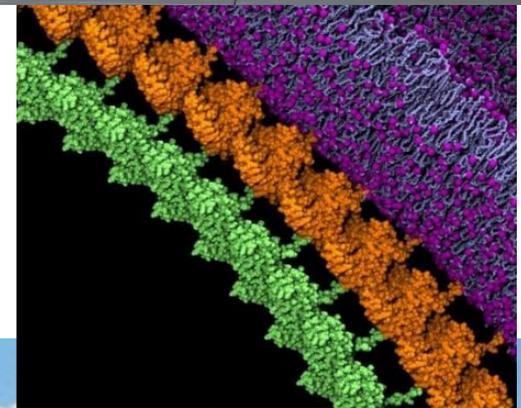
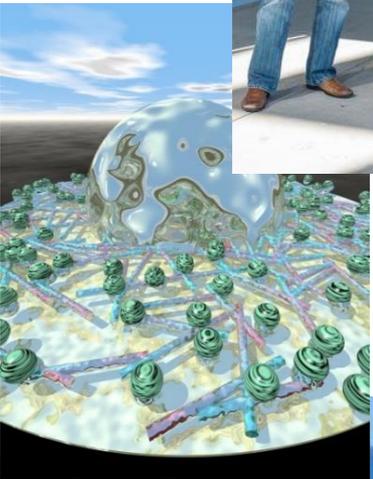
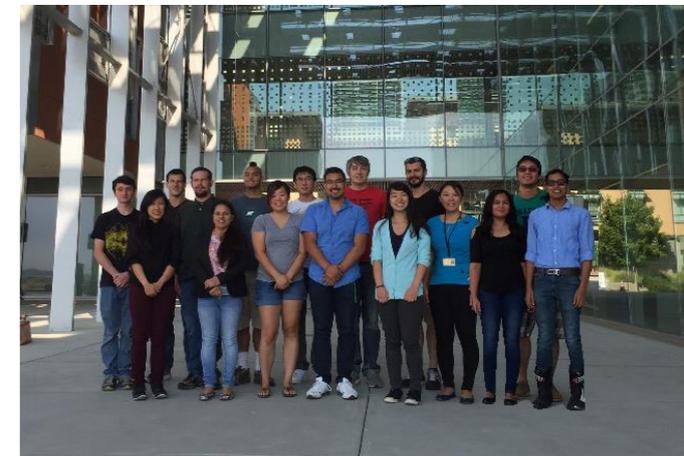


# NSF-CREST Center for Cellular and Biomolecular Machines (CCBM)

## Science and Technology Enrichment Program (STEP) Overview May 11, 2017



- **Multidisciplinary:**

Chemistry, physics, biology, and engineering fields—to study **how biological matter assembles to perform specific tasks**, in hopes of eventually being able to **engineer and develop innovations** (from designer cells and tissue to novel diagnostic and therapeutic devices)

- **Research Thrusts:**

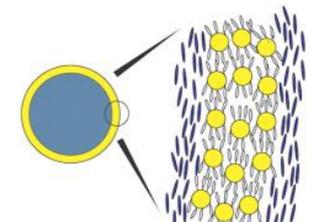
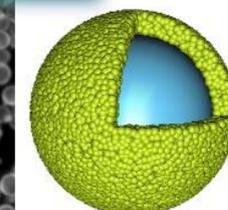
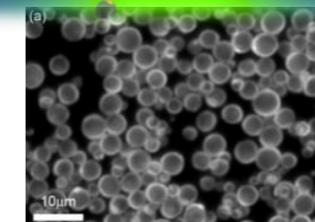
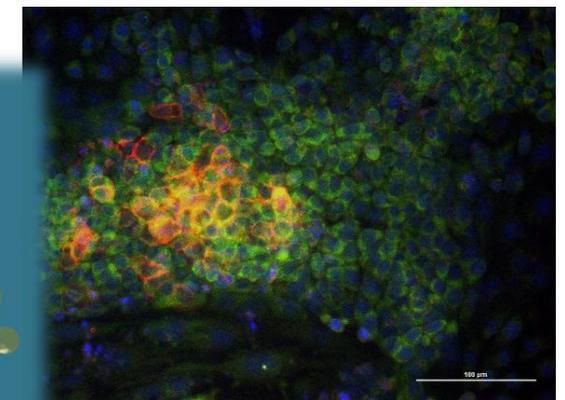
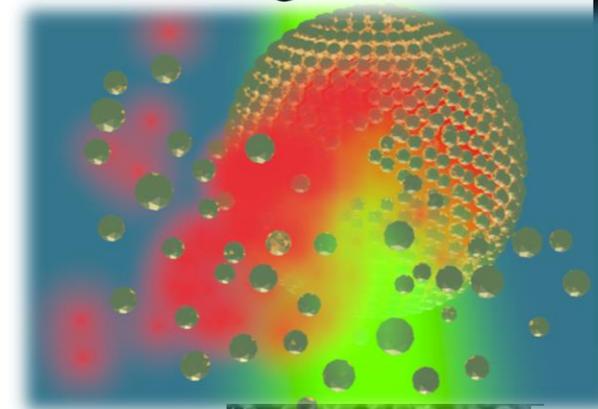
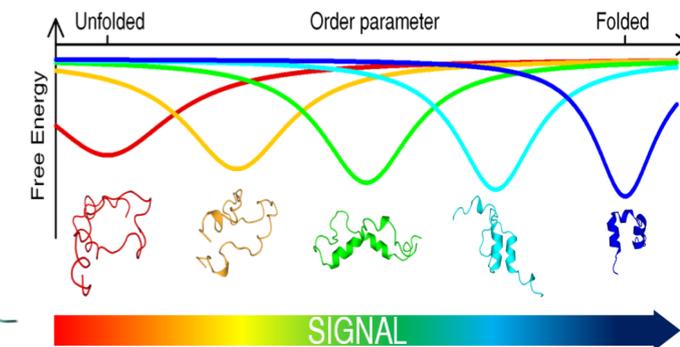
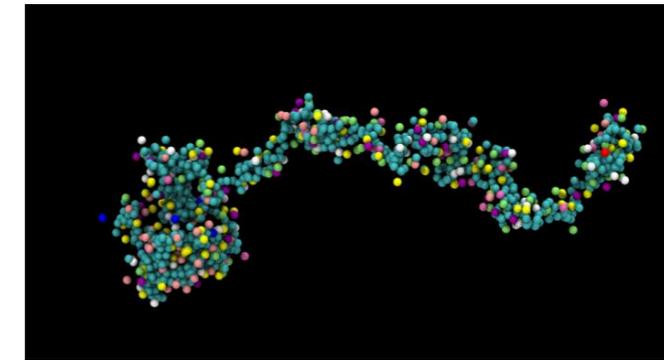
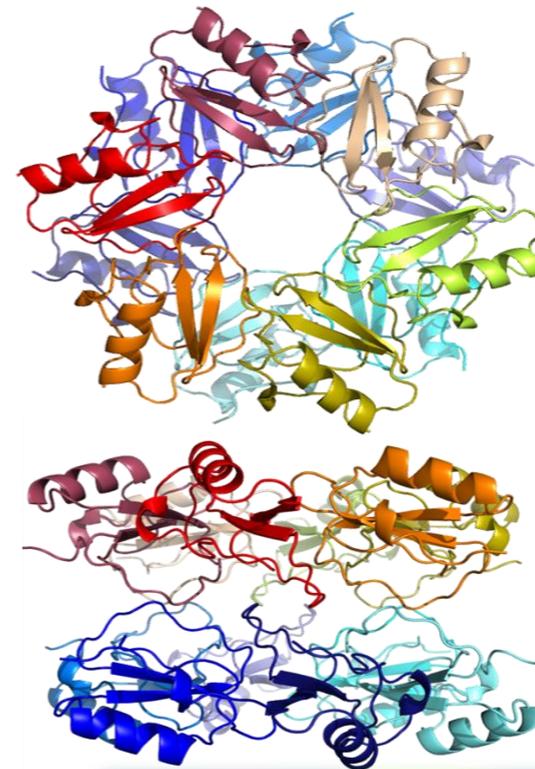
1. *Biomolecular Instruments*
2. *Macromolecular Assemblies and Hybrid Devices*
3. *Cellular and Multicellular Systems*

