IOP | Institute of Physics
Biological Physics Group

NEWSLETTER

August 2011

Issue no. 3

Contents

Items for the newsletter should be e-mailed to Jamie.hobbs@sheffield.ac.uk

Editorial

Welcome to the third newsletter for the Biological Physics Group. I'd like to make a plea to you all to provide some input into what you want to see in this newsletter. We are open to suggestions for content and to offers to provide articles. If you would like to contribute please do get in touch.

In this issue we have an "Opinion Piece" on Systems Biology, a special introduction to the new IOP website containing teaching material for Biological Physics, as well as the normal information on conferences etc. I hope you enjoy it.

Dr Jamie Hobbs
Newsletter editor

Atomic force microscopy of red blood cell membranes showing the cytoskeleton in lower 500 nm zoom. Courtesy of N. Mullin and JK Hobbs, University of Sheffield.

The Committee

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The Chair's commentary

The upheaval in EPSRC priorities and modes of operation will be hugely important for our community. We welcome the identification of 'The Physics of Life' as one of four new 'challenge areas', and hope that this will translate into a tremendous boost to imaginative, important and inter-disciplinary research. We worry, of course, that new funding mechanisms will have the opposite effect by discouraging unconventional proposals, and wonder where the students will come from. The Biological Physics Group committee looks forward to continuing dialogue with the research councils, through the IoP, to achieve support for excellent, long term research and high quality postgraduate training and to encourage the free generation of ideas in order to maintain the UK's global research standing.

Since the January newsletter we have held a one-day meeting on Advanced Photonics Techniques in Biology (11th April, IoP, London). The emphasis of the presentations was on cutting-edge research; it was encouraging that many of those attending were students. We have plans for around five more meetings at various stages of development, including Quantitative Methods of Gene Regulation (22-23 Sept, IoP, London) a symposium at CMMP 2011 (13-15 Dec., Lancashire County Cricket Club), a meeting on biomolecular

motility, and our next international conference in the series Physics Meets Biology 2012 (early September 2012 – watch for the first announcement!).

A very promising new venture is the IoP's teaching website http://biologicalphysics.iop.org/ . The site provides teaching materials for lecturers planning to set up biological physics courses or who wish to use examples from biological physics in courses such as thermodynamics and mechanics – see the article by Athene Donald below. Do look at Athene Donald's introduction on the website, dip into the lectures, and send in feedback. The more this resource is used, the better the chance that it will develop and improve.

Opinion Piece

Systems Biology: what is it and where should it go?

The short answer to the first question is that no one really knows but you tend to know it when you see it! Somewhat less flippantly, systems biology encapsulates the idea that the dynamics of complex biological systems are emergent and often cannot be reduced to the properties of an individual element. In essence, biology is too complex to be described by the simple cartoons one often finds in the discussion section of biology papers, and for a similarly simple intuition of how a system behaves. Instead a thorough quantitative, mathematical analysis is needed to unravel the system's behaviour. Of course, such an approach is actually perfectly complementary to the traditional, reductionist agenda of molecular biology of identifying individual genes. Despite this complementarity, some friction has existed with more traditional-minded biologists. This issue is, however, fading with time: I certainly find it much easier now than 10 years ago to get my suggested experiments done by my collaborators!

However, other tensions are present in the field quite separate from those involving our sometimes complex relationships with biologists. The systems biology community itself is split between those who work on "small" versus "big" systems. The "small" community, of which I am (mostly) a member, works on "small" systems with a restricted number of components but which can still exhibit highly complex behaviour. A good example of this, and the point where I entered the field, is the MinCDE spatiotemporal oscillator that regulates precise cell division positioning in the bacterium *E. coli*. The original model I wrote down for this system involved 4 equations with 8 parameters. Of course, those from the complex systems community within physics will find this approach a natural outgrowth from their previous existence. However, the separate "big" systems biology community works differently and tends to have

a different background (mostly computer science, and, oddly, applied mathematics). Here the idea is to start with a huge network and try to use, for example, high-throughput experimental approaches to populate the enormous number of parameters that are involved. It is not infrequent to hear talks at conferences that include statements like: “our model included 234 ordinary differential equations, with 552 parameters,” talks which tend to make me shudder. How on earth can reliable results be obtained from such an approach?

Yet, such large systems are surely where we want to head eventually. I started out working on an 8 parameter model in 2001; I would be very disappointed if that’s still where I am 20 years from now, especially now that I work in a biology research institute surrounded by microbial and plant geneticists. Biology is big and it is complex and I don’t think it’s sensible to spend the next 30 years working on the biology equivalent of “toy” models. I think it’s time to raise our sights a bit and to work on somewhat “bigger” systems to bridge the gap. If we can humbly build up step-by-step from the bottom-up then maybe some decades from now we will genuinely be able to tackle some of these big problems with confidence that we’re not writing down nonsense. It will be a long haul, it might not be pretty or glamorous, but what’s the alternative?

