THE BIOLOGICAL PHYSICIST

The Newsletter of the Division of Biological Physics of the American Physical Society

Vol 3 № 5 December 2003

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Happy New Year
from The Biological Physicist

THE BIOLOGICAL PHYSICIST Editorial Office (a.k.a. "Sonya's Desk") wishes you a new year filled with publications of high impact factor!

This issue of THE BIOLOGICAL PHYSICIST brings you a profile of research at the Interdisciplinary Center for the Study of Biocomplexity at Notre Dame (turn to page 2). On page 6, we provide updated information about changes in DBP session speakers at the March Meeting. Of course, we have PRE Highlights (page 7). And turn to page 10 for a message from the DPB Chair, and to page 11 for an important conference announcement.

But before you pour yourself a cup of hot cocoa and sit down to enjoy a leisurely hour by the fireplace reading the December issue, turn to page 7, for an important white paper solicitation from the NIBIB. The deadline is January 9, so maybe substitute espresso for that cocoa.

Happy Holidays!

✍✍SB

The Interdisciplinary Center for the Study of Biocomplexity: Systems Biology Research at Notre Dame

Mark Alber and Holly Goodson

Biocomplexity is the study of the complex structures and behaviors that arise from the interaction of biological entities (molecules, cells, or organisms). While physical and chemical processes give rise to a great variety of spatial and temporal structures, the complexity of even the simplest biological phenomena is infinitely richer.

Members of the University of Notre Dame Interdisciplinary Center for the Study of Biocomplexity (ICSB) (http://www.nd.edu/~icsb/) come from eight departments in the schools of science and engineering and are working together to meld physical, mathematical, and computational approaches with those of modern biology to understand this complexity in a quantitative and predictive way.

The main goal of the ICSB is to develop comprehensive multiscale models of cell and tissue organization and relate them to development. We address three scales of structure starting from the subcellular, where we study cell organization, the cytoskeleton, and protein and genetic networks. At the cell level we emphasize cell polarity and cell-cell interactions. At the supracellular level our studies include the aggregation of cells into tissues and tissues into organs. One of our main goals is to improve communication between biological, mathematical and physical scientists with emphasis on developing techniques and tools of broad utility to bioscientists.

All ICSB projects combine quantitative experiments and computer simulation and build on the mutually complementary strengths of the researchers at Notre Dame with the support from collaborators at Indiana University and other institutions. Some of the projects currently under way within the center include:

Organogenesis and tissue development, including the mechanical properties of tissues,

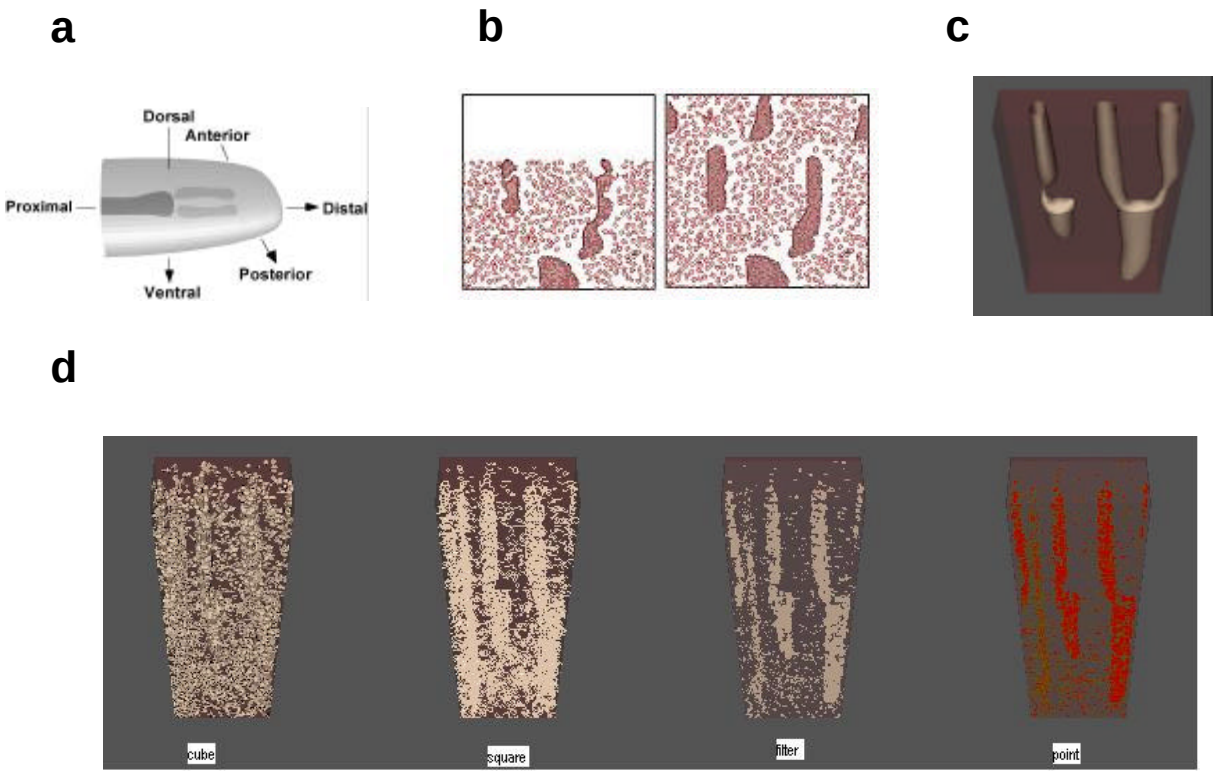
Biological networks, including gene regulation pathways, metabolic pathways, and cell signaling networks, and

