Welcome to the Launch and Information Meeting for

NSF IGERT:
‘Cellular and Molecular Mechanics and Bionanotechnology’ (CMMB)
Acknowledgments

Leadership Team:

Co-PIs: R. Bashir, M. Gillette, K. J. Hsia, T. Saif - UIUC
M. Sheetz, Columbia Univ./Singapore
Also: L. Destefano, I. Ahmad - UIUC
And: V. Leppert - UC Merced

Participants:
Faculty colleagues from UIUC, UC Merced, NCCU

University Support:
Strong support from Engineering, Education, LAS, graduate School, VCR, Provost Office
IGERT Program Goals (Synopsis of Program):

- “To meet the challenges of educating US PhD scientists and engineers for careers in research and education”
- To train PhD students “with interdisciplinary background, deep knowledge, and technical, professional and personal skills to become leaders and agents for change”
- “To catalyze cultural change in graduate education by establishing innovative methods for grad education and training in collaborative research environment that transcends disciplinary boundaries”
- “To facilitate diversity in student participation”
IGERT Program Description: IGERT proposals

- “must describe integrative, research-based, graduate education and training activities in emerging areas of science and eng”
- “should be organized around an interdisciplinary theme that is based on transformative interdisciplinary research in STEM”
- should “provide a framework for integrating research and education, and for promoting collaborative efforts within and across departments and institutions”
- should “provide students with experiences relevant to both academic and nonacademic careers, … and integrate scientific, technical, business, social, ethical, policy, and global issues to confront the challenges of the future”
NSF IGERT: ‘Cellular and Molecular Mechanics and Bionanotechnology’ (CMMB)

R. Bashir, M. Gillette, K. J. Hsia, T. Saif, Univ. of Illinois at Urbana-Champaign
M. Sheetz (Columbia Univ./Singapore)
(+27 faculty from UIUC+UC Merced)

• Produce the next generation of intellectual leaders who will define the new frontiers of Cellular & Molecular Mechanics and BioNanotechnology

• Mechano-chemical transduction processes linking inter-cellular, cellular, and extra cellular scales

• Utilize nanotechnology, imaging, and molecular scale computational

• Applications in regenerative engineering, mechano-biology, sensing and actuation, synthetic biology, etc.
Partners and Collaborators

NSF IGERT: Molecular and Cellular Mechanics and Bionanotechnology (CMMB)

- Institutions with Co-PIs (UIUC, Columbia)
- Minority Serving Collaborators (UC Merced – Satellite IGERT Site; NCCU)
- US Collaborators (Argonne; GIT; Harvard; MIT; UCSD)
- International Collab., iWORLD (Cambridge; Max Plank; NUS; Tsinghua)
### C. Project Description

#### C.1. List of Participants (Co-PIs and Affiliated Faculty)

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Title</th>
<th>Dept/Unit Affiliation</th>
<th>Proposed Role</th>
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<tbody>
<tr>
<td>1</td>
<td>Ahmad, Irfan*</td>
<td>Assoc Director</td>
<td>CNST/MNTL</td>
<td>Program Manager</td>
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<td>2</td>
<td>Bashir, Rashid*</td>
<td>Prof/Director</td>
<td>ECE/Bio/MNTL</td>
<td>PI/Program Dir.</td>
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<td>Boppart, Marni</td>
<td>Assistant Professor</td>
<td>Appl. Health/Kines./Beckman</td>
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<td>Brisher, William</td>
<td>Assistant Professor</td>
<td>MCB</td>
<td>Participant</td>
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<td>Cunningham, Brian</td>
<td>Associate Professor</td>
<td>ECE/Bio/MNTL</td>
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<td>DeStefano, Lizanne*</td>
<td>Prof/Assoc. Dean</td>
<td>College of Education</td>
<td>Participant</td>
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<td>Fang, Nick</td>
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<td>MechSE</td>
<td>Participant</td>
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<td>Gillette, Martha*</td>
<td>Professor</td>
<td>Cell &amp; Dev Biology/MCB</td>
<td>Co-PI</td>
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<td>Ha, Taekip*</td>
<td>HHMI/Professor</td>
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<td>BioE</td>
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<td>Pathobiology</td>
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<td>Lewis, Jennifer*</td>
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<td>Liu, Gang &quot;Logan&quot;</td>
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<td>Schook, Larry*</td>
<td>Professor</td>
<td>Animal Science/IGB</td>
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<td>Schulten, Klaus*</td>
<td>Prof/Director</td>
<td>Phys./Biophysics/Beckman</td>
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<td>Selvin, Paul</td>
<td>Professor</td>
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<td>Sweedler, Jonathan*</td>
<td>Prof/Director</td>
<td>Chemistry/Biotech. Center</td>
<td>Participant</td>
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<td>Takhorshid, Fad</td>
<td>Assistant Professor</td>
<td>Biochemistry/Pharmacology</td>
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<td>Toussaint, Kimani*</td>
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<td>Wagoner, J., Amy</td>
<td>Assistant Professor</td>
<td>MechSE</td>
<td>Participant</td>
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</table>

