

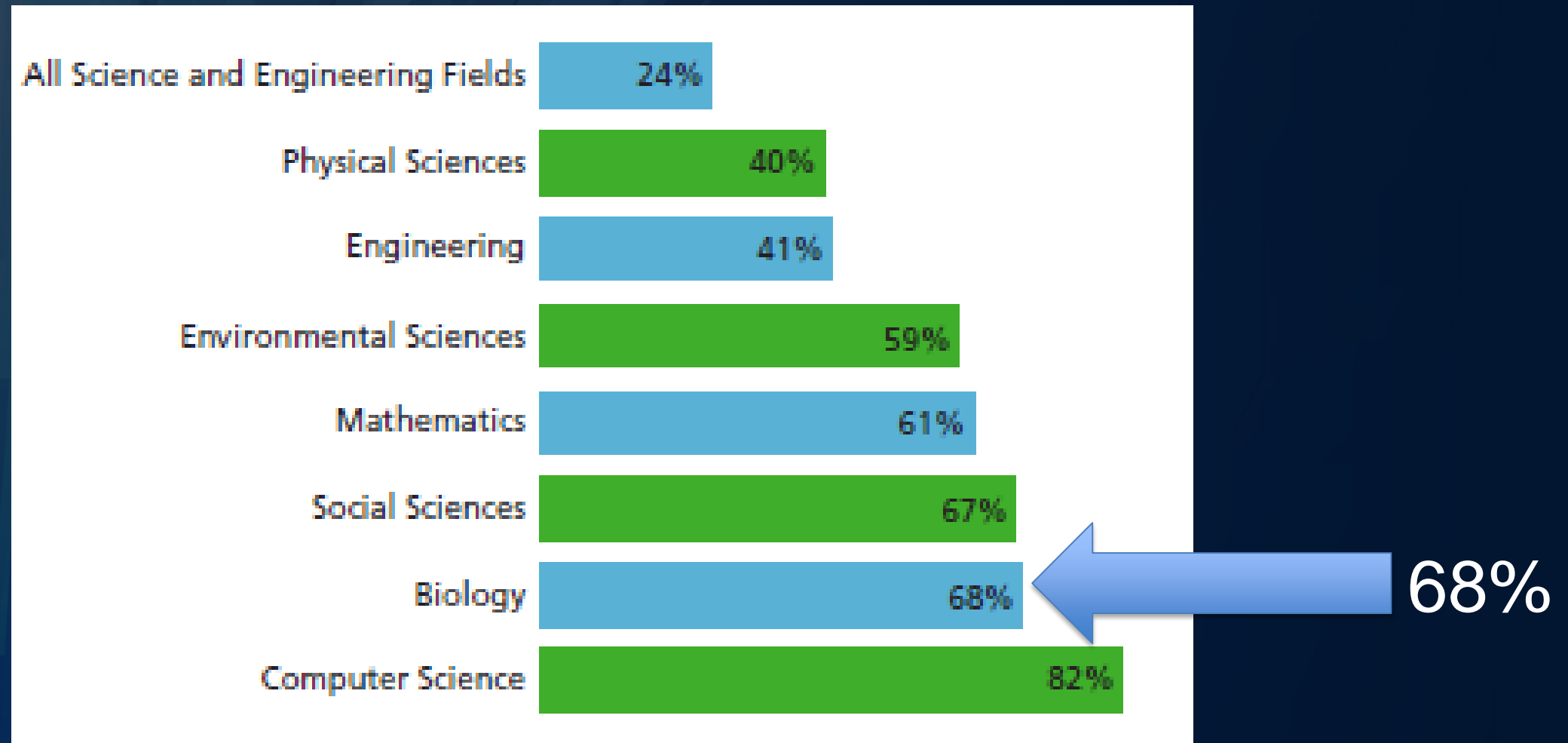
# Directorate for Biological Sciences: Research and Infrastructure Investments

Dr. Jim Olds  
Assistant Director  
National Science Foundation  
Directorate for Biological Sciences



# NSF Support of Academic Basic Research in Selected Fields

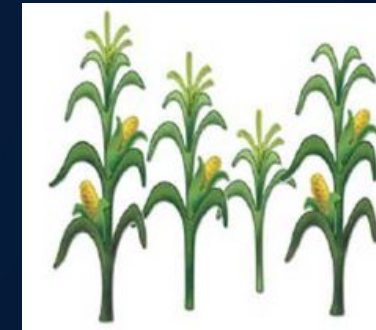
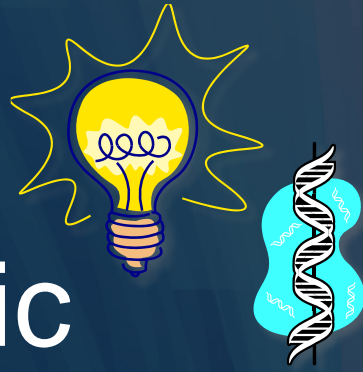
(as a percentage of total federal support)



Biology includes biological sciences and environmental biology; excludes National Institutes of Health.



