



NSF Interdisciplinary Research

*funding opportunities for your
interdisciplinary research and education
proposals*

Presented by
Research Development



The University of Kansas

Agenda

- Introductions
- NSF Interdisciplinary Research
- Examples of funded Interdisciplinary projects
- The INSPIRE proposal process
- Resources available to assist you
- Idea time

Setting the Table

- Think: 2 BIG research problems/topics
- Table introductions
 - Name
 - Affiliation or Work Group
 - Your 2 Big Research problems

NSF Interdisciplinary Research

- NSF Goals:
 - Transform the Frontiers
 - Make investments that lead to emerging new fields of science and engineering
- IDR “...**integrates** information, data, techniques, tools, perspectives, concepts, and/or theories from **two or more** disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are **beyond the scope** of a single discipline or area of research practice.”

NSF FY14 Budget Request*

- +• Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) (\$300M)
- +• Cyberinfrastructure Framework for 21st Century Science, Engineering, and Education (CIF21) (\$155M)
- +• NSF Innovation Corps (I-Corps) (\$25M)
- +• Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE) (\$63M)
 - Science, Engineering, and Education for Sustainability (SEES) (\$223M)
 - Secure and Trustworthy Cyberspace (SaTC) (\$110M)

*www.nsf.gov/about/budget

NSF FY14 R&RA Allocation

| FY2012 | FY2013 | FY2014 |
|--------|--------|--------|
| \$5.7B | \$5.5B | \$5.8B |

- NSF is prioritizing initiatives
- Congress has expressed concern about new initiatives

NSF INSPIRE

- Evolving program
- Key concept
 - *“INSPIRE was established to address some of the most complicated and pressing scientific problems that lie at the intersections of traditional disciplines ... It is intended to encourage investigators to submit bold, exceptional proposals that some may consider to be at a disadvantage in a standard NSF review process”*

NSF INSPIRE

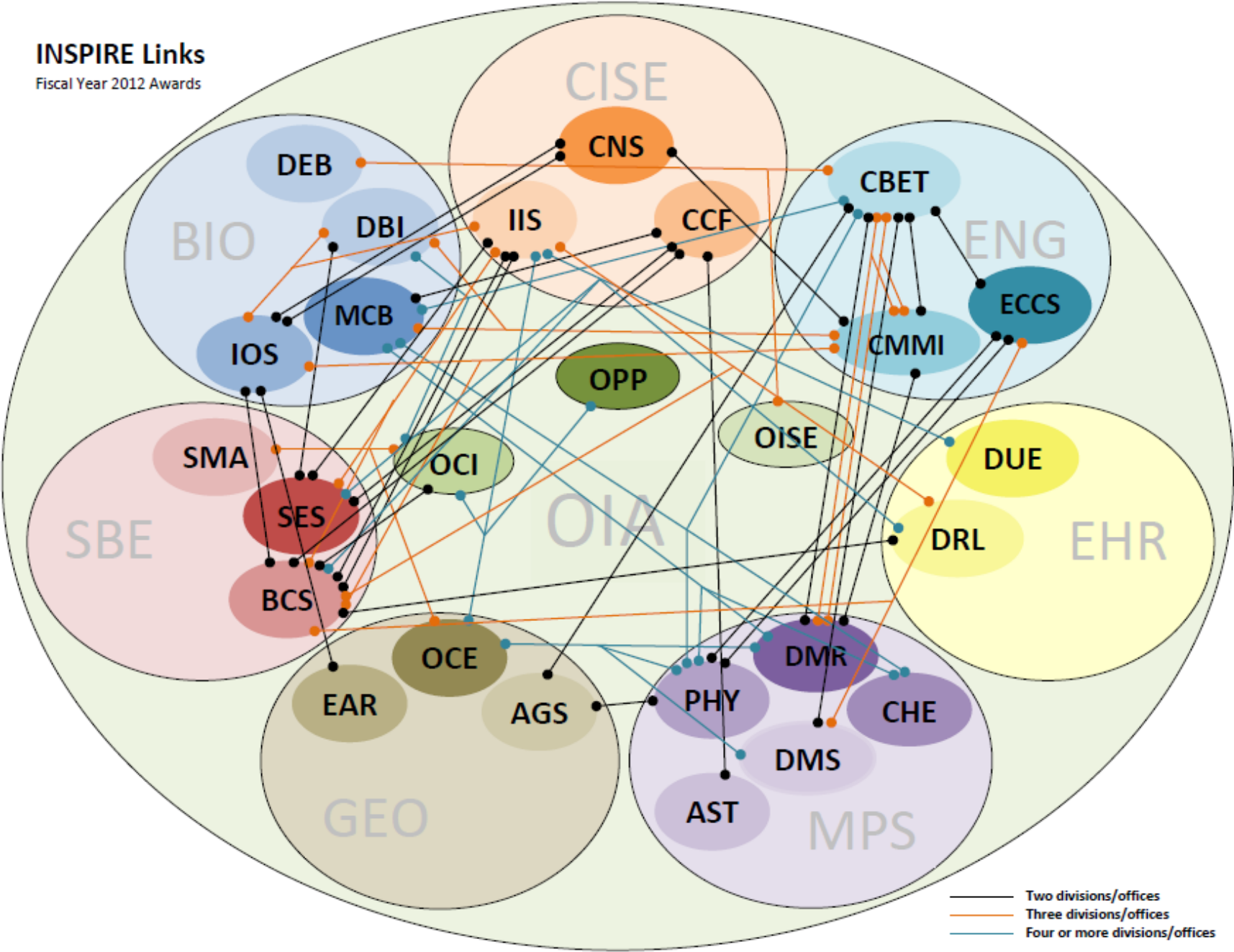
- Support by at least two divisions or programs
- Not suitable for other funding mechanisms
- Track 1: \$800K-\$1M
- Track 2: “mid-scale”, up to \$3M
- Alternative review process (internal)
- LOI was a technical summary

