



Final Program

Second GEM<sup>4</sup> Summer School on

# CELL AND MOLECULAR MECHANICS IN BIOMEDICINE



with a focus on Cancer

(in conjunction with the GEM<sup>4</sup>  
Conference on Cancer 2007)

June 25 - July 6, 2007  
National University of Singapore

[www.gem4.org](http://www.gem4.org)

**Supported by**  
Office of Life Sciences  
NUS Graduate School for Integrative Sciences and Engineering

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Summer school website: [www.gem4.org/summerschool2007](http://www.gem4.org/summerschool2007)  
GEM<sup>4</sup> Conference on Cancer website: <http://www.gem4.org/cancer2007>

## Summer School organization

This two-week long summer school will be the second in the series, following the successful inaugural summer school held at MIT in August 2006 (with a focus on infectious diseases). Strong laboratory experience and exposure to local research facilities will be provided in addition to introductory and advanced tutorials.

### Organized by:

GEM<sup>4</sup>

### Local organization:

National University of Singapore (NUS)

### Scientific Program & Organizing Committee:

Chair: C.T. Lim (NUS)

Co-chair: K.S.W. Tan (NUS)

Members: Y. Ito (NUS)

P. Macary (NUS)

C.N. Ong (NUS)

C.H. Sow (NUS)

Patrick Tan (Duke-NUS Graduate Medical School & Genome Institute of Singapore, A\*STAR)

### International Advisory Committee:

S. Suresh (Chair) MIT, USA

G. Bao Georgia Institute of Technology, USA

D.E. Discher University of Pennsylvania, USA

Barry Halliwell NUS, Singapore

R. D. Kamm MIT, USA

G. Milon Institut Pasteur Paris

T. Saif University of Illinois at Urbana-Champaign, USA

W. Schowalter NUS, Singapore

Michael P. Sheetz Columbia University, USA

### Summer school venue:

Centre for Life Sciences (CeLS), NUS

### Fees:

Fees per participant: S\$3,200.00 (overseas), S\$1,000.00 (local)

(Fees include lunches, refreshments, 2-week accommodation (overseas participants only) & attendance at the GEM<sup>4</sup> Conference on Cancer (<http://www.gem4.org/cancer2007>))

### Registration:

For registration, please visit [www.gem4.org/summerschool2007/registration.html](http://www.gem4.org/summerschool2007/registration.html)

### Overall Organizational support:

GEM<sup>4</sup> Secretariat, National University of Singapore

B.V.R. Chowdari ([chowdari@gem4.org](mailto:chowdari@gem4.org))

Summer course organizational contact: Maureen Oliveiro ([gemoma@nus.edu.sg](mailto:gemoma@nus.edu.sg))

## Summer School Dates

### Period:

25 June to 6 July 2007

### Total Duration:

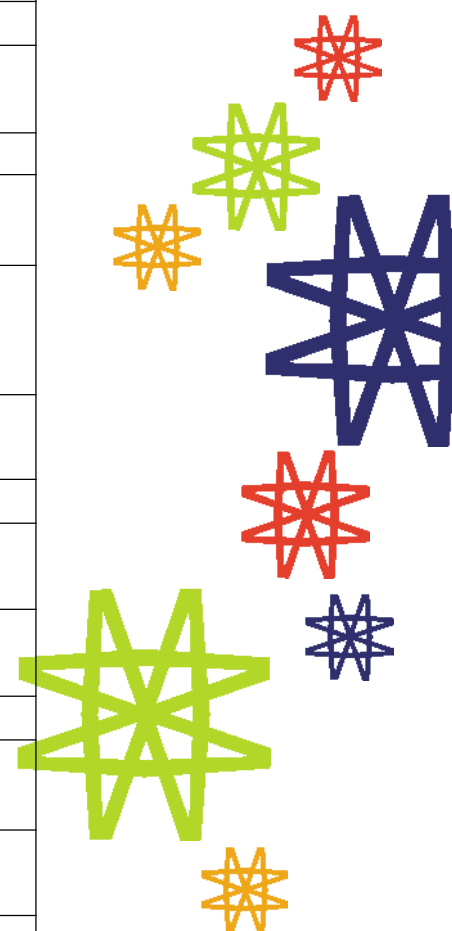
8 days

The summer school will comprise 5 full days (25 – 29 June 2007) and 6 half-days (30 June and 2 – 6 July 2007). For 2 – 6 July 2007, the participants will attend the morning plenary lectures at the GEM<sup>4</sup> Conference on Cancer and resume classes in the afternoons. On 30 June 2007, there will be a social outing in the evening.