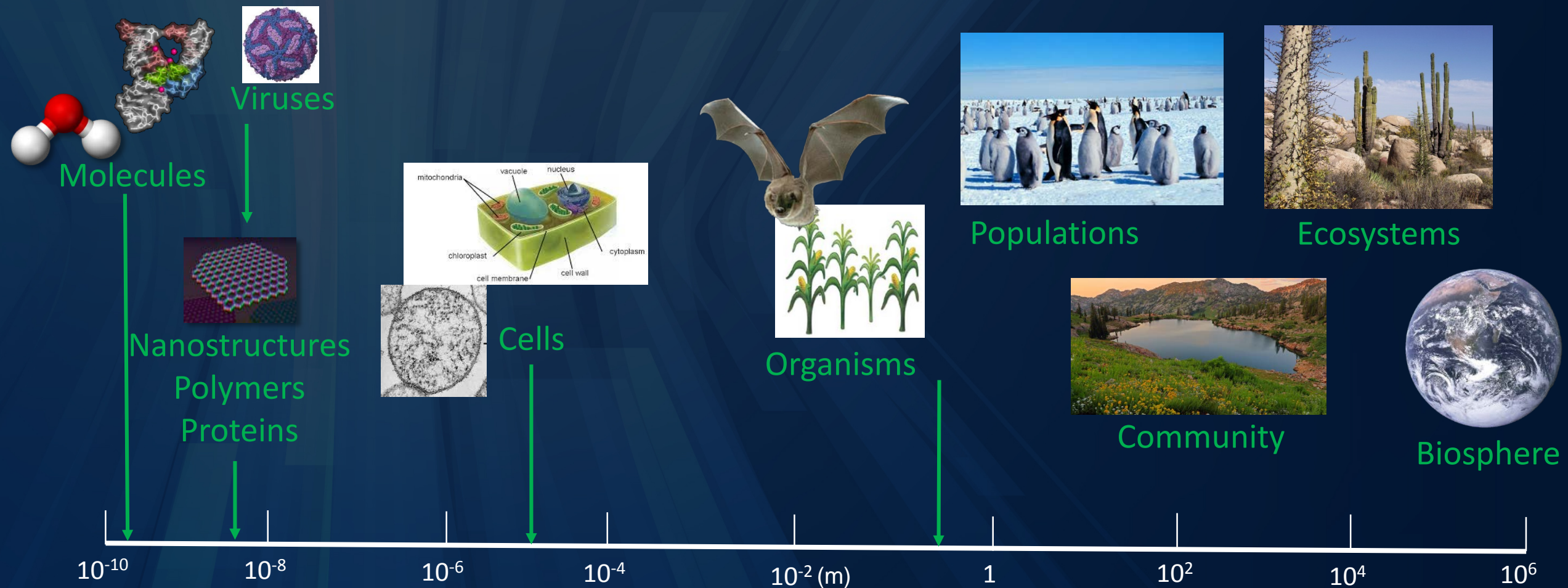
Basic



Applied

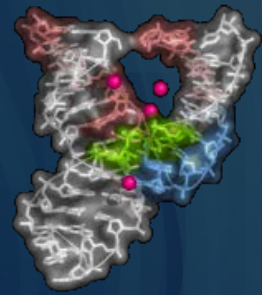






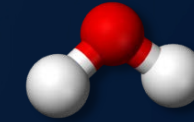
# BIO FY 2017 Budget Request

\$ = Millions  
Total = \$791M



Emerging Frontiers  
\$158

Molecular and  
Cellular Biosciences  
\$137



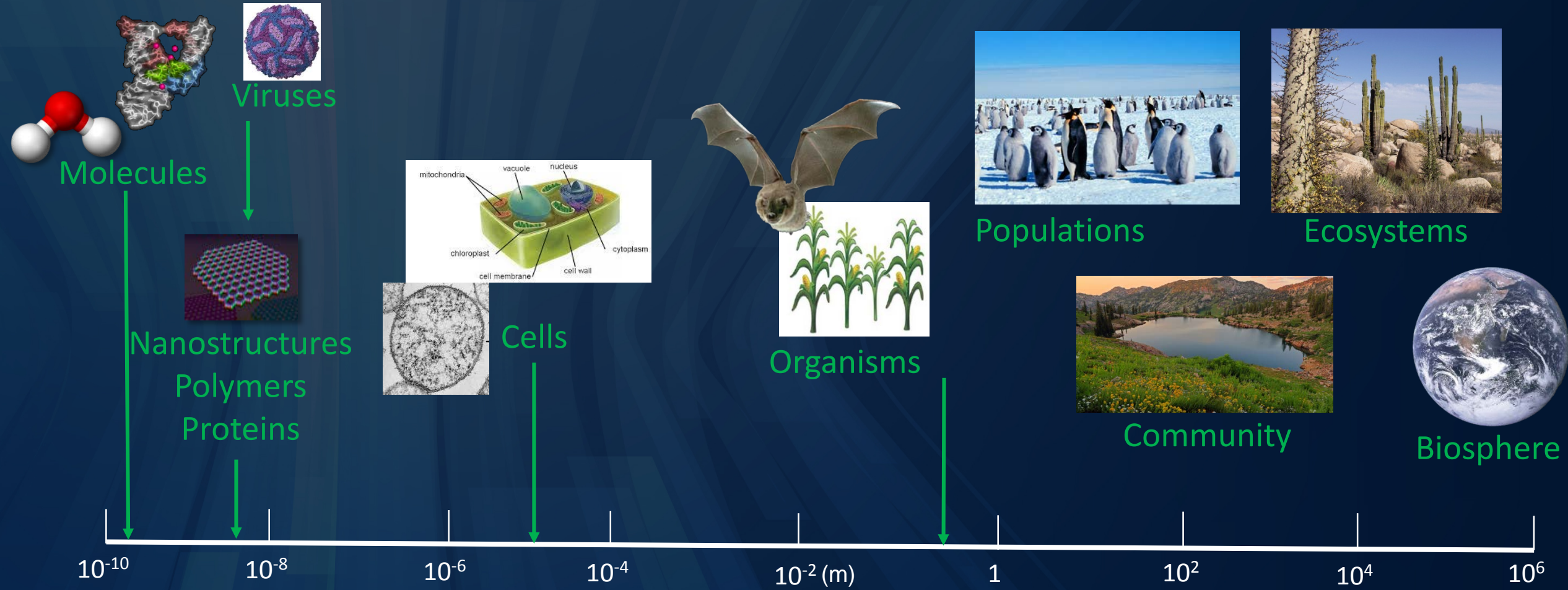
Biological  
Infrastructure  
\$136

Integrative  
Organismal Systems  
\$215

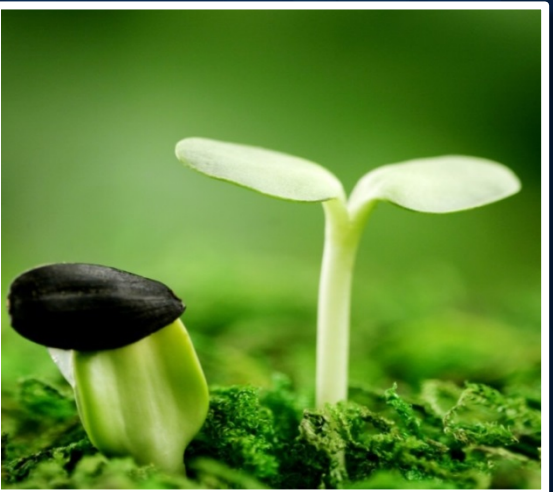
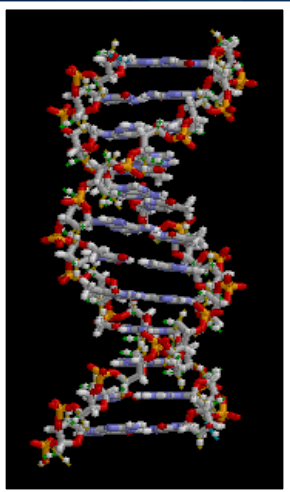
Environmental  
Biology  
\$145





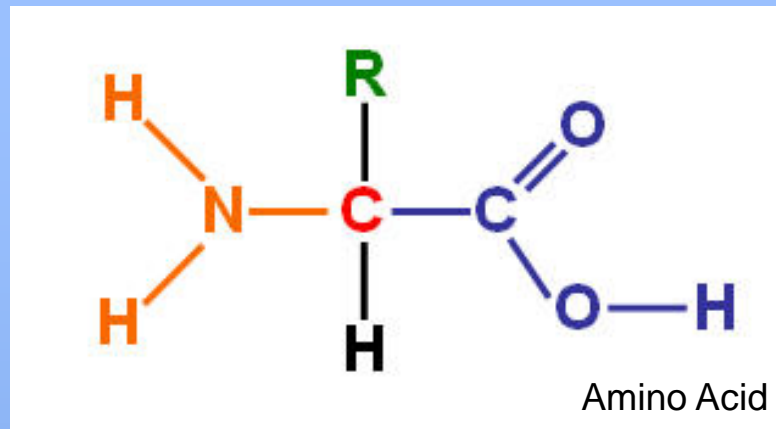


Rules of Life



RoL = \$13M



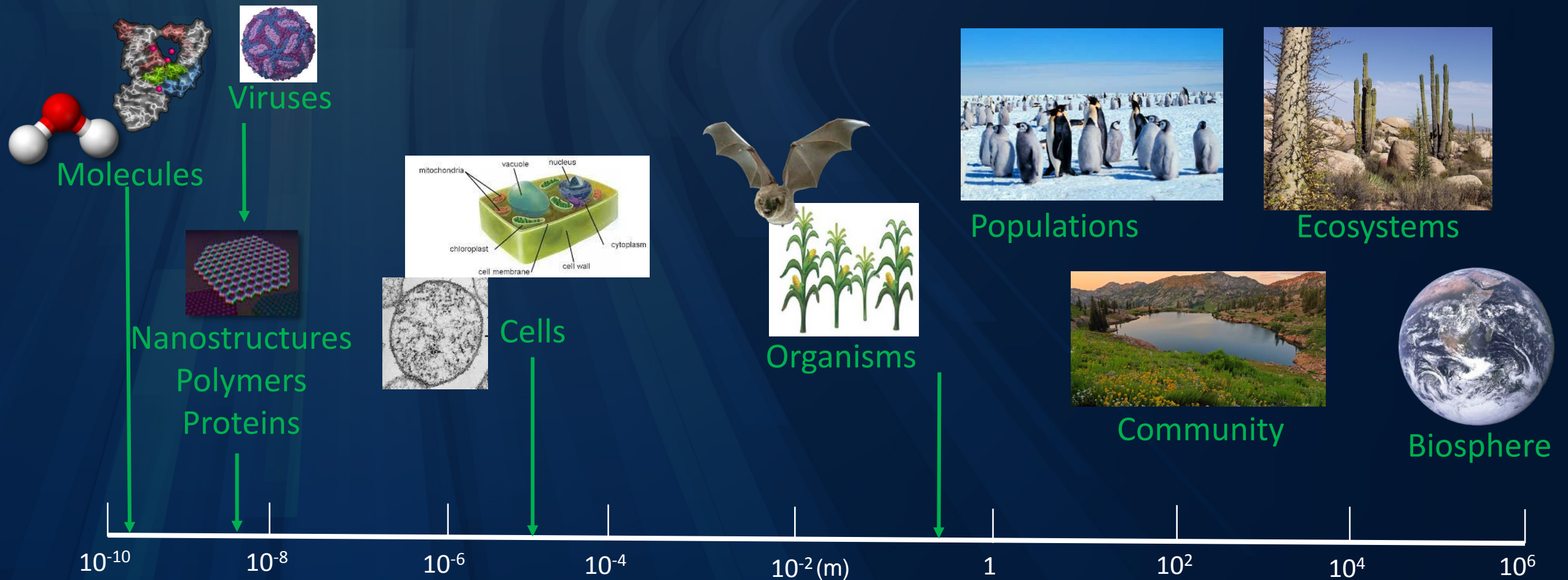




# Modeling and Theory Development

## Experimentation

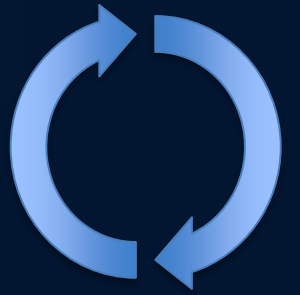
## Observation



Rules of Life



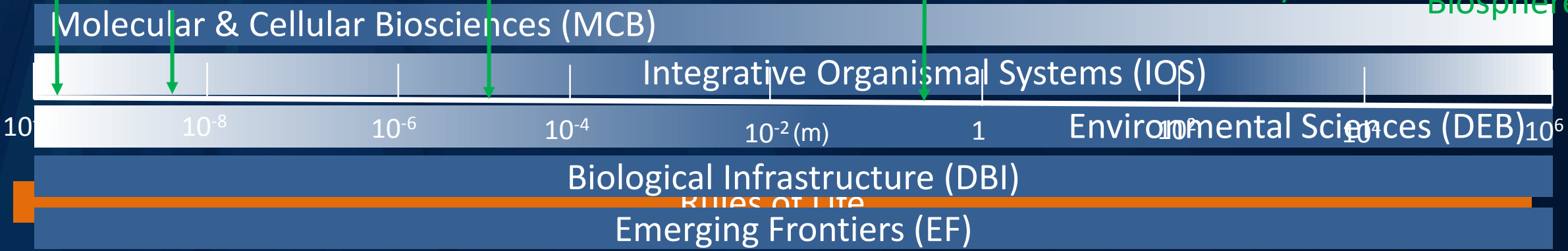
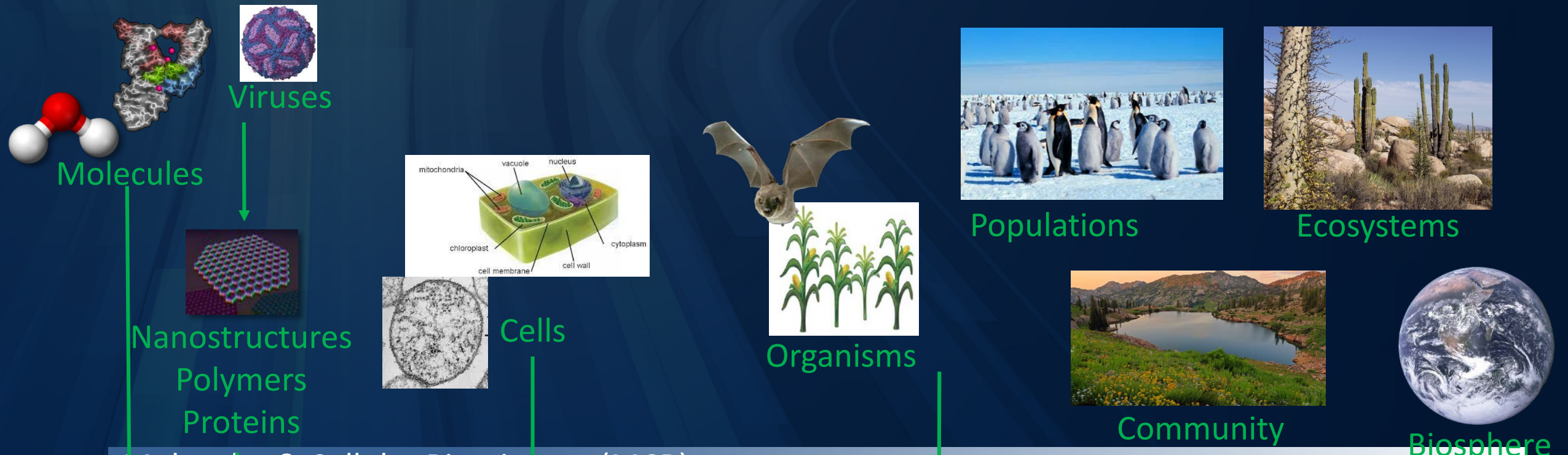