Subcellular organization and dynamics, with a focus on the cytoskeleton.

Organogenesis and Tissue Development

Developing multicellular organisms exhibit dramatic changes in shape and form and successive changes in spatial organization of specialized (differentiated) cell types, e.g. neurons and muscle fibers. How functional and spatiotemporal specialization takes place is an outstanding open question in cell and developmental biology. These events, which generate the body plan and the various organs, depend on regulated gene expression, elaborate interactions among cells, and coordinated cell movement. Differentiation and cell migration may occur simultaneously or sequentially. During development, genetics and biochemistry interact with the physical properties of individual cells creating a multiscale process of enormous complexity.

Recent advances in cell, molecular, and developmental biology have elucidated the pathways and machinery underlying development, but full understanding of the developmental process requires not only approaches that consider these pathways separately but also those that can integrate them. Computer simulations which allow the separate study of individual mechanisms and their reintegration in controlled conditions are essential to disentangle the complex interacting phenomena of both embryonic pattern formation



Chicken limb development simulations; (a) chick limb schematic, (b) developing limb simulations in 2-d (c) 3-d basic pattern from computations, (d) 3-d simulations of cell condensations into chondrogenic patterns. Various visualization approaches are used to bring out the features of the same cell distribution.

and tissue mechanics. Ultimately these simulations, properly tested and tuned against experimental results, should help to elucidate the fundamental principles of development and provide quantitative predictions of morhpogenetic processes

`The Organogenesis and Tissue Development Group is led by Mark Alber (Dept.of Mathematics and Physics) and Jesus Izaguirre (Dept. of Computer Science and Engineering) in collaboration with James Glazier (Dept. of Physics, IU Bloomington) Stuart Newman (Dept. of Cell Biology, New York Medical College), George Hentschel (Dept. of Physics, Emory University) and Gabor Forgacs (Dept. of Physics, University of Missouri, Columbia). This group has developed a variety of quantitative predictive models of organogenesis.

Modeling of biological phenomena in organ systems requires attention to processes at multiple scales, and then an integrated framework for utilizing the various submodels. During the embryonic development of a chicken limb, the phenomena of special interest are the formation of the bone structure (chondrogenesis) with the specific periodicity of the bone pattern that changes along the proximo-distal axis. Members of the group have been able to obtain simulations based on composite discrete and continuous modeling approaches to this essentially three-dimensional complex system. Some of the results of 3-D simulations of organogenesis of an avian (chicken) limb are presented in the figure above. Simulations start from undifferentiated mesenchymal cells, and finally condense into bone patterns of humerus (one), radius and ulna (two) and digits (three). The object oriented software framework of CompuCell, (http://www.nd.edu/~lcls/compucell/) has been developed for this purpose.

