National Science Foundation

Interdisciplinary Research & Training Opportunities

Mary Ann Horn
Program Director, Mathematical Biology
Division of Mathematical Sciences

Howard Hughes Medical Institute
Quantitative Biology Workshop
21—24 July 2008

National Science Foundation

Division of Mathematical Sciences

I. **Disciplinary Programs**

II. **Research Training Grants (EMSW21—RTG)**

III. **Joint DMS/NIGMS Initiative to Support Research in the Area of Mathematical Biology**

IV. **IGMS (*Interdisciplinary Grants in the Mathematical Sciences*)**

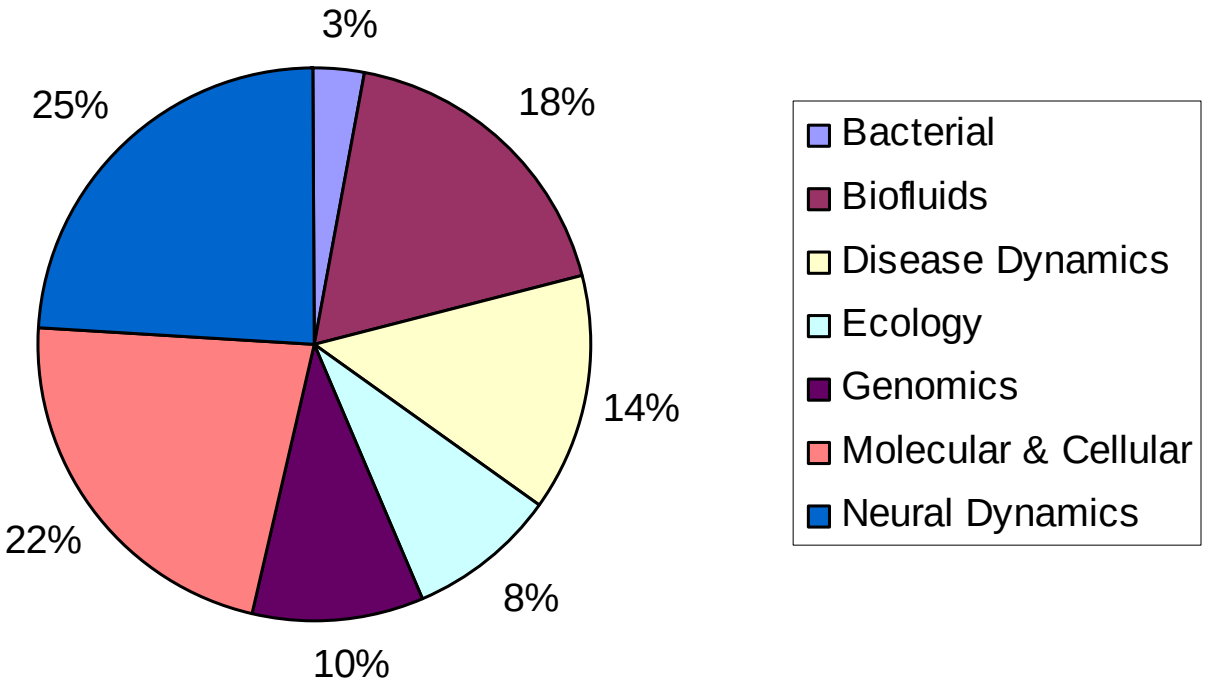
National Science Foundation

Disciplinary Programs in the Division of Mathematical Sciences

- Algebra, Number Theory and Combinatorics
- Analysis
- Applied Mathematics
- Computational Mathematics
- Geometric Analysis, Topology and Foundations
- Mathematical Biology
- Statistics and Probability

National Science Foundation

FY2007 Mathematical Biology
Total Funding by Subarea



National Science Foundation

Special DMS Programs

- **Focused Research Groups in the Mathematical Sciences (FRG)**
- **Research Training Grants (EMSW21—RTG)**
- **Joint DMS/NIGMS Initiative to Support Research in the Area of Mathematical Biology**
- **Interdisciplinary Grants in the Mathematical Sciences (IGMS)**

National Science Foundation

IGMS *(Interdisciplinary Grants in the Mathematical Sciences)*

The objective of the Interdisciplinary Grants in the Mathematical Sciences (IGMS) program is to enable mathematical scientists to undertake research and study in another discipline so as to:

*** expand their skills and knowledge in areas other than the mathematical sciences;**

*** subsequently apply this knowledge in their research; and**

*** enrich the educational experiences and broaden the career options of their students.**

Recipients of an IGMS award are expected to spend full time in a non - mathematical science department in an academic institution or an industrial, commercial or financial organization. The expected outcome is sufficient familiarity with another discipline so as to open opportunities for effective collaboration by the mathematical scientist with researchers in another discipline.

