

PERSPECTIVE

Perspective on the q-bio Summer School and Conference: 2007 – 2014 and beyond

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INTRODUCTION

The q-bio Conference and the associated q-bio Summer School were started in 2007 by a prescient group of researchers based at Los Alamos National Laboratory (LANL) and the University of New Mexico (J. Edwards, J. Faeder, W. Hlavacek, Y. Jiang, I. Nemenman and M. Wall) who envisioned a systems biology community focused on modeling, simulations and targeted experiments to advance the fundamental understanding of biological regulation. Sponsorship for the initial 2007 conference and school came from the Center for Nonlinear Studies at LANL, with additional support from the LANL Institute for Advanced Studies, the New Mexico Consortium, the Molecular Sciences Institute, the Center for the Spatiotemporal Modeling of Cell Signaling, and the University of New Mexico Cancer Center. q-bio is now a well-established international systems biology event in July/August of each year and is currently registering participants for its 8th meeting and summer school (http://q-bio.org/wiki/The_Eighth_q-bio_Conference or http://q-bio.org/wiki/The_Eighth_q-bio_Summer_School).

MISSION

The purpose of the q-bio Conference and Summer School is to advance the predictive modeling of cellular regulatory systems while encouraging early career scientists to pursue quantitative systems biology and concurrently provide a forum for professional networking and the exchange of new results and ideas. In particular

the conference and school aim to advance research in: 1) modeling of genetic regulatory and signal transduction systems, 2) theory of information processing and general design principals of regulatory systems, 3) quantitative experimental studies at the systems level that are directly relevant for physics- and chemistry-based modeling and theoretical studies and, 4) emerging areas in systems biology.

NAME

For the first five years the conference and school were entitled “The 1st–5th q-bio Conference on Cellular Information Processing” or “The 1st–5th q-bio Summer School on Cellular Information Processing”. In the 6th year, in acknowledgment of the expansion of the focus of the conference and summer school into the fields of ecology, evolutionary biology, cell biology, physical chemistry, bioengineering, viral dynamics, and biophysics, the names were changed to The Sixth q-bio Conference and The Sixth q-bio Summer School.

WHAT CONTRIBUTES TO THE LONGEVITY AND SUCCESS OF THE q-bio CONFERENCES AND SCHOOLS?

Each of the following is key to the success of “q-bio”: setting, format of the conference, summer school, new additions, dissemination pipelines, organizers, supporting cast, funding and finally, the participants.



Figure 1. Multiple rainbows can be seen in the sky following a thunderstorm at the St. John's College campus, Santa Fe, NM.

Setting

Each year the q-bio Conference takes over St. John's College campus (Santa Fe) situated 7300 feet above sea level on 250 acres in the foothills of the Sangre de Cristo Mountains, New Mexico. The campus is a perfect setting for a meeting of ~200 people, the majority of participants are housed on campus enabling scientific discussion nearly 24 h a day. The beautiful and culturally rich environment is conducive to promoting a vibrant and engaged q-bio community — hiking trails originate on the campus, and it is just a short walk to museums, galleries and excellent restaurants. In addition, the Los Alamos National Laboratory and the Santa Fe Institute are both relatively close to St. John's College.

Format of the conference

The multi-day conference features a single-track program with both invited and contributed talks, two evening poster sessions that last to midnight, an opening session banquet talk and a concluding session banquet talk. The organizers facilitate and promote an exciting program at each of the conferences; high standards were set in 2007 when W. Bialek (Princeton University) was asked to open the conference and J. Doyle (Caltech) was asked to close the conference. The single-track program, the onsite meal program and the intimate campus setting help create opportunities for, and encourage interactions between, all levels of researchers.

Summer school

A key aim of q-bio is to advance the careers of junior researchers through both the q-bio Conference and the affiliated Summer School, which immediately precedes the conference. For the first five years, the Summer

School was held in Los Alamos with class sizes of 30–40 students per year. As time passed, the number of applicants to the Summer School quickly outgrew the available space — in 2012 the Summer School received more than 180 qualified applicants (graduate students, postdocs and even some professors) from over one hundred institutions around the world. To accommodate more students, more lecturers and more hands-on in-depth instruction in specialized topics, the New Mexico branch of the Summer School was relocated to St. John's College (organizers William Hlavacek and Brian Munsky (LANL)) and a second site for the Summer School was initiated at the University of California at San Diego (organizers Jeff Hasty and Lev Tsimring (UCSD)) in coordination with the school in New Mexico. This year (2014), the New Mexico branch of the school will be relocated from St. John's College to the University of New Mexico to allow for more advanced experimental demonstrations and to accommodate more students in the Summer School.