**Collaborating Institutions:**
- **US-wide**
  - Bao, Gang  
  - Chien, Shu  
  - Kamm, Roger  
  - Leppard, Valerie*  
  - McCloskey, Kara*  
  - Mooney, David  
  - Orlando, Auciello  
  - Siewert, Michael*  
  - Toner, Mehmet*  
  - Yeh, Li-an  
- **International**
  - Lim, C. T.*  
  - Oyen, Michelle*  
  - Spatz, Joachim*  
  - Zheng, Q.*

* Asterisk* indicates CV included in the proposal package; **"** indicate lead external collaborators at Minority-Serving Institution partners. All US and International Collaborators have committed to be part of our IGERT network and participate in student exchanges in their Centers/Labs. Names in italics are external collaborators; Industry list in the proposal (C.4.5(v)).
iGERT Scientific Structure and Organization

**Integrative Research Themes (IRT)**

1. **Molecular Mechanics**
2. **Cellular Mechanics**
3. **Cells and ECM**

**Participants**

- Bao, G.; Brieher, W.; Ha, T. J.; Leppert, V.; Liu, L.; Selvin, P.; Jakobsson, E.; Ravaioli, U.; Schulten, K.; Takhorshid, E.; Yeh, L.

**Core Technologies (CT)**

1. **Molecular and Cellular Computation**
2. **Micro and Nanotechnology**
3. **Molecular and Cellular Imaging**

**Application Domains**

- (i) tissue and regenerative engineering, (ii) cellular and molecular medicine, (iii) mechano-biology, (iv) biological energy harvesting, (v) bio-mimetic sensing and actuation, (vi) cellular factories, (vii) synthetic biology

*Italicized are external US collaborators*
iGERT Student Experience

Year 1: Grad Prog. Curriculum
- Mol. & Cell Biology Core Courses - F/S
- PhysSci/Engineering Dept. Cores - F/S
- Research Lab Rotations - Fall 1 inside/2 outside home dept
- Select PhD lab & co - mentors - Spring

Summer 1: 4 week lab modules
- Cell culture, substrates
- NanoFab/Microfluidics
- Microscopy, analyze image
- Mol. manipulation, computation

Year 2: CMMB Core Curriculum
- CMMB Core Courses - F/S
- Home Engr. Dept. Cores F/S
- Scientific Ethics Course - F
- Qualifying Exam - Spring
- Thesis research

Summer 2: 2 week
- Team building, Ethics
- Presentation skills, Entrepreneurship

Year 3: CMMB Curr., Research
- CMMB Seminar Course - F/S
- Advanced cross - disciplinary courses
- Prelim. Thesis Exam - Spring
- Thesis Research

Summer 3: Thesis Research/External Experience

Year 4: CMMB Curr., Research
- CMMB Seminar Course - F/S
- Preliminary Thesis Exam - Spring
- Thesis Research
- Publish thesis research

Summer 4: Thesis Research/External Experience

Year 5: CMMB Curr., Research
- CMMB Core Courses - F/S
- Entrepreneurship course
- Publish thesis papers
- Write & defend thesis

Summer 5: Thesis Research/External Experience

Pipeline/Recruiting Sources:
- Mol & Cell Bio, MechSE, BioE, ECE, Biophysics, Medical Scholars, REU, SROP, SPI (see Equity Programs)
- NSF-funded NanoCEMMS, WaterCAMPWS, at UIUC

Leaders in Cross-Disciplinary Science/Eng (Academia, Industry, Govt. Labs)

