SYMPOSIUM SB06

Bringing Mechanobiology to Materials—From Molecular Understanding to Biological Design
December 2 - December 4, 2019

Symposium Organizers
Jennifer Curtis, Georgia Institute of Technology
Matthew Paszek, Cornell University
Kate Poole, University of New South Wales
Christine Selhuber-Unkel, University of Kiel

Symposium Support
Bronze
TA Instruments

* Invited Paper

SESSION SB06.01: Cells as Mechanosensory Living Materials I
Session Chairs: Christine Selhuber-Unkel and Ana-Sucana Smith
Monday Morning, December 2, 2019
Hynes, Level 2, Room 201

8:30 AM *SB06.01.01
Sensing Local Strains in the Cytoskeleton via LIM Domains
Patrick Oakes; Loyola University Chicago Stritch School of Medicine, United States

9:00 AM SB06.01.02
Mechanical Manipulation of Tandem Repeats of Biological Motifs—One Molecule at a Time
Jaba Mitra1,2 and Taekjip Ha2; 1University of Illinois at Urbana-Champaign, United States; 2Johns Hopkins University, United States

9:15 AM SB06.01.03
Biologically Inspired, Cell–Selective Release of Aptamer–Trapped Growth Factors by Traction Forces
Benjamin Almquist; Imperial College London, United States

9:30 AM *SB06.01.04
Watching Cellular Mechanotransduction—Piezo1 Activation by Cellular Traction Forces
Kyle L. Ellefsen1, Jesse R. Holt2, Alice C. Chang3, Janisson L. Nourse4, Janahan Arulmoli3, Armen Mekhdjian3, Hamid Abusurda2, Francesco Tombola2, Lisa A. Flanagan3, Alexander Dunn1, Jan Parker4 and Medha M. Pathak3; 1University of California, United States; 2University of California, Irvine, United States; 3Stanford University, United States

10:00 AM BREAK

10:30 AM *SB06.01.05
From Microdishes to Microniches—Controlling Single Cell Apico-Basal Polarity and Lumenogenesis
Virgile Viannof2, Yue Zhang1, Richard deMets1, Celine Stoecklin3; 1National University of Singapore, Singapore; 2Centre National de la Recherche Scientifique, France

11:00 AM *SB06.01.06
Mechanism in Collective Organizations of Living Cells
Joachim P. Spatz; Max Planck Institute for Medical Research, Germany

11:30 AM *SB06.01.07
Soft Tissue Mechanics Result from Fibrous Networks Confined by Close-Packed Cells
Anne van Oosten1,2, Xingyu Chen1,3, Vivek Shenoy1,3 and Paul A. Janmey1; 1University of Pennsylvania, United States; 2Leiden University, Netherlands

SESSION SB06.02: Cell Adhesion and Mechanics
Session Chairs: Christine Selhuber-Unkel and Britta Trappmann
Monday Afternoon, December 2, 2019
Hynes, Level 2, Room 201

1:30 PM *SB06.02.01
Single-Molecule Measurements of Force Transmission by Integrin Heterodimers in Living Cells
Alexander Dunn; Stanford University, United States

2:00 PM SB06.02.02
Multiscale Modeling of the Facet Capsule Ligament—Size Effects and Problem Size Reduction through Generalized Boundary Conditions
Jacob Merson and Catalin Picu; Rensselaer Polytechnic Institute, United States

2:15 PM SB06.02.03
Towards Non-Optical, Label-Free Measurements of Particle and Cell Stiffness in Flow
Charles Dhong1 and Darren J. Lipomi2; 1University of Delaware, United States; 2University of California, San Diego, United States

2:30 PM *SB06.02.04
Local Catalytic Effects in Adherent Membranes
Ana-Sucana Smith; FAU Erlangen-Nürnberg, Germany

3:00 PM BREAK

SESSION SB06.03: Tools to Study Mechanotransduction
Session Chairs: Matthew Paszek and Medha Pathak
Monday Afternoon, December 2, 2019
Hynes, Level 2, Room 201

