History of Space Life Sciences

http://neurolab.jsc.nasa.gov/ustime.htm

The Beginning

Balloon flights Launched from Alamogordo, NM 170 km altitude.	1946-1947	Conducted to study the effects of cosmic radiation in the upper Earth atmosphere on fungal spores and fruit flies.
V-2 rocket Launched from White Sands Missile Range, NM Approximately 100 km. altitude	1946-1948	Suborbital V-2 rockets carried seeds, fungal spores and Drosophila fruit flies. Need for Life Support System identified.
V-2 rockets Launched from White Sands Missile Range, NM Eight suborbital flights 133 km altitude	1948-1952	Telemetric recording of physiological measurements of mice and monkeys, enabled scientists to study the influence of high g-forces and micro-gravity on the cardiovascular system. In addition the behavior of mice was recorded with movie cameras.
Balloon flights Launched from Alamogordo, NM 27 - 30 km altitudes, up to 28 hours.	1950-1954	Fruit flies, mice, hamsters, cats, dogs and rhesus monkeys were flown on several missions to study the effects of the thin atmosphere and radiation.
Aerobee Launched from White Sands Missle Range, NM 71 km altitiude	1951-1952	Rhesus monkeys and mice were flown to study the effects of cosmic radiation and changes in the cardiovascular system.
Mouse in Able Thor-Able missiles Three missions	1958	Physiological data from the mouse was telemetered to the ground 20 minutes of microgravity during launch, flight and reentry.
Bioflight 1 Jupiter rocket	Dec/13/1958	Gordo, the squirrel monkey, had heart rate, heart sounds, body temperature, pressure and radiation monitored

480 km		
Bioflight 2 Jupiter rocket 480 km	May/28/1959	Rhesus monkey Abel and squirrel monkey Baker; the same data as on Bioflight 1, plus muscle performance by electromyogram. Abel was trained to tap a switch when a red light flashed, to collect data on performance.
Discoverer 3	1959	Launch failed. First attempt to orbit a biological payload (4 mice).
Little Joe 84 km altitude	1959 + 1960	Rhesus monkey Sam and Miss Sam on the second flight; verification of Mercury life support equipment
ATLAS	1960	Three mice in space
650 km altitude		
MERCURY		Initiated to demonstrate that humans can survive in space
Mercury 2	Jan/31/1961	A suborbital flight, Chimpanzee, Ham was closely monitored for cardiovascular responses
Mercury 3 Launched from KSC on a Redstone Rocket 250 km high, 15 minutes	May/31/1961	First suborbital flight of man; monitoring the physiological responses of the astronaut American, Alan Shepard
Mercury 4 Launched from KSC on a Redstone Rocket	Jul/21/1961	Second human suborbital flight; monitoring the physiological responses
Mercury 5 Launched from KSC on an Atlas Rocket Two orbit flight 183 minutes	Nov/29/1961	Chimpanzee Enos was recovered in excellent condition
Mercury 6 Launched from KSC on an Atlas Rocket 4 hours 55 min	Feb/20/1962	First orbital flight of American astronaut, John Glenn. Physiological reponses of the astronaut were monitored
Mercury 7 Launched from KSC	May/24/62	General physiological adaptation processes

on an Atlas Rocket 4 hours 56 min flight		
Mercury 8 Launched from KSC on an Atlas Rocket 9 hours 13 min	Oct/3/1962	
Mercury 9 Launched from KSC on an Atlas Rocket 1 day 1 hour 18 min	May/15-16/1963	First episode of postflight orthostatic intolerance
GEMINI		Between March 1965 and November 1966 the United States flew ten Gemini two-manned spacecrafts.
Gemini 3	Mar/23/1965	First manually controlled maneuvers in Space. Experiment about Sea Urchin fertilization and development
Gemini 4	Jun/3-7/1965	First spacewalk performed by an American, Ed White II. Astronauts exercised as a countermeasure to minimize some of the negative effects of space flight
Gemini 5 7 days 22 hours 59 min	Aug/21-28/1965	Cardiovascular deconditioning monitored, testing exercise as a possible countermeasure
Gemini 7	Dec/4-18/1965	Rendezvous with Gemini 6. Cardiovascular deconditioning, bone demineralization, calcium balance during space flight, sleep patterns, otolith function and exercising as a countermeasure.
Gemini 6	Dec/15-16/1965	Rendezvous with Gemini 7
Gemini 8 10 hours 41 min	Mar/16/1966	First docking in space, Frog egg growth experiment
Gemini 9 2 hours 7 min EVA	Jun/3-6/1966	
Gemini 10	Jul/18-21/1966	First time there was no suit overheating during EVA
Gemini 11	Sep/12-15/1966	Docking and joint flight with Agena
Gemini 12	Nov/11-15/1966	Frog egg growth experiment