The Summer School provides many opportunities for junior scientists to interact one-on-one with senior researchers in the field. In 2013, the school accommodated 61 students and 64 volunteer lecturers, representing more than 60 different institutions worldwide. Distributed between two campuses, the school included a total of 76 general lectures, 58 discussion session talks, 8 computer laboratories and software demonstrations, and 10 small group experimental laboratory sessions. All students at the Summer School work on mentored course projects and every student is given opportunities to present their research and/or course projects during both the school and the associated q-bio Conference. Over the 7 years of q-bio, emphasis at the Summer School has included cell signaling (NM, 2007–2014), stochastic biochemical kinetics and gene regulation (NM, 2007–2014), gene regulatory networks (NM, 2007–2009), multi-scale

biomolecular simulations (NM, 2010–2014), viral dynamics (NM, 2012–2013), cancer dynamics (NM, 2013–2014), computational synthetic biology (CA, 2012–2014), computational neuroscience (CA, 2012–2013), and new in 2014: membrane dynamics (NM) and experimental synthetic biology (CA). The Summer School is interested to encourage new students and lecturers to participate — further information is available online at: http://q-bio.org/wiki/The_Eighth_q-bio_Summer_School.

New additions

To continue to have impact q-bio must remain a dynamic forum. In 2011 the 5th q-bio Conference introduced a “pioneer talk” to highlight new directions in quantitative biology. The first pioneer talk was presented by Dr. N. Seeman and was entitled “DNA, not merely the secret of life.” The second pioneer talk was given by Dr. B. Levin in 2012 and was entitled “The population and evolutionary dynamics of adaptive immunity in bacteria: CRISPR and too much fun” and in 2013 the pioneer talk was given by Dr. J. Lippincott-Schwartz and was entitled “Navigating the cellular landscape with new optical probes, imaging strategies and technical innovations.” In 2011 an evening session focusing on “the social aspects of science” was introduced. In the first of these sessions Dr. U. Alon led q-bio participants through a discussion of “Love and Fear in the Lab” complete with guitar accompaniment (the session is preserved online)¹. And, in 2013, Raquel Holmes (ImprovScience) encouraged q-bio attendees to participate in a set of improvisation exercises designed to help scientists learn to communicate more effectively [1]. B. Goldstein (LANL) received the first q-bio award in 2012, the award is intended to be an annual event. And, in February of 2013 the First Annual Winter q-bio Conference (organized by a distinct set of researchers) was held in Hawaii and plans for the third 2015 winter meeting are underway (<http://w-qbio.org/>).

Dissemination pipelines

Since its inception, q-bio has worked to disseminate the work of q-bio scientists, students and lecturers in multiple ways, including: 1) the q-bio website² (http://q-bio.org/wiki/The_q-bio_Summer_School_and_Conference), 2) a commentary written by the organizers reporting on the First q-bio Conference on Cellular Information Processing [2], 3) annual journal issues³ that each contain a meeting summary and original research and review papers and 4) a book entitled “Quantitative Biology” [3], which serves as a practical guide for researchers wishing to initiate work in this field. Summer School organizers are currently planning a new book that will provide a comprehensive overview of modeling techniques used in systems and synthetic biology, by example (current title: “q-bio By Example”). It is envisioned that the book will include chapters written by Summer School students and faculty.

q-bio interactions and discussions have inspired multiple publications: See Ref. [4] for results of experimental tests of a mathematical model of how single cells respond to TNF-(alpha), and Ref. [5] for a recently published example (derived from connections established during the 2010 Summer School) on the construction and modeling of layered synthetic circuits. q-bio has also inspired multiple Summer School attendees to pursue academic careers influenced by their quantitative systems biology training⁴.

The organizers and their supporting cast

q-bio organizers⁵ have been visionary in their plans for q-bio and disciplined in terms of implementing a sustainable strategy. Advisory and Program Committee members⁵ participate in tasks such as speaker recruitment, abstract and manuscript selection, Summer School teaching and Chairing of sessions at the Conference. As detailed in the Acknowledgments, support staffs from both the Conference and Summer School provide a consistent and nurturing foundation for q-bio. In any long-term endeavor

¹See: “Social Aspects of Science”, parts 1–5, August 11th, 2011 at <http://www.weizmann.ac.il/mcb/UriAlon/movies/Nurturing%20Science>.

