators; (2) to allow modeling of visibility restrictions brought about by weather, cockpit constraints, or distortions introduced by sensor systems; and (3) to aid in the development of displays that augment the cockpit window scene and are compatible with the pilot's visual extraction of information from the visual scene. The authors are actively pursuing these questions. We have on-going studies using both low-cost, lower fidelity flight simulators, and state-of-the-art helicopter simulation research facilities. Research results will be presented on: (1) the important visual scene information used in altitude and speed control; (2) the utility of monocular, stereo, and hyperstereo cues for the control of flight; (3) perceptual effects due to the differences between normal unaided daylight vision, and that made available by various night vision devices (e.g., light intensifying goggles and infrared sensor displays); and (4) the utility of advanced contact displays in which instrument information is made part of the visual scene, as on a 'scene linked' head-up display (e.g., displaying altimeter information on a virtual billboard located on the ground). Author

N95-16773*# Krug Life Sciences, Inc., Houston, TX.

A PROTOTYPE CREW MEDICAL RESTRAINT SYSTEM (CMRS) FOR SPACE STATION FREEDOM Abstract Only

S. L. JOHNSTON, F. T. EICHSTADT, and R. D. BILLICA *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Sponsored by NASA. Lyndon B. Johnson Space Center, Houston, TX

Avail: CASI HC A01/MF A02

The Crew Medical Restrain System (CMRS) is a prototype system designed and developed for use as a universally deployable medical restraint/workstation on Space Station Freedom (SSF), the Shuttle Transportation System (STS), and the Assured Crew Rescue Vehicle (ACRV) for support of an ill or injured crewmember requiring stabilization and transportation to Earth. The CMRS will support all medical capabilities of the Health Maintenance Facility (HMF) by providing a restraint/interface system for all equipment (advance life support packs, defibrillator, ventilator, portable oxygen supply, IV pump, transport monitor, transport aspirator, and intervenous fluids delivery system) and personnel (patient and crew medical officers). It must be functional within the STS, ACRV, and all SSF habitable volumes. The CMRS will allow for medical capabilities within CPR, ACLS and ATLS standards of care. This must all be accomplished for a worst case transport time scenario of 24 hours from SSF to a definitive medical care facility on Earth. A presentation of the above design prototype with its subsequent one year SSF/HMF and STS/ACRV high fidelity mock-up ground based simulation testing will be given. Also, parabolic flight and underwater Weightless Test Facility evaluations will be demonstrated for various medical contingencies. The final design configuration to date will be discussed with future space program impact considerations. Author

N95-16775*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

ADVANCED CARDIAC LIFE SUPPORT (ACLS) UTILIZING MAN-TENDED CAPABILITY (MTC) HARDWARE ONBOARD SPACE STATION FREEDOM Abstract Only

M. SMITH, M. BARRATT, and C. LLOYD *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Prepared in cooperation with Krug Life Sciences, Inc., Houston, TX

Avail: CASI HC A01/MF A02

Because of the time and distance involved in returning a patient from space to a definitive medical care facility, the capability for Advanced Cardiac Life Support (ACLS) exists onboard Space Station Freedom. Methods: In order to evaluate the effectiveness of terrestrial ACLS protocols in microgravity, a medical team conducted simulations during parabolic flights onboard the KC-135 aircraft. The hardware planned for use during the MTC phase of the space station was utilized to increase the fidelity of the scenario and to evaluate the prototype equipment. Based on initial KC-135 testing of CPR and ACLS, changes were made to the ventricular fibrillation algorithm in order to accommo-

date the space environment. Other constraints to delivery of ACLS onboard the space station include crew size, minimum training, crew deconditioning, and limited supplies and equipment. Results: The delivery of ACLS in microgravity is hindered by the environment, but should be adequate. Factors specific to microgravity were identified for inclusion in the protocol including immediate restraint of the patient and early intubation to insure airway. External cardiac compressions of adequate force and frequency were administered using various methods. The more significant limiting factors appear to be crew training, crew size, and limited supplies. Conclusions: Although ACLS is possible in the microgravity environment, future evaluations are necessary to further refine the protocols. Proper patient and medical officer restraint is crucial prior to advanced procedures. Also emphasis should be placed on early intubation for airway management and drug administration. Preliminary results and further testing will be utilized in the design of medical hardware, determination of crew training, and medical operations for space station and beyond. Author

N95-16778*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ARTIFICIAL GRAVITY: HOW MUCH, HOW OFTEN, HOW LONG? Abstract Only
R. BURTON (Air Force Systems Command, Brooks AFB, TX.) and J. VERNIKOS *In* Aerospace Medical Association, Aerospace Medical Association 63rd Annual Scientific Meeting Program 1 p 14 May 1992 Prepared in cooperation with Aerospace Medical Research Labs., Brooks AFB, TX
Avail: CASI HC A01/MF A02

The argument is not overwhelming for the need to provide a continuous 1G environment using tethers or other means of spinning a spacecraft in order to maintain crew health in planetary exploration. Even on Earth, we spend a maximum of 16 hours in 1G (upright). Sporadic evidence over the years has suggested that somewhere between 30-minutes and 4-hours of 1G may suffice to prevent the deconditioning effects of bedrest (orthostatic intolerance and the rise in calcium excretion). However, it is not known what the minimum requirements are, whether they vary for different physiological systems and whether passive zero gravity or the enhancement of the effects of activity conducted in an increased G field are more effective. It is similarly not known what the optimal duration and frequency of the G stimulus is, and how time of day might alter its effectiveness. Since acceleration level and duration appear to be physiologically interactive, it seems feasible to hypothesize that periodic acceleration exposures to greater than 1G levels provided by some on-board centrifuge, would suffice and should be explored. Author

N95-16813# Carnegie-Mellon Univ., Pittsburgh, PA. School of Computer Science.
INTEGRATING HUMAN FACTORS WITH SOFTWARE ENGINEERING PRACTICES
WILLIAM E. HEFLEY, ELIZABETH A. BUIE, GENE F. LYNCH, MICHAEL J. MULLER, DOUGLAS G. HOECKER, JIM CARTER, and J. THOMAS ROTH 29 Jul. 1994 11 p Presented at the 38th Annual Meeting of the Human Factors and Ergonomics Society, Nashville, TN, Oct. 1994 See also CMU-HCII-94-103 Submitted for publication (AD-A285210; CMU-CS-94-175; CMU-HCII-94-103) Avail: CASI HC A03/MF A01

The design and development of human-computer interaction (HCI) has been evolving into a full engineering discipline for achieving system usability-developing systems that support their users in accomplishing their tasks with effectiveness, efficiency, and satisfaction. Advances have been occuring both in user interface engineering, focusing on the processes being used to develop artifacts, and in usability engineering, focusing on the products being developed. Large proportions of these systems are heavily software intensive. System engineering activities must therefore integrate HCI engineering with software engineering to achieve usability in software-intensive systems. This effort can take advantage of successful HCI engineering efforts, which have focused on human factors and HCI methods. DTIC

N95-16821# Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft (Netherlands). Hoofdgroep Maatschappelijke Technologie.
ENERGY EXPENDITURE, PHYSICAL WORK LOAD AND POSTURAL CONTROL DURING WALKING ON A MOVING PLATFORM
A. H. WERTHEIM, R. HEUS, and T. G. VRIJKOTTE 1994 30 p (AD-A285343; TNO-TM-1994-B-8; TDCK-94-0048) Avail: CASI HC A03/MF A01

An experiment was performed in which subjects were required to walk on a treadmill inside a moving ship motion simulator (SMS). Ventilatory measures of energy consumption, heart rate, and measures of postural control were taken and compared to a condition in which the SMS did not move. Eleven SMS movement conditions were investigated, two of which consisted of pure one dimensional sinusoidal movements (vertical motion or roll), two of simulated ship movements, and seven of various combinations of (large or small) vertical, pitch and roll movements, derived from these simulated ship motion profiles. The results showed that energy expenditure was largest in conditions which included either large pitch movements, or Large roll components in combination with pitch. Energy expenditure was intermediate in all other conditions which included Large roll movements. Effects of the particular vertical motions used in the present study, were not observed. in this particular study, physiological task toad (expressed in terms of ventilatory parameters) was shown to increase on average with 15 percent during SMS movements. Heart rate appeared to be a less reliable measure of energy expenditure. Movement induced interruptions (MII,s) of the walking task-a measure of postural control-were most frequent in conditions which included a large roll component. The relevance of this work with respect to the development of work load criteria at sea, for the estimation of a crew's operational capacity, and for ship building design are given, together with some recommendations for further research. DTIC