Biological Networks

The completion of the human genome project marks a turning point for biology: while for several model organisms we have a nearly complete list of genes, proteins and metabolites,

we continue to lack an understanding how these parts fit together. The mechanisms that seamlessly integrate the millions of cellular components are as much a mystery today as they were decades ago. Understanding the structure of networks that integrate the diverse components will play a central role in this research. The data explosion generated by the current experimental efforts to catalogue all cellular interactions create unique opportunities for computational biology and statistical mechanics, a combination with an extensive set of tools and expertise to uncover robust organizing principles from large but noisy datasets. Of the many potential applications of the tools and ideas generated by the study of complex networks, we believe that in the next decade biology will benefit the most.

The Biological Networks Group, led by Albert-Laszlo Barabasi (Dept. of Physics, http://www.nd.edu/~alb/), made an exciting discovery based on the realization that the architecture seen in communication and social networks pervades the sub-cellular world as well. Indeed, they found that the metabolism of 43 organisms has a scale-free topology [*Nature*, 2000]. A year later they demonstrated that the same structure emerges at the protein interaction level [*Nature*, 2001], finding that the essentiality of a gene strongly correlates with the gene product's position in the protein interaction network. A comparative study of the metabolic network of dozens of organisms allowed them to probe directly the effect of evolution on the network topology [*Nature Genetics*, 2001]. Recently group reconciled the scale-free topology with the concept of functional modularity [*Science*, 2002], developing computational algorithms to uncover the functional modules in the metabolism.

The Biological Networks Group's current work moves beyond topology to understand the impact of the cellular architecture on cellular traffic and dynamics. Barabasi's group pursues flux balance analysis to uncover the organization of fluxes in the metabolic network, preliminary results indicating a fascinating large-scale structure dominated by a few hot spots—high flux regions whose location can be predicted from the knowledge of the network topology. In parallel, the group is engaged in a series of studies collecting data on network dynamics. They just finished a pilot study on the dynamics of non-biological networks, offering the mathematical framework to address the dynamical organization of the cell as well, which we currently pursue using microarray data. Finally, a series of ongoing studies focus on the evolutionary aspects of the cellular components, aiming to understand the network's influence on a gene's evolutionary rate. To uncover the degree of universality of some of our findings we often return to non-biological systems, keeping a presence in the quite active field focusing on the statistical mechanics of complex networks, with applications to computer science and communication systems. As our research presents formidable computational challenges, advances require a truly interdisciplinary environment within my group, with interests spanning biology, computer science and physics.

To experimentally test his findings, Dr. Barabasi works closely with several biologists, including Dr. Oltvai, a cell biologist from Northwestern University Medical School. The experiments in Dr. Oltvai's lab are based on predictions developed in Dr. Barabasi's group, thus they jointly decide the questions to be addressed and the means to pursue these experimentally. Several of their experiments are done in collaboration with Integrated Genomics, a Chicago-based biotechnology company. A first outcome of this joint experimental-modeling program is the systematic knockout of all genes from the *E coli* bacteria, aiming to determine their essentiality under controlled rich medium conditions, an extensive effort undertaken to offer the necessary input for our modeling program. They are also finalizing an *E. coli* microarray line that will allow them to complement their topological data with gene expression measurements capturing the cellular dynamics.

Cell Organization and Cytoskeletal Dynamics

The process of cell organization underlies fundamental biological processes ranging from polarized growth to multicellular development. Membranes, fibers, even individual proteins all have canonical though dynamic subcellular

localizations, and these subcellular asymmetries give rise to the cellular asymmetries necessary for generation of tissues, organs, and organisms. The long-term goal of the Cell Organization and Cytoskeletal Dynamics group is to understand the origins of this organization.

Though this problem may initally seem intractable, many aspects of cell organization depend on the cytoskeleton, the dynamic network of protein fibers that give the cell shape, tensile strength, and motile properties. The fibers known as microtubules are particularly important -- if microtubules are depolymerized by drugs or genetic perturbation, membranes lose their localization and cell polarity is lost. Therefore, a major part of this problem can be reduced to two questions: a) How is the microtubule cytoskeleton itself morphologically defined? b) How do other cellular components (organelles, chromosomes, the plasma membrane) interact with microtubules?

