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A study of industrial and environmental pollution effect on life science: Opportunities and challenges

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Abstract
In paper refers to the Modern biotechnology application of biological organisms, systems and processes to the provision of goods and services, has grown from being solely the domain of research scientists in academic laboratories to being an enabling technology capable of being incorporated into many different sectors of an economy. Much of this development has thus far been concentrated in the medical field and involves drug-directed research by pharmaceutical and biotechnology companies. The distinct role of environmental biotechnology in the future is emphasized considering the opportunities to contribute with new solutions and directions in remediation of contaminated environments, minimizing future waste release and creating pollution prevention alternatives. To take advantage of these opportunities, innovative new strategies, which advance the use of molecular biological methods and genetic engineering technology, are examined. These methods would improve the understanding of existing biological processes in order to increase their efficiency, productivity, and flexibility. Examples of the development and implementation of such strategies are included. Also, the contribution of environmental biotechnology to the progress of a more sustainable society is revealed. This paper is intended to give an overview of the opportunities and barriers to the industrial and environmental application of biotechnology in developing countries.

Keywords: Pharmaceutical, biotechnology, environmental, biotechnology

Introductions

The target areas for industrial biotechnologies can be seen as falling into three main categories: industrial supplies (biochemicals, enzymes and reagents for industrial and food processing); environmental (pollution diagnostics, products for pollution prevention and bioremediation); and energy (fuels from renewable resources). Industrial processing refers to chemicals, pulp and paper, textiles and leather, while environmental applications relate mostly to the effects of the metal and mineral industries. In the energy sector, an important area is the replacement of fossil fuels with renewable raw materials

In assessing the potential of industrial and environmental biotechnology in developing countries, some points should be considered. First, even in industrialized countries, the expected economic benefits of this sector of biotechnology are orders of magnitude smaller than those found in pharmaceuticals and agriculture [1-2]. This essentially restricts activity to niche markets and justifying production changes with environmental considerations. Second, the capital outlays required to use bio-based industrial processes are presently higher than those of traditional mechanical or chemical processes. Thus, it can be difficult to justify starting new industries based on biotechnology, which leaves such innovations to existing facilities. This leads to the observation that only intermediate developing countries, those with existing industries and some scientific capacity, can realistically consider applying biotechnology to industrial processes. Other developing countries could still become involved in this sector in a limited fashion, through the use of their biological resources.

From the economic perspective, early studies in industrialized countries indicate that replacing existing chemical-based production methods can lower operating and energy costs [3]. This report also found a consistent reduction in hazardous waste products. Thus, the industrial application of biotechnology, if managed properly, could have a net positive effect in developing countries. The qualifier “net” is an important one in this context. Some potential negative effects arise from the Schumpterian concept of innovation, which recognizes that a new innovation can render its predecessor obsolete while creating new opportunities. The potential negative consequences of obsolescence, such as worker displacement, dependence on new materials and changes in process management, should be considered to avoid running the risk of raising expectations too high, as has been the case with agricultural biotechnology.

The incorporation of biotechnology into industrial settings in intermediate developing countries also faces financial barriers. Largely, this comes down to not having enough money for capital equipment upgrades. Since bank financing is not an option in many developing countries (with banks demanding collateral of equal value to the loan), private investment, either domestic or foreign, must be considered. Here there are several constraints including domestic institutional gaps, such as lacking private venture capital companies or underdeveloped stock markets to liquidate investments. There is also missing public capital investment resulting from economic stagnation and falling commodity prices [4].

On the positive side, it may be less expensive to overhaul an obsolete factory in an intermediate developing country than to do the same in an industrialized one. Thus international investors or companies may be more willing to consider bio-based process for their industrial partners in developing countries. Another advantage is that many industrial technologies are scale-neutral so that even small businesses can take advantage of them. Interestingly, the special challenges in obtaining international financing of industrial biotechnology in developing countries may be smaller in some respects than for health or agricultural biotechnology. This derives mainly from the consideration of mining, pulp and paper, textiles and chemical manufacturing as traditional investment targets since investors can calculate net present value and other accounting necessities based on known valuations and experience.

Biotechnology is versatile and has been assessed a key area which has greatly impacted various technologies based on the application of biological processes in manufacturing, agriculture, food processing, medicine, environmental protection, resource conservation as shown in Fig. 1.

