

Second GEM⁴ Summer School on

CELL AND MOLECULAR MECHANICS IN BIOMEDICINE

with a focus on Cancer

(in conjunction with the GEM⁴ Conference on Cancer 2007)

June 25 - July 6, 2007 National University of Singapore

www.gem4.org



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Summer school website: www.gem4.org/summerschool2007 GEM⁴ 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:

GEM⁴

with a focus on Cance

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:

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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 GEM⁴ Conference on Cancer (http://www.gem4.org/cancer2007))

Registration:

For registration, please visit www.gem4.org/summerschool2007/registration.html

Overall Organizational support:

GEM4 Secretariat, National University of Singapore

B.V.R. Chowdari (chowdari@gem4.org)

Summer course organizational contact: Maureen Oliveiro (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 GEM⁴ Conference on Cancer and resume classes in the afternoons. On 30 June 2007, there will be a social outing in the evening.

Proposed Course Topics & Lecturers/ Instructors

The following is a tentative course outline of the 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.

Topics of Interest:

- 1. Introduction to Physiology
- 2. Introduction to Cell Biology
- 3. Introduction to Molecular Biology
- 4. Introduction to Immunology
- 5. Origin of cancer
 - Cell structure and functions
 - The nature of Cancer
 - Tumour progression and metastasis
- 6. Genetic aspects of cancer
 - Cancer inheritance
 - Oncogenes and Tumour suppressor genes
 - Multistep carcinogenesis

7. Cancer immunity and prevention

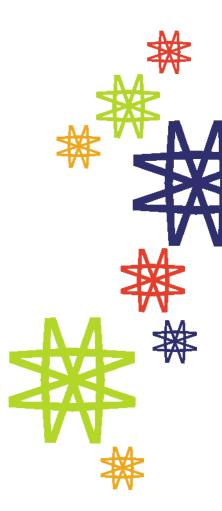
- The immune system and cancer
- Cancer chemoprevention
- Cancer vaccines
- Immunotherapy of cancer (monoclonal antibodies, cytokines etc.)

8. Cancer Therapy

- a. Drugs targeting cancer cells
 - Use of stem cells
 - Nanoparticles
- b. Chemotherapy
- c. Molecular approach to cancer therapy
- d. Nanotherapeutics Innovative application of nanotechnology to gene, immuno-, and cell therapy

9. Cancer detection and Diagnostics

- a. Biomarkers for early detection
- b. Bioimaging



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- c. Genomics and proteomics:
 - Microarrays
 - 2-dimensional electrophoresis
- d. New approaches:
 - Nanotechnological probes quantum dots, nanoshells, gold nanoparticles

10. Cell & Molecular Biomechanics:

- a. Basic mechanics
 - Stress & strain
 - Elastic, plastic and viscoelastic response
- b. Continuum & statistical mechanics
- c. Molecular biomechanics
 - Brief introduction to molecular biomechanics
 - Polymer chains, statistics of random walks, persistence length,
 - Boltzmann distribution, freely jointed chain, worm-like chain model
 - Protein conformational dynamics, the role of force in protein-protein
 - Motor molecules and protein nanomachines
 - Motility at the macromolecular level, polymerization forces
- d. Cell Biomechanics
 - Cell membrane mechanics
 - Cytoskeletal structure and motility
 - Time dependent responses, CSK mechanics
 - Cell adhesion, receptor-ligand interaction, focal adhesions
 - Measurement of cell adhesive forces and kinetics
 - Microrheology
 - Generalized Stokes-Einstein relationship (GSER)
 - Force-fluctuations inside cells, active processes, and breakdown of GSER
 - Nonequilibrium dynamics; evidence for a glassy domain
- e. Tissue Biomechanics
 - Elastic and viscoelastic response of connective tissues
 - Poroelasticity; Darcy's Law; Hydraulic Permeability
- f. Computational Biomechanics
 - Molecular modeling and simulation
 - Continuum modeling of the cell
 - Multi-scale cell modeling
- g. Case studies on cell & molecular biomechanics and its connection to cancer
- h. Space, time and energy landscapes mechanobiology
 - Introduce basic interactions: steric, electrostatic, vdw, hbond, hphobic