National Science Foundation

IGMS *(Interdisciplinary Grants in the Mathematical Sciences)*

Titles of Recent Awards

- **Statistical Methodology and Applications to HIV/AIDS Immunologic and Virologic Outcomes**
- **Medical Image Segmentation**
- **Mathematical Differentiation between Two Types of Wound Healing: Regenerative Repair versus Repair Resulting in a Scar**
- **An Immersion Program in Biology**
- **Mathematical Modeling of Vascular Systems, Angiogenesis, and Tumour Growth**
- **Neural Coding in Visual and Auditory Systems for Natural Stimuli: Mathematical Modeling Based on Data**
- **Statistically Predicting Hotspots and Coldspots in *C. elegans***
- **An Investigation of Biomolecular Graphs**

National Science Foundation

NSF Wide Interdisciplinary Research Programs

- **Collaborative Research in Computational Neuroscience (CRCNS)**
- **Grant Opportunities for Academic Liaison with Industry (GOALI)**
- **Human and Social Dynamics (HSD)**
- **Quantitative Environmental and Integrative Biology (QEIB)**

National Science Foundation

GOALI *(Grant Opportunities for Academic Liaison with Industry)*

Grant Opportunities for Academic Liaison with Industry (GOALI) aims to synergize university-industry partnerships by making project funds or fellowships/traineeships available to support an eclectic mix of industry-university linkages. Special interest is focused on affording the opportunity for:

*** Faculty, postdoctoral fellows, and students to conduct research and gain experience in an industrial setting;**

*** Industrial scientists and engineers to bring industry's perspective and integrative skills to academe; and**

*** Interdisciplinary university-industry teams to conduct research projects.**

This solicitation targets high-risk/high-gain research with a focus on fundamental topics, new approaches to solving generic problems, development of innovative collaborative industry-university educational programs, and direct transfer of new knowledge between academe and industry. GOALI seeks to fund research that lies beyond that which industry would normally fund by themselves.

National Science Foundation

GOALI *(Grant Opportunities for Academic Liaison with Industry)*

Titles of Recent Awards

- **Molecular Modeling of Confined Nano-Phases and Nano-Porous Materials (Westvaco)**
- **Development of Combinatorial Polymeric Substrates for Efficient Screening of Protein Adsorption (BD Technologies)**
- **Multi-Functional Composites for Load-Bearing Skeletal Applications (Teleflex Medical)**
- **Multicomponent Molecular Transport in Nanoporous Materials (ExxonMobil)**
- **Multicomponent Population Balance Modeling of Pharmaceutical Granulation (Merck)**

National Science Foundation

HSD *(Human and Social Dynamics)*

The Human and Social Dynamics (HSD) priority area fosters breakthroughs in understanding the dynamics of human action and development, as well as knowledge about organizational, cultural, and societal adaptation and change. HSD aims to increase our collective ability to

(1) understand the complexities of change;

(2) understand the dynamics of human and social behavior at all levels, including that of the human mind;

(3) understand the cognitive and social structures that create, define, and result from change; and

(4) manage profound or rapid change, and make decisions in the face of changing risks and uncertainty. Accomplishing these goals requires multidisciplinary research teams and comprehensive, interdisciplinary approaches across the sciences, engineering, education, and humanities, as appropriate.

National Science Foundation

HSD *(Human and Social Dynamics)*

The FY 2008 competition will include three emphasis areas:

- **Agents of Change;**
- **Dynamics of Human Behavior; and**
- **Decision Making, Risk and Uncertainty**

HSD encourages projects investigating complexity and systems thinking, with a goal of revealing the emergent properties of dynamic systems. HSD also encourages projects identifying human drivers of environmental change and exploring the consequences of environmental change on humans. Such research is central in equipping us to handle the most pressing environmental problems for our nation and the world.

National Science Foundation

HSD *Highlight*

NSF Highlights

HSD: The Role of Individual Decision Making in Influenza Vaccination Policy

Highlight ID: 14849

A Red Cross volunteer drawing blood to be tested for its concentration of antibodies during an influenza outbreak.