N95-16875# Dayton Univ. Research Inst., OH.
AN EMPIRICAL APPROACH TO VISUAL DISPLAY PREFERENCE BASED UPON MODULATION TRANSFER FUNCTION AND LUMINANCE Final Report, Sep. 1992 - Jul. 1993
RONALD J. EVANS Aug. 1994 80 p
(Contract(s)/Grant(s): F33615-90-C-0005)
(AD-A285450; AL/HR-TR-1994-0107) Avail: CASI HC A05/MF A01

The purpose of the present study was to develop a three-dimensional preference space for displays as a function of the display modulation transfer function (MTF) and average display luminance. For any MTF-luminance combination, then, the goal was to generate a point in the third dimension denoting the preference for that pair. A paired comparison experiment was conducted where, on individual trials, observers viewed side-by-side images varying in MTF (5 levels) and average luminance (4 levels). The 5 X 4 = 20 combinations of MTF and luminance could be thought of as 20 filters. Preferences on individual trials were cumulated into empirical preference probability matrices which denoted the probability of preferring any one of the 20 filters over any of the 20 filters. A psychological model of preference, the Bradley-Terry-Luce (BTL) Model was then fit to the matrices in order to estimate a scale value or preference for each of the 20 filters or points in the three-dimensional space. Regression techniques (R(2)=.98) were used to generate a preference surface in the three-dimensional space, from which the preference for any display could be predicted. Additional analyses indicated that not only did ratings differ significantly based upon changes in MTF and luminance, but ratings change significantly (P less than. 001) as a function of using different scenery in the images. Finally, in predictive equations generated from the data, changes in MTF area (measured in percent contrast x cycles per degree of visual

angle) tended to have about three times as much effect on preference as did changes in luminance (measured in foot lamberts).
DTIC

N95-16894*# Georgia Tech Research Inst., Atlanta, GA. School of Textile and Fiber Engineering.
DESIGN AND TECHNICAL SUPPORT FOR DEVELOPMENT OF A MOLDED FABRIC SPACE SUIT JOINT Final Report, 1 Oct. 1992 - 31 Dec. 1994
L. HOWARD OLSON 21 Dec. 1994 6 p
(Contract(s)/Grant(s): NAG2-806; PROJ. E27-666)
(NASA-CR-197521; NAS 1.26:197521) Avail: CASI HC A02/MF A01

NASA Ames Research Center has under design a new joint or element for use in a space suit. The design concept involves molding a fabric to a geometry developed at Ames. Unusual characteristics of this design include the need to produce a fabric molding draw ratio on the order of thirty percent circumferentially on the surface. Previous work done at NASA on molded fabric joints has shown that standard, NASA qualified polyester fabrics as are currently available in the textile industry for use in suits have a maximum of about fifteen percent draw ratio. NASA has done the fundamental design for a prototype joint and of a mold which would impart the correct shape to the fabric support layer of the joint. NASA also has the capability to test a finished product for suitability and reliability. Responsibilities resting with Georgia Tech in the design effort for this project are textile related, namely fiber selection, fabric design to achieve the properties of the objective design, and determining production means and sources for the fabrics. The project goals are to produce a prototype joint using the NASA design for evaluation of effectiveness by NASA, and to establish the sources and specifications which would allow reliable and repeatable production of the joint.
Author

N95-16953# Technische Univ., Delft (Netherlands).
EFFICIENCY IN WORK BEHAVIOUR: A DESIGN APPROACH FOR MODERN TOOLS Ph.D. Thesis
F. R. H. ZIJLSTRA 23 Nov. 1993 189 p
(PB94-197761; ISBN-90-6275-918-1) Avail: CASI HC A09/MF A02

The study described in the book aims at presenting a scientific contribution to the (re)design of modern tools, i.e. personal computers. Some general principles of behavior economics are described and the concepts of psychological costs and psychological efficiency are developed. Certain theoretical viewpoints on mental effort are looked at. Several methods and instruments for measuring mental workload and mental effort are discussed. The validity of the Rating Scale Mental Effort (RSME) is explicitly examined in a laboratory study. A study is described in which the RSME is applied in an interface evaluation study. This study aims at collecting empirical evidence for the validity of the Action Facilitation Approach (AFA). The results contain several leads for designers and can therefore be seen as an illustration of the necessity of an interdisciplinary approach to system design.
NTIS

N95-16966# Chicago Univ., Chicago, IL. Dept. of Computer Science.
QUALITATIVE VISION AND ACTION Annual Report
R. J. FIRBY and MICHAEL J. SWAIN 23 Apr. 1994 34 p
(Contract(s)/Grant(s): N00014-93-1-0332)
(AD-A282697) Avail: CASI HC A03/MF A01

The objective of the Animate Agent Project is to understand both the basic motor and visual skill required to support robot behavior in a mixed man-machine environment and the planning techniques reuired to combine and coordinate those skills. As mobile robots and other complex machines are deployed in the world, the will come into contact with human beings and will have to be able to function in environments designed primarily for human use. It is imperative that the machines be capable of interacting with these environments and the people within them effectively and cooperatively. Our approach is built around a robot architecture that uses reactive planning, active perception and behavioral ocntr. The RAP reactive execution system selects actions to execute at run time based on an agent's goals and an understanding of the immediate situation. Making action decisions after situations actually unfold ensures that the decisions are based on what is really happening and gives tremendous flexibility in the face of bad information, actuator failure, and unexpected events.
Derived from text

N95-17468 Technische Univ., Delft (Netherlands). Faculteit der Werktuigbouwkunde en Maritieme Techniek.
TOWARDS A HUMAN OPERATOR MODEL OF THE NAVIGATOR Ph.D. Thesis
R. PAPENHUIJZEN 15 Feb. 1994 187 p
(PB94-197985; ISBN-90-370-0096-7) Copyright Avail: Issuing Activity

The study is aimed at investigating the feasibility of a general purpose human operator model of the navigator. Maneuvering issues in the realm of fairway design and fairway regulation and legislation are met in sea navigation as well as in inland waterway navigation. Consequently, it was decided that the field of application of the navigator model to spring from the study should range from navigating large deep-sea vessels to steering small inland vessels. The common factor is that practically always the waterway is more or less confined in relation to the dimensions and maneuvering characteristics of the vessel concerned. Further, for a human operator model of the navigator to be of any practical relevance, it is necessary that a variety of strategic and tactical aspects of the navigator's behavior be covered by the navigator model, in a clearly distinguished way. To be more precise, explicit modeling of planning, control and state estimation behavior is expected to be indispensable. An isolated navigator model, not coupled or fit to be coupled to suitable models of a ship and a fairway, is of no use. And what is more, it would be impossible for such a model to come into existence, every possibility to test or validate it being excluded. So, building a prototype navigator model inevitably implies the creation of a testing environment to complement it, thus arriving at a complete navigation simulation facility.
NTIS

N95-17484# Army Aeromedical Research Lab., Fort Rucker, AL.
APACHE HELICOPTER SEAT CUSHION EVALUATION Final Report
BARCLAY P. BUTLER and NABIH M. ALEM Jul. 1994 61 p
(AD-A284300; USAARL-94-32) Avail: CASI HC A04/MF A01

Two prototypes of the AH-64 pilot seat cushions were evaluated against the standard cushion set by each of a group of 12 AH-64 instructor pilots after being exposed to simulated AH-64 vibration signatures for a period of 1 hour. Objective indications of vibration attenuation were obtained by measuring transfer functions across each cushion. Subjective pilot preferences also were obtained after each ride using a questionnaire. Results of the objective measurements indicate both the air-filled and the foam-filled prototypes reduced low-frequency transmission of vibration better than the standard cushions. Subjective responses indicate significant improvement in comfort and vibration absorption for the seat back and bottom cushions of both prototypes over the standard cushion set.
DTIC

N95-18029# Army Research Lab., White Sands Missle Range, NM. Battlefield Environment Directorate.
NIGHT VISION GOGGLES (NVG) SOFTWARE USER'S GUIDE, VERSION 5.1 Final Report
DAVID SAUTER and GAVINO ZERTUCHE Jun. 1994 37 p
(AD-A284563; ARL-TR-524) Avail: CASI HC A03/MF A01

Numerous military applications utilize night vision devices (NVD). Aviation and ground transportation are two applications that the computer program Night Vision Goggles (NVG) is intended to support. Aviators and vehicle drivers must have an idea of what the ambient light levels are before using NVD's. Not enough light precludes safe use of the devices, while enough light allows for adequate performance of the required tasks by the unaided eye. The

weather also effects natural illumination. NVG is intended to provide users of NVD's with forecasts of favorable and unfavorable times of use. The criteria for NVD use times are specified by the user in terms of lunar altitude and percent illumination as well as illumination level to ensure wide application of the software in terms of the different NVD's and different services. The illumination level for user specified times can also be determined. Current or forecast meteorological conditions or climatology may be input to realistically account for the effects of clouds, fog, precipitation, and surface reflectivity. The user friendly program is menu driven for ease of operation. DTIC