NSF Organization

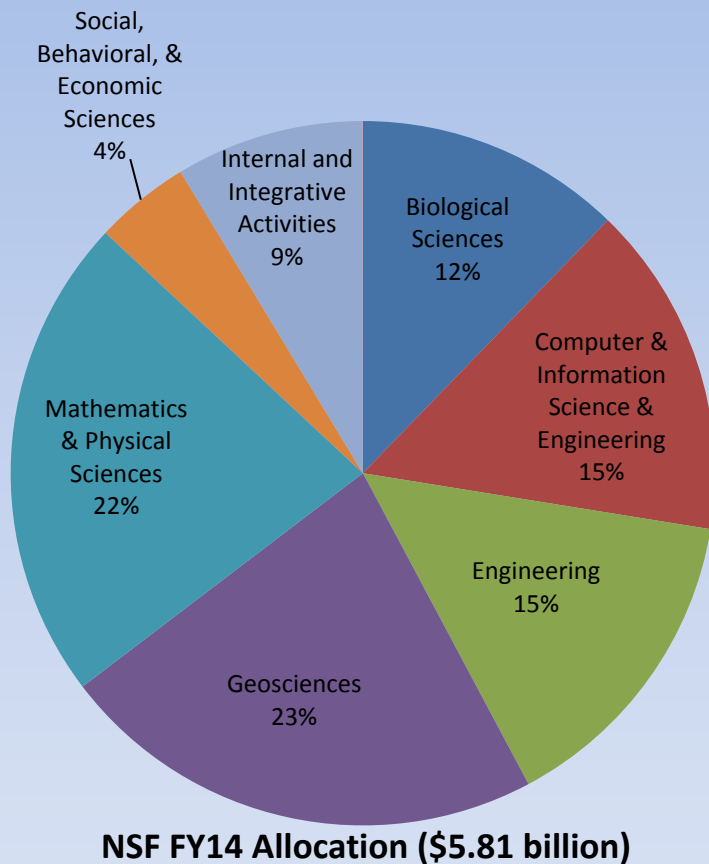
| Office of Director | | | | | | |
|--------------------------------------|---|-----------------------------------|--|--------------------------------|--------------------------------|-------------------------------------|
| Biological Sciences (BIO) | Computer & Information Science (CISE) | Education & Human Resources (EHR) | Engineering (ENG) | Geosciences (GEO) | Math & Physical Sciences (MPS) | Social, Behavioral, Economic (SBE) |
| Biological Infrastructure (DBI) | Computer and Network Systems (CNS) | Graduate Education (DGE) | Chem, BioEngr, Environ and Transport CBET) | Atmospheric and Geospace (AGS) | Astronomical Sciences (AST) | Behavioral and Cognitive (BCS) |
| Environmental Biology (DEB) | Computing and Communication (CCF) | HR Development (HRD) | Civil, Mech and Mfg Innovation (CMMI) | Earth Sciences (EAR) | Chemistry (CHE) | Social and Economic (SES) |
| Integrative Organismal Systems (IOS) | Advanced Cyberinfrastructure (ACI) | Research on Learning (DRL) | Elect, Comms and Cyber Sys (ECCS) | Ocean Sciences (OCE) | Materials Research (DMR) | Science and Engr Statistics (NCSES) |
| Molecular & Cellular Biosci (MCB) | Information and Intelligent Systems (IIS) | Undergrad Education (DUE) | Engr Education Centers (EEC) | Polar Programs (PLR) | Mathematical Sciences (DMS) | |
| Emerging Frontiers (EF) | | | Industrial Info & Partnerships (IIP) | | Physics (PHY) | |
| | | | Emerging Frontiers (EFRI) | | MultiD Activities (OMA) | |

