

# **A Survey of Biotechnology Education in Schools of Iran**

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## ***Introduction***

Nowadays, biotechnology techniques with their dramatic effects and high benefits for human health, protection of the environment and decreasing pollution, for preparing food, new products and opening up new ways of doing scientific research, have stirred the interest of groups of people such as researchers, producers and consumers, economists, politicians, and legislators. Investment, marketing and research, becomes more attractive as there is increased possibility of gaining benefits with the continuing rapid growth of biotechnology all over the world.

The advantages of biotechnology have been recognized in advanced countries such as the USA, Japan and some European countries, and in order to make the best use of these advantages, steps have been taken made to improve human resources relating to the biotechnology sectors. This has included biotechnology education for not only public sector workers and academics, but for students of K-12 grades.

Modern biotechnology education in Iran started in 1990 in Master courses in Tarbiet Modares University under the title of Chemical Engineering-Biotechnology and from that time education has spread, but still the sum of educated persons working in related sectors is much lower than the number set within the targets of the 5 Year Plan [1] This national plan as prepared by the Iranian government, is the Third Five-Year Socio-Economic and Cultural Development Plan, and was put in action in 2000. In this paper, the present situation of biotechnology education especially in K-12 grades is surveyed and some guiding points are presented for developing human resources related to biotechnology through education in secondary schools in Iran.

Biotechnology uses living organisms or parts of organisms to produce or modify products, to improve plants or animals, to develop microorganisms for scientific use, to identify targets for small molecule pharmaceutical development and to transfer biological systems into useful processes and products. Biotechnology with its multidisciplinary nature overlaps with other fields such as microbiology, genetics and genetic engineering, biology, biochemistry, chemical engineering, food science and engineering, pharmacology, agriculture, botany, animal husbandry, environmental and energy engineering, and marine science [2].

Biotechnology has applications in medicine for faster and more efficient diagnosis and treatment of diseases such as fibrosis, cancer, sickle cell anemia and diabetes. Recombinant organisms will be used in industry to produce new vaccines, different drugs, solvents and chemicals of all kinds, and furthermore, in the extraction of some minerals.

Biotechnology has applications in both plant and animal breeding. Scientists are developing disease and herbicide resistant crops, disease resistant digest compound that are currently polluting environment [2].

Biotechnology has many more benefits for human society, for other organisms and the environment in general. These advantages have created many opportunities and challenges for investment, research, marketing, and education in biotechnology.

## ***Biotechnology education in Iran***

Although the benefits of biotechnology for society and the necessity of biotechnology education have been recognized in Iran, the rates of educational growth in these sectors and the number of biotechnology centers are still low.

In the survey carried out in 2000 by the commission of biotechnology for the National Council for Scientific Research of the presidential office, a total of 46 institutes and centers (in whole or in part) are recognized as involved in biotechnology activities. Of these, 29 are universities and 17 are non-

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universities. In total, 26 centers have research projects related to biotechnology and 8 universities have regular courses in biotechnology for graduate students. Overall there are 536 people working in these sectors, of which 251 are in universities and 285 people in non-university centers. Furthermore, up to the year 2000, 300 projects related to biotechnology were reported (completed or under operation) [1].

The number of universities in Iran that offer biotechnology as a major or as a component of another degree is increasing. However it is still low compared to advanced countries. The universities which currently offer biotechnology courses are shown in the appendix.

According to the 5-Year development plan, the number of researchers and employees in biotechnology sectors should have reached 10000 by 2002. However the actual number in 2002 was less than 1000, exposing a large discrepancy between the reality and the plan [3]

In the report of the biotechnology commission, only graduate courses and a very limited number of centers were mentioned as biotechnology education centers, and there was no mention of biotechnology education carried out by the Ministry of Education in K-12 grades. Other surveys carried out by the author show that either there is no biotechnology education in the curriculum of secondary school students, or that at the best, such education is exceedingly inadequate.

The Ministry of Education, as the biggest educational organization in Iran where there are around 19 million students, has enormous potential for training semi-skilled human resources (high school leavers) for employment in biotechnology sectors. It is responsible for K-12 programs and also has jurisdiction over some post secondary school programs such as primary and middle teacher training colleges and higher institutes of technical and vocational education.