• External experiences in summers includes international experience, or US Collaborators, or industry internships
• The IGERT fellows would follow the two track curriculum in Figure 12
Concept of a 2-Track Educational Program

Introduction to Cellular and Molecular Mechanics and Bionanotechnology, New

Lab Modules

Cell Culture
- Basics of Cell Culture
- Advanced Cell Culture
- Advanced Cell Substrates

Imaging
- Advanced Microscopy
- Single Molecule Visual.
- Cell Visualization
- Cell Force Probes

Computational Mechanics Seminar, new

Nanofabrication
- Nanofabrication Methods
- Nanofabrication of Cell Sensors
- Microfluidics

Life/Career Module

- Communication skills
- Leadership skills
- S&T Policy
- Ethics training
- Patent and IP
- Industry environment
- Entrepreneurship

Advanced Courses

- Advanced Bioinstrumentation, BIOE 507
- Analytical Methods in Bioengineering, BIOE
- Advanced course in Bionanotech, new
- Hands-on Course in Comput. Biology, PHYS 590C
- Engineering Applications of Biological systems, ABE 498
- Introduction to Nanotechnology ECE 498 JL
- Special Topics in Cell Biol., MCB 592
Fellowship Details

- **NSF:** 7 at UIUC, 2 at UCM in 1st year
- **Matching:** 5 committed (+3 pending) at UIUC, 1 at UCM per year
- **NSF:** 10 in 2nd – 5th year, 2 at UCM in 2nd – 5th year
- **Matching:** 5 committed (+3 pending) at UIUC, 1 at UCM per year

UIUC 5 NSF + 4 matching per year

UCM 1 new NSF per year

- 2 years (upon satisfactory participation and performance) + 1 year for exceptional students
- NSF funds for US citizens, residents
- Each fellow to be co-advised
- **Matching:**
  - 1 from ChBE
  - 1 from MechSE
  - 1 from College of Education
  - 2 from College of Engineering SURGE – SURGE/IGERT Fellow

- Fellowships to be used as recruiting tool (focus on UR groups)
- Balance between new students and existing students that are eligible
UC Merced - First New Research University of 21st Century
UC Merced Diversity and Interdisciplinarity

Fast Facts

School of Engineering Demographics

- 66.1% Non-URM
- 27.5% African-American
- 6.0% Native-American
- 0.4% Hispanic
- 15.4% Female

Opened in 2004 to Grad Students
Opened in 2005 to Undergrads

Students from
- Central Valley (1/3)
- Northern CA (1/3)
- Southern CA (1/3)

Three Schools
- Social Sciences, Humanities, Arts
- Natural Sciences
- Engineering

Enrollment ~4200 (Fall 2010)

Nine Graduate Groups

Emphasis on Interdisciplinarity

Three Institutes
- Health Sciences
- Energy
- Sierra Nevada
IGERT Partnership

“Sharing Research, Education, and Outreach Opportunities”

- Two IGERT Fellows @ UCM + Match
- UCM Faculty/Student Participation in
  - IGERT Symposium
  - Summer Workshop
  - International Experience
  - Web-based Course Development and Delivery
  - REU Experience (possible pipeline of URM students to UIUC)
  - IGERT Executive Committee (SOE Assoc. Prof. Valerie Leppert)
  - External Advisory Board (NS Dean Maria Pallavicini)
- UIUC Faculty Involvement with UCM (helping a new campus)
  - Participation on Select Qualifying and/or PhD Exam Committees
  - Guest Seminars and Joint Symposia
  - Advice on establishing UCM’s new Micro/Nano Core Facility
Research Synergies

Three of Nine Graduate Groups at UC Merced

- Biological Engineering and Small Scale Technologies
  (UCM PI Valerie Leppert is Chair and co-PI Kara McCloskey is Past Chair)
  - Bioengineering
  - Micro and Nano Technologies
  - Materials Science and Engineering
  - Tissue Engineering
- Quantitative Systems Biology
  - Stem Cell Research
  - Regenerative Medicine
  - Nanotoxicology
- Physics and Chemistry
  - SERS
  - Biosensing
Fellow and PI Requirements

As per our IGERT proposal, below are the minimum requirements for the IGERT fellows:

- enrolling in the capstone course,
- performing the 3 lab rotations in the first semester (for new students),
- taking the lab modules in the first or second summer,
- choosing between either international experience (strongly preferred), US collaborator lab experience, or industry experience for one summer,
- participation and presentation in the seminar series and at the annual symposium.
- There would be additional requirements such as help in teaching/executing the summer schools, participation in assessment, participation in the student leadership council.

