

Biotechnology – Perspectives and prospects

Of late, biotechnology is seen as a panacea for all in the scientific and educational world. Almost 90% of the students from the science stream (contrary to IT from the technology stream) aspire for biotechnology than for any other course. Most of the college departments teaching science for decades, have now started giving degrees with a suffix 'and Biotechnology' to the respective degrees qualifying in plant and animal sciences. In spite of these developments, most of the private colleges still offer 'biotechnology' as the sole subject. The syllabi of these courses extend from cell and molecular biology to biochemistry to microbiology to molecular biology, rDNA technology to nanotechnology apart from lot of biotechnology papers with prefixes, viz. plant-, animal-, medical-, pharmaceutical-, nano-, microbial-, etc. Most postgraduates qualifying in these courses claim that they gain experience in a variety of areas of biotechnology starting from isolation, identification and characterization of microbes, animal cell-line cultures, *in vitro* propagation of plants, agarose gel electrophoresis, PCR, SDS-protein gel electrophoresis, gel documentation, immunoelectrophoresis (rocket, double-diffusion, etc.), cell cycle, drug analysis, Ramachandran plot, BLAST, etc. When analysed closely, they have neither thorough knowledge on any single subject nor are they trained in all these, except for the one time practical

session held to satisfy the university requirements. This leaves the students without any specialization. One good example is that most students taking up microbial technology as a separate course, do not know much about heat transfer, mass transfer, Monod's equation, etc.

Moreover, as indicated earlier¹, the only solace is when they are sent for project work and are exposed to some areas in which they are asked to work. Also most of the students want to work only on cloning, GMOs, etc. Majority of the students do not consider mass production of microbes for enzyme production, studies on microbial biofertilizers, microbial biopesticides, biopulping, biobleaching, production of alcohol, organic acids, amino acids and vitamins as biotechnology. Many students are drawn towards and prefer to work on plant tissue culture but without knowing the reality that only a little can be achieved within the short span of 2–3 months. Hence, the teaching faculty should be in a position to tread cautiously in moulding the students by not making much hype about the subject and in providing correct information about biotechnology.

Biotechnology education in India needs more reforms in terms of curriculum and structure of teaching. The University Grants Commission should restrict institutions from offering stand-alone biotechnology courses and advise them to conduct courses at least with a prefix like

plant-, animal-, microbial-, medical- and pharmaceutical-biotechnology, with one year foundation course and one full year of specialization in the major (chosen) subject area. This will help the students focus only on one area rather than meandering over many. Alternatively, the institutes could be persuaded to implement a convergent model by amalgamating departments like botany, zoology, microbiology, biochemistry, biophysics, etc. into a single department (Life sciences or Biosciences), where the student, after a strong foundation course, will be permitted to choose a specialization.

India is seen as a future hub of biotechnology, and is churning out more biotechnology students than what it requires in terms of employment. There is a possibility in future that the growing biotechnology industries may require persons with specialized skills than just a degree in biotechnology.

1. Seshadri, S., *Curr. Sci.*, 2006, **91**, 1594–1595.

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Rice cultivation and maintenance of the water-table

Rice is one of the oldest crops in the history of human civilization and its cultivation was pioneered in South and Southeast Asia in ancient times. A salient feature of rice cultivation is that the rice fields are flooded with water by an intricate and carefully planned method of irrigation, for a time ranging from weeks to a month or longer. This method is followed more than once a year when there are two rice harvests each year in Kerala, the Konkan coast, Northeast India and many other regions of India.

An ecologically important and interesting aspect of this method of farming is that some of the standing water seeps and percolates into the ground and helps replenish the groundwater and maintain the water-table. When more than 10% of a region is under rice cultivation, this may be a significant way of replenishing and maintaining the water-table, in addition to percolation of rainwater, canal-water and riverwater into the ground. Indirectly, this may play a role in maintaining the water-table and keep-

ing wells and springs charged with water.

When farming methods change for economic or other reasons, and this method of rice cultivation ceases and affects more than 10% of a region, it may have some negative impact on the replenishment of groundwater and maintenance of the water-table. Then replenishment of groundwater is limited to percolation of rainwater, canal-water and riverwater only, while this form of replenishment of groundwater is absent.