3:30 PM *SB06.03.01
Synthetic Extracellular Matrices to Study Mechanotransduction in 3D
Britta Trappmann; Max Planck Institute for Molecular Biomedicine, Germany

4:00 PM SB06.03.02
A Sensitive Tool for Probing Cellular Mechanics—Tracking Longitudinal Rotation with a Kinked-Silicon Nanowire
Youjin Lee, David Wu, Yuxing Peng and Bozhi Tian; The University of Chicago, United States

4:15 PM SB06.03.03
NIR-Actuated Composites to Perturb and Profile Mechano-Chemical Cell Signaling
Nicholas Vishnosky and Rachel Steinhardt; Syracuse University, United States

4:30 PM *SB06.03.04
A Materials Approach to Studying Forces, Form and Function in Cells and Tissues
Christopher Chen1,2; 1Boston University, United States; 2Harvard University, United States
SESSION SB06.04: Poster Session I: Bringing Mechanobiology to Materials—From Molecular Understanding to Biological Design I
Monday Afternoon, December 2, 2019
8:00 PM - 10:00 PM
Hynes, Level 1, Hall B

SB06.04.01
Towards the Development of a Macroscopic, Biohybrid, Hydrogel-Based Actuator
Christine Arndt1, Mohammadreza Taale2, Florian Ceynowa1, Fabian Schuett3, Rainer Adelung2 and Christine Sellhuber-Unkel; Kiel University, Germany

SB06.04.02
Detachment of the Biomolecule Bindings between the Microtubules and Kinesins
Kenta Hatazawa1, Ryuzo Kawamura2 and Takayuki Hoshino1; 1Hiroasaki University, Japan; 2Saitama University, Japan

SB06.04.03
Behavior and Phenotype of Cancer Cells in Response to Varied Mechanical Environment in 3D Hydrogel Models Cultured In Vitro
Tayler Laycox1, Riley Aspinwall1, Ian Schmidt2 and Jason W. Nichol; Endicott College, United States

SB06.04.04
The Signaling Response of Artificial Neurons Made from Chemical Oscillators
James Sheehy1 and Seth Fraden1; Brandeis University, United States

SB06.04.05
Characterizing Hetero-Oligomers from Amyloid-Beta and Alpha-Synuclein with AFM
Fun Ji Shin1 and Joon Won Park2; Pohang University of Science and Technology, Korea (the Republic of)

SB06.04.06
Designed Liquid Crystalline Polypeptide Fibres
James MacDonald1, Hannah Leece2, Karan Bali1, Paul Freemont1 and Milo Shaffer1; 1Imperial College London, United Kingdom; 2University of Bath, United Kingdom

SB06.04.07
Cortex Dominates Bacillus subtilis Spore’s Water-Responsive Behaviors
Zhi-Lun Liu1, Haozhen Wang and Xi Chen1; The City University of New York, United States

SB06.04.08
Understanding the Molecular Mechanism of Cartilage Degradation and Cation Channel Activity
Deng Li1, Kai-Chih Yeh2, Yuan Chiang1 and Sha-Wei Chang; National Taiwan University, Taiwan

SB06.04.09
Nano-fibrils as Basic Building Blocks of Natural Spider Silk
Qijue Wang1, Chloé Walsh1, Dinidu Perera1 and Hannah C. Schniepp1; College of William and Mary, United States

SB06.04.10
Influence of Different Mechanical Conditions on Cell Behavior
Sandra Sind1, Yasmin El-Rayyes1, Galen Ream1 and Christine Sellhuber-Unkel1; Kiel University, Germany

SB06.04.11
Rapid Magnetic Printing of 3D Cell Structures
Sarah Mishriki1, Abdul Rahman Abdel Fattah2, Tobias Kammann3, Srivatsa Athal4, Rakesh Sahu1, Fei Gong1 and Ishwar K. Puri1; 1McMaster University, Canada; 2KU Leuven, Belgium; 3Friedrich-Schiller-University, Germany

