

Scientific research and training in biotechnology in Latin America and the Caribbean: the UNU/BIOLAC experience

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It is well known that the number of researchers in Biotechnology in Latin America and the Caribbean is too small to cope with the needs of research and to successfully confront the number of short and long-term problems.

The United Nations University created its Biotechnology Program for Latin America and the Caribbean, UNU/BIOLAC, and the results of the efforts aiming to the promotion of a shared sense of direction within the region's scientific community are presented and discussed herein.

The United Nations University and its Biotechnology Program

Aiming towards the promotion of international understanding, the United Nations sponsored the creation of an academic institution that would help developing countries in their struggle for a better and more peaceful life.

Under the initiative of the Secretary General at that time, Mr. U. Thant, The United Nations University, UNU, was created in 1973, beginning its activities in 1975. In 1988, under the Rectorship of Prof. Heitor Gurgulino de Souza, with the income of two out of the seven million dollars paid from the ten million dollars pledged by the Venezuelan Government to the Universities Endowment Fund, the UNU created the Biotechnology Program for Latin America and the Caribbean, UNU/BIOLAC. Since then, it has received additional contributions from the Governments of Canada and Peru. With those limited resources, basically the income of the two million dollars pledged by the Venezuelan Government the

UNU/BIOLAC Program has been concentrating on three areas recommended by its Scientific Advisory Committee. These are Diagnostics and Vaccines for Human and Animal Disease, Plant Genetics Engineering, and Microorganisms of Industrial Interest.

The goal of the UNU/BIOLAC Program is essentially to promote through its actions, a shared sense of direction that might have an impact on intellectual development in the region, specifically in Biotechnology. The Program's strategy is to develop human resources in the scientific community with the collaboration of well known scientists and institutes already established in the region and enlarge the capacity of scientific research in the region by integrating those human resources in research networks.

The Program has a General Coordinator located in Caracas, Venezuela, who is assisted by the Scientific Coordinators of the Research Networks, and two Associated Experts. It is important to stress that the overheads expenditure of the Program only reaches 10% of its budget, approximately 57% goes into training and fellowships leaving the rest for the research activities of the Networks.

Development of human resources

The UNU/BIOLAC Program began its activities in 1989, developing human resources in the region by granting short term fellowships, supporting high level academic courses with the collaboration of Centers of Excellence in the region, and by establishing research networks, see Table 1.

Table 1. Mechanisms followed by UNU/BIOLAC to fulfill its objectives

Courses
Fellowships
Research Networks

The scheme intends to strengthen the region's academic institutions, and to assist the career development of scholars and scientists, particularly young researchers. It also aims to promote an understanding of complex problems in their global context, the development of analytical skills and the ability to conduct and direct research.

The results presented here are those found in the Program's data bank and covers the eight year period since the Program was created, including all the participants of the training fellowships and courses sponsored by the Program.

Training courses

The Program uses the human resources already established in the region, to improve the scientific skills of others that

would directly benefit from the Program by taking advantage of the training programs and courses offered.

To run the highly specialized courses, many institutions were visited in order to identify qualified academic institutions that were willing to serve as centers for the Program in order to fulfil its task in the region.

The Program annually offers an average of five international two-week training courses. The support given to each course includes the support of international participants, covering 75% of the register.

During a seven-year period, forty courses were held in the region sponsored by UNU/BIOLAC. Table 2 shows the countries that hosted those 40 courses.

Table 3 shows the list of all the courses lectured over the seven-year period.

Table 2. Courses per country

Argentina	5
Brazil	2
Cuba	2
Chile	1
Guatemala	5
Mexico	12
Venezuela	13
Total	40

Fellowships

In order to accomplish its goals, the Program uses the same methods as other international academic institutions that grant fellowships. The candidates for a short-term training fellowship have to submit a form stating their scientific background including research experience and their areas of interest, giving reasons why they are interested in the Program. In addition, the applicant has to submit a supporting letter from the institution where he or she is currently working. This is to guarantee that the institution is interested in training the candidate and to insure that he or she is an active employed scientist. Finally, the candidate has

to be accepted by the laboratory where the training will take place. This avoids the possibility of converting the Program into a placement office. Scientists have discovered that there are many possibilities for collaborative projects that can be developed within Latin America and the Caribbean.

Whenever possible, we interview the candidates at their working place in order to have a closer look at their capacity and interest. In most cases we complete the data with what we call a "Site Visit Report", which allows us to focus our attention in the institution where the candidate is actually working. By doing so, we have a better knowledge of the institutional capacities in the region.