N95-18077 *Army Aeromedical Research Lab., Fort Rucker, AL.*
DESIGN AND DEVELOPMENT OF AN ENHANCED BIODYNAMIC MANIKIN, PHASE 1 Final Report
PAUL H. FRISCH and WILLIAM BOULAY Aug. 1994 106 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A284725; USAARL-CR-94-1) Avail: CASI HC A06

Manikins have been used as substitutes for human subject in biodynamic testing since 1944. The original manikin was a simple wooden form to provide an equivalent weight to body mass for testing an ejection seat in a German DO335 aircraft. Since then, manikins have undergone a gradual evolution trying to achieve the goal of a biofidelic human analog. Standard Hybrid 3-type manikins have a rigid thoracic and lumbar spine, limiting the response of the manikin's back in a dynamic environment. The predominant injury in survivable U.S. Army rotary-wing mishaps often is spinal injury. The U.S. Army wants to procure a manikin with an enhanced spinal biofidelity with self-contained data acquisition and storage capabilities. The proposed evolution in manikin design to meet the needs of the Army is discussed. A standard Hybrid 3-type manikin will be modified. A standard DOT part 572 head and Hybrid III flexible neck will be used. The spinal column includes a flexible spine with multiple vertebral segments, adjustment blocks, biodynamic load cells and sensors, and mountings for the neck and shoulder. DTIC

N95-18086# *Texas Univ., Austin, TX. Computer and Vision Research Center.*
FUSION OF MULTIPLE SENSING MODALITIES FOR MACHINE VISION Final Report, 1 Feb. 1991 - 31 May 1994
J. K. AGGARWAL 31 May 1994 39 p
(Contract(s)/Grant(s): DAAL03-91-G-0050)
(AD-A284762) Avail: CASI HC A03/MF A01

We report on a broad program of research in machine vision to develop an approach based upon synergistically combining diverse sensing modalities. The research projects fall into four general categories: (1) Outdoor Scene interpretation via the Fusion of Multiple Imaging Modalities; (2) Motion Computation and Object Recognition Using Range Images; (3) Structure and Identity Based on Color and Shape Information; and (4) Autonomous Navigation. Accomplishments include the development of the AIMS (automatic interpretation using multiple sensors) knowledge-based system to interpret registered laser radar and thermal images for the detection and recognition of man-made objects in outdoor rural scenes; the development of a new approach for the detection of large man-made objects using perceptual organization techniques; new algorithms for object recognition and motion estimation, including improved algorithms for using three-dimensional (range) images to compute structure and motion; a CAD-based object recognition system; a decision-theoretical algorithm to estimate 3D structures from extended sequences of 2D images taken by a moving camera; an algorithm for matching line segments based on perceptual grouping relaxation labeling; and the construction of an autonomous mobile robot, Robo-Tex, as a testbed for navigation algorithms. DTIC

N95-18189*# *National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.*
GEOMETRY AND GRAVITY INFLUENCES ON STRENGTH CAPABILITY
JEFFREY POLINER (Lockheed Engineering and Sciences Co., Houston, TX.), ROBERT P. WILMINGTON (Lockheed Engineering and Sciences Co., Houston, TX.), and GLENN K. KLUTE Dec. 1994 26 p
(Contract(s)/Grant(s): NAS9-17900)
(NASA-TP-3511; S-784; NAS 1.60:3511) Avail: CASI HC A03/MF A01

Strength, defined as the capability of an individual to produce an external force, is one of the most important determining characteristics of human performance. Knowledge of strength capabilities of a group of individuals can be applied to designing equipment and workplaces, planning procedures and tasks, and training individuals. In the manned space program, with the high risk and cost associated with spaceflight, information pertaining to human performance is important to ensuring mission success and safety. Knowledge of individual's strength capabilities in weightlessness is of interest within many areas of NASA, including workplace design, tool development, and mission planning. The weightless environment of space places the human body in a completely different context. Astronauts perform a variety of manual tasks while in orbit. Their ability to perform these tasks is partly determined by their strength capability as demanded by that particular task. Thus, an important step in task planning, development, and evaluation is to determine the ability of the humans performing it. This can be accomplished by utilizing quantitative techniques to develop a database of human strength capabilities in weightlessness. Furthermore, if strength characteristics are known, equipment and tools can be built to optimize the operators' performance. This study examined strength in performing a simple task, specifically, using a tool to apply a torque to a fixture. Author

N95-18385 *Air Force Inst. of Tech., Wright-Patterson AFB, OH.*
CROSSHIFT VIBROMETRY: BIOMARKER FOR ERGONOMIC STRESS Ph.D. Thesis
EDWARD J. KLINENBERG Sep. 1994 244 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality
(AD-A284337; AFIT/CI/CIA-94-035D) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

Identification of a reliable and sensitive biomarker for ergonomic stress would be important for the early identification of high risk tasks that may lead to the development of carpal tunnel syndrome. This dissertation consisted of three field studies conducted at a large aircraft repair facility which looked into the use of multi-frequency vibrotactile thresholds changes over the workday (crosshift vibrometry) as a potential biomarker for ergonomic stress. In the first study, 121 industrial workers (82 male, 39 female) from a variety of occupations had their vibrotactile thresholds measured at four frequencies (31.5 Hz, 125 Hz, 250 Hz, 500 Hz) in the morning and afternoon. Fingertip skin temperature, demographic information, time of test, hand/wrist pain, and task information were recorded for each worker. Overall, vibration sensitivity increased as the day progressed. The effect was small and frequency dependent with higher frequencies producing greater effects. Crosshift vibrometry was significantly associated with fingertip skin temperature differences and exposure duration, but only at the highest frequencies (250, 500 Hz). Crosshift vibrometry was not associated with sex or age at any frequency. In the second study, 52 workers from five shops (36 male, 16 female) were tested on two separate days. At the lowest frequency tested (31.5 Hz), crosshift vibrometry was associated with the shops that employees worked in (sheetmetal repair, engine repair, grocery scanners). DTIC

N95-18531# *Virginia Univ., Charlottesville, VA. School of Engineering and Applied Science.*
IMPROVED FILTRATION MATERIALS AND MODELING Final Report, Jun. 1990 - Jun. 1993
M. D. LEVAN Jul. 1994 101 p
(Contract(s)/Grant(s): DAAA15-90-C-0012)
(AD-A284684; ERDEC-CR-132) Avail: CASI HC A06/MF A02

The objective of this work was to develop new approaches to identify, measure, and correlate relevant data and derive appropriate mathematical models for designing and evaluating regenerable adsorbent-based air filtration systems. The contract contained two tasks: (1)

the measurement and interpretation of single and multicomponent adsorption equilibria of vapors of organic compounds and water on BPL activated carbon; and (2) the construction and testing of a generic mathematical model for pressure swing adsorption (PSA) incorporating the adsorption isotherms and including rate phenomena and thermal effects. This final report discusses research accomplishments in two areas and the current status of knowledge in the areas. The contract work proceeded as planned, was coordinated with the U.S. Army Edgewood Research, Development and Engineering Center personnel at all times, and was consistent with the contract schedule. DTIC

N95-18990*# East Carolina Univ., Greenville, NC. School of Human Environmental Sciences.
DEVELOPMENT OF MICROGRAVITY, FULL BODY FUNCTIONAL REACH ENVELOPE USING 3-D COMPUTER GRAPHIC MODELS AND VIRTUAL REALITY TECHNOLOGY
PATRICIA F. LINDSEY *In* Alabama Univ., Research Reports: 1994 NASA/ASEE Summer Faculty Fellowship Program 6 p Oct. 1994 Avail: CASI HC A02/MF A03

In microgravity conditions mobility is greatly enhanced and body stability is difficult to achieve. Because of these difficulties, optimum placement and accessibility of objects and controls can be critical to required tasks on board shuttle flights or on the proposed space station. Anthropometric measurement of the maximum reach of occupants of a microgravity environment provide knowledge about maximum functional placement for tasking situations. Calculations for a full body, functional reach envelope for microgravity environments are imperative. To this end, three dimensional computer modeled human figures, providing a method of anthropometric measurement, were used to locate the data points that define the full body, functional reach envelope. Virtual reality technology was utilized to enable an occupant of the microgravity environment to experience movement within the reach envelope while immersed in a simulated microgravity environment. Derived from text

N95-19061*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ANALYTICAL CONTROL TEST PLAN AND MICROBIOLOGICAL METHODS FOR THE WATER RECOVERY TEST
M. S. TRAWEEK, ed. and J. D. TATARA, ed. (ION Electronics, Hunsville, AL.) Washington Dec. 1994 194 p
(NASA-TM-108473; NAS 1.15:108473) Avail: CASI HC A09/MF A03