**Modeling and Theory Development**

**Experimentation**

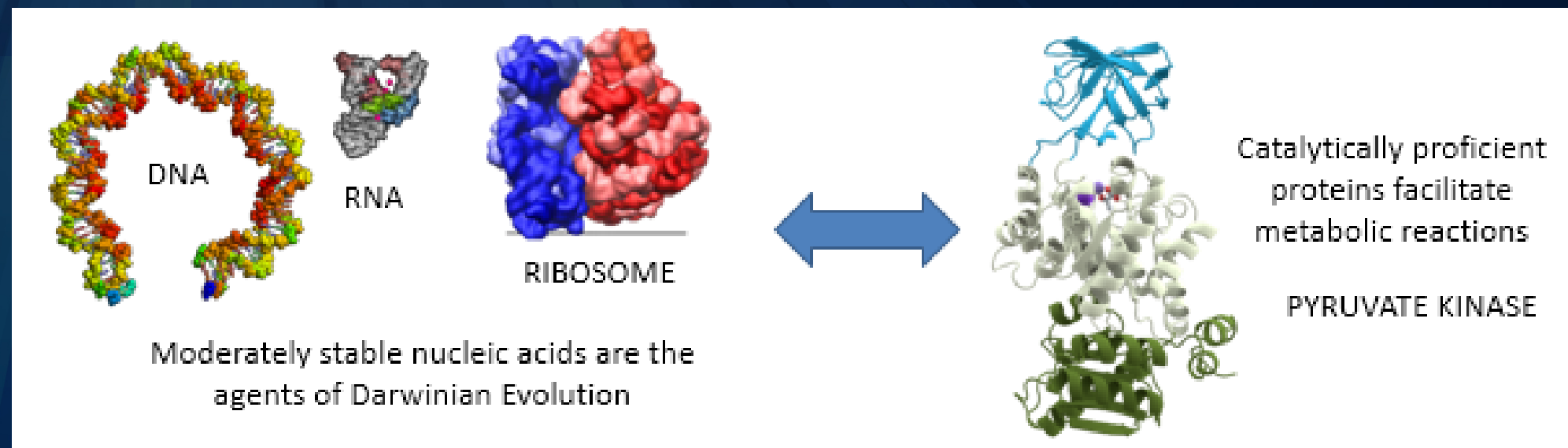
**Observation**



# Origin of Life (Ideas Lab)

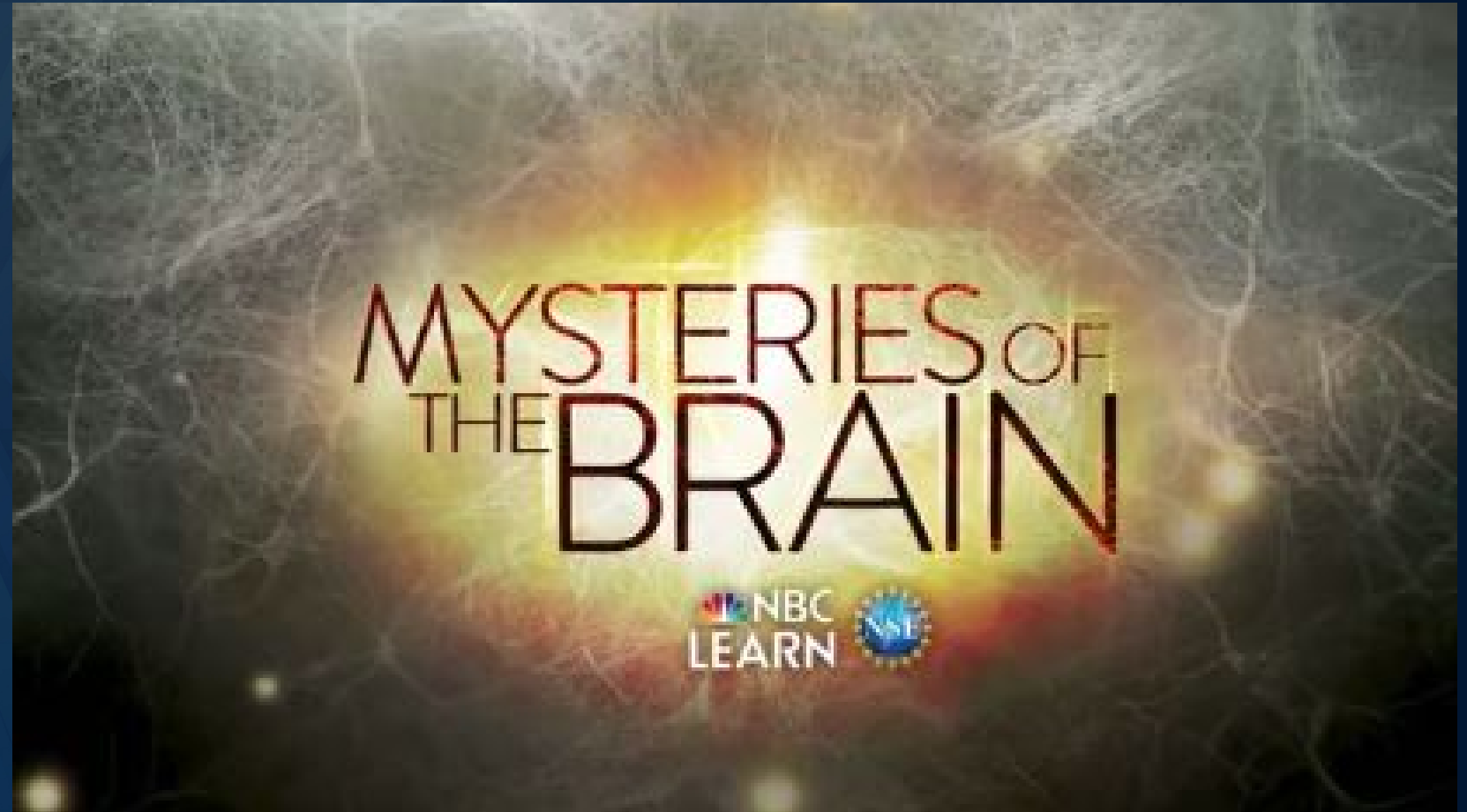
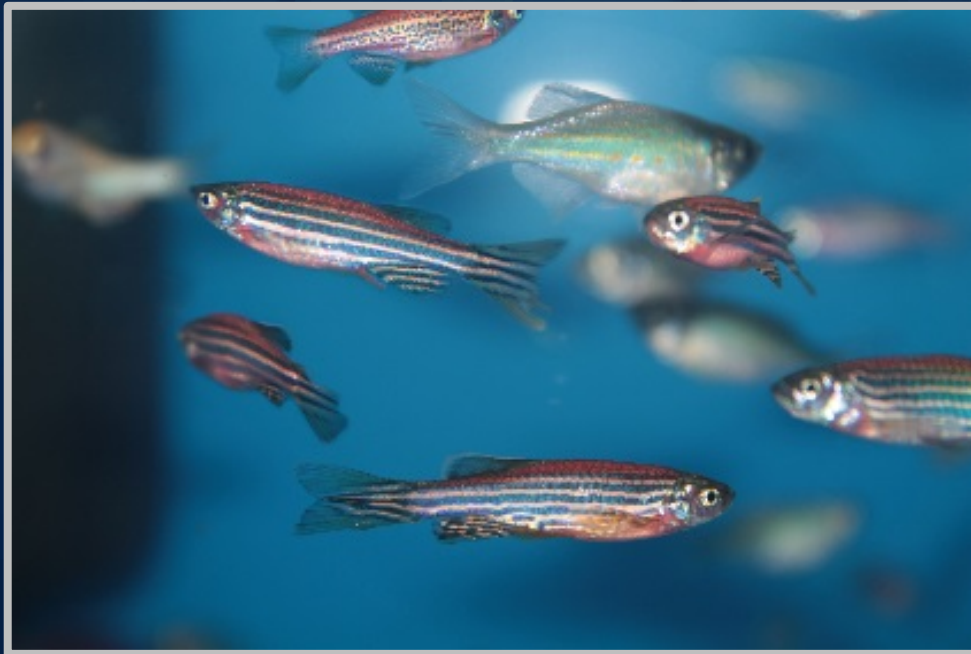
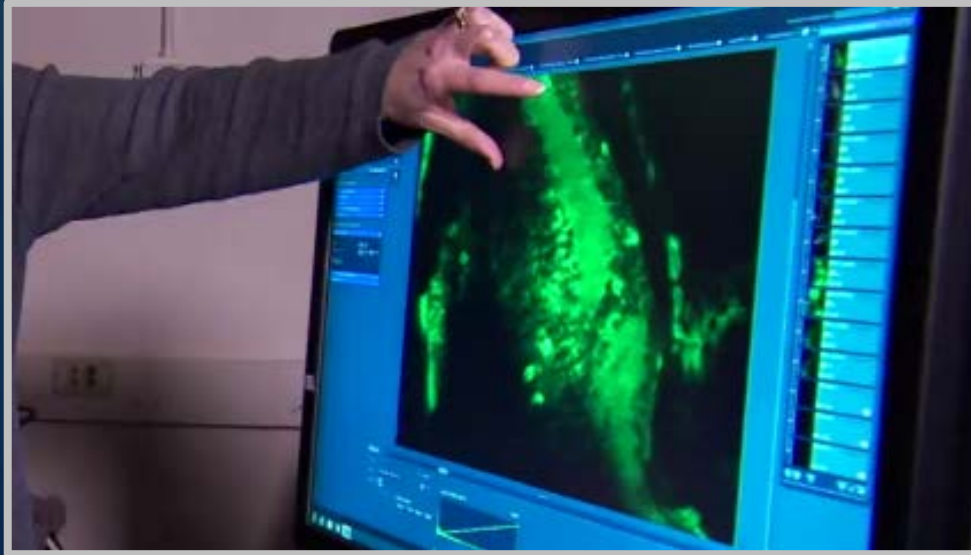
Goal: Innovative approaches that explore the origin and early evolution of the two-polymer system that both drives and constrains life on Earth.

Impact: Understanding plausible pathways for the origin of life will contribute directly to understanding the indispensable properties of life on Earth and inform the search for life on other worlds.