- **Significance:**

Nobel Prize, 2016—molecular machines  
Multi-scale biomolecular and cellular assemblies  
Control over Biological Systems and Designs

- **Education and outreach:**

A pipeline for highly qualified STEM workforce  
Produce high caliber, diverse trainees at all levels  
Spur growth in Central Valley



## Why do we need a center to work in this area?

**Transformative advances in this area require contributions from many different fields:**

**Biochemistry** to understand biomolecular recognition and signaling mechanisms

**Soft matter physics and materials science and engineering** to understand and characterize material properties

**Optical physics** for cutting edge imaging and manipulation

**Bioengineering** approaches for molecular, mechanical and manipulation

**Biology and chemical biology** to probe functional properties in vivo

**Theory and computation** to rationalize and test what is observed experimentally

**No single department, unit or group can accomplish such an innately interdisciplinary task**

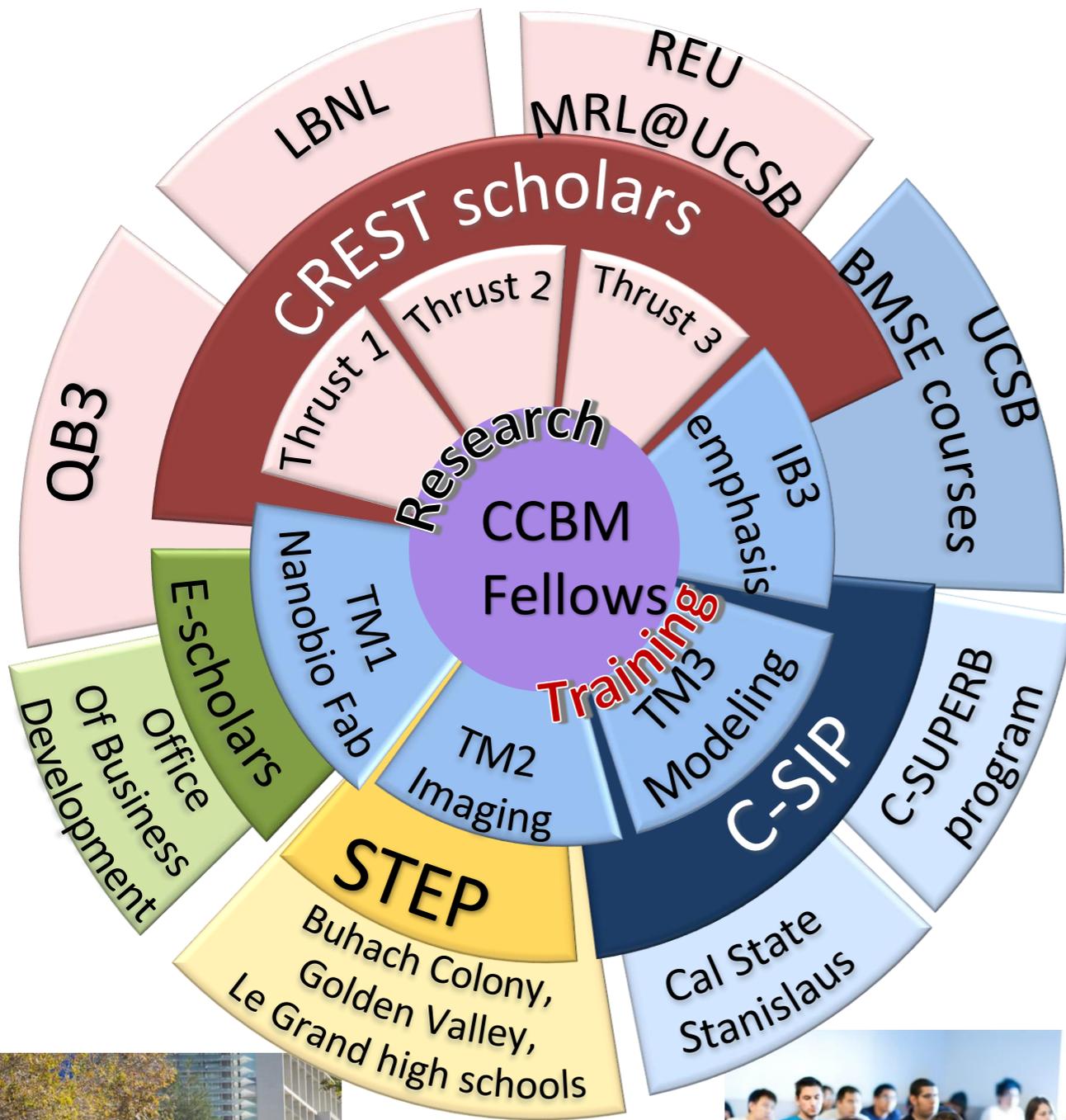
## Novel Approaches:

- A. Interdisciplinary research and training across physics, chemistry and biology, hands on training modules
- B. Entrepreneur/scholar program
- C. Team-based student-led research

## Challenges and opportunities for a center on young campus with local UR demographics

- Newest UC campus (2005)/first American research university of 21st century
- Extends URM student access to UC system
- Major base of advanced research, model of sustainable design-construction and stimulus to economic growth and diversification
- Horizon 2020 Project—\$1.3 billion to duplicate campus size and number of faculty
- Aligned with Strategic Academic Focusing Initiative





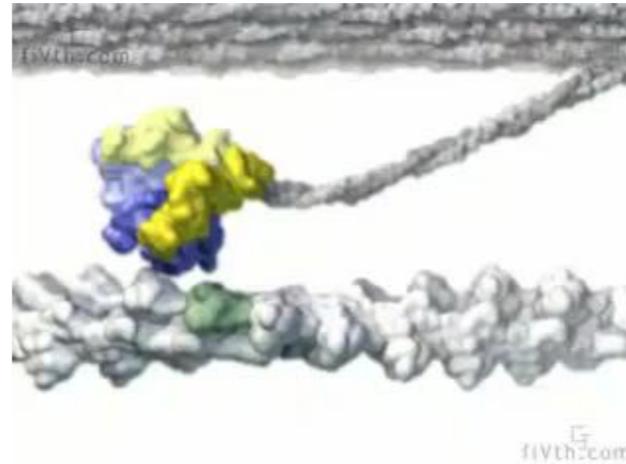
- Strong internal and external partnerships/collaborations to enhance programming and efforts
- Recruitment of URM students from the Central Valley
- First NSF center on campus
- Maintaining NSF center presence on campus
- Grow into a Full Fledged Research Institute
- Influencing direction of university in growth stage
- Nucleate expertise, research facilities and funding opportunities in biophysics and bioengineering