Qualitative and quantitative laboratory results are important to the decision-making process. In some cases, they may represent the only basis for deciding between two or more given options or processes. Therefore, it is essential that handling of laboratory samples and analytical operations employed are performed at a deliberate level of conscientious effort. Reporting erroneous results can lead to faulty interpretations and result in misinformed decisions. This document provides analytical control specifications which will govern future test procedures related to all Water Recovery Test (WRT) Phase 3 activities to be conducted at the National Aeronautics and Space Administration/Marshall Space Flight Center (NASA/MSFC). This document addresses the process which will be used to verify analytical data generated throughout the test period, and to identify responsibilities of key personnel and participating laboratories, the chains of communication to be followed, and ensure that approved methodology and procedures are used during WRT activities. This document does not outline specifics, but provides a minimum guideline by which sampling protocols, analysis methodologies, test site operations, and laboratory operations should be developed. Author

N95-19412 Selskapet for Industriell og Teknisk Forskning, Trondheim (Norway). Div. for Informatics.
GUIDELINES FOR REDUCTION OF HUMAN ERRORS DURING MAINTENANCE OF SAFETY SYSTEMS; MAINTAINABILITY AND MAINTENANCE SUPPORT
L. BODSBERG, R. ROSNESS, and K. OEIEN 18 Mar. 1994 45 p
(PB94-215597; STF75-A93065) Avail: Issuing Activity

Guidance on reduction of human errors during maintenance of process control and safety systems are presented. The guidance is presented on three levels: (1) General design principles; (2) General requirements (maintainability and maintenance support of systems in general); (3) and Specific requirements (maintainability and maintenance support of safety systems in particular). The document covers the maintainability and maintenance support aspect of the safety systems availability performance. The report serves as a collection and transfer of operational experience from operating companies to vendors of process control and safety systems, to those in the operating companies responsible for writing system specifications, and to those responsible for the management and organization of the maintenance activities. NTIS

N95-19502 Materials Research Labs., Ascot Vale (Australia).
EVALUATION OF PUREAU WATER FOR USE AS EMERGENCY DRINKING WATER FOR ADF AIRCRAFT
G. E. DRIVER Dec. 1993 14 p
(MRL-TN-648; AR-008-562) Copyright Avail: Issuing Activity

A commercially available, purified water packed in PET bottles has been tested for suitability as an emergency drinking water for ADF aircraft. The water meets chemical and organoleptic requirements of the ADF, and is preferred to the current product on the basis of taste and the lower permeability of the package to water. The product failed to meet the ADF's stringent microbiological specifications. Further testing is required to determine the ability of the package to withstand the forces of ejection, and the high temperatures within the cockpit of aircraft parked in the sun in tropical areas of Australia. Author

55
SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

A95-63320
OPTICAL SEARCHES FOR VENUSIAN LIGHTNING: IMPLICATIONS FOR NIGHTSIDE FIELD AND PLASMA RELATIONSHIPS
HARRY A. TAYLOR, JR. Taylor Enterprises, Beaver River, Canada and PAUL A. CLOUTIER Rice Univ., Houston, TX, US Earth, Moon, and Planets (ISSN 0167-9295) vol. 64, no. 3 March 1994 p. 201-205
(HTN-95-50108) Copyright

Repeated searches for optical evidence of lightning across Venus nightside regions reported as exhibiting almost incessant activity have failed to detect any evidence of lightning. Owing to the extensive nature of these investigations, the negative results contribute strongly to the interpretation that the plasma noise initially attributed to a lightning source is instead stimulated by interaction of the solar wind and draped interplanetary magnetic field with the nightside ionosphere. Author (Hemer)

A95-63436* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE VERTICAL DISTRIBUTION AND ORIGIN OF HCN IN NEPTUNE'S ATMOSPHERE
EMMANUEL LELLOUCH Observatoire de Paris-Meudon, Paris, France, PAUL N. ROMANI NASA. Goddard Space Flight Center, Greenbelt, MD, US, and JAN ROSENQVIST Observatoire de Paris-

Meudon, Paris, France ICARUS (ISSN 0019-1035) vol. 108, no. 1 March 1994 p. 112-136 Research sponsored by Neptune Data Analysis
(HTN-95-70123) Copyright

Measurements and modeling of the (3-2) rotational line of hydrogen cyanide at 265.9 GHz in Neptune's atmosphere are presented. High signal-to-noise observations provide information on the HCN vertical distribution in Neptune's stratosphere. The HCN mixing ratio is found to be nearly uniform with height above the condensation level. Best fits occur for HCN distributions that have a slight increase with altitude. A least-squares analysis yields a mixing ratio of (3.2 +/- 0.8)10(exp -10) at 2 mbar and a mean mixing ratio scale height of 250(sup 750)(sub -110) km in the 0.1-3 mbar region. To interpret these results, we developed a photochemical model of HCN. HCN formation is initiated by the reaction between CH3 radicals, produced from methane photochemistry, and N atoms. The primary sink for HCN is condensation, with minor contributions from photolysis and chemical losses. Two possible sources of N atoms are investigated: (1) infall of N escaped from Triton's upper atmosphere, and (2) galactic cosmic ray (GCR) impact on internal N2. Given the uncertainties on (i) the transport and possible ionization of N in Neptune's magnetosphere, and the fate of N(+) reaching Neptune's upper atmosphere and (ii) the N2 mixing ratio in Neptune's deep atmosphere, we suggest that both sources of N atoms may significantly contibute to the formation of HCN.
Author (Herner)

A95-63438* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE CHEMICAL REACTIVITY OF THE MARTIAN SOIL AND IMPLICATIONS FOR FUTURE MISSIONS
AARON P. ZENT NASA. Ames Research Center, Moffett Field, CA, US and CHRISTOPHER P. MCKAY NASA. Ames Research Center, Moffett Field, CA, US ICARUS (ISSN 0019-1035) vol. 108, no. 1 March 1994 p. 146-157 Research sponsored by the Office of Exploration and the Exobiology Program at NASA
(HTN-95-70125) Copyright

Possible interpretations of the results of the Viking Biology Experiments suggest that greater than 1 ppm of a thermally labile oxidant, perhaps H2O2, and about 10 ppm of a thermally stable oxidant are present in the martian soil. We reexamine these results and discuss implications for future missions, the search for organics on Mars, and the possible health and engineering effects for human exploration. We conclude that further characterization of the reactivity of the martian regolith materials is warrented-although if our present understanding is correct the oxidant does not pose a hazard to humans. There are difficulties in explaining the reactivity of the Martian soil by oxidants. Most bulk phase compounds that are capable of oxidizing H2O to O2 per the Gas Exchange Experiment (GEx) are thermally labile or unstable against reduction by atmospheric CO2. Models invoking trapped O2 or peroxynitrates (NOO2(-)) require an unlikely geologic history for the Viking Lander 2 site. Most suggested oxidants, including H2O2, are expected to decompose rapidly under martian UV. Nonetheless, we conclude that the best model for the martian soil contains oxidants produced by heterogeneous chemical reactions with a photochemically produced atmospheric oxidant. The GEx results may be due to catalytic decomposition of an unstable oxidizing material by H2O. We show that interfacial reaction sites covering less than 1% of the available soil surfaces could explain the Viking Biology Experiments results.
Author (Herner)

A95-63750
THE ORGANIC AND MINERAL INVENTORY OF COMETS AND THE POSSIBLE ROLE IN EARLY BIOLOGICAL ACTIVITIES: A SUMMARY OF THE MASS SPECTROMETRIC STUDIES OF COMET P/HALLEY
J. KISSEL MPI fuer Kernphysik, Heidelberg, Germany and F. R. KRUEGER Eng.-Office Krueger, Darmstadt, Germany ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 90
Copyright

Space missions VEGA 1+2 and GIOTTO to comet p/Halley have provided the only mass-spectrometric data on cometary organics available so far. The analysis of the minor constituents in the mass spectra by Kissel and Krueger (1987) allowed a characterization of the nature of the organic material as mostly unsaturated hydrocarbons with a low fraction containing oxygen or nitrogen as heteroatoms. On this basis Krueger and Kissel (1989) developed a scenario for a possible role of comets in the origin of life on earth. Later, a comparison with the Positive Ion Cluster Composition Analyzer (PICCA) data from on board GIOTTO allowed an estimate of the average molecular weight of the refractory part of the organics to be some 150 to 250 Da. The abundance of the rock forming elements and correlations between them show a mineral phase that provides enough voids and catalytic surfaces to provide the potential to accelerate synthesis of more complex organic molecules. Although the mean elemental composition of the grains appears as solar, there is a great variety of special grain compositions. Surely this is an advantage for prebiotic evolution. Also the mean isotopic compositions of H, C, O, Mg, Si, Ca, and Fe appear solar. However, large variations in individual grains are found in C isotopy. The low D/H-ratio with respect to the C-13/C-12 ratio is shown to greatly favor the production of replicable chemical units with evolutionary properties. It seems very probable that a different elemental and isotopic composition, as found with other star nebulae, and/or a randomly mixed composition is not suitable for prebiotic evolution, so that our home solar system may well be unique. Author (Herner)

