National Space Biomedical Research Institute

REVISED
STRATEGIC PLAN

July 17, 2003

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Table of Contents

Introduction

The National Space Biomedical Research Institute (NSBRI) Strategic Plan is bold, forward-looking, and science-driven. It contains integrated and interconnected programs and education programs in Countermeasures Development Research and Education, Training, and Public Outreach. In partnership with NASA, the Institute's programs and goals provide unprecedented capabilities for focused, outcomes-driven research that leads to the development of effective countermeasures to mitigate the adverse effects of the space environment on crews and to ensure safe, long-duration human space flight.

The NSBRI/NASA partnership unites the expertise and resources of the broad biomedical research community with NASA's engineering and operational capabilities. The programs emphasize the importance of integrated research teams and encourage productivity and diversity at all levels. The Institute's mission is consistent with NASA's Bioastronautics Strategy, namely managing risk, increasing efficiency, and returning benefits to Earth. The Institute supports the Agency's mission-driven and enabling goals, especially, "to extend the duration and boundaries of human space flight to create new opportunities for exploration and discovery" and assists NASA in fulfilling its overall vision "to improve life here, to extend life to there, to find life beyond."

Mission

The mission of the National Space Biomedical Research Institute is to lead a national effort for accomplishing the integrated, critical path, biomedical research necessary to support long-term human presence, development, and exploration of space and to enhance life on Earth by applying the resultant advances in human knowledge and technology acquired through living and working in space.

Vision

The vision of NSBRI is to conduct world-class space biomedical research using innovative science, technology, and management strategies. The Institute, in partnership with NASA, will develop effective countermeasures that substantially reduce significant biomedical risks associated with human space travel. These discoveries will ensure crew health and well-being by mitigating the adverse effects of the space and microgravity environment. They will also improve life on Earth. The Institute will engage a diverse, open community of outstanding scientists, engineers, and clinicians to work on peer-reviewed projects in integrated research teams using the resources of leading institutions to achieve the Institute's mission and inspire the next generation of space life scientists. The Institute will be the focal point of, and major resource for, NASA-sponsored space biomedical research.

Operational Concept and History

NSBRI is a unique, non-profit scientific partnership established in 1997 following competitive selection by NASA. Since its inception, and in collaboration with the Johnson Space Center (JSC) through a Cooperative Agreement, NSBRI has initiated and cultivated its leadership role in space biomedical research through novel strategies to meet its mission, goals, and objectives as set forth by NASA.

The Institute engages, facilitates, and coordinates outstanding academic, government, and industry researchers and educators in a team-based effort to develop countermeasures to reduce and/or eliminate health risks associated with human space travel. It also leverages the resources of the nation's leading biomedical research institutions and industry, allowing the combined intellectual and infrastructural capabilities to advance NASA's biomedical research program in an unprecedented manner. NSBRI is well positioned to efficiently and effectively conduct ground and critical in-flight studies of high relevance and impact for NASA, with tangible benefits for people on Earth. The Institute's operational concept is represented in Figure 1.

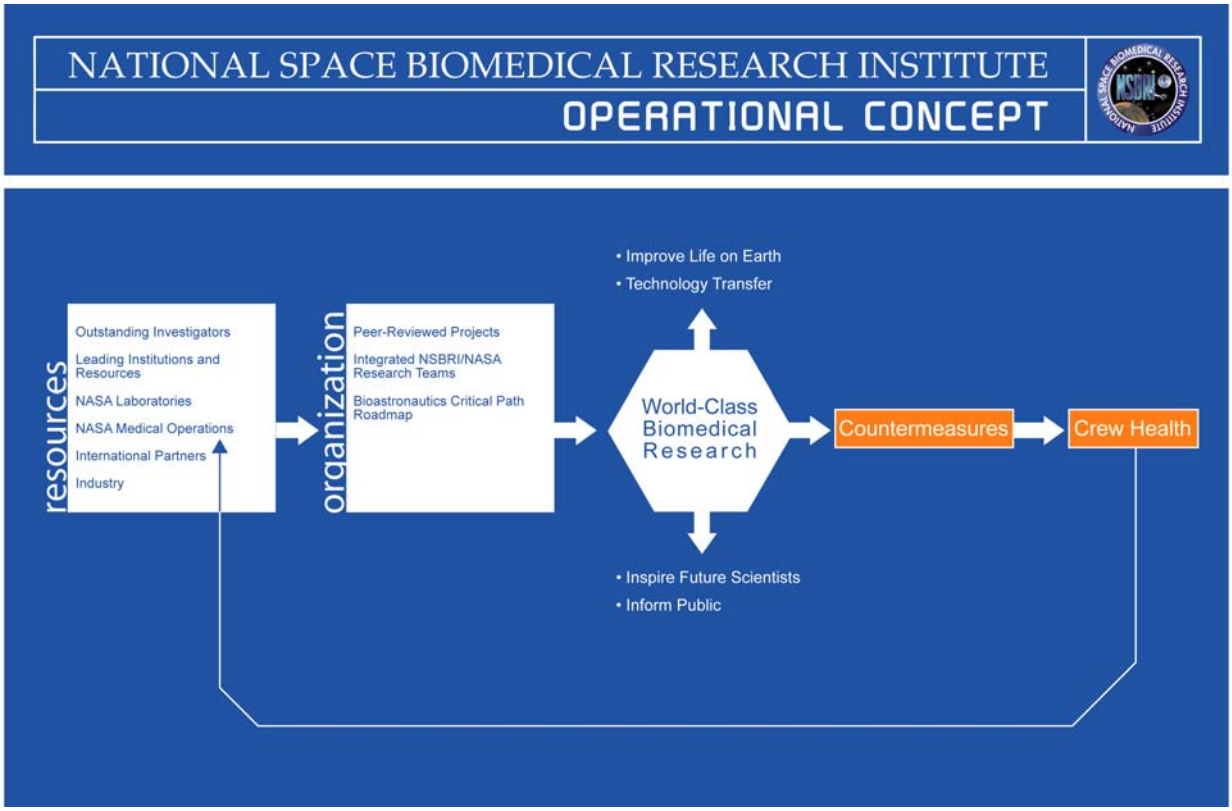
NSBRI was selected by NASA following a two-phase, competitive review of proposals received in response to the NASA Cooperative Agreement Notice 9-CAN-96-01. Seven academic institutions (Baylor College of Medicine, Harvard Medical School, The Johns Hopkins University School of Medicine and Applied Physics Laboratory, Massachusetts Institute of Technology, Morehouse School of Medicine, Rice University, and Texas A&M University) made up the initial Consortium governing the NSBRI. Baylor College of Medicine is the lead institution and houses the NSBRI headquarters.

In 1999, NASA approved an NSBRI augmentation plan. This plan was later incorporated in the Bioastronautics initiative established in the 2001 Presidential budget. The augmentation plan enabled the Institute to:

- Strengthen the original integrated research teams by increasing the number of tasks/teams.
- Identify and initiate new discipline research teams, including an increased focus on crew health.
- Open participation to the entire academic community.
- Accelerate countermeasure research in order to facilitate space flight studies.
- Increase emphasis on the Bioastronautics Critical Path Roadmap.
- Expand the education and public outreach program, consistent with Institute growth.
- Develop graduate and postdoctoral training programs.
- Increase emphasis on space biomedical data collection, evaluation, and consolidation.
- Grow Consortium membership through open competition.

The Consortium membership was expanded in 2000 from seven to 12 institutions following a competitive review process. Brookhaven National Laboratory, Mount Sinai School of Medicine, University of Arkansas for Medical Sciences, University of Pennsylvania Health System, and University of Washington were added to the Consortium.

Figure 1
National Space Biomedical Research Institute
Operational Concept



In November 2000, NASA's Chief Scientist appointed a site visit committee to conduct a comprehensive review of NSBRI's activities and progress in accordance with the Cooperative Agreement. The site visit Review Committee stated in their report:

> "The committee was impressed by the scientific strengths of the NSBRI, by its progress in developing countermeasures, by its innovative scientific leadership and by its outstanding student trainees. We recommend that NSBRI continue for its second five-year funding period. We commend NSBRI for providing added value both for the Institute as a whole and for individual teams."

The Institute's Strategic Plan requested by the site visit Review Committee was submitted to NASA and reviewed in 2002. The Strategic Plan Review Committee noted:

> "In the first five years of its existence, the Institute has made outstanding progress. It has:

- Developed a comprehensive research strategy that addresses key medical, physiological and technical issues associated with space travel;
- Recruited distinguished investigators from across the nation; and
- Established links to the key NASA end users, including astronauts, flight surgeons, engineers, other federal agencies, industry, and international partners."