The K-12 education system in Iran is a coordinated and coherent system and the Ministry of Education determines the curriculum, the educational materials including textbooks and the examinations that are used by schools throughout the country.

The education system in Iran is divided into Pre-primary (1 year), Primary (5 year), Middle (3 year), High school (3 year), Pre-university (1 year) and post secondary educations. High school education offers three branches: Theoretical, Technical-Vocational, and Skill-Knowledge (Kar-Danesh). Each is divided into different fields. The purpose of the technical-vocational education system is providing human resources for industry. Figure 1 shows the structure of the education system in Iran

Some of the reasons that biotechnology education has not been developed in K-12 education system of Iran are as follows:

1. Biotechnology is a relatively young field that is interdisciplinary. As a result, it has often not been clear which department(s) should offer biotechnology topics.
2. Managers, curriculum planners and teachers in related departments are not sufficiently familiar with biotechnology.
3. There is a lack of skilled biotechnology specialists and teachers in K-12 educational system.
4. There is scarcity of appropriate textbooks and other educational materials for biotechnology.
5. Biotechnology education that is available in K-12 has not been continually updated, as would be necessary for a rapidly changing field.
6. The limitations imposed by the boundaries of subject fields mean that textbook publishing in K-12 education system is not interdisciplinary.
7. There are insufficient financial resources for performing biotechnology education projects.
8. There are other limitations caused by the rules and regulations of the administrative bureaucracy.

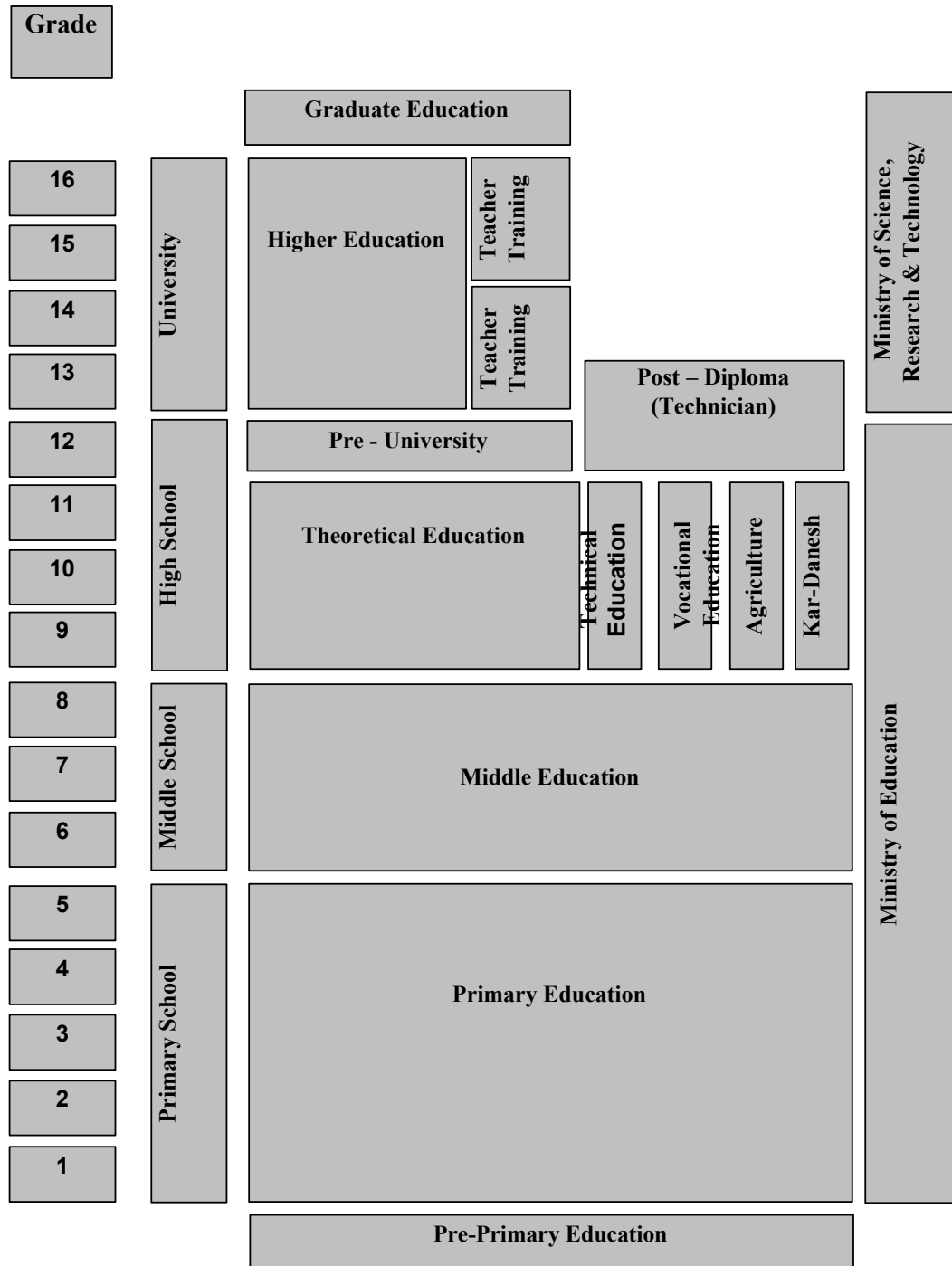
#### ***Improvements of biotechnology education system in Iran***

