A SUMMARY OF PRINCIPAL INVESTIGATORS' 180-DAY REPORTS

SLS-1 Flight Experiments Preliminary Significant Results

January 1992

SPACELAB LIFE SCIENCES 1

(NASA-TM-108033) SLS-1 FLIGHT EXPERIMENTS PRELIMINARY SIGNIFICANT RESULTS (NASA) 39 p

Unclas

ORIGINAL PAGE COLOR PHOTOGRAPH
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Director, Life Sciences Division
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Biomedical problems encountered here on Earth, space flight and, as in the past, will be applied to many problems of long duration returning to Earth. The experimental results will be used in the adaptation to the microgravity environment and re-adapting when the mechanisms involved in the adaptation to the subjects. The SLS-1 preliminary results gave insight to neuroscience disciplines in both human and rodent models. The SLS-2 (SLS-1) mission will test the effects of adaptations to spaceflight and the physiological effects of weightlessness and the mechanism involved in the first set of disabilities. Special Life Sciences 1 (SLS-1) is the first of a series of experiments selected for flight on SLS-1 missions responsible for the observed phenomena. Integrated experiments lead to the formulation of several hypotheses, generated from the physiological effects observed during the mission. Subsequent readaptation to 1 g (G). Hypotheses for investigating the mechanism involved in the anatomy and physiology of spaceflight and the effects of adaptations to spaceflight.
Spacelab provides the capability to perform life sciences research in space

Spacelab Life Sciences 1
Special Life Sciences 1

GOALS

- Test the validity of using rodents as human models for space flight research
- Investigate the consequences of the body's adaptations to weightlessness and reestablishment of G forces
- Study the mechanisms, magnitudes, and time courses of physiological changes that occur during space flight
- Acquire fundamental scientific knowledge concerning life sciences and biotechnology in space
- Ensure the health, safety, and productivity of humans
SLS-1 was launched on June 5, 1991.
Special Life Sciences 1

United States
Switzerland
Canada
Australia

35 Co-investigators from 4 countries:

The experiments were developed by an international

1 utilized jellyfish
7 utilized rodents
10 utilized human subjects

The primary payload consisted of 18 investigations:

Neuroscience
Musculoskeletal
Regulatory Physiology
Cardiovascular/Cardiopulmonary

The experiment was conducted in the following disciplines:

3 Orbiter crewmembers
4 Payload crewmembers

Crew: 4 days
Duration: 9 days
Launch: June 5, 1991

MISSION PROFILE
CARDIOVASCULAR/ CARDIOPULMONARY DISCIPLINE
and blood pressure
cardiac baroreflex receptors that control heart rate

To quantify CV/CP deconditioning by examining the
weightlessness to pulmonary function at 1 G

To compare pulmonary function during
cardiac dimensions at rest and during exercise

To investigate acute changes in CV function and
induced by exercise

To determine how acute and prolonged exposure to
adaptation and readaptation to 1 G.

• To investigate the mechanisms contributing to the CV/CP

Four experiments were conducted on the SLS-1 mission
orthostatic intolerance.

• Lungs: Spontaneous and cardiac response to exercise, and
increase in heart rate and blood pressure, a decrease in
changes observed in previous space flight include an
space flight has been shown to cause changes in the

EXPERIMENT OBJECTIVES

OVERVIEW

CARDIOVASCULAR/CARDIOPULMONARY
CV/CP measurements were made before and during exercise.
RESULTS OF CARDIOVASCULAR/CARDIOPULMONARY INVESTIGATIONS

EXERCISE CAPABILITY
Exercise capability, for both moderate and maximum exercise levels, was reduced after flight due to the decrease in stroke volume, cardiac output, and oxygen uptake. Exercise capability had nearly returned to preflight levels within 7 days.

RESPIRATORY SYSTEM
Increases were observed during flight in the pulmonary capillary blood volume, the diffusing capacity of carbon monoxide, and the membrane diffusing capacity. This suggests that interstitial pulmonary edema, contrary to prior theory, is unlikely.
Echocardiography was performed to study heart function.
Orthostatic intolerance after light human baroreflex function during light and contributes to Exposure to weightlessness leads to a degradation of decreased cardiac output.