INSPIRE Links

Fiscal Year 2012 Awards



Examples of NSF Interdisciplinary Projects



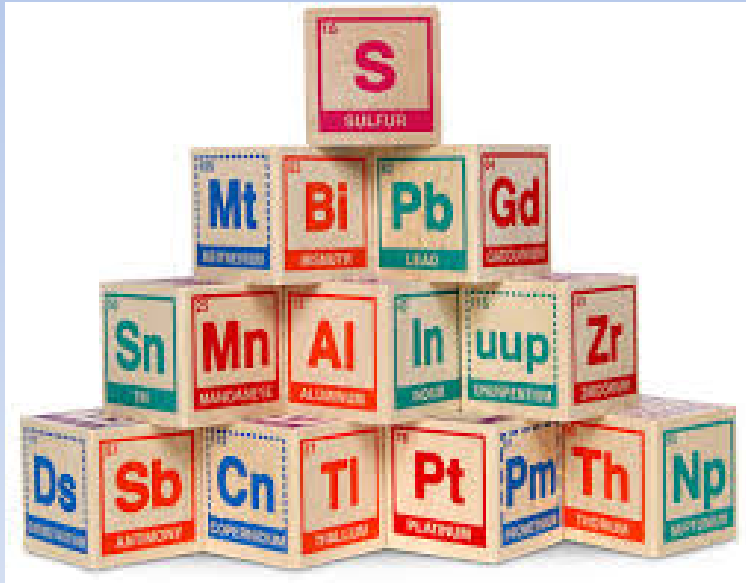
- Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE)
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504852
- Sustainability Research Networks Competition (SRN)
www.nsf.gov/funding/pgm_summ.jsp?pims_id=503645
- Collaborative Research in Computations Neuroscience
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5147
- Dynamics of Coupled Natural and Human Systems
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13681
- Interdisciplinary Behavioral and Social Science Research (IBSS)
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504832
 - Dear Colleague Letter:
<http://www.nsf.gov/pubs/2012/nsf12123/nsf12123.jsp>

#1. Develop your concept

- Transforming disciplines
- Transform your thinking
- Integration and synthesis of methods, skills and theories
- Starting point is common interest in a complex problem
- Communication is the key



IDR Concept



Vs.



