

IT, Stem Cells, and Poverty: Modernity and the social impact of technological innovation in India

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India holds a peculiar position in the existing world order. More often than not it is described as an underdeveloped, impoverished nation – at times even as third-world. It is also frequently touted as the next great hope for science; a country populated by engineers, mathematicians, and biologists – poised to develop the most advanced biotechnologies. An analysis of India's place in the world of scientific innovation must be viewed at the juncture of these two situations, and begs the question: should the Indian government be praised for promoting scientific research, or faulted for diverting funds from the needs of its citizens? This paper will examine this question by first exploring a number of new biotechnology innovations and India's place in their development. The explanation will be followed by an analysis of the salient aspects of Indian culture and their effects on the biotechnology industry. Further, this information will be used to disprove claims that increased state funding for biotechnological growth would be a positive move for the Indian Economy. India's National Biotechnology Development Strategy (NBDS) is the best framework from which to interpret the government's position and the controversial place of scientific advancement in Indian society.

The future of India's development is almost entirely geared toward the growth of its biotechnological industry. In light of India's social makeup, the conclusion drawn from the NBDS is that the government of India is ignoring unavoidable realities of its nation in order to make it internationally appealing to scientific development. Advancements in biotechnology may well come at the expense much of India's people, or at the very least fail to improve their everyday lives. India states in the NBDS that biotechnology is a "technology of hope... promising... food, health, and environmental sustainability."^[1] Although India has already undergone massive social reconfiguration, it is not enough to support a rapidly growing biotechnology industry. Judging by the recommendations in the NBDS, much more will be required to bring India's social, economic, and humanitarian circumstances up to the level necessary for a successful biotechnology revolution.

The Biotechnology Revolution

The biotechnology revolution currently facing India and the rest of the world is "something much broader than genetic engineering. What we are living through today is... a revolution in the underlying science of biology."^[2] These advanced elements of biotechnology, sciences

“broader than genetic engineering,” include such technologies as stem-cell research and synthetic biology. Although these specific sciences do not form the sole basis of India’s NBDS, there are certainly provisions to encourage their future development, and an underlying hope that India will become a world leader in these fields.

Synthetic biology is one of the newest, most controversial, and most closely scrutinized branches of biotechnology. It merges elements of biology, chemistry, and engineering. The process is defined as a “transformative innovation that will make it possible to build living machines from off-the-shelf chemical ingredients.”[3] It is “a field involving synthesis of novel biological systems which are not generally found in nature.”[4] In this sense it is not surprising that synthetic biology is frequently compared to engineering; it is in effect building, inventing new living things out of existing DNA and biological parts. Synthetic biology is the human creation of new life.

Many industries are involved in synthetic biology research, and just as many stand to gain from its discoveries. The organisms created have the potential to “produce pharmaceuticals, detect toxic chemicals, break down pollutants, repair defective genes, destroy cancer cells, and generate hydrogen for the post-petroleum economy.”[5] The two primary advocates of synthetic biology are pharmaceutical firms, and those involved in research into petroleum alternatives. There is the potential to produce pharmaceuticals more cheaply, faster, and in greater quantities than at present,[6] and promises to developing nations that eventually malaria and HIV treatments will be affordable. It is also claimed, however, that synthetic biology will liberate humans “from our biological

constraints,”[7] and change the nature of living organisms.

Synthetic biology carries with it many of the controversies that plague stem-cell research, including accusations of humans ‘playing god,’ and meddling in natural processes. In fact, references to Frankenstein and a new “definition of life, including what it means to be human” are common elements in discussions of synthetic biology.[8] Although the US is the current leader in synthetic biology research, and as yet there are no political agendas or laws against the science, it is unlikely that it will remain unchecked for long – particularly in light of the recent treatment of stem-cell research. There are a multitude of factors which could allow India to excel in synthetic biology research, and it is in a position to “leapfrog”[9] into the synthetic biology industry if it can take advantage of the current world situation and its growing reputation in biotechnology.

The NBDS recognizes this opportunity and puts regulations and plans in place for bioengineering.” In the Context of India’s specific strategy, bioengineering consists of practices including, but not exclusive to, “tissue engineering, biomaterials for therapeutics [and], biomedical devices” and acknowledges the future potential of “novel biomaterials.”[10] Ethics and regulations, although vague, are in place for India’s synthetic biology development: “test methods for safety evaluation of tissue engineered and combinational products” will be instituted, as well as establishment of “effective institutional mechanisms” and “appropriate regulatory process[es].”[11]

