NATIONAL SCIENCE FOUNDATION

FISCAL YEAR 2013 BUDGET REQUEST

DIRECTORATE FOR BIOLOGICAL SCIENCES

Dr. John C. Wingfield
Assistant Director

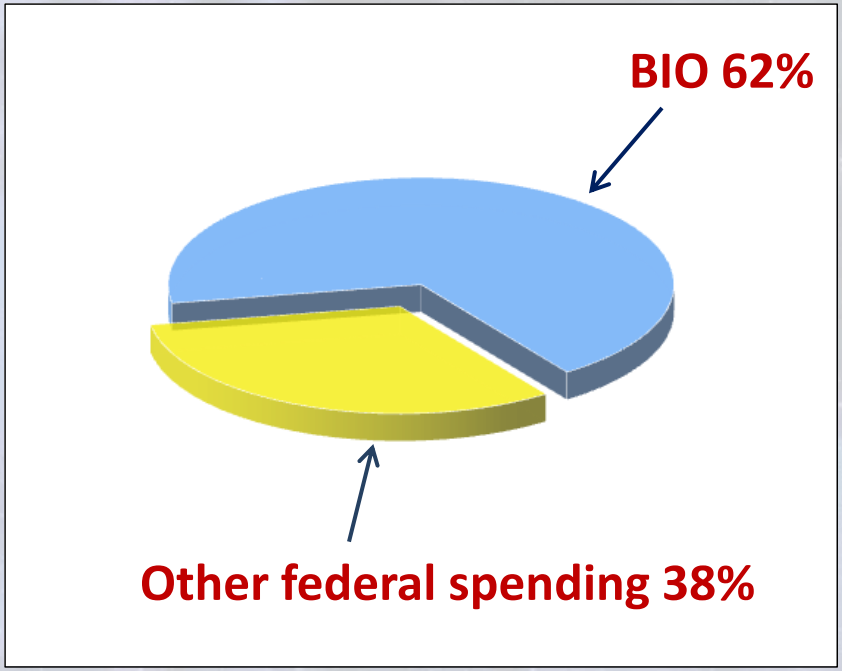
April 26, 2012

BIO FY 2013 Budget Request

TOTAL, BIO R&RA: $733.86 million, +3.0%

Research:	**$552 million**
Learning:	**$30 million**
Infrastructure:	**$141 million**
Administration:	**$11 million**

NEON 3rd Year Construction:
$91 Million



Federal Support for Basic Research in Non-Medical Biological Sciences at Academic Institutions

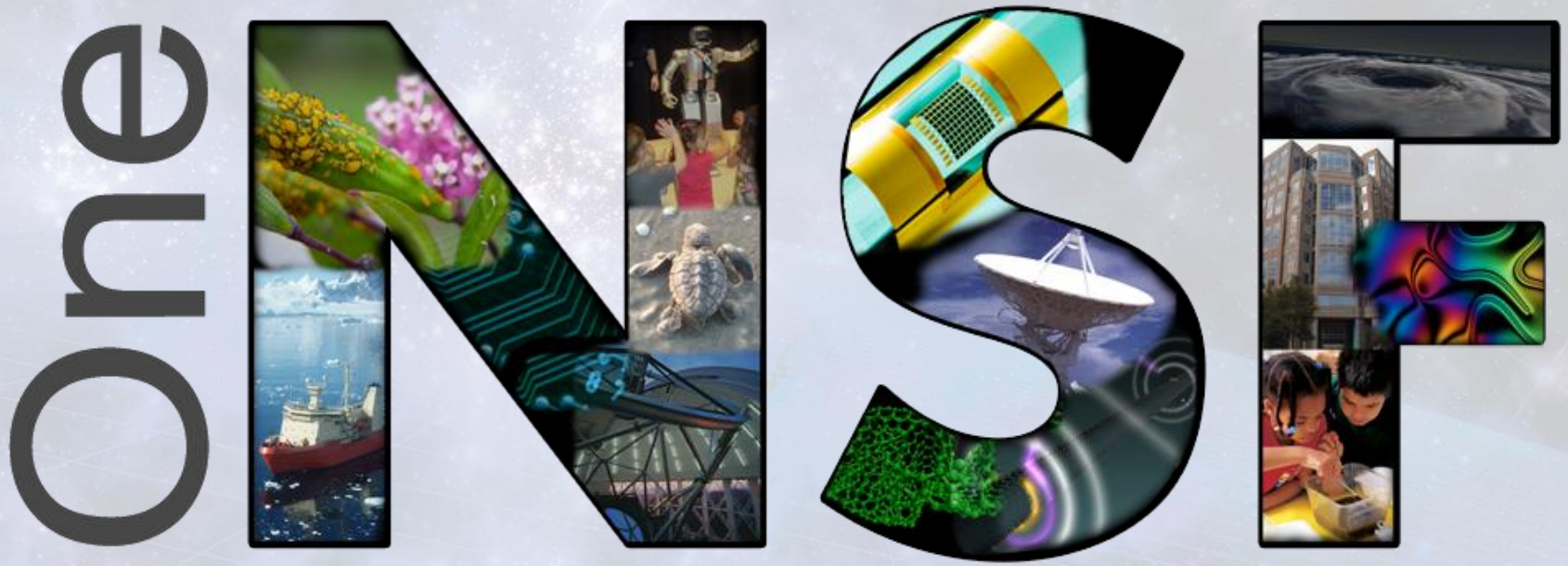
BIO FY 2013 Budget Request

Biological Sciences Funding

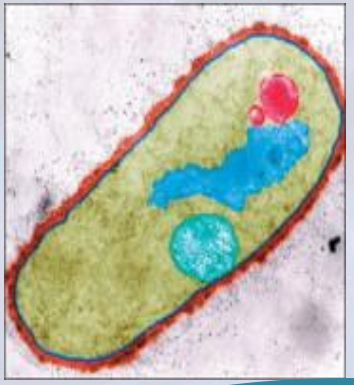
(Dollars in Millions)

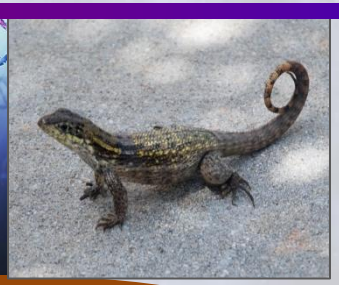
	FY 2011 Actual	FY 2012 Current Plan	FY 2013 Request	Change Over FY 2012 Estimate Amount	Change Over FY 2012 Estimate Percent
Molecular and Cellular Biosciences MCB)	$123.93	$125.79	$132.68	$6.89	5.5%
Integrative Organismal Systems (IOS)	212.56	212.33	220.52	8.19	3.9%
Environmental Biology (DEB)	142.72	142.56	143.73	1.17	0.8%
Biological Infrastructure (DBI)	129.28	126.18	129.68	3.50	2.8%
Emerging Frontiers (EF)	103.79	105.52	107.25	1.73	1.6%
Total, BIO	$712.27	$712.38	$733.86	$21.48	3.0%

Totals may not add due to rounding.