# Research Thrusts

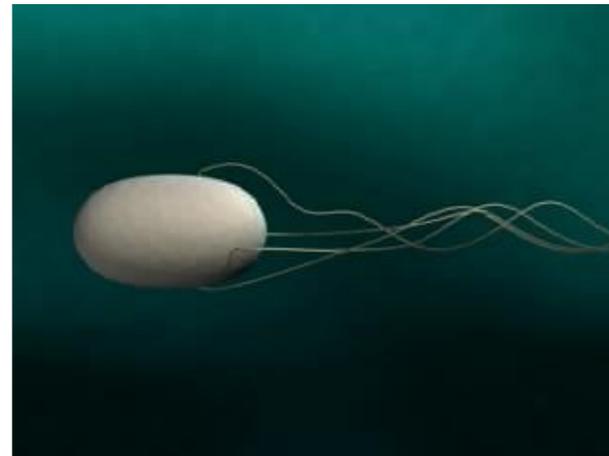
## Biomolecular Machines

Circadian Molecular Clocks  
Rheostatic Protein Biosensors  
(Munoz (co-director), Escobar,  
Colvin, LiWang)



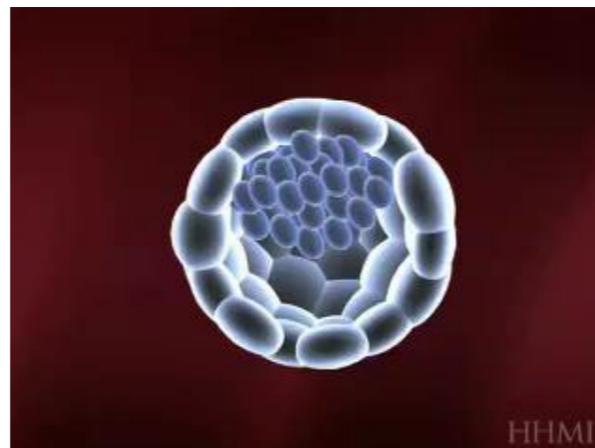
## Macromolecular Assemblies and Hybrid Devices

Designer Vesicles for Transport  
DNA Origami-Nanocomposites  
Graphene-based Biosensors  
(Gopinathan (co-director), Hirst, Xu,  
Ghosh, Ye, Tian, Tung, Chin,  
Gadre)



## Cellular and Multicellular Systems

Differentiating Tissue  
Bacterial Community Motility  
(McCloskey, Gopinathan, Lu, Liu,  
BalaSubramanian, Gopinath)



Supplementary Movie 1:  
Simulating movement of transfer RNA into the  
ribosome during decoding

Sanbonmatsu\*, K.Y., Joseph, S. and C.S. Tung  
Los Alamos National Laboratory

Explicit Solvent Targeted Molecular Dynamics

$$N_{\text{atoms}} = 2.64 \times 10^6$$

ASCI Q Machine (LANL)

\*corresponding author: kys@lanl.gov

[www.t10.lanl.gov/kys](http://www.t10.lanl.gov/kys)

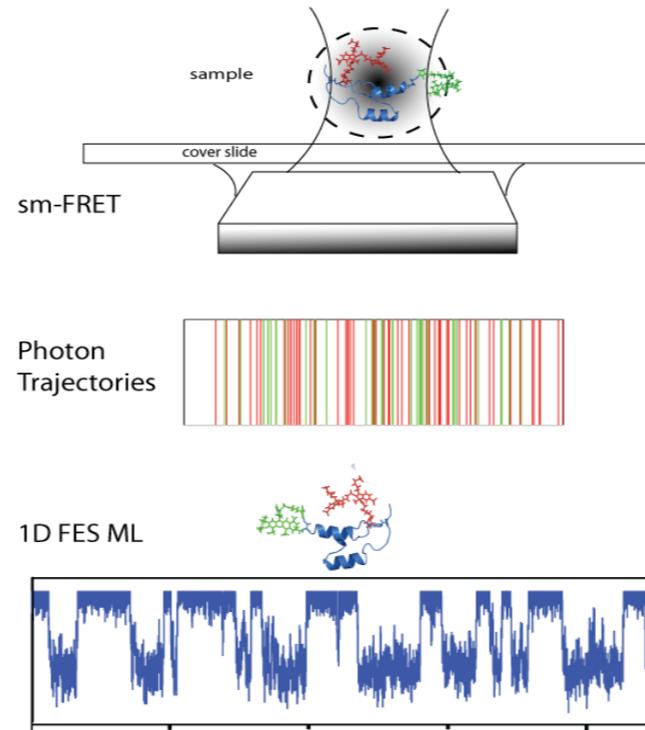
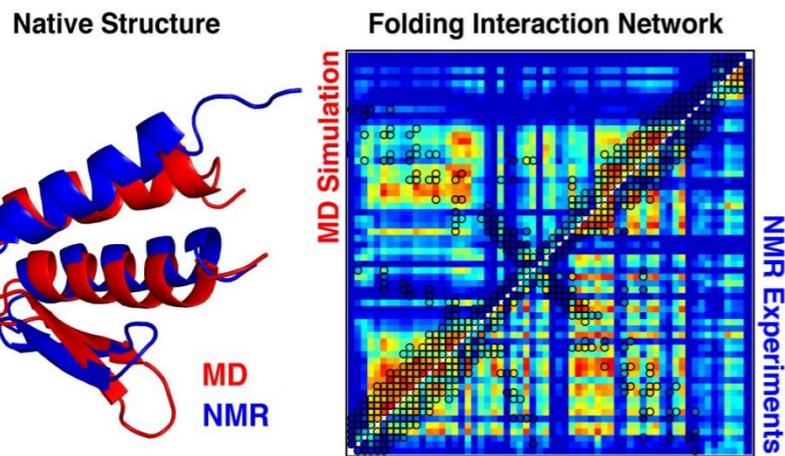