Table 3. Courses lectured between 1990 and 1997

Name of the Course	Date	Organizer
"Diagnostic Methods of Human Disease"	11-23 Nov. 1990 I.V.I.C.-Venezuela	Dr. Manuel Rieber
"Scaling up of Biotechnological Processes"	12-30 Nov. 1990 CEINGEBI-UNAM Mexico	Dr. Rodolfo Quintero
"Engineering of Biological Reactions and Processes"	13-24 May 1991 ICAITI - Guatemala	Dr. Carlos Rolz
"New Production Technologies and Control of Pertussis Vaccine"	11-29 Nov. 1991 CINDEFI - Argentina	Dr. Osvaldo Yantorno
"Genetic Manipulation of Plants: Transfer and Expression of Foreign Genes"	04-16 Nov. 1991 CEFOTI-Argentina	Dr. Rubén Vallejos
"Recombinant DNA Techniques"	11-27 Sept. 1991 U.C.V - Venezuela	Dr. Juan Carlos Mendible
"Second Advanced Course on Biotechnological Processes"	07-25 October 1991 CEINGEBI-UNAM México	Dr. Rodolfo Quintero
"Food Biotechnology"	17-28 February 1992 ICAITI - Guatemala	Dr. Francisco Calzada
"Molecular Basis of Diagnosis"	02-14 February 1992 I.V.I.C. - Venezuela	Dr. Manuel Rieber
"Third Advanced Training Course on Industrial Scaling of Biotechnological Processes"	12-23 October 1992 CEINGEBI - UNAM México	Dr. Rodolfo Quintero
"Plant Transformation of the Plant Genetic Engineering"	03-05 October 1992 IPN - Irapuato, México	Dr. Luis Herrera E.
First Workshop of the Diagnostics and Vaccines Research Network	15-17 June 1992 U.C.V - Venezuela	Dr. Juan Carlos Mendible
"2nd Advanced course on Recombinant DNA Techniques"	14 Sep - 3 Oct. 1992 U.C.V. - Venezuela	Dr. Juan Carlos Mendible
"Analysis and Manipulation of the Plant Genome"	13-27 March 1993 IPN - Irapuato, México	Dr. Luis Herrera E.
"Immunology and Molecular Genetics of Human and Animal Retroviruses"	03-14 May 1993 I.V.I.C. - Venezuela	Dr. Raúl Walder
"Biotechnology of Anaerobic Treatment of Refuse"	16-24 August 1993 ICAITI - Guatemala	Dr. Francisco Calzada
"Fourth Advanced Training Course on Biotechnological Processes"	11-22 October 1993 CEINGEBI - UNAM México	Dr. Rodolfo Quintero

"Basic Recombinant DNA Techniques and RFLP Course"	07-24 September 1993 U.C.V. - Venezuela	Dr. Juan Carlos Mendible
"Identification, Mapping, Expression and Regulation of Plant Genes"	24-26 Nov. 1993 Guarujá, São Paulo Brazil	Dr. Ruben Vallejos
"Aplicaciones de la Biotecnologías Modernas en la Agricultura"	01-21 Nov. 1993 INGEPI - CONICET Buenos Aires - Argentina	Dr. Alejandro Mentaberry
"Molecular Basis of Tumor Growth Control, Differentiation and Cell Cycle"	24 Jan.- 6 Feb. 1994 I.V.I.C - Caracas Venezuela	Dr. Manuel Rieber
"Application of Biotechnology for Protection of Crops Against Diseases and Pests"	03-14 October 1994 UNAM - México	Dr. Rodolfo Quintero
"Basic Procedures for Antigen Purification and Characterization from Pathogenes: Mycobacterium Tuberculosis y Leishmania sp."	09-21 January 1995 U.C.V. - Venezuela	Dra. Fracehuli Dagger
"Molecular Growth of Tumor Growth Control, Differentiation and the Cell Cycle"	22 Jan.-3 Feb. 1995 I.V.I.C. - Venezuela	Dr. Manuel Rieber
"Analysis and Manipulation of the Plant Genome"	12 - 25 March 1995 IPN - Irapuato -México	Dr. Luis Herrera E.
"Applications of New Biotechnology's to Agriculture"	15 May 3 June 1995 INTA - Moron - Argentina	Dr. Alejandro Escandón
"Applications of Biotechnology to Tuberculosis Research"	12-15 June 1995 I.V.I.C. -Venezuela	Dr. Howard Takiff
"Application of Biotechnological Processes"	09-20 October 1995 UNAM - México	Dr. Rodolfo Quintero
"Biochemical Engineering Applications in Environmental Biotechnology and Cleaner Production"	18-29 September 1995 ICATTI - Guatemala	Dr. Francisco Calzada
"Polymerize Chain Reaction (PCR), Differential Gene Expression and DNA pplication in Diagnosis"	21 Jan.- 01 Feb. 1996 I.V.I.C. - Venezuela	Dr. Manuel Rieber
"Immunology and Molecular Genetics of Human and Animal Retroviruses: Aspects of Viral Diversity and Immunopathology"	08-19 July 1996 IVIC - Caracas	Dr. Raúl Walder
"Food and Environmental Biotechnology"	07-18 October 1996	Dr. Rodolfo Quintero UNAM - México
"Molecular Biology of Tuberculosis"	16-31 October 1996 INTA - Moron, Argentina	Dr. Angel Cataldi
"Theoretical Practical aspects on Epidemiology Diagnosis and Vaccination on Brucellosis"	06-20 January 1997 Universidad Austral de Chile	Dra. Ximena Rojas
"Polymerize Chain Reaction (PCR), Differential Gene Expression DNA Application in Diagnosis"	19-31 January 1997 I.V.I.C - Venezuela	Dr. Manuel Rieber
"Analysis Manipulation of the Plant Genome"	10-21 March 1997 CINVESTAV - Mexico	Dr. Luis Herrera E.
"Environmental Biotechnology"	30June-11 July 1997 UNAM - México	Dr. Rodolfo Quintero
"Developments in Agro Biotechnology"	02-21 November 1997 INGEPI - Buenos Aires Argentina	Dr. Alejandro Mentaberry
"Expression of Antibody Fragments in Bacteria as Fusion Proteins in Bacteriophage: A Theoretical-Practical Course"	18-29 November 1997 CGEB - Cuba	Dr. Jorge Gavilondo
"II International course on Diagnosis of Tuberculosis"	25 Nov. 5 Dec. 1997 IPK - La Habana - Cuba	Dr. José Valdivia