SB06.04.12
Design of Novel Scaffolds for Effective Healing of Bone Fractures Using Topology Optimization Based on Mechano-Biological Model, Angiogenesis and Scaffold Degradation
Mervenaz Sahin1, Mehmet Serhat Aydin1 and Gullu Kizilitas Sendur5,2,3; 1Sabanci University, Turkey; 2Sabanci University Nanotechnology Research and Application Center, Turkey

SB06.04.13
Modulation of Chemical Reactivity by Strong Coupling to Molecular Vibrations
Wonmi Ahn1,2, Igor Vurgaftman3, Adam Dunkelberger2, Jeffrey Owrzutsky2 and Blake S. Simpkins4; 1Excet Inc., United States; 2U.S. Naval Research Laboratory, United States

SESSION SB06.05: Hot Topics in Bringing Mechanobiology to Materials
Session Chairs: Matthew Paszek and Christine Sellhuber-Unkel
Tuesday Morning, December 3, 2019
Hynes, Level 2, Room 201

8:00 AM SB06.05.01
Nano-wire-Based Spatio-Mechano-Chemical Guidance of the Cell Immune Activity
Mark Schwartzman1, Viraj Bhingardive2 and Guillaume Le Saux1; Ben-Gurion University of the Negev, Israel

8:15 AM SB06.05.02
Extracellular Matrix Plasticity as a Driver of Cell Spreading
Joshua M. Grolman1, Philipp Weinand2 and David J. Mooney1; Harvard University, United States

SESSION SB06.06: Responsive Biomaterials
Session Chairs: Christine Sellhuber-Unkel and Michael Timmermann
Tuesday Morning, December 3, 2019
Hynes, Level 2, Room 201

8:30 AM *SB06.06.01
Photoresponsive Materials for Resolving Mechanobiology in Collective Cell Migration
Jun Nakamishi; National Institute for Materials Science, Japan

9:00 AM SB06.06.02
Dynamic, Reversible Control of Biomaterial Properties Using DNA
Nicholas Stephanopoulos; Arizona State University, United States

9:15 AM SB06.06.03
Design and Development of Mechanobiological Gels That Can Control Mechanical Property
Takeshi Ueki1, Ryota Tamate2, Aya Akimoto2, Ryo Yoshida1 and Jun Nakamish1; 1National Institute for Materials Science, Japan; 2The University of Tokyo, Japan

9:30 AM *SB06.06.04
Building with Cells—Exploiting Mechanobiology to Use Living Cells as an Engineering Material
Kevin Kit Parker; Harvard University, United States

10:00 AM BREAK

SESSION SB06.07: Bioinspired and Biofunctional Materials
Session Chairs: Cornelia Lee-Thedieck and Angela Pitenis
Tuesday Morning, December 3, 2019
Hynes, Level 2, Room 201

10:30 AM *SB06.07.01
Bioinspired Materials for Deconstructing Matrix Structure-Cell Function Relationships
Kristopher Kilian; University of New South Wales, Australia

11:00 AM SB06.07.02
The Adaptive Behavior of Cells as Archetype for Novel Strain-Stiffening Structures
Michael Timmermann, Leonard Siebert, Rainer Adelung and Christine Sellhuber-Unkel; University of Kiel, Germany
SESSION SB06.07.03
Stiff and Responsive Hybrid Bacterial Assemblies through Covalent Crosslinking of Nanoparticles to Engineered Bacterial Surface Proteins Dong Li, Marimikel Charrier, Sneha Jani, Behzad Rad, Bruce E. Cohen, Kathleen Ryan, Caroline Ajo-Franklin and Paul Ashby; 1University of California, Berkeley, United States; 2University of California at Urbana-Champaign, United States

SESSION SB06.07.04
Microfluidic Fabrication of Asymmetric Lipid and Polymer Vesicles Yuting Huang and David A. Weitz; Harvard University, United States

