

Special section dedicated to The Sixth q-bio Conference: meeting report and preface

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PREFACE

Special section dedicated to The Sixth q-bio Conference: meeting report and preface

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This special section consists of ten original research reports that elaborate on work presented at The Sixth q-bio Conference, which took place on 8–12 August 2012 on the campus of St John's College in Santa Fe, NM, USA.

The q-bio community is a vibrant group of researchers that develop and promote integrated *modeling, theoretical and quantitative experimental* approaches aimed at understanding cellular information processing and other related complex biological phenomena with the quantitative rigor of the physical sciences. This community is transforming the way research in biology is done, making it more quantitative, and using the power of mathematics to discover and systematize biological knowledge in a way that has long eluded the field. The q-bio Conference is our annual flagship conference, held every August in Santa Fe, NM, USA. It is a major system biology forum for exchanging results and ideas, networking and continued education in q-bio.

Since its beginning in 2007, the conference has emphasized studies of cellular regulation, and it was originally called The q-bio Conference on Cellular Information Processing. To more effectively serve the community and impact other fields of biology, we later decided that the conference should broaden to include ecological and evolutionary contexts, and bridge into other areas in systems biology, cell biology, physical chemistry, bioengineering and biophysics. The scope of the conference has gradually expanded, and thus, since 2012, the conference has become known simply as The q-bio Conference. Even with its expanded scope, a majority of contributions to the conference continue to focus on cellular information processing and decision-making.

In a field that spans a diverse array of biological systems and emphasizes multidisciplinary approaches, a unifying conference that brings together all of its constitutive groups (researchers from the life, physical and engineering sciences) continues to be as crucial as ever. With The q-bio Conference, we have aimed at creating a dynamic atmosphere where junior researchers can meet and interact with senior investigators in an intimate setting and also present their work in posters and talks. There is ample time for impromptu discussions and opportunities for interactions amongst attendees, which is not always the case at larger meetings. The q-bio Conference features a single-track programme, which unfolds over four days. The meeting continues its tradition of being hosted at the campus of St John's College in Santa Fe, NM, USA. This unique location in the foothills of the Sangre de Cristo Mountains has allowed the conference to capitalize, on the one hand, on the solitude of the campus, where most of the attendees sleep and eat on site, promoting spontaneous informal meetings and discussions, and, on the other hand, on the relative closeness to arts, culture and outdoors of Santa Fe, which provide participants and their families with recreational opportunities. The size of the conference (about 200–50 attendees) is aimed to be large enough to sustain a diverse field, and yet small enough to foster intimate interactions.

The Sixth q-bio Conference included (see http://q-bio.org/wiki/2012_schedule for the detailed program): 21 invited talks (including four special talks), 27 contributed talks, 17 short poster spotlight talks and 131 poster presentations. The emphasis on contributed talks and posters places the focus of the conference on junior investigators, and, indeed, more than half of the attendees in 2012 were graduate students and postdoctoral scientists. Contributed and invited talks were anchored by four special presentations and events. For 2012, these included the following.

- The opening banquet talk was delivered by Byron Goldstein (Los Alamos National Laboratory), who described his lifetime of research focused on quantitative modeling of immunoreceptor signaling.
- The pioneer talk was delivered by Bruce R Levin (Emory University), who presented his research on the CRISPR bacterial adaptive immune system and personified the 2012 focus on populations and evolutionary biology.
- The special session talk on social aspects of science was led by David Botstein (Princeton University), who focused on q-bio education; and
- The closing banquet talk was delivered by Arthur D Lander (University of California, Irvine, CA), who, as a frequent attendee and close observer of the conference, raised the question *Beyond q-bio?*

New in 2012 was the introduction of what we expect to be an annual q-bio award. We are proud to announce that the first recipient of the award was Byron Goldstein (LANL), who was presented with a plaque that read as follows.

For pioneering studies of cell surface receptors and signaling systems and for being a visionary q-biologist even before q-bio was fashionable.