It has been noted in some states of India, that rice cultivation has been reduced significantly for a variety of reasons. In case this correlates with a drop in the water-table, it may be coincidental or there may be a causal relationship. In the latter case, this would indicate that remedial measures may be

required to maintain the water-table at the required level. It would also suggest that a shift from rice cultivation to other crops might have ecological effects different from what would have been initially expected. This may be important for other crops, the flora and fauna of the region (including medicinal

plants) in addition to the wells themselves.

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The digital opportunity index

The Digital Opportunity Index (DOI) is being developed by the International Telecommunication Union (ITU) and other partners in the 'Digital Opportunity Platform'. The second full release for 181 economies, was published in the 2007 edition of the World Information Society Report, available at <http://www.itu.int/wisr>. On behalf of the other members of the Platform, we are pleased to confirm that we welcome and encourage informed debate and constructive criticism of the DOI, which we still consider a work in progress. However, James¹ did not discuss his article with any member of the Platform prior to publication. Furthermore, James does not disclose that he received funding to participate in the Digital Opportunity Forum 2006, held in Seoul, the Republic of Korea from 31 August to 1 September 2006, where the methodology of the DOI was discussed.

James engages in extensive discussion of the equal weights assigned in the Index to the three clusters of opportunity, infrastructure and utilization. He claims that 'there is barely any discussion of the equal weights'. This is untrue. The Index was prepared following a prolonged series of open meetings in Busan (September 2004), Geneva (February 2005), Seoul (June 2005), Geneva (June 2006) and Seoul (August–September 2006). During these meetings, the issue of component weighting was discussed in detail and the Index results were subjected to sensitivity analysis. One of the forerunners of the DOI – ITU's Mobile/Internet Index (see <http://www.itu.int/mobileinternet>) – uses complex weightings calculated by factor analysis. Ultimately, for the DOI, a decision was taken to use equal weights (one-third each) for each component due to the lack of any objective or theoretical basis for alternative weights and a desire to keep the index as simple as possible,

so that it can be easily replicated and used as a policy tool by as broad an audience as possible.

James proposes a set of weights (one-sixth, two-thirds, three-sixths) that is erroneous, since his weights sum to greater than one (eight-sixths), which would distort the index. One can only attribute this to a typing error. Furthermore, he offers no theoretical justification for this particular set of weights, any more than the weights he seeks to criticize. I would suggest James' own illustration is proof of the need for simplicity in the weights.

James also criticizes the choice of the measure of 'percentage of population covered by mobile phone service'. He criticizes this because it is a measure of availability of service, rather than actual level of access, and because, in many developed countries, it is approaching 100%. Actual levels of access are measured by other indicators (the DOI includes this in its measure of cellular mobile subscribers per 100 inhabitants). It is important to include mobile coverage because this is a conceptual measure of the level of universal service (traditionally measured by availability, accessibility and affordability). Although it is close to 100% in many developed economies, it is considerably less in many developing economies and provides a useful differentiator of digital opportunity at lower levels of economic development.

James suggests instead to use either:

- Percentage of population covered by mobile signal that is actually able to use a phone (fixed or mobile); or
- The total number of mobile phones covered by mobile phone signal.

Data are insufficient and patchy for the first indicator. It would be difficult to find a comparable measure for 180 economies, except by using survey data which are generally not available and difficult

to update annually. For the second indicator, nearly all of mobile phones are likely to be covered by a mobile signal, as there is little value in purchasing a mobile phone unless it is usable most of the time. So, both James' suggestions for reformulating this measure of opportunity are impractical and less meaningful than mobile coverage. The DOI aims to cover as many economies as possible. The measures proposed by James would reduce the usefulness of the index, as well as introducing double-counting.

In summary, while James is correct in pointing out that the DOI is imperfect and that there is scope for improvement, his criticism is hardly constructive and he offers no real, practical advice. In our view, James should not offer criticism simply for the sake of it. The DOI represents a working compromise between what is desirable and what is possible, given the data limitations involved in measuring digital opportunity for 181 economies around the world. In this bold endeavour, we consider that the DOI succeeds quite well.

1. James, J., *Curr. Sci.*, 2007, **92**, 46–50.

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Response

Kelly and Biggs apparently welcome criticism, except when it comes from someone who has been paid to attend a workshop devoted partly to the DOI. In