By an increased heart rate response, resulting in a decreased in stroke volume, only partially compensated. This intolerance was characterized by a larger postural 

unchanged. Decreased, allowing cardiac output to remain 

During light, stroke volume increased and heart rate 

CENTRAL VENOUS PRESSURE

Orthostatic Intolerance

(Concluded)

Results of Cardiovascular/Cardiopulmonary Investigations
activation and proliferation

To study the effect of weightlessness on lymphocytes

Immunological System/Biotechnology

Rats

mass and plasma volume in human subjects and

To examine the reduction in the circulating RBC

RBC in 0 G

suppressed production or increased destruction of

To determine if the decrease in RBC mass is due to

Circulatory System

headward fluid shift experienced in weightlessness

head, electrolyte, and hormonal response to the

To investigate the acute and adaptive changes in the

Renal/Endocrine System

EXPERIMENT OBJECTIVES

REGULATORY PHYSIOLOGY


terrestrial systems. Changes that occur during early space flight

The Regulatory Physiology discipline consists of the

Overview

various systems of the Regulatory Physiology discipline.

Five experiments on the SLS-1 mission investigated the

understood:

adaptation to weightlessness are not completely

the time of onset of the physiological response, and the

lymphocytes. The mechanisms causing the changes.

include a headward fluid shift and an decrease in total

body fluid, red blood cell (RBC) mass, and circulating

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OVERVIEW

REGULATORY PHYSIOLOGY

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The Regulatory Physiology discipline consists of the

OVERVIEW
Samples were collected to study fluid volume regulation mechanisms.
Fluid Regulation and Fluid-Regulating Hormones

RESULTS OF REGULATORY PHYSIOLOGY INVESTIGATIONS
The regulation of red blood cell production was studied in humans and rodents.
Special Life Sciences

Lymphocyte Production

IMMUNOLOGICAL SYSTEM/BIOTECHNOLOGY

RBCs, indicating a suppression of RBC production. After RBC levels, the RBC incorporation of iron decreased in rodents.

Iron Kinetics

Red Blood Cell Mass

differential during illness.

Regulation of Erythropoiesis

CIRCULATORY SYSTEM

RESULTS OF REGULATORY PHYSIOLOGY INVESTIGATIONS

(Concluded)
Musculoskeletal System

To study muscle mass loss and energy utilization in slow- and fast-twitch muscles that break down cellular proteins

To study muscle protein breakdown and energy utilization in slow- and fast-twitch muscles

To determine how muscle mass loss and energy utilization in slow- and fast-twitch muscles correlates with protein breakdown by analyzing the concentrations of enzymes

To determine if alterations in bone growth patterns and strength are caused by inhibited bone formation, the rate of bone mineral loss, and pathophysiology of bone mineral loss during space flight

To determine if alterations in bone growth patterns and strength are caused by inhibited bone formation, the rate of bone mineral loss, and pathophysiology of bone mineral loss during space flight

To study the musculoskeletal system and muscle metabolism by measuring protein synthesis and breakdown rates and nitrogen balance

Muscular System

EXPERIMENT OBJECTIVES

Six experiments on the SLS-1 mission investigated the effects of six experiments on the SLS-1 mission investigated the effects of countermeasures to reduce or halt possible adverse musculoskeletal alterations critical for developing space. An understanding of the mechanisms causing which may affect how long humans can safely remain in physical fitness and a decrease in skeletal strength

Musculoskeletal System

OVERVIEW
Changes in skeletal muscle function, structure, and biochemistry were investigated.
Weightlessness causes increased bone resorption.

Indirect measurement indicated that exposure to
hormone levels, which regulate serum calcium levels.
An increase in serum calcium levels was observed in

Bone Loss

SKELETAL SYSTEM

recovered immediately after flight.

energy source is reduced during flight, and the ability is
The muscle's ability to utilize certain fatty acids as an

Energy Utilization

aggravated by positional reorienting in 1 g.

Muscles show an atrophy-related vulnerability to muscle

RESULTS OF MUSCULOSKELETAL INVESTIGATIONS

bearing during early phases of recovery.
characteristics, making them less efficient for weight
The slow- and twitch muscles acquired less-twitch muscle

The fast-twitch muscles.

twitch muscles recovered a greater portion of mass than

within the fast-twitch muscles. After flight, the slow-

During flight, more atrophy occurred in the slow-twitch

flight.

Flight during flight and is partially replaced by 9 days after

a significant decrease in total muscle mass occurs

Muscle Mass

response.

stress response and not a ground-based bed rest.

term space flight. This increase is associated with a

An increase in protein synthesis occurs during short-

Protein Synthesis

MUSCULAR SYSTEM
Three experiments were conducted in the Neuroscience discipline. A role in altered sensory perception, sized that structural changes in sensory organs may play a role in altered sensory perception. It has been hypothesized that adaptation also includes learning to interpret sensory perception and control. Adaptation also includes learning to interpret sensory perception and control. Adaptation also includes learning to interpret sensory perception and control. Adaptation also includes learning to interpret sensory perception and control. Adaptation also includes learning to interpret sensory perception and control. Adaptation also includes learning to interpret sensory perception and control.