# Thrust 1: Biomolecular Machines

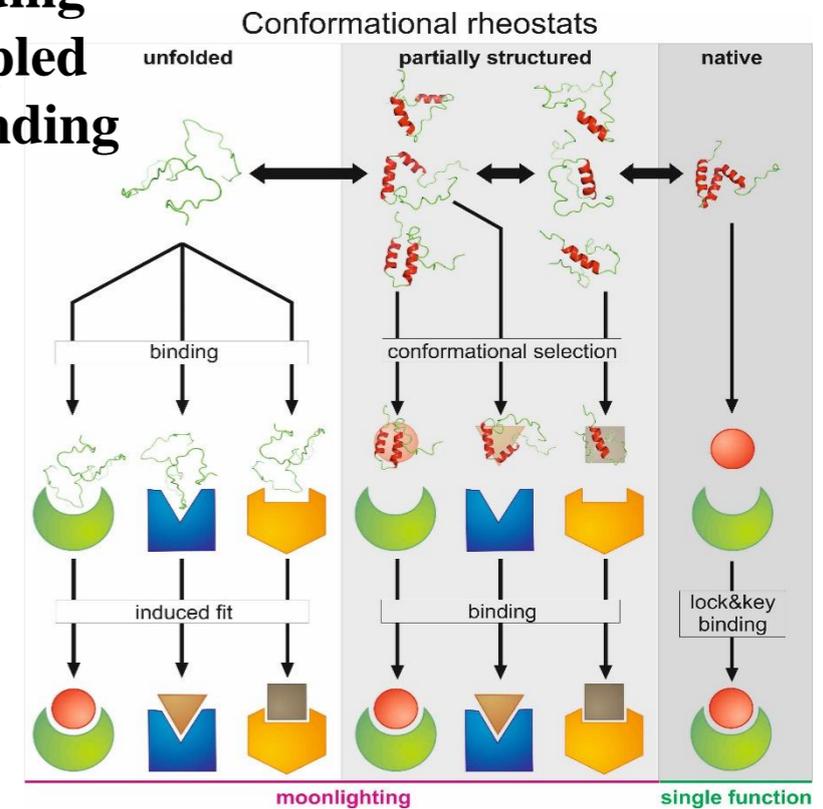


V. Munoz, A. Li Wang

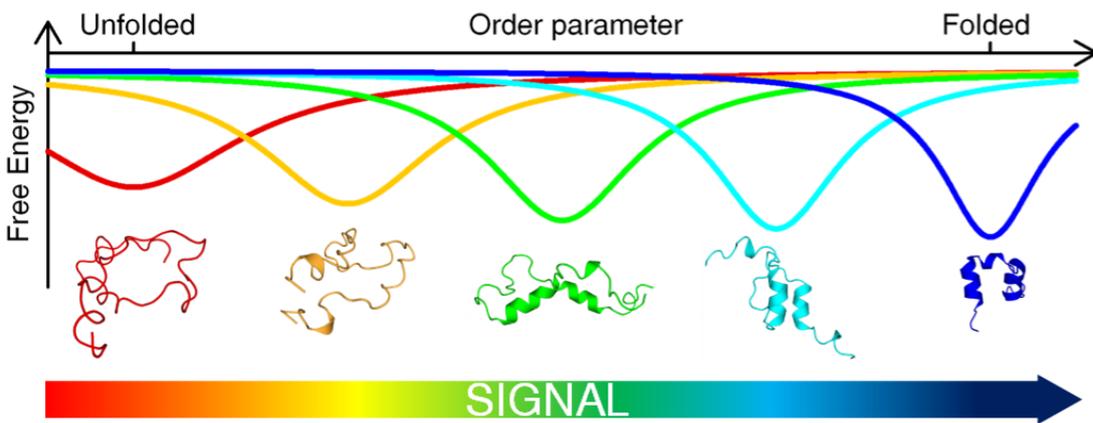
## Protein Folding at Atomic Resolution



## Folding Coupled to Binding

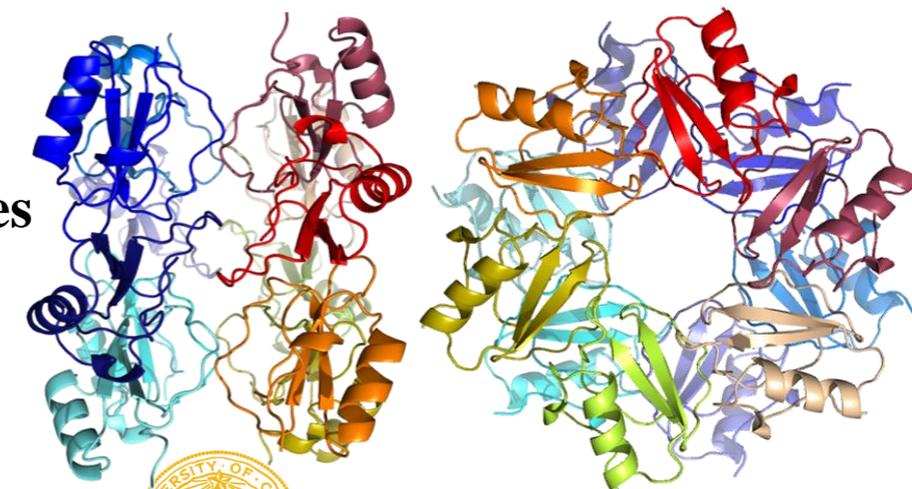


## Engineering Protein Analogical Nanosensors



## Protein Folding in Single Molecules

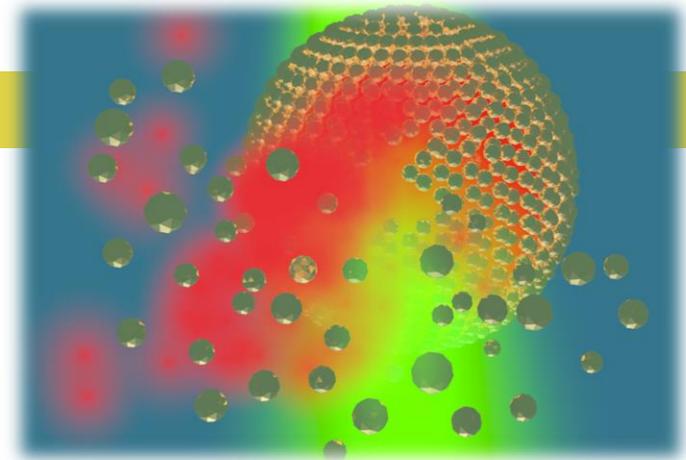
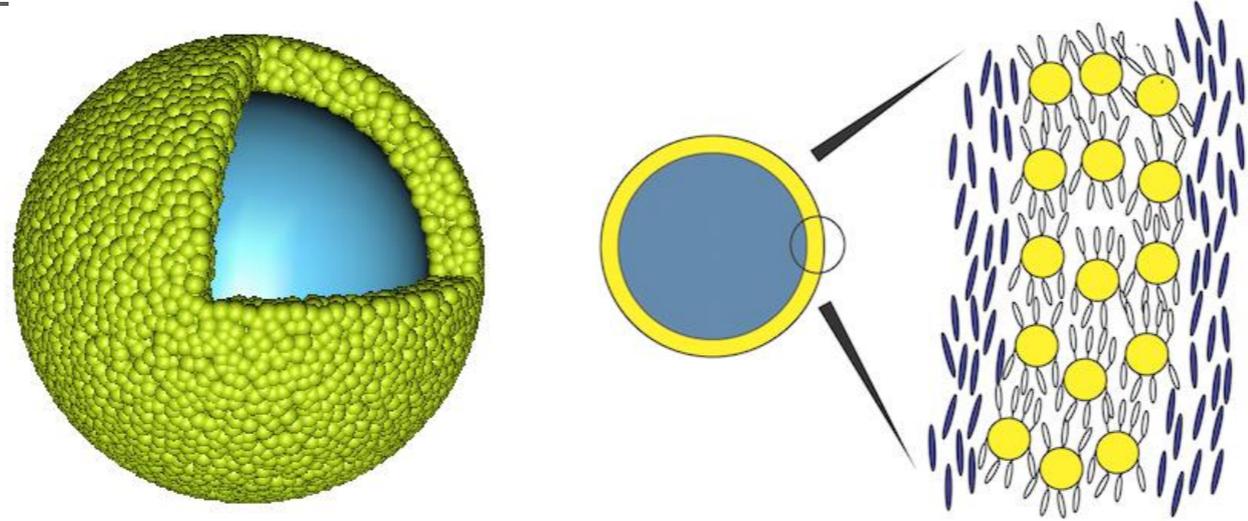
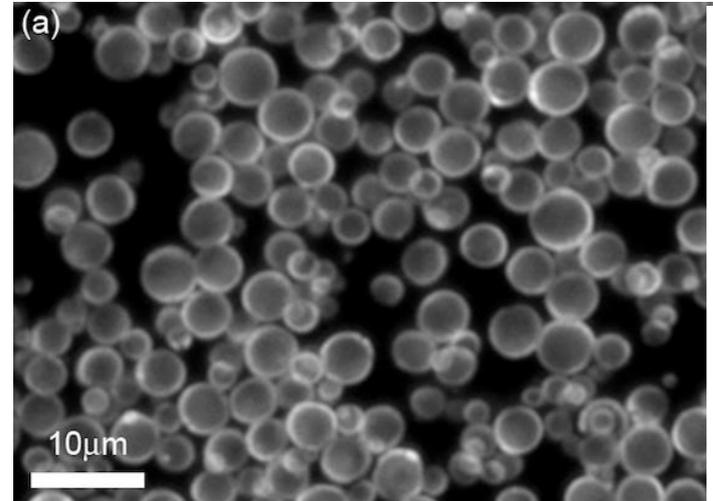
## Engineering Controllable Macromolecular Assemblies