To address these questions, the Cell Organization and Cytoskeletal Dynamics group, led by Holly Goodson (Dept. of Chemistry and Biochemistry) in collaboration with Mark Alber, is focusing on developing a quantitative and predictive understanding of microtubule dynamics, the proteins that control microtubule (MT) dynamics, and of the proteins that and mediate cargo-MT interactions. At present, our experimental efforts are focused on quantitatively characterizing interactions between microtubule binding proteins, tubulin, and microtubules, in order to understand the mechanisms by which these proteins operate and obtain the necessary affinity and rate measurements for performing computer simulations. These efforts are focused on the so-called “microtubule plus-end tracking proteins”, a set of proteins that dynamically track microtubule plus ends. These proteins have been shown to regulate microtubule dynamics and are also involved in membrane-microtubule interactions, implicating them in the answers to both of the “cell organization” questions outlined above.

Our computational efforts are focused on developing an improved Monte-Carlo model of microtubule dynamic instability. Previous models have treated microtubules as a population, but analysis of parameters such as polymer mass misses the dynamic behavior of individual microtubules, which is so central to the function of the microtubule network. These previous models also did not allow for the inclusion of microtubule binding proteins. Therefore, we have developed a visual model in which individual microtubules compete for tubulin subunits, allowing us to follow individual dynamics or population characteristics. We are using this model to develop principles of polymer behavior, test our understanding of the mechanism of microtubule binding proteins, and develop quantitative predictions for the behavior of the microtubule cytoskeleton in response to perturbation.

Educational Initiatives

Our goal is to educate scientists to combine a deep knowledge of biology with the mathematical, computational and physical sophistication needed to address the increasingly complex problems of post Human-Genome-Project biology, particularly the patterns and other forms of organization which arise from the interactions of many autonomous agents.

Students receive training to appreciate the various interacting scales that compose biological organisms. They also learn fundamentals of both mathematical and computational modeling and quantitative experimental techniques. Our goal is to produce researchers who, regardless of their home department, are equally comfortable with the languages of developmental and cell biology, molecular biology, computer science, mathematics and physics. We meet these educational objectives by revising both the graduate and undergraduate curricula to include a broader range of existing departmental courses and by developing new explicitly interdisciplinary courses. We provide research opportunities in Biocomplexity at both graduate and undergraduate levels and support the short and long-term visits of our students to other major institutions and programs, and the short and long-term visits by members at other institutions to Notre Dame. Similar programs exist at the postdoctoral and faculty levels. The ICSB runs an active Biocomplexity Seminar and Distinguished Lecture Series.

The ICSB also conducts international workshops essential to the training mission of the ICSB. Thus far the ICSB has organized, in cooperation with the Biocomplexity Institute at IU Bloomington, (http://www.biocomplexity.indiana.edu/) five such Biocomplexity Workshops, the most recent entitled "Biocomplexity Workshop V: Multiscale Modeling in Biology " held August 14–17, 2003 at the University of Notre Dame (see http://www.nd.edu/~icsb/multiscaleinbiology.html for details).

References

1) "Multi-model simulations of chicken limb morphogenesis," Chaturvedi, R., Izaguirre, J. A., Huang, C., Cickovski, T., Virtue, P., Thomas, G., Forgacs, G., Alber, M., Hentschel, G., Newman, S. A., and Glazier, J. A., in Lecture Notes in Computer Science, Volume 2659, Springer-Verlag, New York, 39-49 (2003).

2) "CompuCell, a multi-model framework for simulation of morphogenesis" by Izaguirre, J. A., Chaturvedi, R., Huang, C., Cickovski, T., Coffland, J., Thomas, G., Forgacs, G., Alber, M., Hentschel, G., Newman, S.A., and Glazier, J.A., in Bioinformatics (accepted for publication) – Manuscript ID: BIOINF-2003-0175-03/162

3) "The large-scale organization of metabolic networks", Jeong, H., Tombor, B., Albert, R., Oltvai, Z., Barabasi, A.-L., in Nature **407**, 651-655 (2000).

4) "Lethality and centrality in protein networks", Jeong, H., Mason, S.P., Barabasi, A.-L., Oltvai, Z.N., in Nature **411**, 41-42 (2001).

