THE BIOLOGICAL PHYSICIST

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

Vol 5 № 1 April 2005

In this Issue

THE BIOLOGICAL PHYSICIST BEGINS ITS 5TH YEAR

Though it may seem hard to believe, with this issue, we begin the fifth volume of THE BIOLOGICAL PHYSICIST!

This issue brings you an interview with Harvard's Howard C. Berg, whose most recent book on biological physics is "*E. coli* in Motion", just published by Springer (2004). Turn to page 6 for important DBP updates, including the minutes of the Business Meeting from the March Meeting in Los Angeles. PRE Highlights can be found on page 11.

-- SB

A Conversation with Howard Berg

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S. Bahar

DBP member Howard C. Berg is Herschel Smith Professor of Physics, and Professor of Cellular and Molecular Biology, at Harvard University. As his academic titles suggest, his research is truly interdisciplinary. Among other areas, his research has made pioneering contributions to the study of bacterial locomotion. He is the author of Random Walks in Biology (Princeton, 1993). Berg's most recent book, E. coli in Motion, was published by Springer last year. Howard Berg talked with THE BIOLOGICAL PHYSICIST *about his scientific background, his new book, and his thoughts on interdisciplinary science in general.*

What led you into science in the first place?

My father was a biochemist at the University of Iowa in Iowa City, so I grew up among scientists. But the major spark was the discovery of a cache of 1920's radios in my grandfather's cellar in Wahoo, Nebraska. I became hooked on electronics. This led me to Caltech, where I thought I would become an electrical engineer. I started studying physics, because it appeared more fundamental, and then I became interested in chemistry, inspired by Linus Pauling, who taught the introductory course. I changed majors in my junior year and ended up with a bachelor's degree in chemistry. Along the way, I worked with Victor Neher, building electronics for his cosmic-ray balloons, and with Jerry Vinograd, doing experiments with his Beckman Model E ultracentrifuge. I might have stayed in physics had I been better advised: Willy Fowler was my physics advisor, but he said I needed no advice, because my grades were so good. In retrospect, that was because I lacked a sense of discrimination.

So how did you end up in biology?

That was the product of an extended identity crisis. I studied protein chemistry with Linderstrøm-Lang in Copenhagen and then enrolled in the Harvard Medical School. Within 10 minutes I realized that was a mistake – I was much more interested in basic science – but it took me 2 years to figure out what to do about it. I withdrew, crossed the river, entered Harvard's chemical physics graduate program, and did a thesis with Norman Ramsey on the atomic hydrogen maser. A stint in the Society of Fellows led me back to biology, where I began research on the architecture of the human red cell membrane. I was appointed Chairman of the Board of Tutors in Biochemical Sciences, an undergraduate teaching program, so half of my time belonged to the Dean.

Describe some of the first research you did that you would label "interdisciplinary".

I suppose it was realizing that atomic hydrogen was undergoing free-radical reactions at the surface of the storage bottle in the hydrogen maser. Dan Kleppner and I figured out how to coat the bottle with Teflon, which solved the problem. While in the Society of Fellows, Ed Purcell and I teamed up to develop a new kind of separation technique called sedimentation field-flow fractionation. The test particle for the centrifuge version of this device was a spherical virus called R17, which I got from Joan Steitz, then in Jim Watson's lab. So I did a bit of interdepartmental roaming. It was a few years later, while in the Biology Department, that I got interested in the motile behavior of bacteria. I built a microscope that tracked individual cells of *Escherichia coli* as they swam in three-dimensions. I tried to use the biology instrument shop to build this device, but they threw me out. So I went back to my friends in the physics shop, where I had made parts for Ramsey's second hydrogen maser. I discovered some wonderful 16-mm films of swimming bacteria, reconstructions of experiments done in the late 19th century by Theodor Engelmann, made by the microbiologist Norbert Pfennig, in

Göttingen. I found a projector and showed them to Ed Purcell, on his office wall. He was captivated. His first comment was seminal, "How do they swim in a straight line?!" That was the beginning of our second and more long-lived collaboration.