Frank and Ernest



#2. Sponsor Interests

- Directorate/Division/Program websites
http://www.nsf.gov/od/iaa/additional_resources/interdisciplinary_research/
- Background Reports (ex. CyberSEES)
- “What has been funded” links

Contacting the Program Officer

- NSF offers guidelines at http://www.nsf.gov/od/ia/additional_resources/interdisciplinary_research/contact_options.jsp
- Other Resources
 - SPIRES, Michael J. (2012, Mar. 28). What to say--and not say--to program officers. *The Chronicle of Higher Education*. <http://chronicle.com/article/what-to-say-and-not-say-to/131282>
 - Nader, Richard. (n.d.) Advice for Meeting Directors at NSF. http://research.ku.edu/grant_writing_tips_helpful_suggestions
 - PORTER, Robert. (2009). Can we talk? Contacting grant program officers. *Research Management Review*, 17 (1), 8 pp. http://research.ku.edu/grant_writing_tips_helpful_suggestions

#3 Find the Funding Opportunity

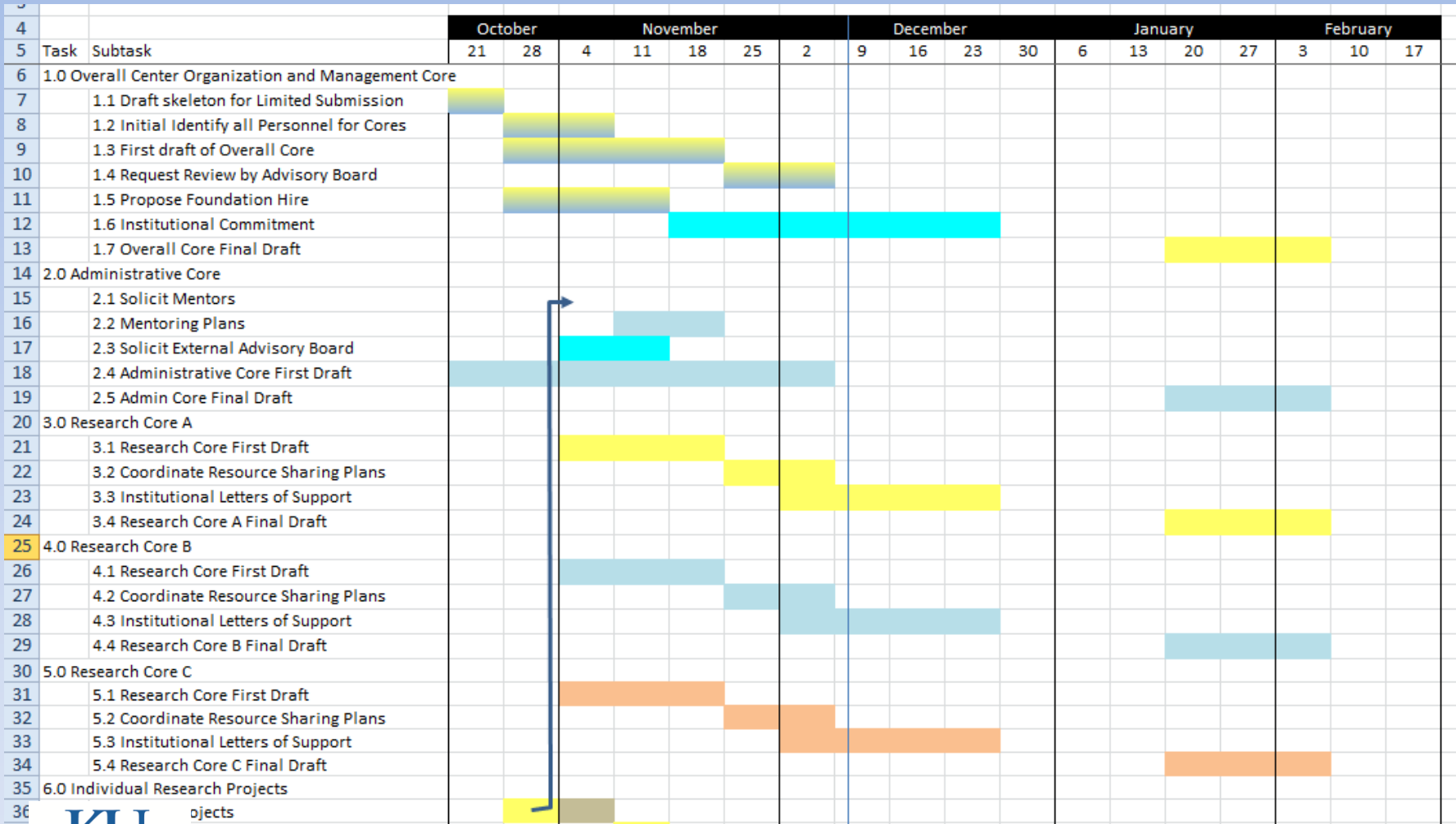
- Solicited Interdisciplinary programs
- Unsolicited IDR
 - Program Officer contacts
 - Directorate IDR contacts
 - http://www.nsf.gov/od/iia/additional_resources/interdisciplinary_research/poc.jsp