SESSION SB06.08: Synthetic Mechanoresponsive Materials
Session Chairs: Patrick Oakes and Matthew Paszek
Tuesday Afternoon, December 3, 2019
Hynes, Level 2, Room 201

1:30 PM *SB06.08.01
Force Amplification in Mechanochemically Active Polymers Nancy R. Sottos, Tae Ann Kim, Jaeuk Sung and Jeffrey Moore; University of Illinois at Urbana-Champaign, United States

2:00 PM SB06.08.02
Engineering Elasticity Inspired by Natural Biopolymers Anna Tarakanova; University of Connecticut, United States

2:15 PM SB06.08.03
Morphogenic Patterning in Synthetic Polymers Evan M. Lloyd, Adam Feinberg, Philippe Guebelle, Nancy R. Sottos and Jeffrey Moore; 1University of Illinois at Urbana-Champaign, United States; 2Beckman Institute for Advanced Science and Technology, United States

2:30 PM *SB06.08.04
Embodied Intelligence and Energy in Autonomous Matter Rob Shepherd; Cornell University, United States

3:00 PM BREAK

SESSION SB06.09: Soft Materials for Biomedicine
Session Chairs: Alexander Dunn and Patrick Oakes
Tuesday Afternoon, December 3, 2019
Hynes, Level 2, Room 201

3:30 PM *SB06.09.01
Cells, Gels and Shear—Designing Soft Materials for Biomedicine Angela Pitenti; University of California, Santa Barbara, United States

4:00 PM SB06.09.02
Mechanically Tunable Structured Hydrogels and Their Impact on Cells Katharina Siemens, Chanh Hu Trinh, Florian Ceynowa, Rainer Adelung, Jan Lammersing and Christine Selhuber-Unkel; 1Kiel University, Germany; 2Cornell University, United States

4:15 PM SB06.09.03
Hyper-Activation of Cellular Rigidly Sensing Pathways by the Surface Tension of Biomedical Silicones Zhu Cheng, Carolyn Shurer, Samuel Schmidt, Vivek Gupta, Grace Chuang, Jin Su, Amanda Watkins, Jason Specter, Chung-Yuan Hui, Heidi Reesink and Matthew Paszek; Cornell University, United States

4:30 PM *SB06.09.04
Mechanobiology in the Hematopoietic Stem Cell Niche Cornelia Lee-Thedieck; Leibniz University Hannover, Germany

SESSION SB06.10/SB09.08: Joint Session: Mechanics of Cancer Invasion
Session Chairs: Ming Guo, Jan Lammersing, Susan Leggett and Ian Wong
Wednesday Morning, December 4, 2019
Hynes, Level 3, Room 304

8:30 AM *SB06.10.01/SB09.08.01
Cell-Matrix Interactions in Cancer and Fibrosis—Multiscale Chemo-Mechanical Models Vivek Shenoy; University of Pennsylvania, United States

9:00 AM *SB06.10.02/SB09.08.02
Biomechanical Imaging of Cancer Cells and Tumor Development in 3D Ming Guo; Massachusetts Institute of Technology, United States

9:30 AM SB06.10.03/SB09.08.03
3D Traction Force Microscopy of Multicellular Invasion in Biomimetic Silk-Collagen Hydrogels Susan E. Leggett, Mohak Patel, Thomas M. Valentín, Christian Franck and Ian Y. Wong; 1Brown University, United States; 2University of Wisconsin–Madison, United States

9:45 AM SB06.10.04/SB09.08.04
Unjamming and Collective Migration in MCF10A Series of Breast Cancer Cells Lines Jia Hu & Kim and Jeffrey Fredberg; Harvard University, United States

10:00 AM BREAK

10:30 AM *SB06.10.05/SB09.08.05
Mechanical Forces, the Microenvironment and Metastasis of 3D Microtumors Joe Tien, Celeste Nelson and Bryan A. Nerger; 1Boston University, United States; 2Princeton University, United States