UNU/BIOLAC tries to select individuals particularly from key institutions in order to strengthen their capacities in the Program's priority areas. The fellowships are intended for individuals who already have a strong background in basic biological sciences, and have an advanced university degree,

but who lack specific practical experience in biotechnological techniques.

The fellowships last for a minimum of three and a maximum of twelve months. UNU/BIOLAC provides a monthly

stipend for the fellow, the round trip air ticket, travel accident and sickness insurance, and the eventual bench fees for the training institution.

Table 4 shows the total number of fellows benefited from UNU/BIOLAC. A striking feature is that 62% of them are

women. This suggests that, as opposed to long term academic fellowships, short-term training periods are considered by women as a positive step towards advancement

Table 4. Total number fellowships granted by UNU/BIOLAC period 1990-97

Women	79
Men	48
Total	127

The participation of women not only corresponds to the use of short-term training fellowships, they are also a very active and important part of the Networks. We are proud to say that the participation of women in the UNU/BIOLAC Program activities is as important as that of men.

Politics are not involved in the process of granting a fellowship. This is clear when we observe that countries with different political environments, such as Cuba and Peru with 21 and 24 fellowships respectively, have taken almost as much advantage of offered fellowships as Venezuela the host country, where 30 fellowships have been granted. The number of granted fellowships per country depends solely on the desire of the applicant and the human resource policy of each institute from which the postulants come from.

Only one fellowship has been granted to the English speaking Caribbean, Barbados. This suggests that, together with the possible language barrier, there is an old custom in

the scientific community of those countries to train their scientists within the British Commonwealth, ignoring the possibilities that exists in Spanish speaking regions.

Keeping in mind that UNU/BIOLAC follows the same SOUTH-SOUTH cooperation framework of the University, we can observe in Table 5 that the new trend offered by the Program of training scientists for short periods of time within the region, has been accepted by all countries, developed or underdeveloped.

Table 6 shows the countries where training have taken place. Many of the granted fellowships have been used to learn new research techniques in those institutions where frontier science is made, while others have been employed to carry out collaborative projects in laboratories with which scientific linkages have become a reality. This means that one of the Program's objectives, to strengthen institutional capacities, has been fulfilled.

Table 5. Country of origin of fellows

Argentina	14	Costa Rica	4	Peru	24
Barbados	1	Cuba	21	Paraguay	1
Bolivia	5	Chile	6	Rep. Dom.	1
Brazil	2	Ecuador	2	Uruguay	1
Colombia	12	Mexico	3	Venezuela	30

Integration of human resources

Networks

The University has in its charter the mandate to promote collaborative work among scientists in the developing world. As a result, the UNU/BIOLAC Program provides the infrastructure for Regional Networks involving scientists and their laboratories in order to improve the contact and sharing of information among institutions in the region.