# Thrust 2: Macromolecular Assemblies



## Plasmon actuated cargo delivery

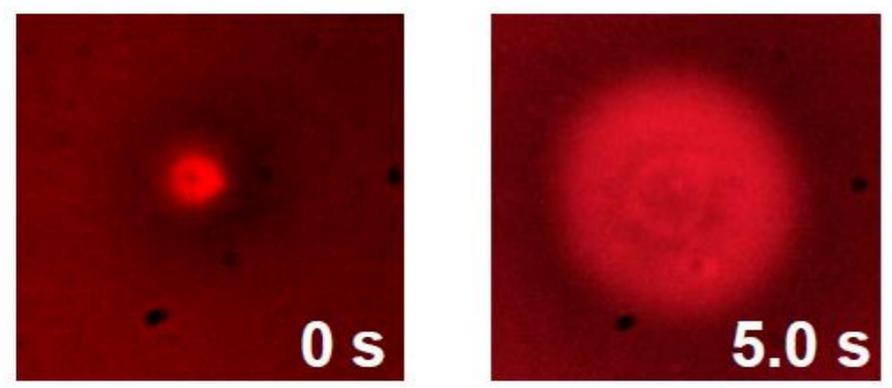


S. Ghosh, L.S. Hirst

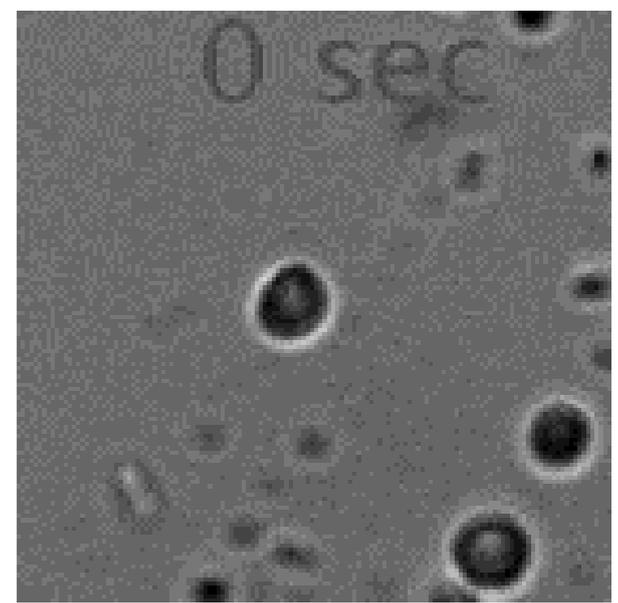
Gold quantum dot shells self-assembled by liquid crystal ordering

