nature medicine
VOLUME 6 • NUMBER 2 • FEBRUARY 2000

The changing face of biomedical research?

Who would be so bold as to attempt to predict the future of biomedical research? Lots of people, as it turns out. With the turning of such a celebrated new year, the pundits have been particularly busy cataloguing our finest and foulest moments of the last century and predicting what to expect of the next. Although much of this is frivolous and entertaining, the scientific community, often cautious about making distant predictions, has at least seemed willing to extrapolate trends and puzzle over the implications. (See, for example, "Impacts of Foreseeable Science," a supplement from the Nature group of journals.)

In a recent straw poll of some two dozen leading biomedical researchers (representing such fields as neuroscience, infectious diseases, cancer, cardiovascular disease, immunology, cell biology, public health, gene therapy and others), a strong consensus emerged as to how biomedical research is likely to develop over the next decade or so and what would influence it most. There was near-unanimous agreement that basic research will continue to provide the insights that will affect the future of medicine. The most promising lines of research included stem cells, vaccine development (for all manner of ills) and gene therapy (said by many to be facing an upturn after many years of disappointing results), and the most exciting single development was, not surprisingly, the human genome project and all it promises.

Commenting on the pace of progress, it is gratifying to hear so many agree that whereas a generally bullish Western economy is fueling a tremendous growth in biomedical funding, issues such as global health, ethics and public support should be kept at the forefront and allowed to influence the biomedical research community. Others stressed the influence of the commercial sector, arguing that whereas collaboration between private and public sectors was important, care had to be taken to acknowledge the influence of shareholders and bottom lines.

This last point is nicely illustrated by the 10 January announcement by Celera that they have 90% of the human genome sequence in their computers. (See *News*, page 116.) Whereas this 'beating of the biotechnology chest' is likely to boost their stock price, there is little scientific advance to trumpet. Celera's 'shotgun' sequencing approach means that although they now have millions of small pieces of sequence, many are not assembled into complete gene sequences. Or, as Tim Hubbard, head of the Wellcome Trust's human genome analysis effort, said in the *Financial Times*, "It's…the equivalent of putting two copies of the Encyclopedia Britannica in a shredding machine." The more serious point is that data is not knowledge and there can be a significant gap between the two.

In fact, a dominant theme emerging from our respondents was the growing influence of physics, mathematics and engineering on biology, and in particular how these disciplines will help biologists interpret their huge and growing data sets.

A sizeable part of the biomedical research community is recognizing that the popular practice of reductionist biological experimentation does not hold up beyond the simplest questions, and that biology rarely produces simple questions. Instead there is a move to recognize that only an interrogation of the entire complex system will allow one to fully understand the system. And most biomedical researchers agree that the better the understanding of the system, the more likely we are to be able to manipulate it. Biologists, however, have little experience of complex systems, whereas physicists and others do.

The areas in which multidisciplinary approaches can help biology have grown well beyond bioinformatics and huge data sets (although this remains the most popular application) to include physical studies of single molecules using the exquisite sensitivity of optical tweezers, the application of nonlinear dynamics (and chaos theory) to understand heart failure or infectious epidemics, and a better physical understanding of DNA hybridization.

However, at this stage most of the action belongs to physicists, who seem adept at spotting interesting questions and then designing tools—both physical and mathematical—to use to investigate them. For the convergence of physics and biology to really take hold, grow and bear fruit for the biomedical and ultimately medical communities, biologists must become more familiar and comfortable with quantitative skills and grow more mature in their approach to mathematics and physics.

Perhaps the most telling evidence that physics will play a growing part in biomedical research is the development of major physics research programs in the bastions of biology and medicine, such as Rockefeller University (an institution "dedicated to science for the improvement of health and life"), which as long ago as October 1994 opened The Center for Studies in Physics and Biology. Although we may still be a long way from seeing biology graduate students discuss a unified theory of biology in journal clubs, the writing is on the wall.