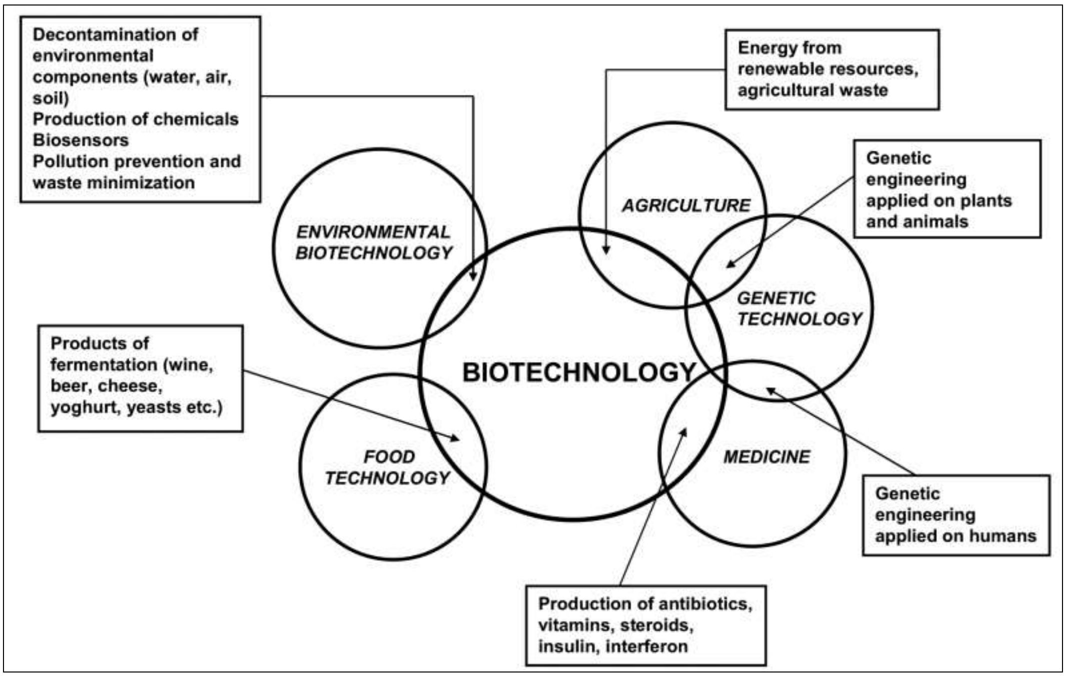

Fig 1: Application of biotechnology in anthropogenic activities

This new wave of technological changes has determined dramatic improvements in various sectors (production of drugs, vitamins, steroids, interferon, products of fermentation used as food or drink, energy from renewable resources and waste, as well as genetic engineering applied on plants, animals, humans) since it can provide entirely novel opportunities for sustainable production of existing and new products and services [5-7]. In addition, environmental concerns help drive the use of biotechnology not only for pollution control (decontamination of water, air, soil), but prevent pollution and minimize waste in the first place, as well as for environmentally friendly production of chemicals, biomonitoring.

Role of biotechnology in development and sustainability

The responsible use of biotechnology to get economic, social and environmental benefits is inherently attractive and determines a spectacular evolution of research from traditional fermentation technologies (cheese, bread, beer making, animal and plant breeding), to modern techniques (gene technology, recombinant DNA technologies, biochemistry, immunology, molecular and cellular biology) to provide efficient synthesis of low toxicity products, renewable bioenergy and yielding new methods for environmental monitoring. The start of the 21st century has found biotechnology emerging as a key enabling technology for sustainable environmental protection and stewardship [8-9].

The requirement for alternative chemicals, feedstocks for fuels, and a variety of commercial products has grown dramatically in the early years of the 21st Century, driven by the high price of petroleum, policies to promote alternatives and reduce dependence on foreign oil, and increasing efforts to reduce net emissions of carbon dioxide and other greenhouse gases. The social, environmental and economic benefits of environmental biotechnology go hand-in-hand to contribute to the development of a more sustainable society, a principle which was promoted in the Brundtland Report in 1987, in Agenda 21 of the Earth Summit in Rio de Janeiro in 1992, the Report of the World

Summit on Sustainable Development held in Johannesburg in 2002 and which has been widely accepted in the environmental policies.

Environmental biotechnology - Issues and implications

As a recognition of the strategic value of biotechnology, integrated plans are formulating and implementing in many countries for using biotechnology for industrial regeneration, job creation and social progress. With the implementation of legislation for environmental protection in a number of countries together with setting of standards for industry and enforcements of compliance, environmental biotechnology gained in importance and broadness in the 1980s.

