



Note

The following charts are the posters displayed in JSC Building 21 Biomedical Research and Environmental Sciences Division (SK) during the HHPC2 Industry Day Tour of April 2, 2024. These are representative but not an exhaustive set—some labs/facilities are not represented herein.



Biomedical & Environmental Analytical (12): South Wing

- Animal Care Facility
- Behavioral Health & Performance
- Clinical
- Core
- Environmental Chemistry
- Immunology & Virology
- Microbiology
- Nutritional Biochemistry
- Pharmacotherapeutics
- Radiation Biology
- Space Cell Biology
- Toxicology & Risk Assessment Group



Human Performance (6) : North Wing

- Anthropometry, Injury & Biomechanics
- Bone & Mineral
- Cardiovascular & Vision
- Environmental Physiology
- Exercise Physiology
- Neuroscience



Projects & Services : Anchor Wing

- Administrative Management
- Biostatistics Capabilities
- Exploration Science Integration
- Integrated Products Management

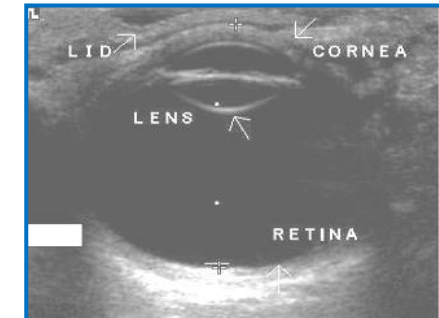
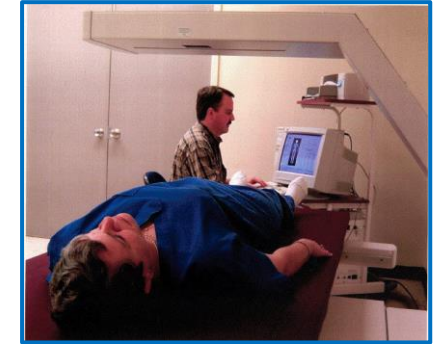
Infrastructure

- Machine Shop & Laboratory Support Services (LSS)



Direct support to Space Medicine Operations

- Flight Related Activities
 - Medical testing for preflight certification and recovery/rehabilitation on astronauts
 - Support **operational inflight exercise countermeasures** and contingencies
 - Support **inflight environmental monitoring** and contingencies
 - Provide analytical laboratory capabilities used to support key ISS and JSC decision making on crew health and environments
 - Direct interfaces with the Crew Surgeons and Astronaut Strength Conditioning Rehabilitation (ASCR) staff for crew training and rehabilitation
 - **Requirements and standards** for human systems
- Flight Medicine and Occupational Health Clinic Support
 - Astronaut medical tests for annual Physical Exam
 - AsCan medical screening and anthropometry
 - Center environmental health monitoring
 - Monitor the spacecraft to assure a safe flight environment



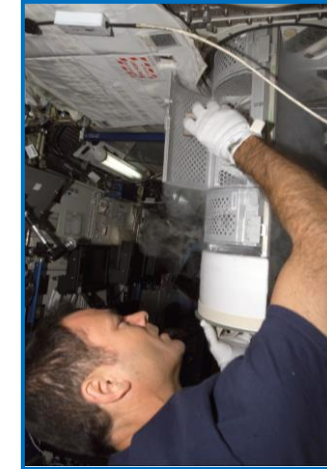
Preflight space vehicle assessments (e.g., food & air quality)

- Confirm flight readiness (e.g., toxicology, microbiology) with JSC analytical capabilities
- Technical experts and laboratory support of ECLSS system development and operations by environmental laboratories
- Ensures that environmental standards, crew health, and safety are achieved onboard space vehicles, and provides critical analytical data for Program decisions

BIOMEDICAL RESEARCH AND CREW TRAINING



- ❖ Scientists, engineers, and physicians conduct **peer-reviewed applied biomedical research** to characterize the normal human response to spaceflight
 - International Space Station
 - Spaceflight Analog Environments (ie, Bed Rest, Desert Research and Technology Studies (RATS), Polar, NEEMO, Chambers, etc.)
 - **Host eminent scientists** involved with ISS biomedical research
- ❖ Develop, test, and deliver
 - Biomedical **countermeasures and prescriptions** to mitigate the affect of spaceflight on crew health, safety, and performance
 - **Environmental monitoring** technologies and strategies to minimize impact of the environment on the crew for all mission types and durations (e.g., lunar dust, microorganisms, etc)
 - Assessing design and human performance for advanced space suits
- ❖ Conduct Astronaut Training
 - Astronaut Candidate Training (AsCAN)
 - Biomedical Basics
 - Generic Rodent Training
 - Specific Payload Training
- ❖ Partnerships
 - Industry, Academia and Other Government Agencies