In addition to his obvious and undeniable contributions to the field, Byron has impacted q-bio in many subtle ways, including training a substantial number of current leaders in the field, and half of the original conference organizers. It is safe to say that the conference would not have existed without Byron, which makes this recognition especially meaningful to us.

One of the most important goals of the conference organizers is to foster and serve a vibrant and diverse q-bio community. The conference supports diversity by making special accommodations for researchers and their families available on an as needed basis, by supporting the needs of families with children, and by organizing thematic sessions to discuss and confront social aspects of academic life. This year the further growth and diversification of the community were evidenced by the emergence of the Winter q-bio Conference, organized by a sister organizing committee and held on 18–21 February 2013, at Waikiki Beach, Hawaii. The Winter Conference featured 24 high-profile invited talks, nearly 100 contributed talks and over 80 posters presented from participants around the world.

Community starts with establishing a common core of knowledge and transferring it to the next generation of scientists. Thus, since its inauguration, The q-bio Conference has been coordinately organized with The q-bio Summer School, which has attracted graduate students and postdoctoral researchers beginning q-bio careers from all over the world. In 2011, summer school applications greatly exceeded openings, which in 2012 led to the establishment of a second campus. The two campuses (one in Santa Fe, NM and the other in San Diego, CA) accepted over 60 students in 2012 and offered five different courses: *stochastic gene regulation*, *cell signaling systems*, *viral dynamics*, *biomolecular simulations*, *synthetic biology* and *computational neuroscience*. Students from both campuses were brought together in Santa Fe for the first annual q-bio student symposium, held between the summer school and main conference to give summer school students the opportunity to interact with each other and with senior researchers arriving early for The q-bio Conference. Starting in 2013, The q-bio Summer School will be supported by a resource/education project grant from the National Institute of General Medical Sciences (NIGMS) of the National Institutes of Health (NIH) (R25GM105608). We expect that this award will have a significant impact on building and strengthening the q-bio community of young and enthusiastic scientists.

As is the case for any community, the q-bio community needs a means to disseminate new knowledge, promote the field, open communication channels amongst community members and preserve snapshots of the current state of the community for posterity. To provide this service, we edit a special issue dedicated to q-bio science, which collects contributions from attendees of the previous year's q-bio Conference and also provides a meeting report. Over the last several years, to produce the annual special issue, we have partnered with *Physical Biology*. We are pleased to announce that this partnership will continue into the future under the terms of a multi-year collaboration agreement that should enhance the impact of the special issue. In the short term, this partnership has resulted in the current special section and this meeting report. In the long term, we hope that our collaboration with *Physical Biology* will further crystallize the q-bio community and realize

new synergies. The organizers, and especially Ilya Nemenman, who serves as a chief editor of the special section, are grateful to Andrew Malloy (the publisher of *Physical Biology*) and Nigel D Goldenfeld (our liaison with the editorial board) for their support and commitment to promoting The q-bio Conference and its agenda in quantitative biology, and for their significant contributions to the current special section.

In this special section, we are proud to present ten papers that reflect the scientific excitement of the 2012 q-bio Conference. The papers represent modeling, theoretical, experimental and methodological contributions. Although these papers do not reflect the full breadth of work presented at the 2012 meeting, they illustrate the singular most distinctive aspect of q-bio science, namely tight integration of quantitative experimentation and modeling. Biological research has long been dominated by experimentation. Without rejecting the need for experimentation, we aim to advance the use of theory and mathematical/computational modeling to complement quantitative data, for the interpretation of empirical observations and for designing experiments that rigorously test hypotheses. The spirit of this goal of The q-bio Conference is captured in a saying of Bruce R Levin, who presented the 2012 pioneer talk, which he originally coined in the context of population biology (see <http://eclf.net>). We paraphrase this saying (with permission) to apply to q-bio:

Doing research in modern biology without mathematical models or computer simulations is like playing tennis without a net or boundary lines.