Proposal Development Resources

- Where to Begin?
- Sources of Support:
 - Research Centers
 - KUCR Pre-Award
 - Research Development and Collaboration



A Lot of Effort



Final Thoughts

- NSF has Performance Goals
- Continuing to innovate in funding mechanisms
- Traditional Divisions remain >80% of funding
- Why chase this rabbit?
 - Personal development
 - KU competitive position
- Resources available to help

Your Time

- Table topics
- Introductions
- “What do you see as the key problem?”
- “How would you propose to approach research?”
- “Are there other disciplines that you need to solve the problem?”



Contacting Us



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Interdisciplinary NSF Award Examples

INSPIRE Track 1: What is Normal Milk? Sociocultural, Evolutionary, Environmental, and Microbial Aspects of Human Milk Composition \$742,000, Michelle McGuire (Washington State University) with team from UK, Gambia, Ghana, Peru, Kenya, Sweden, Central African Republic, and Canada. *Funded by: Symbiosis, Defense & Self-Recognition Program, Emerging Frontiers (Biology); Information Integration and Informatics and Special Projects programs (Computer & Information Science & Engineering); Office of International Science and Engineering.*

This project represents the first comprehensive investigation of the global differences in human milk composition along with the various microbial, evolutionary, environmental, and sociocultural factors that might influence both milk composition and infant health. An international, interdisciplinary collaboration of physiologists, nutritional scientists, anthropologists, microbiologists, and mathematicians will collect biological data from breastfeeding women and their infants, in concert with extensive anthropologic and ecological data, in both developed (US, Spain, Sweden) and developing countries (Central African Republic, Gambia, Ghana, Peru, and Kenya). To test the possibility of a correlation between milk oligosaccharide composition, milk microbiota, and the gastrointestinal microbiome of infants, milk samples and infant fecal samples will be analyzed using state-of-the-art biochemical and genomic techniques. This study will allow important cross-cultural comparisons of milk composition and infant feeding practices; it also will utilize sophisticated computational methods to integrate the extensive, diverse body of combined biological and anthropological data to elucidate the relationships among sociocultural factors, evolutionary history, environmental exposures, microbial constituents and milk composition. The researchers predict that what is considered "normal" milk composition in one population may not support optimal health in another. This information is crucial to the humanitarian quest to understand how infant nutrition and overall health can be improved around the world. In addition, this project will provide extensive research training opportunities for undergraduate, graduate and postdoctoral scientists.

http://www.nsf.gov/awardsearch/showAward?AWD_ID=1344288&HistoricalAwards=false

RCN-SEES: Coordinating Phosphorus Research to Create a Sustainable Food System \$750,000, James Elser (Arizona State University), with University of Arizona. *Funded by Science, Engineering and Education for Sustainability NSF-Wide Investment (SEES).*