What led you to write "Random Walks in Biology"?

I had learned a lot about diffusion from Ed Purcell, thinking about sedimenting R17 and swimming *E. coli*. Often, in our discussions, when I tried to write a differential equation on the board, he would tell me that we would do better to ignore the mathematics and think, instead, about the physics. I was not very comfortable with differential equations, anyway, even though George Carrier had done his best. (Carrier began

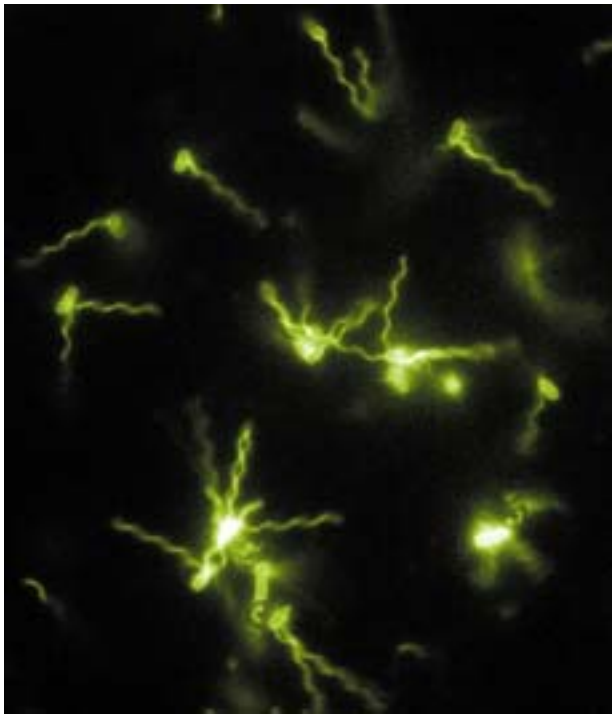

Figure 1. *E. coli labeled with an Alexa Fluor dye and observed in a fluorescence microscope. For movies of such cells swimming, go to the visit* http://www.rowland.harvard.edu/labs/bacteria/index *and click on the "movies" link.*

that course with the admonition that the best way to solve a differential equation was to ask someone who knew the answer, the second best way was to guess and then prove the guess to be right, and the third best way was to use the methods he would try to teach. I suppose Matlab and Mathematica have changed that landscape completely, but I haven't caught up.) Neither Ed nor I were comfortable with thermodynamics, which has little to say about the random motion of molecules, in any event. So we thought in terms of the random walk. Once you think about what individual particles are doing, much of the mystery vanishes. Physical chemistry textbooks of that day gave you Fick's first equation (zap) and Fick's second equation (zap again) … but what might they mean?! I got invitations from graduate students to talk about bacterial behavior, notably at the University of Wisconsin at Madison and at Duke. Instead of giving a research seminar, I decided to describe diffusion in terms of the random walk, i.e., to try to teach students something. After a few minutes, one could feel the astonishment in the audience, "I can understand that!" So, there seemed to be a genuine need for such a book. And besides, by writing, I could come to better grips with the subject. The book does derive some relevant differential equations and discuss some solutions of interest, but the emphasis is on what these equations mean in biology, not how they might be solved.

What was the genesis of your new book "*E. coli* in Motion"?

A number of people have been working hard on bacterial chemotaxis for more than 30 years, ever since Julius Adler showed in a classic paper – Chemoreceptors in bacteria. Science **166**: 1588-1597 (1969) – that *E. coli* has specific chemoreceptors, i.e., that cells pursue specific chemicals because they like their taste. Of course, motility and chemotaxis were invented so that cells could find more to eat, but it is taste first, metabolism later. Adler showed that cells are happy chasing substances that taste good, even if they are inedible. I know a lot about the history of this subject – it goes all the way back to 1676, when van Leeuwenhoek first discovered motile bacteria – and about the physics, and somewhat less about the biochemistry and genetics. I thought it would be of interest to summarize this knowledge and to review some of the experiments done along the way. The book is intended for readers who know some science or engineering but who are not trained as microbiologists, readers who would like to learn more about molecular machines. It has the merit of being short.