A95-63751
POLYMERS AND OTHER MACROMOLECULES IN COMETS — A POSSIBLE RELATIONSHIP TO THE ORIGINS OF LIFE
W. F. HUEBNER Southwest Research Institute, San Antonio, TX, US and D. C. BOICE Southwest Research Institute, San Antonio, TX, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 91
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Ions of complex molecules with masses up to about 120 amu have been detected in the CRA (Plasmag-1 Analyzer) of the Vega 2 spacecraft and the Positive Ion Cluster Composition Analyzer (PICCA) instrument of the Giotto spacecraft during the Comet P/Halley flyby missions. The Vega 2 spacecraft passed through the coma on 9 March 1986 at a distance of 8000 km from the nucleus, while the Giotto spacecraft passed the nucleus on 14 March 1986 at a distance of 600 km. Thus the two sets of data are complementary, corresponding to different dates and different cometocentric distances. Other spacecraft instruments, in particular ion and neutral mass spectrometers and dust analyzers, and ground-based observations of carbon-rich volatiles and dust components provide a broad database for the investigation of organic molecules in comets. While icy organic constituents in the nucleus contribute directly to the organic inventory of small molecules, organic dust particles are the most likely candidates for distributed sources of organic macromolecules in the coma. Author (Herner)

A95-63752
THE ORIGIN AND EARLY EVOLUTION OF THE ATMOSPHERES OF THE INNER PLANETS
TOBIAS C. OWEN University of Hawaii, Honolulu, HI, US and AKIVA BAR-NUN Tel-Aviv University, Tel-Aviv, Israel ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 92
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Laboratory studies of the trapping of heavy noble gases in ice formed at temperatures from 30-75 K demonstrate that a temperature dependent fractionation occurs in the gases that are trapped. Near 50 K, the pattern of relative abundances of Ar/Kr/Xe fits an extrapolated mixing line that passes through the atmospheres of Mars and Earth on a three-isotope plot. Data on noble gases from SNC meteorites and

from submarine terrestrial basalts fit this same line. Coupled with a detailed analysis of xenon isotopes in these samples, this correlation supports the idea that comets played a major role in the delivery of volatiles to the inner planets. A low-temperature comet could explain the anomalous noble gas distribution on Venus. Evidence of impact erosion on Mars can be found in the relative abundances of nucleogenic isotopes and the global depletion of noble gases. The model for the early Martian atmosphere emerging from this work suggests the existence of an original CO2 reservoir of approximately 10 bars, with the equivalent of a 1 km global layer of water. Clement conditions on the planet may have been episodically available, depending on the balance between delivery and removal of volatiles. Author (Herner)

A95-63753
TITAN: A PLANETARY LABORATORY FOR STUDYING PREBIOTIC EVOLUTION
FRANCOIS RAULIN Universite Paris 12, Creteil, France ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 93-94
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The largest satellite of Saturn, Titan, has a dense atmosphere, mainly composed of N2 and CH4 and very rich in organic compounds, both in gas and aerosol phasess. Titan's surface is probably covered - at least locally - by oceans of mixtures of liquid methane and ethane, including many dissolved organics. Several of these organics are of the same chemical nature as the organic compounds involved in terrestrial prebiotic chemistry. If liquid water was present in Titan's early history, then a prebiotic chemistry, based on eutectics formation, similar to that of the early Earth, may have occured. In that case, studying Titan now should provide direct information on terrestrial prebiotic chemistry. However, because of the low temperature of Titan's environment, liquid water is currently absent on the satellite. This quasi planet thus appears as a natural laboratory to study prebiotic evolution toward complex organic systems in a planetary environment over a long time scale. The Cassini-Huygens planetary mission, NASA and European Space Agency (ESA) will jointly send an orbiter, called Cassini, around saturn and Titan and a probe, called Huygens, in the atmosphere of Titan. Several of the scientific instruments aboard the orbiter and most of the instruments on the probe, will provide many precious information on the organic chemistry which is currently going on in Titan's environment. This mission (launch: October 1997, Saturn arrival 2004) will offer a unique opportunity to study in detail extra-terrestrial prebiotic processes, with important implications in the field of exobiology and the origins of life. Author (revised by Herner)

A95-63754
ORGANIC AEROSOLS IN THE ATMOSPHERE OF TITAN
BISHUN N. KHARE Cornell University, Ithaca, NY, US, W. REID THOMPSON Cornell University, Ithaca, NY, US, CARL SAGAN Cornell University, Ithaca, NY, US, and E. T. ARAKAWA Oak Ridge National Laboratory, Oak Ridge, TN, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 95-96
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After Voyager confirmed the presence of aerosols in the atmosphere of Titan and detected several hydrocarbons and especially, the nitriles HCN, NCCN, and HC2CN, Titan became recognized as a natural laboratory for the study of chemical evolution and the steps that led to the origin of life on Earth. We coined the word tholin for the complex solids produced in such experiments. Groundbased modeling of the spectrum of Titan using our measured values of the optical constants shows that the optical constants of Titan haze and Titan tholin agree within the probable error. We have measured the optical constants of a variety of other tholins such as those obtained from charged particle irradiation of CH4 gas, 1:6 C2H6:H2O ice, kerogen, and organic residue from the Murchison carbonaceous chondrite. We find that the imaginary parts of the refractive index k of all these materials are distinctly different from those of Titan tholin. Poly-HCN, recently measured by our group, also differs significantly from Titan tholin. An organic solid photochemically produced from 5% HCN in CH4 or argon is neither poly-HCN nor Titan tholin, as the measured k values are different from both. Additional support for Titan tholin as the best analogue for Titan aerosols comes from the agreement between the abundances of gas-phase products in our experiments and Voyager-derived abundances.
Author (revised by Herner)

A95-63755 National Aeronautics and Space Administration, Washington, DC.
THE METEORITIC RECORD OF PRESOLAR AND EARLY SOLAR SYSTEM ORGANIC CHEMISTRY
JOHN R. CRONIN Arizona State University, Tempe, AZ, US and SANDRA PIZZARELLO Arizona State University, Tempe, AZ, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 97
(Contract(s)/Grant(s): NAGW-1899) Copyright

Carbon, hydrogen, and nitrogen isotopic analyses of various classes of organic compounds done in collaboration with Epstein and Krishnamurthy (Caltech) have shown these compounds to be enriched to varying degrees in the heavier isotopes. These results, in particular the large deuterium enrichments, have been interpreted as indicating an interstellar origin for the meteorite compounds or their precursors. Such isotopic fractionations, of hydrogen especially, are characteristic of low temperature ion-molecule reactions in cold interstellar clouds. There is also evidence from the large corresponding suites of alpha-amino and alpha-hydroxy acids found in meteorites suggesting that aqueous phase chemistry on the meteorite parent body played an important role in the formation of these compounds. These data support the hypothesis that interstellar compounds survived in the solar nebula at a radial distance corresponding to the asteroid belt, were incorporated into the parent body in icy, volatile-rich, planetesinals, and underwent further reactions during a period of aqueous activity within the early parent body to give the present suite of meteorite compounds. This formation hypothesis will be discussed and the results of recent isotopic and molecular analyses bearing on it will be presented.
Author (Herner)

A95-63756
PREBIOTIC MOLECULES IN COMETS
CRISTIANO B. COSMOVICI Istituto di Fisica dello Spazio Interplanetario, Frascati, Italy ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 98
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The exceptional discoveries made by the Giotto spacecraft during the Comet Halley Fly-by in March 1986 improved considerably our knowledge of the organic chemistry of cometary nuclei and comae. The fact that at 1 A.U. a surface temperature of +50 C was measured (200 C higher than calculated) dramatically increased the available energy for chemical reactions leading to complex organic molecules. The discovery made by the Giotto Mass Spectrometer of POM (Polyoxymethylene) confirmed the detection of HCO in Comet Iras. The observation made in February 1991, that a strong cometary activity is also possible independently from solar irradiation, led to the conclusion that other internal sources of energ are available. Decay of Al-26 and other pre-solar isotopes entraped in the cometary ices, exothermic reactions due to phase transitions from the amorphous to the crystalline structure of water ice or chemical explosions produced by NH and NH2 radicals: that kind of internal energy sources acting on the rich cometary biogenic compounds could be responsible for the generation of an enormous amount of prebiotic molecules. Author (Herner)

A95-63775
PHOTOLYSIS OF GASEOUS MIXTURES CONTAINING PHOSPHINE OR GERMANE
JEAN-CLAUDE GUILLEMIN Universite de Rennes, Rennes, France and LAURENT LASSALLE Universite de Rennes, Rennes, France
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 131-132

