

Bioinformatics: Blowing up a balloon

A few weeks ago, the trade fair Bio2002 was held in Bangalore. This is becoming an annual event, organized by the Karnataka state government's Vision Group on Biotechnology, emphatically reiterating the conviction that the biotechnology industry will lead the economic boom of the future. Two states in India, Karnataka and Andhra Pradesh, have been particularly supportive of the fledgling biotechnology industry, taking the initiative to establish 'parks and corridors', welcoming the setting up of new biotech ventures within their boundaries. The thrust in Indian biotechnology comes well over a decade after the gold rush in biology began in the United States. Indeed, the beginnings of the biotechnology revolution can be traced to the early days of DNA cloning in the 1970s, when work done in Herbert Boyer's laboratory at the University of California, San Francisco, led to the establishment of Genentech, signalling the birth of the biotechnology industry. True historians will, of course, note that the 20th century also marked the coming of age of 'classical biotechnology', a subject that traditionally deals with the production of useful chemicals by biological processes. While fermentation, breweries and alcohol have been in vogue for centuries, the use of microbial fermentation for production of antibiotics is clearly a 20th century landmark, hastened by the need for penicillin in World War II. The more modern phase of biotechnology, which gathered momentum in the 1980s, was initially driven by the need to produce pharmaceutical proteins, insulin foremost among them, using the powerful methods of recombinant DNA technology. Despite nearly twenty years of effort, the number of pharmaceutical proteins that are major successes at the marketplace is limited; insulin, erythropoietin, growth hormone, colony-stimulating factors and interferons are some examples. In India the first efforts to produce recombinant insulin began about twenty years ago, with the Department of Science and Technology (the Department of Biotechnology (DBT) was still only a gleam in the eyes of its promoters) playing a highly supportive role. Industry however, resolutely avoided investments in biological research, showing some signs of interest only in the late 1990s. Financial institutions were generally wary of biotechnology ventures; a far cry from the present situation, where both government funds and venture capital are available to start-up companies. Recombinant insulin is still not

produced and sold in India; the foreign product rules the roost. But once again there are stirrings in industry and maybe a locally-produced insulin will soon be a reality. The first recombinant DNA-derived products in India have reached the shelves of pharmacies; these are, however, products in which bioprocess development and downstream processing have been the key elements standardized locally. Little or no basic research has been involved in biotechnology product development; an historical course of industrial growth in India, that parallels the rise of the pharmaceutical industry in a legal climate that did not recognize product patents. If organic chemistry and chemical technology were the key disciplines for the pharmaceutical sector thus far, fermentation and biopurification may be the pillars of pharmaceutical biotechnology in the future.

In the last few years biotechnology has expanded immeasurably, fuelled by the spectacular progress in biological research. Its applications have made major inroads into the areas of agriculture and medicine. Transgenic crops and recombinant vaccines are rapidly becoming commonplace. Advances in stem cell research and the prospects of 'therapeutic cloning' may be harbingers of a new biological revolution. But if any single recent event in biology has captured the public imagination, it is the determination of the human genome sequence. To many uncritical observers, it appears that the 'secret of life' has been unravelled. To others the 'book of life' is waiting to be read and interpreted. With biology awash in genome sequences, which need to be annotated and translated into meaningful biochemical insights, computational biology has acquired a new importance. And, in the popular mind a new and important discipline of science, bioinformatics, has emerged. If its prophets are to be believed, bioinformatics is central to biology, today. The nature of biological information that must be stored, catalogued, indexed and understood has grown beyond nucleic acid sequence data; there are growing databases on protein three-dimensional structures, gene expression profiles, two-dimensional protein maps generated by electrophoresis and a bewildering range of information emerging from studies using nucleic acid and protein arrays. A recent commentary is tantalizingly titled: 'Creating a bioinformatics nation' (L. Stein, *Nature*, 2002, **417**, 119).