Permission Granted

Credit: Janet Astor of Centers for Disease Control and Prevention

Researchers are using game theory to study how individuals' voluntary vaccination decisions influence the spread of infectious diseases. They tested whether subjects' vaccination choices correspond to those that maximize their individual advantage and whether voluntary vaccination decision-making results in a Nash equilibrium outcome - a societal outcome where no individual has anything to gain by changing his/her strategy unilaterally.

Unfortunately, decisions made purely based on one's own self interest result in thousands or, in the case of pandemics, millions of deaths each year. The reason is simple: the young are disproportionately responsible for spreading infectious diseases and they are the ones choosing not to get immunized. A utilitarian policy that relied on community-wide programs to vaccinate younger members of the population would be more effective in reducing the spread of infectious diseases. This research has implications for policy-makers and public health practitioners trying to plan and implement preventative health efforts to achieve the greatest societal benefit.

National Science Foundation

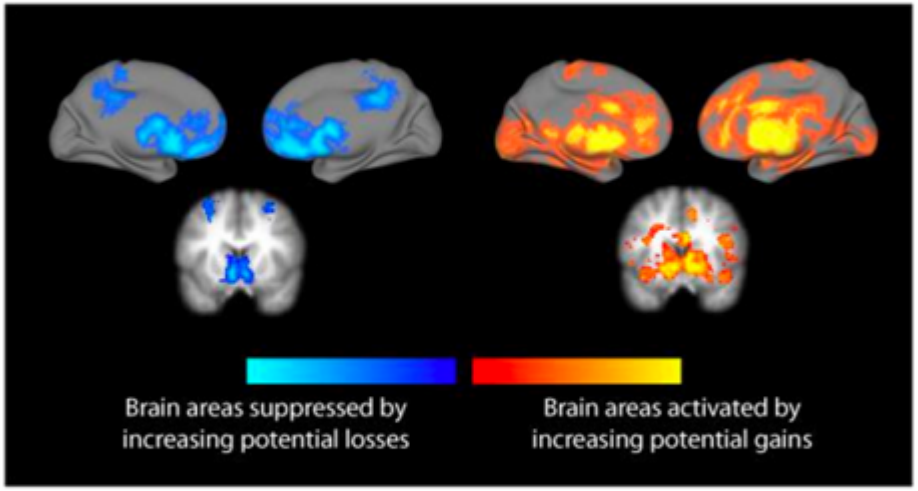
HSD *Highlight*

NSF Highlights

HSD DHB: The Neural Basis of Risky Decision Making

Highlight ID: 14004

Humans make countless risky decisions over the course of their lives – ranging from whether to leave a comfortable job for a higher paying, but less secure one to whether to seek aggressive, but potentially harmful, treatments for diseases. Russell Poldrack and colleagues at the University of California Los Angeles have been conducting the first neuroscience research comparing how our brains evaluate the possibility of gaining versus losing when making risky decisions. Poldrack's study, funded by the Human and Social Dynamics program, combines experimental and fMRI data. The researchers have discovered a strong predictive correlation between brain activity and behavior. By looking at oxygen levels in the brain (as a measure of neural activity), they have found important differences across individuals.



This figure depicts how brain activity changes when individuals contemplate winning or losing money. On the left, regions shown in blue/white became less active as people contemplated losing larger amounts of money (from $5 to $20). On the right, regions in red/yellow became more active when people contemplated winning larger amounts of money (from $10 to $40).

Permission Granted

Credit: Permission granted by the researcher

National Science Foundation

Training Programs

- **Graduate Research Fellowship Program (GRFP)**
- **Integrative Graduate Education and Research Traineeship Program (IGERT)**
- **Course, Curriculum, and Laboratory Improvement (CCLI)**
- **Interdisciplinary Training for Undergraduates in Biological and Mathematical Sciences (UBM)**
- **Research Experiences for Undergraduates (REU)**
  - **Sites**
  - **Supplements**
- **Math and Science Partnership (MSP)**

National Science Foundation

GRFP
(Graduate Research Fellowship Program)

The purpose of the Graduate Research Fellowship Program (GRFP) is to ensure the vitality of the scientific and technological workforce in the United States and to reinforce its diversity. The program recognizes and supports outstanding graduate students in the relevant science, technology, engineering, and mathematics (STEM) disciplines who are pursuing research-based master's and doctoral degrees. NSF Fellows are expected to become knowledge experts who can contribute significantly to research, teaching, and innovations in science and engineering.