The Committee also noted:

> "The benefits of the NSBRI Program to NASA and to health care on earth are potentially very significant. NASA must therefore commit to adequate and stable funding for the Institute to be able to develop effective countermeasures to enhance safety of prolonged and recurrent space travel."

NASA/NSBRI Critical Issues and Strategies in Bioastronautics

The Institute is an integral constituent of NASA's Bioastronautics effort, which is sponsored by the Office of Space Flight, the Office of Biological and Physical Research, and the Office of the Chief Health and Medical Officer. The Bioastronautics mission statement, as stated in the Bioastronautics Strategy, defines the human as a critical subsystem of space flight. The strategy endorses a risk-based approach that "allows for understanding and controlling the human health and performance risks, identifies specific outcomes, enables informed decision-making, and provides the Agency with highly developed risk management solutions to meet its enabling and mission-driven goals and objectives." (Bioastronautics Strategy, p. 4) NSBRI significantly contributes to the implementation of the 11 Bioastronautics strategies.

Aims and Objectives

The Institute's aims and objectives are to:

- Integrate the knowledge base relevant to the biomedical response of humans in space, understand and quantify the risk levels associated with this knowledge base, and recommend acceptable risk levels for long-duration missions. Risk levels in this context relate to present and future medical risk to the human participants as a result of deleterious effects of space flight, as well as to the subsequent risk to overall mission success.
- Develop and manage the implementation of an integrated research plan that will develop the required knowledge and technologies (across all biomedical and associated technological disciplines) to enable long-duration human space flight, including specific countermeasures where required.
- Implement a "best value" research program for the available resources.

- Demonstrate an understanding of the space medicine environment through an integrated on-site presence at JSC; feed back this knowledge to the discipline research teams.
- Facilitate science community access to the NASA space infrastructure associated with biomedical research.
- Develop and provide a science management process that will support the overall human in space biomedical research program.
- Ensure the dissemination of advances in knowledge resulting from this program to the scientific community.
- Promote and provide active collaboration with for-profit entities to ensure that developed technologies are transferred to the private sector.
- Conduct education and public outreach programs consistent with NSBRI's Mission and in support of NASA's education and public outreach objectives.

Programs and Goals

To fulfill its mission, vision, aims, and objectives, NSBRI has integrated and interconnected research and education programs that add unique value and complement NASA's Bioastronautics Strategy. These programs are in **Countermeasures Development Research,** and **Education, Training, and Public Outreach**.

Countermeasures Development Research Program

The goals of the program are:

- Lead a national peer-reviewed, integrated research effort to develop and test countermeasures that reduce biomedical risks of long-duration human space flight, and enable safe and productive missions and exploration of space.
- Provide directed medical and research capabilities that:
  - Support the transition to countermeasure validation and implementation, and the development of the Clinical Status Evaluation.
  - Create mechanisms for integrating and sharing knowledge and technologies.
  - Support an NSBRI/NASA translational workforce.
  - Establish strategic relationships and partnerships.
- Improve healthcare on earth and translate discoveries for possible commercialization.

NSBRI research teams are developed and modified to provide a continuum of countermeasure research in the countermeasure readiness level (CRL 3-7 range that eventually leads to valid operational countermeasures that ensure crew health, safety, and performance. The teams complement and integrate with other NASA components of the Bioastronautics Program. To optimize the effectiveness, the Institute plans to develop cross-cutting efforts in radiation efforts, space medicine, technology and modeling. In addition, going forward, NSBRI research will advance to higher CRLs .

NSBRI Role in Bioastronautics

The development of countermeasures by NSBRI/NASA emanates from ideas and concepts that emerge from basic research and are then developed into research protocols and operational solutions (Figure 2). The process begins with the identification of the biomedical issues, risks, and priorities established through the CPR and progresses through a sequence of Countermeasure Readiness Levels (CRL). This includes basic and applied research to test and validate hypotheses (CRL 1-3), formulation of countermeasure concepts and initial demonstrations of efficacy (CRL 4-5), clinical trials and testing (CRL 6-7), and finally, validation and operational implementation (CRL 8-9). The CPR consists of 55 risks and the critical research questions/issues associated with each of the risks.

NSBRI countermeasures research focuses on CRL 3-7. To optimize its impact for NASA and generate outstanding deliverables for Bioastronautics risk management, NSBRI countermeasure research is coordinated and integrated with efforts in NASA medical operations and other components of the Bioastronautics program. The continuum from hypothesis-driven research, through the NSBRI and other NASA programs, to medical operations, forms the basis of an outcome and metrics-based model for risk assessment, risk reduction, and health care delivery. The Institute plays an important role in enabling and strengthening the Bioastronautics program to meet its risk management objectives.