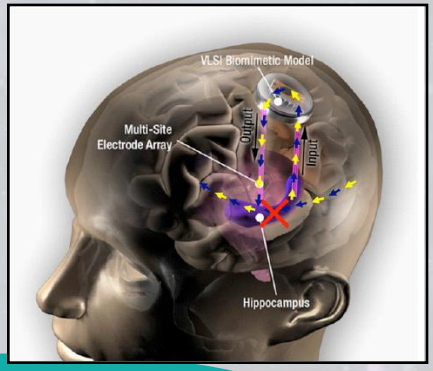

One NSF

Grand Challenges for 21st Century Biology





Genomes to Phenomes



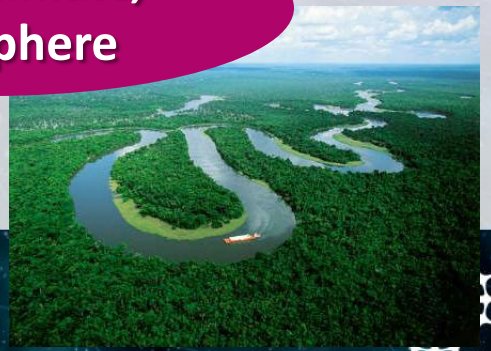
Synthesizing Life

Neural Systems

BIO CORE PROGRAMS

Biological Diversity

Earth, Climate, & Biosphere



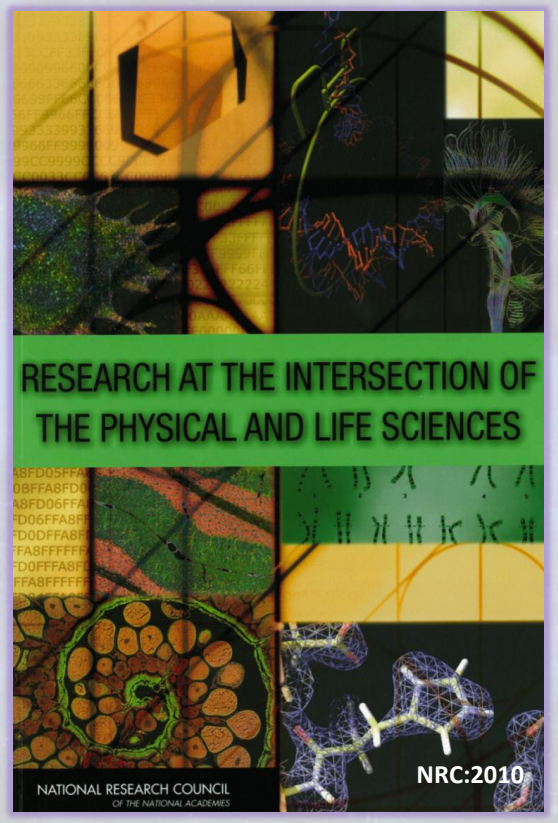
Five Grand Challenges

[From 2009 National Research Council Report]

All BIO Core Programs

+ $20 million

1. Synthesizing Life-Like Systems
2. Genomes to Phenomes
3. The Brain: NeuroSystems
4. Earth, Climate, and Biosphere
5. Biological Diversity



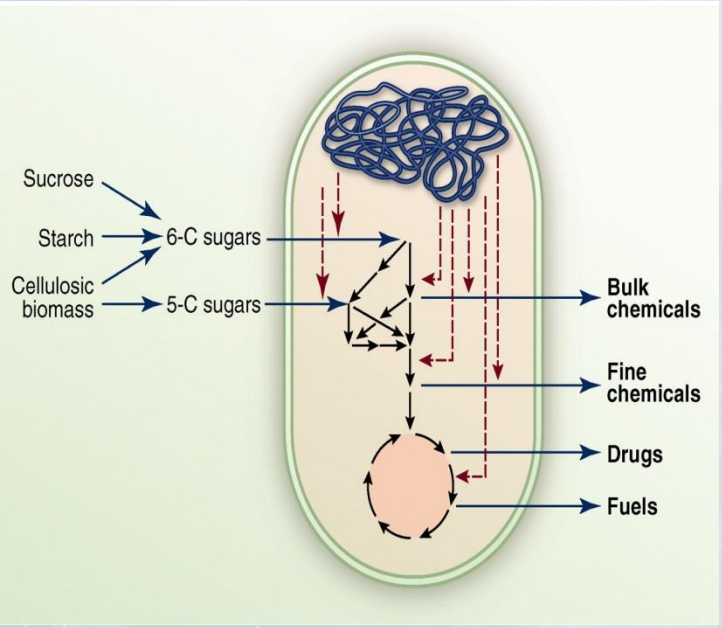
Synthetic Biology

Synthesizing functional genomes and useful compounds

Synthetic chromosome arms in yeast generate phenotypic diversity by design

J. Boeke, NATURE 477: 471; 2011 (NSF)

Yeast cells



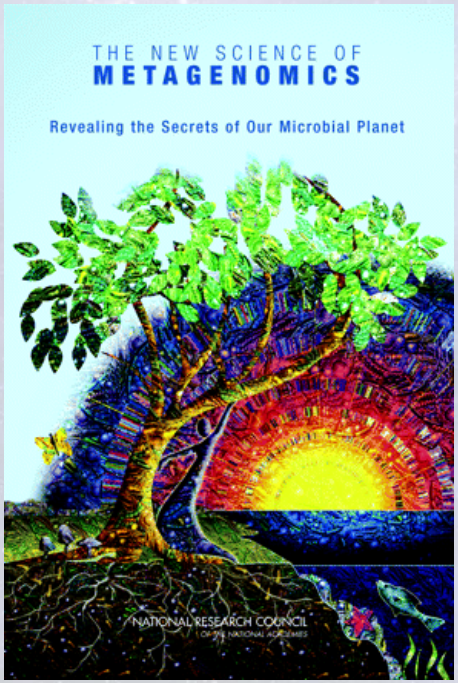
Metabolic engineering using microbes to synthesize the Malaria drug *artemisinin* andthe polyester intermediate *1,3-propanediol*