²The website contains an archive from each q-bio Conference and Summer School. The Conference archives include the conference program, abstracts from each presentation and poster, lists of speakers, poster presenters, participants, organizers, program committee members and advisory committee members. The Summer School archives include the school schedule and school projects and starting in 2013 all course materials, video lectures, q-bio related software and a job board.

³IET Systems Biology (2008: volume 2, issue 5; 2009: volume 3, issue 5 and 2010: volume 4, issue 6); Physical Biology (2011; 8, 050301; 2012: 9, 050201; 2013: 10, 030301).

⁴See: Rosemary Braun (<http://fsmweb.northwestern.edu/faculty/FacultyProfile.cfm?xid=23119>; 2010 Summer School class), Paul Bogdan (http://ee.usc.edu/faculty_staff/faculty_directory/bogdan.htm; 2010 Summer School class) and Brian Munsky (<http://www.engr.colostate.edu/cheme/pages/brian-munsky.html>; 2007 Summer School class) for 3 examples. The organizers plan to post a complete list on the q-bio website.

⁵See the q-bio website for a list of organizers, program and advisory committee members from each year of the q-bio Conference and Summer School.

funding is a key component to sustainability and growth, and as detailed in the Acknowledgments, q-bio organizers have consistently worked to diversify funding for both the Conference and the Summer School. And finally, key members of the supporting cast are the q-bio participants who are responsible in large part for the vibrant and engaged q-bio community.

THE LANDSCAPE

There are currently 17 NIGMS-supported National Centers for Systems Biology, which were preceded by two centers: a Center for Cell Dynamics and a Center for Modeling Integrated Metabolic Systems. Several q-bio organizers participate in the current New Mexico Center for the Spatiotemporal Modeling of Cell Signaling (J. Edwards, D. Lidke and W. Hlavacek), L. Tsimring and J. Hasty (Summer School organizers) are members of the San Diego Center for Systems Biology, while many researchers from various other Centers for Systems Biology participate in q-bio as invited and contributed conference speakers or as lecturers in the summer school. In addition to the connection to NIGMS-supported Centers for Systems Biology, there is also a strong connection between q-bio and many of the graduate programs in quantitative biology such as the Program in Computational Biology (Carnegie Mellon University and the University of Pittsburgh), the Mathematical and Computational Biology Graduate Program (UC-Irvine), the Integrative Program in Quantitative Biology (UCSF) and the Quantitative and Computational Biology Program (Princeton University).

2014 AND BEYOND

The 8th annual q-bio conference and summer schools will be held August 13–16 and July 27–August 12, 2014 respectively (http://q-bio.org/wiki/The_Eighth_q-bio_Conference and http://q-bio.org/wiki/The_Eighth_q-bio_Summer_School). As we write this perspective, agendas for both are being finalized — the exciting list of invited and confirmed speakers include W. Bialek (Princeton University), N. Barkai (Weizmann Institute of Science), A.D. Lander (UC-Irvine) and P.K. Sorger (Harvard Medical School). We hope that you will also participate.

From 2015 forward, q-bio will be hosted in different parts of the world by local organizers at or near their home institutions. In January of 2014 the q-bio board (J. Faeder, S. Gnanakaran, W. Hlavacek, Y. Jiang, B. Munsky, I. Nemenman and M. Wall) sent out a request to the q-bio community for meeting proposals to host q-bio in 2015 and 2016. Several excellent proposals were received and Virginia Tech was selected as the site of the conference. A

significant outcome of this process is that the pool of organizers, the program committee and the advisory committee will be diversified, while the q-bio organization will continue to provide substantial support to local organizers to ensure the continuity and success of q-bio. Please consider contacting the q-bio board (or any member individually) if you are interested in hosting q-bio in the future (q-bio-board@newmexicoconsortium.org).

Where are q-bio organizers now? Several original q-bio organizers remain at LANL while many are currently affiliated with other institutions: W. Hlavacek (LANL & University of New Mexico), Y. Jiang (Georgia State University), B. Munsky (Colorado State University), J. Faeder (U. of Pittsburgh) and I. Nemenman (Emory University). At their new institutions, these q-bio pioneers are working to transform the manner in which biology is done by nucleating research groups and collaboration partners who will integrate modeling and theoretical and quantitative experimental approaches to further understanding of complex biologic processes. In addition, these q-bio leaders are influencing quantitative biology curricula at their respective institutions.