Figure 2. Bioastronautics Countermeasure Development Process*

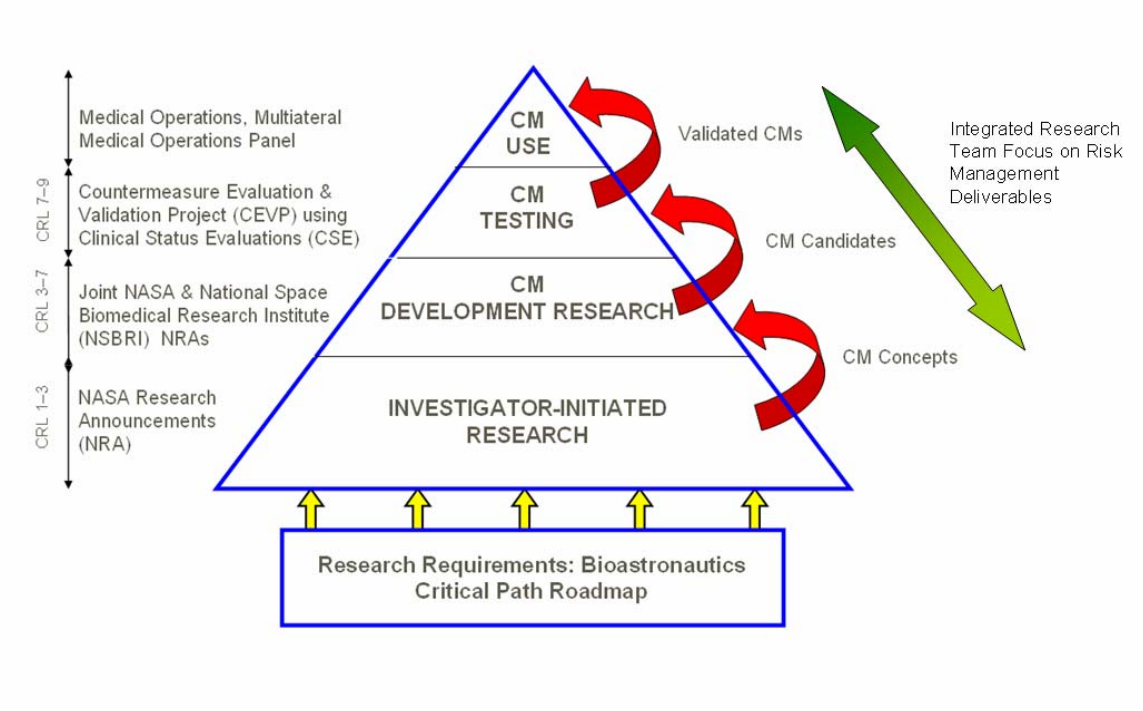


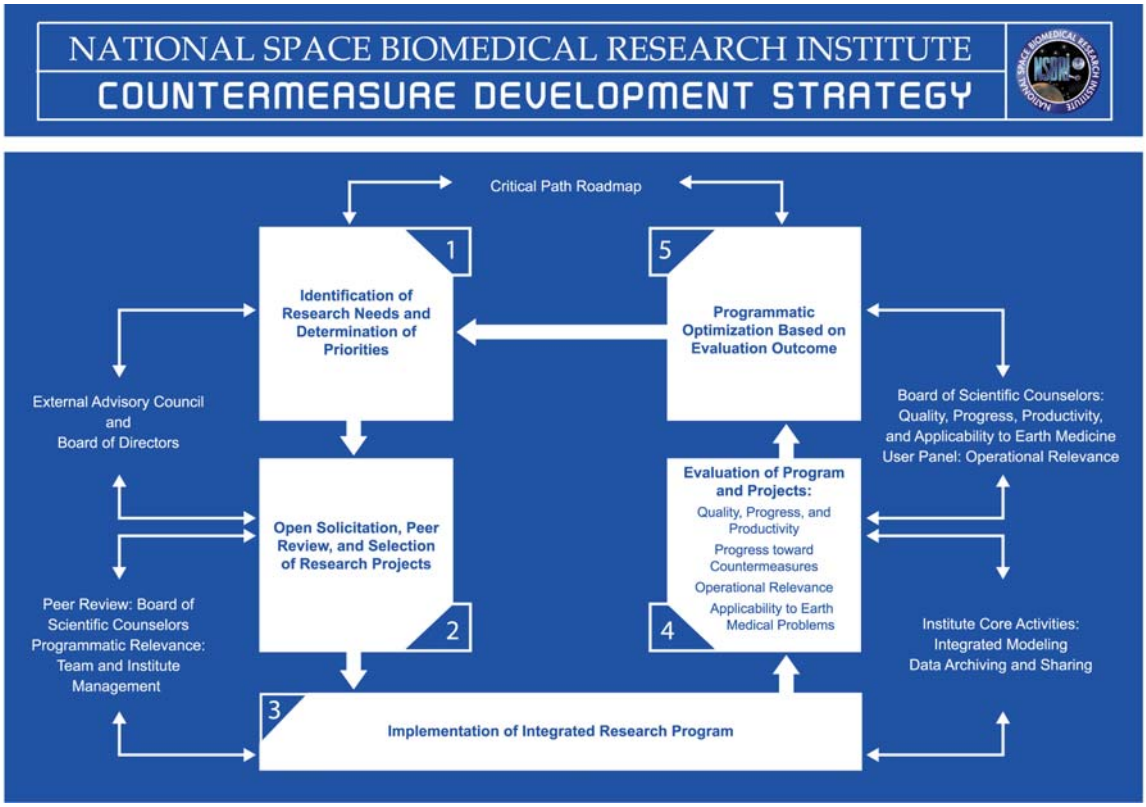
***Chart from the Bioastronautics Strategy, p. 5**

NSBRI countermeasure development strategy involves five distinct, but related, steps in developing and managing its focused, integrated research program. These steps are based on the CPR and culminate in operational countermeasures. The strategies are:

- Identification of research needs and determination of priorities.
- Open solicitation, peer-review, and selection of research projects.
- Integrated research program.
- Evaluation of program and projects.
- Optimization of program based on evaluation outcome.

The Institute carries out these steps, as depicted in Figure 3, using an integrated, team-based research infrastructure. The approach has demonstrated effectiveness by enabling higher and higher levels of countermeasure readiness to be achieved in each of the high-priority research areas and by drawing outstanding new investigators to space-related problems. The strategy is coordinated with NASA at each step at multiple levels of NSBRI/NASA research and management. The strategic efforts in risk reduction are the responsibility of the NSBRI/NASA Steering Committee, comprised of senior NSBRI and JSC Space and Life Sciences personnel.

Figure 3.
Countermeasure Development Strategy



Research Priorities and Teams

The identification of research needs and determination of priorities are based on the CPR. NSBRI works interactively with JSC to ensure that its integrated research teams effectively complement NASA's research and operational efforts in CPR risk mitigation.

Currently, NSBRI's Countermeasures Development Research Program consists of eleven integrated discipline research teams: **Bone Loss; Cardiovascular Alterations; Human Performance Factors, Sleep and Chronobiology; Immunology, Infection and Hematology; Muscle Alterations and Atrophy; Neurobehavioral and Psychosocial Factors; Neurovestibular Adaptation; Nutrition, Physical Fitness and Rehabilitation; Radiation Effects; Smart Medical Systems; and Technology Development**. Each team has a strategic plan that summarizes the steps a team takes to develop specific countermeasures and technologies to manage biomedical risks. (See Table 1 of Appendix IV.) The plans

- Map specific risks on the CPR that a team addresses.
- List the risk-based and non-risk-based goals.
- Identify strengths, weaknesses, and gaps in the current team's program; and, set forth objectives and strategic activities for each goal.
- Provide the schedule and milestones for task completion given available resources..
- Describe the ways teams interact with other NSBRI teams and NASA to move concepts and deliverables through the countermeasure development process (Figure 2).

Two of these teams, radiation effects and technology development as well as space medicine, bioinformatics and modeling are cross cutting teams. These groups are a part of each of the integrated teams bridging each area to address the issues of the entire human system.

Project Selection

The Institute solicits ground-based research projects from the entire biomedical research community annually through open solicitations that are coordinated with, and approved by, NASA. The solicitations emphasize research areas that address gaps and issues identified in the **Team Strategic Plans**, and reflect high-priority critical questions in the CPR. Independent, peer-review panels of scientists with relevant expertise evaluate the proposals. These panels are selected by the same outside entity that NASA uses for its NASA Research Announcement (NRA) program. NSBRI selects an independent **Board of Scientific Counselors** (BSC) who are assigned to these panels according to their expertise. BSC members serve for several years in order to provide a corporate memory to the review process.

During peer review, proposals are scored for merit and evaluated for relevancy to the appropriate Team Strategic Plan and research solicitation topics. Proposals scoring within the competitive range are presented to the Institute's **External Advisory Council** (EAC) for discussion. Specific recommendations concerning the proposals, and their added value to the research teams and the entire program are made to NSBRI senior management (**Director** and **Associate Director**). Senior management is responsible for

selection, which is done in coordination with JSC and NASA Headquarters to maximize the overall benefit of the Institute to NASA's Bioastronautics program.

Flight NRAs for Bioastronautics are coordinated with JSC, NASA Headquarters and NSBRI and are selected in a standard process involving multiple steps, including definition and feasibility assessments.

Integrated Research Approach

Each integrated research team carries out a focused research program containing individual projects tied tightly together by a Team Strategic Plan. Team members, including Team Leaders, are geographically dispersed, remain at their own institutions, and are not grouped at one site. Investigators are invited to become team members after their grant application is selected for NSBRI funding. It is the responsibility of the Team Leader to work with team members, senior management, and NASA to shape an effective team and add value across projects for the purpose of focusing countermeasure research and managing risk in accord with the CPR. Team Leaders play a pivotal role in the Institute's success.

All teams actively communicate among project investigators, foster synergy in experimental activities, share samples, interact with NASA scientists, technical experts, and flight surgeons, and participate in the Institute's Bioinformatics Initiative. (See Table 2 of Appendix IV.) A **Science Integration Manager** is responsible for optimizing scientific collaboration at the NASA/NSBRI interface and establishing ways for NASA scientists, engineers, and computer programmers to work collectively with NSBRI investigators. With advancement through the CRL, team projects interact more closely with JSC medical operations and with the Institute's **User Panel**, made up of current and former astronauts and flight surgeons who evaluate the operational suitability of emerging countermeasures.

Many steps may be required to identify where in the physiological cascade of events to apply countermeasures and what form the countermeasures should take. These steps include performing research to decipher the mechanisms underlying the physiological changes induced in a microgravity environment and preliminary testing of candidate countermeasures on animal or human models of microgravity. An important feature of NSBRI's integrated research team structure is the ability to facilitate, optimize, and support research across teams. For example, dietary and/or immunological countermeasures may be effective in reducing the risk imposed by space radiation, and a combined team approach can address this concept. Another inter-team project may develop new enabling technologies that are lightweight, portable, non-invasive, and unobtrusive, in order to provide in-flight assessment of bone loss and other CSE measures, while also enhancing clinical care. Interdisciplinary efforts in managing risk and countermeasure research are central to the NASA/NSBRI partnership. These efforts span multiple countermeasures, including:

- Training,
- Exercise,
- Diet and nutrition,
- Environmental manipulation,
- Daily rhythm and schedule manipulation,

- Pharmacological agents,
- Selection and retention requirements,
- Monitoring and diagnostic assessment, and
- Medical and surgical procedures.

Space Medicine Research

The Bioastronautics countermeasures development process (Figure 2), medical operations, and the Multilateral Medical Operations Panel are instrumental in countermeasure implementation. NSBRI works closely with NASA space medicine as part of its integrated research team focus on risk management deliverables. The Institute has flight surgeon representation on the teams and receives countermeasures research advice from the User Panel. Also, bidirectional exchanges are encouraged between NSBRI and NASA personnel with respect to evidenced-based space medicine data, the operations environment, engineering and human factors requirements, training, and clinical care.