5) "Comparable system-level organization of Archea and Eucaryotes", Podani, J., Oltvai, Z. N., Jeong, H., Tombor, B., Barabasi, A.-L., Szathmary, E., in Nature Genetics **29**, 54-56 (2001).

March Meeting Program Update

Some alterations have been made in the programs for several DBP sessions in the March Meeting. Below are the updated listings of speakers for the sessions that have been changed.

Symposium

Interacting Biological Agents in Experiment and Theory

Organizer: **Anke Ordemann**
Chair: **Frank Moss**

Speakers:
Herbert Levine *Self-Organization During Dictyostelium Amoeba Aggregation*
Iain Couzin *Self-Organization and Collective Behavior in Animal Groups*
John Toner *Tentative Title: Can You Beat the Second Law of Thermodynamics if You're Too Dumb to Know Which Way is Up? A Theory of Nematic Flocks and Granular Materials*
Chad Topaz *Dynamics of a two-dimensional continuous model for swarming*
Udo Erdmann *Tentative Title: The Theory of Swarming Active Brownian Particles*

Focus Session
(Sorting Category 10.9.1)

Interacting Biological Systems: Single Particles to Waves and Swarms.

Organizer and Chair: **Frank Moss**

Speakers:
Kenneth Showalter *Stability and Control of Unstable Propagating Waves*
Ai Nihongi *Small Aquatic Animals Sensing Their Environment: Feeding, Mating, and Predator Avoidance*

NIBIB SOLICITS SUGGESTIONS FOR "QUANTUM" PROJECTS

The National Institute of Biomedical Imaging and Bioengineering (NIBIB) is soliciting suggestions from academia, industry, and the broad healthcare community for problems that need to be solved or research advances that represent high-impact, large-scale, technology-based projects and will result in significant (quantum) improvements in healthcare or quality of life. Details concerning this request and the "quantum" project program being considered by the NIBIB are available in "NIH Guide" Notice NOT-EB-03-011 that was released on November 7, 2003, and can be accessed at
http://grants.nih.gov/grants/guide/notice-files/NOT-EB-03-011.html

To demonstrate the NIBIB's commitment to improving human health, the Institute is considering supporting one or more "quantum" projects that have the following characteristics:

- A major problem that needs to be solved or a research advance that requires a collaborative, multi-disciplinary research and development effort and will provide a product or benefit that results in a significant healthcare improvement;

- Research based on technological approaches and applications; and

- Can be accomplished (i.e., solve the problem or provide the research advance - not necessarily make available for patient use) by a focused and sustained effort in a five-to-ten year period.

One-page (maximum) suggestions consisting of a descriptive title, one or two paragraphs describing the project and healthcare benefit, and contact information for the submitter are due at the location given in the "NIHGuide" Notice by e-mail, US Mail, or fax by January 9, 2004.

Announcement provide to The Biological Physicist by James Deye, Ph.D. Program Director, NCI, DCTD, RRP.

PRE HIGHLIGHTS

Biological Physics Articles from Physical Review E

October 2003
Volume 68, Number 4,
Articles (04xxxx)
http://ojps.aip.org/dbt/dbt.jsp?KEY=PLEEE8&Volume=68&Issue=4

ARTICLES

Food-web based unified model of macro- and microevolution
Debashish Chowdhury and Dietrich Stauffer
Published 1 October 2003 (6 pages)
041901

Hofmeister effects in membrane biology: The role of ionic dispersion potentials
M. Boström, D. R. M. Williams, P. R. Stewart, and B. W. Ninham
Published 3 October 2003 (6 pages)
041902

Speciation in multidimensional evolutionary space

A. Vukics, J. Asbóth, and G. Meszéna
Published 7 October 2003 (10 pages)
041903

Statistical mechanics of RNA folding: Importance of alphabet size
Ranjan Mukhopadhyay, Eldon Emberly, Chao Tang, and Ned S. Wingreen
Published 7 October 2003 (5 pages)
041904

E**xistence of high-order correlations in cortical activity**
Andrea Benucci, Paul F. M. J. Verschure, and Peter König
Published 8 October 2003 (9 pages)
041905