Phosphorus (P) is an essential element to life and, with few exceptions, a necessary fertilizer for high agricultural yield. Because P cannot be manufactured and global supply is limited, this chemical element poses a unique, double-sided threat to sustainability. P scarcity leads to high prices and poverty for poor farmers in developing countries, but in industrialized nations, excess P from farms and in urban waste streams degrades downstream water quality. The issues surrounding P sustainability are deeply complex and involve diverse geological, biogeochemical, economic, and geopolitical dimensions that are currently unconsolidated. Environmental degradation due to nutrient runoff and potential threats to global food security urgently call for an end to this disjointed approach to phosphorus. The goal of the P Sustainability Research Coordination Network (RCN) is to spark an interdisciplinary synthesis of data, perspectives, and understanding about phosphorus to identify and implement solutions for P sustainability.

The RCN theme, objectives, and initial topics build upon broad agreement on key P sustainability challenges reached at a recent Sustainable P Summit (SPS) led by James Elser

and colleague Dan Childers. The RCN will involve two phases centered on three Challenge Areas. Phase I groups will work on two Challenges: (1) Improving P efficiency in food production and (2) Developing robust pathways of P recycling. At the Kick-off Workshop, identified Core Members will develop Working Groups centered on these challenge areas. These Groups will be further populated with At-Large Members recruited through a widely advertised application process that will allow us to target qualified graduate students, postdocs, and members of under-represented groups. In Year 3, a Synthesis Workshop will report on the science and solution outcomes from Phase I and develop new Phase II Working Groups focused on Challenge 3: Integrating efficiency and recycling to create a sustainable food system. <http://sustainability.asu.edu/research/project/704> and http://www.nsf.gov/awardsearch/showAward?AWD_ID=1230603&HistoricalAwards=false

CRCNS: Robust Dynamics of a Feeding Pattern Generator \$509,999, Hillel Chiel (Case Western Reserve University). *Funded by: Directorate for Mathematical & Physical Sciences; Collaborative Research in Computational Neuroscience (CRCNS)*

Walking, swimming, flying, burrowing and chewing are rhythmic behaviors that allow animals to survive and reproduce. These behaviors remain effective even in the presence of unexpected perturbations or noise. The investigators hypothesize that the robustness of a pattern generator is primarily mediated by the interplay of neural dynamics and sensory input. This hypothesis will be tested by (1) studying in vivo responses of a feeding pattern generator to mechanical perturbations in the marine mollusk *Aplysia californica*, whose identified neurons and well-studied biomechanics make it especially experimentally tractable, (2) using theoretical, computational and mathematical tools to develop insight into dynamical architectures of robustness, like globally stable limit cycles or stable heteroclinic channels and (3) testing the central hypothesis using a semi-intact preparation that can generate behavior, and can respond to mechanical perturbations, to determine the role of identified sensory neurons in generating appropriate responses to these perturbations by selectively activating or inhibiting neurons.

Developing an understanding of robust dynamical architectures would have many applications. In particular, the research will open up the possibility of creating control architectures for robots that can flexibly cope with unpredictable environmental changes, and successfully pursue long-term goals despite environmental perturbations. It will play an important role in developing robust prosthetic devices that cope flexibly with everyday tasks, simplifying the process of rehabilitation. http://www.nsf.gov/awardsearch/showAward?AWD_ID=1010434

CNH: Feedbacks Between Human Community Dynamics and Socioecological Vulnerability in a Biodiversity Hotspot \$1,449,521, Scott Yabiku (Arizona State University), with San Diego State University and University of Michigan. *Funded by: Dynamics of Coupled Natural and Human Systems (CNH) Program; Office of International Science and Engineering.*

