Contemplating chemical biology

In this special issue, *Nature Chemical Biology* takes a look at the past, present and future of chemical biology.

In June, *Nature Chemical Biology* marked its fifth year of publication. As part of our anniversary celebrations, the editorial team gathered feedback from the community on the 'state of chemical biology'. First, we asked a panel of veteran chemical biologists for their views on the history and scientific accomplishments of chemical biology and the challenges facing the field today. Second, we invited chemical biologists just starting their independent careers to share their visions of the field's future by contributing to our 'grand challenges in chemical biology' essay competition (*Nat. Chem. Biol.* **6**, 385, 2010). In this issue, we report back on the results of these two initiatives.

A feature article, entitled "A decade of chemical biology" (p. 847), presents the results of our survey of a panel of chemical biologists (p. 854) and provides a perspective on the origins, development and current landscape of the field. Though our panelists voiced diverse opinions on how chemical biology should be defined, there was a general consensus that modern chemical biology is a distinct discipline by virtue of its unique heritage and its subsequent evolution within a dynamic scientific era. Our panelists also reached a remarkable concordance in identifying the key scientific contributions of chemical biology over the past decade.

As highlighted in the feature article, the next generation of chemical biologists is inheriting a discipline poised to make distinct and lasting contributions at the forefront of science. A cross-section of the exciting directions of chemical biology is represented in the 10 winning 'grand challenge' commentaries that are published in this issue (pp. 857–879). These essays, which we chose from among an outstanding collection of international submissions, outline the myriad ways that chemical biologists will advance scientific frontiers across the chemistry-biology interface. The commentaries are published in alphabetical order (based on the surname of the first author), and we commend each author for presenting such compelling ideas within the confines of our article requirements.

One recurrent theme expressed by our panel and the commentaries is that future chemical biologists will develop ever more sophisticated chemical tools enabling unprecedented molecular-level insights into chemical and biological systems. As noted by one of our panelists, Gerald Joyce, "chemical biology has now permeated the thinking of both chemists and biologists. Chemists find the ultimate proving ground for their wares in the complexity of biological systems, and biologists recognize that chemistry is the most fruitful level of description for biological phenomena." Commentary writer Joshua Kritzer (p. 868) points out that biologists have been receptive to using chemical probes, but he stresses that future chemical tools must meet a high bar for delivering new biological insights. Sivaraman Dandapani and Lisa Marcaurelle (p. 861) argue that the future development of one class of chemical tools—small-molecule probes—requires expanding the chemical space from which they are derived.

Many of our 'grand challenge' authors emphasized that, to be optimally successful, next-generation chemical tools must be combined with the mechanistic thinking of chemical biologists. Rahul Kohli argues that this blending of chemical biology approaches and know-how will be critical for understanding our "dynamic genome" (p. 866). Similarly, mechanistic probes will be essential for examining potential cellular "RNA epigenetics" pathways, according to Chuan He (p. 863). From a different perspective, Erick Strauss (p. 873) maintains that new methods for analyzing individual molecules and cells will provide a foundation for understanding the phenotypic heterogeneity of populations. The remarkable breadth of these predictions indicates that chemical biology is certain to change our understanding of fundamental processes in chemistry and biology.

Many chemical biology studies, including those outlined in the grand challenge commentaries discussed above, have important practical applications, particularly in the areas of drug discovery and medicine. One of our panel members, Stuart Schreiber, sees a broader scientific trend: "Scientists in the areas of genome biology, disease biology and chemical biology are evolving towards a new interdisciplinary field that is focused on human biology." As an example of this trend, Ryan Bailey (p. 857) predicts that chemical biologists will be key members of scientific teams involved in developing diagnostic approaches in support of personalized medicine. Given the centrality of the immune system in human health, David Spiegel feels that chemical biologists must build on previous successes at understanding and manipulating immunity with the goal of ameliorating and eliminating disease (p. 871). As Bridget Wagner points out (p. 877), chemical biologists are also poised to help transform regenerative medicine, by bringing their expertise to the burgeoning area of stem cell biology.

Beyond medicine, chemical biology is likely to be a catalyst for important future advances in synthetic biology and biotechnology. Christopher Dobson notes that "by contributing diverse techniques, chemical biology will be equipped to address some of the most urgent problems of our world, including the development of renewable energy sources, better forms of agriculture and more sustainable materials." This new direction for chemical biology is reflected in two grand challenge commentaries. In the first, Travis Bayer (p. 859) argues that chemical biologists need to merge their knowledge of biosynthetic pathways with informatics to enable scientists from diverse backgrounds to make new and useful molecules on demand. Claudia Vickers, Lars Blank and Jens Krömer (p. 875), in parallel, describe the insights needed from chemical biologists to build "chassis cells" that can be outfitted with modular components that will enable the programmed assembly of any desired molecule and, perhaps, transform us to a "bio-based" economy.

The themes permeating the feature article and the grand challenge commentaries reflect the community's well-founded belief that we are standing at the doorstep of an exciting era for chemical biology. We are grateful to the people who made these insights possible: our advisory panel for their keen insights and everyone who submitted essays on the 'grand challenges' of chemical biology. Most of all, we extend our great thanks to all of the chemical biologists who go to the lab each day to uncover the grand challenges that, in the decades to come, will take the field in new directions.