J. Keasling, Science 330:1355 ; 2010 (NSF)

Genomes to Phenomes

Links genomes to ecosystems to understand the history of our planet and identify possible sustainable futures

Community DNA



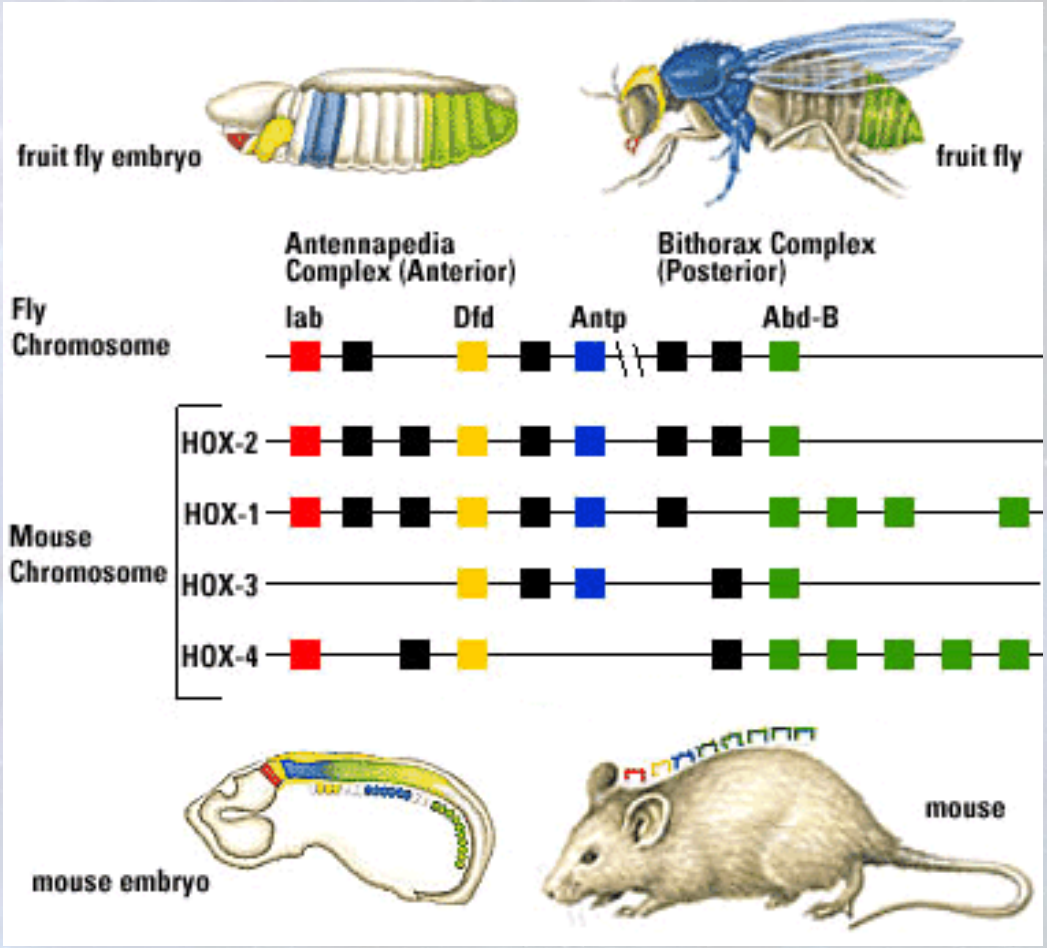
Ecophysiology

Ecosystem Metabolism

EVOLVING GENOMES → **EVOLVING POPULATIONS** → **CHANGING ECOSYSTEMS**

Gene Expression Directly Determines Animal Body Plan (Phenotype)

1. *Hox* gene families occur throughout the animal kingdom.
2. Differential *Hox* gene expression specifies the organization of the animal body plan during development.



Organism - Environment Interactions

The adaptation or extinction of a species depends on its ability to:

1. Anticipate predictable events such as day/night cycles
2. Respond to unpredictable events such as severe storms or climate change