The Institute also supports targeted projects in space medicine for high-priority operational and clinical status evaluation (CSE) needs. NSBRI scientists, engineers, and clinicians work with their NASA counterparts on specific projects, approved by NASA, related to assessing and ensuring acceptable levels of risk for the human subsystem. NSBRI participation in these joint NASA/NSBRI projects is coordinated through the Office of the Director and supervised by the NSBRI/NASA **Space Medicine Lead/Manager**, who acts as a bridge between NSBRI projects and NASA space medicine. There is coordination among these parallel approaches to advance the field of space medicine, promote more favorable outcomes, and increase the probability that NSBRI countermeasure developments will be successfully used to mitigate health risks in space.

Bioinformatics Initiative

Bioinformatics is a key cross-cutting discipline with sets of analysis tools that span all NSBRI research. The Institute's Bioinformatics Initiative includes data acquisition and mining, modeling, and simulation. The initiative is coordinated by a **Bioinformatics Manager** who works closely with NSBRI and NASA investigators and managers to develop an infrastructure for advanced information techniques, that will effectively catalog data and also assess whether unexpected relationships may be present in acquired databases.

The Institute presently supports the development and implementation of a distributed, but integrated, data management system for ground research, medical, and space flight data. The system, known as the **Institute Data Archive System** (IDAS), is web-based and will be configured to interface with NASA's archiving systems. All NSBRI investigators are required to electronically transfer appropriate research data to IDAS. A search engine allows NSBRI/NASA researchers and the broader scientific community to access data by categories.

Modeling, simulation, and development of visualization tools are part of the Bioinformatics Initiative designed to integrate research across the different teams and

guide the use of multi-system models. The construction and testing of theoretical models for simulation is complemented by NASA/NSBRI activities in space medicine using hardware analogs, such as a human patient simulator. The coordinated approaches and analysis of complex data apply to all CPR risks and provide a substrate for future refinements in multiple areas, including health care maintenance and support in space, crew selection and rehabilitation, and environmental and engineering adaptations for long-duration space missions.

Evaluation and Metrics

NSBRI, NASA, and periodic external reviews regularly evaluate NSBRI projects, teams, and programs. The Institute's independent, peer-review panels and the BSC provide high quality and objectivity in initial peer review. The BSC, on an annual basis, evaluates the quality, productivity, and progress of each project toward countermeasure development. The BSC also evaluates the teams' annual reports using a set of metrics for assessing team performance over time and across disciplines.

In order to ensure standardized assessment, the Institute, in coordination with NASA, tracks the distribution of projects by CRL and Technology Readiness Level. It also monitors the distribution of tasks and funding by CPR criticality (likelihood and consequences). In consultation with NASA, research projects are prioritized with respect to the CPR and programmatic need. Through its **NSBRI Information Management System** (NIMS), the Institute has an ongoing electronic database of productivity measures, which includes the number of peer-reviewed publications and invention disclosures/patents per project and team resulting from NSBRI-sponsored research. The system also tracks investigator success in obtaining support for related research aims and objectives from the National Institutes of Health, the Department of Defense, National Science Foundation, Department of Energy, and other funding sources such as the American Cancer Society and American Heart Association.

Productivity metrics and reports from the BSC are provided to the EAC to help determine program effectiveness. The EAC meets semiannually and is charged with assessing strategy and tactical implementation. The Institute Strategic Plan, Team Strategic Plans, competitive proposals, and team accomplishments are discussed with, and vetted through, the EAC. This Council advises the **Director** and **Board of Directors,** including the **Chairman of the Board and CEO,** regarding the best allocation of resources to meet the Institute's mission, objectives, and goals. The Board of Directors subsequently reviews the major fiscal and programmatic issues confronting the Institute and oversees necessary high-level actions.

The Institute provides NASA with monthly progress and annual scientific and technical reports, along with other documentation of productivity and fiscal accountability. The individual teams and the Institute as a whole are reviewed by NASA in the third or fourth year of each five-year increment.

Program Optimization

Optimization and success of the Institute's Countermeasures Development Research Program rely on the outcome of evaluations and adjustments and/or changes in direction

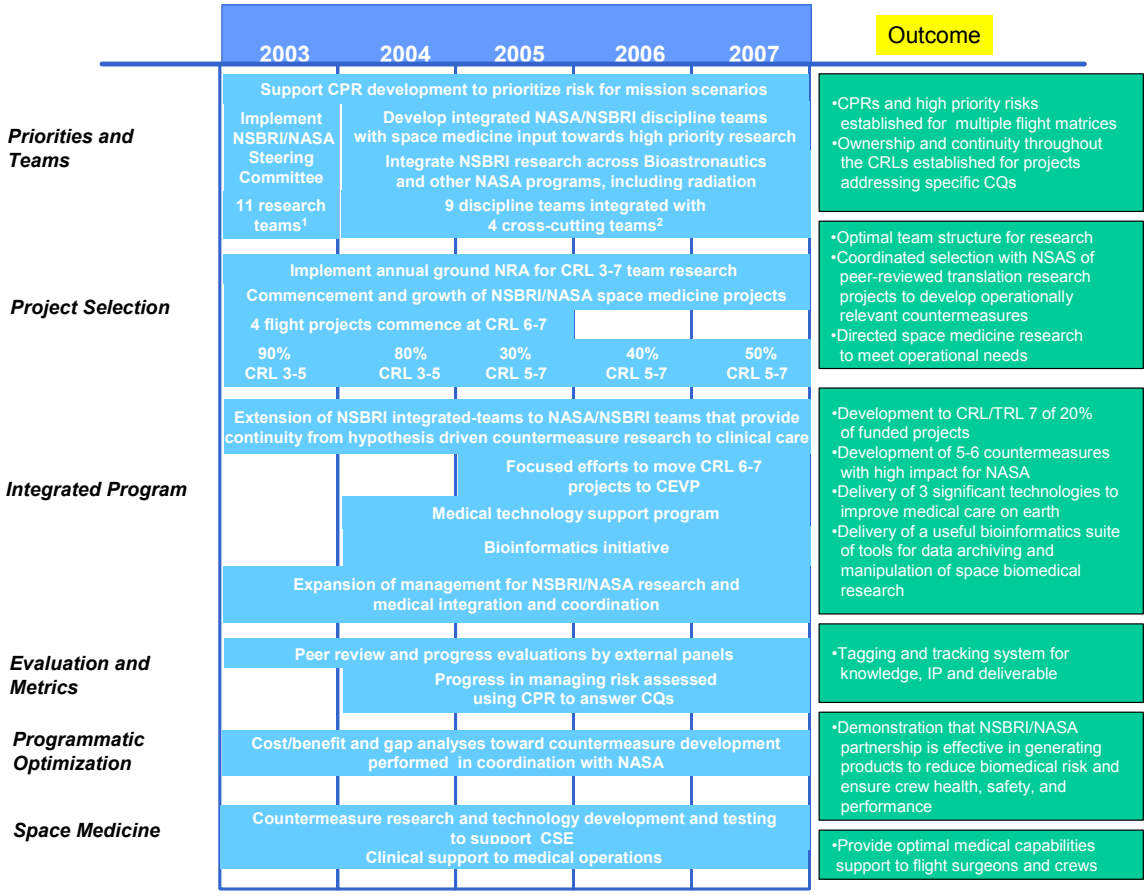
made by the Institute with its NASA partner. The NSBRI/NASA Steering Committee is an effective mechanism for addressing timely issues to maximize impact, opportunity, and success, given the evolving nature of the CPR and NASA programs (e.g., space flight opportunities, new research initiatives).

CounterMeasure Development Research Strategic Timeline

Figure 4 is a five-year strategic timeline with proposed outcomes for NSBRI countermeasure development research.

Figure 4

Countermeasure Development Research Strategic Timeline
FY2003 – FY2007



1 The research teams are Bone Loss; Cardiovascular Alterations, Human Performance Factors, Sleep and Chronobiology; Immunology, Infection and Hematology; Muscle Alterations and Atrophy; Neurobehavioral and Psychosocial Factors; Neurovestibular Adaptation; Nutrition, Physical Fitness and Rehabilitation; Radiation Effects; Smart Medical Systems; and Technology Development.
2 The nine research teams are Bone Loss; Cardiovascular Alterations, Human Performance Factors, Sleep and Chronobiology; Immunology, Infection and Hematology; Muscle Alterations and Atrophy; Neurobehavioral and Psychosocial Factors; Neurovestibular Adaptation; Nutrition, Physical Fitness and Rehabilitation; and Smart Medical Systems the four cross-cutting teams are Radiation Effects, Space Medicine, Technology Development, and Modeling.