The Present situation of biotechnology education in Iran involves the education only of groups of people who belong to a certain number of centers with limited capacities and often only at graduate levels. This has resulted in increasing distance between the targets of the 5-Year Plan and the reality of the situation. The education of biotechnology through K-12 can increase the rate of semi-skilled human resources (high school leavers) and as a result decrease this gap and help to reach the national goals of biotechnology in Iran.

Some arguments showing the comparative advantages of the inclusion of biotechnology education in K-12 are as follow:

1. The K-12 biotechnology courses are available to a much greater number of students than university courses.

Figure 1: The structure of education system in Iran



2. The education system of the Ministry of Education is based more on educational learning techniques and as a result the efficiency of the education provided is increased.
3. Biotechnology sectors need workers with a variety of skill levels. In universities education is largely directed towards high level researches. Thus, the training of semi-skilled human resources (high school leavers) in biotechnology is also necessary and can be covered by training courses in K-12 education system.
4. Those beginning study in the biotechnology field at universities will be more successful if they have passed biotechnology courses in secondary school prior to arriving at university.

Thus it seems that compared with the present methods, biotechnology education in secondary schools would result in a more rapid systematic growth of human resources in biotechnology. Important aspects to promote reaching sufficient levels in human resources in biotechnology through K-12 education included the training of curriculum planners and educators and the preparation of theoretical and practical textbooks. Establishing special workshops and courses for these groups and also writing textbooks will be necessary. This can be done with the cooperation of national organizations of biotechnology such as National Biotechnology Committee (NBC), National Council for Scientific Research and The National Research Center of Genetic Engineering & Biotechnology of Iran and the corresponding departments in the Ministry of Education. However, as a prerequisite, meetings with education bureaus and departments and some concordat will be vital to gain political and budget support.

To prepare appropriate programs in K-12 education system it is necessary, not only to develop educational materials, but also to train specialists who are familiar with K-12 education system. Thus, it will be necessary to establish a separate biotechnology committee or department in the Ministry of Education to coordinate with the national organizations and ensure accommodation of the programs. In addition it will be necessary to adapt biotechnology committee programs with successful patterns of biotechnology education in advanced countries such as USA, Japan and some European countries, by making links and cooperating with related organizations and communities. Also, it will be necessary and helpful to seek the technical, financial and advisory assistance of International organizations such as: the United Nations Educational, Scientific and Cultural Organization (UNESCO), World Health Organization (WHO), United Nation Development Program (UNDP), Food and Agriculture Organization of the United Nations (FAO) that have a very broad range of educational materials on different topics of biotechnology for all over the world. Such coordination will aid the success of biotechnology education programs in Iran, and furthermore support harmony within programs of global activity.