# Brains and Behavior



“I love watching these cells be active while the animal is behaving. It’s just remarkable to me that we can see the brain work and try to understand how it’s functioning.” – PI Melina Hale

Rules of Life





# Looking Ahead: Ten Big Ideas



**Navigating the New Arctic**





**Harnessing Data for 21st Century Science and Engineering**




**Work at the Human-Technology Frontier: Shaping the Future**


## RESEARCH IDEAS

**Understanding the Rules of Life: Predicting Phenotype**



**The Quantum Leap: Leading the Next Quantum Revolution**



**Windows on the Universe: The Era of Multi-messenger Astrophysics**


## PROCESS IDEAS



**Growing Convergent Research at NSF**



**NSF-INCLUDES: Enhancing Science and Engineering through Diversity**



**Mid-scale Research Infrastructure**



**NSF 2050: Seeding Innovation**

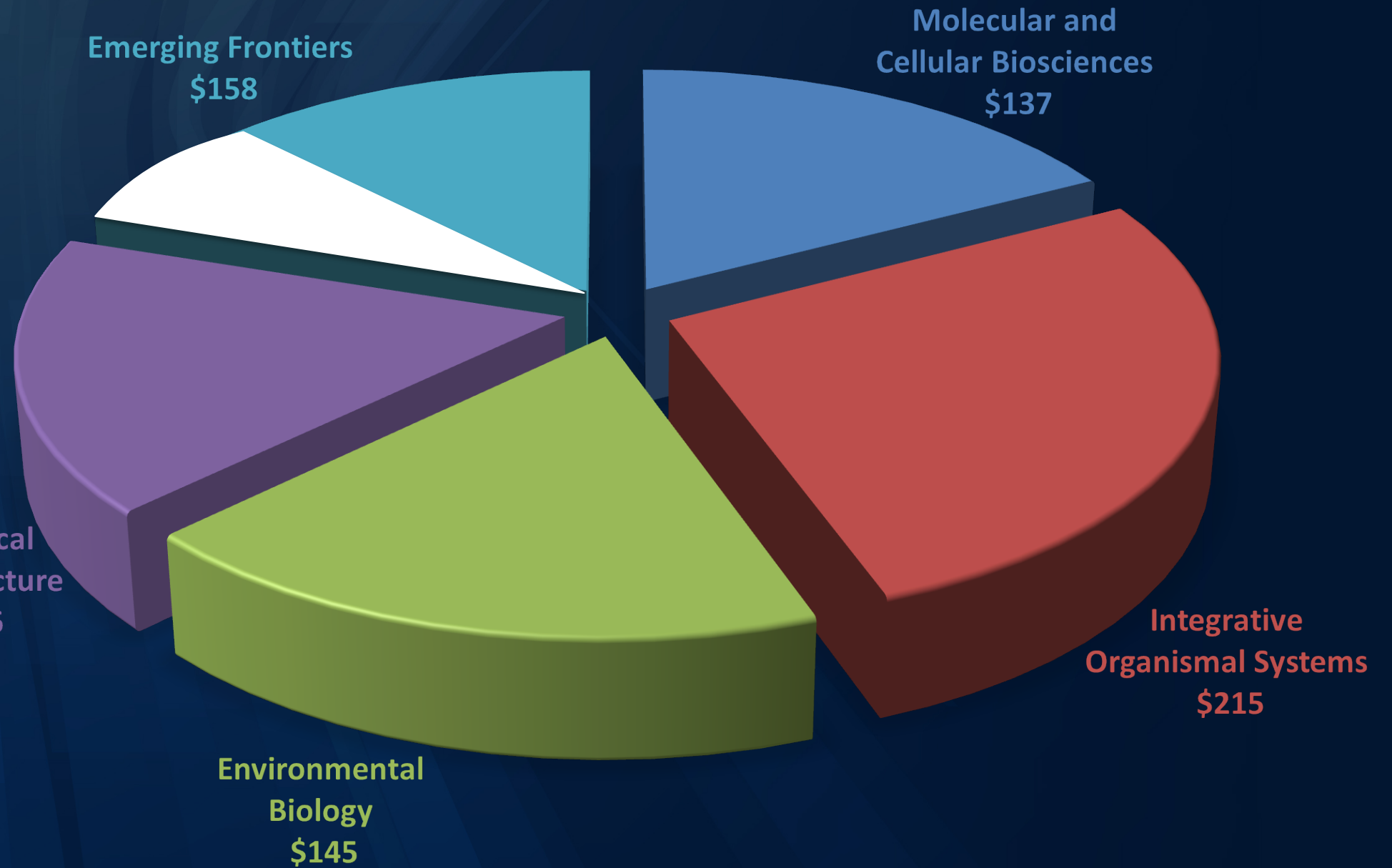
Rules of Life



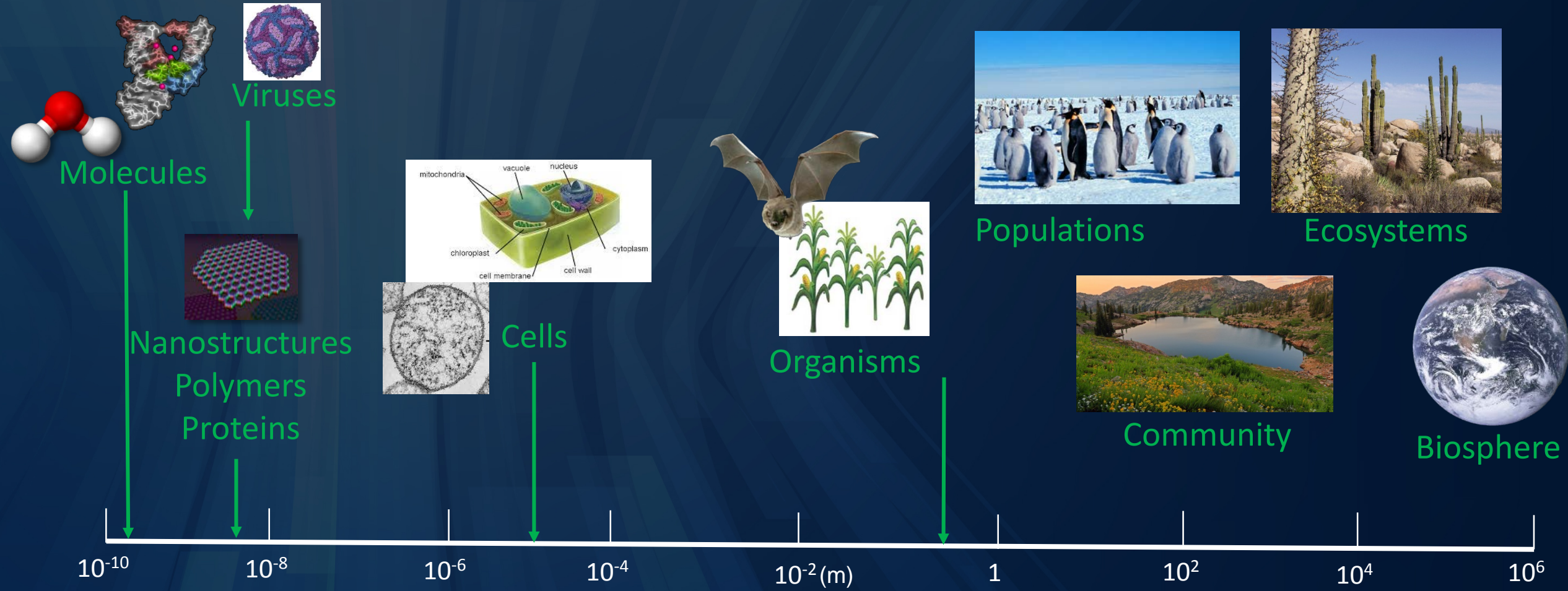


# NEON

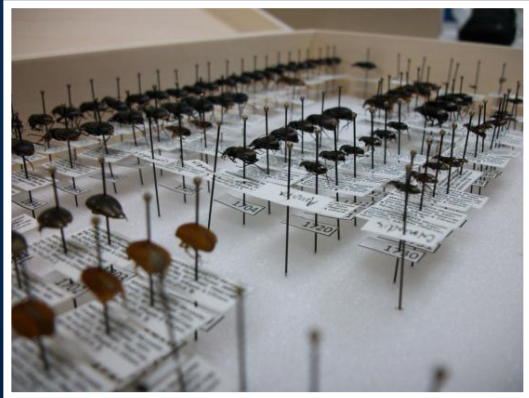
\$ = Millions  
NEON = \$65M







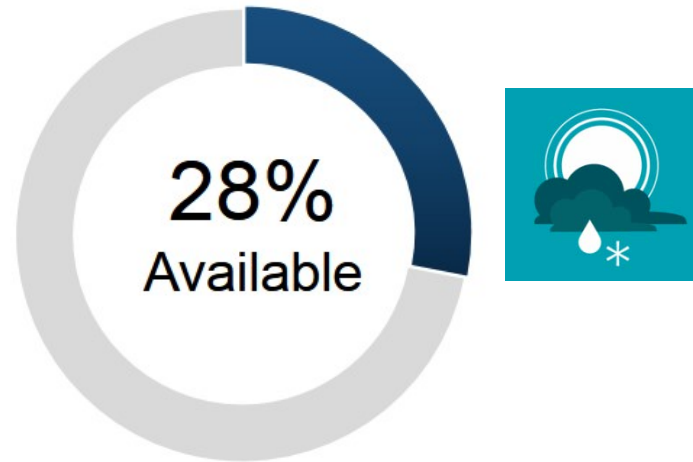
National Ecological Observatory Network (NEON)



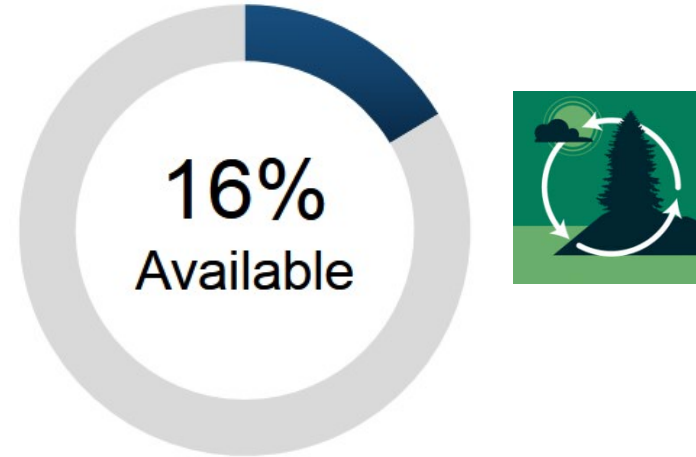


# Availability of Data Products

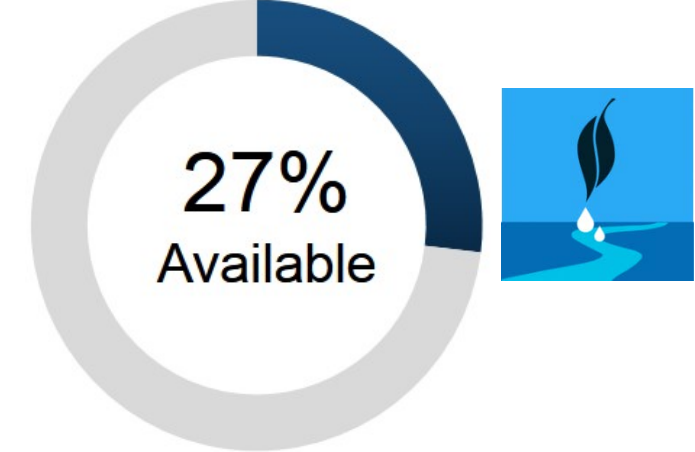
## Atmosphere (57)