The Graduate Research Fellowship provides three years of support for graduate study leading to research-based master's or doctoral degrees and is intended for students who are in the early stages of their graduate study. The Graduate Research Fellowship Program (GRFP) invests in graduate education for a cadre of diverse individuals who demonstrate their potential to successfully complete graduate degree programs in disciplines relevant to the mission of the National Science Foundation.

National Science Foundation

IGERT *(Integrative Graduate Education and Research Traineeship Program)*

- **The Integrative Graduate Education and Research Traineeship (IGERT) program has been developed to meet the challenges of educating U.S. Ph.D. scientists and engineers who will pursue careers in research and education, with the interdisciplinary backgrounds, deep knowledge in chosen disciplines, and technical, professional, and personal skills to become, in their own careers, leaders and creative agents for change.**
- **The program is intended to catalyze a cultural change in graduate education, for students, faculty, and institutions, by establishing innovative new models for graduate education and training in a fertile environment for collaborative research that transcends traditional disciplinary boundaries.**
- **It is also intended to facilitate diversity in student participation and preparation, and to contribute to a world-class, broadly inclusive, and globally engaged science and engineering workforce.**

National Science Foundation

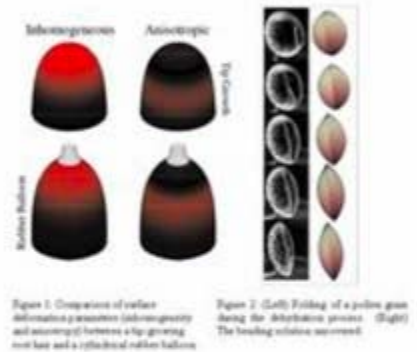
IGERT *Highlight*

NSF Highlights

Ballooning Cells

Highlight ID: 15355

How cells grow and form have wide ranging implications on topics ranging from the invasiveness of cancer cells to the capacity of fungi to cause disease. The Integrative Graduate Education and Research Traineeship (IGERT) program in Biomechanics at Harvard University, led by PI Noel Holbrook, brings together as its interdisciplinary theme aspects of mathematical modeling, physics, biology and genomics to develop and provide simple and tractable frameworks for understanding cell growth. The interdisciplinary research and educational training in this IGERT provides trainees with the tools and expertise to demonstrate how types of cell growth may be tackled both experimentally and theoretically. For example, in fungi, hyphal tip growth can determine how invasive or pathological different species may be. Although cell surface and cytoskeletal mechanics have always been considered key players in maintaining tip growth, it is only recently that the full power of the mechanical approach has been realized. The breakthrough was achieved by comparing the growth of plant cells with that of cylindrical rubber balloons. A comparison of the deformation parameters for the surface revealed a striking similarity between the living cell and physical analog (Figure 1). This observation prompted IGERT trainees Enrique R. Rojas and Roberto Bernal to look for a generic model that could be applied to these two systems. What emerged is a simple mechanical model of tip growth whose predictive power surpasses that of all previous models.



Tip folding and pollen growth.

Permission Granted
Credit: : Jacques Dumais

The simplicity of the model has already proven valuable since it has shown its usefulness in interpreting other biological observations. As an example of another biological question addressed, this same powerful line of reasoning has been expanded to the challenging problem of understanding pollen folding/unfolding. In pollen, proper unfolding is a requirement for fertilization. Therefore designing pollen grains to guarantee unfolding is critical for reproductive success.

Thus, proper understanding of a physical system has shed light on seemingly much more complex biological problems. As a part of their training, IGERT students in this program are developing the interdisciplinary skills to address a variety of biological problems successfully in novel ways.

National Science Foundation

CCLI *(Course, Curriculum, and Laboratory Improvement)*

The Course, Curriculum, and Laboratory Improvement (CCLI) program seeks to improve the quality of science, technology, engineering, and mathematics (STEM) education for all undergraduate students.

- **The program supports efforts to create, adapt, and disseminate new learning materials and teaching strategies, develop faculty expertise, implement educational innovations, assess learning and evaluate innovations, and conduct research on STEM teaching and learning.**
- **The program supports three types of projects representing three different phases of development, ranging from small, exploratory investigations to large, comprehensive projects.**