Do you think there really is an increase in interdisciplinary work now, vs. a decade or two ago?

It seems to be more in the air. There are a plethora of interdisciplinary centers and funding schemes, where one is encouraged to find collaborators in other fields. I find this somewhat off-putting, if not superficial. The best interdisciplinary work is done by people trained in one subject (or even better, more than one) who become immersed in another. Look at the giants of molecular biology: Max Delbrück, Francis Crick, Max Perutz, etc. More recent examples include those pioneering single-molecule biophysics. I think it would be a tragedy if we do not maintain support for individual investigators, chosen by broadly-based peer review.

How would you define "biological physics"? Do you see it as a distinct discipline separate from "biophysics"?

Hans Frauenfelder and I discussed this topic in 1994, in an issue of Physics Today dedicated to physics and biology (February 1994, with our editorial comments on pp. 20-21). Put colloquially, the first is more what biology can do for physics and the second what physics can do for biology. However, I argued that biophysics also includes physics mastered by living things, taught to them by evolution. I think our discussion is still relevant. I feel very strongly that someone interested in an interdisciplinary subject needs to learn more than one language. If you are a physicist, learn some biology, and if you are a biologist, learn some physics. The physicist has a much easier task, because biology is an historical science and thus largely descriptive. It's much easier to learn descriptive subjects once you have mastered analytical ones than the other way around. In short, don't let someone in another culture do your thinking for you.

You have appointments in both Molecular and Cellular Biology and in Physics. Would you call yourself a "biological physicist"?

Perhaps, had I stayed in physics departments and taught physics. However, my laboratory space and teaching responsibilities have been in biology departments, so my working knowledge of physics has declined. (For example, I am no longer able to understand the theoretical section of my Ph.D. thesis: I have not used quantum mechanics for more than 40 years.) So, it's more accurate to say that I am a physicist who does biology, or a biologist who knows some physics. So I guess I am a biophysicist.

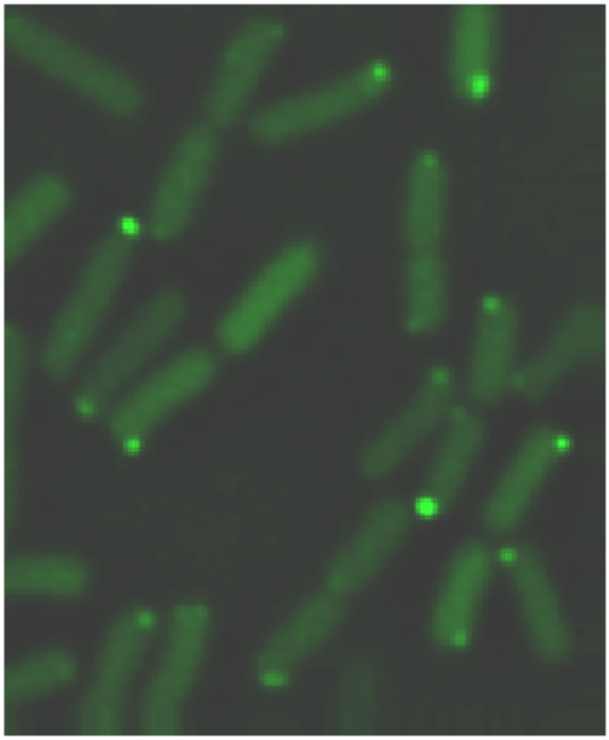

Figure 2. *E. coli has a brain… but it is very small. Cells labeled with a methyltransferase (CheR) yellow fluorescent protein fusion, which binds to chemoreceptors. The receptors form tight clusters, usually at one pole of the cell. Much of the computation involved in sensing changes in the concentrations of attractants in the environment goes on in such clusters, so they are referred to here as brains. When swimming in spatial gradients of attractants, cells make temporal comparisons over a time span of 4 s, so the brain has a short-term memory.*

What advice would you give to an undergraduate student interested in biological physics?