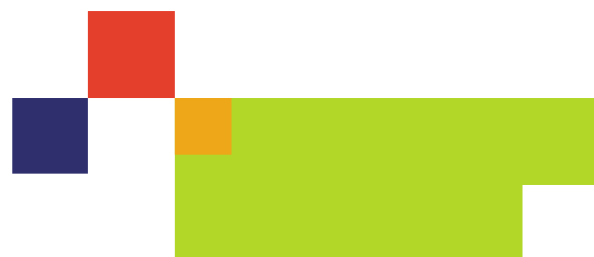
# Final Summer School Program & Speakers

The following schedule contains topics for both cancer biology and cellular and molecular biomechanics. For the biology components, participants will be exposed to a broad range of topics encompassing the physiology, cell and molecular biology, immunology, basic biology of cancer, cancer diagnosis and treatment. Advances in nanotechnology and their applications to diagnosis and therapy will also be discussed.

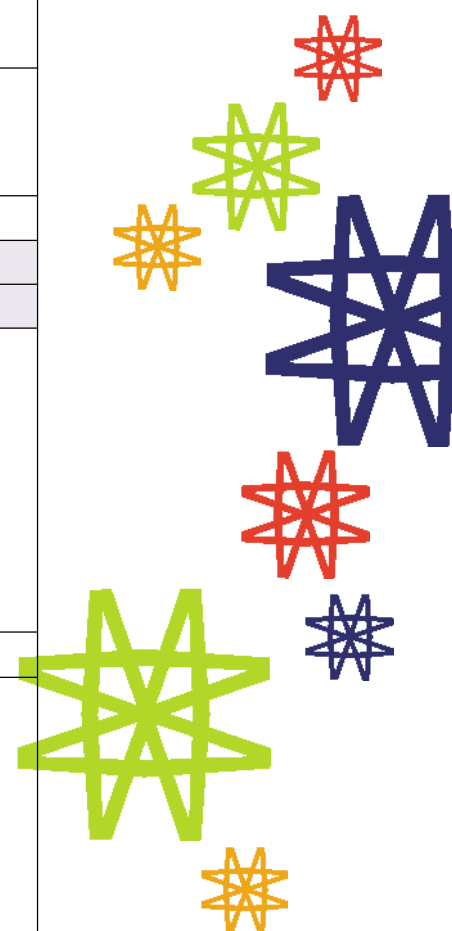
Date/Day	Time	Topics/Speakers
23 – 24 Jun 07 (Sun)		<b>Arrival / Check-in</b> Prince George's Park Residences (PGPR) Dormitory, NUS
Day 1 25 Jun 07 (Mon)	0800 – 0830	<b>Registration</b>
	0830 – 1230	<b>Welcome Address</b>
		<b>Basic Mechanics</b> Vincent Tan (NUS), Ming Dao (MIT)
	1230 – 1400	Lunch
	1400 – 1730	<b>Introduction to Physiology</b> Shazib Pervaiz (NUS)
1830 – 2130	<b>Evening Mixer @ NUS Guild House</b> (To meet at PGPR Main Foyer at 1800hrs for participants staying at PGPR)	
Day 2 26 Jun 07 (Tue)	0830 – 1230	<b>Continuum &amp; Statistical Mechanics</b> Ju Li (Ohio State University) , Raj Rajagopalan (NUS)
	1230 – 1330	Lunch
	1330 – 1730	<b>Introduction to Cell Biology</b> Hanry Yu (NUS), Boon Huat Bay (NUS)
Day 3 27 Jun 07 (Wed)	0830 – 1230	<b>Molecular Mechanics</b> Markus Buehler (MIT), Huajian Gao (Brown University)
	1230 – 1330	Lunch
	1330 – 1730	<b>Introduction to Molecular Biology</b> Norbert Lehming (NUS)
Day 4 28 Jun 07 (Thu)	0830 – 1000	<b>Space, Time and Energy Landscapes</b> Ju Li (Ohio State University)
	1000 – 1030	Coffee Break
	1030 – 1230	<b>Mechanobiology: From Mechanosensing to Mechanoreponse</b> Mike Sheetz (Columbia University)
	1230 – 1330	Lunch
	1330 – 1700	<b>Introduction to Immunology</b> Paul MacAry (NUS)
	1700 – 1730	<b>Sampler of NSF-Sponsored Projects on Cell &amp; Molecular Mechanics</b> Jimmy Hsia (National Science Foundation)