Hydrogen and helium are the main components observed in the atmospheres of the giant planets, Jupiter and Saturn. However, numerous other molecules have been detected as CH4, NH3, PH3, C2H6, C2H2, C3H4, HCN, AsH3, GeH4,. .. etc. The detection of amine (NH3) and phosphine (PH3) on Jupiter prompted both theoretical and experimental studies on their role in the atmospheric chemistry of these planets: laboratory simulations of PH3 photolysis has shown its fast decomposition and the formation of diphosphine; photolysis of C2H2-NH3 mixtures resulted in the formation of acetonitrile and hydrogen cyanide. Now, we study the photolysis of some gaseous mixtures containing C2H2, C3H4, C2H2-NH3, C3H4-NH3 and PH3 or GeH4 to characterize the heterocompounds formed in the photolytic products. The first experiments performed at room temperature with a 185-nm lamp on C2H2-PH3 and C2H2-GeH4 have shown the formation of ethenyl derivatives (vinylphosphine and germane respectively), which can react with the starting material to lead to alkyl- and alkenylderivatives.
Author (revised by Herner)

A95-63859
THE ORIGIN OF THE TERRESTRIAL OCEANS INFERRED FROM THEIR OXYGEN ISOTOPIC COMPOSITIONS
FRANCOIS ROBERT Museum Histoire Naturelle, Paris, France
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 271-272

In 1973 Clayton et al. suggested that the solar system was not isotopically mixed at the time of the planetary formation. This conclusion was based on the fact that, among different minerals in meteorites and among the different classes of meteorites, the two oxygen isotope ratios O-18/O-16 and O-17/O-16 were not mass dependently correlated: i.e. delta O-17 values were not equal to 0.52 times delta O-18. We will refer hereafter to this linear relation betwen delta O-17 and delta O-18 as the 'mass-dependent fractionation line'. This linear correlation carracterizes any type of isotopic fractionation occuring through physicochemical reactions. Therefore the variations of oxygen isotopic compositions in meteorites that did not follow this rule were interpreted as the result of the mixing of reservoirs with distinct nucleosynthetic histories. The aim of this paper is to look for this signature in terrestrial sediments (cherts) in order to detect possible isotopic heterogeneities of the Precambrian oceans. We report in the present paper oxygen isotopic compositions in recent and Archean cherts - through which the sea water composition can be derived. Possible constant O-16 variations with geological time were also investigated by comparing Archean and Mesozoic or Cenozoic samples. Precambrian chert samples are also among the 'classics': several belong to the Precambrian Paleobiology Research Group (PPRG) and some of them have already been recognized in the literature to be among the best preserved precambrian samples, judging from their highest delta O-18 values. The isotopic correlation line defined by Precambrian and modern chert goes precisely to the origin, a result that establishes the high degree of isotopic homogeneity between the different natural systems of the Earth. Therefore, from the present data it can be concluded that the constant O-16 value of the Precambrian Ocean from which the cherts precipitated, was isotopically similar to that of the present day ocean.
Author (revised by Herner)

A95-63860
IMPACT MELTING OF A FROZEN OCEAN ON THE EARLY EARTH AND THE IMPLICATIONS FOR THE ORIGIN OF LIFE
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ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 273-274

Solar evolution models predict that the young Sun was 20-30 % less luminous than today (Newman and Rood, 1977). A decease in solar luminosity of this magnitude would have resulted in a totally ice covered ocean if the early atmosphere had a composition similar to today (Sellers, 1990). Global surface temperatures would have been less than -40 C because of a planetary albedo near that of ice. According to this scenario, the Earth would have become a permanently frozen planet early in its history. Several solutions to the faint young Sun paradox have been proposed, with an atmosphere containing CO2 at 10(exp 3)-10(exp 4) times its present value being the one generally favored (Kasting and Ackerman, 1986). However, impact erosion of the atmosphere (Ahrens, in press) could have resulted around 4 billion year ago in atmospheric CO2 levels insufficient to prevent the formation of a permanently frozen Earth. The periodic thawing and freezing of a partly frozen early ocean is attractive from a prebiotic organic chemistry point of view. At -2 C, the water temperature below the ice layer, the stability of organic compounds would have been enhanced in comparison to higher temperatures. Dissolved gases important in prebiotic syntheses released from hydrothermal vents such as NH3 and CH4 would have been retained in the frozen ocean and stabilized with respect to their destruction in the atmosphere by photochemical reactions. Periodic thaw-freeze cycles on the early Earth associated with bolide impacts and an atmosphere without sufficient greenhouse gases to prevent freezing of the ocean surface could have been important for the initiation of abiotic reactions that gave rise to the first living organisms. Author (revised by Herner)

A95-63890* *National Aeronautics and Space Administration*, Washington, DC.
EXOBIOLOGY OPPORTUNITIES FROM DISCOVERY-CLASS MISSIONS
MICHAEL A. MEYER LESC, Washington, DC, US and JOHN D. RUMMEL NASA. Headquarters, Washington, DC, US
ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 326-327

Discovery-class missions that are now planned, and those in the concept stage, have the potential to expand our knowledge of the origins and evolution of biogenic compounds, and ultimately, of the origins of life in the solar system. This class of missions, recently developed within NASA's Solar System Exploration Program, is designed to meet important scientific objectives within stringent guidelines—$150 million cap on development cost and a 3-year cap on the development schedule. The Discovery Program will effectively enable "faster, cheaper" missions to explore the inner solar system. The first two missions are Mars Environmental Survey (MESUR) Pathfinder and Near Earth Asteroid Rendezvous (NEAR). MESUR Pathfinder will be the first Discovery mission, with launch planned for November/December 1996. It will be primarily a technical demonstration and validation of the MESUR Program—a network of automated landers to study the internal structure, meteorology, and surface properties of Mars. Besides providing engineering data, Pathfinder will carry atmospheric instrumentation and imaging capabilities, and may deploy a microrover equipped with an alpha proton X-ray spectrometer to determine elemental composition, particularly the lighter elements of exobiological interest. NEAR is expected to be launched in 1998 and to rendezvous with a near-Earth asteroid for up to 1 year. During this time, the spacecraft will assess the asteroid's mass, size, density, map its surface topography and composition, determine its internal properties, and study its interaction with the interplanetary environment. A gamma ray or X-ray spectrometer will be used to determine elemental composition. An imaging spectrograph, with 0.35 to 2.5 micron spectral range, will be used to determine the asteroid's compositional disbribution. Of

the 11 Discovery mission concepts that have been designated as warranting further study, several are promising in terms of determining the composition and chemical evolution of organic matter on small planetary bodies. The following mission concepts are of particular interest to the Exobiology Program: Cometary coma chemical composition, comet nucleus tour, near earth asteroid returned sample, small missions to asteroids and comets, and solar wind sample return. The following three Discovery mission concepts that have been targeted for further consideration are relevant to the study of the evolution of biogenic compounds: Comet nucleus penetrator, mainbelt asteroid rendezvous explorer, and the Mars polar Pathfinder.

Author (revised by Herner)

A95-63891* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXOBIOLOGY EXPERIMENTS FOR EARTH-ORBITAL PLATFORMS

J. L. HUNTINGTON NASA. Ames Research Center, Moffett Field, CA, US, D. M. STRATTON NASA. Ames Research Center, Moffett Field, CA, US, T. W. SCATTERGOOD NASA. Ames Research Center, Moffett Field, CA, US, and J. R. MARSHALL NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 328-329

Low-gravity (microgravity) studies relevant to prebiotic evolution and the history of the biogenic elements (C, H, N, O, P, S) are particularly suited to orbital platforms. Relevant to these topics are phenomena such as gas-particle interactions (e.g., formation of organic aerosols via photolytic reactions) including nucleation, condensation, evaporation, adsorption, and catalytic reactions on surfaces; and, small-particle or grain interactions (e.g., growth of interstellar dust particles and planetesimals) including processes such as aggregation (or coagulation), scavenging, and collisions. Both gas-particle and grain (i.e., dust, crystals, organic aerosols, etc.) interactions studies can benefit from microgravity and are pertinent to studies in the areas of chemical evolution in the solar nebula, the interstellar medium, and planetary atmospheres; growth of planetesimals; and prebiotic evolution. In general, the microgravity environment allows for long duration and controlled simulations of processes occurring in exobiologically significant systems such as Titan's atmosphere, interstellar dust clouds, and the solar nebula in which gas-particle or particle-particle interactions play a significant role. Author (revised by Herner)

A95-63892* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FEASIBILITY OF AN INTEGRATED X-RAY INSTRUMENT FOR MARS EXOBIOLOGY AND GEOLOGY

M. L. FONDA NASA. Ames Research Center, Moffett Field, CA, US, D. E. SCHWARTZ NASA. Ames Research Center, Moffett Field, CA, US, L. N. KOPPEL ARACOR, Sunnyvale, CA, US, E. D. FRANCO ARACOR, Sunnyvale, CA, US, and J. A. KERNER ARACOR, Sunnyvale, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 330

By employing an integrated X-ray instrument on a future Mars mission, data obtained will greatly augment those returned by Viking; details relevant to the possibility of the origin and evolution of life on Mars will be acquired. An integrated combined X Ray Fluorescence/X Ray Detection (XRF/XRD) instrument has been breadboarded and demonstrated to accommodate important exobiology and geology experiment objectives outlined for Mars Environmental Survey (MESUR) and future Mars missions. Among others, primary objectives for the exploration of Mars include: the intense study of local areas on Mars to 'establish the chemical, mineralogical, and petrological character of different components of the surface material; to determine the distribution, abundance and sources and sinks of volatile materials, including an assessment of the biologic potential, now and during past epochs; and to establish the global chemical and physical characteristics of the Martian surface'. The XRF/XRD breadboard instrument identifies and quantifies soil surface elemental, mineralogical, and petrological characteristics and acquires data necessary to address questions on volatile abundance and distribution. Additionally, the breadboard is able to characterize the biogenic element constituents of soil samples providing information on the biologic potential of the Mars environment.