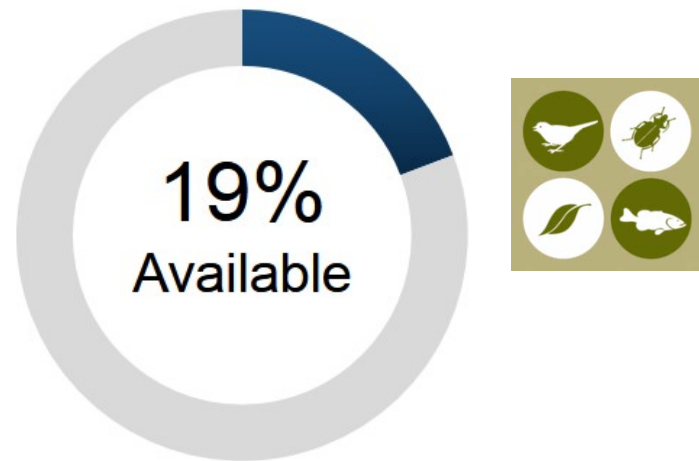
## Biogeochemistry (61)



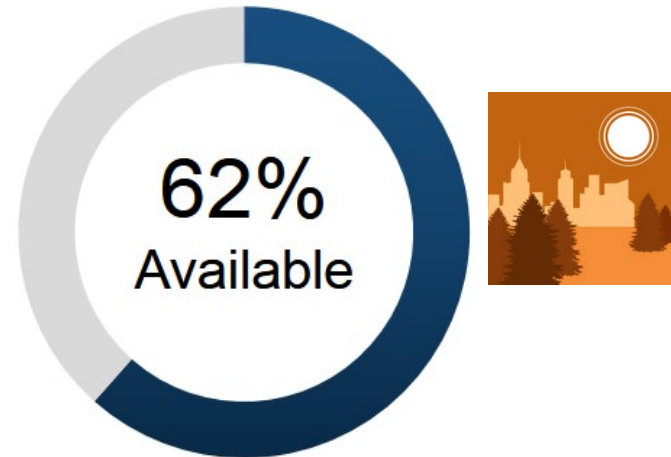
## Ecohydrology (26)



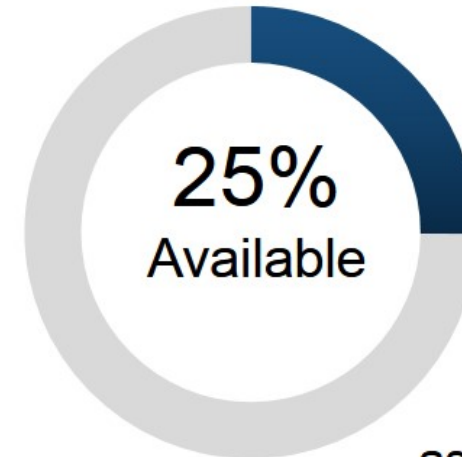
## Organisms (26)



## Land Use (13)



## Total (183)



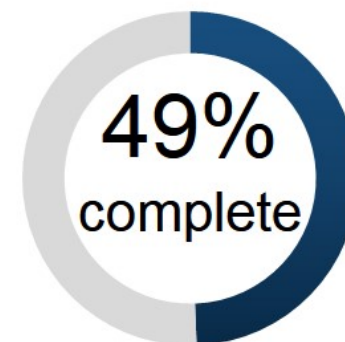
as of September 9, 2016

# Current Construction Status (81 locations in 20 domains)

Sensor  
Deployment



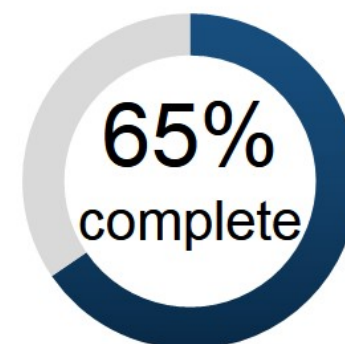
40 locations  
in 16 domains



Biological  
Sampling



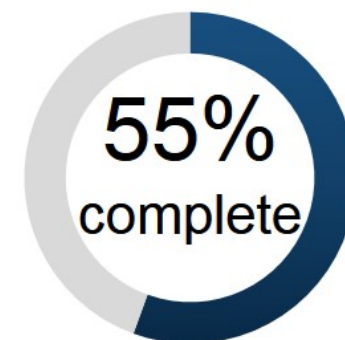
53 locations  
in 16 domains



Airborne  
Sensing



45 locations  
in 11 domains



as of September 9, 2016

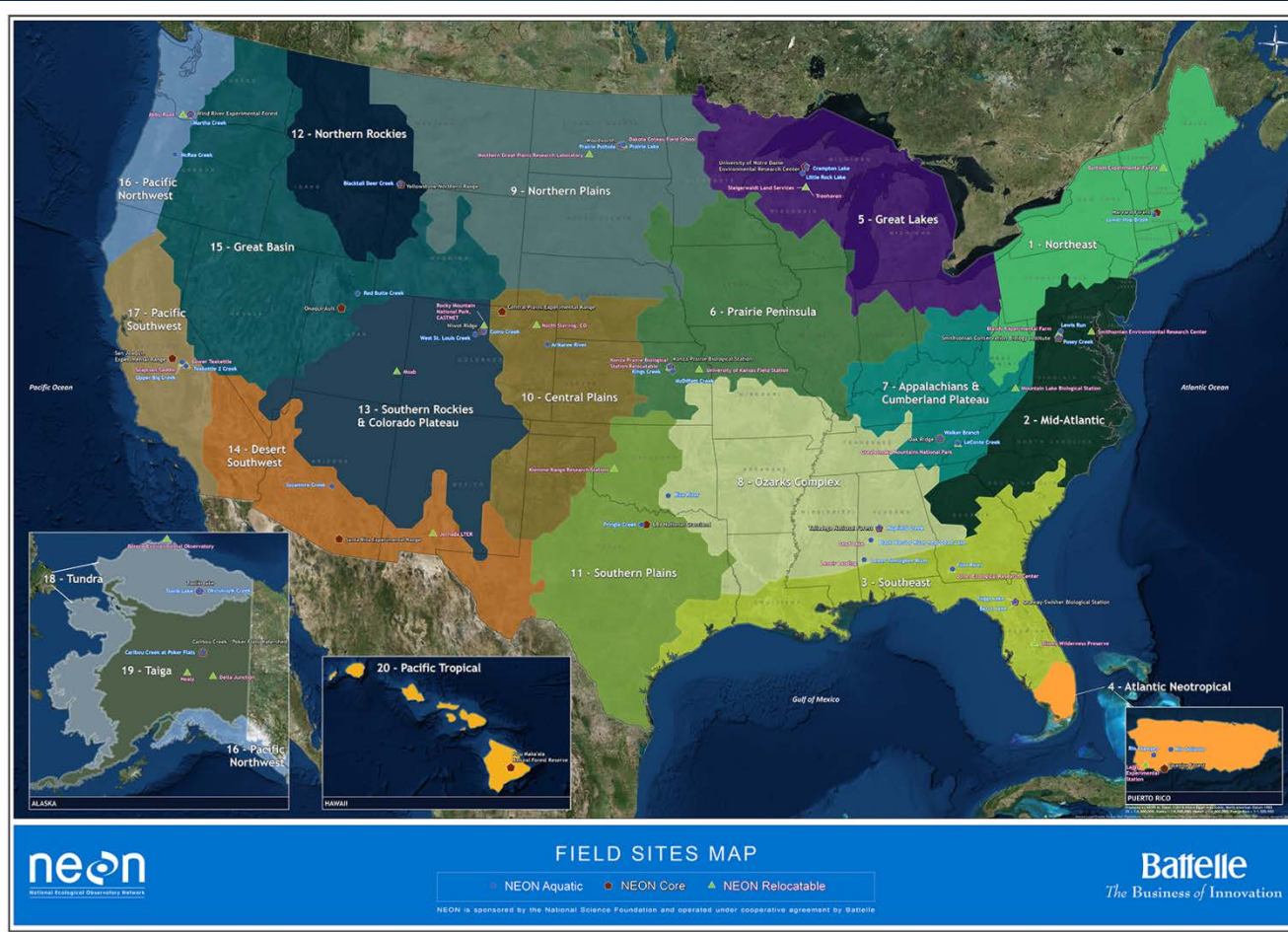




# MacroSystems Biology and Early NEON Science Awards

Press Release 16-111

NSF awards \$15.9 million to foster new understanding of biological systems on regional to continental scales