Plasmon heating releases cargo

Fluorescence

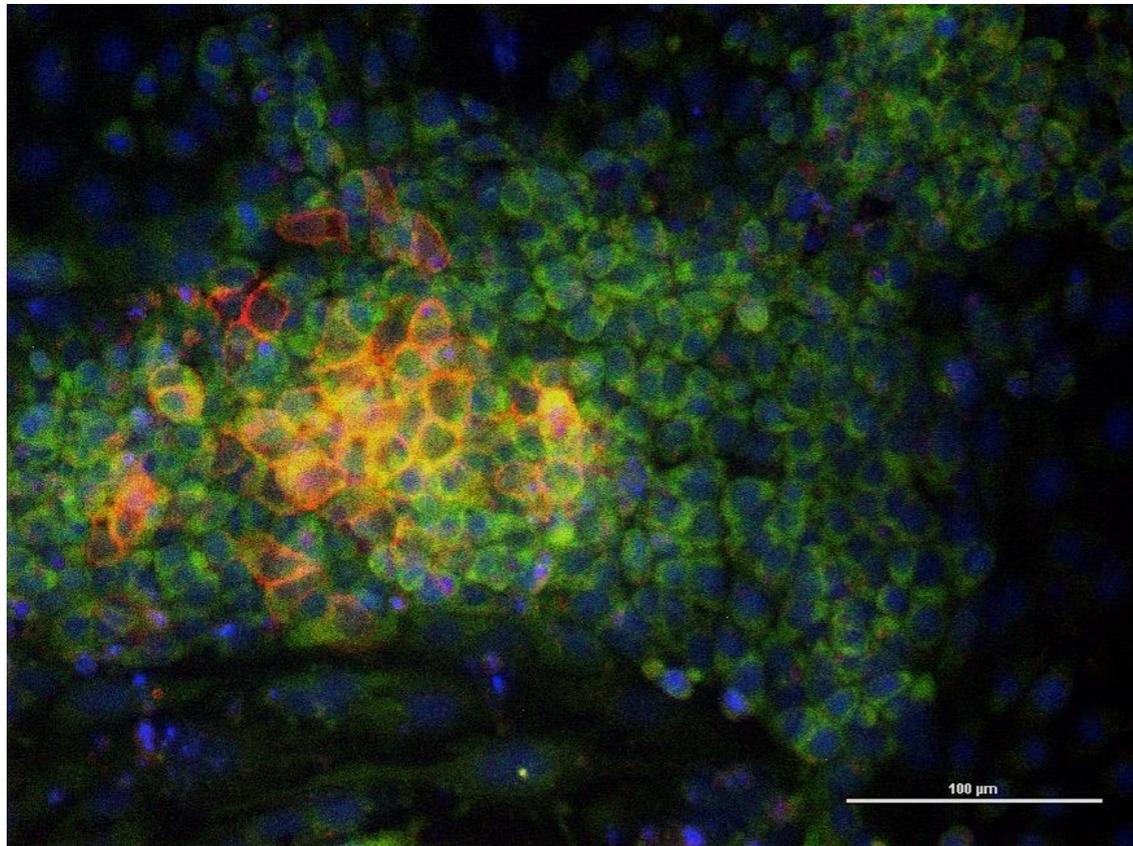


Versatility in encapsulation  
Low power, fast, tunable release

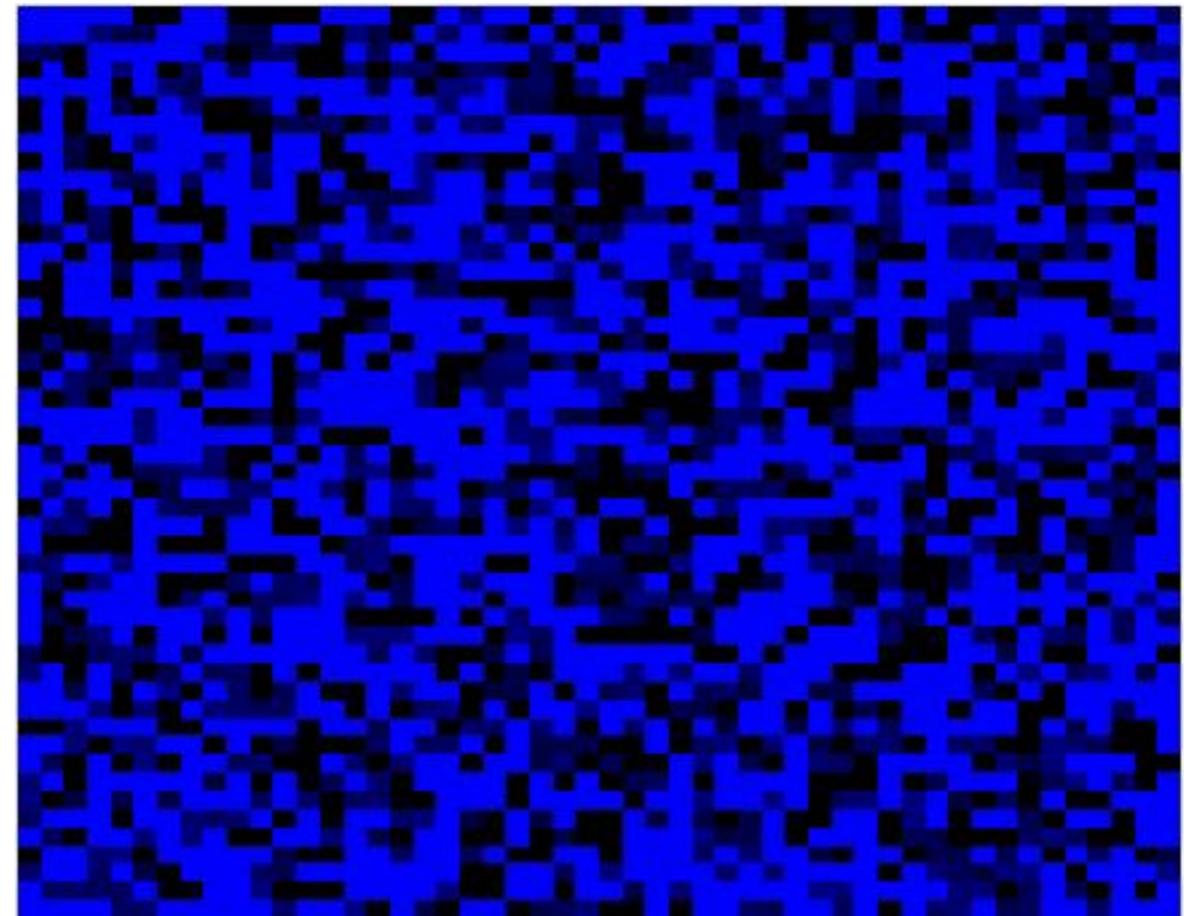




K. McCloskey, A. Gopinathan

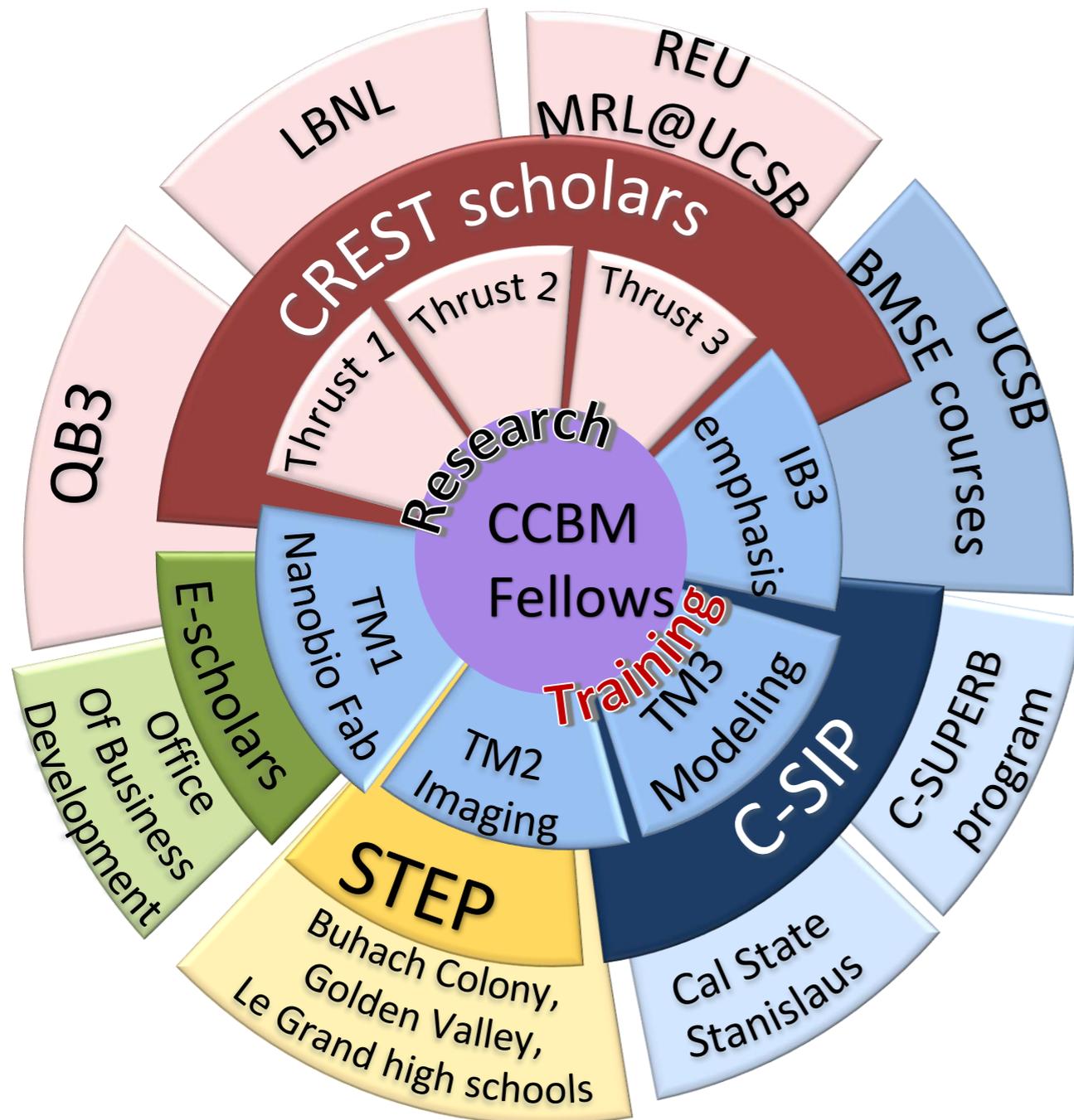


**Development of spatially patterned  
cardiac tissue from stem cells**



**Mathematical model**

# Research, Education, & Outreach



## Mission

- 1- Perform cutting edge interdisciplinary research on multi-scale biomolecular and cellular assemblies
- 2- Become a model for integrated research, education and outreach that develops a pipeline for a highly qualified STEM workforce and produces high caliber, diverse trainees at all levels