The rise of biotechnology and bioinformatics has also led to the emergence of a new breed of high profile salesmen for these disciplines, who are motivated by the irresistible smell of commercial success. We are promised 'designer drugs' which will presumably be optimized to suit a patient's 'genetic background'; even as the struggle to develop new drugs for difficult diseases has proved long, costly and often, unsuccessful. But, the promise of biotechnology and bioinformatics has been so widely touted, a new problem has begun to surface in India – the mushrooming of biotechnology and bio-informatics courses, which appear remarkably attractive to students. In the 1980s, in one of its most successful programs, the DBT supported the starting of M Sc (Biotechnology) programs, in a few chosen institutions. These departments were well funded, attracted and recruited good faculty and for a period of several years produced a new breed of biology students, trained in the developing techniques of molecular biology. However, more recently, the number of departments have swelled; many lacking the necessary facilities or faculty. B Sc courses have also been started in colleges. Most disturbingly, in many places, 'biotechnology' departments have been separated from the core disciplines of biochemistry and microbiology. There are a very large number of 'biotechnologists', with Masters degrees, in search of employment. In this setting, the enthusiasm of the Ministry of Human Resource Development (MHRD) for starting BTech (Biotechnology) programs in the Indian Institutes of Technology (IITs), must be viewed with caution. Many IITs do not have even the minimum number of faculty trained in biology to sustain these courses and may have to resort to the device of inviting 'guest' unhappy situation for institutions that have always maintained high standards of rigour in their teaching programs.

Even more alarming than the proliferation of biotechnology degrees, is the veritable explosion of bioinformatics courses. Bioinformatics in India has been conceived as the product of an illegitimate fusion between information technology (IT) and biotechnology (BT). Even as the IT industry experienced a mild slump, the many teaching shops, that cater to the needs of students to learn computer languages, have begun to rediscover themselves as institutions for teaching bioinformatics. In a cursory survey, I discovered advertisements from 'institutions' in the Bangalore suburbs, which offered bioinformatics courses covering an impressive range of subjects in their 'modules'. The topics ranged from *Biochemical and Biophysical Techniques, Molecular Biology, Genetic Engineering, Neural Networks and Artificial Intelligence*; subjects which are taught in universities and advanced institutions. In addition, the advertised modules include, *Chemoinformatics, Drug Discovery and Combinatorial*

Chemistry; courses for which our best institutions would be hard pressed to find willing and competent instructors. These bioinformatics shops, which now sprout in all our major cities, attract unsuspecting students, who pay substantial fees. Typically, the costs can mount to as high as Rs 1,00,000 (over thrice the annual fees for BTech programmes at IITs), for courses of dubious content and doubtful utility. While some courses list minimum requirements for students, I discovered one 'university', which advertised an M Sc bioinformatics course open to students with an Arts background. This institution had a succinct description of the discipline: *Tools and techniques from computer science, biology and mathematical statistics are used to provide a variety of molecular maps of genomes, including DNA and protein sequences.* The rationale for students to pay for these courses is clearly laid out in another pamphlet: *The trend to out source low-cost research and development in biotechnology is increasing. This provides an immense opportunity for Indian companies for overseas contract research.*

The bioinformatics courses are money spinners for those who run them; attracting parents and students, who sometimes invest unaffordable amounts in the search for a guaranteed future. These courses advertise the fact that they teach students how to use bioinformatics software, all of which are freely available on the internet. There is the seductive promise of wonderful career opportunities for those 'who understand both biology and computers'. Some questions spring to mind. Are teaching shops that have sprung up like pizza parlours, without facilities or faculty, teaching biology so effectively that they transform students, irrespective of background, into bioinformaticists? Or, are we creating a large pool of poorly trained certificate holders, who will struggle to obtain jobs in the promised biotechnology boom?

The rise of the teaching shop is a peculiar by-product of the IT age. There are new and sometimes, disturbing trends that are surfacing. The spectacle, of faculty of publicly-funded institutions teaching as 'guests' in private teaching shops, offering courses which are not available within the precincts of traditional institutions is discomfiting. For years, our schools and colleges have faced the issue of conflict between the conventional classroom and the private tutorial class; with teachers often preferring the latter. The commercialization of education, with little control on course content and misleading advertisements, is a sign of our times. The fact that this trend may be tacitly supported by governments is a matter of concern. The balloon of bioinformatics is being assiduously expanded. When it blows up, many unsuspecting students will be poorer.

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