Date/Day	Time	Topics/Speakers
Day 5 29 Jun 07 (Fri)	0830 – 1230	<b>Experimental Methods I</b> <ul style="list-style-type: none"> <li>• Multiphoton Microscopy – Peter So (MIT)</li> <li>• 3D Quantitative Confocal Microscopy using Digital Volume Correlation – G. Ravichandran (Caltech)</li> <li>• Theory of Fluorescence Resonance Energy Transfer (FRET) – Barry Masters (MIT)</li> <li>• Atomic Force Microscopy – CT Lim (NUS)</li> <li>• Molecular Force Spectroscopy – Daniel Muller (Technische Universität Dresden)</li> <li>• Optical Traps for Cell &amp; Particle Manipulation – CH Sow (NUS)</li> <li>• Optical Traps as Molecular Force Probes – Matt Lang (MIT)</li> </ul>
	1230 – 1330	Lunch
	1330 – 1500	<b>Experimental Methods II</b> <ul style="list-style-type: none"> <li>• MEMS – Taher Saif (University of Illinois at Urbana-Champaign)</li> <li>• Microfluidics – Gabriel Lee (NUS)</li> <li>• Anti-Metastasis &amp; Cytotoxicity Assays – Choon Nam Ong (NUS)</li> </ul>
	1500 – 1530	Coffee Break
	1530 – 1630	<b>Application of Advanced Microscopy and Nanomanipulation in the Study of Cell Mechanotransduction</b> Masahiro Sokabe (Nagoya University)
	1700 – 1900	<b>Poster Session (with beer &amp; finger food)</b> (CeLS Foyer)
Day 6 30 Jun 07 (Sat)	0830 – 1100	<b>Tissue Mechanics</b> <ul style="list-style-type: none"> <li>• Microstructure and Micromechanics of Cortical Bone – Rob Ritchie (UC Berkeley)</li> <li>• Microstructure and Micromechanics of Trabecular Bone – Ed Guo (Columbia University)</li> <li>• Magneto-Mechanical Stimulation of Early Bone Growth into Surface Layers on Implants – Athina Markaki (Cambridge University)</li> <li>• Fracture Studies of Collagenous Soft Tissues – Michelle Oyen (Cambridge University)</li> </ul>
	1100 – 1130	Lunch
	1130 – 1700	<b>Lab Demonstrations</b> (see separate Lab Demo Schedule for details) <ul style="list-style-type: none"> <li>• Cell &amp; Tissue Culture Lab – Yinjing (NUS), Manoj K Puthia (NUS), Kevin Tan (NUS)</li> <li>• Anti-Metastasis – Qin Huang (NUS), Choon Nam Ong (NUS)</li> </ul>