Study analytical subjects first: applied mathematics, electricity and magnetism, statistical mechanics, and the like. Pick up the more descriptive subjects later: some biochemistry, molecular biology, genetics. So start with physics and then learn some biology. Once you know a bit

of both languages, you will be able to take your own measure of the biophysical terrain. Neurobiology is clearly a field of the future, albeit immensely complicated. I think of myself as a neurobiologist, but one who has had the courage to deal only with the simplest single-celled nervous systems.

What about advice for graduate students, postdoctoral fellows, and young faculty members?

One becomes more specialized as one goes along. If you want to do biophysics, use your physics, but immerse yourself in biological problems until you find one that you hope to solve. If you want to do biological physics, i.e., work where the physics itself is paramount, then choose your problems accordingly. To take an example from my field, consider the bacterial rotary motor. If you want to understand how it is assembled and how this assembly is controlled, than do the biochemistry and genetics. If you want to understand its mechanical properties, e.g., the torque that it can generate at different speeds or whether or not it steps, then devise microscopic methods for making such measurements. If you want to understand how the rotation of helical flagella filaments generates thrust or how such helices interact to form flagellar bundles, then grapple with the hydrodynamics. There is a wide range of approaches here from very wet to rather dry. It sounds idealistic and old fashioned, but let curiosity be your guide. Grope about until you find problems that seem really interesting.

Where is your laboratory research headed in the next few years?

We are using fluorescence resonance energy transfer (FRET) to probe interactions between different proteins that constitute *E. coli*'s signal transduction pathway. How do the receptors talk to the flagella, and how, precisely, do the flagellar motors respond? We would like to understand every nut and bolt. Imagine, receptor clusters that count molecules of interest and make temporal comparisons; activation of a diffusible signaling molecule; reversible rotary engines that drive propellers of variable pitch; pistons, rotors, drive shafts, bushings, universal joints; a system with prodigious sensitivity with amplification generated by receptor-receptor interactions. To learn more, see Berg, H.C. Motile behavior of bacteria. *Physics Today*, January 2000, pp. 24-29.

Howard C. Berg

Some recent papers:

Sensory transduction in *E. coli*

1. Sourjik, V. and Berg, H.C. Receptor sensitivity in bacterial chemotaxis. *Proc. Natl. Acad. Sci. USA* **99**, 123-127 (2002).
2. Sourjik, V. and Berg, H.C. Binding of the *Escherichia coli* response regulator CheY to its target measured *in vivo* by fluorescence resonance energy transfer. *Proc. Natl. Acad. Sci. USA* **99**, 12669-12674 (2002).
3. Sourjik, V., and Berg, H.C. Functional interactions between receptors in bacterial chemotaxis. Nature **428**, 437-441 (2004).
4. Vaknin, A., and Berg, H.C., Single-cell FRET imaging of phosphatase activity in the *Escherichia coli* chemotaxis system. *Proc. Natl. Acad. Sci. USA* **101**, 17072-17077 (2004).

Movement near surfaces

5. Darnton, N., Turner, L., Breuer, K., and Berg, H. C. Moving fluid with bacterial carpets. Biophys. J. **86**, 1863-1870 (2004).
6. DiLuzio, W.R., Turner, L., Mayer, M., Garstecki, P., Weibel, D.B., Berg, H.C., and Whitesides, G.M. *Escherichia coli* drive on the right. *Nature*, in press (2005).

Gliding in *Mycoplasma*

7. Miyata, M., Ryu, W.S. and Berg, H.C. Force and velocity of *Mycoplasma mobile* gliding. *J. Bacteriol.* **184**, 1827-1831 (2002).
8. Jaffe, J.D., Miyata, M., and Berg, H.C. Energetics of gliding motility in *Mycoplasma mobile*. *J. Bacteriol.* **186**, 4254-4261 (2004).

Reviews

9. Berg, H.C. The rotary motor of bacterial flagella. *Annu. Rev. Biochem.* **72**, 19-54 (2003)
10. Berg, H.C. *E. coli* in Motion. (Springer-Verlag, NY, 2004).