Measurements and modeling of water transport and osmoregulation in a single kidney cell using optical tweezers and videomicroscopy
A. D. Lúcio, R. A. S. Santos, and O. N. Mesquita
Published 10 October 2003 (6 pages)
041906

Finite-size thermomechanical effects in smectic liquid crystals: The vapor pressure paradox as an anharmonic phenomenon
Lianghui Gao and Leonardo Golubovic
Published 13 October 2003 (26 pages)
041907

Experimental support for a model of birdsong production
G. B. Mindlin, T. J. Gardner, F. Goller, and R. Suthers
Published 13 October 2003 (5 pages)
041908

Dynamical mean-field theory of noisy spiking neuron ensembles: Application to the Hodgkin-Huxley model
Hideo Hasegawa
Published 14 October 2003 (13 pages)
041909

Single stranded DNA translocation through a nanopore: A master equation approach
O. Flomenbom and J. Klafter
Published 14 October 2003 (7 pages)
041910

He**lix versus sheet formation in a small peptide**
Yong Peng and Ulrich H. E. Hansmann
Published 20 October 2003 (7 pages)
041911

Generating neural circuits that implement probabilistic reasoning
M. J. Barber, J. W. Clark, and C. H. Anderson
Published 21 October 2003 (11 pages)
041912

Synchronization between main rhythmic processes in the human cardiovascular system
M. D. Prokhorov, V. I. Ponomarenko, V. I. Gridnev, M. B. Bodrov, and A. B. Bespyatov
Published 22 October 2003 (10 pages)
041913

Time scale and other invariants of integrative mechanical behavior in living cells
Ben Fabry, Geoffrey N. Maksym, James P. Butler, Michael Glogauer, Daniel Navajas, Nathan A. Taback, Emil J. Millet, and Jeffrey J. Fredberg
Published 27 October 2003 (18 pages)
041914

Evaluation of entrainment of a nonlinear neural oscillator to white noise
Jason Ritt
Published 29 October 2003 (7 pages)
041915

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RAPID COMMUNICATIONS

Long-range interaction and heterogeneity yield a different kind of critical phenomenon

Mark Ya. Azbel'
Published 20 November 2003 (4 pages)
050901(R)

ARTICLES

Kinetics of the coil-to-helix transition on a rough energy landscape
A.Baumketner and J.-E. Shea
Published 3 November 2003 (10 pages)
051901

Cohesive energy, stability, and structural transitions in polyelectrolyte bundles
Joseph Rudnick and David Jasnow
Published 5 November 2003 (10 pages)
051902

Stability and bifurcation in an integral-delay model of cardiac reentry including spatial coupling in repolarization
Philippe Comtois and Alain Vinet
Published 11 November 2003 (5 pages)
051903

Statistical mechanics of RNA folding: A lattice approach
P. Leoni and C. Vanderzande
Published 11 November 2003 (8 pages)
051904

Theoretical ellipsoidal model of gastric electrical control activity propagation
Andrei Irimia and L. Alan Bradshaw
Published 20 November 2003 (5 pages)
051905

Drug-induced modification of the system properties associated with spontaneous human electro-encephalographic activity
David T. J. Liley, Peter J. Cadusch, Marcus Gray, and Pradeep J. Nathan
Published 24 November 2003 (15 pages)
051906

Particle transport in asymmetric scanning-line optical tweezers
B. Liesfeld, R. Nambiar, and J. C. Meiners
Published 24 November 2003 (6 pages)
051907

Electronic structures of *Ascaris* trypsin inhibitor in solution
Haoping Zheng
Published 25 November 2003 (8 pages)
051908

G**lobal stability of neural networks with distributed delays**
Hongyong Zhao
Published 25 November 2003 (7 pages)
051909

Virus shapes and buckling transitions in spherical shells
Jack Lidmar, Leonid Mirny, and David R. Nelson
Published 25 November 2003 (10 pages)
051910

BRIEF REPORTS

Stability of a neural network model with small-world connections
Chunguang Li and Guanrong Chen
Published 21 November 2003 (4 pages)
052901

A Message from the DBP Chair

December 29, 2003

Dear DBP Members,

On December 12/13 the Sorters' Meeting was held at APS headquarters in Maryland to assemble all the contributed and invited talks for the March meeting into sessions. Denis Rousseau and I are pleased to report from that meeting that submissions of contributed papers increased almost 40% over last year. This is a remarkable statistic that speaks to the vibrancy of biological physics and the health of our division. Thanks to the great response we had to our calls for Focus and Invited Sessions we have an extremely broad program covering all aspects of biological physics.