JSC/NSBRI Translational Workforce

NASA and NSBRI support the efficient use of all resources in order to obtain maximum scientific results and advances in managing risks on the CPR. With the downsizing of civil servant positions at JSC, the Institute and its NASA partner support a translational workforce of non-government employee scientists and research associates. This workforce is predominantly based at JSC and contributes to the integration and coordination between NSBRI and NASA research efforts. The workforce is linked to Baylor College of Medicine, the lead Consortium institution.

Strategic Relationships

Several programs in the nation are complementary to NSBRI. A number of Federal and non-Federal agencies support pre-clinical research into the mechanisms responsible for microgravity-associated risks and other space flight effects. For example, the National Institutes of Health is the premiere funding agency for the study of bone and muscle abnormalities and various other disease conditions. NSBRI encourages strategic relationships with complementary organizations and programs, to the added benefit of all the involved agencies and parties. Through these relationships, advances in the development of countermeasures and science and health-monitoring technologies will be accelerated. In turn, this will lead to reduction, elimination, or prevention of the adverse consequences of space travel. These discoveries may also be adapted to have practical value in health care delivery on Earth.

The Institute also encourages international relationships, including postdoctoral fellow and visiting scientist exchanges, and research project collaborations with international affiliates. A primary function of national and international strategic relationships is to engage a broad and diverse community of expertise in space life sciences to strengthen and ensure the Institute's success.

Returning Benefits to Earth

Knowledge, discoveries, and technologies developed by the Institute can be adapted for effective diagnosis, therapies, and aids to restore or promote health on Earth. Accordingly, all risk management strategies and results, including medical- and environmental-monitoring deliverables undertaken by the NSBRI, are reviewed monthly. Team Leaders and Institute management discuss promising advances, and NSBRI Headquarters uses NIMS to disseminate information on new discoveries. The Institute is proactive in enabling the return of important scientific and medical findings for Earth-based applications and commercialization.

These activities are complemented by the NSBRI **Industry Forum**, consisting of member representatives of space and biomedical-related industries who keep the Institute in touch with the industrial community. To further promote success in translational research for Earth benefit, the Institute has recently established an advisory **Committee on Research and Technology Transfer** that includes representation from its different advisory panels and boards, as well as outside venture capital experts.

Education, Training, and Public Outreach Program

The goals of this program are:

- Develop education and training programs designed to produce the next generation of space biomedical researchers.
- Transfer the medical and biomedical findings of space research to the scientific community and public.

Most of NSBRI's aims and objectives are pertinent to the Education, Training, and Public Outreach Program.

Scientist Education and Training

NSBRI, through its Consortium institutions and affiliated entities, is strategically positioned to assist NASA in its educational objectives. The Institute offers world-class opportunities for focused biomedical training. The leading professors and outstanding associated institutional resources of NSBRI provide NASA with a unique network for attracting and inspiring exceptional and diverse students and professionals at all levels to pursue unparalleled advanced education and training.

Specific opportunities include:

- **Graduate Student** experiences with access to programs leading to an advanced degree under the supervision of an NSBRI-sponsored investigator at his/her academic institution. Opportunities also exist to participate in university curricula that have space biomedical courses and engage in research activities at NASA laboratories.

- **Postdoctoral Fellowships** for new investigators seeking to pursue a career in space biomedical research. Fellows are encouraged to help bridge the NSBRI/NASA research interface by spending time at both academic and NASA laboratories.

- **Visiting Scientist** placements that provide bilateral exchanges between the academic community and NASA to the benefit of the NSBRI/NASA partnership and the community at large.

K-12 and Undergraduate Education

NSBRI's Education and Public Outreach Team focuses on K-12 and undergraduate education. It is well aligned and coordinated with the Educational Outreach Program of NASA's Office of Biological and Physical Research. The Institute supports peer-reviewed projects that communicate the significance and excitement of space life sciences to local, national, and international audiences, while transferring and disseminating knowledge gained through the biomedical advances achieved by the NSBRI research teams. Going forward the institute's effort in K-12 and undergraduate education will support integrated projects to achieve defined measures of success. Strategic approaches for the team include:

- Enhancing educational access, curricula, and career awareness in space life sciences among K-12 and undergraduate students across diverse communities.

- Designing and conducting teacher professional development programs to help teachers understand space life sciences and improve the learning experiences they provide K-12 and undergraduate students.

- Increasing scientific literacy and public awareness of the real-life impacts of NSBRI research through media, informal science activities, direct mailings, and magazine stories.

Community Education and Public Outreach

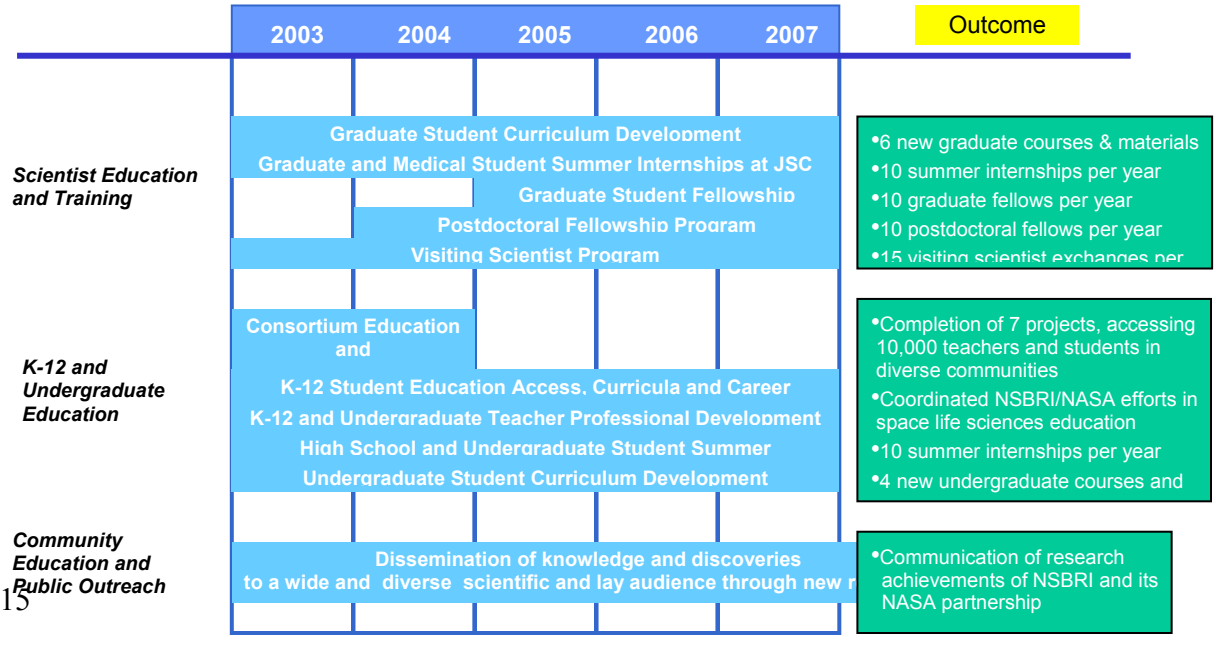
Through public information, the Institute promotes scientific literacy and shares, with a broad audience, an appreciation for the opportunities and the value that space life sciences research offers. This is accomplished in coordination with NASA and academic institutions and uses a multimedia approach orchestrated through NSBRI Headquarters to disseminate biomedical and countermeasures research achievements using:

- An award-winning web site.
- Magazine stories that disseminate space biomedical knowledge.
- Award-winning brochures for public distribution.
- Exhibits for scientific and industrial events.
- Hands-on museum exhibits.
- A network of personal contacts with space and science reporters.
- A national outreach program with PBS and other television exposure.
- Monthly research-based news releases.

Education, Training and Public Outreach Program Strategic Time Line

Figure 5 presents the NSBRI's five year strategic plan for Education, Training and Public Outreach programs as well as proposed outcomes.