New Members of the DBP Executive Committee

Vice Chair:
Dean Astumian, University of Maine

Members-at-Large:
Stephen Hagen, University of Florida
Chao Tang, University of California at San Francisco

Appointments to the Fellowship Committee

2005 DBP Fellowship Committee, one-year term to expire in March 2006

Chair:
Dean Astumian, University of Maine

Committee Members:
Leon Glass, McGill University
Earl Prohofsky, Purdue University
Mark Williams, Northeastern University
Ned Wingreen, Princeton University

Biological Physics Prize Committee

Chair

Paul Champion (term ends 3/2006)

Members

David Piston (term ends 3/2006)
Peter Wolynes term ends 3/2006)
John Nagle (term ends 3/2008)
Aihua Xie (term ends 3/2008)

Call for 2006 Biological Physics Prize Nominations

The American Physical Society and the Division of Biological Physics invite DBP members to nominate qualified candidates for the Biological Physics Prize. Nomination packages should be received by July 1, 2005 in order to be considered for the 2006 Prize Nominations remain active for three review cycles (until 2009).

The nomination package should include:
(1) A letter of not more than 1,000 words evaluating the nominee's qualifications for the Biological Physics Prize and identifying the specific work to be recognized.
(2) A biographical sketch (optional).
(3) A list of the most important publications.
(4) A least two, but no more than four, seconding letters and up to five reprints or preprints.
Five copies of the complete nomination package should be mailed to the Chair of the Biological Prize Committee:

Prof. Paul M. Champion
Department of Physics,
Northeastern University
110 Forsyth Street, Boston, MA. 02115.

For further information and questions, please contact the Prize Committee Chair at p.champion@neu.edu

Division of Biological Physics 2005 Business Meeting Minutes

Shirley Chan

Denis Rousseau, DBP Chair, presides and opens the DBP Business Meeting at 6 pm, March 22, 2005. The number of attendees is around 25.

Denis asks Shirley Chan, DBP Secretary-Treasurer, to give the financial report for 2004.

Shirley presents the summary on a transparency as shown in the table (see page 9).

(1) The total revenue for 2004 is $19,801.64 and total spending is $16,306.90. Thus DBP has an operating surplus of $3,494.74, adding to the net assets of total $50,683.85 as of 12/31/2004. In budgeting the student travel grants, Denis and Shirley agreed to provide all the surplus, to a combined total of $3,700, for the student applicants who will present their research at this March Meeting. Each award ranges from $150 to $300. (The student recipients were listed in February Newsletter.)

(2) The Biological Physics Prize fund has enough money for one recipient in 2006, but will need new donations for subsequent years.

Denis introduces all the attending Executive Committee Members: Peter Jung, the Chair Elect, Marilyn Gunner, the Vice Chair, Shirley Chan, the Secretary-Treasurer, Ray Goldstein, the Past Chair, Bob Eisenberg, the APS Councillor, 4 Members-at-Large: Leon Glass, Herbert Levine, Lois Pollack and Steve Quake. Also present are the newly elected Members: Dean Astumian, the Vice-Chair Elect, and Steve Hagen, the Member-at-Large. (Absentees: Members-at-Large Andrea Markelz, Ka Yee Lee, and newly elected Chao Tang.) Bob Eisenberg has been re-elected as the Councillor serving a 4-year term until December 2008.

Denis announces that four DBP members have been elected as APS Fellows in 2004, and presents the Fellowship certificates and the pins to each attending one. (The absentees will receive theirs by mail.) The names and citations are as follows:

Eisenberg, Robert S.,
Rush University Medical Center
Citation: Pioneering contributions to the understanding of ion permeation through membrane proteins.

Jung, Peter,
Ohio University
Citation: For distinguished contributions to statistical and nonlinear physics far from equilibrium and for elucidating the role of noise in biological systems.

Linsker, Ralph,
IBM T.J. Watson Research Center (absent)
Citation: for fundamental contributions to computational neuroscience, using insights from physics to account for self-organization in neural systems, with applications to automated pattern discovery; and for pioneering work in ultraviolet laser angioplasty.

