Jordan: Status and Future Prospects of Biotechnology

Moh'd M. Ajlouni and H. Malkawi

Biotechnology is considered to be a frontier area offering a new technological base for the provision of solutions to some of mankind's problems. This technological base involves interactions amongst people, microorganisms, biomass, and industry, underscoring the utilization of renewable resources with a low environmental impact and high regenerative capacity.

Biotechnology has produced new products and processes in a number of economic sectors including agriculture, food processing, chemical and pharmaceutical industries, pesticides, detergents, feed stocks, recycling, and waste treatment.

Biotechnology has advanced rapidly in industrial countries. Jordan still lags behind because of the lack of:

- Major funding to establish laboratories and to have the needed infrastructure and facilities
- A national strategy for biotechnology and its applications
- Know-how at the technical level
- Experienced scientists, many of whom go to the industrial countries
- Insufficient collaboration with international institutions and agencies that are involved in biotechnology development.

Despite these major shortcomings, Jordan has made some progress in biotechnology projects for research and development. Projects have been undertaken by university laboratories, research institutions, and private companies in the following fields: plant tissue culture and basic biotechnology research (in medicine, biological nitrogen fixation (BNF), and in vitro selection for salt tolerance.

Current Status

Jordanian universities have covered research and development (R&D) fields in biotechnology, in the following activities:

- Embryo transfer in animals
- Early diagnosis using monoclonal antibodies
- Applied microbiology
- Biogas
- Single cell protein
- Enzymes and antibiotics
- Plant growth inhibitors
- Natural products
- Cloning
- Protein solvent concentration
- Bioreaction
- Gene isolation
- Biological nitrogen fixation.

Most of the activities are in the field of natural products, early diagnosis using monoclonal antibodies, applied microbiology in food, and biogas production. Antibiotics, growth regulators, embryo transfer in animals, bioreaction, and biological nitrogen fixation are all considered important.

In one of the surveys conducted among the researchers working in biotechnology, the respondents identified areas of importance for Jordan (Table 1). The absence of some fields such as insulin and interferon production, separation technology, process development, developing equipment and biosensors, which are all consid-

Table 1 Research areas specified by biotechnology researchers working in Jordanian universities

Field	*No. of researchers*
Amino acid sequence determination	2
Applied microbiology	8
Biochemical engineering	4
Biological response modifiers	1
Bioreactor modeling	2
Environmental engineering	3
Eukaryotic molecular genetics	1
Gene mapping , transfer, and synthesis	3
Hormone synthesis	2
Hybridoma technology	4
Molecular genetics	4
Molecular immunology	4
Molecular modeling	1
Monoclonal antibodies	8
Plasmid vector fusion	3
Process engineering	1
Protein engineering	4
Recombinant DNA technology	4
Single cell protein	6
Enzymes	6
Tissue culture	14
Vaccine production	10
Viral molecular genetics	1

ered to be important, clearly reflects the absence of scientific specialization and implies shortages in these fields. Researchers have also shown a willingness to work as a group with common concerns to develop their research programs.

Private industry is pursuing R&D in the following areas: tissue culture, biofertilizers, monoclonal antibodies, production of pesticides, developing some equipment used in biotechnology, and yeast production. Future projects planned include enzyme production, veterinary drugs, and laboratory equipment.

Current and future areas, in addition to those considered of a great interest to researchers and technologists in the industrial sector, are given in Table 2.

There are many common interests between the industrial sector and Jordanian universities in important activities such as tissue culture, vaccine production, monoclonal antibodies and applied microbiology, single cell protein, and enzyme production.

The industrial sector, however, highlights its interest in environmental engineering, process engineering in industries and its improvements, and other areas. This results from their sense of the importance of industrial production over the academic research which may not result in any direct products or goods.