EXPERIMENT OBJECTIVES

OVERVIEW

NEUROSCIENCE
Measurements were made to study how the vestibular system relies on visual cues
Special Life Sciences

**Results of Neuroscience Investigations**

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The development and function of jellyfish gravity receptors were studied.
Behavior
Jellyfish development and swimming

consistent with behavior exhibited by 1-6 controls.
swimming behavior exhibited during night is not
complete with a swimming contractions of swimming.
neuromuscular systems with their graviceptors to permit

generalizing graviceptors and are able to integrate their
jellyfish that melastomaphoe during night are capable of

Otoconial study

Rodents, demineralization of show other signs of deterioration in
that the gravity sensing organs, the otoconia, did not
analysis conducted 4 hours after landing demineralized

Results of neuroscience investigations

(Concluded)
The intravenous fluid pump test was one of the hardware verification tests conducted in preparation for extended duration space flight.
animal cages.

The results indicated the particulate mass concentration influenced significantly by the air cleaning system or the
PCDT's permitted in high rodent handling.

PCDTs validated the containment capabilities of the
rodent hardwared, the successful completion of the
 demonstrators(CD's) validated the containment capabilities of the

Particulate Containment Demonstration Tests

Particulate Containment Demonstration

Specimens flown on SLS-1.
Animal tissue samples were shared with the international

Biospecimen Sharing Plan

experiments, proved to be operationally successful.
experiments were used to measure the acceleration level effect on
the Space Acceleration Measurement System, which

Space Acceleration Measurement System

Intravenous Fluid Pump

Results of Additional Life Sciences Investigations

Airborne Particulate Measurement

Design considerations.
Reevaluated for increased stability and for microgravity
examinations. The MRS design, however, needs to be
a full-time space high medical workstation, was
A Medical Retraint System (MRS) evaluated for use as

Medical Restraint System

mode when positive pressure was applied.
Freedom offered successfully in 0 G in the manual
A prototype Intravenous (IV) Fluid pump for Space Station
The results of the SLS-1 mission will pave the way for ensuring the health, safety, and productivity of humans in space.
Special Life Sciences

SL-2 is to be launched in mid-1993.

SL-1.

Statistical significance for the data collected on SLS-2 will provide science enhancement and

and future missions.

Life sciences research that will be continued on SLS-2.

The Biospecimen Sharing Program of SL-1 provided

SLS-1 contributions to future space flight

animal experimentation on future life sciences

handing and maintaining hardware for in-flight

SL-1 provided the opportunity to test animal

SL-2 payload and future SLS missions.

Lessons learned from SL-1, both scientific and

future long-duration space flight missions.

Data collected will contribute to the preparation of

adaptation to weightlessness.

Information necessary to understand physiological

Data collected on SL-1 are providing background

SLS-1 contributions to future space flight
SLS-1 – AN INTERNATIONAL EFFORT

UNITED STATES

Academia
- University of California at Irvine
- University of California at San Francisco
- University of California at San Diego
- State University of New York at Buffalo
- University of Medicine and Dentistry of New Jersey
- University of Texas Southwest Medical Center
- University of Tennessee Medical Center at Knoxville
- Medical College of Wisconsin
- Eastern Virginia Medical School
- Massachusetts Institute of Technology
- Baylor College of Medicine

Government
- NASA
- Veterans Administration
- National Institute of Health

Industry
- GE Government Services
- Lockheed Engineering & Sciences Company
- Rockwell International, Inc.
- KRUG Life Sciences Company
- Sverdrup Technology, Inc.
- Teledyne Brown Engineering

INTERNATIONAL

Academia
- Institut fur Biotechnologie, Switzerland
- University of Sydney, Australia
- Universite Physiologie de l'Environnement, France
- Unite d'Histopathologie Institut Pasteur, France
- Laboratoire Ecologie et Physiologie du Systeme Digestif, France
- Medizinische Klinik Innenstadt der Universität Ziemssentr, Germany
- Sechenov Institute of Evolutionary Physiology and Biochemistry, USSR

Government
- Centre National d'Etudes Spatiales, France
- Canadian Space Agency, Canada
- Deutsche Agentur fur Raumfahrtangelegenheiten, Germany
- Institute of Biomedical Problems, Russia
- Brain Research Institute, Russia
- Severtsev Institute of Evolutionary Morphology and Ecology of Animals, Russia
- Defence and Civil Institute of Environmental Medicine, Canada

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