

EDITORIAL

ALL SYSTEMS GO...

Systems biology represents a new way of thinking about biological questions and requires new technologies and new approaches. Microbiology has a pivotal role to play in this process.

Systems biology, as a concept, is not new but the recent explosion of genomic sequences and related data has revitalized interest in the field and is set to change the way we look at the microbial world. But what is meant by a term with the breadth and vagueness of ‘systems biology’? There are many definitions available but an uncontroversial description would contend that systems biology seeks to explain complex biological systems in terms of their molecular components and their interactions. With the completion of the first bacterial genome, *Haemophilus influenzae*, in 1995, the scientific community was presented with an ‘instruction manual’ on how to construct a living organism. The fact that we were unable to interpret this information at a systems level highlighted our ignorance of biological systems — nothing rivals the complexity of living organisms and unravelling this sophistication is the great promise of the systems biology approach. Or so the hype goes. But, despite the hype — inevitable with the emergence of any new biomedical field — there is little doubt that this approach will transform all fields of biology as much as molecular biology has over the past 30 years. The big unanswered questions in biology are systems-level problems and will only be solved by embracing the systems biology approach. The pertinent question now is when? The new molecular era of systems biology is in its infancy and to mature will require new technology and new intellectual approaches. In this context, the role of microbiology and microbiologists will be vital.

Systems microbiology, a term coined by the American Academy of Microbiology (AAM), is a category within systems biology where the focus is on microbiological systems. In addition to their crucial roles in health, the environment and industry, microorganisms are ideal candidates for systems research because they are relatively easy to manipulate. Systems microbiology will lead to the development of tools and insights that can eventually be applied to the systems analysis of non-microbial life.

In recognition of the importance of this area, the AAM recently convened a group of prominent microbiologists

to discuss the scientific merits and promise of systems microbiology and published the outcome of their deliberations in a report. In addition to detailing the benefits of applying a systems approach to the study of microbial life, the report also made a number of crucial recommendations that will be essential if the full potential of this approach is to be realized. The report recommends that those engaged in systems microbiology research develop more collaborative research efforts and that the funding required to facilitate this process be made available. A major obstacle to realizing the full potential of systems microbiology is underestimating the educational requirements of the next generation of researchers. The systems approach is inherently multidisciplinary and requires expertise not only in biology but also in mathematics, computer science and engineering. Meeting these educational requirements will represent a major challenge for the existing departmental structures typical of academia. Finally, the report also points out that the single most critical need is for a centralized database that will enable rapid submission and retrieval of data and expedite access to information from different areas of research. In a welcome development, Nature Publishing Group and the European Molecular Biology Organization have joined together to launch an online-only, open-access journal dedicated to the discipline. A stated aim of *Molecular Systems Biology* (www.molecularsystemsbiology.com) will be to work together with the systems biology community to establish guidelines, standards and metrics for global complex datasets.

The championing of a rational approach to systems biology is crucial and there is an onus on microbiology funding bodies, professional societies and publishers to be proactive in this process. Challenges remain and significant hurdles need to be crossed but the rewards for tackling and overcoming these barriers are enormous. Systems biology is set to revolutionize the biological sciences research and microbiology has a responsibility to be at the vanguard of this revolution.

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