Figure 5.
Education, Training and Public Outreach Program Strategic Time Line

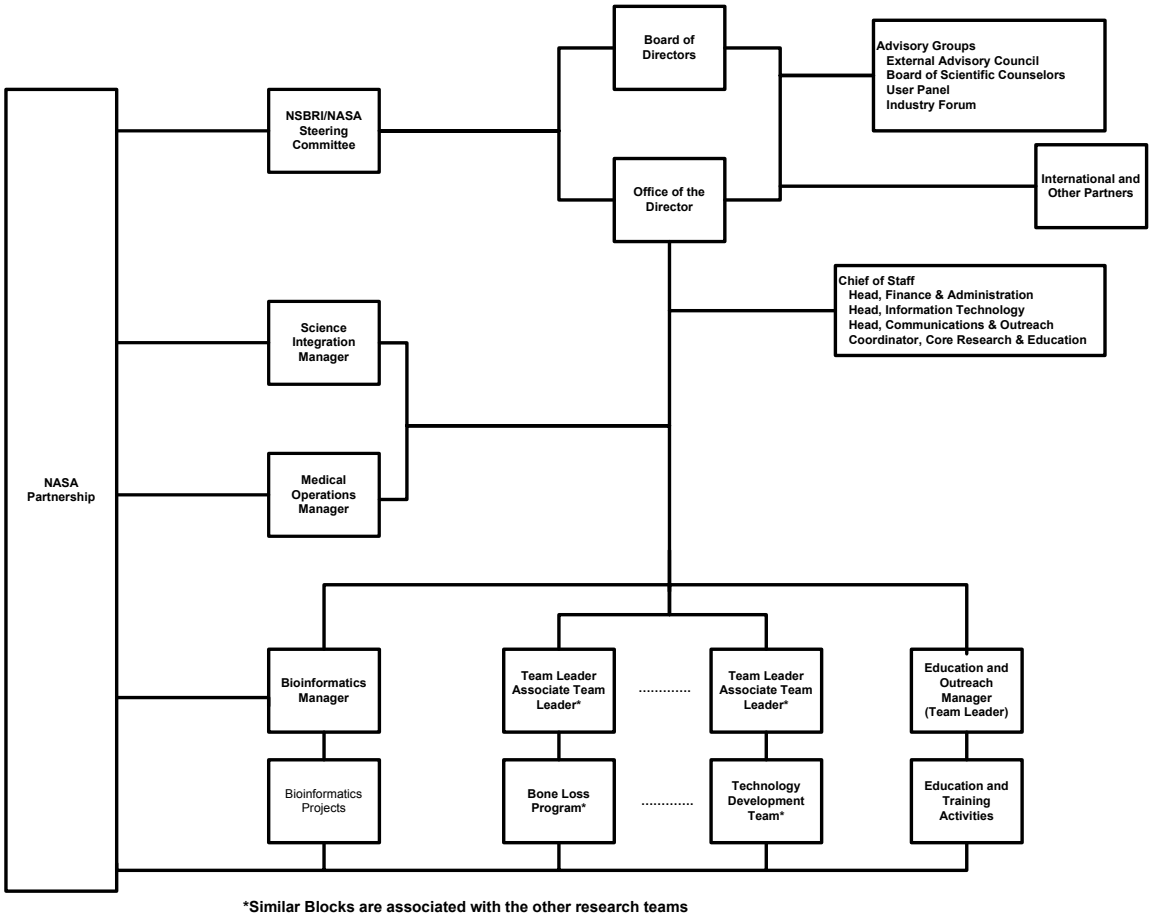


Institute Management

Organizational Structure

NSBRI's organizational structure fosters the NASA/NSBRI partnership at multiple levels. NASA and NSBRI manage and conduct their joint activities to benefit all stakeholders (e.g., NASA, Congress, the public, academic institutions, team leaders, investigators, international partners). The organizational structure facilitates the effective implementation of the Institute's strategies to fulfill its mission, aims, objectives, and goals.

Figure 4. NSBRI Organizational Structure



The Board of Directors has the ultimate authority and responsibility for the activities of the Institute. The Director has the responsibility for successfully carrying out the mission and achieving all of the Institute's aims and objectives. The Associate Director works in the Office of the Director as the deputy. The Chief of Staff oversees operations at NSBRI Headquarters and interfaces with administrative activities at Baylor College of Medicine (as the lead Consortium institution) and at JSC. The Science Integration Manager and the Space Medicine Lead/Manager facilitate, coordinate, and maximize interactions among NSBRI investigators and NASA scientists, engineers, flight surgeons, and astronauts to develop productive countermeasures. The Team Leaders manage their respective integrated programs in research and education. There is also a Bioinformatics Manager who implements the Institute's Bioinformatics Initiative. The NSBRI's advisory system includes the BSC, EAC, User Panel, and Industry Forum.

Budget

The Institute's core budget is established by NASA and supports a critical mass of peer-reviewed research activity that uniquely and effectively contributes to NASA's Bioastronautics Strategy. NASA and NSBRI have agreed that either entity can propose specific work element/projects that are within the overall scope of the NASA Cooperative Agreement Notice, but by their nature would not normally be research activities included within the NSBRI core research plan. When such projects are approved, a project plan for implementation will be prepared and included as a supplement to the Cooperative Agreement.

Correspondence with the President's Management Agenda

NSBRI is an exemplary, performance-driven science institute. Its partnership with NASA addresses all five components of the President's Management Agenda.

Strategic Management of Human Capital – NSBRI is a private, non-profit entity that engages outstanding biomedical researchers to work with, and fill skill shortages at, NASA augmenting government civil servants with the unique and complimentary NSBRI skill base.

Competitive Sourcing – NSBRI, competitively supported by NASA, implements aims, objectives, and goals that focus on high-quality, timely results and outcomes desired by NASA.

Improved Financial Performance – NSBRI uses a streamlined accounting process operating with minimal bureaucracy and provides NASA with accurate and timely financial reports and clean audits. The NSBRI financial management system allows tracking of resources as well as day-to-day operations and task-completion productivity metrics.

Expanded Electronic Government – NSBRI's distributed structure and its multiple joint interactions with NASA are supported by efficient electronic communications, business operations, and data management capabilities (e.g., NIMS, IDAS). Most business operations, including grant proposal submission and productivity monitoring, are conducted electronically.

Budget and Performance Integration – NSBRI is task-oriented and uses the CPR, in coordination with NASA, for research prioritization and resource allocation enabling the development of countermeasures. There is a focus on deliverables, progress, productivity metrics, and a process for shifting resources to meet risk management needs.

Appendix I

The 55 Risks of the Bioastronautics Critical Path Roadmap

ID[1]	Risk Title	Rank[2]	Discipline Area[3]
1	Inability to Maintain Acceptable Atmosphere in Habitable Areas	1	Advanced Life Support
2	Inability to Provide and Recover Potable Water	2	Advanced Life Support
3	Inadequate Supplies (including maintenance, emergency provisions, and edible food)	2	Advanced Life Support
4	Inability to Maintain Thermal Balance in Habitable Areas	3	Advanced Life Support
5	Inability to Adequately Process Solid Wastes	3	Advanced Life Support
6	Inadequate Stowage and Disposal Facilities for Solid and Liquid Trash Generated During Mission	4	Advanced Life Support
7	Inadequate Nutrition (Malnutrition)	1	Food & Nutrition
8	Unsafe Food Systems	2	Food & Nutrition
9	Acceleration of Age-Related Osteoporosis	1	Bone Loss
10	Fracture & Impaired Fracture Healing	2	Bone Loss
11	Injury to Soft Connective Tissue, Joint Cartilage, & Intervertebral Disc Rupture w/ or w/o Neurological Complications	3	Bone Loss
12	Renal Stone Formation	4	Bone Loss
13	Occurrence of Serious Cardiac Dysrhythmias	1	Cardiovascular Alterations
14	Impaired Response to Orthostatic Stress	1	Cardiovascular Alterations
15	Diminished Cardiac Function	2	Cardiovascular Alterations
16	Manifestation of Previously Asymptomatic Cardiovascular Disease	3	Cardiovascular Alterations
17	Impaired Cardiovascular Response to Exercise Stress	4	Cardiovascular Alterations
18	Human Performance Failure Because of Poor Psychosocial Adaptation	1	Human Behavior & Performance
19	Human Performance Failure Because of Sleep and Circadian Rhythm Problems	2	Human Behavior & Performance