Antarctic snow petrel

Earth, Climate and Biosphere

Understanding how living systems respond to environmental change

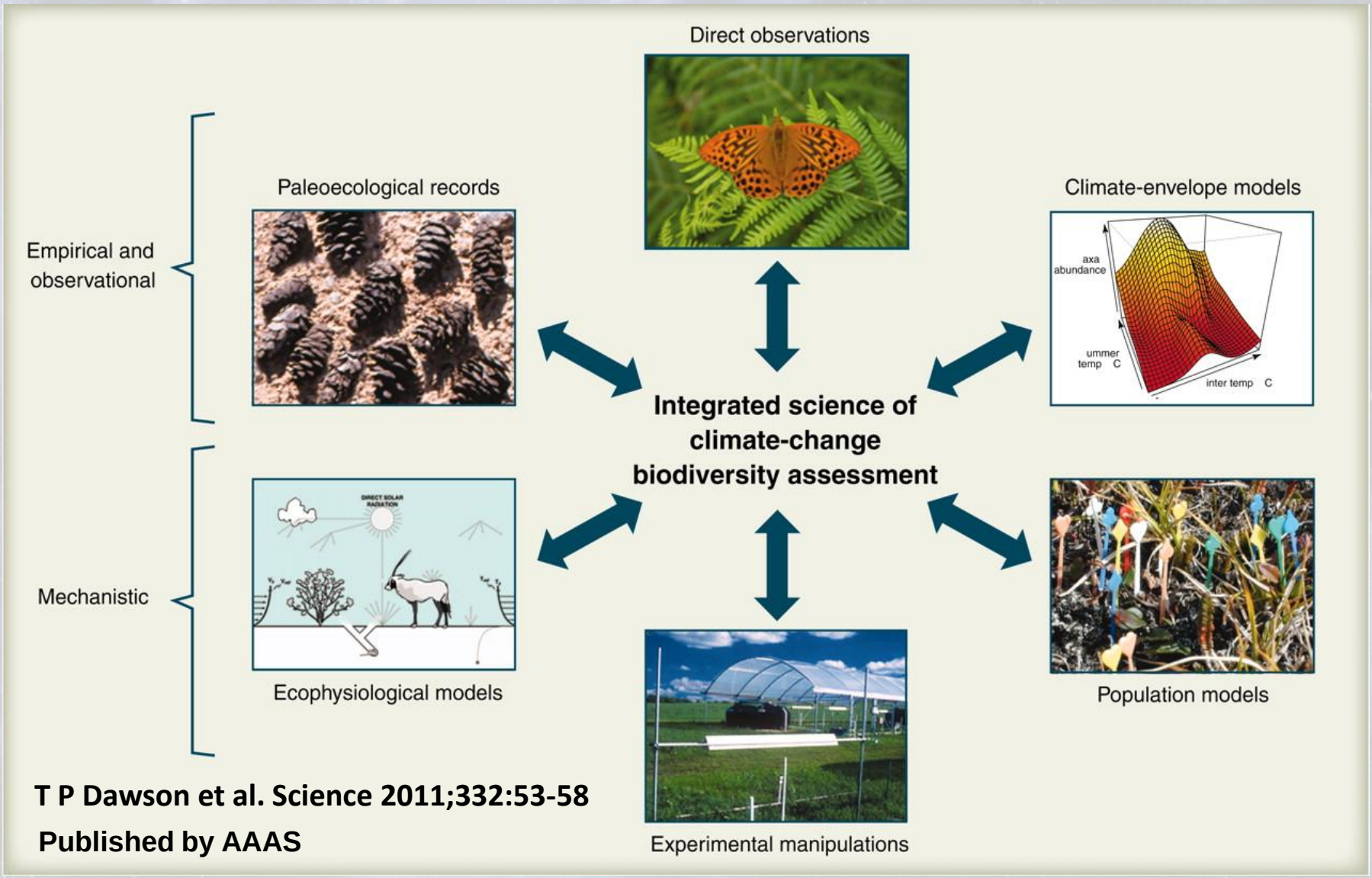
National Ecological Observatory Network

The National Socio-Environmental Synthesis Center

Long-term Ecological Research Program (BIO, GEO, OPP)

Cyber-Enabled Observatories, Synthesis Centers, and Long Term Ecological Research Programs

Biodiversity: Multiple sources and approaches



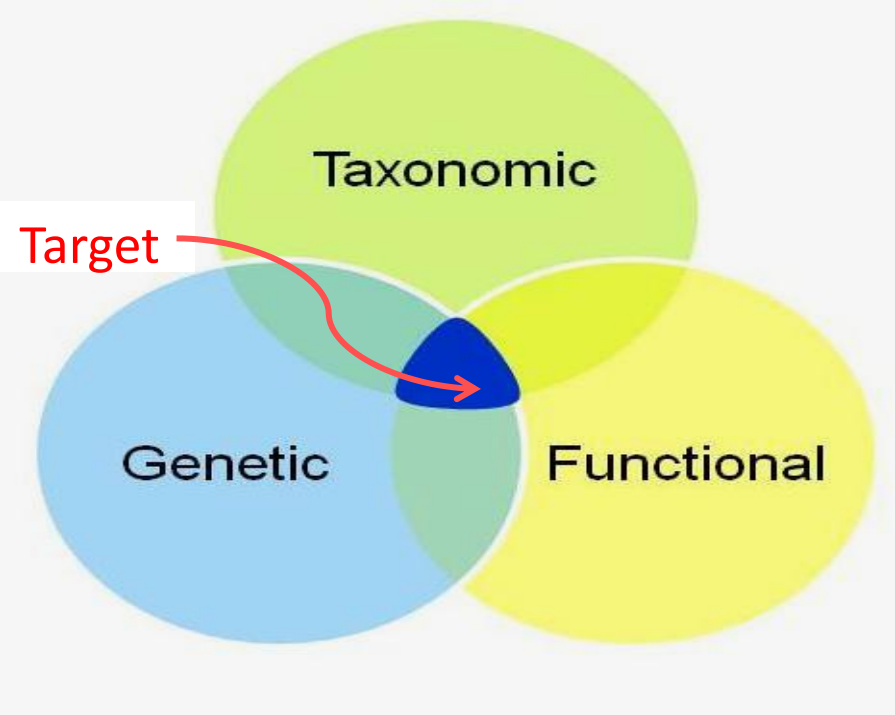
T P Dawson et al. Science 2011;332:53-58

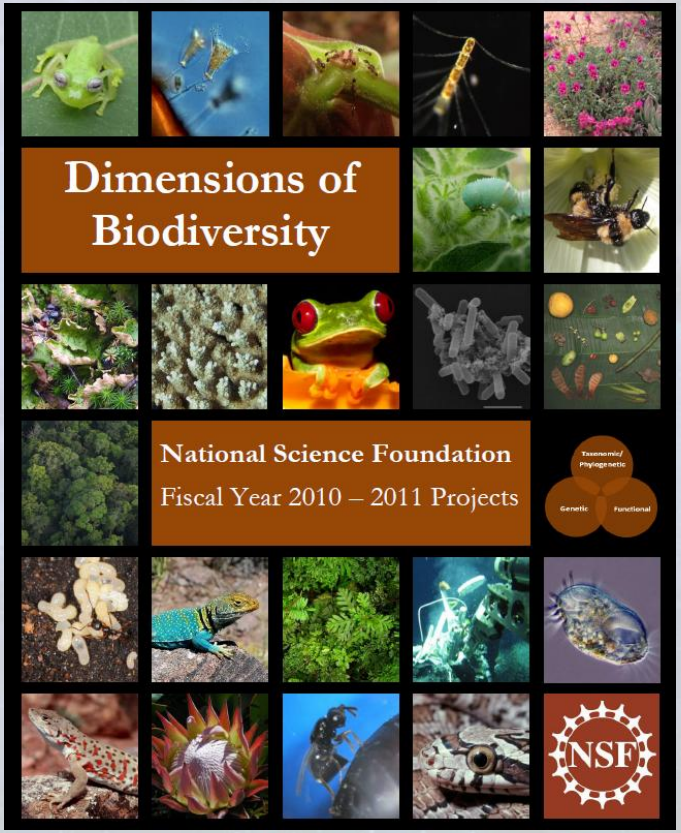
Published by AAAS

Dimensions of Biodiversity

[BIO, GEO, OISE, OPP, Brazil, China]