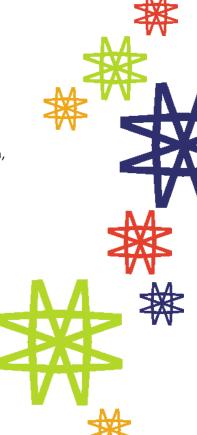
- Macromolecular surface forces: electrostatic double layer, DLVO, surface tension, etc.
- kT as ruler of molecular forces
- Self-assembly as a result of competing molecular forces
- Thermal forces and Brownian motion
- Random walk
- Meaning of the Central Limit Theorem
- Diffusion vs Langevin equation descriptions ('Average' vs 'Individual')
- Diffusion coefficient and fluctuation-dissipation theorem
- Reaction kinetics
- Michaelis-Menten kinetics
- Arrhenius relation
- Binding energy/affinity
- Classical equilibrium picture vs stochastic picture of rate processes
- Cooperativity
- Mechanostransduction: Biological relevance in the context of cell migration, sensing and force generation

i. Experimental methods

- Optical stretcher, optical tweezers, molecular force probes
- AFM imaging and force spectroscopy
- Magnetic trap
- 3D microscopy deconvolution, confocal, 2-photon
- Micropipette aspiration & dual pipette assay
- Mcrofluidics

j. Lab Sessions:

- Cell & tissue culture lab
- Multi-photon confocal microscopy
- Optical trap: DNA & cells
- Magnetic tweezers
- Microfluidics: cancer cell
- AFM: Live cell & DNA imaging
- AFM: Force spectroscopy
- Micropipette aspiration
- Dual pipette assay
- Cell stretching
- Anti-metastasis
- Cytotoxicity



with a focus on Cancer

List of Speakers & Instructors (in alphabetical order)

Boon Huat Bay National University of Singapore Markus J. Buehler MIT	Speakers	Affiliation
Markus J. Buehler Jianzhu Chen MT Maxey Chung National University of Singapore Kevin D. Costa Columbia University Ming Dao MT Dennis E. Discher Cheng Dong Penn State University S.S. Feng National University of Singapore Hudjian Gao Brown University Aorteza Gharib Colifornia Institute of Technology Nir Gov The Weizmann Institute of Science John Groopman Johns Hopkins University Ed Guo Columbia University of Singapore National University Mingyong Han Institute of Materials Research & Engineering, A*STAR Yoshiaki Ito National University of Singapore National University of Singapore National University of Singapore National University of Singapore Nathew J. Lang MIT Norbert Lehming National University of Singapore Kam W. Leong Duke University Ju Li Ohio State University C.T. Lim National University of Singapore Shazib Pervaiz National University of Singapore Shazib Pervaiz National University of Singapore Shazib Pervaiz National University of Singapore Shazib Revaiz Gunaretnam Rajagopal Bioinformatics Institute, A*STAR National University of Singapore National University of Si	-	National University of Singapore
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Hanry Yu National University of Singapore		<u> </u>
	Hanry Yu	National University of Singapore

Instructors

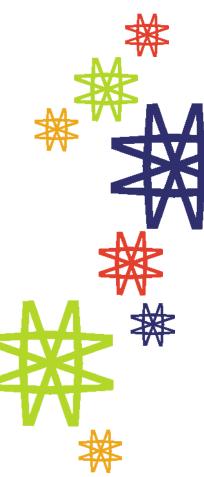
Monica Diez (GEM⁴), Christian Franck (Caltech), B.R. Hairul Nizam (NUS), Gabriel Lee (Singapore-MIT Alliance), Ang Li (NUS), Q.S. Li (NUS), John P. Mills (MIT), Maxim Shusteff (MIT), Manoj K Puthia (NUS), David Quinn (MIT), E.P.S. Tan (NUS), S.J. Tan (NUS), S.R.K. Vedula (NUS), Yinjing (NUS)