3 EVA's, one lasting 5 hours		
BIOSATELLITE		The Biosatellite program was the first major effort by the United States to exploit Earth-orbital missions to study basic biological processes in space.
Biosatellite I	Dec/14/1966	The 13 experiments of Biosatellite I were repeated during the Biosatellite II mission, since they were not recovered when the retrorocket failed to ignite
Biosatellite II 45 hours flight	Sep/7-9/1967	13 experiments in developmental biology, plant biology and radiation effects studied on bacteria, fungus, frog eggs, beetle pupae, amoeba, fruit flies and wheat seedlings. The primary objective of the mission was to determine if the sensitivity of organisms to ionizing radiation changes under microgravity conditions.
Biosatellite III	Jun/28-Jul/7/69	Mission terminated after 9 days due to bad health of monkey, (plannned for 30 days). Study of a pig-tailed macaque monkey. The mission's objective was to investigate the effect of spaceflight on brain states, behavioral performance, cardiovascular status, fluid and electrolyte balance, and metabolic state.
APOLLO		Crew time and weight restrictions were very critical during the Apollo missions, therefore biomedical experiments requiring no or only small additional hardware items were flown.
Apollo 7 First manned Apollo flight	Oct/11-22/1968	Crew experienced upper respiratory symptoms during flight
Apollo 8 First manned circumlunar flight	Dec/21-27/1968	First report of space motion sickness, Health Stabilization Program is instituted
Apollo 9 First flight of lunar lander	Mar/3-13/1969	Viral infection postponed launch for 3 days, plans for EVA revised because of space motion sickness
Apollo 10 Lander descending to 15m above the lunar surface	May/18-26/1969	Fiberglass insulation caused skin, eye and upper respiratory irritation.
Apollo 11 First moon (lunar) landing	Jul/16-24/1969	Postflight quarantine established

Apollo 12 Second lunar landing	Nov/14-24/1969	Contact dermatitis from biosensor electrodes
Apollo 13 Mission aborted	Apr/11-17/1970	Urinary tract infection delayed launch
Apollo 14 Third lunar landing	Jan/31-Feb/9/1971	
Apollo 15 First time usage of lunar rover.	Jul/26-Aug/7/1971	Cardiac arrhythmias and extrasystoles noted during flight. Experiments investigating skeletal responses and eye functions.
Apollo 16 Fifth lunar landing.	Apr/16-27/1972	Skeletal responses to spaceflight in humans and tests investigating the function of the human eye.
Apollo 17 Sixth and last lunar landing	Dec/7-19/1972	BIOCORE, five pocket mice were flown to study HZE radiation effects; functional changes of the human eye were also studied
APOLLO-SOYUZ (ASTP)		ASTP was the first rendezvous and docking of an American and Russian spacecraft as a means of promoting international cooperation in space ventures.
ASTP First US/Russian joint mission	Jul/15-24/1975	Electrophoresis, height measurements, Achilles tendon reflex, immunology, cardiovascular adaptation, fluid shift, muscle responses, endocrinology and pulmonary functions.
ORBITING FROG OTOLITH (OFO)		The main goal of OFO program was to study the vestibular organ function in space and enable researchers to collect neurophysiological data on the response of the otolith to prolonged expose periods of microgravity. Originally the OFO program was part of the Apollo flights, but because of low acceleration levels needed for the experiments (a maximum of 3g was allowed) it was chosen to separate the programs.
OFO-A 5 days	Nov/9-15/1970	Two Bullfrogs were selected, because their otholith organ is similar to the human vestibular system. Upon entering microgravity several changes in vestibular responses of the bullfrogs were noted. All observed changes were back to normal during the last 10-20 hours of the space flight.
SKYLAB		Skylab was launched into orbit in May 1973 at an altitude of approximately 450 km. The space outpost was 28 m long and weighed 75 (metric) tons.
Skylab2 28 days, first U.S. physician in space	May/25-Jun/22/1973	During the Skylab flights similar or identical investigations flew on all three missions. These experiments investigated the dynamics of changes in fluid-electrolyte metabolism in