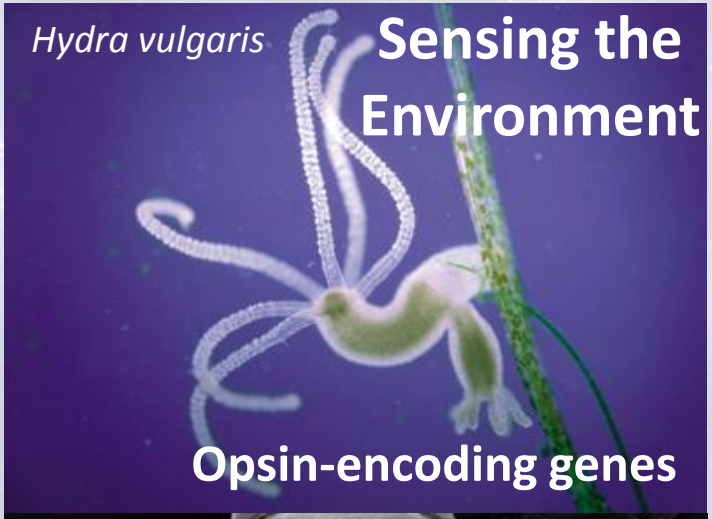
A multi year effort to characterize the dimensions of biodiversity at the intersections of three areas

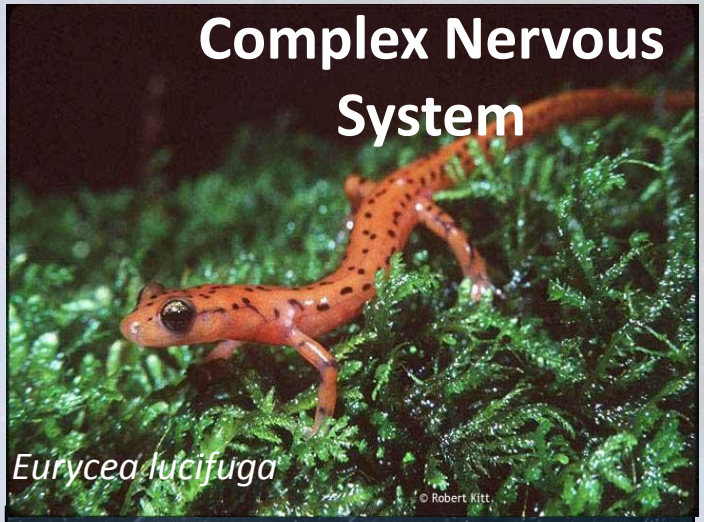


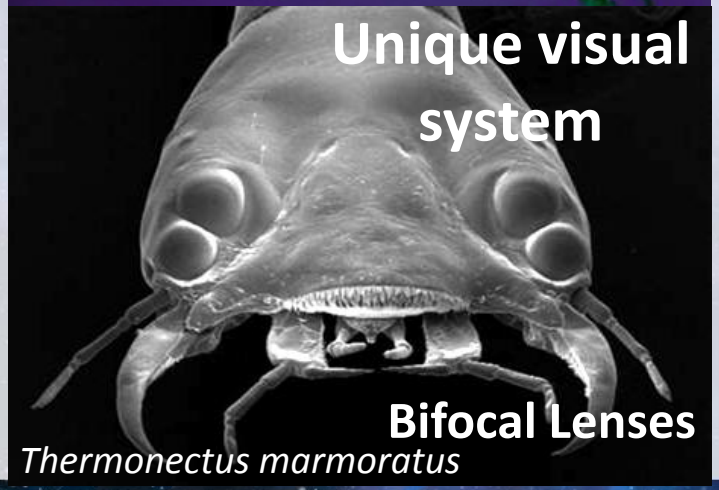


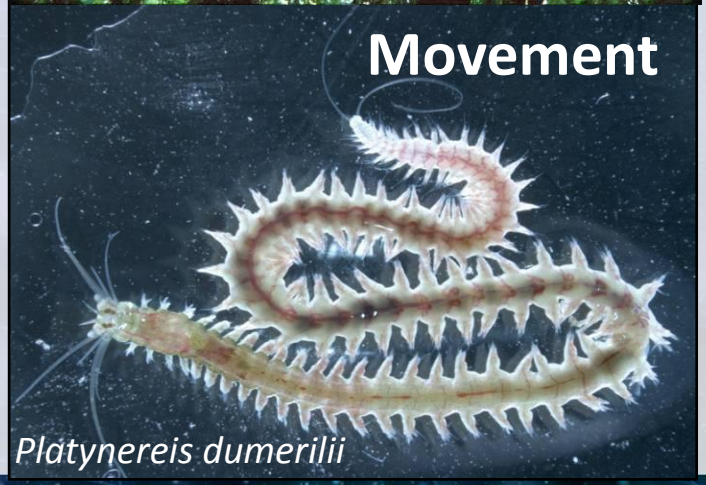
Neural Systems: Understanding the Brain

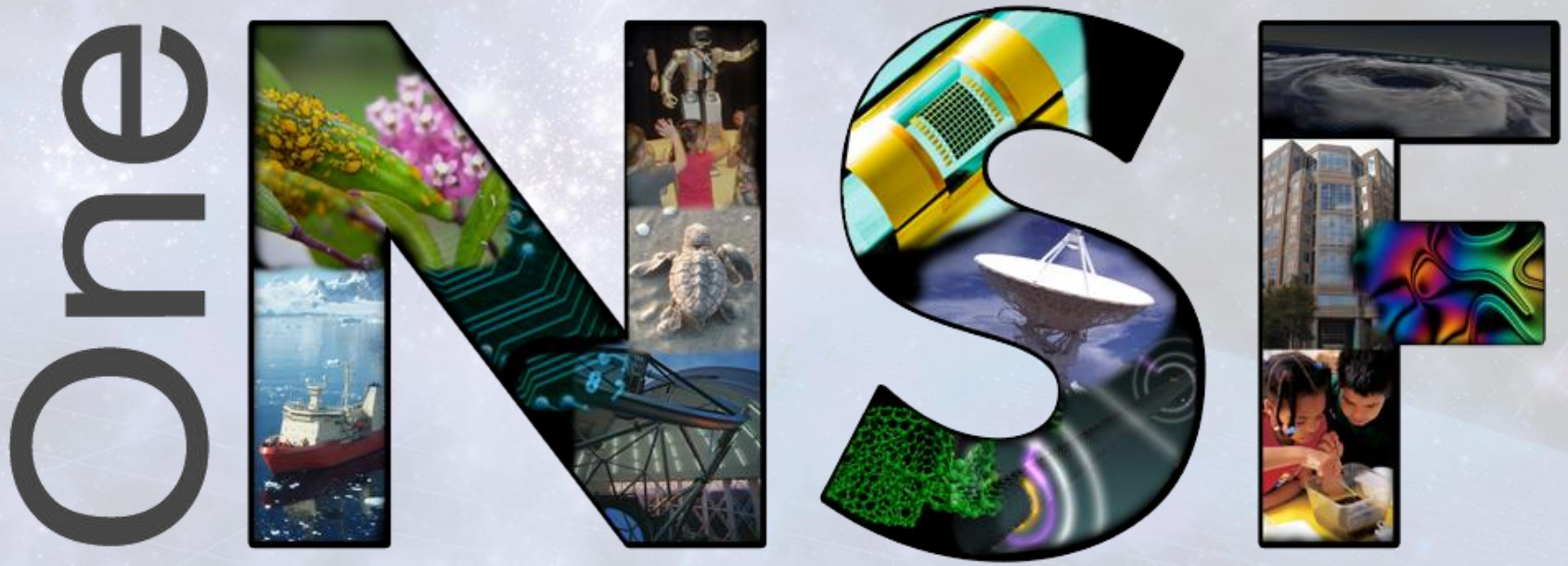
Comparative approaches reveal how the brain evolved and functions, and about the evolution of complex behavior