National Science Foundation

CCLI *Highlight*

NSF Highlights

Molecular Structure and Function in an Undergraduate Curriculum

Highlight ID: 790

The Milwaukee School of Engineering is exploring the use of physical models of molecular structures in teaching concepts of molecular structure and function, with the support of the CCLI program. They are particularly interested in exploring the relationship between physical models and computer-based molecular visualization software. The Center for BioMolecular Modeling at the Milwaukee School of Engineering uses rapid prototyping technology to produce accurate three dimensional physical models of proteins and other biomolecules based on the atomic coordinates of their structures as deposited in the Protein Data Bank. These models are being field tested in undergraduate and high school classes, as well as research laboratories. Sample field-test sites include biochemistry courses at DePauw University, a large freshman chemistry course and honors cell biology class at UW-Madison, and an upper-level graduate course UW-Milwaukee. In the summer of 2002, the project hosted a meeting of 28 undergraduate educators to discuss their experiences in using physical models in conjunction with computer modeling software. The models created in this project are also used in a professional development program targeting high school science teachers in a large urban Milwaukee Public School District. The physical models are receiving an enthusiastic reception from all field testers, and the project is collecting data supporting the notion that physical models greatly enhance the value of computer-based molecular visualization software in the molecular biosciences. As reported in an annual report submitted in February 2003. http://www.rpc.msoe.edu/cbm/.

Students experimenting with three-dimensional physical models of biomolecules in conjunction with computer visualization software.

Permission Not Granted

National Science Foundation

UBM *(Interdisciplinary Training for Undergraduates in the Biological and Mathematical Sciences)*

- **The goal of the Undergraduate Biology and Mathematics (UBM) activity is to enhance undergraduate education and training at the intersection of the biological and mathematical sciences and to better prepare undergraduate biology or mathematics students to pursue graduate study and careers in fields that integrate the mathematical and biological sciences.**

  The core of the activity is jointly-conducted long-term research experiences for interdisciplinary balanced teams of at least two undergraduates from departments in the biological and mathematical sciences.

- **Projects should provide students exposure to contemporary mathematics and biology, addressed with modern research tools and methods.**
- **Projects must involve students from both areas in collaborative research experiences and include joint mentorship by faculty in both fields.**

National Science Foundation

UBM *Highlight*

NSF Highlights

UBM: Training Undergraduates in Mathematics and Biology at the University of Louisiana Lafayette

Highlight ID: 14362

Professor Azmy S. Ackleh, working with Jacoby Carter, an ecologist from the USGS National Wetlands Research Center (NWRC), developed a two-year pilot program for training undergraduates in the interdisciplinary area of mathematical biology through course work and research. The research project that the selected undergraduates participated in involves the integration of mathematical modeling and field data to understand the dynamics of the green tree frog population at four ponds around the NWRC complex. Using a mark-recapture technique and statistical methods, Professor Ackleh and his team were able to obtain weekly estimates of this frog population during their breeding season. Furthermore, they developed an age-structured population model which describes the dynamics of this species. Initial results indicate that this model exhibits similar behavior as suggested by the weekly population estimates obtained from field data.

This project has recently been expanded to add Professor Susan Mopper, Department of Biology, as another faculty mentor. In addition, considerable work has been done to create more sophisticated tools to track the tree frogs and obtain more informative field data.

Primary Strategic Outcome Goal:

- Learning: Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens.

Secondary Strategic Outcome Goals:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This project serves as an interdisciplinary training ground for undergraduate students who participate in both the mathematical modeling of the dynamics of the frog population and the collection of the field data. By incorporating field data into mathematical models, students receive training and experience in the increasingly essential mathematical and computational tools necessary for understanding complex biological systems.

Green tree frog.

Permission Not Granted

Lanminh measures the frog's body length while Joanna records the alpha numeric tag number.

Permission Not Granted

National Science Foundation

UBM *Highlight*

NSF Highlights

UBM: Truman State Student Receives Environmental Award at MAA MathFest

Highlight ID: 16381

Echolocation calls have often been used by biologists to identify free flying bats, thereby allowing an investigator to survey an area without ever physically capturing a specimen. However, groups of closely related species often have similarly structured bat calls, and determining the presence of a particular species may not be possible. Accurate identification of free flying bats from their calls is dependent upon a reference library of known calls and a rigorous analytical methodology to differentiate species. This project entailed building a reference library of calls for Missouri bats (*i.e.*, going out and recording their calls) and using statistical and analytical techniques such as discriminant function analysis, used to determine which variables will discriminate between two or more naturally occuring groups, to refine the analytical capabilities of current identification tools.