Animal Care Facility



□ Tools

- Multi Species Animal Cage System with Integrated Vented Exhaust
- Surgical/medical intensive care recovery cage rack with integrated heater
- Animal Cage Washer
- Biosafety Cabinets
- Change Stations
- Gas Anesthesia Machine
- Mock-up of ISS Glove Box

□ Description and Purpose

- Oversees the care of all laboratory animals at JSC
- Provides housing and caring for animals used in ground-based life sciences experiments
- Provides consulting and guidance for animal model development for a variety of human health risks in spaceflight
- Provides and cares for animals used for training astronauts for in-flight animal experiments and animal handling
- Provides animal handling training for other scientists
- Provide facilities for animal projects outside JSC
- Maintained in accordance with the American Association for the Accreditation of Laboratory Animal Care (AAALAC) certification requirements
- Supported by an animal technician and a veterinarian

Cardiovascular & Vision Laboratory



Tools

- 2D/3D Ultrasound Systems (including portable)
- Continuous Transcranial Doppler
- Fundoscopy
- Developmental and Analytical Software (eg, MATLAB, PROSOLV, Prism, Lab Chart)
- Continuous and Oscillometric Blood Pressure Monitors
- Optical Coherence Tomography (OCT)
- Tympanic Membrane Displacement
- Otoacoustic Emissions
- Ocular Tonometry
- Near Infrared Spectroscopy
- Rapid Cuff Inflators and Tilt Tables
- Electrocardiogram / Holter Monitoring
- Transcutaneous Carbon Dioxide Sensors
- Electroretinography

Description and Purpose

- Supports testing in the selection of new astronaut candidates, as well provide clinical support to the space medicine clinic
- Investigates, evaluates or develops countermeasures for:
 - Multi-system
 - Neuroendocrine and Cardiovascular assessment of orthostatic intolerance, including baroreflex and heart rate variability measures
 - Ocular changes related to headward fluid shifts. Tilt table testing to assess both footward and headward fluid shifts, including design and validation of countermeasures.
- Develops requirements for commercial crew providers regarding orthostatic protection
- Provides comprehensive ultrasound capabilities for cardiac, vascular and ocular measures of structure and function, including flow mediated dilation
- Assesses ocular health, including intraocular pressure, in-depth imaging of the posterior globe with spectral domain OCT, including enhanced depth imaging
- Develops and evaluates hardware and software for medical and research
- Evaluates potential countermeasures using:
 - Artificial Gravity; Lower Body Negative Pressure (LBNP)
 - Gradient Compression Garments; Thigh Cuffs
 - Fluid Loading
 - Pharmaceuticals
- Supported by physiologists, biomedical engineers, ultrasound scientists and other clinical professionals



Environmental Chemistry Laboratory



Tools

- Gas Chromatograph / Mass spectrometers (GC-MS)
- Fourier Transform Infrared Spectrometer (FTIR)
- Total Organic Carbon Analyzers (TOC)
- Trace Gas Analyzers (TGA)
- GC-Flame Ionization Detector (GC-FID)
- GC-Thermal Conductivity Detector (GC-TCD)
- Ion Chromatography (IC)
- Liquid Chromatography - MS (LC-MS)
- High Performance Liquid Chromatography (HPLC)
- Inductively Coupled Plasma-Mass Spectrometer (ICP/MS)
- Spectrophotometers
- Force Tensiometer
- Purpose-built test stands for specialized projects

Description and Purpose

- Performs analysis of archival air, water, and wastewater samples returned from human spaceflight missions
- Provides JSC and facility support by performing analysis of bulk gases for JSC Occupational Health and other ground-based projects
- Provides operational support for Environmental Control and Life Support Systems (ECLSS) by analyzing samples from ground testing and providing technical inputs
- Provides verification of the quality of water used for processing and testing of Extravehicular Mobility Units (EMUs)
- Performs pre-flight processing, preparation, testing, and calibration of environmental monitoring hardware for Crew Health Care Systems (CHeCS)
- Develops and tests advanced technologies for measuring pollutants in spacecraft atmospheres
- Provides ISS operational support by interpreting data and trend analyses from monitoring hardware
- Develops and assesses environmental sampling and monitoring strategies
- Monitors, samples, assesses and develops standards for air and water quality
- Works with outside groups, both internal and external to JSC, to provide analytical expertise and experience with utilizing small sample volumes
- Supported by chemists and engineers



