SLS-1 CREW

Clockwise from back left:
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Spacelab Life Sciences 1
Special lab Life Sciences I

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Biomedical problems encountered here on Earth, space flights and, as in the past, will be applied to many
physical and health and safety for future long duration
returning to Earth. The experimental results will be used
microgravity environment and readaptation when
the mechanisms involved in the adaptation to the
subjects. The SLS-1 preliminary results gave insight to
neurosciences disciplines in both human and rodent
regulatory, psychology, musculoskeletal, and
investigated the cardiovascular/cardiopulmonary,

The 15 experiments selected for flight on SLS-1
mechanisms responsible for the observed phenomena.
Integrated experiments to determine the underlying
earlier missions led to the formulation of several
generated from the physiological effects observed during
subsequent readaptation to 1 g, (1 G) hypotheses
physiological adaptation to weightlessness and the
protein metabolism in the body.

Special lab Life Sciences I (SLS-I) is the first of a series
Spacelab provides the capability to perform life sciences research in space
GOALS

LIFE SCIENCES PROGRAM
• Ensure the health, safety, and productivity of humans in space
• Acquire fundamental scientific knowledge concerning space biological sciences

SPACELAB LIFE SCIENCES 1 MISSION
• Study the mechanisms, magnitudes, and time courses of physiological changes that occur during space flight
• Investigate the consequences of the body's adaptation to weightlessness and readjustment to 1 G
• Test the validity of using rodents as human models for space flight research
SLS-1 was launched on June 5, 1991.
The experiments were developed by an international team consisting of 17 principal investigators and 35 co-investigators from 4 countries.

The primary payload consisted of 16 investigations:
- 1 utilized jellyfish
- 7 utilized rodents
- 10 utilized human subjects

Research was conducted in the following disciplines:
- Neuroscience
- Musculoskeletal
- Regulatory Physiology
- Cardiovascular/Cardiopulmonary

Crew:
- 3 Orbiter crew members
- 4 Payload crew members

Duration: 9 days
Launch: June 5, 1991
Special Life Sciences

Research Objectives

- To quantify CV/CP deconditioning by examining the weightlessness-to-protocol function at 1 G.
- To compare pulmonary function during cardiac dimensions at rest and during exercise induced by exercise.
- To investigate acute changes in CV function and weightlessness after the CV/CP response to stress.
- To determine how acute and prolonged exposure to adaptation and readaptation to 1 G, orthostatic intolerance, lung capacity and cardiac response to exercise, and increase in heart rate and blood pressure, a decrease in changes observed in previous spaceflight investigations in the cardiovascular/cardiovascular (CV/CP) system. The space flight has been shown to cause changes in the

-overview

Cardiovascular/Cardiovascular

Special Life Sciences
CV/CP measurements were made before and during exercise.
prior theory is unlikely, suggests that interstitial pulmonary edema, contrary to monoxide, and the membrane diffusing capacity. This capillary blood volume, the diffusing capacity of carbon increases were observed at high in the pulmonary RESPIRATORY SYSTEM.

Excessive capability, exercise capability, within 7 days. Excessive capability, has nearly returned to uptake, decrease in stroke volume, cardiac output, and oxygen exercise levels, was reduced after right due to the exercise capability, for both moderate and maximum,
Echocardiography was performed to study heart function.
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Orthostatic intolerance after hiatal hernia.

Exposure to weightlessness leads to a degradation of
decreased cardiac output.

By an increased heart rate response, resulting in a
decrease in stroke volume, only partially compensated.

This intolerance was characterized by a larger postural
unchanged.

during hiatal hernia, stroke volume increased and heart rate

Central Venous Pressure

(Concluded)

Results of Cardiovascular/Cardiopulmonary Investigations
Specialized Sciencies 1

Regulatory Physiology

Experiment Objectives

Immunological System/Biotechnology

To study the effect of weightlessness on lymphocytes

Rodents

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

rapidly shift fluid experienced in weightlessness

headward fluid shift expected in weightlessness

To investigate the acute and adaptive changes in the

Renal/Endocrine System

various systems of the Regulatory Physiology discipline.

Five experiments on the SLS-I 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 a decrease in total

systems. Changes that occur during early space flight

renal/endoctrine, the circulatory, and the immunological

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

Results of Regulatory Physiology Investigations

Renal Function

Renal/Endocrine System
The regulation of red blood cell production was studied in humans and rodents.
Special Life Sciences

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**LYMPHOCYTE PRODUCTION**

1-lymphocytes.

by macrophages and not the lack of adhesion or
T-lymphocytes.

This was due to the decrease of interleukin-2 production
of microcarriers, activation was depressed 50 percent.

compared to the T-C controls, whereas in the absence
presence of microcarriers was increased 100 percent.

indicate that lymphocyte activation at 0 G in the
lymphocyte activation studies in vitro. These studies
the use of microcarriers are available to conduct
with advances in biotechnology, applications such as

**IMMUNOLOGICAL SYSTEM BIOTECHNOLOGY**

rodents, indicating a suppression of RBC production.