Biotechnology education in K-12 education system may be produced in the following ways:

- Establishing a new major with the title of biotechnology.
- Establishing new courses with title of biotechnology in related fields.
- Introduce some chapters in related textbooks with the title of biotechnology.
- Introduce biotechnology simultaneously with other education materials in textbooks.
- Introduce separate boxes on biotechnology in related textbooks.
- Outside class room activities.
- Special short-term workshops and courses.

The biotechnology committee in cooperation with other related departments may choose any of these methods.

In k-12 education system of Iran the following majors and courses are related to biotechnology:

Technical-Vocational education departments:

- Chemical industries education field
- Food industries education field
- Agricultural education department:

Skill-Knowledge (Kar-Danesh) education departments:

- Majors subdivided into chemical industries, drug industries, food industries and agriculture.

Theoretical education departments:

- Biology and chemistry courses in high school

Primary and Middle education departments:

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- Science courses

### **Conclusion**

Biotechnology has many applications in industry, agriculture, medicine, and the protection of the environment and so on. Future projections of biotechnology indicate continuing rapid growth all over the world. To provide human resources working in related sectors in advanced countries, biotechnology education is conceived of at different levels. In Iran, biotechnology education is carried out only at graduate levels and in other limited centers. This makes it difficult to achieve the targets in biotechnology human resources of the national 5-Year Plan. The main reasons for under-developed biotechnology education in K-12 education system of Iran include a lack of skilled specialists and teachers in K-12 education systems, lack of educational materials and prohibitive rules.

The greater number of students in high schools, higher efficiency in education through the Ministry of Education system and the need to create persons of different skills levels in biotechnology make it necessary to include biotechnology education in K-12 grades, to reach the human resource goals of the 5-Year national development plan. To this end it is necessary to establish a committee to coordinate the Ministry of Education and national biotechnology organizations, and to cooperate with advanced countries and international organizations. The creation of new majors, new courses, new chapters or new parts in textbooks, are methods for the inclusion of biotechnology topics in K-12 education levels. These materials may service chemical and food industries education, and agriculture in Technical-Vocational and Skill-Knowledge (Kar-Danesh) education, and also biology and chemistry courses in the theoretical fields and science courses of primary and middle education. The aim of such programs in the educational system in Iran would be, ultimately, to make the benefits of biotechnology available to all of society.

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4. Lawrence Livermore National Laboratory Education Program web page.

### **Appendix:** The list of universities in Iran offering Biotechnology courses

PhD programs in biotechnology, University of Tehran  
 PhD programs in biotechnological products, Pasteur Institute of Iran  
 PhD programs in Chemical engineering-biotechnology, Tarbiat Modares University  
 PhD programs in Chemical engineering-biotechnology, Sharif University of Technology  
 PhD programs in Molecular genetic, Tarbiat Modares University and NRCGEB  
 PhD programs in Cellular and molecular biology, Kermanshah University and NRCGEB  
 PhD programs in Plant modification- Genetic Engineering, University of Tehran  
 MS programs in Agricultural biotechnology, University of Tehran  
 MS programs in Medical Biotechnology, Tarbiat Modares University  
 MS programs in Chemical engineering-biotechnology, Tarbiat Modares University  
 MS programs in Chemical engineering-biotechnology, Sharif University of Technology  
 MS programs in Chemical engineering-biotechnology, Azad University  
 MS programs in Chemical engineering-biotechnology, Science and Industry University  
 MS programs in Chemical engineering-biotechnology, Amir Kabir University

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Teaching (1985~1987), B.Sc. in Education of Chemistry (1988~1992), M.Sc. in Chemical Engineering-Biotechnology (1992~1996), PhD course in Biofunctional Engineering(2001 ~2005), Several short in service courses in education and science(1993~2000), Teacher in 5 primary grades, 3 grades of middle, 4 grades in high school and 4 grades in University (1986~2001), Part time expert in theoretical chemistry department of Research and Curriculum Organization (1993~1996), Responsible for Chemical Industries Education in Technical & Vocational Education Bureau (1996~2001), Coordinator of preparing curriculum of Drug Industry Education in Skill-Knowledge Bureau (1997~1998).