□ Description and Purpose

- Performs flight and ground-based research studies to evaluate human performance and injury risk while working in EVA suits
- Performs research studies to understand the risk of decompression sickness (DCS) and to develop pre-breathe protocols to mitigate the risk of DCS during spaceflight and for future Exploration missions
- Performs flight and ground-based research to understand physiological impacts of environmental factors (e.g., thermal, CO₂ exposure, etc.) in suits
- Supports physiologic testing during EVA simulations at the Neutral Buoyancy Laboratory and Active Response Gravity Offloading System (ARGOS)
- Provides EVA and environmental physiology subject matter expertise to programs, integrated product teams, commercial vendor insight teams, and reviews programmatic and commercial vendor requirements
- Develops EVA simulation technologies including XR/VR EVA simulations and supports research implementation of EVA simulations
- Develops technologies to support future autonomous EVAs including predictive modeling of crew physiological state during EVA
- Conducts prebreathe protocol training for astronauts prior to flight
- Collects metabolic data during EVA training at the Neutral Buoyancy Lab (per MEDB 6.1)
- Analyzes metabolic data rates for use by mission flight surgeons during EVAs to predict consumable usage
- Conducts/supports analog field tests to evaluate EVA operational concepts for future Exploration missions
- Supported by physiologists, physicians, biomedical engineers, and data scientists

□ Tools

- Metabolic Analyzers
- Heart rate monitoring
- VR/XR EVA Simulators
- Hybrid spacesuit simulator
- Ultrasound
- In-suit CO₂ quantification



□ Tools

- Treadmills
- Cycle Ergometers
- Rowing Devices
- Metabolic Gas Analyzers
- Force Plates
- Resistance Exercise Devices and Dynamometers
- Exploration exercise devices

□ Description and Purpose

- Supports astronaut medical assessment testing requirements pertaining to musculoskeletal and aerobic fitness (e.g., MEDB 5.3 Isokinetic Testing and MEDB 4.1 Cycle Ergometer Test/Aerobic Functional Capacity)
- Monitors, evaluates, and validates exercise countermeasures hardware, test protocols, and conditioning programs for the maintenance of crew health and performance during ISS and future exploration missions
- Provides agency wide subject matter expertise on exercise physiology and programmatic exercise and fitness requirements
- Develops and conducts research studies to better understand the effects of microgravity on human physiology and performance both during and after spaceflight and ground-based analogs to mitigate human health risks of reduced muscle strength and aerobic capacity resulting from long duration spaceflight
- Develops and performs operational medical requirements testing and establish operational physiological guidelines
- Performs physical fitness testing (including measurement of aerobic capacity, muscle strength, power, and endurance), evaluation of biomechanics of exercise
- Develops requirements for and evaluate in-flight exercise hardware
- Evaluates and validates prototype/candidate exercise devices, procedures, protocols, and conditioning programs
- Develops new technologies to support exploration exercise and autonomous operations
- Develops and evaluates biomechanical models of terrestrial and in-flight exercise
- Supported by scientists who maintain certifications for Advanced Cardiac Life Support and Certified Strength and Conditioning Specialists



- **Tools**
 - Biosafety Cabinets
 - Microscopes for various tasks
 - Incubators
 - Nucleic Acid Sequencing
 - Nucleic Acid Amplification Platforms
 - Nucleic Acid quantification and quality analysis platforms
 - Microplate readers
 - Automated Microbial Analysis Systems
- **Description and Purpose**
 - Designs and builds spaceflight hardware through both Class 1 and Class 1-E processes
 - Designs, tests, and evaluates microbial monitoring hardware
 - Develops microbial contamination control standards
 - Researches microbial responses to microgravity
 - Performs microbial sampling, measurement and characterization of air, potable water, food, surfaces and hardware (space and ground)
 - Performs microbial risk assessments to prevent infectious disease
 - Proficient in utilizing and maintaining hardware for varying microbial types (bacteria, fungi, viruses) and tissue culture
 - Performs diverse molecular biology quantification, identification and analysis for bacterial, fungal, and viral RNA expression (transcriptomics)
 - Performs crew microbiome next-generation sequencing and bioinformatics analyses
 - Performs nucleic acid extractions in support of crew DNA and RNA sequencing analysis
- Certified as a Biosafety Level (BSL) 2 facility
- Supported by microbiologists, molecular biologists, and registered biosafety professionals

Neuroscience Laboratory



□ Tools

- Posture Platform
- Motion Control/Perturbation Systems, including:
 - 6 Degrees of Freedom (DoF) Motion Platform Systems
 - Augmented Reality Headsets
 - Rotators
 - Galvanic-Vestibular Stimulation (GVS)
- Operational Task Simulators
- Gravity Bed (horizontal sled with air-bearings)
- Data Acquisition and Experiment Control H/W
- Data Collection Systems / Transducers, including:
 - Video-based Motion Capture System
 - Vestibular-evoked Myogenic Potential
 - Eye Movement Recording Systems
 - Inertial Measurement Units
 - Force Plates