After initial the RBC incorporation of iron decreased in
RBC incorporation of iron decreased.

remained constant while ferritin levels increased and the
iron kinetics

unchanged in both humans and rodents.

ground control rodents. The RBC survival remained
decreased relative to body mass and RBC mass of
suppression of erythropoiesis. In rodents RBC mass
in human subjects RBC mass decreased, indicating a

Red Blood Cell Mass

differentiation during pregnancy.

competent to differentiate into mature RBCs, failed to
The RBC precursor cells of rodents, which were

Regulation of Erythropoiesis

**CIRCULATORY SYSTEM**

(Concluded)

**RESULTS OF REGENERATIVE PHYSIOLOGY INVESTIGATIONS**
Specialized Life Sciences

- Development of increased bone loss and strength are caused by inhibited bone growth patterns during spaceflight.
- To determine if alterations in bone growth patterns during spaceflight are responsible for muscle and bone loss.
- Study the pathophysiology of bone mineral loss.
- To study muscle mass loss and energy utilization in slow- and fast-twitch muscles.
- To study muscle mass loss and energy utilization in slow- and fast-twitch muscles.
- To compare atrophy rates in the slow- and fast-twitch muscles.

Musculoskeletal System

- Syntheses and breakdown rates and nitrogen balance.
- To study protein metabolism by measuring protein synthesis.

Muscular System

Experiment Objectives

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 space. An understanding of the mechanisms causing physical fitness and a decrease in skeletal strength.

A decrease in skeletal strength.

Loss of muscle tissue and bone mineral during space

Overview
Changes in skeletal muscle function, structure, and biochemistry were investigated.
results of musculoskeletal investigations
NEUROSCIENCE
DISCIPLINE
Special Life Sciences

**EXPERIMENT OBJECTIVES**

Three experiments were conducted in the Neuroscience discipline.

- A role in altered sensory perception.
  - Studies that structural changes in sensory organs may play in reinterpreting sensory perception. It has been hypothesized that adaptation also includes learning to interpret sensory perceptions and control. Adaptation also includes learning to causally perceive SNS are critical to improving crew efficacy, which is the same. Discovered and corroborating the mechanisms of SNS symptoms are similar to Earth motion sickness symptoms experienced by a large percentage of astronauts. SNS is sensate perception conflicts. Early in flight, SNS is need to overcome space motion sickness (SMS) and is sensed by the nervous system. Requiring adaptation to weightlessness.

**OVERVIEW**
Measurements were made to study how the vestibular system relies on visual cues.
Specialized Life Sciences

Transient postural instability appears to be

caused by a combination of altered muscle and
vestibular functions.

Landing.

Period of time after flight.

It was further confirmed that crew members who are
susceptible to ground motion sickness for a

period of time after flight.

develop an immunity to ground motion sickness for a

A period of time after flight.

RESULTS OF NEUROSCIENCE INVESTIGATIONS

HUMAN VESTIBULAR EXPERIMENT

cues relied upon by subjects.

fatigue. Individual variability was noted in the types of
proprioceptive – to maintain the body’s sense of own-
uses nonvestibular cues – particularly visual, tactile, and

In weightlessness, the central nervous system primarily

HUMAN VESTIBULAR EXPERIMENT

developed an immunity to ground motion sickness for a

HUMAN VESTIBULAR EXPERIMENT

It was further confirmed that crew members who are

susceptible to ground motion sickness for a
The development and function of jellyfish gravity receptors were studied.
consistent with behavior exhibited by 1-G controls.
swimming behavior exhibited during light is not
complete pulsing contractions and swimming. The
neuromuscular systems with their graviceptors to permit
generating graviceptors and are able to integrate their
Jellifish that metamorphose during light are capable of
BEHAVIOR
Jellifish Development AND SWIMMING

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.
Special Life Sciences

Results of Additional Life Sciences Investigations

animal cages.

Influenced significantly by the air cleaning system or the

did not significantly increase with time and was not

The results indicated the particulate mass concentration

AEROBIC PARTICULATE MEASUREMENT

design considerations.

revaluated for increased stability and for microgravity

examinations. The MRS design, however, needs to be

successfully used in performing standard physical

a tilting space high medical workstation, was

a medical restraint system (MRS), evaluated for use as

MEDIACAL RESTRAINT SYSTEM

mode when positive pressure was applied.

Freedom operated successfully in 0 G in the manual

A prototype intravenous (IV) fluid pump for space station

INTRAVENOUS FLUID PUMP

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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

SLS-1 is to be launched in mid-1993.

- SLS-1: will provide the opportunity to test animal
  life sciences research that will be continued on SLS-2
  and future missions.
- Lessons learned from SLS-1, both scientific and
  operational, will be incorporated into planning the
  future long-duration spaceflight missions.
- Data collected will contribute to the preparation of
  adaptation to weightlessness.
- Data collected on SLS-1 are providing background
  information necessary to understand physiological

SLS-1 CONTRIBUTIONS TO FUTURE SPACE FLIGHT