In order to capitalize best on this phenomenal growth, we need to continue increasing our membership. Shortly, we will send instructions to all current DBP members to assist them in getting new members. Please do your best to sign them up!

Ray Goldstein, Chair

Physics and Biology: a Materials Approach

June 28-30, 2004

Institut Curie
12 Rue Lhomond
75005 Paris, FRANCE

Topics & Speakers

Cell Adhesion	P.G. de Gennes, A.J. Garcia, B. Gumbiner, M. Steinberg
Tissue Engineering	A. Buguin, M. Bissell, R. Clark, C. McFarland
Proteins and Interfaces	D.L. Allara, H.P. Erickson, C. Mioskowski, B.Goud, N. Pernodet
Biomolecular Separation Technology	R.H. Austin, D. Branton, F. Brochard, J.F. Joanny, M. Rafailovich, B. Tinland
Biomimetic Systems	A. Eisenberg, G, Fuhr, D. Gersappe, P. Keller, J. Livage, J. Prost, M. Rubinstein, J.P. Sauvage
Micromechanics of Biological Systems	P. Coulombe, F. Gallet, F. Grinnell, P, Hansma, D. Ingber, D. Louvard, Y-L Wang
Polymers at the Interface	B. Chu, G. Decher, F. Kas, S. Satija, S. Sinha, J. Sokolov, A. Ulman
Funding the Interface	U. Strom, K.Shukla- NSF, C. Kelly- NIH Representitives from the CNRS

For information contact: npernodet@notes.cc.sunysb.edu
To register contact: nancy.rifkind@stonybrook.edu

Co-Sponsored by the NSF Garcia MRSEC, CNRS, and the Curie Institue

Physics and Biology a Materials Approach

This international workshop aims to highlight the forefronts of physical and biological sciences that can be bridged by materials science, engineering, and other enabling technologies. The goal is to identify areas of dynamic research that cut across traditional disciplines and encourage the establishment of multi-national research and education colaboration.

Registration

Name _____

Affiliation _____

Address _____

_____

_____

_____

Phone _____

FAX _____

Email _____

registration fee $100
payable to Stony Brook University

Please mail to:

Nancy Rifkind/Coordinator
Engineering Building
Stony Brook University
Stony Brook, NY 11794-2275
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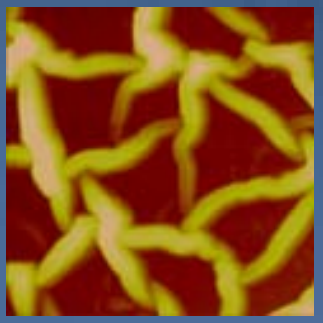
Physics and Biology a Materials Approach



Organizers:
F. Brochard, P. Silberzan- France
M. Rafailovich, N. Pernodet- U.S.A

June 28-30, 2004

Institut Curie
12 Rue Lhomond
75005 Paris
FRANCE

Monday, June 28

8:45-9:00
Welcome- **M. Rafailovich, P. Silberzan**

9:00-9:30
P.G. de Gennes, Nobel Prize Laureate
Modelling Cell Adhesion

Cell Adhesion

9:30-10:00
M. Steinberg, *Cell Adhesion Energies to Specify Tissue Self-Organization and Behavior*

10:00-10:30
A.J. Garcia, *Biomaterial Strategies, Surfaces Directing Cell Adhesion and Function*

11:00-11:30
B. Gumbiner, *Mechanism and Regulation of Cadherin-Mediated Cell Adhesion*

Tissue Engineering

11:30-12:00
A. Buguin, *Biophysics in Microfabricated Structures*

12:00-12:30
C. McFarland, *Surface Chemistry, Protein Adsorption, and Cell Attachment*

12:00-12:30
P. Bornstein, *The Biological Response to Implanted Biomaterials: the Host's Point of View.*