Stem-cell research is considered one of the stepping-stones to successful synthetic biology development. In stem-cell research, India’s culture has one

distinct advantage over many Western nations; there is not a cultural or moral backlash against the controversial science. Even in its desire to ingratiate itself with US trading partners, India has not condemned research of this type, despite a US moratorium on stem-cell research. The political implications of stem-cell research are vast; stem-cell research affords the medical profession rights to manipulate the brain, “the source of all human behaviour,”^[12] and “raises most directly the prospect of a new kind of eugenics, with all the implications with which that word is fraught, and ultimately the ability to change human nature.”^[13] India has already instituted guidelines for this kind of study: “the regulatory framework is already defined for medical biotechnology such as r-DNA healthcare products and stem-cell research.”^[14] The NBDS addresses stem-cell research, and notes that India is ready to take on a global role in the development of the science. There are elaborate guidelines in place, and a number of the strategies cite the need to: “formulate a comprehensive Human tissue act.” They emphasize intellectual property rights and the confidentiality of research and form extensive regulation for “human tissue engineered products.”^[15] The NBDS also states that “India must consider the potential medical applications of stem-cell research. We [the Indian government] must reassure end users on the safety and quality [of these products] by ensuring regulation on stem lines having stable characterizations so that safety risks are predictable.”^[16] These regulations come in stark contrast to the US bill to criminalize all research using, or producing stem-cells.^[17]

Many in the scientific community claim American scientists are envious

“that religious and moral considerations do not seem to inhibit Indian biotechnologists.”^[18] Although this particular assertion is not entirely true, it is apparent that Hinduism is “less monolithic and more diverse than Islam and Christianity; they can yield contradictory arguments.”^[19] Indian scientists are therefore not charged with the moral transgressions that plague stem-cell, and advanced biotechnology researchers in Western nations – the concept of ‘playing god’ does not seem to apply.^[20] Although many Hindus, like Christians, believe life begins at conception, there are myths available in Hindu doctrine which can justify stem-cell research.^[21] Unlike common Christian interpretations of scripture which condemn the process, Hinduism is generally far more accepting of the science. India’s open attitude and the religious beliefs of its predominantly Hindu population uniquely situate the country to take on stem-cell and synthetic biology research.

Indian Culture and Biotechnology

India is in a period of unprecedented change and modernization in all aspects of its society. Publicity tends to focus on the advancements in the scientific sector, but social changes have in fact enabled this advancement in India’s industrial and scientific quarters. Although these social changes are felt most strongly in the urbanized upper classes and high castes, they are apparent in all locations and social groups, and are most commonly realized as a leveling of India’s strict social hierarchy.

One of the primary leveling agents in Indian society, and the one that is bringing about the most modernization and change, is education. It is realigning traditional hierarchies and the accepted social order, as well as providing useful

means of upward mobility for lower castes and classes. What began as a tool of colonialism has, in a modern context, become a crucial tool of Indian nationalism and an important way to escape the traditional social order. Schools create commonalities between disparate groups and they lessen differences present in children of different classes.[22]

Although India has a huge population, until recently only a tiny proportion of that population was educated enough to have any involvement in the biotechnology industry.

An important initiative of the Indian government is caste reservations; affirmative action to integrate scheduled castes into society. Although it has not yet succeeded in eliminating caste barriers, it has the potential to increase the number of educated and middle class Indians, thereby increasing the available workforce. One of the most frequent claims made by promoters of Indian biotechnology is the size of India's "intelligent human resource pool." [23] However, without improving the efficacy of its affirmative action programs in education, there will not be enough educated personnel to meet the goal of "creating one million jobs by 2010." [24] Education of the lower castes and classes is far below the national average; "at most 6 per cent of the Untouchables have obtained non-traditional, though not usually middle-class occupations." [25] Most affirmative action programs and caste reservations apply only to government and civil service jobs, not schools. As Mallick states, "few non-elite Untouchables would have the education to compete for ...jobs." [26] This applies strongly to the biotechnology industry itself, or related professions in administration, finance

and marketing. In order to use the caste reservation system productively to make India's human resource base competitive, a universally available and standardized education system must ensure a population of qualified professionals who are able to fill the positions reserved for the lower castes in the biotechnology industry.

Another important change is the integration into public life, and the scientific and professional advancement of women. Educating women has led to later marriages, smaller families, and more qualified labour in the workforce. [27] The NBDS recognizes the importance of this change, and strategies and programs are being created to bring women into the biotechnology field: "Women scientists will be encouraged to take up careers in biotechnology. Service conditions will be liberalized for women to be able to return to research/academics after maternity breaks." [28] In this move, India could potentially double the labour force available in the biotechnology sector, but societal prejudices must first be removed before women can be considered truly part of the educated and professional class – especially women of low caste.