Environmental biotechnology is concerned with the application of biotechnology as an emerging technology in the context of environmental protection, since rapid industrialization, urbanization and other developments have resulted in a threatened clean environment and depleted natural resources. It is not a new area of interest, because some of the issues of concern are familiar examples of "old" technologies, such as: composting, wastewater treatment etc. In its early stage, environmental biotechnology has evolved from chemical engineering, but later, other disciplines (biochemistry, environmental engineering, environmental microbiology, molecular biology, ecology) also contribute to environmental biotechnology development [10].

The development of multiple human activities (in industry, transport, agriculture, domestic space), the increase in the standard of living and higher consumer demand have amplified pollution of air, water, soil, the use of disposable goods or non-biodegradable materials, and the lack of proper facilities for waste as shown in Fig. 2.

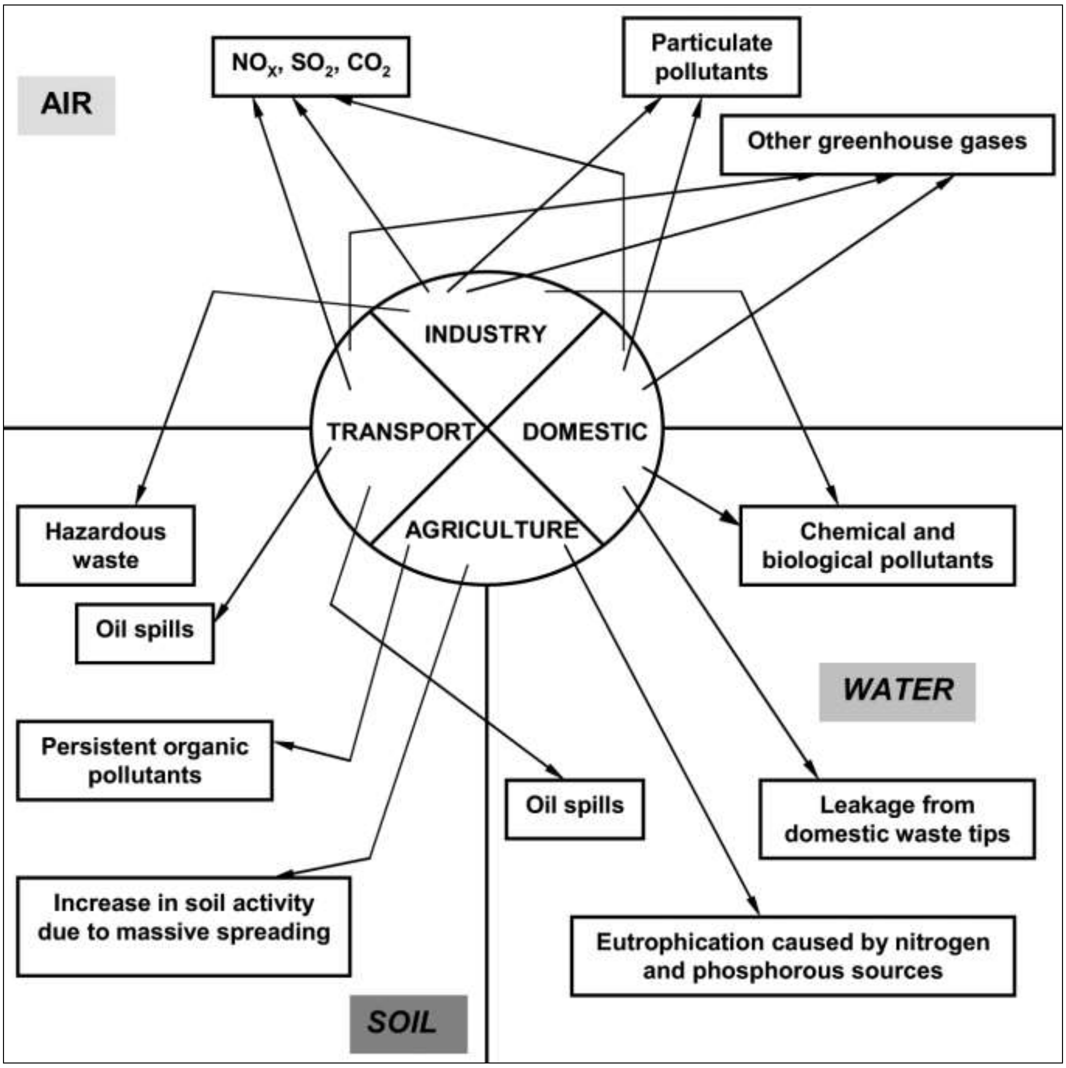

Fig 2: The spider of environmental pollution due to anthropogenic activities.