14:30-15:00
R. Clark, *Engineering 'Smart' Matrix for Wound Healing*

Proteins and Interfaces

15:00-15:30
H.P. Erickson, *Stretching Fibronectin*

15:30-16:00
N. Pernodet, *Control of Fibronectin Organization and Impact on Cell Morphology*

16:00-16:30
D.L. Allara, *The Role of Interfaces in Molecular and Biomolecular Adsorption*

16:30-17:00
C. Mioskowski, *Synthesis of Lipids for 2D Crystallization of Proteins*

17:00-17:30
B. Goud, *Lipid Sorting and Fission in Model Membranes*

19:00-22:00
Banquet
S. Stupp, *Biomolecular Self-Assembly*

Tuesday, June 29

8:35-9:00
J.M. Lehn, *Nobel Prize Laureate*

Biomolecular Separation Technology

9:00-9:30
F. Brochard, *Extrusion of Lipidic Tubes from Vesicles and Cells*

9:30-10:00
R.H. Austin, *Using surfaces and Confined Geometries for Sequencing*

10:30-11:00
D. Branton, *Prospects for Probing DNA and Other Polymers with a Nanopore*

11:00-11:30
M. Rafailovich, *DNA Separation on a Surface*

11:30-12:00
B. Tinland, *Electropheretic Transport of DNA in Confined Geometries*

12:00-12:30
J.F. Joanny, *Pulling Tubes from Vesicles with Molecular Motors*

Biomimetic Systems

14:00-14:30
J. Livage, Collège de France, Paris, France.
Life in Glass

14:30-1500
M. Rubinstein, *Virtual Lung*

15:00-15:30
J. Prost, *Physics Inspired by Cell Motility*

15:30-16:00
G. Fuhr, *Active Micro-Implants for Human Use and Aspects of Biocompatibility*

16:30-17:00
D. Gersappe, *Behavior of Self-Assembling Biopolymeric Systems*

17:00-17:30
P. Keller, *A Model For Artificial Muscles*

17:30-18:00
J.P. Sauvage, *Synthetic Molecular Machines Based on Catenanes and Rotaxanes*

19:00-22:00
Dinner on the Seine

Wednesday, June 30

Luncheon Workshop, *Funding the Interface*

U. Strom, K. Shukla, NSF
C. Kelley, R. Pettigrew, NIH/NBIB
A. Kini, DOE- Tentative
Representatives from the CNRS

Wednesday, June 30

Micromechanics of Bio-Systems

8:30-9:00
P. Coulombe, *Intermediate Filaments as Dynamic Determinants of Cellular Viscoelastic Properties*

9:00-9:30
D. Louvard, *Actin Dynamics: Control of Cell Shape, Plasticity and Signaling*

9:30-10:00
F. Grinnell, *Fibroblast Biology In Three Dimensional Collagen Matrices: Mechanical Reciprocity and Adaptation*

10:00-10:30
D. Ingber, *Biophysics of Living Cells*

11:00-11:30
F. Gallet, *Microrheology in Living Cells to Probe the Cytoskeleton Dynamics*

11:30-12:00
Y-L Wang, *Physical and Chemical Events at the Cell-Substratum Interface*

12:00-12:30
P. Hansma, *A Materials Science Approach to Understanding the Molecular Origin of the Fracture Toughness of Bone*

Polymers at the Interface

14:00-14:30
J. Kas, *Polymers in Cells- A Journey from Fundamental Polymer Science to Cancer Diagnosis and Nerve Repair*

14:30-15:00
S. Sinha, *Studies of Dynamical Fluctuations on Polymer Surfaces and the Glass Transition*

15:00-15:30
J. Sokolov, *Effect of Surface Conductivity on DNA Surface Electrophoresis*

15:30-16:00
S. Satija, *Protein Adsorption to Functionalized Lipid Langmuir Monolayers by Neutron and X-ray Reflectivity*

16:30-1700
G. Decher, *Polyectrolyte Multi Layers In Life Sciences*

17:00-17:30
A. Ulman, *Synthesis of Nanoparticle with Biological Function*

17:30-18:00
B. Chu, *Manipulation of Macromolecular Structures and Morphology for Biomedical Applications*

19:00-22:00
Dinner—Speaker: Adi Eisenberg, *Morphologically Biomimetic Structures and Processes in Block Copolymer Self-Assembly*