□ Description and Purpose

- Supports ground-based and in-flight investigations, crew health monitoring via neurovestibular platform tests (MEDB 1.5), risk mitigation operational activities, and countermeasure development and evaluation research
- Investigates the effects of spaceflight on sensorimotor/vestibular function, with emphases on:
 - Postural and Locomotor Control and Functional Performance
 - Eye-Head-Hand Coordination and Manual Control
 - Perception, Orientation, and Space Motion Sickness
- Develops countermeasures to mitigate the risks of spaceflight-induced sensorimotor/vestibular adaptations impacting the performance of mission critical tasks during manual vehicle control, emergency vehicle egress, or extravehicular activities
 - Studies head-trunk movement coordination as it relates to vestibular adaptation
 - Evaluates balance control
 - Records and analyzes oculomotor control and vestibular-ocular reflexes
 - Performs clinical and research vestibular testing
 - Develops and evaluates flight hardware
 - Develops and implements operational medical assessment tests and physiological guidelines
- Supported by neuroscientists and biomedical engineers

Nutritional Biochemistry Laboratory



Tools

- Triple Quadrupole Tandem Mass Spectrometer (LC-MS/MS) systems
- High Performance Liquid Chromatography, including coulometric analysis
- Gamma Radiation Counter
- Nitrogen Analyzer
- Automated Biochemical Analyzers
- Inductively Coupled Plasma Mass Spectrometer
- Nutrient Database for Research (NDS-R) for dietary intake assessment
- Custom designed Laboratory Information Management System

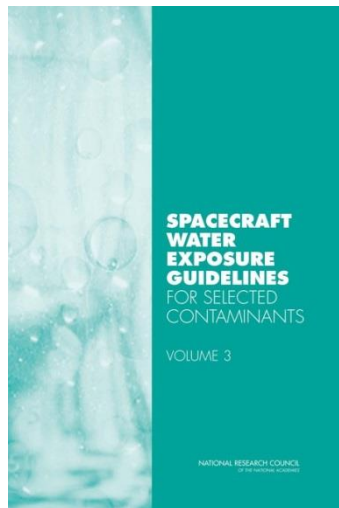
Description and Purpose

- Performs Clinical Nutritional Assessment medical requirement (MEDB 8.1), which is completed for all ISS flights and includes pre- and post flight biochemical assessments and dietary intake and body mass monitoring during the mission
- Trains crewmembers on the completion of preflight questionnaires and inflight iPad Apps for tracking dietary intake. Recorded food intake data are downlinked weekly from ISS, and analysis using NDS-R software allows for determination and reporting of nutrient intake while crewmembers are on-orbit
- Completes biochemical testing for determination of nutritional status (e.g., protein, vitamin, mineral, hematology, lipid, and antioxidant assessments, renal stone risk) before and after flight
- Provides dietary counseling per referral from the JSC Flight Medicine Clinic
- Updates nutrition databases used for analysis of flight foods and the food system(s)
- Develops, evaluates, and validates nutritional countermeasures to prevent or minimize the negative effects of long-duration spaceflight on human physiology and to better understand the role of nutrition in astronaut health
- Performs nutrition and related physiology research, including:
 - One-carbon pathway genetics and biochemistry as related to vision/SANS
 - CHAPEA Mars Simulations
 - Establishing and monitoring nutritional requirements for astronauts
 - Assessment of bone metabolism and renal stone risk
 - Collaborations with intra- and extramural and international scientists on a wide breadth of studies, including bed rest and Antarctic winter over
- Supported by biochemists, analytical chemists, scientists, research and clinical dietitians

Toxicology and Risk Assessment



Spacecraft Maximum
Allowable Concentrations
for Selected Airborne
Contaminants
Volume 5



■ Description and Purpose

- Develops and maintains Spacecraft Maximum Allowable Concentrations (SMACs) and Spacecraft Water Exposure Guidelines (SWEGs) for ISS, Commercial Crew and Exploration Programs
- Provides hazard assessment of chemical and biological substances used in vehicle and payload systems/hardware to inform appropriate design and containment
- Supports operational decision-making regarding air and water quality as related to crew health
- Assesses in-flight monitoring data in the context of crew exposure and health
- Establishes requirements for measuring pollutants in spacecraft atmospheres
- Assesses environmental sampling and monitoring strategies
- Performs and/or commissions toxicology research
- Supported by toxicologists, microbiologists, material scientists, and environmental life support engineers

■ Tools

- eHMST