11:00 AM *SB06.10.06/SB09.08.06
Engineered Microfluidic Environments to Study the Role of Nuclear Mechanobiology in Cancer Progression Jan Lammersing; Cornell University, United States

11:30 AM *SB06.10.07/SB09.08.07
The National Cancer Institute’s Support for the Interface of Bio/Nano Materials with Cancer Research Nas Zahir; National Cancer Institute, United States

SESSION SB06.11/SB09.09: Joint Session: Cancer Cell—ECM Interactions
Session Chairs: Sidi Bencherif, Matthew Paszek, John Slater and Nas Zahir
Wednesday Afternoon, December 4, 2019
Hynes, Level 3, Room 304

1:30 PM *SB06.11.01/SB09.09.01
Nuclear Rupture at High Curvature and High Rates Upsets DNA Repair to Affect Cell Cycle, Differentiation and Genome Variation Dennis E. Discher; University of Pennsylvania, United States

2:00 PM *SB06.11.02/SB09.09.02
The Dynamic and Reciprocal Relationship between Tissue Tension and Pro Tumor Immunity Valerie Weaver; University of California, San Francisco, United States

2:30 PM BREAK
3:30 PM *SB06.11.03/SB09.09.03
Biosynthetic Hydrogels for Islet Engraftment and Immune Acceptance  
Andres Garcia; Georgia Institute of Technology, United States

4:00 PM *SB06.11.04/SB09.09.04
Viscoelasticity and Cancer  
David J. Mooney; Harvard University, United States

4:30 PM SB06.11.05/SB09.09.05
Integrin-Specific Hydrogels Direct Mesenchymal Stem Cell Immunomodulation and Bone Regeneration  
Karen E. Martin1, Amy Y. Clark1, José R. García1, Christopher T. Johnson2,3, Hannah S. Theriault1, Woojin M. Han1, Dennis W. Zhou1, Edward Botchwey1,2 and Andres Garcia1; 1Georgia Tech, United States; 2Emory University, United States

SESSION SB06.12: Poster Session II: Bringing Mechanobiology to Materials—From Molecular Understanding to Biological Design II  
Wednesday Afternoon, December 4, 2019  
8:00 PM - 10:00 PM  
Hynes, Level 1, Hall B

SB06.12.01
Elucidating the Effects of Direct Physical Contact between Dental Pulp Stem Cells Cultivated on Polybutadiene with Different Stiffness on Proliferation and Differentiation Behaviors  
Yihan Shen1, Zijian Ma2, Ya-Chen Chuang3,4, Jessica Hofflich1, Miriam Rafailovich1 and Marcia Simon3; 1St. Andrew's School, United States; 2Tianjin Nankai High School, China; 3Stony Brook University, United States; 4ThINC Facility, Advanced Energy Center, United States

SB06.12.02
Bio-Inspired and Bio-Mimetic Self-Assembled Materials  
Sharon Gilead and Ehud Gaizt; Tel Aviv University, Israel

SB06.12.03
Investigating Substrate Mechanics Effects in Combination with TiO2 Thin Layer Coated by Atomic Layer Deposition (ALD) for Dental Pulp Stem Cell Proliferation and Differentiation  
Megha Gopal1, Jessica Hofflich2, Ya-Chen Chuang2,2 and Miriam Rafailovich1; 1New Hyde Park Memorial High School, United States; 2Stony Brook University, The State University of New York, United States

SB06.12.04
Shape Memory Cell Culture Platform for Mechanobiology  
Keiichiro Uto and Mitsuhiro Ebara; National Institute for Materials Science, Japan

SB06.12.05
Engineering Tubular Structured Epithelial Organoids by Directed Tissue Assembly  
Yan Yan Shery Huang, Ye Liu, Joo-Hyeon Lee and Catherine Dabrowska; University of Cambridge, United Kingdom