The special section starts with ‘A conceptual framework for the evolutionary origins of multicellularity’ by Libby and Rainey [1], which emphasizes the 2012 Conference focus on evolutionary biology. This contribution is followed by two papers presenting novel experimental results. First, Flusberg and Sorger [2] present exciting data about cellular sensitivity to tumor necrosis factor-related apoptosis, inducing ligand at the single-cell level. Then Wynn *et al* study neural crest formation in ‘Follow-the-leader cell migration requires biased cell–cell contact and local microenvironmental signals’ [3]. The next three papers analyze and model specific experimental systems previously discussed in the literature: intercellular calcium dynamics (Szopa *et al* [4]); variability of V genes in B cell antigen receptor and the T cell receptor (Schwartz and Hershberg [5]), and ERK signaling cascade (Kocieniewski and Lipniacki [6]). Abstracting from specifics, the identification of certain design principles of stochastic cellular regulatory networks is attempted then in ‘Toggle switch: noise determines the winning gene’ by Jaruszewicz and Lipniacki [7] and in ‘A large number of receptors may reduce cellular response time variation’ by Cheng *et al* [8]. At the purely theoretical end of the spectrum, the special section concludes with two methodological papers, which aim at establishing new modeling techniques for stochastic systems biology. First, in ‘Time-ordered product expansions for computational stochastic system biology’ [9], Mjolsness leverages the mathematical apparatus of quantum field theory to derive accurate simulation algorithms for general stochastic biochemical dynamics. Second, Stromberg and co-authors discuss merging population biology and stochastic systems biology in ‘Population-expression models of immune response’ [10].

This is an exciting and diverse special section, and we hope that the readers will be enriched as much in reading it as we were in compiling it.

What’s next for q-bio? The Seventh Annual q-bio Conference will take place in Santa Fe on 7–10 August 2013, preceded as usual by The q-bio Summer School, which will start on 21 July in Santa Fe and San Diego. In 2013, the school curricula will include a new course on cancer at the Santa Fe campus. Looking farther into the future, The Eighth q-bio Conference will be held on 13–16 August 2014, with the affiliated q-bio Summer School starting on 27 July 2014. We are highly interested in diversifying the pool of organizers, programme committee and advisory committee members, and summer school lecturers, further extending The q-bio Conference and Summer School events beyond their New Mexico roots. Please feel free to contact an organizer if you would like to get involved. Up-to-date information about these events is available at <http://q-bio.org>.

We are looking forward to seeing you in the Land of Enchantment in 2013!

Acknowledgments

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We thank the authors who contributed to this special section and the approximately 30 anonymous reviewers of the papers, as well as the staff of *Physical Biology* for their continued support of the q-bio special section. Additionally, we would like to thank the staff of St John's College Conference Services and the staff of the Theoretical Biology and Biophysics Group in Los Alamos and CNLS. These individuals include Jenny Esch, Andie McLaughlin-Kysar, Adam Shipman and Ellie Vigil. We want to especially thank Adam for his on-site support throughout the event, which required long hours. Finally, we thank the advisory and programme committee members, who helped the organizers to assemble the programme, recruit speakers, review submitted abstracts and publicize the event. The programme committee consisted of seven organizers (listed on page one) and the following researchers: Andre Levchenko (Johns Hopkins University), Diane S Lidke (University of New Mexico School of Medicine), Orna Resnekov (Molecular Sciences Institute), Thomas S Shimizu (FOM Institute for Atomic and Molecular Physics), Aleksandra M Walczak (CNRS), Jin Zhang (Johns Hopkins University) and Anton Zilman (University of Toronto). The advisory committee consisted of the following researchers: Barbara A Baird (Cornell University), Elaine L Bearer (University of New Mexico School of Medicine), Michael E Berens (Translational Genomics Research Institute), Howard C Berg (Harvard University), Hans Frauenfelder (Los Alamos National Laboratory), Byron Goldstein (Los Alamos National Laboratory), Arthur D Lander (University of California, Irvine), Janet M Oliver (University of New Mexico School of Medicine), Linda R Petzold (University of California, Santa Barbara), Thomas D Pollard (Yale University), John Reinitz (University of Chicago), Michael A Savageau (University of California, Davis), Eduardo D Sontag, (Rutgers, The State University of New Jersey) and Thomas C Terwilliger (Los Alamos National Laboratory).

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