

Degree courses in biotechnology

The 'Opinion' by Lakhota¹ minus its pessimism is largely acceptable. The concluding proposal that '... all school and undergraduate stand-alone teaching programmes in biotechnology/bioinformatics, etc. are stopped...', necessitates amendment considering diversification and unprecedented expansion of biotechnology and paradigm shifts in worldview.

Ereky² coined the term 'biotechnologie' (biotechnology) in 1919 as an important engine for economic growth and social development through innovations for higher food production. The modern concept of biotechnology remained unattended until the construction^{3,4} of plasmid *pSC101*. Businesses were attracted on the conclusion of Asilomar debates⁵ on recombinant DNA (rDNA) biosafety and after settlement of Diamond vs Chakrabarty suit⁶.

The definition of biotechnology varies widely. OECD⁷ proposed four subfields of biotechnology – green biotechnology applicable to agriculture, blue biotechnology concerned with aquatic systems, white biotechnology, also called grey biotechnology used in industry, and red biotechnology for medical purposes. Nasar⁸, in agreement with OECD⁷, divides biotechnology into two broad categories: 'first generation non-rDNA' and 'second generation rDNA' biotechnologies that have widened enormously in knowledge, range and application. Discoveries in eDNA, biofilms, epigenetics, HGT, sub-molecular-to-supramolecular biology, sub-cellular-to-organ biology, designer cell, organ and organism, bioassay, bioaugmentation, biochip, biosensing, biodegradation, bioremediation, synthetic biology, forensic science, etc. in conjunction with revolutions in computer technology, automation, engineering, medicine, surgery, nanotechnology, astrobiology, etc. have further altered applications of biotechnologies in innovative research, education, and production-value addition–consumption systems. Global trade and business in biotechnologies are intricately linked with IPR regime, international protocols, novel laws and societal

preferences. Demand for a wide array of biotechnologists is growing for intercontinental-to-domestic business ranging from sales and marketing, to education, research and development, to manufacturing, quality control and assurance, to community participation and to neo-global laws. Biotechnology education and research in India should serve today's needs and fulfil tomorrow's obligations.

The private sector took the lead in biotechnology business, investment, research and education. Government-funded public sector institutions took-off reluctantly. Degree-awarding teaching–research institutions with traditional life sciences departments were loathe to addressing new challenges but, curiously, squeezed biotechnology into existing syllabi at the cost of advances in their own subjects. Consequently, the students could neither concentrate on relevant basic sciences, nor on varied facets of biotechnology. The private-sector institutions operated in coordination with biotechnology business, reoriented syllabi accordingly, and found jobs for alumni. In spite of the disparity, both public and private institutions regrettably lack due focus on basic sciences, practical classes and globally competitive researches on development of consumer-acceptable products and services. Here lies the downside of biotechnology education and research in India.

Biotechnology failed aspirations for three major reasons. First, biotechnology is considered by some in the academia as confined to rDNA biotechnology to the exclusion of new and emerging areas. Second, lack of vital efforts to provide trained faculty for diverse biotechnologies and, third, insufficient investments in infrastructure development. 'Innumerable private and public institutions joined the bandwagon resulting in mushrooming of biotechnology courses in every city and small town of the country'¹, should be considered positively as a redeeming feature; a beginning has been made. The task now is to reorganize these institutions into skilled, forward-looking and globally competitive organizations.

Each institution may be encouraged to undertake a specialized approach to selected areas of biotechnology. Pooling of inter-disciplinary and inter-institutional expertise and infrastructure is essential. Juridical institutions may provide specializations in areas pertaining to national and international laws, protocols and instruments concerning biology, biotechnology, biodiversity and environment. Universities may be persuaded to commence studies in biotechnology management, business and futurology. Newer biotechnologies will keep popping up at an ever-increasing pace. The National Policy on Biotechnology should continuously monitor emerging issues and initiate strategic actions. India can and should become a leader in biotechnology.

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