## Examples:

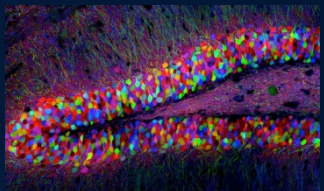
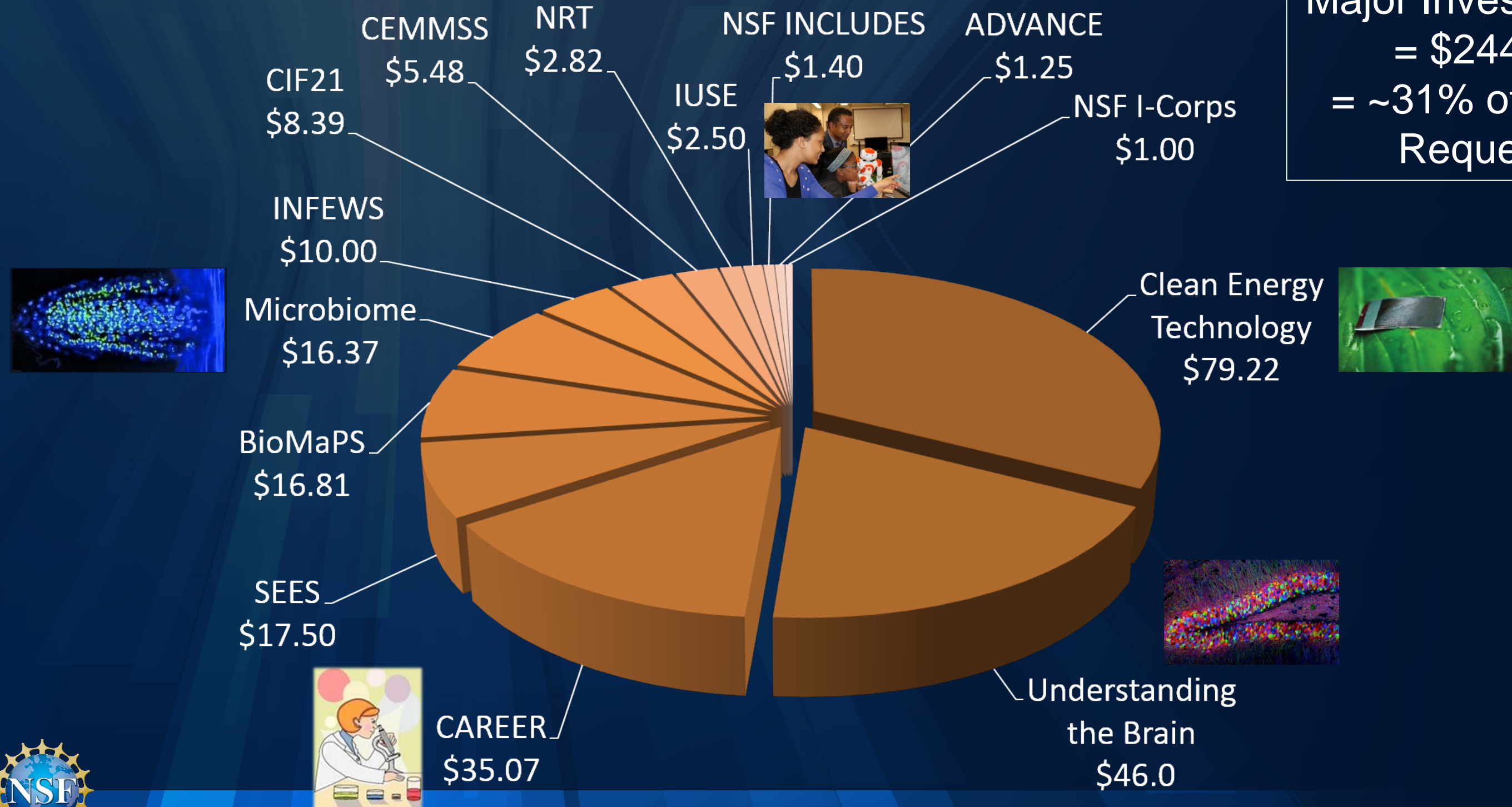
- Collaborative Proposal: MSB-ENSA: Forest Function **from Genes to Canopies**: Disentangling the fine scale spatio-temporal variation in gene expression and tree growth (Nathan Swenson, University of Maryland)
- MSB-ECA: Local and Migratory Spatial Foraging Affects **Plant-Pollinator-Pathogen Networks** (Erin Wilson-Rankin, University of California-Riverside)
- MSB-FRA Modeling **Invasion Dynamics Across Scales** (MIDAS) (Songlin Fei, Purdue University)

National Ecological Observatory Network (NEON)

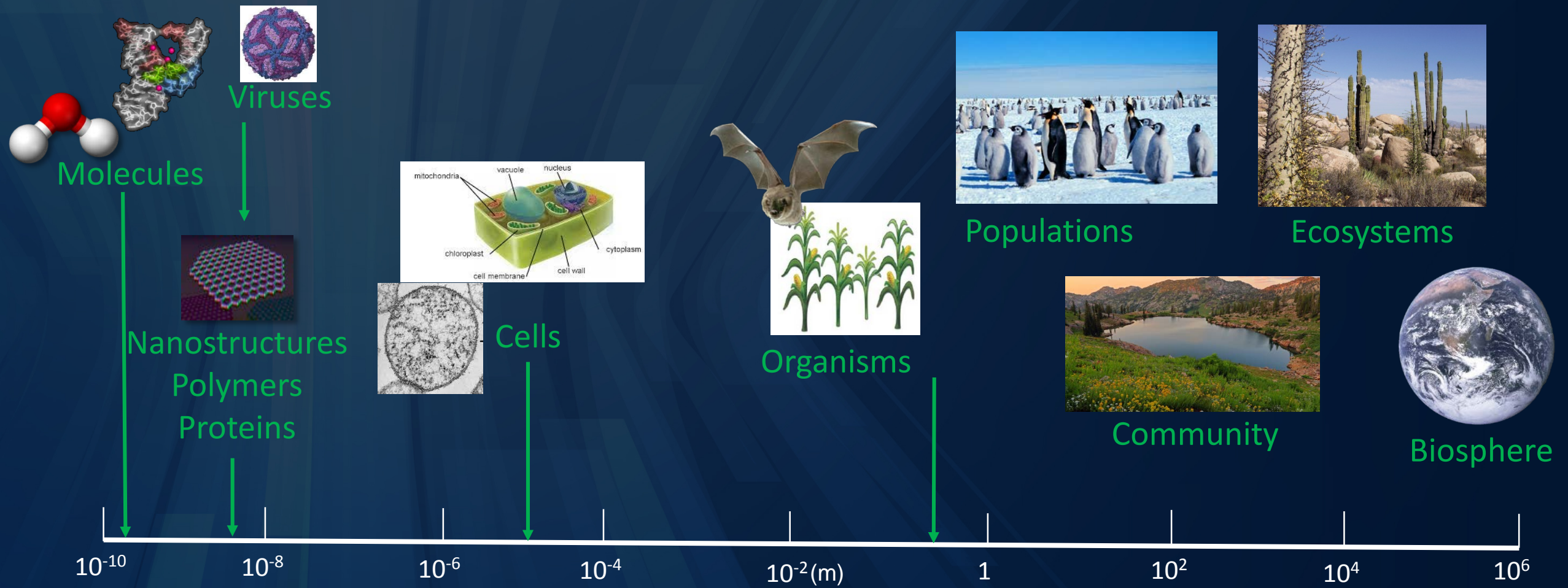


# FY 2017 Request: Major Investments

\$ = Millions  
 Major Investments  
 = \$244M  
 = ~31% of Total  
 Request







**Understanding the Brain (UtB)**

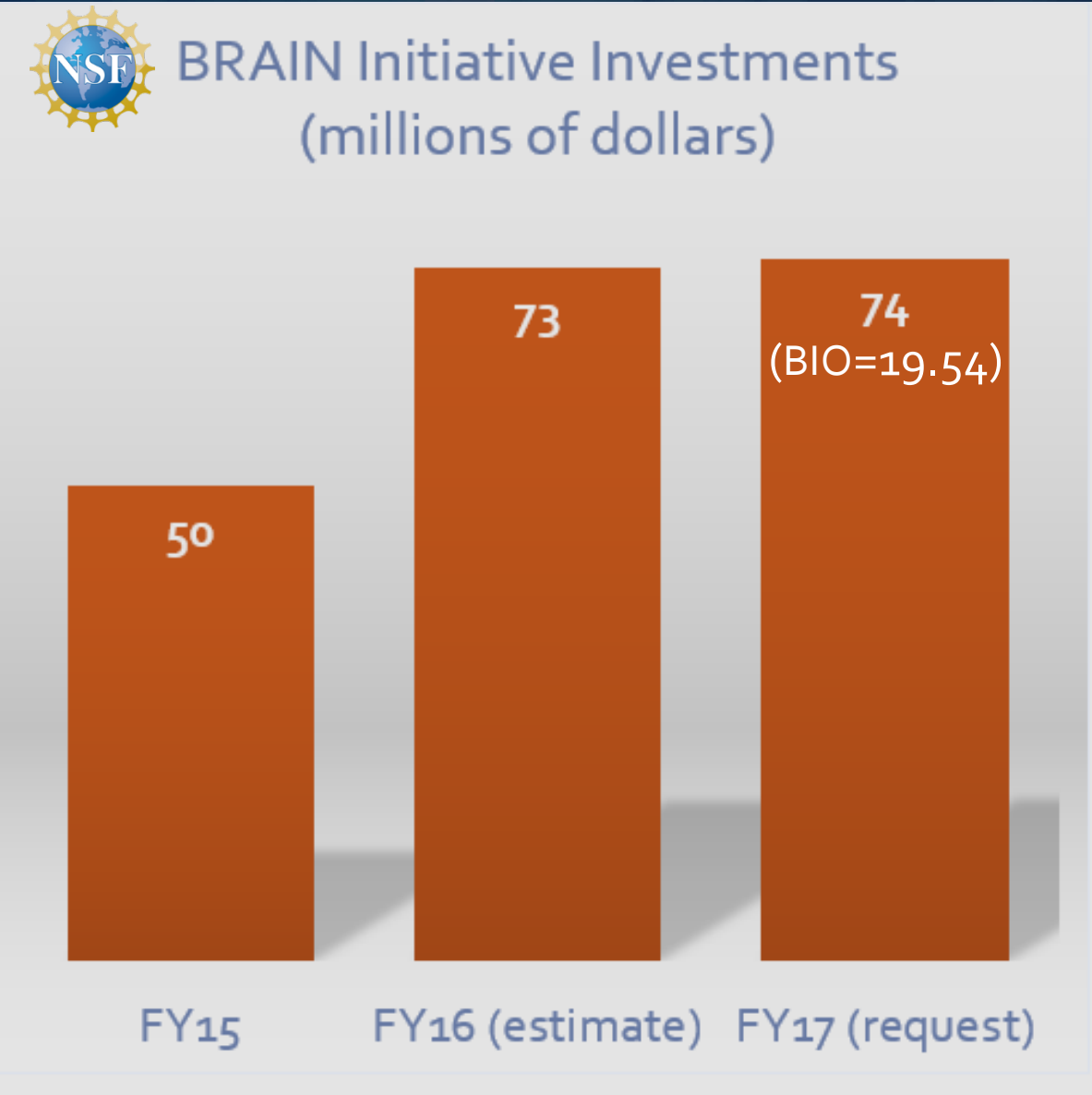


UtB = \$46M  
 (Includes \$19.54M for BRAIN Initiative activities)





# BRAIN Initiative & Coordinating Global Brain Projects



Understanding the Brain (UtB)