Author (Herner)

A95-63893* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE IN SITU EXOBIOLOGICAL INVESTIGATION OF THE MARTIAN SURFACE MINERALOGY DURING UNMANNED MISSIONS

ROCCO L. MANCINELLI NASA. Ames Research Center, Moffett Field, CA, US and MELISA R. WHITE NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 331-332

An important goal of exobiological research is to determine if life arose on planets other than Earth. The only other planet known, to date, on which life may have arisen is Mars. The data suggest that the physical environment of early Mars (i.e., temperature, pressure, and radiation regimes) was suitable for life to arise. Thus far, the data also suggest that early Mars possessed sufficient quantities of the required building blocks and a number of the chemical compounds necessary for life to arise. It is not known, however, if water existed in the appropriate state (i.e., liquid) in sufficient quantities long enough for life to arise. Determining the mineralogy and components of the Martian soil through in situ analyses during missions to Mars will provide information from which an assessment can be made for the probability of the origin of life on Mars. Missions to Mars in the near future will be unmanned and capable of in situ analyses. Our studies have shown that differential thermal analysis coupled with gas chromatography (DTA/GC) is a more appropriate analytical technique than, x-ray fluorescence, x-ray diffraction, alpha-proton backscatter, gamma-ray spectrometry, differential scanning calorimetry coupled with mass spectrometry (DSC/MS), or DSC/GC to identify the mineralogy of the Martian surface material in situ. DTA/GC is an advancement over the pyrolytic techniques flown on previous missions that have supplied only limited mineralogical information (Biemann et al. 1977). Author (Herner)

A95-63899

EXOBIOLOGY EXPERIMENTS IN EARTH ORBIT: RESULTS AND PERSPECTIVES FOR FUTURE RESEARCH

GERDA HORNECK DLR Institute of Aerospace Medicine, Koln, Germany ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 339-340

From in-situ experiments on the responses of microorganisms to the space environment it is known that the most deleterious factor is solar UV-radiation, especially that in the wavelength range from 200 nm to 300 nm, which is specifically absorbed by the DNA. Furthermore, space vacuum and solar UV act synergistically in reducing microbial viability. This phenomenon which is due to the formation of specific scarcely reparable DNA-lesions further decreases the chance for microorganisms to survive extended exposure in space. With the NASA satellite LDEF, a six year study in space showed, that spores can withstand the dehydration process induced in space vacuum over extended periods of time, provided they will be protected from solar UV. Such shielding is reached by dust or soil particles, or by shadowing, or by thick layers of spores themselves. Several facilities will be available for future exobiological research in Earth orbit, such as the ERA and BIOPAN of ESA, the KNA of Russia, and the Gas Grain Simulation

Facility of NASA, providing opportunities for studying questions as: relevance of extra-terrestrial organic molecules to the emergence of life with in situ studies on the stability of organics in space or in simulated planetary environments and on the dynamics and mechanisms of their formation. The role of solar UV-radiation in evolutionary processes by utilizing the full spectrum of solar UV-radiation for studies on photochemical and photobiological processes under simulated planetary conditions, such as early Earth, early and present-day Mars, Titan, comets or the interstellar medium. The consequences of a reduced ozone layer for the biosphere by studying the biological responses to solar UV filtered corresponding to various thicknesses of the ozone layer. Chances and limits for life to be transported from one body of the solar system to another or beyond, by simulating potential escape processes, by studying the chances of survival of resistant life forms in space and possible protection mechanisms, by simulating non-destructive entry processes. Upper boundary of the biosphere by vertical mapping of air spora up to high altitudes and by searching for extra-terrestrial particles of biological interest in the stratosphere and beyond. Impact of hot atomic chemistry on organic matter, entering the Earth atmosphere and behavior of aerosols by utilizing microgravity as a tool for simulating aggregation processes of particles in interstellar medium, comet coma or planetary atmospheres. Author (Hemer)

A95-63900* National Aeronautics and Space Administration, Washington, DC.
FUTURE NASA PLANS FOR EXOBIOLOGY AND SOLAR SYSTEM EXPLORATION
JOHN D. RUMMEL NASA. Headquarters, Washington, DC, US and MICHAEL A. MEYER LESC, Washington, DC, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 341
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The prominence of exobiology as a part of the NASA program in solar system exploration reached its peak during the Viking missions of the mid-1970's. Even before those missions were finished, the Exobiology Program had been transferred out of the Division responsible for solar system exploration, and many of the direct ties to future missions became more difficult to make, providing a bureaucratic impediment to the conduct of exobiology research in space. Early in 1993, the Exobiology Program was brought back in to the Solar System Exploration Division, as an integral part of NASA's program to study this and other solar systems. As such, the Program stands to gain from an overall broad investment in missions that will study Mars, small bodies such as asteroids and comets, and outer planetary bodies such as Saturn, Titan, and even Pluto. Additional opportunities may be forthcoming on the Moon and elsewhere in Earth-orbit. Ground-based studies will continue to be an important foundation for work in space, while additional effects will be continue to use ground-based astronomical instruments to study other planetary systems, and to search for life on planets around other stars. This paper provides a current planning and budgetary prospectus on the future of Exobiology in NASA.
Author (Hemer)

A95-63901* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN EXOBIOLOGY SCIENCE STRATEGY FOR MARS EXPLORATION
H. P. KLEIN NASA. Ames Research Center, Moffett Field, CA, US and D. L. DEVINCENZI NASA. Ames Research Center, Moffett Field, CA, US ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 342-343
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Of all the other planets in the solar system, Mars remains the most promising for further elucidating concepts about chemical evolution and the origin of life. Exobiological objectives for Mars exploration include: determining the abundance and distribution of the biogenic elements and organic compounds, detecting evidence of an ancient biota on Mars, and determining whether indigenous organisms exist anywhere on the planet. Both approved and planned missions to Mars were evaluated for their potential to contribute to the understanding of these exobiology science objectives and an exploration strategy was developed for each objective. Author (Hemer)

A95-63923
POSSIBLE PRESENCE OF UNSATURATED HYDROCARBON GASES IN COMET NUCLEI AND THEIR ROLE IN THE ORIGIN OF LIFE
G. P. VDOVYKIN ISSOL Meeting, 7th, Barcelona, Spain, July 4-9, 1993. A95-63744 Origins of Life and Evolution of the Biosphere (ISSN 0169-6149) vol. 24, no. 2-4 June 1994 p. 377-378
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The introduction of comet matter to the Earth's surface at an early stage of its development is supposed (Oro, 1961, 1986; Vdovykin, 1970) to have had importance in the process of spontaneous rise of life on the Earth (Oparin, 1960). The carbonaceous chondritic meteorites stand closer in their composition to comet matter. They contain hydrocarbon gases. By means of gas-chromatographic method we examined hydrocarbon gases isolated by thermodesorbtion method at step heating from 100 to 900 C (through 100 C) from the Mighei meteorite - carbonaceous chondrite. They are represented by C(sub 1)-C(sub 5) gases, both saturated and unsaturated ones.
Author (Hemer)

A95-65618
TERRAFORMING WITH NANOTECHNOLOGY
CHARLES R. MORGAN STEP Space Project Office, Minato, Tokyo, Japan British Interplanetary Society, Journal (ISSN 0007-094X) vol. 47, no. 8 August 1994 p. 311-318
(HTN-95-60319) Copyright

This discovery that the basic processes of cellular life are carried out by many simple molecular scale machines has prompted the idea that man should be able to construct molecular machines based on the same principles and that man-made molecular machines, or 'nano-robots', which share cellular life's capacity for self replication should be possible. The recent rapid development of technology for the manipulation of single atoms suggests that such molecular machinery could even become a reality in the 21st century. Without going into detailed workings of such nano-robots this paper suggests how this technology may be applied to construct plastic membranes over the surfaces of Mars and other planetary bodies to make them habitable in timescales of a decade or less. Author (Hemer)