Skylab 3 59 days	Jul/28- Sep/25/1973	various bones and muscles, total body weight and tissue dehydration, orthostatic intolerance, physical endurance and the dynamics of postflight recovery. Factors determining the severity of space motion sickness symptoms, as well as potential predictive indicators and prophylactic countermeasures were studied.
Skylab4 84 days	Nov/16/73- Feb/4/74	
<u>COSMOS</u>		The Cosmos biosatellite program was a series of missions dedicated to biological experimentation in unmanned, Earth-orbiting satellites and was inaugurated with the launch of Cosmos 110 in 1966.
Cosmos 782 20 days	Nov/25- Dec/15/1975	Experiments investigating development, immunology and musculoskeletal and regulatory adaptations as well as radiation effects on rats, fruit flies, killifish eggs and carrot tissue.
Cosmos 936 19 days	Aug/3- 22/1977	Rats and fruit flies were flown to study effects on biological stems and effects caused by radiation. Evaluation of usage of a centrifuge as a countermeasure to microgravity.
Cosmos 1129 19 days	Sep/25- Oct/14/1979	Radiation studies and mammalian reproduction and embryogenesis in space on rats and Japanese quail
Cosmos 1514 5 days	Dec/14- 19/1983	Circadian rhythms in rhesus monkeys and morphological develop- ment of rat fetuses
Cosmos 1667 7 days	Jul/10- 17/1985	Cardiovascular and cardiopulmonary adaptation processes in primates (rhesus monkeys)
Cosmos 1887 13 days	Sep/29- Oct/12/1987	Study the effects on biological systems in rats and quantitative analysis of skeletal changes in primates
Cosmos 2044 14 days	Sep/15- 29/1989	Effects of spaceflight on circadian rhythms, temperature regulation and metabolism as well as neuromuscular adaptations in rhesus monkeys. And to repeat the rat analyses on Cosmos 1887.
Cosmos 2229 13 days	Dec/29/92- Jan/10/93	Bone, neuromuscular and vestibular physiology, circadian rhythms and metabolism, two rhesus monkeys served as experimental subjects.
<u>SPACE-SHUTTLE</u>		The Space Shuttle is the world's first reusable spacecraft and the first US vehicle having a standard sea-level atmospheric pressure and composition.
STS-1 First flight of Space Shuttle Columbia	Apr/12- 14/1981	
STS-2 First reflight of a	Nov/12- 14/1981	

(reusable) spacecraft		
STS-3	Mar/22-30/1982	Plant lignification experiment
STS-4	Jun/27-Jul/4/1982	Neurovestibular studies
STS-5 First commercial satellite deploy	Nov/11-16/1982	
STS-6 First flight of Challenger, TDRS-A deploy	Apr/4-9/1983	First Studies of orthostatic funtion during reentry shuttle EVA
STS-7 First American female in space	Jun/18-24/1983	Medical studies by physician astronaut
STS-8	Aug/30-Sep/5/1983	Extensive monitoring of fluid shifts, vestibular and neurosensory changes, rodent studies
STS-9 First Spacelab mission First non U.S. astronaut	Nov/28-Dec/8/1983	Vestibular, cardiovascular, fluid and electrolyte changes, radiation experiments, biology experiments
41-B First use of MMU	Feb/3-11/1984	Prebreathe time for EVA is shortened by reduced cabin pressure
41-C First satellite repair in space	Apr/6-13/1984	Gravitational biology studies using rodents
41-D First flight of Discovery	Aug/30-Sep/5/1984	Continous flow electrophoresis sample processing
41-G First EVA by U.S. female	Oct/5-13/1984	Cardiovascular and neurosensory studies
51-A First retrieval of 2 satellites	Nov/8-16/1984	
51-C DoD	Jan/24-27/1985	Aggregation of red blood cells experiment