This interdisciplinary research project will focus on people, community organizations, and the long-term health of natural ecosystems that support people's livelihoods. Early research on human well-being and the environment showed that strong, collectively governed institutions help people to manage common lands in ways that enhance ecosystem services and quality of life. This knowledge has been a key facet of biodiversity conservation and resilience of rural societies worldwide. Some communities are able to adaptively manage their natural resources much better than others under conditions of rapid change and uncertainty. What factors enable collectively governed management institutions to effectively respond to potentially catastrophic

environmental disturbances? In rural societies that are urbanizing, activities of daily life increasingly take place outside the family home, in "non-family organizations" that expand people's perspectives and choices, such as schools, stores, employers, and health clinics. These non-family organizations are not collectively governed and have no clear constituents or responsibilities other than to respond to supply and demand for their services, goods, and experiences. In this project, the researchers will test the hypothesis that the responsiveness of resource- management institutions to rapid environmental change is ultimately tied to the distribution and types of market-driven, non-family organizations within communities. They will conduct their research in the forested buffer zone of the Chitwan National Park, Nepal, a biodiversity hotspot that is home to the endangered Bengal tiger and more than 200,000 Nepali people who live and farm nearby. One of the world's most invasive plants, *Mikania micrantha* ("mile-a-minute weed") recently has spread through community forests and degraded critical ecosystem services that affect wildlife habitat and the livelihoods of residents. To explore the links among non-family organizations, management institutions, and the spread of *Mikania*, the researchers will collect social and ecological data in 21 heterogeneous community forests to develop models of social-ecological vulnerability and resilience to environmental change. They will conduct two experiments to test the relative strength of factors related to *Mikania* success, including an educational intervention with management institutions, and a common garden experiment that manipulates environmental variables linked to *Mikania* growth.

This project will test the ability of the "family modes of organization" framework, a powerful explanatory tool in demography, to identify factors that cause coupled natural and human systems to be vulnerable or resilient to rapid change. The project will be an exemplar of "translational science," interdisciplinary research focused on practical solutions to current problems. The investigators will translate research findings into local action through an intervention aimed to slow the catastrophic spread of invasive, exotic species that threatens biodiversity and human well-being. <http://chans-net.org/projects/cnh-feedbacks-between-human-community-dynamics-and-socioecological-vulnerability-biodiversi> and http://www.nsf.gov/awardsearch/showAward?AWD_ID=1211498&HistoricalAwards=false

IBSS: Age Changes and Gender Differences in Spatial Abilities: Testing the Role of Mobility in Three Non-Industrial Societies and in the U.S. \$999,871, Elizabeth Cashdan (University of Utah). *Funded by: Interdisciplinary Behavioral and Social Sciences Research.*

This interdisciplinary research project will focus on determining how spatial ability is affected by navigational experience and how spatial abilities differ by gender and change with age. Previous research has observed that males generally have larger geographic ranges than females across a wide range of cultures, and males generally have done significantly better at some spatial tests. Because large ranges pose navigational and spatial challenges, many theorists have speculated that gender-related differences in mobility may underlie gender-related differences in spatial performance. This project will test three hypotheses that may explain the root causes of gender-related differences in mobility patterns and evaluate how natural mobility, navigational style, and spatial ability are related. Because there are large cultural differences in age and gender-related patterns of mobility, this project will include participants in communities in Tanzania, Namibia, and Ecuador that subsist on foraging and small-scale farming, and it also will include participants in the United States, where lifestyles are considerably different. The researchers will assess mobility through the use of interviews and by tracking subjects using GPS devices. They will assess navigational and spatial ability through the use of cognitive tests adapted to make them broadly applicable across cultures. The navigational data will be based on both real and virtual world tasks and will include both field and laboratory-based components.

This project will enhance basic understanding of the factors that shape spatial performance as well as how it differs by gender and across cultures. The project will test a number of hypotheses that have been posited in hopes of relating spatial ability to different kinds of experience. Because spatial skills are related to higher levels of performance in mathematics and science, and women and minorities are underrepresented in science, mathematics, engineering, and technology-related fields, greater knowledge about the factors that enhance spatial thinking has the potential to make scientific and technical education and related employment opportunities more broadly accessible. The project will develop and disseminate assessment tools that can be used with people of all ages and different cultures, including non-literate populations, which should help improve spatial capabilities for people in many different environments.

http://www.nsf.gov/awardsearch/showAward?AWD_ID=1329091&HistoricalAwards=false