In a presentation at MathFest 2007, sponsored by the Mathematical Association of America, Joshua Kelly described the results of this project, which involved collaborations between mathematics and biology students and was supervised by Professors Scott Burt (Biology) and Jason Miller (Mathematics). Measurements from echolocation recordings of seven species of bats were used to construct algorithms for identifying bats to species. Resulting classification rates compared well to those in the scientific literature. Not found in the literature are reports on the reliability of similar models and their susceptibility to biotic and abiotic variations in data. Classification trees are shown to be somewhat sensitive to such variation and discriminant analysis models are shown to be more robust. To conclude the presentation, Mr. Kelly discussed the appropriateness of these models for determining species richness as well as the implications of using such models for conservation efforts of endangered species.

Mr. Kelly's presentation received an Environmental Special Interest Group Award.

Just after learning the technique, Prof. Jason Miller demonstrates how to hold a bat safely.

Permission Not Granted

National Science Foundation

REU
(Research Experiences for Undergraduates)

REU projects involve students in meaningful ways in ongoing research programs or in research projects specifically designed for the REU program. This solicitation features two mechanisms for support of student research:

(1) REU Sites are based on independent proposals to initiate and conduct projects that engage a number of students in research. REU Sites may be based in a single discipline or academic department, or on interdisciplinary or multi-department research opportunities with a coherent intellectual theme. Proposals with an international dimension are welcome. A partnership with the Department of Defense supports REU Sites in DoD-relevant research areas.

(2) REU Supplements may be requested for ongoing NSF-funded research projects or may be included as a component of proposals for new or renewal NSF grants or cooperative agreements.

National Science Foundation

REU *Highlight*

NSF Highlights

Alcohol's Effect on Neuron Firing

Highlight ID: 12105

Undergraduate researchers Jeannine Abiva (Loyola Marymount University), Edna Joseph (University of the Virgin Islands), Arpy Mikaelian (University of California-Santa Barbara) and Charles Rogers (North Carolina State University) working with faculty mentors Erika Camacho and Stephen Wirkus at the REU site at California State Polytechnic University Pomona mathematically modeled the effects of alcohol on a single neuron firing using the Hodgkin-Huxley model as a framework. Neurons are responsible for transmitting messages throughout the body via long distance electrical signals known as action potentials. These depend on the active transport of sodium and potassium ions across the cell membrane. The Hodgkin-Huxley equations mathematically model the influx and efflux of these ions across the cell membrane. In the presence of alcohol, the release of potassium ions is accelerated. Their hypothesis that the initial proportion of open potassium gates can not be less than that for the original Hodgkin-Huxley equations was supported. The enhanced recovery period implies that a stronger stimulus is required during the recovery period for a second action potential to be achieved. Thus, under the influence of alcohol a neuron is less receptive to any stimulus. Foremost, the hypotheses that they tested and confirmed explained mathematically how alcohol effects a single neuron firing.

Cal Poly- Pomona REU students

Permission Not Granted

Primary Goal Indicators:

- Connections

Secondary Goal Indicators:

- Contributions

This work is notable because:
The results could serve as a guide for other researchers to better understand alcohol's effects on the human body and thereby find possible ways of reducing these effects.

National Science Foundation

MSP
(Math & Science Partnership Program)

- **The Math and Science Partnership (MSP) program is a major research and development effort that supports innovative partnerships to improve K-12 student achievement in mathematics and science.**
- **MSP projects are expected to raise the achievement levels of all students and significantly reduce achievement gaps in the mathematics and science performance of diverse student populations.**
- **In order to improve the mathematics and science achievement of the Nation's students, MSP projects contribute to the knowledge base for mathematics and science education and serve as models that have a sufficiently strong evidence base to be replicated in educational practice.**

National Science Foundation

MSP *Highlight*

NSF Highlights

University Scientists, Mathematicians and Engineers Bring the Vitality of Research into the K-12 Classroom

Highlight ID: 10747

The Math and Science Partnership (MSP) program engages and challenges mathematics, science and engineering faculty to create new and interesting roles by which they can contribute to the work of K-12 science and mathematics. The MSP project called *SCALE (System-wide Change for All Learners and Educators)* which partners the school districts of Denver, Los Angeles, Madison (WI) and Providence (RI) with the University of Wisconsin-Madison, University of Pittsburgh and California State University, Dominguez Hills has, for example, fashioned interdisciplinary teams to develop and implement Immersion Units for K-12 students. Each Immersion Unit is an extended, guided and rigorous investigation of a science/mathematics topic, coordinated with district standards and curriculum, that provides strategic opportunities for students to pose their own questions on relevant topics, do research on those topics and then design an experiment to answer the questions they have posed.