Selvin, Paul R.,
University of Illinois at Urbana-Champaign (absent)
Citation: for imaginative use of single molecule fluorescence to visualize movements of a molecular motor at the nanometer level.

APS Division of Biological Physics
2004 Financial Summary

OPERATING FUND

	Actual 2003	Actual 2004	Projected 2005
INCOME			
Members, Yr End Count	1522	1668	1700
Dues	$7,610.00	$8,340.00	$8,500.00
March Meeting	$6,289.71	$7,995.00	$9,000.00
Investment Income	$3,348.28	$3,466.64	$3,500.00
Total Income	**$17,247.99**	**$19,801.64**	**$21,000.00**
EXPENSES			
Dinner: Excom Mtg	$2,371.58	$1,097.30	$1,400.00
Rental: Projector/Video	$78.00	$523.68	$100.00
Lunch: Students	$350.46	$997.26	$800.00
Reception	$830.72	$0.00	$0.00
Reg. Waiver: Speakers	$3,300.00	$2,100.00	$3,040.00
Travel: Speakers	$5,550.00	$5,000.00	$5,600.00
Travel: Students	$856.92	$2,600.00	$3,700.00
Travel: Sorters & others	$879.01	$1,411.41	$1,500.00
Lobbying Fee	$4,000.00	$2,500.00	$0.00
Misc (printing,postage..)	$176.95	$77.25	$343.85
Total Expenses	**$18,393.64**	**$16,306.90**	**$16,483.85**
Net Gain/Loss	**-$1,135.65**	**$3,494.74**	**$4,516.15**
YR END NET ASSETS	**$47,189.11**	**$50,683.85**	**$55,200.00**

BIOLOGICAL PHYSICS PRIZE FUND

ASSETS	
Balance on 01/01/04	$10,020.53
Contribution	$250.00
Investment Income	$417.01
Total Income	**$10,687.54**
EXPENSES	
Prize for 2004	$5,000.00
Travel for Recipient	$435.56
Total Withdrawals	**$5,435.56**
NET ASSETS, 12/31/0	**$5,251.98**

Denis says that the Executive Committee Board Meeting held on Monday, 3/21 was a very long one, started at 6:45 pm and adjourned about 11 pm. There were many good discussions. Marilyn Gunner would like to raise the attendance level at poster sessions. She suggests scheduling one dedicated poster session in the 2006 March Meeting, possibly in a late afternoon, that has no conflict with any oral sessions. Refreshments and food would be provided.

Denis asks the audience to suggest program topics for 2006 March Meeting, Baltimore.

For Student Travel Grants, Denis wants to encourage more applications in the future. 16 applications were received. It was a good mix of applicants geographically, ethnically and in gender. All have been given some support, ranging from $150 to $300 each.

For Fellowship nominations, DBP has an allowed quota of 8 in 2004, but only 5 nominees were submitted. Four were elected. For 2005, we would like to see more nominations submitted so that DBP will be better represented within the APS.

Nominations for the 2006 Biological Physics Prize are due July 1, 2005. Repeatedly, we have a problem with the fund, and will need new donations to maintain the balance. The Prize is $5K, awarded once every two years. $50K total donations will be able to generate enough earning to sustain the Prize at its current level. Steve Quake has volunteered to head the effort of fundraising.

Ken Dill, who heads the Bridging the Sciences Initiative started by the Biophysical Society, was invited to our Executive Committee Board Meeting to report the progress that lobbyist John Porter has made with Congress for funding research areas not usually funded by NSF or NIH. The Bridging Initiative was initially supposed to be a 2-year effort. The APS is one of the original members of the Coalition for Bridging the Sciences. Now the Coalition has grown to include 14-15 societies. The APS contributed $5K in 2003 to support Porter, and in 2004, DBP and APS each

contributed $2.5K. Dill is requesting an additional $5K contribution from the APS for 2005 to complete the effort. Judy Franz says that the APS Executive Board cannot justify the spending, and it is up to DBP to decide. DBP Board Members have voted to contribute $5K from our operating fund. This amount has not been included in the projected spending as budgeted by Shirley. Peter Jung would like to ask other Units to share the support.