ACKNOWLEDGMENTS

The q-bio Conference and Summer School were launched as part of an initiative of the Center for Nonlinear Studies (CNLS) at Los Alamos National Laboratory (LANL), which at the time was headed by Drs. Robert E. Eke and William S. Hlavacek. The launch of this initiative would not have been possible without the involvement of several CNLS affiliates, including Drs. James R. Faeder, Yi Jiang, Ilya Nemenman, and Michael E. Wall, in particular Dr. Wall, who was a key driver of conference organization, and Dr. Nemenman, who was a key driver of summer school organization. CNLS is supported by the Laboratory-Directed Research and Development (LDRD) Program Office at LANL, which in turn is supported by the National Nuclear Security Administration (NNSA) of the US Department of Energy (DOE) through contract DE-AC52-06NA25396. The school was launched in partnership with the LANL Institute for Advanced Studies (IAS), which was the principal sponsor of the school in its early years. At the time, IAS was headed by Dr. Steven J. Buelow, under the oversight of LANL Institutes Director Dr. Nancy N. Sauer. The LANL Information Science and Technology Center, headed by Dr. Francis J. Alexander, has also supported the q-bio Conference and Summer School over the years. From the start, several regional organizations, in addition to those mentioned above, have supported the q-bio Conference and Summer School, including the New Mexico Consortium, a non-profit research institute located in Los Alamos that is headed by Ms. Katharine Chartrand; the University of New Mexico (UNM) Cancer Center, which is supported by a grant (P30CA118100) from the National Cancer Institute (NCI) of the National Institutes of Health (NIH) and which is headed by Dr. Cheryl L. Willman; and the Center for the Spatiotemporal Modeling of Cell Signaling (STMC), which is a National Center for Systems Biology supported by a grant (P50GM085273) from the National Institute of General Medical Sciences (NIGMS) of NIH. The STMC was originally headed by Dr. Janet M. Oliver and is currently headed by Dr. Bridget S. Wilson. Several STMC affiliates played key roles in launching and sustaining the q-bio Conference

and Summer School; in addition to those already mentioned these individuals include Drs. Elaine L. Bearer, Jeremy S. Edwards, and Diane S. Lidke. The Molecular Sciences Institute (MSI) was one of the original sponsors of the q-bio Conference. Additional sponsors of the conference have included Plectix BioSystems and Emory University. The q-bio Conference enjoyed direct support from NIGMS for five years through grant R13GM082163, and since 2013, the q-bio Summer School has been supported by NIGMS through grant R25GM105608. The conference has been strongly supported by researchers in the quantitative biology community who have served as local organizers, program committee members and advisory committee members¹. Likewise, the summer school has been strongly supported by researchers who have served as course leaders and lecturers². Finally, we acknowledge the editors and editorial staffs of the journals *IET Systems Biology* and *Physical Biology*, which have published special issues dedicated to work discussed at the q-bio Conference, and the q-bio reviewers who have helped select manuscripts for publication. We also acknowledge the critical contributions of the support staff of the conference and summer school, which have been drawn mostly from CNLS, NMC, UNM, and St. John's College, and the volunteers

who have assisted the organizers of the conference and summer school over the years. The content of the summer school and this perspective article is solely the responsibility of the organizers and authors and does not necessarily represent the official views of the National Institutes of Health.

REFERENCES

1. Bernstein, R. (2014) Communication: Spontaneous scientists. *Nature*, 505, 121–123
2. Edwards, J. S., Faeder, J. R., Hlavacek, W. S., Jiang, Y., Nemenman, I. and Wall, M. E. (2007) Q-bio 2007: a watershed moment in modern biology. *Mol. Syst. Biol.*, 3, 148
3. Wall, M. E., ed. (2013) *Quantitative Biology*. Boca Raton FL: CRC Press
4. Tay, S., Hughey, J. J., Lee, T. K., Lipniacki, T., Quake, S. R. and Covert, M. W. (2010) Single-cell NF- κ B dynamics reveal digital activation and analogue information processing. *Nature*, 466, 267–271
5. Lou, C., Stanton, B., Chen, Y. J., Munsky, B. and Voigt, C. A. (2012) Ribozyme-based insulator parts buffer synthetic circuits from genetic context. *Nat. Biotechnol.*, 30, 1137–1142

¹See the q-bio website (http://q-bio.org/wiki/The_q-bio_Summer_School_and_Conference) for lists of organizers, program and advisory committee members from each year of the q-bio Conference and Summer School.

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