1. IB3 graduate training emphasis
2. 2 project scientists
3. Team based research Grad+UG
4. Training Modules
5. Entrepreneurship
6. High school outreach
7. CCBM fellowships
8. Summer research program/UG
9. Travel fellowships, supplies \$\$

*NSF-CREST Center for  
Cellular and Biomolecular Machines  
(CCBM)*

Science and Technology Enrichment Program (STEP)  
for STEM High School Teachers/High School Students

University of California, Merced—Summer





- For physics, chemistry, biology, math, engineering, and computer science teachers
- For interested high school students
- Summer training workshop for HS STEM teachers and HS students

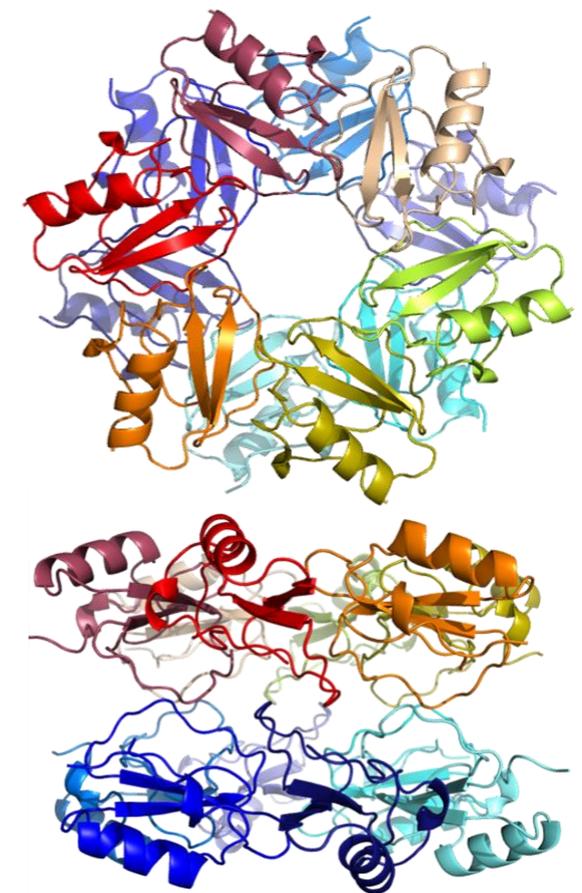
- Professional development and research experience for Merced area STEM high school teachers and high school students
- Access to science and engineering research labs
- Faculty-led learning & research activities in biophysics, biochemistry, & bioengineering, as well as campus lab tours
- Research topics include biology, optics, physics, biochemistry and computational modeling
- Research & academic guidance and mentoring from CCCBM faculty, graduate students, staff & affiliates, with networking opportunities
- Guidance in curriculum development & NGSS, with other professional development

- \$1250 stipend for teachers
- \$250 additional payment upon completion of optional related educational module
- \$300 for classroom materials/supplies
- \$150 stipend for high school students
- UC Continuing Education Credits



## Dates

- June 5-7: orientation activities
- 50 hours of lab experience in summer, flexible dates and hours—5 hours/day for 2 consecutive weeks required
- Other professional development (date TBD)
- Participation in CCCBM Open House (September, date TBD)
- Other optional sessions

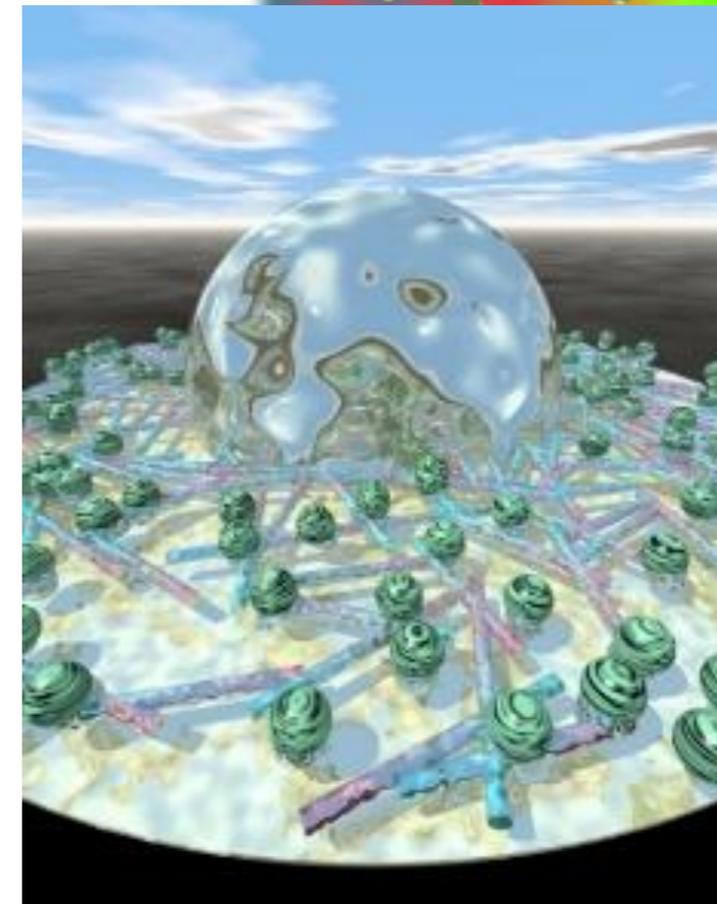
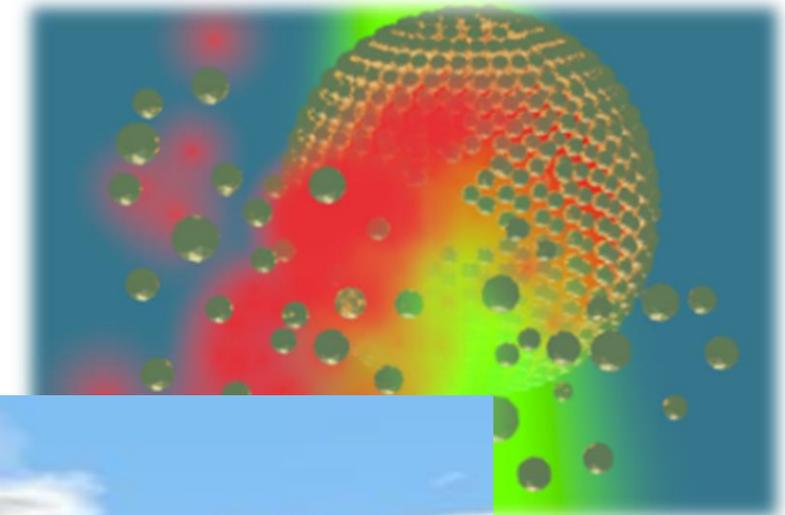