# Next Generation Networks For Neuroscience (NeuroNex)

## SYNOPSIS

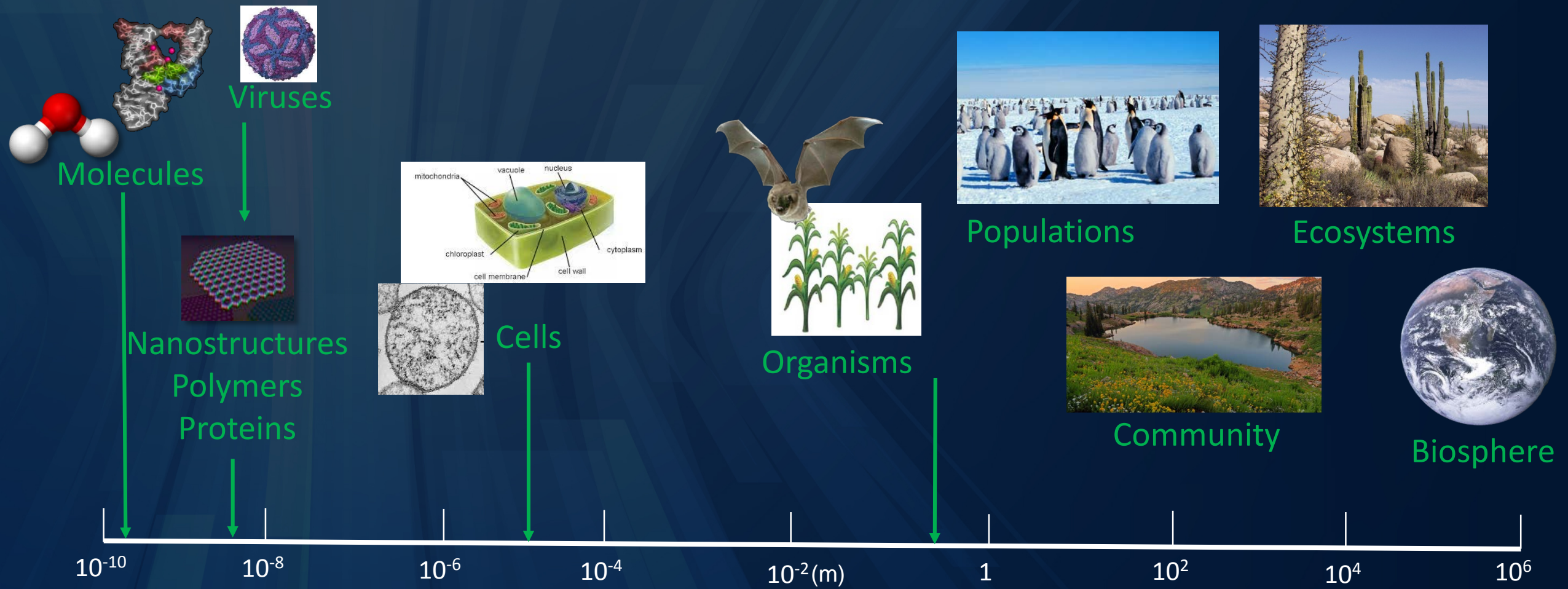
The goal of this solicitation is to foster the development and dissemination of (1) innovative research resources, instrumentation, and neurotechnologies, and (2) theoretical frameworks for understanding brain function across organizational levels, scales of analysis, and/or systems including humans. This interdisciplinary program is one element of NSF's broader effort directed at Understanding the Brain (UtB), which includes NSF's participation in the Brain Research through Advancing Innovative Concepts (BRAC) program (<http://www.nsf.gov/brain/>) and the phased approach to develop a national research infrastructure portfolio of transformative research resources, instrumentation, and neurotechnologies. The Dear Colleague Letter NSF16-047. NSF envisions a connected portfolio of transformative research resources, instrumentation, and neurotechnologies, yielding novel ways of tackling the most challenging questions in neuroscience and in context.

This solicitation is for innovative neurotechnologies and/or theoretical frameworks that advance the understanding of cognition and behavior across different systems, and the dissemination of these technologies and theoretical frameworks.

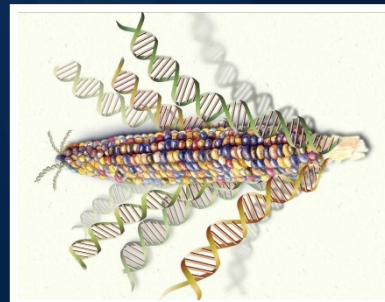
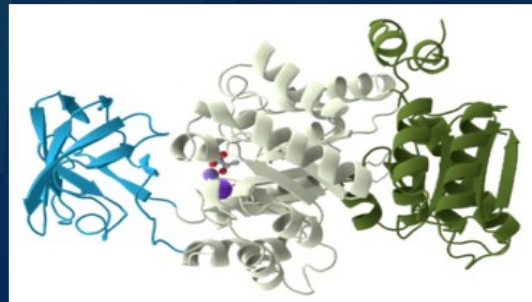
**2. Theoretical frameworks for understanding brain function...**

Understanding the Brain (UtB)





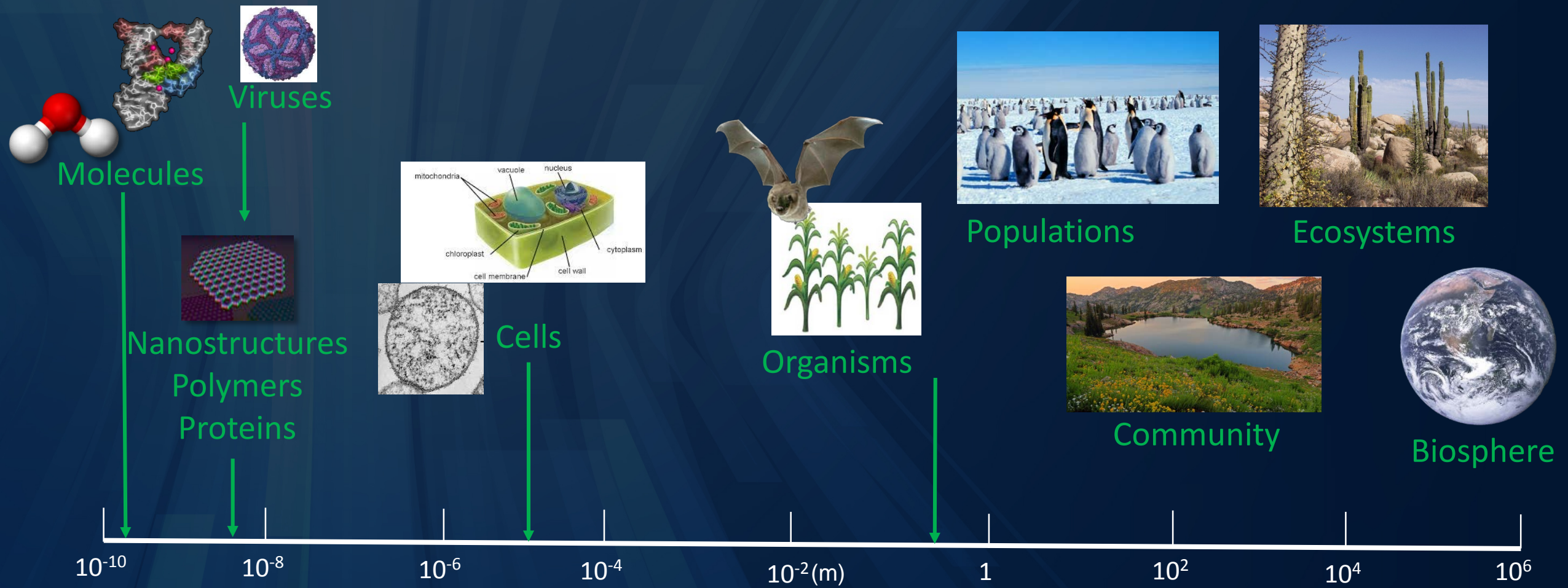
Clean Energy Technology



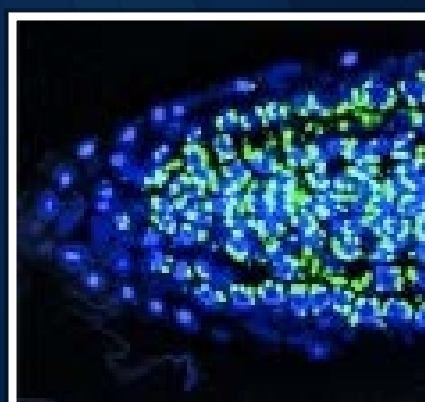
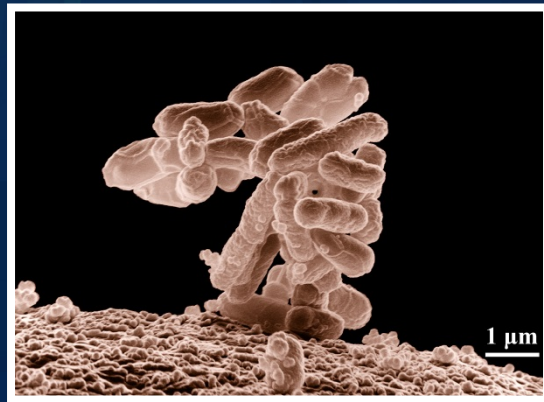
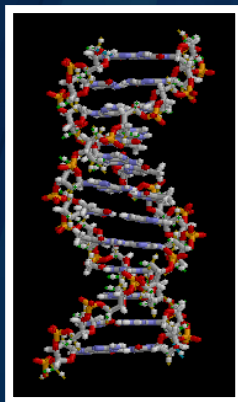
CET =  
\$79.22M