Denis says that Sonya Bahar, the DBP Newsletter Editor, has been doing a great job for several years. She cannot come to this Meeting due to the scheduling conflict with her own talk. On her behalf, Denis urges all members to read the Newsletters, which have many DBP business announcements. Job ads have been added in 2004 to connect employers with the job seekers within the DBP community.

Andrea Markelz has volunteered to be the new Website Coordinator for the DBP web site, and Lois Pollack will be the Website Assistant. We thank Dan Gauthier for his years as the Website Coordinator.

Bob Eisenberg suggests that DBP should organize a small meeting similar to the Biophysical Discussions of Biophysical Society.

Several attending members, including Hans Frauenfelder and Robert Austin, disagree, and say that there is no need to add a new meeting.

Dean Astumian comments that the DBP should keep the March Meeting as is, but encourage the Biophysical Society members to come to the March Meeting. Bill Eaton agrees.

Marilyn Gunner would like to see that the March Meeting becomes the must-go meeting for biophysicists. Citing the example in this Meeting, there are four sessions under the topic of energy landscapes and conformations, with senior people as speakers. They resemble the format of a mini Gordon Conference within a large conference. She suggests choosing several topics for some symposium sessions, and continuing the same topics over 2 or 3 years in a row to attract the attendance. She suggests topics like nano-imaging, single molecule detections, or some with a cellular theme to be considered.

Leo Van Hemmen objects to Marilyn's idea. He wants a good program planned for each year, but sees no need to have the same topics several years in a row. He questions how many symposia might be in the same topic. If there are 1/3 of the sessions in the same topic planned, it will be too much.

Denis says that it would not be 1/3, and is suggesting around 10%. Leo says 10% is more acceptable.

Marilyn defends her idea of topic continuity over several years. She claims that if good sessions with senior people are organized, they will attract new members and new blood. Leo is not convinced by her argument.

Dean points out that continuity has already existed, but has not been emphasized. There is no traumatic departure from the current planning. He suggests that topical sessions could be organized in a tutorial format as regular sessions, so that there would be no additional charge for attendance.

Denis points out that the format cannot be mixed up with the Sunday's Tutorials. A different term must be used for these sessions if organized that way. He stops the discussions for now since more thoughts will be needed and can be continued via e-mail.

Denis turns the Business Meeting over to Peter Jung, who will serve as the DBP Chair for 2005-6.

Peter adjourns the Meeting at 6:35 pm.

The Minutes were recorded on 3/21/05 and submitted on 4/22/05 by Shirley Chan, the Secretary-Treasurer.

PRE HIGHLIGHTS

Biological Physics articles from

Physical Review E

(Statistical, Nonlinear, and Soft Matter Physics)

February 2005

Volume 71, Number 2, Articles (02xxxx)

http://scitation.aip.org/dbt/dbt.jsp?KEY=PLEEE8&Volume=71&Issue=2

RAPID COMMUNICATIONS

Dynamics of the antibody-*T.cruzi* competition during Chagas infection: Prognostic relevance of intracellular replication
G. J. Sibona, C. A. Condat, and S. Cossy Isasi
Published 22 February 2005 (*4 pages*) 020901(R)

Evidence of universality for the May-Wigner stability theorem for random networks with local dynamics
Sitabhra Sinha and Sudeshna Sinha
Published 24 February 2005 (*4 pages*) 020902(R)

ARTICLES

Topographical maps as complex networks
Luciano da Fontoura Costa and Luis Diambra
Published 1 February 2005 (*7 pages*) 021901

Detection of pulses in a colored noise setting
Gregor Wenning, Thomas Hoch, and Klaus Obermayer
Published 8 February 2005 (*9 pages*) 021902

Coupled dynamics of voltage and calcium in paced cardiac cells
Yohannes Shiferaw, Daisuke Sato, and Alain Karma
Published 8 February 2005 (*5 pages*) 021903