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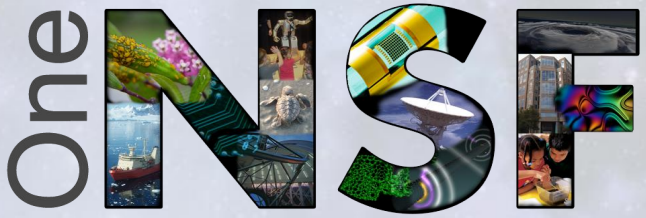


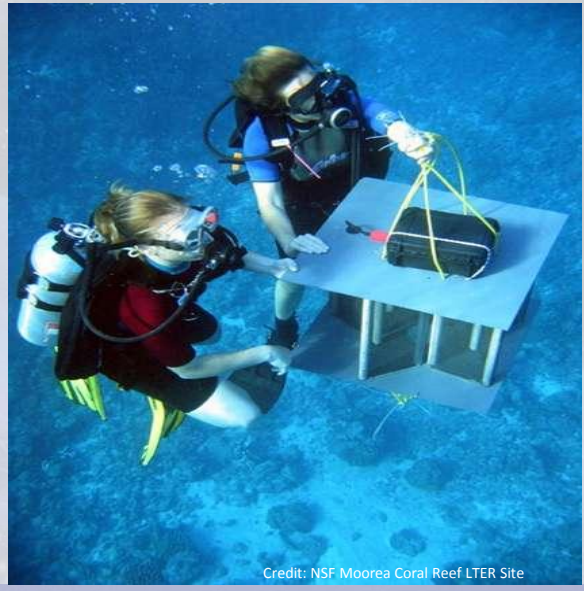
- **SEES** - Science, Engineering, and Education for Sustainability
- **BioMaPS** - Intersections of Biological, Mathematical and Physical Sciences
- **CIF21** - Cyberinfrastructure Framework for 21st Century Science and Engineering
- **CEMMSS** – Cyber-Enabled Materials, Manufacturing & Smart Systems
- **I-Corps** - Innovation Corps
- **INSPIRE** - Integrated NSF Support Promoting Interdisciplinary Research and Education

Science, Engineering, and Education for Sustainability (SEES)

Interdisciplinary research to understand human systems, biological systems, and educate the next generation of scientists.

BIO contributions to SEES:

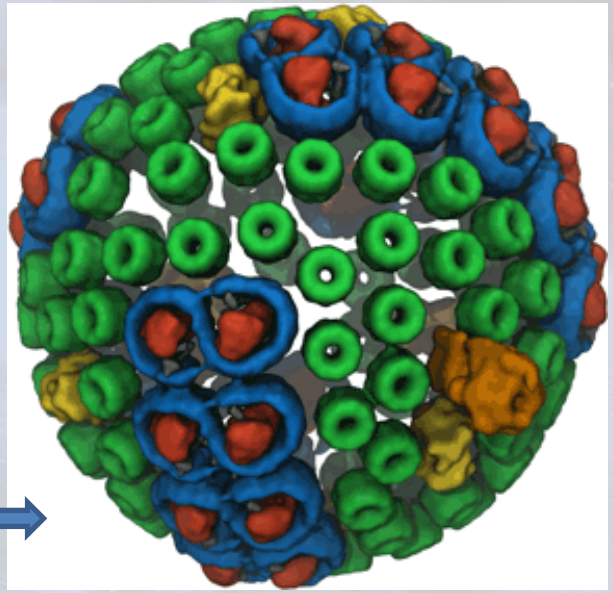
- Core research programs in all four divisions
- Coupled Natural and Human Systems
- Dimensions of Biodiversity
- Ocean Acidification
- Sustainability Research Networks
- SEES Research Coordination Networks
- SEES Fellows


Credit: NSF Moorea Coral Reef LTER Site

Biological, Mathematical & Physical Sciences and Engineering (BioMaPS)

- **Goal: Discover fundamental new knowledge at the *intersections* of the biological, mathematical and physical sciences and engineering**
- **FY 2013 priorities:**
  - ***Accelerate understanding of biological systems to enable innovation in clean energy, climate science, and advanced manufacturing***
  - ***Attract future scientists and engineers***