In another MSP project, *Teachers and Scientists Collaborating* (TASC) partners Duke University's Pratt School of Engineering with eight school districts in North Carolina, the North Carolina Department of Public Instruction and GlaxoSmithKline. Scientists from universities, government agencies and industry engage K-8 teachers and students in experiences that facilitate the acquisition of the habits of mind of the scientist and the ability to think as the scientist thinks: critically, creatively and independently. The scientists themselves participate in professional development on the use of inquiry-based science curricula and in turn work with teachers on curriculum-specific topics, collaborate on the development of lessons and contribute to the delivery of on-site professional development for teachers and to the implementation of challenging units in their classrooms.

A Providence Public Schools administrator holding a sow bug garden necklace during a demonstration by a University of Wisconsin-Madison scientist.

Permission Granted

Credit: Project team for SCALE, Award 0227016

National Science Foundation

Where to Find More Information

- National Science Foundation Website
  - www.nsf.gov
- Solicitations
  - Search on acronyms, if known
- Contact a program officer in the directorate closest to your interests

National Science Foundation

Proposal Development and Submission

National Science Foundation

A Good Proposal Is:

- **A Good Idea**
- **Well Expressed**
- **With a Clear Indication of Methods for**
  - o ***Pursuing the Idea***
  - o ***Evaluating the Findings***
  - o ***and Making Them Known to All Who Need to Know***

National Science Foundation

Research Development Strategies
Individual Investigator

- **Determine Your Long-Term Research Goals or Plan**
- **Develop Your Bright Idea**
  - ***Survey the Literature***
  - ***Contact Investigators Working on Topic***
  - ***Prepare a Brief Concept Paper***
  - ***Discuss With Colleagues/Mentors***
- **Prepare to Do the Research**
  - ***Determine Available Resources***
  - ***Realistically Assess Needs***
  - ***Develop Preliminary Data***
  - ***Present to Colleagues/Mentors/Students***

National Science Foundation

Research Development Strategies
Individual Investigator (con't)

Determine Possible Funding Sources

Understand the Ground Rules

- **Ascertain Overall Scope and Mission**
- **Read Carefully Announcement/Instructions**
- **Determine Where Your Project Fits**
- **Ascertain Evaluation Procedures and Criteria**
- **Talk With Program Officer:**
  - ***Your Proposed Project***
  - ***Specific Program Requirements/Limitations***
  - ***Current Program Patterns***
  - ***Reviewing a Successful Proposal***

Coordinate With Your Institution/Research Office

National Science Foundation

Project Development Key Questions for Prospective Investigator

1. What Do You Intend to Do?
2. Why Is the Work Important?
3. What Has Already Been Done?
4. How Are You Going to Do the Work?

National Science Foundation

Project Development

Clear Problem Statement

- **Needs to Be Met or Problem to Be Solved**
- **What You Want to and Can Accomplish**

Significance of Proposed Work

- **Background**
  - ***Relevant Literature***
  - ***Gaps to Be Filled***
- **Importance/Justification**
  - ***Discipline***
  - ***Fields Outside of Discipline***
  - ***Future (Long Term Context)***

Feasibility of Proposed Research

- **Valid, Testable Hypothesis**
- **Qualifications of Investigators**
- **Available Resources**
- **Preliminary Data**

National Science Foundation

Project Development (con't)

Experimental Plan

- **Project Design**
- **Methodology (Feasible, Adequate, Appropriate)**
  - ***Innovations***
  - ***Limitations***
  - ***Difficulties Anticipated/Alternative Approaches***
- **Sequence (Activities Schedule/Timeline)**

Outcome and Assessment

- **Data Analysis**
- **Interpretation of Anticipated Results**
- **Evaluation**
  - ***Assessment Activities***
  - ***Check Points to Chart Progress***

Continuation

- **Plan(s) for Continuation Beyond Grant Period**
- **Long Range Research Plan**

National Science Foundation

Project Description

Utilize Available Expertise

- Peer/Mentor Input
- Pre-Submission "Reviewer" Comments
- Previous Submission Input
  - *Program Officer*
  - *Reviewers*
- Consultant Use on Project

Develop Ideas Clearly and Logically

- Put Essence of Work at Beginning, Not End
- Ensure Coherent Direction
- Organize to Permit Ease of Skimming
- Never Assume, "Reader Will Know What I Mean"

National Science Foundation

Project Description (con't)

Selectively Use Clarifying Materials to Accent Main Points

- **Well Designed Visuals**
- **Other Clarifying Materials**
- **Confine Supplementary Material to Appendix**