51-D	Apr/12-19/1985	Echocardiography experiment, continuous flow electrophoresis sample processing
51-B Spacelab-3	Apr/29-May/6/1985	Tests of Research Animal Holding Facility for rodents and small primates, visual observations confirmed motion sickness in primates, experiments on exercise and fluid-loading as countermeasures for cardiovascular deconditioning.
51-G	Jun/17-24/1985	French echocardiography and posture experiments
51-F Spacelab-2	Jul/29-Aug/6/1985	Endocrinology and gravitational-biology studies
51-I	Aug/27-Sep/3/1985	
51-J First flight of Atlantis DoD	Oct/3-7/1985	Visual-adaptation studies
61-A Spacelab D1	Oct/30-Nov/6/1985	Vestibular sled tests, studies of fluid shifts and central venous pressure (CVP)
61-B	Nov/26-Dec/3/1985	Inoculation of bacteria experiment, internal equilibrium tests, fluid shift measurements, pharmacokinetic tests, electrophoresis processing
61-C	Jan/12-18/1986	Noninvasive measure of central venous blood pressure, fluid shift, electrolyte balance, pharmacokinetics and cardiovascular responses to maximal exercise, characterization of space motion sickness.
51-L Challenger accident	Jan/28/1986	
STS-26 TDRS-C	Sep/29-Oct/3/1988	Experiment studying aggregation of red blood cells
STS-27 DoD	Dec/12-16/1988	
STS-29 TDRS-D	Mar/13-18/1989	Chromosome and plant cell division experiments, protein crystal growth and rodent bone-healing experiments, chicken embryo development
STS-30 Magellan deployed	May/4-8/1989	
STS-28 DoD	Aug/8-13/1989	Large proton event

STS-34 Galileo	Oct/18-23/1989	First fiber-optic transmission of images back to Earth. Growth hormone concentration and distribution in plants
STS-33 DoD	Nov/22-27/1989	Non-invasive CVP measurements, baroreflex function test, muscle atrophy and echocardiography (pre-, in- and postflight)
STS-32 LDEF retrieval	Jan/9-20/1990	Exercise and muscle performance studies, LBNP tests, and respirable airborne particulates testing
STS-36 DoD Launch delayed 3 days by upper respiratory infection	Feb/28-Mar/4/1990	Preflight adaptation and fluid loading experiments
STS-31 Launch of Hubble Space Teleskope	Apr/24-29/1990	Hyperosmotic fluid countermeasure experiment, radiation monitoring
STS-41 Ulysses	Oct/6-10/1990	Orthostatic function tests during entry, landing and egress, postural equilibrium control tests during landing and egress, visual-vestibular integration studies, gravitational-biology studies using rodents
STS-38 DoD	Nov/15-20/1990	Noninvasive CVP and muscle performance studies
STS-35 Astro-1	Dec/2-10/1990	Variability in blood pressure, muscle size and lipids
STS-37 Gamma-Ray-Observatory	Apr/5-11/1991	Radiation monitoring
STS-39	Apr/28-May/6/1991	Radiation monitoring
STS-40 SLS-1	Jun/5-14/1991	First space mission dedicated to biomedical research, experiments in cardiovascular, cardiopulmonary, regulatory, neurovestibular, muscle and bone physiology in both humans and rodent subjects
STS-43 TDRS-E	Aug/2-11/1991	LBNP evaluated as countermeasure, exercise regimens evaluated for cardiovascular and musculoskeletal function
STS-48	Sep/12-18/1991	Gravitational-biology studies with rodents, radiation monitoring and studies of cosmic radiation effects
STS-44 DoD	Nov/24-Dec/1/1991	Cosmic radiation monitoring and effects studies
STS-42	Jan/22-	Spacelab Mission Basic vestibular experiments