India's Potential

India has just undergone the largest economic and technological change in its post-colonial history. It succeeded in its own information technology revolution and created a near nationwide IT boom. The government is taking initiatives to combine the already existing IT industry with the emerging biotech industry. [29] The NBDS equates the impending biotechnology revolution to the IT industry: "Biotechnology can deliver the next wave of technological change that can be as radical as and even more pervasive than that brought about

by IT.”[30] The implications for the synthetic biology industry are clear; India has learned, and gained confidence from the IT boom of the 1990s. The IT and software movement not only put infrastructure in place for international corporations, but created “IT parks”[31] and industrial regions which can be adapted to biotechnology and synthetic biology needs. The experience with the IT revolution taught India how to open its economy and to provide well for a potential biotechnology industry. With this past experience and success, the process will be much faster for a synthetic biology industry.[32]

The information technology itself plus easy access to locally made software and computer technology will be a huge asset to a biotechnology and synthetic biology research industry. The various forms of bioengineering enumerated in the NBDS require computer models, advanced software and countless forms of IT in order to be successful. The Indian government hopes to use these local IT initiatives to provide the foundation for its biotechnology industry.[33] However, the government understands that the software and technology required will be significantly different from that which it already produces. Although the basic infrastructure and facilities exist, huge numbers of resources have been placed in an “extensive bioinformatics network” to integrate the emerging biotechnology sector and the existing IT industry.[34]

India has learned from its mistakes in the IT industry as well—particularly those concerning patents, intellectual property protection and open access to facilities. Although India is often criticized by international firms for poor patent and intellectual property protection, India’s “open source movement” is a huge advantage in sharing and developing research in

synthetic biology.[35] Software and tools are in the public domain—in research institutes and universities instead of controlled by corporations and the Indian government, and so the ease of knowledge dissemination increases. The Indian government is working on a patent and intellectual property rights strategy which will be effective, open and affordable to encourage research by international institutions but which will not inhibit the sharing and use of findings.[36]

Previously, the Indian government was accused of regulating research too stringently and damaging scientific advancement by decoupling research and teaching. Research findings were not easily or frequently disseminated to the public.[37] The open source movement and the creation of new combined education and research facilities during the IT boom helped to solve this problem; the positive results will carry over into new biotechnology and synthetic biology research.

A third advantage which was realized during the IT boom was India’s low cost of production and low-cost labour market – although this advantage does not necessarily apply to those employed in the biotechnology industry itself. “Industry observers say India’s vast reservoir of low-cost scientific talent and vibrant pharmaceuticals sector, along with rising research costs in the U.S. and Europe, give it an edge in biotech, the use of biological organisms to make products.”[38] Not only are land, equipment and resources cheaper in India, but scientists and researchers are often willing to work for a fraction of the cost of their Western counterparts.[39] This may be a positive factor for luring business to India, but provides a host of ethical questions about

the equitable treatment of India's scientists.

Ethical Considerations

Francis Fukuyama outlines the unique ethical position of the biotech industry: "Biotechnology presents us with a special moral dilemma, because any reservations we may have about progress need to be tempered with recognition of its undisputed promise."^[40] The promise of biotechnology has already been discussed, as well as its potential to spur further change in Indian society. However, the NBDS does not recognize many of the potential ethical dilemmas that will undoubtedly arise from a national biotechnology project of this magnitude.

India is praised as the world's largest democracy. Although it is still considered a developing, and in certain instances, a third world country, its open economy and functioning infrastructure make it accessible to research opportunities and foreign business. The bulk of India's population, however, may not benefit at all from the country's dive into the biotechnology industry. There are humanitarian and cultural consequences to this program which must be considered.

The NBDS claims that in biotechnology research "both 'public good' and 'for profit' research should be... mutually reinforcing."^[41]

But will this "public good" research be accessible to India's population? Scholars and analysts are afraid that this will be a step backwards for India and not the golden opportunity for development that the Government claims. Vandana Shiva explains the common results of rapid and ground-breaking development in underdeveloped nations:

The experience of all industrial revolutions illustrates how poverty and underdevelopment are created as an integral part of the whole process of contemporary growth and development, in which gains accrue to one section of the society or nation and the costs, economic or ecological, are borne by the rest.^[42]

Elements of this disproportionate development are clearly visible in India's National Biotechnology Development Strategy and will only increase once the strategy is implemented. In a nation where much of the population is without access to water or electricity, the government plans to provide constant power to biotech parks, and make it easier for these industries, and their employees, to receive and access resources which are unattainable for most of India's population.^[43] Individual states are taking similar initiatives. In Haryana, for example, "the state is endeavouring to provide continuous and uninterrupted power supply for biotech industry to exempt them from scheduled power cuts."^[44] This is a case of "economically inappropriate science... a mismatch between the needs of society and the requirements of a technological system."^[45]

Although the biotechnology revolution will bring jobs to India, and these will be comparatively well-paying jobs, they will be primarily available to those who already have a high standard of living. Liberalization of the economy has allowed for some movement among social classes, but most families remain in similar socioeconomic conditions from generation to generation.^[46] It is unlikely that impoverished families will have access to these new jobs, as they lack

both the education and the social clout to apply successfully.