A95-65619
TERRAFORMING OF MARS THROUGH TERRESTRIAL MICROORGANISMS AND NANOTECHNOLOGICAL DEVICES
M. D. NUSSINOV INT, Moscow, Russia, S. V. LYSENKO Russian Academy of Sciences, Moscow, Russua, and V. V. PATRIKEEV Russian Academy of Science, Moscow, Russia British Interplanetary Society, Journal (ISSN 0007-094X) vol. 47, no. 8 August 1994 p. 319-320
(HTN-95-60320) Copyright

For many years, the idea of taking terrestrial life to other planets remained just a science fiction topic. The gist of the theory of inverse panspermia, consists of the transportation of terrestrial genetic material to the planetary systems of selected stars, as a way of preserving the unique terrestrial genetic material from all possible Earthly catastrophes. The idea of colonising the planets of the Solar System has now become more generally accepted, its first objective being the transformation of the climate of Mars into a climate similar to that of the Earth. The general conceptual basis of changing planetary environments is that of 'ecopoiesis', a term from the ancient Greek meaning 'establishment of an abode', i.e., the creation of self-supporting ecosystems on a lifeless planet. Accordingly, its realization on Mars might begin following certainty that the planet is lifeless. Such a stage might be reached towards the middle or end of the 21st century, but it is time now to prepare for that possible terraforming process. Author (Hemer)

A95-65620
THE EVOLUTIONARY SOLITON-LIKE IMPULSE PARADIGM OF MATTER: PERSPECTIVES OF UNITY IN THE NANOTECHNOLOGY/NANOBIOLOGY DICHOTOMY
M. D. NUSSINOV INT, Moscow, Russia, V. I. MARON Gosudarstvennaya Akademiya, Moscow, Russia, and S. SANTOLI INT, Rome, Italy British Interplanetary Society, Journal (ISSN 0007-094X) vol. 47, no. 8 August 1994 p. 321-324
(HTN-95-60321) Copyright

Studies towards miniaturization down to the nm-scale (the mesoscopic level) of electronic and mechanical devices and towards the understanding and control of life phenomena on that level are considered as having an evolutionary meaning and a unitary character, in that they will ultimately give rise to Man-independent self-organizing systems. Bifurcation points in the highly chaotic dynamics of the informational evolutionary flow of molecular systems are the points of emergence of novelties in self-organizing systems. Author (Herner)

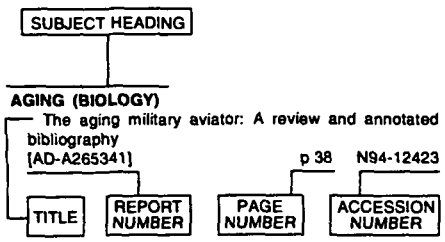
A95-65778
DISCRETE VELOCITY MODEL FOR AN ESCAPING SINGLE-COMPONENT ATMOSPHERE
WILLIAM J. MERRYFIELD Univ. of British Columbia, Vancouver, BC, Canada and BERNIE D. SHIZGAL Univ. of British Columbia, Vancouver, BC, Canada Planetary and Space Science (ISSN 0032-0633) vol. 42, no. 5 May 1994 p. 409-419 Research sponsored by the NSERC of Canada
(HTN-95-50283) Copyright

The structure of an escaping single-component planetary atmosphere is computed by direct numerical integration the nonlinear Boltzmann equation. The transition from collision-dominated behavior deep in the atmosphere to nearly collisionless behavior at great altitudes is therefore treated self-consistently for the first time. We consider a hypothetical planet having the same mass and radius as the Earth, surrounded by an atmosphere of atoms having the same mass and total hard-sphere collision cross-section as atomic hydrogen. The atmosphere is initially hydrostatic and isothermal, at a temperature of 1000 K. As the computation progresses, the atmosphere gradually escapes. Eventually, a quasi-steady state is reached in which the density decreases significantly more rapidly than the initial barometric distribution, and the temperature decreases nearly 200 K between the planetary surface and an altitude of 10,000 km. The bulk upward flow speed increases with altitude above the exobase. However, because the most energetic particles escape and are not replenished, the atmosphere gradually cools, and the deep, collision-dominated portion of the atmosphere settles towards the planet's surface. The high-velocity tail of the velocity distribution function is quite anisotropic over a large range of altitudes, and remains largely depleted of incoming unbound particles even well below the exobase. At the highest altitudes in our simulation, the population of escaping unbound particles is considerably enhanced by the streaming of such particles from the warmer and denser regions below. The computed escape flux is at least 30% greater than the Jeans flux as a result of this effect. It is suggested that computations similar to this one may prove useful for studying atmospheric escape from the primeval terrestrial planets, comets and Pluto. Author (Herner)

N95-18569*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
US EXPERIMENTS FLOWN ON THE SOVIET BIOSATELLITE COSMOS 2044. VOLUME 1: MISSION DESCRIPTION, EXPERIMENTS K-7-01 - K-7-15 Final Report
JAMES P. CONNOLLY, ed., RICHARD E. GRINDELAND, ed., and RODNEY W. BALLARD, ed. Sep. 1994 487 p
(Contract(s)/Grant(s): RTOP 199-08-12)
(NASA-TM-108802-VOL-1; A-94031-VOL-1; NAS 1.15:108802-VOL-1)
Avail: CASI HC A21/MF A04

Cosmos 2044 was launched on September 15, 1989, containing radiation dosimetry experiments and a biological payload including two young male rhesus monkeys, ten adult male Wistar rats, insects, amphibians, protozoa, cell cultures, worms, plants and fish. The biosatellite was launched from the Plesetsk Cosmodrome in the Soviet Union for a mission duration of 14 days, as planned. The major research objectives were: (1) Study adaptive response mechanisms of mammals during flight; (2) Study physiological mechanisms underlying vestibular, motor system and brain function in primates during early and later adaptation phases; (3) Study the tissue regeneration processes of mammals; (4) Study the development of single-celled organisms, cell cultures and embryos in microgravity; (5) Study radiation characteristics during the mission and investigate doses, fluxes and spectra of cosmic radiation for various types of shielding. American and Soviet specialists jointly conducted 29 experiments on this mission including extensive preflight and post flight studies with rhesus monkeys, and tissue processing and cell culturing post flight. Biosamples and data were subsequently transferred to the United States. The U.S. responsibilities for this flight included development of flight and ground-based hardware, the preparation of rat tissue sample procedures, the verification testing of hardware and experiment procedures, and the post flight analysis of biospecimens and data for the joint experiments. The U.S. investigations included four primate experiments, 24 rat experiments, and one radiation dosimetry experiment. Three scientists investigated tissue repair during flight for a subgroup of rats injured preflight by surgical intervention. A description of the Cosmos 2044 mission is presented in this report including preflight, on-orbit and post flight activities. The flight and ground-based bioinstrumentation which was developed by the U.S. and U.S.S.R. is also described, along with the associated preflight testing of the U.S. hardware. Author

Typical Subject Index Listing



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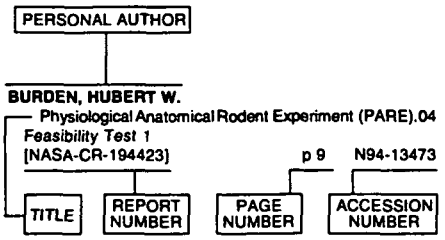

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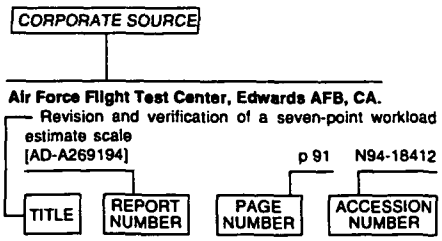

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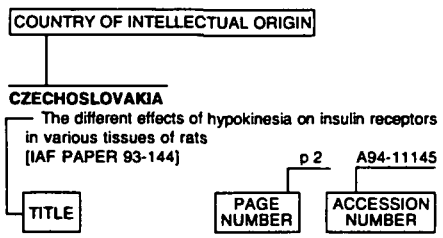

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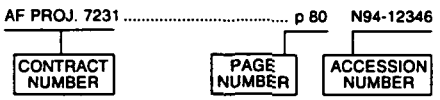

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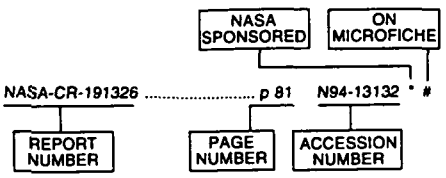

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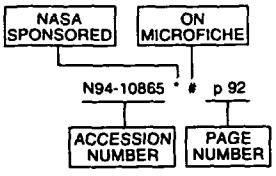

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