Constraints

A recent survey on constraints to the applications of biotechnology in Jordan identified the following issues:

- Lack of financing is the most important restriction in universities and institutions in the pri-

Table 2 Current, future, and essential biotechnology research in the industrial private sector

Current activities	*Future activities*	*Essential activities*
Tissue culture	Enzyme production	Amino acid sequence determination
Natural fertilizer	Veterinary drugs	Applied microbiology
Monoclonal antibodies	Scientific laboratory equipment	Biochemical engineering
Pesticides		Bioreactor modeling
Scientific equipment evolution		Environmental engineering
Yeast production		Gene mapping, transfer, and synthesis
		Hormone synthesis
		Molecular genetics
		Molecular immunology
		Monoclonal antibodies
		Process engineering
		Protein engineering
		Single cell protein
		Enzymes
		Tissue culture
		Vaccine production

vate sector (over 40 percent in the survey).

- Although financial support is a serious problem, researchers (15 percent) cited other problems such as the shortage of professional technicians trained on advanced and specialized scientific equipment. Also of concern is the approvals procedures for biotechnological research, especially the long time between presenting the proposal and its implementation. The result is decreased interest of the researcher, who will often pursue other areas of research.
- Another problem facing researchers in this area is the lack of consumable materials and routine ordering procedures.
- It is important to mention that the right scientific atmosphere is often absent for this type of research activity; the importance of this type of research is not made clear; it is expensive; it does not directly produce goods for people; and there is a lack of scientific literature and other materials. This lack of public awareness of the importance of biotechnology research and the absence of scientific groups who will provide the necessary cooperation and technical assistance to the researcher were cited by 30 percent in the survey.
- University professors claim they do not have enough time to do their research, and the system itself does not allow the appointment of research staff. Professors in the universities should teach and do research at the same time, but because of the heavy teaching load, they cannot find enough time for research. The research would be of an academic nature and not applied research.
- The industrial sector in this field is unable to compete with other international brand products, especially at the beginning of the production and development processes. This results in reduced financial support. As a result, the industry prefers not to be involved in this activity, which requires that most of the products be manufactured locally. The private sector, therefore, concentrates on accumulating imported products and promoting them locally, or dealing in international products only.
- There is an additional problem regarding lack of cooperation among institutions in the same field to reach common objectives and solve problems. There are many drug companies, for example, but there is no common interest in biotechnological R&D.
- There is a prevalent lack of knowledge in both private and governmental sectors about the importance of biotechnology adoption, and what is necessary to facilitate and expedite work in this field.

Conclusions

- Most biotechnology research activities are restricted to universities, with a limited activity adopted by the private sector, which is represented by some industrial institutions.
- Universities pursue basic rather than applied science.
- The role of the private sector is limited in biotechnology R&D, mostly concentrating on improving and promoting current products or producing new ones.
- There is some fragmented biotechnology research in Jordan, mainly of conventional biotechnology.
- There is limited cooperation between Jordan's universities and the private sector.

Constraints and problems encountered by biotechnology researchers at universities and in the private sector include:

Universities: Technical and financial problems; lack of time for research by teaching professors; environment not conducive for research and innovations; lack of public support for research; lack of specialized equipment and information; shortage of laboratory materials and spare parts, and maintenance of scientific equipment.

Private Sector: Marketing problems; technical production and its improvement, which limits the concentration on R&D as a necessity for economic growth in these institutions; lack of appreciation by decisionmakers and the private companies on the role of biotechnology.

The following suggestions may help solve some of the problems and obstacles, and improve and develop biotechnology activities in Jordan in universities, the private sector, and the public sector.

1. Establish a biotechnology center to:
   - Encourage biotechnology research activities and development

- Create a suitable environment for researchers
- Establish specialized and well equipped laboratories
- Direct research into fields of interest in Jordan, which could be applied in industrial institutions
- Encourage private sector research where possible.

2. Supervise and link the various institutions doing biotechnology research by:
   - Providing the requested technical support and finance for the researchers in universities and the private sector
   - Creating a connecting link among different sectors to integrate information and research between the private sector and universities.