Studies and researches demonstrated that some of these pollutants can be readily degraded or removed thanks to biotechnological solutions, which involve the action of microbes, plants, animals under certain conditions that envisage abiotic and biotic factors, leading to non-aggressive products through compounds mineralization, transformation or immobilization as shown in Fig. 3.

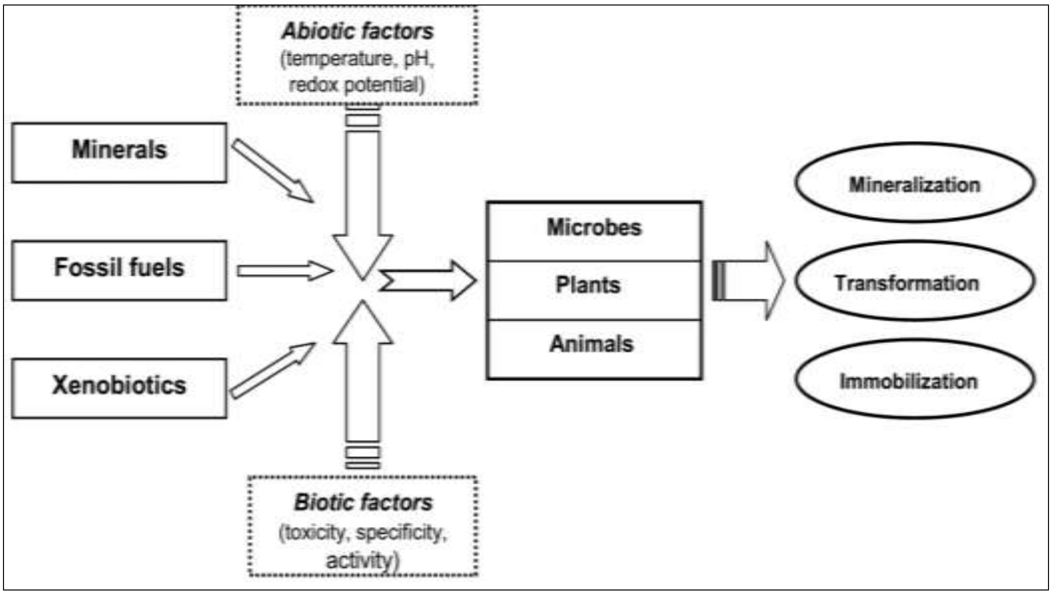

Fig 3: Sources of environmental pollutants and factors

Environmental biotechnology in pollution detection and monitoring

Environmental monitoring deals with the assessment of environmental quality, essentially by measuring a set of selected parameters on a regular basis. In general, two methods – physicochemical and biological – are available for measuring and quantifying the extent of pollution. In the past decades environmental monitoring programmes concentrated on the measurement of physical and chemical variables, while biological variables were occasionally incorporated. Physicochemical methods involve the use of analytical equipment, having as limitations their cost (because of the complexity of the samples and the expertise of the operators needed to conduct the analysis) and the lack of hazard and toxicological information.

Environmental monitoring is of great importance for its protection. The harmful effect of toxic chemicals on natural ecosystems has led to an increasing demand for early-warning systems to detect those toxicants at very low concentrations levels [11]. Typically contaminant monitoring involves the regular and frequent measurement of various chemicals in water, soil, sediment and air over a fixed time period, e.g., a year. Integration of environmental biotechnology with information technology has revolutioned the capacity to monitor and control processes at molecular levels.

Conclusion

In the near future, industrial and environmental biotechnology will likely only benefit those intermediate developing countries that have already established some industrial enterprises, for example in leather or metal production, and have at least a rudimentary set of environmental regulations. Reasons for this include the reality that it is generally easier to modify existing industries than to create new ones and that even minimal pollution control measures can be used to convince industrialists to take advantage of external assistance, either national or foreign, to adopt bio-based cleaner production process.

Since environmental biotechnology proved to have a large potential to contribute to the prevention, detection and remediation of environmental pollution and degradation, it is a sustainable way to develop clean processes and products, less harmful, with reduced environmental impact than their forerunners, and this role is illustrated with reference to clean technology options in the industrial, agro forestry, food, raw materials, and minerals sectors. Since some new techniques make use of genetically modified organisms, regulation to guarantee safe application of new or modified organisms in the environment is important.

An evaluation of the consequences, opportunities and challenges of modern biotechnology is important both for policy makers and the industry.

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