The PIs would agree to the following:

- be willing to co-advice each fellow with another faculty,
- each advisor would be available to serve on committee of students from Merced as needed,
- advisor would give a seminar per year in the series and participate in the annual symposium,
- Open and involve their labs for rotations for new students.
Additional Information

- $90K for research equipment, $42K for A/V equipment, $50K/year for International travel
- Stipends would be the same for all fellows regardless of home departments.
- We will start the rotations next year in the Fall. The rotations would be 3 per semester and should be interdisciplinary in nature. We will require a short report at the end.
- Program manager position to be filled within 2 weeks.
- Website development
- We need to keep the students together as cohorts and build a sense of community. This will be critically important as we move forward and set up the various programs.
- The proposal review can be performed by a panel from campus which is different than the executive committee to ensure no conflict of interest. Irfan could manage this process.
- We will develop a matrix for participation and involvement for each fellow and this would be used during the process of renewal of the fellowship.
- International Program: We will make contact with all the international partners and develop a mechanism to connect students and the potential hosts.
Fellows Recruitment

We plan to have at least half of the IGERT fellows from underrepresented groups.

- **Research Experience for Undergraduates:**
- **Partner Institutions (UCM, NCCU)**
- **IGERT Open House with the home departments in spring semesters:**
- **Recruitment at National Meetings:**
  - Annual Big Ten Outreach Puerto Rico Graduate School & Summer Research Forum:
  - NSBE (National Society of Black Engineers), April every year:
  - SHPE (Society of Hispanic Professional Engineers), January every year:
- **UIUC Campus Equity Recruitment Programs:**
  - *Multicultural Engineering Recruitment for Graduate Education Program (MERGE)*
  - We will work and advertise the IGERT to minority and women student organizations at the UIUC campus such as MERGE, Morrill Engineering Program, LSAMP, SROP, SURGE (*Support for Under-Represented Groups in Engineering*) on the UIUC campus.
  - We will also work closely with the NSF Neuro-IGERT, NSF funded NanoCEMMS Center and the NSF funded WaterCAMPWS Center at UIUC, and leverage the very strong recruitment and educational programs already developed.
Mentoring and Retention Activities

• **Creating a Nurturing Environment:** We will work to create and sustain a highly interdisciplinary environment for students to interact and understand and become part of the IGERT educational culture by;
  – IGERT Seminar Series
  – Annual IGERT workshop
  – State of the art facilities and environment
  – Summer school
    • Incorporation IGERT fellows in the development of the experimental modules and exposing them to state-of-the-art equipment.

• **Mentoring Program:** We will set up mechanisms for IGERT fellows to mentor other students. The mentoring program will get underway in Fall of every year.

• **Student Leadership Council:** 4 students for 2 year term, that are empowered to promote their professional development and become part of the IGERT leadership in a tangible manner providing strategic and operational support to the PIs and participating faculty.
Assessment/Evaluation

• The evaluation is designed to answer four questions:
  – Implementation: Is the IGERT program being implemented on schedule and as planned?
  – Effectiveness: Are key components of the IGERT model (e.g. student recruitment, faculty involvement, introductory course, co-advising, laboratory modules, new courses, seminars, internships, Student Leadership Council, etc.) operating effectively? How might they be improved?
  – Impact: What outcomes are associated with participation in the IGERT program? How do these compare with a comparable group of students in traditional programs? What is the value-added of participation in the IGERT program?
  – Institutionalization: How and to what extent are elements of the IGERT becoming institutionalized at Illinois and other participating institutions? What opportunities and barriers exist?

• Internal evaluator, Lizanne Destefano and associates from the College of Education,

• Prof. Eliezer Geisler as an external evaluator.
Next Steps

- Proposals due Sept 10\textsuperscript{th}, 5pm
- Fellowships awarded Sept 28\textsuperscript{th}
- Recruit new students for next year
Let's work together and make this the best IGERT program in the Nation