Tentative Summer School Schedule

ieiliai	ive Juili	mer school schedule
Date/Day	Time	Activity
24 Jun 07		Arrival / Check-in
(Sun)		Prince George's Park Residences (PGPR) Dormitory
	0800 – 0830	Registration
Day 1	0830 – 1230	Welcome Address
25 Jun 07	0030 - 1230	Basic Mechanics
(Mon)	1230 – 1330	Lunch Break (Foyer)
, ,	1330 – 1730	Introduction to Physiology
	1800 – 2000	Evening Mixer
Day 2	0830 - 1230	Continuum & Statistical Mechanics
26 Jun 07	1230 – 1330	Lunch Break (Foyer)
(Tue)	1330 – 1730	Introduction to Cell Biology
Day 3	0830 - 1230	Molecular Mechanics
27 Jun 07	1230 – 1330	Lunch Break (Foyer)
(Wed)	1330 – 1730	Introduction to Molecular Biology
Day 4	0830 - 1230	Space, time and energy landscapes in mechanobiology
28 Jun 07	1230 – 1330	Lunch Break (Foyer)
(Thu)	1330 – 1730	Introduction to Immunology
<u> </u>	0830 – 1230	Experimental Methods
Day 5 29 Jun 07	1230 – 1330	Lunch Break (Foyer)
(Fri)	1330 – 1730	Lab Demonstrations
, ,	0830 - 1230	Tissue Mechanics
Day 6	1230 – 1330	Lunch Break (Foyer)
30 Jun 07	1330 – 1730	Lab Demonstrations
(Sat)	1730 – 1730 1730 onwards	Social Outing
1 1 1 07	1730 onwards	
1 Jul 07 (Sun)		GEM4 Conference Registration
	0830 - 1200	GEM4 Conference Plenary Lecture
Day 7	1200 – 1315	Lunch Break (Conference Site)
2 Jul 07	1400 – 1530	Cell Mechanics
(Mon)	1530 – 1600	Coffee Break (Foyer)
	1600 – 1730	Computational Biomechanics
	0830 - 1200	GEM4 Conference Plenary Lecture
Day 8	1200 – 1315	Lunch Break (Conference Site)
3 أَبِرُ 07	1400 – 1530	Origin of cancer
(Tue)	1530 – 1600	Coffee Break (Foyer)
	1600 – 1730	Genetic Aspects of Cancer
Day 9 4 Jul 07 (Wed)	0830 - 1200	GEM4 Conference Plenary Lecture
	1200 – 1315	Lunch Break (Conference Site)
	1400 – 1530	Cancer Immunity & Prevention
	1530 – 1600	Coffee Break (Foyer)
	1600 – 1730	Cancer Therapy
Day 10	0830 - 1200	GEM4 Conference Plenary Lecture
	1200 – 1315	Lunch Break (Conference Site)
5 Jul 07	1400 – 1730	23.13.13.13.13.13.13.13.13.13.13.13.13.13
(Thu)	(with 15min	Cancer Detection and Diagnostics
	coffee break)	
	0830 - 1200	GEM4 Conference Plenary Lecture
Day 11	1200 – 1315	Lunch Break (Conference Site)
6 Júl 07	1200 1010	Cell & molecular biomechanics
(Fri)	1400 – 1730	and its connection to cancer (Case Studies)
		Summer School Adjourns
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Acknowledgements

The Organizing Committee would like to acknowledge the partial support for the GEM⁴ summer school from member institutions, NUS, GEM⁴ 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.



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About GEM⁴

GEM⁴ 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.

GEM⁴ 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, GEM⁴ 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 GEM⁴

- California Institute of Technology
- Columbia University
- Chulabhorn Research Institute
- **Duke University**
- Georgia Institute of Technology
- Harvard University
- Institut Pasteur

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B.V.R. Chowdari (Executive Coordinator)

Department of Physics National University of Singapore, Singapore

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- Massachusetts Institute of Technology
- Max-Planck Institute
- National University of Singapore
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Ram Sasisekharan

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

Geert Schmidt-Schoenbein

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