Prof. Martin Howard
Dept. of Computational and Systems Biology, John Innes Centre, Norwich

Teaching Biological Physics

http://www.biologicalphysics.iop.org/

Those who attended last year’s Physics meets Biology meeting in Oxford, will have heard about a new initiative in Biological Physics teaching the IOP has instigated. The IOP has generously sponsored the production of teaching materials in Biological Physics for departments and individual lecturers to incorporate into their own courses as they see fit, particularly when they currently have no staff members expert or even familiar with some of the topics themselves. The material is provided in modular form, incorporating both explanatory text and detailed Powerpoint slides, as well as book recommendations for further reading. It can be used in different ways – for instance simply in the form provided to give stand-alone modules, or to provide information on specific examples (or inspiration for further examples) which may be incorporated into existing courses, for instance on thermodynamics or condensed matter.

The material for this course has been written by a group of experts specifically for the purpose of facilitating teaching in mainstream undergraduate physics courses, with the content devised and overseen by a project board. The material currently available will be augmented over the months ahead to cover a broad swathe of what might be termed 'biological physics', ultimately including:

- Thermodynamics, as relevant to biology including membranes, aggregation and Brownian motion;
- Classes of biological molecules, their structures and functions;
- Basic architecture of the cell, including the cytoskeleton;
- Tissues and organisms;
- Classical physiology;
- Biological energy;
- Molecular machines;
- Regulatory networks;
- Biomechanics;
- Biodiversity.

Not all of these modules are currently on line. The choice of topics is intended to be broad and illustrative of the key ideas which would be appropriate to introduce at an undergraduate level for physicists. But it is not exhaustive and one thing the project board is clear about is that there are many different ways, utilising a variety of themes and topics, to expose undergraduates to this important area depending on existing course structures within any given institution. However, as the recent EPSRC International Review of Physics made clear, Biological Physics needs to be given more prominence in the undergraduate curriculum than it currently is in many UK universities.

As Project Director, I hope this material finds favour in the community. I hope all institutions will review the material available, both now and in the months ahead, and evaluate how best to incorporate the topics into their teaching programmes. Please spread the word!

Prof Athene Donald, DBE FRS.
Cavendish Laboratory, University of Cambridge.

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Conference Calendar

Physics of Gene Regulation

https://www.eventsforce.net/iop/frontend/reg/thome.csp?pageID=61733&eventID=161&eventID=161

22nd-23rd September 2011
Institute of Physics, London, UK.

For further information please contact Pietro Cicuta, University of Cambridge (pc245@cam.ac.uk).

CMMP 2011

https://www.eventsforce.net/iop/frontend/reg/thome.csp?pageID=64380&ef_sel_menu=1080&eventID=167&eventID=167

13-15th December 2011, Lancashire County Cricket Club, Manchester, UK.

Following the success of last year, there will again be a biological and soft matter theme running through CMMP.

Prof Andrew Turberfield (Oxford) will be giving one of the plenary lectures, and Prof Tom Duke (UCL) will be giving an invited talk. Further invited talks still to be confirmed.

The deadline for abstracts is 7th October, and the deadline for early registration is 7th November.

If you have any questions please contact Dr Aline Miller (aline.miller@manchester.ac.uk).

Conference report

Advanced Photonics Techniques in Biology (III) – meeting report
11 April 2011, Institute of Physics, London, UK.

This was the third in the series organized by the Biological Physics Group of the IoP, since its creation in 2007. The numbers have increased steadily every year and the turnout has always been good, and this year was no exception with a full venue of ca. 70 attendees demonstrating quite clearly the popular depth of interest in this highly interfacial subject area. The meeting had a broad remit, but with a common goal to explore new photonics techniques that have been successfully applied to real biological problems. As with previous years the standard of speakers for the event was high, and it was very encouraging to see a significant presence of graduate students in the audience, with a bustling contribution of posters enjoyed during coffee and lunch.

In the morning seminar session Dr. Julian Moger (Exeter) and Prof. Wolfgang Drexler (Cardiff/Vienna) examined new Raman and Optical coherence tomography technologies respectively, followed by a description of developments in photonic nanostructures from Prof. Thomas Krauss (St. Andrew's) and practical applications of fluorescence lifetime imaging by Dr. Simon Ameer-Beg (KCL). After lunch more optical spectroscopic imaging techniques were explored by Dr. Cees Otto (Twente), along with zoological photonics of polarized light detection in nature by Dr. Nick Roberts (Bristol) and a talk on coherent x-ray scattering techniques in biology by Prof. Ian Robinson (UCL). In the last session of the day we then had a discussion on the use of infrared spectroscopy to monitor human tissue oxygenation in real-time by Prof. Clare Elwell (UCL), and finally a description of optical coherence tomographic rheology methods by Dr. Thomas Waigh (Manchester).

It is clear that the photonics community has a significant presence within the Biological Physics Group of the IoP, and the meeting closed with the hope of a future fourth incarnation of the meeting most probably to be held in 2013.

Dr. Mark Leake, Dr. Thomas Waigh and Prof. Peter Winlove (meeting organizers).