Date/Day	Time	Topics/Speakers
Day 6 30 Jun 07 (Sat)	1130 – 1700	<ul style="list-style-type: none"> <li>• Cytotoxicity – Qin Huang (NUS), Choon Nam Ong (NUS)</li> <li>• 3D Confocal Microscopy – Wei Sun (NUS), Christian Franck (Caltech)</li> <li>• Optical Traps – CH Sow (NUS)</li> <li>• Microfluidics – Gabriel Lee (SMA), David Quinn (MIT)</li> <li>• AFM: Imaging – Qingsen Li (NUS), CT Lim (NUS)</li> <li>• AFM: Force Spectroscopy – CT Lim (NUS), Ang Li (NUS)</li> <li>• Micropipette Aspiration &amp; Dual Pipette Assay – SRK Vedula (NUS), CT Lim (NUS)</li> </ul>
	1830 onwards	<b>Beach Dinner Party @ Sentosa</b> (To meet at PGPR Main Foyer for transport at 1800hrs for participants staying at PGPR)
1 Jul 07 (Sun)		GEM4 Conference Registration
Day 7 2 Jul 07 (Mon)	0830 – 1200	GEM4 Conference Plenary Lecture
	1200 – 1315	Lunch Break (Conference Site)
	1400 – 1530	<b>Cell Mechanics I</b> <ul style="list-style-type: none"> <li>• Matrix Elasticity Directs Stem Cell Differentiation – Dennis Discher (UPenn)</li> <li>• From Cell Physiology and Biology to Cellular Biomechanics – Cheng Dong (Penn State University)</li> <li>• Biomechanics and Biophysics of Cancer Cells – Subra Suresh (MIT)</li> </ul>
	1530 – 1600	Coffee Break
	1600 – 1800	<b>Computational Biomechanics</b> <ul style="list-style-type: none"> <li>• Molecular Modeling and Simulation – Ju Li (Ohio State University)</li> <li>• Coupling the Membrane and the Cytoskeleton – Nir Gov (Weizmann Institute of Israel)</li> <li>• Continuum Modeling of the Cell – Ming Dao (MIT)</li> <li>• Multi-Scale Cell Modeling – JN Reddy (Texas A&amp;M)</li> </ul>
Day 8 3 Jul 07 (Tue)	0830 – 1200	GEM4 Conference Plenary Lecture
	1200 – 1315	Lunch (Conference Site)
	1400 – 1530	<b>Cell Mechanics II</b> <ul style="list-style-type: none"> <li>• Mechanics of Mechanotransduction – Roger Kamm (MIT)</li> <li>• Probing Forces Mediated in Cell-Cell Adhesion – CT Lim (NUS)</li> <li>• Elastic and Viscoelastic Response of Biological Materials: Bone, Ligaments, Arteries, Tendons, Skin, Collagen – Marc Meyers (UC San Diego)</li> </ul>
	1530 – 1600	Coffee Break



Date/Day	Time	Topics/Speakers	
Day 8 3 Jul 07 (Tue)	1600 – 1800	<b>Origin &amp; Genetic Aspects of Cancer</b> <ul style="list-style-type: none"> <li>Oncogenes and Tumor Suppressor Genes – Yoshiaki Ito (NUS)</li> <li>Genomic Approaches to Cancer and Clinical Oncology – Patrick Tan (Duke-NUS)</li> </ul>	
	0830 – 1200	GEM4 Conference Plenary Lecture	
Day 9 4 Jul 07 (Wed)	1200 – 1315	Lunch (Conference Site)	
	1400 – 1500	<b>Cancer Immunity &amp; Prevention</b> John Groopman (Johns Hopkins University)	
	1500 – 1530	Coffee Break	
	1530 – 1800	<b>Cancer Therapy</b> <ul style="list-style-type: none"> <li>Nanomedicine/Cancer Nanotechnology/ Chemotherapeutic Engineering: Concepts and Examples – SS Feng (NUS)</li> <li>Cancer Chemotherapy – Boon Cher Goh (NUS)</li> <li>Nanotechnology for Cancer Therapy – Kam Leong (Duke University)</li> </ul>	
		0830 – 1200	GEM4 Conference Plenary Lecture
Day 10 5 Jul 07 (Thu)	1200 – 1315	Lunch (Conference Site)	
	1400 – 1730	<b>Cancer Detection and Diagnostics</b> <ul style="list-style-type: none"> <li>Biomarkers for Early Detection – John Groopman (Johns Hopkins University)</li> <li>Optical Spectroscopy and Imaging for Cancer Diagnostics and Detection – ZW Huang (NUS)</li> <li>Pathology Cancer Detection and Diagnostics: Basic Concepts for Scientists – Manuel Salto-Tellez (NUS)</li> <li>2-Dimensional Electrophoresis (2DE) as a Tool in Cancer Biomarker Discovery – Sandra Tan (NUS)</li> <li>Luminescent Quantum Dots for Bioimaging and Sensitive Detection – Mingyong Han (NUS)</li> </ul>	
		0830 – 1200	GEM4 Conference Plenary Lecture
		1200 – 1315	Lunch (Conference Site)
Day 11 6 Jul 07 (Fri)	1400 – 1530	<b>Cell &amp; Molecular Biomechanics and its Connection to Cancer (Case Studies)</b> <ul style="list-style-type: none"> <li>Mechanochemistry of Cell Adhesion; Its Relevance in Tumor Progression – JP Thiery (IMCB)</li> <li>Thomas Seufferlein (University of Ulm School of Internal Medicine)</li> </ul>	
		<b>Final Discussion</b> Subra Suresh, CT Lim	
	1530 – 1630		
	1630	<b>Summer School Adjourns</b>	