"Sell" Your Project

- **Write to Evaluation Criteria**
- **Address Special Requirements**
- **Convey a Sense of Enthusiasm for Your Work**

National Science Foundation

Project Description (con't)

Use Concise Scientific Writing Style

- **Simple Sentence Structure**
- **Acronyms and Jargon**
- **Page Limitation**

Allow Time for Thorough Editing and Proofing

Convey Image of Investigator's Work Through Proposal

Package Neatly, Not Slickly

Check for Completeness

Special Situations

- **Equipment Proposals**
- **Group Proposals**

National Science Foundation

Budgetary Guidelines

- **Amounts**
  - **Reasonable for Work - Realistic**
  - **Well Justified - Need Established**
  - **In Line with Program Requests**
- **Eligible Costs**
  - **Personnel**
  - **Equipment**
  - **Travel**
  - **Other Direct Costs, Subawards**
  - **Indirect Costs**
- **General Suggestions**
  - **Cost Sharing by Institution and Other Sources**
  - **All Funding Sources Noted**
  - **Help from Research Office**

Post Facto

- **Follow-Up with Program Officer**
  - **Changed Circumstances**
  - **Proposed Work Affected by New Developments**
  - **Inquiries**
- **Grant - Reward for:**
  - **Outstanding Qualifications**
  - **High Quality Research**
  - **Good Presentation**
  - **Sustained Effort and Considerable Patience**
- **Don’t Despair!**
  - **Perseverance Pays Off**
  - **NSF Awards Highly Competitive**
  - **Declination May Be Because of Budgetary Limitations**
  - **Resubmit - Try, Try Again**

National Science Foundation

Getting Support In Proposal Writing

- NSF Publications
  - Program Announcements
  - Grant Proposal Guide
  - Web Pages
- Program Officers
  - Incumbent
  - Former “Rotators”
- Mentors on Campus
- Previous Panelists
- Serve As Reviewer
- Sponsored Research Office
- Experienced Panelists
- Serve as Panelist
- Successful Proposals

National Science Foundation

Getting NSF Publications

- **World Wide Web**
  - **http://www.nsf.gov**
- **Internet Gopher and FTP**
  - **stis.nsf.gov**
- **E-Mail Requests (Electronically)**
  - **stisserve@nsf.gov**
- **E-Mail Requests (Paper Copies)**
  - **pubs@nsf.gov**
- **Phone Requests**
  - **703-306-1130**
- **FAX Requests**
  - **703-644-4278**
- **Mail Requests**
  - **NSF Forms and Publications Unit**
    4201 Wilson Boulevard
    Rm. P-15
    Arlington, VA 22230

National Science Foundation

Grant Proposal Guide

- **Provides Guidance for Preparation of Proposals**
- **Contains All Forms Necessary for Proposal Submission**
- **Specifies Process for Deviations Including:**
  - **Individual Program Announcements; and**
  - **By Written Approval of Cognizant AD or Designee**

National Science Foundation

Grant Proposal Guide (cont'd)

- **Describes Process for Withdrawals, Returns and Declinations**
- **Describes the Award Process and Procedures for Requesting Continued Support**
- **Identifies Significant Grant Administrative Highlights**
- **Provides Listing of Programs Providing Support**

National Science Foundation

NSF Merit Review

National Science Board approved criteria include:

- **Intellectual Merit**
- **Broader Impacts of the Proposed Effort**

National Science Foundation

What is the intellectual merit?

- **Potential Considerations:**
  - **How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields?**
  - **How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.)**
  - **To what extent does the proposed activity suggest and explore creative and original concepts?**
  - **How well conceived and organized is the proposed activity?**
  - **Is there sufficient access to resources?**

National Science Foundation

What are the broader impacts?

- **Potential Considerations:**
  - **How well does the activity advance discovery and understanding while promoting teaching, training and learning?**
  - **How well does the activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?**
  - **To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks and partnerships?**
  - **Will the results be disseminated broadly to enhance scientific and technological understanding?**
  - **What may be the benefits of the proposed activity to society?**

National Science Foundation

Reasons for Funding a Competitive Proposal

- **Likely high impact**
- **PI Career Point (tenured?/"established"/ "young")**
- **Place in Program Portfolio**
- **Other Support for PI**
- **Impact on Institution/State**
- **Special Programmatic Considerations (CAREER/RUI/EPSCoR)**
- **Diversity Issues**
- **Educational Impact**
- **"Launching" versus "Maintaining"**