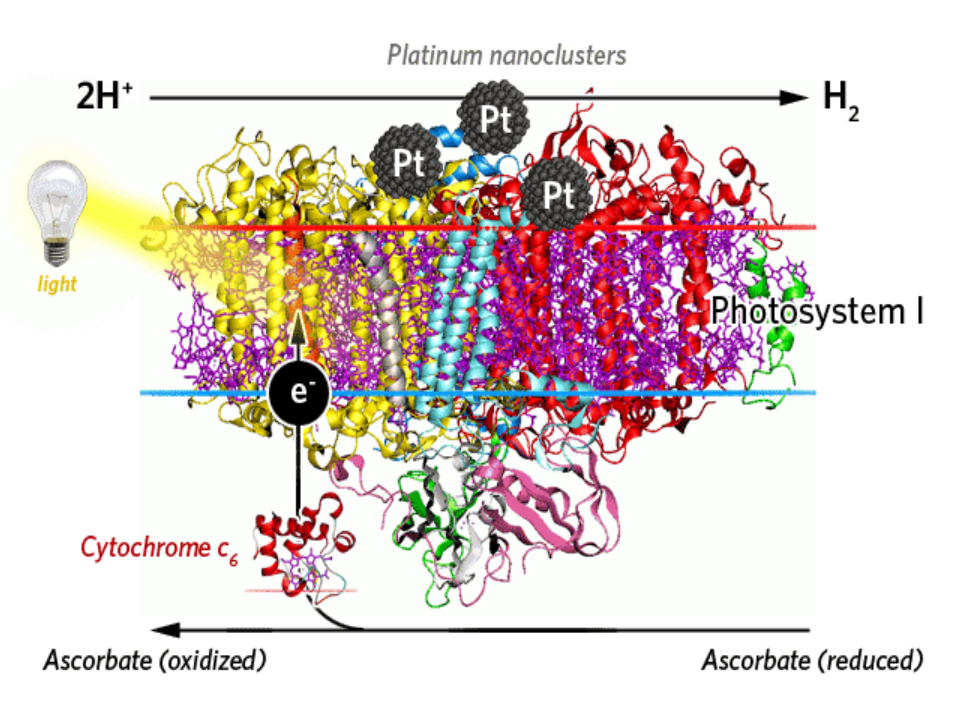
Structural basis for photosynthetic energy capture revealed by supercomputer simulation and modeling



Photosynthetic Membrane Vesicle
K. Schulten, UIUC

CLEAN ENERGY

Natural energy transduction systems can inspire biology-based technologies capable of delivering sustainable clean energy.



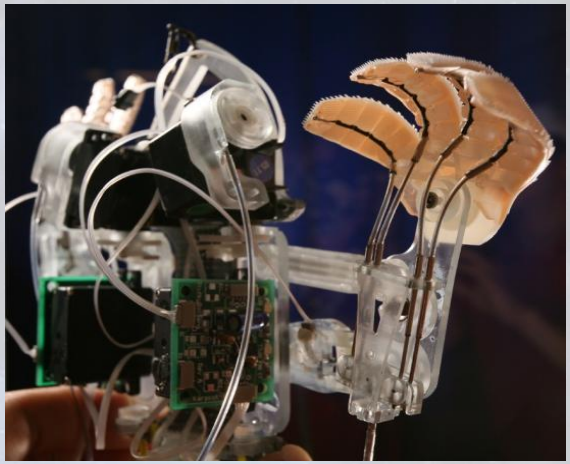
Platinum -Photosystem I nanoparticle that produces hydrogen fuel

Barry Bruce, Univ. TN Knoxville

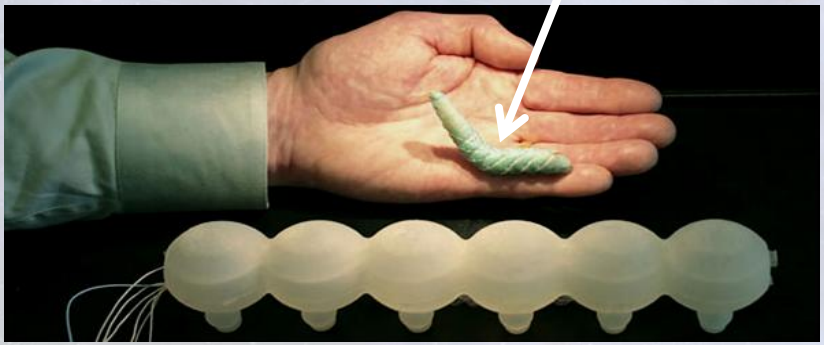
Cyber-Enabled Materials, Manufacturing & Smart Systems (CEMMSS)

Stickybot: **Biology inspired synthetic adhesive that mimics gecko feet for climbing.** ***Developed by an engineer and a biologist***

M. Cutkosky, Stanford Univ.
K. Autumn, Lewis & Clarke Col.



Caterpillar *Manduca sexta*



Barry Trimmer, Tufts University

Softbot: **Biology inspired locomotion over irregular surfaces**
Application: hazardous environments.

INSPIRE Awards

- **CREATIV -** Second year of the CREATIV *pilot* grant awards
  - Open to all NSF-supported fields
  - Typically for an individual PI or a small team
  - Proposals *must* be interdisciplinary and potentially transformative
  - Internally merit-reviewed by program directors with option for external expert review where needed
- **New open pilot** mechanism under INSPIRE to begin in FY 2013
  - Larger "mid-scale" interdisciplinary awards
  - Utilize novel internal & external merit review approaches

BIO Cyber Activities

- **CIF21** - Cyberinfrastructure Framework for 21st Century Science and Engineering
  - **SI²** - Software Infrastructure for Sustained Innovation
- **ADBC**- Advancing Digitization of Biological Collections
- **iPlant** Collaborative
- **DRYAD** - Digital Data Repository
- **NIMBIOS** - National Institute for Mathematical and Biological Synthesis
- **NEON** - National Ecological Observatory Network

The Biology DATA Dilemma

"Technology gives us the tools to analyze organisms at all scales, but we are drowning in a sea of data and thirsting for some theoretical framework with which to understand it."

Sydney Brenner (Nobel Laureate)
*Nature **482**: 461, February 23, 2012*

First Human Genome Sequence (2003) took ~ 12 Years at a cost of ~ $2.7 Billion

Milestone: $1000 human genome in a day

Ion Proton Sequencer
Life Technologies

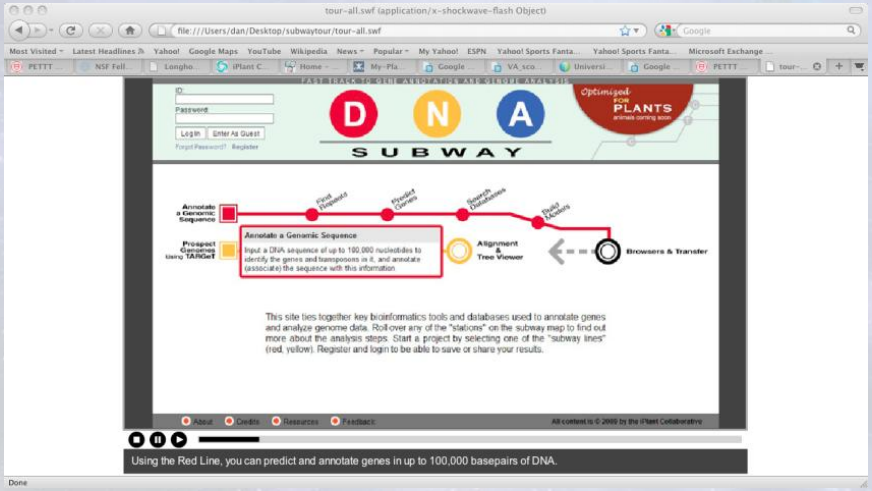
BIO Big Data Issues

- One data solution or many (e.g., Genbank, Protein Data Bank, Digital Data Repository)
- What data are saved and for how long – legacy data and new data? (e.g. iPlant, LTER, NEON)
- Common standards for adding/annotating data to ensure broad access and interoperability?
- How will access to data be provided?
- How and where will data be stored?
- Who pays? Who is in charge?