20	Human Performance Failure Because of Human System Interface Problems & Ineffective Habitat, Equipment, Design, Workload, or Inflight Information and Training Systems	3	Human Behavior & Performance
21	Human Performance Failure Because of Neurobehavioral Dysfunction	4	Human Behavior & Performance
22	Immunodeficiency/Infections	1	Immunology, Infection & Hematology
23	Carcinogenesis Caused by Immune System Changes	1	Immunology, Infection & Hematology
24	Altered Hemodynamic and Cardiovascular Dynamics caused by Altered Blood Components	1	Immunology, Infection & Hematology
25	Altered Wound Healing	2	Immunology, Infection & Hematology
26	Altered Host-Microbial Interactions	3	Immunology, Infection & Hematology
27	Allergies and Hypersensitivity Reactions	3	Immunology, Infection & Hematology
28	Loss of Skeletal Muscle Mass, Strength, and/or Endurance	1	Muscle Alterations & Atrophy
29	Inability to Adequately Perform Tasks Due to Motor Performance, Muscle Endurance, and Disruption in Structural and Functional Properties of Soft & Hard Connective Tissues of the Axial Skeleton	1	Muscle Alterations & Atrophy
30	Inability to Sustain Muscle Performance Levels to Meet Demands of Performing Activities of Varying Intensities	2	Muscle Alterations & Atrophy
31	Propensity to Develop Muscle Injury, Connective Tissue Dysfunction, and Bone Fractures Due to Deficiencies in Motor Skill, Muscle Strength and Muscular Fatigue	3	Muscle Alterations & Atrophy
32	Impact of Deficits in Skeletal Muscle Structure and Function on Other Systems	NR	Muscle Alterations & Atrophy
33	Disorientation and Inability to Perform Landing, Egress, or Other Physical Tasks, Especially During/After G-Level Changes (Acute spontaneous & provoked vertigo, nystagmus, oscillopsia, poor dynamic visual acuity)	1	Neurovestibular Adaptation

34	Impaired Neuromuscular Coordination and/or Strength (Gait ataxia, postural instability)	2	Neurovestibular Adaptation
35	Impaired Cognitive and/or Physical Performance Due to Motion Sickness Symptoms or Treatments, Especially During/After G-Level Changes (Including short term memory loss, reaction time increase, drowsiness, fatigue, torpor, irritability, ketosis)	3	Neurovestibular Adaptation
36	Vestibular Contribution to Cardioregulatory Dysfunction (Postlanding orthostatic intolerance, sleep and mood changes)	4	Neurovestibular Adaptation
37	Possible Chronic Impairment of Orientation or Balance Function Due to Microgravity or Radiation (Imbalance, gait ataxia, vertigo, chronic vestibular insufficiency, poor dynamic visual acuity)	5	Neurovestibular Adaptation
38	Carcinogenesis Caused by Radiation	1	Radiation Effects
39	Late Degenerative Tissue Effects including Non-Cancer Mortality, Cataracts, and Central Nervous System (CNS) Effects	2	Radiation Effects
40	Synergistic Effects from Exposure to Radiation, Microgravity and other Spacecraft Environmental Factors	3	Radiation Effects
41	Early or Acute Effects from Radiation Exposure	4	Radiation Effects
42	Radiation Effects on Fertility, Sterility, and Heredity	5	Radiation Effects
43	Trauma and Acute Medical Problems	1	Clinical Capabilities
44	Toxic Exposure	2	Clinical Capabilities
45	Altered Pharmacodynamics and Adverse Drug Reactions	3	Clinical Capabilities
46	Illness and Ambulatory Health Problems	4	Clinical Capabilities
47	Prevention, Development and Treatment of Space-Induced Decompression Sickness	5	Clinical Capabilities
48	Difficulty of Rehabilitation Following Landing	6	Clinical Capabilities
49	Post-landing Alterations in Various Systems Resulting in Severe Performance Decrements and Injuries	1	Multisystem (Cross Risk) Alterations

50	Allergies and Hypersensitivity Reactions from Exposure to the Enclosed Spacecraft & Other Environmental Factors	3	Environmental Health
51	Inability to Maintain Acceptable Atmosphere in Habitable Areas Due to Environmental Health Contaminants	1	Environmental Health
52	Inability to Provide and Recover Potable Water Due to Environmental Health Contaminants	2	Environmental Health
53	Inadequate Nutrition (Malnutrition) Due to Inability to Provide and Maintain a Bioregenerative System	3	Advanced Life Support
54	Difficulty of Rehabilitation Following Landing Due to Nutritional Deficiencies	4	Food & Nutrition
55	Human Performance Failure Due to Nutritional Deficiencies	3	Food & Nutrition

[1]Risk Identification number: Unique number assigned to each risk (1-55) used to track/identify each risk.
[2]The Rank Order assigned to each risk by discipline experts in each Discipline; a Discipline may have more than 1 risk with the same risk ranking.
[3]There are 12 Discipline Areas in the CPR.

Appendix II

NATIONAL SPACE BIOMEDICAL RESEARCH INSTITUTE
POLICY ON TEAM LEADERSHIP

I. Overview

Each Institute team is led by a single Team Leader who is assisted by an Associate Team Leader. Team Leaders play a pivotal role in guiding the Institute's research program and achieving the ultimate success of the Institute. Their expertise and "hands-on" approach to research management add value across projects and across teams. The Team Leader is guided by the Bioastronautics Critical Path Roadmap (CPR), which is the cornerstone for developing the team's integrated strategic research plan, the key to accomplishing the Institute's mission. The Team Leader's stature and reputation as a strong scientist enable recruitment of other scientific leaders as team members. The Team Leader's communication skills and insight enable the appropriate synergistic discussions among the various research projects, with the objective of assuring a team research program that has higher value than the sum of the values of its separate projects.

II. Duties and Responsibilities

Team Leaders are responsible for:

- Preparing and periodically updating the team research strategic plan. This plan should be consistent with the Institute mission, the CPR and available resources.
- Reporting progress to the Institute's External Advisory Council (EAC), Board of Scientific Counselors (BSC) and NSBRI management.
- Preparing and presenting the initial recommendation to the EAC of new research projects for inclusion in the team's program.
- Representing the team and disseminating knowledge about team activities and progress to NASA; specifically coordinating with NASA-JSC scientists and physicians, the scientific community and the general public.
- Pursuing involvement with NASA operational activities.
- Maintaining appropriate communication links among the team investigators and to other team leaders.
- Developing, with team investigators, individual project plans that ensure scientific and operational synergy and lead to productive countermeasure development.
- Nurturing opportunities and seeking funding support to collaborate with, and cross-fertilize, research within and between NSBRI teams and with Johnson Space Center, other NASA Centers and other agencies.
- Acting as the senior NSBRI discipline representative for ongoing development of the CPR.

Associate Team Leaders assist Team Leaders in carrying out the above activities.

III. Qualifications

Team Leaders are NSBRI-funded principal investigators who possess the following qualifications:

- Achieved intermediate or senior rank at a research or educational institution.

- Demonstrated record of securing independent competitive research funding for at least the last five years.
- Recognized within the biomedical community as an outstanding research contributor to at least one field of study; prior involvement with a NASA flight investigation would be beneficial.
- Manifest broad scientific understanding across the team's research area.
- Demonstrated leadership and program/group management skills, as evidenced by experiences such as a section head, department chair, dean, research center director or principal investigator on a program project.
- Exhibit good communication, public speaking and organizational skills.
- Show a willingness and availability to spend the necessary time and energy to fulfill the role of Team Leader.

Associate Team Leaders are principal or co-investigators on NSBRI-funded projects who possess at least the first four of the above qualifications required for a Team Leader. Generally, Team Leaders and Associate Team Leaders are not from the same institution.

IV. Term of Service

Team Leaders are appointed by the Director for a term that is identical with the term of their NSBRI-funded research project (generally four years), subject to satisfactory performance as determined at their annual performance review. The Team Leader appoints Associate Team Leaders for a term that does not exceed the Team Leader's term of service. The Team Leader's term is competitively renewable, while the Associate Team Leader's term is renewable.

V. Funding and Authority

Team Leaders and Associate Team Leaders are provided with discretionary funds to enable them to carry out their duties and responsibilities. Wide latitude is provided concerning the expenditure of these funds within the guidelines of the involved institutions. Such funds may be used for support personnel, team meetings, special travel and other expenses generally associated with team communication and operations. However, these funds may not be used to support research.

Team Leaders are ultimately responsible for carrying out the duties and responsibilities listed in Section II. They are expected to work cooperatively with their Associate Team Leader in all matters and should develop a clear understanding of the distribution of their shared responsibilities. Team Leaders report to the Director.

VI. Selection

In the year before a Team Leader's term of service ends, a special "Call for Candidates" section will be included in the annual Institute Research Announcement requesting applications for the Team Leader's position. Research applications may then be accompanied by a special short application for the Team Leader position. Following the evaluation of the research application by a peer committee, Institute Senior Management (Director and Associate Director) will evaluate the merits of the applicants for Team

Leader and recommend a selection to the Chairman of the Board who will seek confirmation of the selection from the Board of Directors.

Associate Team Leaders are nominated and selected by the Team Leader, with the advice and consent of the Director in consultation with the Associate Director.

In selection of Team Leaders and Associate Team Leaders, attempts will be made to balance the scientific and managerial expertise of candidates and to develop diversity within the Institute's research leadership.