## Application Options

- Teachers apply independently
- Teachers and 1-2 high school students apply as a team
- 1-2 students apply as a team

**Application Deadline:**

**May 19, 2017**

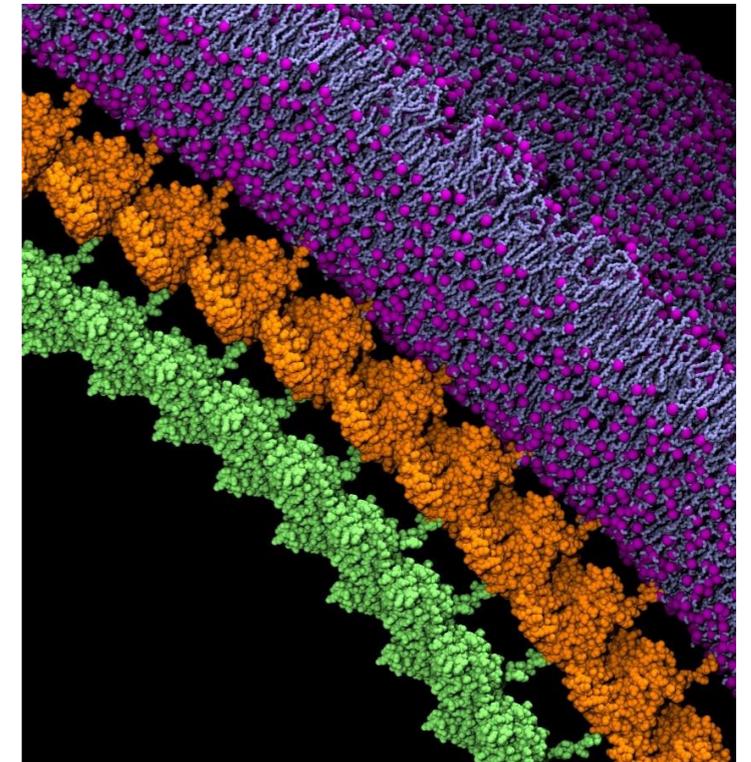


## ***Eligibility for teachers/students:***

- Practicing teacher in STEM field, high school level preferred; current or recently graduated high school student
- Bachelor's degree for teachers
- U.S. citizen, U.S. national, or permanent resident (NSF requirement) to receive payment

## ***Strongly encouraged to apply:***

- Merced area high school teacher/student teams
- Teachers/students from underrepresented minority groups, women, and students/teachers with disabilities



## Application materials:

- Applicant resume(s)
- 250-500 word statement of interest in program, including thrust area preference:

<http://ccbm.ucmerced.edu/>

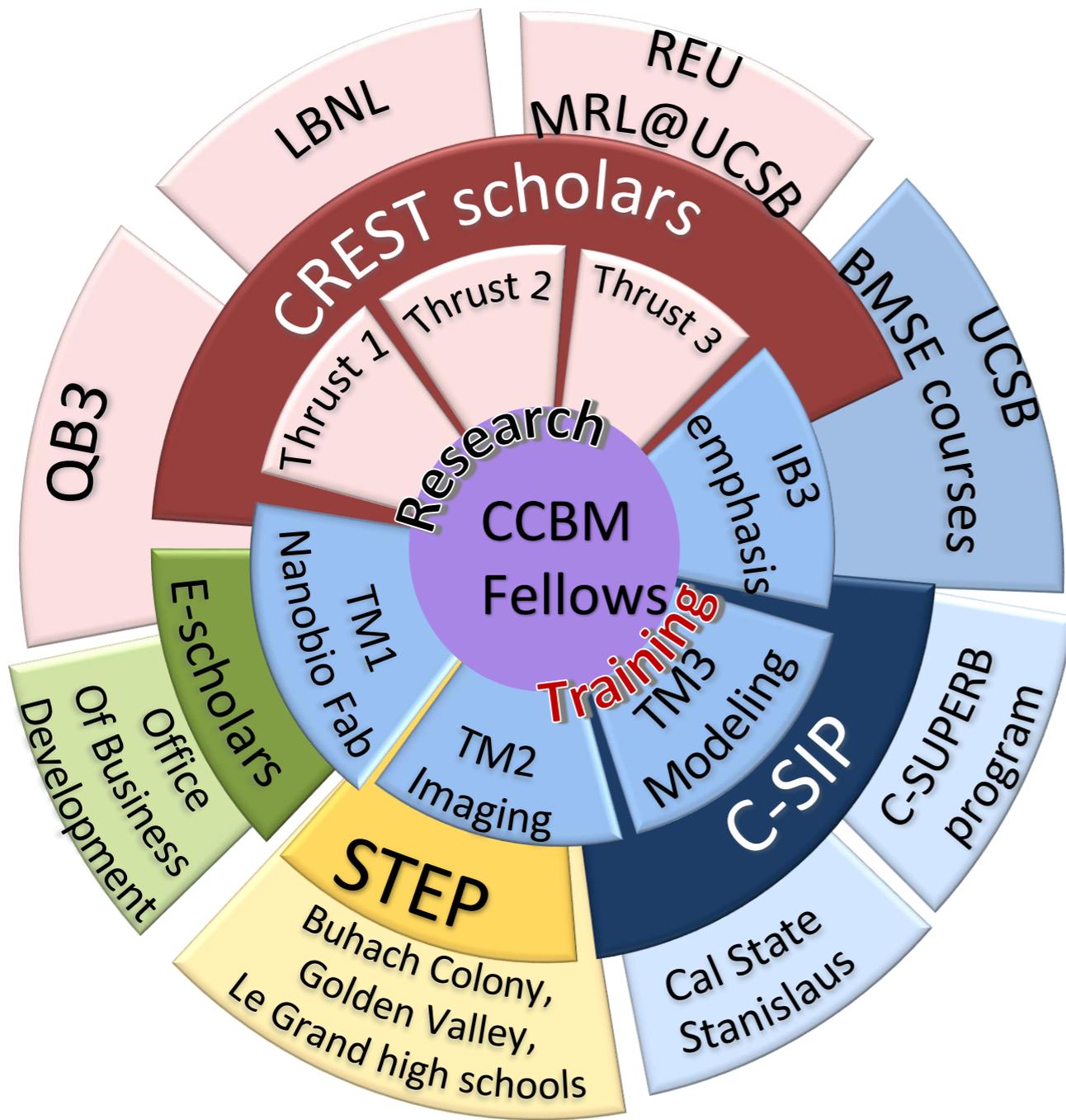
**Email application as a combined PDF to:**  
Carrie Kouadio, CCCBM Executive Director

[ckouadio@ucmerced.edu](mailto:ckouadio@ucmerced.edu)

A program overview meeting will be held in May.

Please note: transportation, parking, and room and board are not provided

# Other Opportunities



- Open House (September 22?)
- Presentations in schools by CCBM fellows and faculty (science and engineering topics, careers, college applications and preparation)
- Future programs



## Center Website

<http://ccbm.ucmerced.edu>

## General Inquiries:

Carrie Kouadio

CCBM Executive Director

[ckouadio@ucmerced.edu](mailto:ckouadio@ucmerced.edu)