STEM Education

- **Transforming Undergraduate Biology Education (TUBE)**
- **Expeditions in Education (E^2)**

  - New Age Cyber Learning



iPlant - DNA Subway

E^2: Expeditions in Education

engage, empower, and energize

Transform STEM learning for the Nation through cognitive research and frontier science.

Focus Topics for 2013:

- **Transforming Learning for STEM Undergraduates**
- **People and the Planet**
- **Cyberlearning and Big Data**

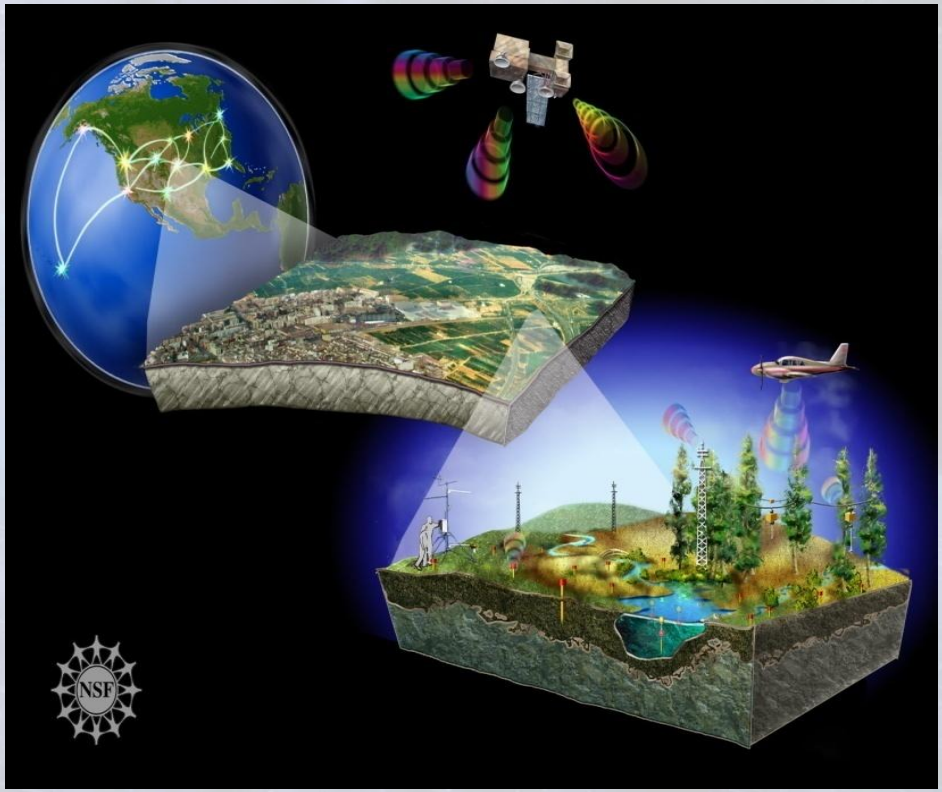
E^2 Investments will:

- Make frontier science central
- Use theory and research on STEM learning
- Aim for bold learning outcomes
- Commit to common metrics
- Involve all NSF directorates and offices

National Ecological Observatory Network (NEON)

Unique platform for regional to continental scale environmental research

- Research platform for all BIO, from molecules to the biosphere
- Long-term measurements with standardized infrastructure, procedures, quality control
- Free and open data access policy for near real time data
- Decision support tools
- Potential network with international observatories for global scale research



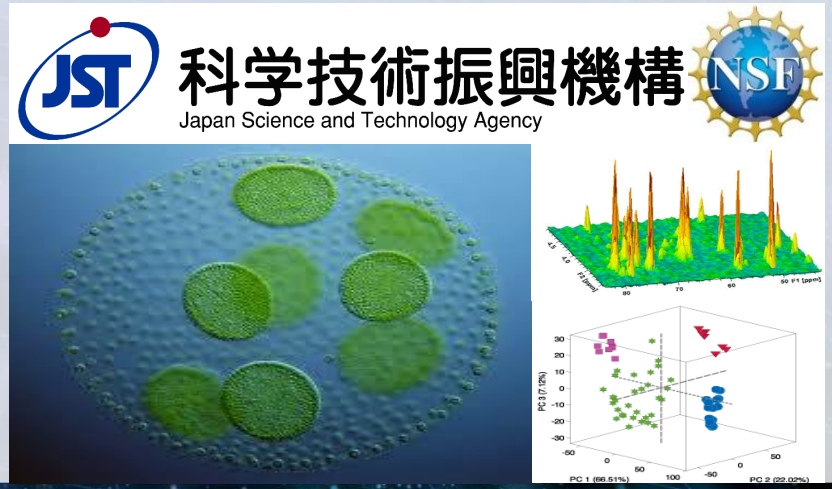
National Ecological Observatory Network (NEON)

- **MREFC** $91M, Year 3 of 6 years of construction
  - Civil and facility construction in 15 of 106 neon sites
  - Stream Experimental and Observatory Network (STREON) construction will begin
- **R&RA** $30M for Management and Operations; $3M for Concept & Development :
  - 15 Sites: 10 Sites constructed in FY12, 5 in FY13
  - Airborne Observatory
  - Calibration and Validation Laboratory
  - Data Center

Programs in International Science

Basic Research to Enable Agricultural Development
BREAD
NSF, Bill & Melinda Gates Foundation

Metabolomics for a Low Carbon Society
BIO & JST



BIO: Opportunities & Challenges

- BIO: The Five Grand Challenges
- Undergraduate Biology Education
- The Data Dilemma
- Broadening Participation
- Public Outreach

Thank you.

Questions?

www.nsf.gov/about/budget/fy2013/index.jsp