While the implementation of biotechnology facilities produces ethical concerns, the outcome of this research is just as contentious. Advocates of synthetic biology see it as a cheap and efficient way to address India's problems, such as fuel, food and medicine.[47] But the process will be slow, and synthetic biology is still in its infancy. Humanitarian problems in India are far too urgent to rely on advances in synthetic biology and biotechnology to solve them. Even if new sciences and technologies are used to ease the "developing world's major problems, such as sanitation, food security and poverty,"[48] who will be able to afford the products and techniques that are produced by synthetic biology and biotechnological research? Bailey states that synthetic biology is "a recipe for eliminating genetic inequalities,"[49] but India's inequalities are not genetic, they are social, economic, caste-based and familial. Medical technologies such as stem-cell research are costly and do not even begin to address the most basic health problems faced by most of India's population: malaria, HIV/AIDS, and tuberculosis.[50] The results and products of the biotechnology revolution will not be available to India's poor.

These new medical technologies require intensive longitudinal clinical trials. India is already recognized as a "global clinical trial hub,"[51] and the government intends to increase the number of clinical trials based in India, and start outsourcing trials to international corporations.[52] As previously stated, India's lower castes and classes are largely un- or under-educated. There is a fear among ethicists that India's "poor may be asked to offer themselves as guinea pigs" for clinical

trials.[53] This fear is highlighted by the NBDS. The majority of the ethics strategies listed in the clinical trials section concern patents and intellectual property requirements; there is very little mentioned about participant safety.[54]

A fourth concern is an ethical dilemma that may not be realized by many advocates of Indian biotechnological advancement: Westernization of the Indian education system. The government intends to design a national task force to "formulate model undergraduate and postgraduate curricula in Life Sciences keeping in view future needs." The new curricula will "address the underlying need for multidisciplinary and inter-disciplinary learning and the appropriate stage for biotechnology training." [55] These reforms are summarized by Parmar as an attempt to standardize "curricula for biotechnology and life sciences programmes aligning it to Western standards." [56] There are ethical questions raised by these educational standards, however. As developed as India becomes, one must keep in mind that it is not a Western nation and the beliefs, cultural paradigms, and economic necessities of India should not be measured in Western terms.

Westernization, modernization and industrialization are almost always part of development plans for developing nations, and knowledge is almost always based around a Western paradigm. Although an Indian biotechnology industry can hardly be called an indigenous knowledge system, it still exists in a culturally subjective worldview. Third world institutions and research facilities are rarely able to exist in a culturally appropriate manner, or are logistically prevented from achieving internationally recognized research. Most educational and lab supplies are

imported from the developed world, and Western countries retain the advantage of the best labs, universities and research facilities. Students and researchers in the non-Western world “can hardly do top-level research without migrating, at least temporarily,” to the West.”[57] Although it is becoming more and more self-sufficient in scientific development, India still relies on foreign universities to educate its top scientists, ultimately inculcating a Western style of education, and a Western worldview in its scientific community.

Finally, environmental impacts must be considered. The NBDS mentions the assets of India’s biodiversity early in the report: “India is ... a mega biodiversity country and biotechnology offers opportunities to convert our biological resources into economic wealth and employment opportunities.”[58] The government, however, must once again be wary of disadvantaging India’s poor and indigenous populations: “modernization based on resource-hungry processes materially impoverishes communities which use those resources for survival, either directly, or through their ecological function.”[59] As with the benefits of medical research, environmental degradation or modification could further polarize the distribution of wealth, and benefit only a small portion of the population – a portion that is already at the top of the economic hierarchy.

Conclusion

India is preparing to take the next step in its technological boom; it is beginning to organize its education and economic systems for the advancement of biotechnology. It remains to be seen whether or not this program will be successful, and if it will bring the

expected growth of the economy and international recognition of India as a world power. If India wants to gain international recognition as a developed, wealthy, and democratic nation, the ethical breaches in its NBDS must be reconciled or the nation will become increasingly polarized along class lines. In order to preserve the strides made in development through the opening of India’s economy, such as the legal abolition of caste discrimination and increased accessibility of education, India will likely be forced to change its national strategy and divert funds and attention from its biotech program. India’s current infrastructure and social programs cannot support a population of 1.1 billion, and most certainly cannot support a massive biotechnology industry without serious improvements to the provision of basic needs to its citizens.

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