## Acknowledgements

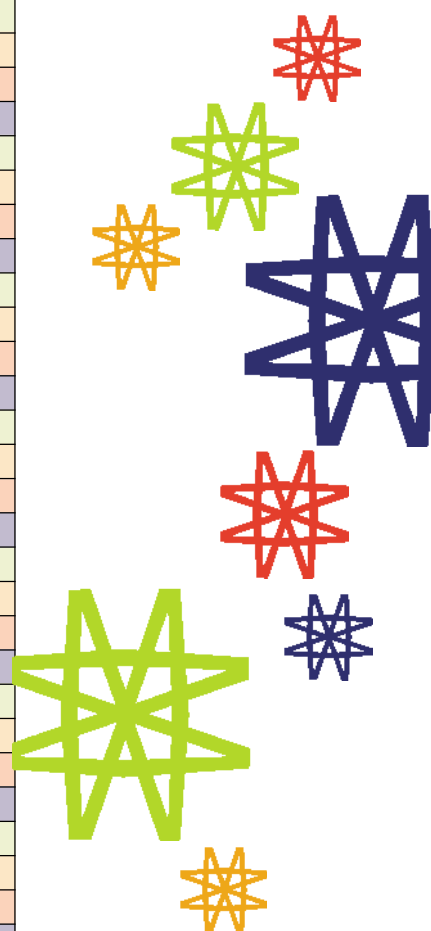
The Organizing Committee would like to acknowledge the partial support for the GEM<sup>4</sup> summer school from member institutions, NUS, GEM<sup>4</sup> secretariat, NUS Graduate School for Integrative Sciences and Engineering (NGS), NUS Office of Life Sciences, and US National Science Foundation. We would also like to thank the speakers and instructors for volunteering their time and effort to teach in this summer school.

