FRONTIERS

Bio-Revolution

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Developing countries have joined the front lines of the biotechnology revolution in health and agriculture.

We are living through an unprecedented era of progress in biotechnology. Consider what has already been achieved. Thanks to an extraordinary international effort, scientists have sequenced the genomes of humans, plants and animals. This has led to the discovery of DNA signatures for a growing number of human and plant diseases. There has also been considerable progress in identifying both drug-resistant microbes and 'transmission hot spots', which can serve as the epicentres of epidemics.

Now, consider what scientists might achieve in the future. Projects include new ways to bioengineer circuits with DNA, complete with mechanisms that allow cellular computing, programming and communication between cells. In the field of synthetic biology, researchers have built long stretches of DNA and synthesized viruses that link DNA fragments using methods akin to computer-based engineering. Toggle switches, oscillators, and pattern-forming and edge-detecting devices that are currently under design could lead to bio-computers that sense abnormalities in the body, including the emergence of cancer cells, which can then be made to self-destruct.

In developing nations, biotechnology has the potential to revolutionize food production and health care. In agriculture, for example, researchers are using DNA-based technologies to create pest-resistant, higher-yielding plants for both normal and environmentally stressed soils.

Biotechnologies are also a key to 'bio-fortification'. Vitamin A deficiency, which, if untreated, can lead to blindness, affects millions of people in over 100 countries, mostly in the developing world. Anaemia caused by iron deficiency is another common condition in the undernourished population.

To help combat these and other health problems, biotechnology is creating plants that are 'fortified' with vitamin A, iron, micronutrients, proteins and antioxidants. One of the best-known examples is rice enriched with vitamin A (golden rice), which was first developed in 2000. Bangladesh, China, India, Indonesia, Iran, the Philippines and Vietnam now fund research and development programmes to enrich local rice. The United Nations estimates that, by 2015, the world will need to increase food production by 50% if we are to avoid global food shortages. Biotechnology will be a critical tool in meeting this goal.

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Yet, several hurdles stand in the way of progress, especially for developing countries. First among these are intellectual property rights (IPR). These are often legally restricted to individuals, companies and universities in the developed world, rendering access to critical technologies expensive and time consuming. A second hurdle is the opposition of interest groups concerned about biotechnology's impact on health and the environment.

Together, these hurdles can make the introduction of biotechnologies in the developing world problematic.

The example of golden rice is a case in point. Some 70 patents held by 30 companies and universities — all in developed countries — protect the technologies used in the production of golden rice. Following a major lobbying effort, IPR holders granted licenses to allow the royalty-free sharing of technology with people in need. However, many interest groups in the North and South remain opposed to genetically modified (GM) crops, which might pollinate non-GM crops. Such opposition is a recent phenomenon. By contrast, earlier commercialization of transgenic tomatoes, maize and soya bean faced no opposition.

Cross-pollination issues can be minimized with newer technologies. Furthermore, pollination occurs continually between wild and cultivated rice varieties without leading to ecological changes.

There is no doubt that biotechnologies (in common with all new technologies) come with risks as well as rewards. Thanks to many studies and assessments, we can be confident that GM plants are safe for human consumption. Yet, large segments of the public continue to harbour suspicions towards the use of biotechnology. Such perceptions cannot — and should not — be ignored.

Another worry, shared by both the scientific community and the larger society, involves the potential misuse of biotechnology by those seeking to create weapons capable of doing great harm. Biotechnology research functions under a rigorous international regulatory regime. No fewer than 15 international codes, designed to maintain public safety and environmental health, govern the regulation and trade of GM organisms.

So, what should developing countries do to ensure that they stay aboard the 'biotechnology train'? The ultimate goal should be to create an environment conducive to innovation. This requires training an adequate number of scientists and technologists, building proficient universities and research centres, providing ample funding, forging strong international links and opening up broad channels of communication.

To help ensure that developing countries gain the full benefits of biotechnology, governments should offer incentives to companies to produce the kinds of products that are most beneficial to their populations, such as vaccines against childhood diseases. Yet, it is crucial that in their efforts to promote innovation, governments achieve a proper balance between public good and private profit. In India, for example, Shantha Biotech has developed a yeast-based recombinant hepatitis B vaccine that has reduced the price from Rs400 (US$9) to Rs25 (US$0.60). India, Brazil and Cuba are all producing recombinant therapeutics and vaccines through collaborative arrangements between academia and private companies.

Biotechnology holds great promise for developing countries. Yet, this promise can only be fulfilled if these countries build the capacity needed to reap the benefits of this cutting-edge science and technology. ■

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