IML-1	30/1992	
STS-45 ATLAS-1	>Mar/24- Apr/2/1992	Neurovestibular and performance studies, radiation monitoring
STS-49 First flight of Endevour Longest EVA to date (8 h 29 min)	May/7- 16/1992	
STS-50 USML-1 Spacelab Mission	Jun/25- Jul/9/1992	Tested countermeasures to deconditioning that could affect landing first EDO mission and egress activities
STS-46 TSS-1 Eureca launch	Jul/31- Aug/8/1992	Pituitary growth hormone cell function
STS-47 Spacelab-J	Sep/12- 20/1992	Experiments investigating human health, cell separation, biology, developmental biology, animal and human physiology and behavior, radiation and biological rhythms.
STS-52	Oct/22- Nov/1/1992	Canadian sponsored life sciences, and basic biomedical experiments, biotechnology studies using rodents
STS-53 DoD	Dec/2-9/1992	Cosmic radiation effects
STS-54 TDRS-F	Jan/13- 19/1993	Gravitational biology studies, evaluation of cardiovascular and musculoskeletal deconditioning on rodents
STS-56 ATLAS-2 Spartan 201	Apr/8- 17/1993	Physiological and anatomical studies on rodents, tissue loss and radiation effects
STS-55 Spacelab D-2	Apr/26- May/6/1993	Life sciences experiments conducted in the fields of hormonal regulatory, cardiovascular and cardiopulmonary adaptation, and gravitational biology as well as cell fusion under microgravity.
STS-57 Spacehab-1 Eureca retrieval	Jun/21- Jul/1/1993	Studies of body posture in microgravity
STS-51	Sep/12- 22/1993	Plant cell division, radiation monitoring
STS-58 SLS-2	Oct/18- Nov/1/1993	Second Spacelab mission dedicated to life sciences. Experiments investigating cardiovascular, cardiopulmonary, regulatory, neurovestibular and musculoskeletal systems.
STS-61 First Hubble repair	Dec/2- 12/1993	

mission		
STS-60 Spacehab-2 WSF-1	Feb/3- 11/1994	Biological and immune response studies.
STS-62 USMP	Mar/4- 18/1994	Cell culture growth, biotechnology experiments
STS-59 SRL-1	Apr/9- 20/1994	
STS-65 IML-2	Jul/8-23/1994	Gravisenory test of aquatic animals, rotating centrifuge (hypogravity experiments), spinal changes in humans and LBNP
STS-64 Spartan 201	Sep/9- 20/1994	
STS-68 SRL-2	Sep/30- Oct/11/1994	Radiation monitoring, physiological processes in insects such as spiders, centipedes and crustaceans
STS-66 ATLAS-3	Nov/3- 14/1994	
STS-63 Spacehab-3 Spartan 204	Feb/3- 11/1995	Plant studies rendezvous Shuttle/Mir
STS-67 Astro-2	Mar/2- 18/1995	
STS-71 First Shuttle/Mir docking 100 th human U.S. space flight	Jun/27- Jul/7/995	Investigations concerning the cardiovascular and pulmonary systems, neurosensory research, behavior and performance after long duration space flight, fundamental biology research. STS-71 "picked-up" Norm Thagard after his 4 month stay onboard the Russian space station Mir (Mir 18 mission)
STS-70 TDRS-G	Jul/13- 21/1995	Radiation monitoring, effects of microgravity on embryogenisis of rats and Medaka embryos, plant growth and development
STS-69 WSF-2 Spartan 201	Sep/7- 18/1995	Bone loss, gravisensity of mammalian cells
STS-73 USML-2	Oct/20- Nov/5/1995	Starch accumulation in potato plants
STS-74 Second Shuttle/Mir docking	Nov/12- 20/1995	Testing of biomedical hardware for space station

STS-72 SFU retrieval	Jan/11-20/1996	Micromolecular tissue samples, effects of microgravity on rodent development and metabolsim
STS-75 TSS-2 USMP	Feb/22-Mar/9/1996	
STS-76 Spacehab Third Shuttle/Mir	Mar/22-31/1996	Bone density, T-lymphocytes, HZE radiation monitoring Mir docking
STS-77 Spacehab-4 Spartan	May/19-29/1996	Immune system of rat, production of pharmaceutical relevant substances in plants and effects of space flight on anthopod and plant species
STS-78 LMS - Life and Microgravity	Jun/20-Jul/7/1996	Muskuloskeletal experiments, research in metabolic, pulmonary and neuroscientific areas, as well as investigations concerning human behavior and performance in space. Also biology experiments investigating bone loss in rats and lignin formation in plants.

Thanks to Simone Thomas of the Mission Science Office for construction of this timeline!

Curator: Jacque Havelka & Julie Heath
NASA Official: Katherine Newkirk
Last Updated: 31 August 1997