## List of Speakers & Instructors (in alphabetical order)

Speakers	Affiliation
Boon Huat Bay	National University of Singapore
Markus J. Buehler	MIT
Ming Dao	MIT
Dennis E. Discher	University of Pennsylvania
Cheng Dong	Penn State University
S.S. Feng	National University of Singapore
Huajian Gao	Brown University
Boon Cher Goh	National University of Singapore
Nir Gov	The Weizmann Institute of Science
John Groopman	Johns Hopkins University
Ed Guo	Columbia University
Mingyong Han	Institute of Materials Research & Engineering, A*STAR
Yoshiaki Ito	National University of Singapore
Roger D. Kamm	MIT
Matthew J. Lang	MIT
Gabriel Lee	Singapore-MIT Alliance
Norbert Lehming	National University of Singapore
Kam W. Leong	Duke University
Ju Li	Ohio State University
C.T. Lim	National University of Singapore
Paul MacAry	National University of Singapore
Athina Markaki	University of Cambridge
Barry R. Masters	MIT
Marc Meyers	University of California, San Diego
Daniel Müller	Technische Universität Dresden
Choon Nam Ong	National University of Singapore
Michelle Oyen	University of Cambridge
Shazib Pervaiz	National University of Singapore
Raj Rajagopalan	National University of Singapore
G. Ravichandran	California Institute of Technology
J.N. Reddy	Texas A&M University & National University of Singapore
Robert O. Ritchie	University of California, Berkeley
Taher Saif	University of Illinois at Urbana-Champaign
Manuel, Salto-Tellez	National University of Singapore
Thomas Seufferlein	University of Ulm School of Internal Medicine
Michael P. Sheetz	Columbia University
Peter So	MIT
M. Sokabe	Nagoya University
C.H. Sow	National University of Singapore
Subra Suresh	MIT
Kevin Tan	National University of Singapore
Patrick Tan	Genome Institute of Singapore, A*STAR
Sandra Tan	National University of Singapore
Vincent B.C. Tan	National University of Singapore
Jean Paul Thiery	Institute of Molecular and Cell Biology, A*STAR
Henry Yu	National University of Singapore

### Instructors

Christian Franck (Caltech), Gabriel Lee (Singapore-MIT Alliance), Ang Li (NUS), Q.S. Li (NUS), Manoj K Puthia (NUS), David Quinn (MIT), S.R.K. Vedula (NUS), Yinjing (NUS), Wei Sun (NUS), Y.B. Ong (NUS)



**About GEM<sup>4</sup>**

GEM<sup>4</sup> will bring together researchers and professionals in major institutions across the globe with distinctly different, but complementary, expertise and facilities to address significant problems at the intersections of select topics of engineering, life sciences, technology, medicine and public health.

GEM<sup>4</sup> will create new models for interactions across scientific disciplinary boundaries whereby problems spanning the range of fundamental science to clinical studies and public health can be addressed on a global scale through strategic international partnerships.

Through initial focus areas in cell and molecular biomechanics, and environmental health, in the context of select human diseases, GEM<sup>4</sup> will create a global forum for the definition and exploration of grand challenges and scientific studies, for the cross-fertilization of ideas among engineers, life scientists and medical professionals, and for the development of novel educational tools.

**Institutions Participating in GEM<sup>4</sup>**

- California Institute of Technology
- Columbia University
- Chulabhorn Research Institute
- Duke University
- Georgia Institute of Technology
- Harvard University
- Institut Pasteur
- Johns Hopkins University
- Massachusetts Institute of Technology
- Max-Planck Institute
- National University of Singapore
- University of California
- University of Illinois at Urbana-Champaign
- Weizmann Institute of Science

**GEM<sup>4</sup> Organization Structure****Subra Suresh (Director)**

Ford Professor of Engineering  
Massachusetts Institute of Technology, USA

**B.V.R. Chowdari (Executive Coordinator)**

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National University of Singapore, Singapore

**Steering Committee****Subra Suresh (Chair)**

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Massachusetts Institute of Technology, USA

**B.V.R. Chowdari (Executive Coordinator)**

Department of Physics  
National University of Singapore, Singapore

**Gang Bao**

Biomedical Engineering  
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**Roger D. Kamm**

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**Taher Saif**

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**Leona Samson**

Center for Environmental Health Sciences  
Massachusetts Institute of Technology, USA

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Engineering Division  
Massachusetts Institute of Technology, USA

**Ram Sasisekharan**

Biological Engineering Division  
Massachusetts Institute of Technology  
and Momenta Pharmaceuticals, USA

**Geert Schmidt-Schoenbein**

Department of Bioengineering  
University of California, USA

**William Schowalter**

Senior Advisor to the President  
National University of Singapore, Singapore

**Joachim Spatz**

Max-Planck Institute, Stuttgart and  
University of Heidelberg, Germany