With the support of the Canadian Government, the UNU organized a Network of Researchers in Brucellosis which, after UNU/BIOLAC's creation in 1988, became part of the Program. This was so successful that in 1996 another Network of researchers was organized. This time the target was Tuberculosis. If funds are made available, we plan to organize a Network for each of the Program's concentration areas.

Both Networks, under the direction of a Scientific Coordinator, organize annual workshops for the members and a course in specific topics of the research interest of the Network. Members of the Networks execute collaborative research projects that in many cases are financed by international funding agencies. In addition the two research

networks have an active network of electronic communication that interconnects its members and makes available recent relevant bibliographic information.

The Brucellosis Research Network

Brucellosis is a zoonosis that has become a public health problem in several countries in the region, whose economies have been affected by the appearance of the disease. In 1985 the Brucellosis Network was created through the initiative of The United Nations University, UNU, and with the support of Canadian Institutions such as the International Development and Research Center (IDRC), and the Government of Canada. When UNU/BIOLAC was created, this network was incorporated into the activities of the Program.

The Network, as shown in Table 7, is formed by researchers from the region, and includes the United States and Canada. Its objectives include the improvement of diagnostic tools, the identification of candidate molecules for vaccines or diagnosis, and the development of mutant strains of *Brucella abortus* that might be evaluated in protection studies.

Table 6. Country where training took place

Argentina	5	Chile	10
Bolivia	1	France	2
Brazil	15	Mexico	49
Belgium	1	Peru	1
Costa Rica	1	Venezuela	31
Colombia	7	USA	2
Cuba	3		

The Brucellosis Network carries out a very active scientific program. The network has already published a book with the results of their first works and the publication of their second book is scheduled for the next future.

The Tuberculosis Research Network

Socio-economic changes occurring in recent years in Latin America and the Caribbean, with consequent diminished standards of living, have contributed to the resurgence of a disease that appeared to be on its way to eradication: tuberculosis. It is believed that a third of the world's population is infected with *Mycobacterium tuberculosis*, leading to over 600,000 cases and 125,000 deaths per year in Latin America, and more than 3,000,000 deaths worldwide,

mostly in developing countries. This disease, frequently associated with AIDS, has become increasingly dangerous because of the emergence of drug resistant strains.

The Tuberculosis Research Network, RELACTB, has the active collaboration of researchers from 12 countries of the region, as shown in Table 8. Invited scientists from Belgium, Canada, France, The Netherlands, Portugal, and Spain are also participating. This network studies the genetics and molecular biology of the mycobacterium, mechanisms of resistance, geographical distribution of strains within the region, use of techniques from molecular biology in diagnosis and development of simpler methods of cultivation in non-conventional mediums.

Table 7. Member countries of the brucellosis research network

Argentina	Mexico
Brazil	Peru
Canada	Uruguay
Colombia	USA
Chile	Venezuela

With the support of UNU/BIOLAC, RELACTB organizes advanced courses for young researchers, in order to disseminate new biotechnology for the study of this disease. It publishes an electronic bulletin, "RELACTBulletin" which describes the activities of its members.

Final comments

It is well known that the number of researchers in Latin America and the Caribbean is too small to cope with the needs of research and to successfully confront the number of short and long-term problems. In order to face these problems, the recommendations given are for the long run, and activities such as those carried out by UNU/BIOLAC play a very important role in the updating, recycling and permanent interchange of scientists in the region.

The Program has proven to be an important tool in preventing scientists from emigrating, as it allows the creation of new horizons for cooperative projects, thus producing favorable conditions for research.

In only seven years of work, the results produced by UNU/BIOLAC support the hypothesis of a shared sense of direction within the region's scientific community. This, combined with the efforts of well established scientists in the region, is creating a new and stronger community which is

working towards solving the problems of the current crisis and meeting the challenges of the near future.

This initiative demonstrates that entities such as UNU/BIOLAC, regardless of their limited financial resources, through their encouraging policy of supporting human resource improvement, can be successfully used by developing countries for their own benefit.

In order to guarantee the sustainability of scientific and technological developments in all countries of the region, it is important to encourage young scientists to strengthen their professional background. Therefore, it is desirable that other non-governmental organizations support efforts such as those made by UNU/BIOLAC.

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Table 8. Member countries of the tuberculosis research network

Argentina	Dominican Republic.	Belgium
Bolivia	Honduras	Canada
Brazil	Mexico	France
Colombia	Nicaragua	The Netherlands
Cuba	Peru	Portugal
Chile	Venezuela	Spain

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