Theoretical studies of the kinetics of mechanical unfolding of cross-linked polymer chains and their implications for single-molecule pulling experiments
Kilho Eom, Dmitrii E. Makarov, and Gregory J. Rodin
Published 11 February 2005 (*10 pages*) 021904

Viscoelastic dynamics of spherical composite vesicles
S. B. Rochal, V. L. Lorman, and G. Mennessier
Published 11 February 2005 (*13 pages*) 021905

Multiscale entropy analysis of biological signals
Madalena Costa, Ary L. Goldberger, and C.-K. Peng
Published 18 February 2005 (*18 pages*) 021906

Three-dimensional bead position histograms reveal single-molecule nanomechanics
Nils B. Becker, Stephan M. Altmann, Tim Scholz, J. K. Heinrich Hörber, Ernst H. K. Stelzer, and Alexander Rohrbach
Published 22 February 2005 (*7 pages*) 021907

Approximate solution to the bidomain equations for defibrillation problems
Salil G. Patel and Bradley J. Roth
Published 23 February 2005 (*9 pages*)
021908

Exact theory of kinkable elastic polymers
Paul A. Wiggins, Rob Phillips, and Philip C. Nelson
Published 23 February 2005 (*19 pages*)
021909

Nucleotide correlations and electronic transport of DNA sequences
E. L. Albuquerque, M. S. Vasconcelos, M. L. Lyra, and F. A. B. F. de Moura
Published 23 February 2005 (*7 pages*)
021910

Formation of loops in DNA under tension
Sumithra Sankararaman and John F. Marko
Published 24 February 2005 (*13 pages*)
021911

Non-Michaelis-Menten kinetics model for conductance of low-conductance potassium ion channels
Igor S. Tolokh, Illya I. Tolokh, Hee Cheol Cho, Nazzareno D'Avanzo, Peter H. Backx, Saul Goldman, and C. G. Gray
Published 24 February 2005 (*9 pages*)
021912

Dependence of RNA secondary structure on the energy model
Bernd Burghardt and Alexander K. Hartmann
Published 25 February 2005 (*9 pages*)
021913

Deformation of a helical filament by flow and electric or magnetic fields
MunJu Kim and Thomas R. Powers
Published 28 February 2005 (*10 pages*)
021914

Interactions between water soluble porphyrin-based star polymer and amino acids: Spectroscopic evidence of molecular binding
Nicola Angelini, Norberto Micali, Valentina Villari, Placido Mineo, Daniele Vitalini, and Emilio Scamporrino
Published 28 February 2005 (*7 pages*)
021915

BRIEF REPORTS

Ion conduction in the KcsA potassium channel analyzed with a minimal kinetic model
Salvador Mafé and Julio Pellicer
Published 18 February 2005 (*4 pages*)
022901

March 2005

Volume 71, Number 3, Articles (03xxxx)
http://scitation.aip.org/dbt/dbt.jsp?KEY=PLEEE8&Volume=71&Issue=3

ARTICLES

Characterization of degree frequency distribution in protein interaction networks
Sebastián A. Romano and M. C. Eguia
Published 3 March 2005 (*5 pages*)
031901

Understanding mechanochemical coupling in kinesins using first-passage-time processes
Anatoly B. Kolomeisky, Evgeny B. Stukalin, and Alex A. Popov
Published 8 March 2005 (*8 pages*)
031902

Selective advantage for conservative viruses
Yisroel Brumer and Eugene I. Shakhnovich

Published 8 March 2005 (*4 pages*)
031903

Discrete layers of interacting growing protein seeds: Convective and morphological stages of evolution
Marcello Lappa
Published 15 March 2005 (*12 pages*)
031904

Nonlinear elasticity of an α-helical polypeptide
Buddhapriya Chakrabarti and Alex J. Levine
Published 17 March 2005 (*15 pages*)
031905

Multicanonical study of coarse-grained off-lattice models for folding heteropolymers
Michael Bachmann, Handan Arkın, and Wolfhard Janke
Published 17 March 2005 (*11 pages*)
031906

Nonequilibrium model for estimating parameters of deleterious mutations
Isabel Gordo and Francisco Dionisio
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