VII. Training and Support

To assist Team Leaders in performing their duties, the NSBRI provides electronic reporting and managerial tools, along with training as needed. Forums are held at least three times a year for Team Leaders to meet as a group with the Director and Associate Director.

VIII. Performance Evaluation

Once a Team Leader is selected, five groups evaluate the performance and effectiveness of Team Leaders: the EAC, BSC, team principal investigators, NSBRI Senior Management and NASA. Each group focuses on different aspects of a Team Leader's performance:

- Annually, the BSC will review each team's annual report of productivity and progress in carrying out the team strategy, including evidence that the research projects are functioning synergistically within the research team and evidence that the team is collaborating effectively with other teams and with NASA life scientists.
- Semi-annually, the EAC will review the effectiveness of the Team Leader in communicating the team vision and successes, and in discussing and handling team issues and problems.
- Annually, team principal investigators will evaluate the leadership, communication and other relevant skills of their Team Leader.
- Annually, Institute Senior Management will evaluate the Team Leader's overall effectiveness and responsiveness.
- At least every four years, and more frequently if necessary, the four research area representatives on the EAC and BSC (two each) will review the team strategic plan and furnish a written critique of the strengths and weaknesses of the plan along with a rating of the overall team strategy embedded in the plan.
- Every five years, just prior to conducting an Institute-wide review, an *ad hoc* review team, appointed by NASA, will evaluate all aspects of the team's performance, including the Team Leader's performance.

Institute Senior Management will produce an annual overall rating of each Team Leader's performance based on the available inputs.

An unsatisfactory Team Leader rating will normally result in a specific warning to the Team Leader and include a recommended action plan to correct the identified deficiencies in performance. Two unsatisfactory Team Leader ratings in successive years

will result in removal of the Team Leader and appointment of an acting Team Leader to serve out the remainder of the Team Leader's term. The Institute supports the need for leadership continuity, but only if the evaluative process supports an annual reappointment. Team Leaders are ultimately judged by their team's ability to successfully develop and deliver, in whole or part, countermeasures in areas of high impact for NASA, for the purpose of decreasing the biomedical or human performance risks associated with long duration human space flight.

Associate Team Leaders are evaluated annually by Team Leaders for their contribution to team goals, achievements, function, productivity and representation. Unsatisfactory performance may lead to removal of Associate Team Leaders, but such action requires the concurrence of the Director in consultation with the Associate Director.

IX. Conflict of Interest

Team and Associate Team Leaders must adhere to the highest ethical standards as they carry out their leadership duties. They must not make decisions based on institutional affiliation or personal bias. They must conduct all leadership duties with integrity, fairness and objectivity to ensure the scientific credibility of the Institute.

To avoid a conflict of interest during a selection in which a Team Leader has a competing application, Institute Senior Management selects the Team Leader and project before any other projects are selected. Then the Team Leader develops and presents a selection recommendation concerning the other competing projects to the EAC. The EAC recommends the final selection to Institute Senior Management, taking into account the science merit rating and programmatic relevance rating furnished by the BSC in addition to the Team Leader recommendation. Institute Senior Management makes the final selection decisions following coordination with NASA. If the Team Leader does not have a competing application during a selection cycle, the process is similar but the Team Leader will be assisted by the Associate Team Leader in developing the selection recommendation to the EAC.

Appendix III

Mapping Between NSBRI Research Teams and CPR Risks

RESEARCH TEAM	NUMBER OF UNIQUE RISKS	CPR RISK NUMBERS
Bone Loss	4	9, 10, 11, 12
CV Alterations	5	13, 14, 15, 16, 17
Human Perf Factors	1	19
Imm, Inf & Hem	5	22, 23, 25, 26, 27
Muscle Alt & Atrophy	5	28, 29, 30, 31, 32
Neurobehav, Psychosocial	3	18, 20, 21
Neurovestibular Adaptation	5	33, 34, 35, 36, 37
Nut, Phys Fitness & Rehab	3	7, 54, 55
Radiation Effects	5	38, 39, 40, 41, 42
Smart Med Systems	6	43, 44, 45, 46, 47, 48
Tech Development	N/A	
	1	49 (cross-risk)
TOTAL	**43**	

Appendix IV

Table 1. Example of Project Research Activities from Team Strategic Plans (Cardiovascular Alterations Team)

PI/Project	Risk(s) Addressed	Countermeasure Target	Experimental System	Phase 1 Activities: Focused Mechanistic Research	Phase 2 Activities: Preliminary Countermeasure Development Research	Phase 3 Activities: Mature Countermeasure Development Research
COHEN/Effects of Space Flight on Cardiovascular Stability	Orthostatic hypotension Exercise Dysrhythmias	• Pharmacological (Midodrine and Spironolactone) • Diet (Electrolytes)	Pre and post flight humans	Effects of microgravity on: • CV regulation (CV System Identification) •Dysrhythmias (T-Wave Alternans)	Pre and post flight in humans of • Midodrine • Spironolactone • Diet (Electrolytes)	Pre and post flight in humans of • Midodrine • Spironolactone • Diet (Electrolytes) • Spironolactone
COOLAHAN/Distributed Simulation of Integrated Human Function	Orthostatic hypotension Dyshythmias Cardiac function CV Disease Exercise	Simulation of effects of wide variety of different potential countermeasures including exercise	Computer model of the cardiovascular system integrated with other systems	Develop and validate accurate model of myocyte and heart	•Develop integrated CV model •Develop integrated model incorporating other systems •Simulate effects of space flight and potential CMs	Analyze data from animal and human tests of countermeasures
DELP/Circulatory Remodeling with Simulated Microgravity	Orthostatic hypotension Cardiac function Exercise	Peripheral vascular countermeasures	• Hindlimb unloading (HU) of rats • Shuttle flight (STS-107) of rats	Measure effects and mechansims of HU and shuttle flight on: cerebral & peripheral vascular beds, lymphatics, cardiac mass	Evaluate data to identify and then test potential countermeasures	Test countermeasures in human studies

Table 2. Example of Project Integration Activities from Team Strategic Plans (Smart Medical Systems Team)

	CRUM HIFU for mission critical care	**DAVIES** Vascular genomics in g transitions	**KLEMPNER** Smart microorganism detection sys	**PUTCHA** Microcapsule drug formulation	**SOLLER** Non-invasive blood & tissue chemistry	**SUTTON** Near infrared brain imaging for space med	**THOMAS** Diagnostic 3D ultrasound for space	**THOMAS** Echo-cardiographic resource
Internal Communication	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings	Monthly team telecon; Biannual team meeting; NSBRI retreat; Biannual NASA meeting; National scientific meetings
Integrated Experiment Development	Sensor aspects link to both THOMAS projects	Vascular studies link Cardiovascular Alterations team	Algorithms link to SUTTON project; Phage library studies link to IIH team	Promethazine development links to Neurovestibular Adaptation team	Sensor links to SUTTON project; Applications links to Muscle team	Sensor links to SOLLER project; Algorithms link to KLEMPNER and THOMAS projects	Sensor links to CRUM project; Algorithms link to SUTTON project; Echo links to CV team	Sensor links to CRUM project; Algorithms link to SUTTON project; Echo links to CV team
Sample Sharing			Specimen sharing with JSC microbiology		Collaboration with CABRARA project	Cognitive task sharing with JSC flight surgeons	Vascular investigations link to DAVIES project	Resource is shared within NSBRI and NASA
Synergistic Studies of Opportunity	Studies with DoD / DARPA	Bioengineering Center, U Penn	SRU Biosystems, biotechnology industry	Pharma industry collaborations	Medical assessment for diabetics, surgical patients	Neuro monitoring in ICU, Harvard	Cardiac, renal imaging apps in med practice; flight apps	Resource of National value
Development of Computer Model of Integrated Human Function	Image / model guided surgery	Data mining	Neural nets for pattern recognition		Algorithms for pattern identification	Neural nets, software engineering platform	Algorithms for individualized astronaut models	Modeling for training purposes

Acronym List

Acronym	Definition
CPR	Bioastronautics Critical Path Roadmap
BSC	Board of Scientific Counselors
CAMP	Cooperative Agreement Management Plan
CRL	Countermeasure Readiness Levels
CSE	Clinical Status Evaluation
EAC	External Advisory Council
IDAS	Institute Data Archive System
JSC	Johnson Space Center
NASA	National Aeronautics and Space Administration
NIMS	NSBRI Information Management System
NRA	NASA Research Announcement
NSBRI	National Space Biomedical Research Institute