Microbiome

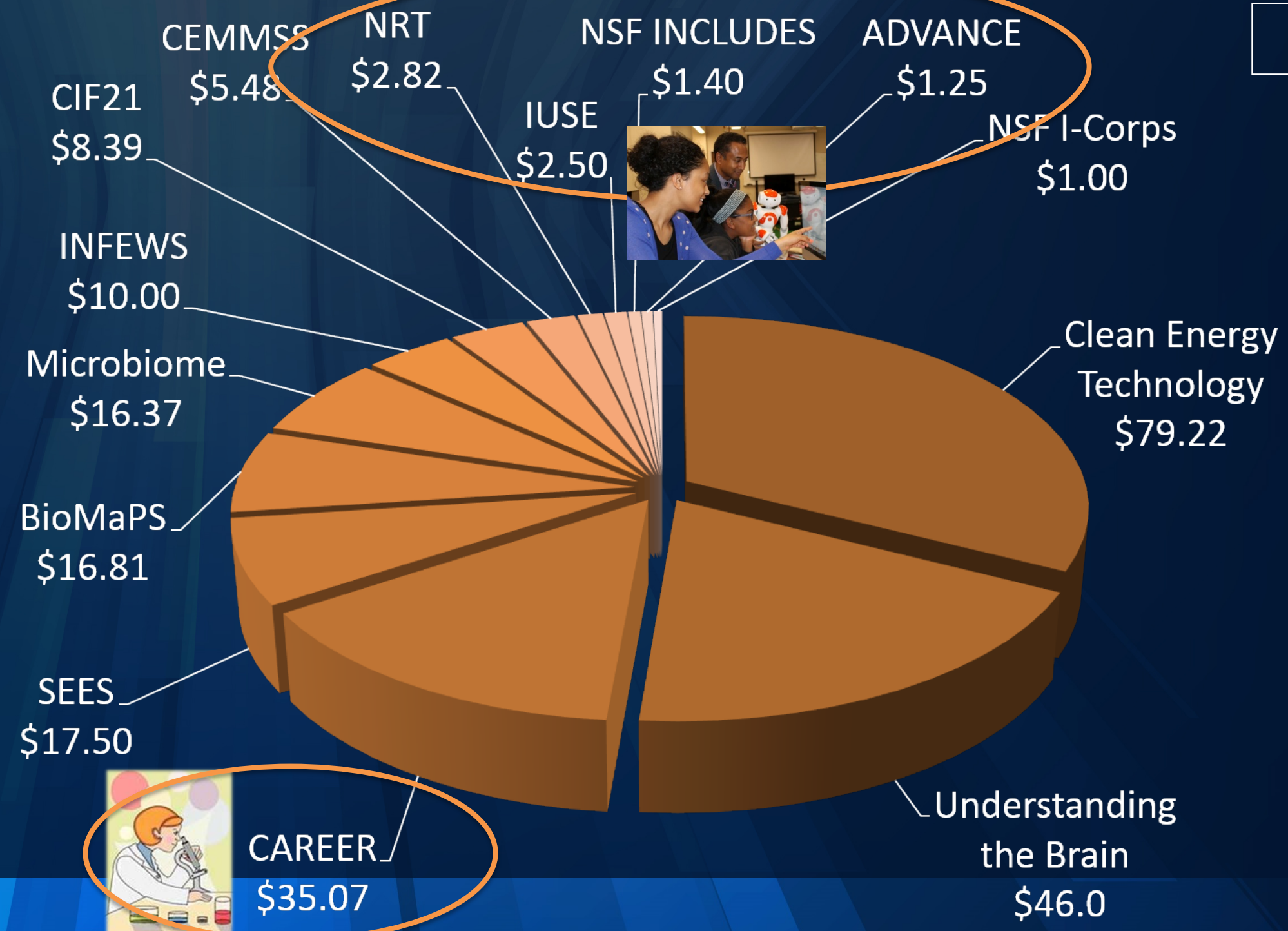


Microbiome = \$16.37M



# Education, Training, & Career Development

\$ = Millions



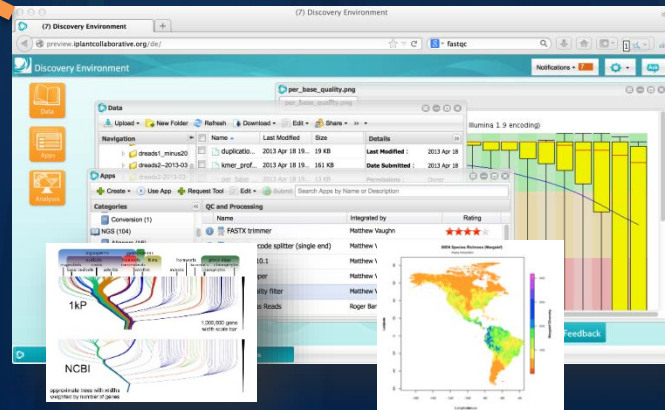
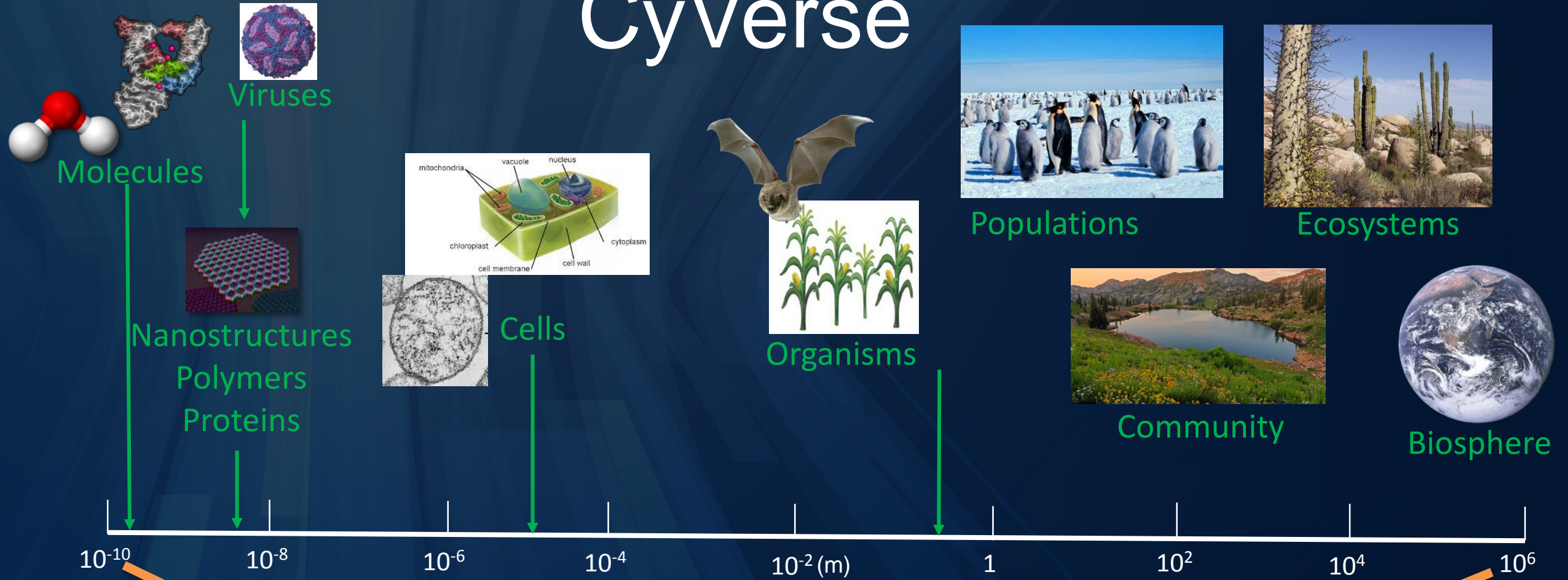


# Tools and Data

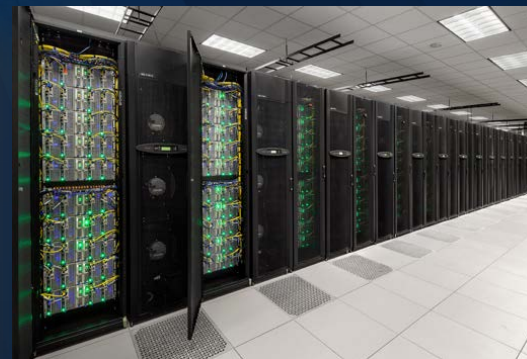




# CyVerse



Platforms, tools, datasets



Storage and compute



Training and support

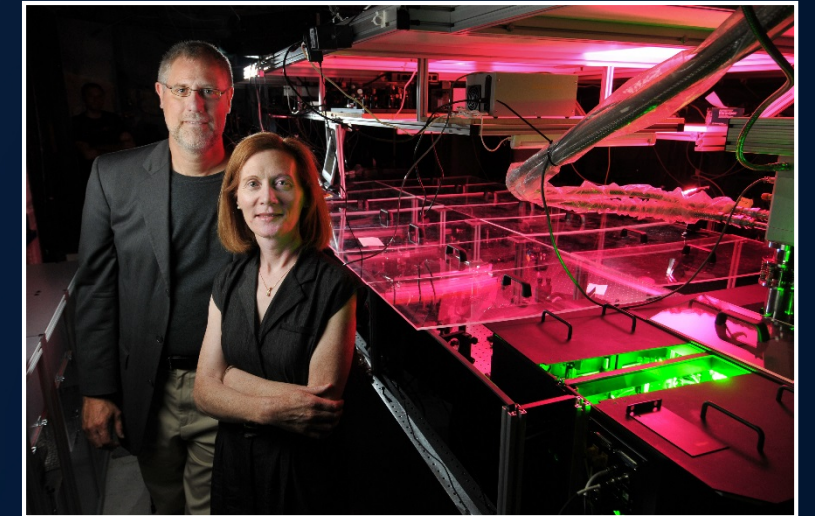




# Science and Technology Centers

Press Release 16-112

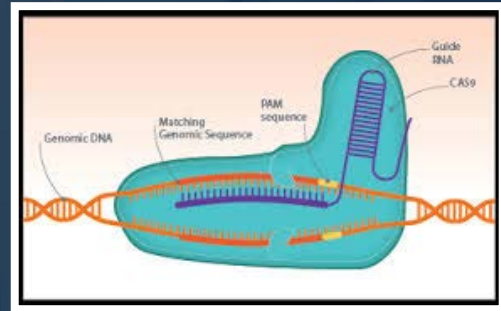
NSF awards \$94 million to create four new Science and Technology Centers



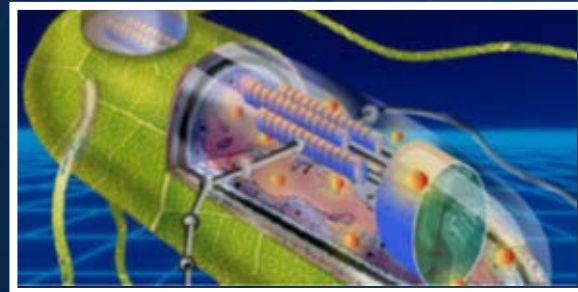
- Center for Cellular Construction
- Science and Technology Center for Engineering MechanoBiology
- Science and Technology Center on Real-Time Functional Imaging
- Center for Bright Beams



# BIOLOGY IS THE ENGINE OF INNOVATION



Basic Discoveries  
Tool Development



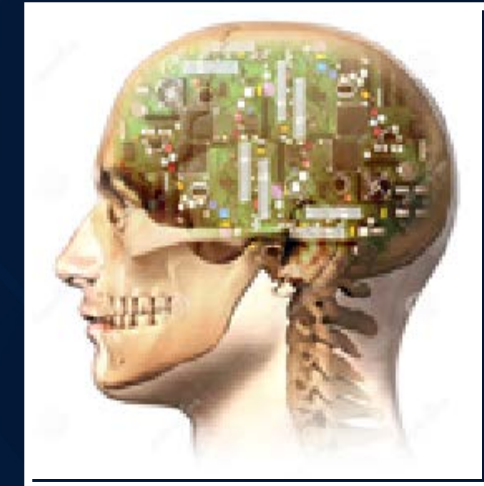
Synthetic  
Biology

Data

BioData



Organisms  
&  
Ecosystems





# Questions?



# Key Questions



## Understanding the Rules of Life: Predicting Phenotype

- ❖ How can computational modeling and informatics methods enable data integration for the purpose of analysis and prediction of complex living systems?
- ❖ Variation in traits expressed by organisms is a feature of all life; what are the genetic, epigenetic and environmental factors that explain its magnitude and occurrence?
- ❖ How to predict the behavior of living systems, from single molecules to whole cells, whole organisms, and whole ecosystems? To what degree do group interactions and behavior affect phenotypic expression?
- ❖ To what degree is an organism's phenotype a result of the microorganisms that live in symbiosis with it? To what degree is the production of a phenotype a 'joint effort' among genomes of different organisms?
- ❖ Can we synthesize cells and organisms based on knowledge of genome sequence and physical features of other basic molecules?