Postgraduate Programs in Molecular Epidemiology

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Resumen

La Epidemiologia Molecular es un nuevo campo que ha emergido recientemente de la integración de la Biología Molecular con la investigación epidemiológica. Hasta ahora, pocos países cuentan con recursos suficientes para el desarrollo de esta área debido principalmente a la carencia de epidemiólogos entrenados en Biología Molecular, y a insuficientes equipos y reactivos. Por esta razón hay notable necesidad para: 1. Formación de recursos humanos que integren la Biología Molecular, la Genética Humana, la Epidemiologia y la Salud Pública, y 2. Consecución de equipo novedoso de biotecnología, reactivos y materiales para el análisis molecular de factores potenciales de riesgo genético y ambiental. El IMETAF se estableció en 1993 y está contribuyendo activamente al desarrollo de programas de entrenamiento, así como la transferencia de tecnología en varios países. Este trabajo trata de fomentar las oportunidades de entrenamiento en Epidemiologia Molecular, muchas de las cuales son apoyadas por IMETAF.

Palabras clave: *Epidemiología Molecular, Epidemiología, Genética, Biología Molecular, Biotecnología, Salud Pública, Educación de Posgrado.*

Summary

Molecular epidemiology is a new field that has recently emerged from the integration of molecular biology into epidemiologic research. As yet, few countries have significant capabilities in molecular epidemiology due to a lack of trained molecular epidemiologists, and a shortage of necessary equipment and supplies. Thus, there is a great need for: 1) training in methods for integrating molecular biology and human genetics into epidemiology and public health, and 2) advanced biotechnology equipment, reagents and supplies for molecular analyses of potential genetic and environmental risk factors. The International Molecular Epidemiology Task Force (IMETAF) was established in 1993, and is actively contributing to the development of training programs, as well as effective technology transfer in several countries. This paper focuses on approaches for enhancing training opportunities in molecular epidemiology, many of which are being supported by IMETAF.

Key Words: *Molecular epidemiology, epidemiology, genetics, molecular: biology, biotechnology, public health, training, graduate education*

Introduction

The recent revolution in molecular biology has led to numerous applications of advanced biotechnology for medicine and public health. These are illustrated in Table 1, and include: 1) the diagnosis of viral, bacteria and parasitic diseases, 2) the development of new vaccines, 3) the diagnosis of genetic disorders, 4) the detection of mutations and susceptibility markers, 5) DNA sequencing and fingerprinting, and 6) the evaluation of biomarkers of environmental exposure.[1] While the potential for these applications to improve health is great, they require proper evaluation and comparisons with existing approaches, using less advanced technology, to assess their future utility. These investigations will allow clinicians, health professionals and epidemiologists to assess the contribution of the

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most recent scientific discoveries to medicine and public health. Without such studies, accurate information regarding risk of disease among individuals who carry a newly identified gene, for example, will not be forthcoming. These investigations represent the foundation of molecular epidemiology, which is one of the most rapidly growing fields of public health.

Molecular epidemiology has been defined as "a science that deals with the contribution of potential genetic and environmental risk factors, identified at the molecular and biochemical level, to the etiology, distribution and control of disease in groups of relatives and populations".[2] This field represents an interface between epidemiology, molecular biology and human genetics. Molecular epidemiology can be considered a new paradigm given that research questions that could not be previously addressed, can now be investigated through molecular epidemiology. To meet the increasing demands confronted by molecular epidemiologists, access to advanced biotechnology, as well as the development of formal and informal training opportunities are urgently needed.

Access to advanced biotechnology

Molecular epidemiology requires advanced biotechnology.[1,2] The equipment, reagents and supplies needed for molecular epidemiology are identical to those employed for basic science research.

Table 1. Applications of Advanced Biotechnology for Medicine and Public Health

1. **Diagnosis of viral,** bacterial **and parasitic** diseases **(eg., hepatitis, tuberculosis, malaria)**
2. **Development of new vaccines (eg., AIDS, malaria)**
3. **Diagnosis of** genetic **disorders (eg., cystic fibrosis, hemophilia, thalassemia)**
4. **Detection of carriers of mutant** alleles and/or disease susceptibility **markers (eg.,** HLA genes for autoimmune diseases, oncogenes **for cancer)**
5. **DNA sequencing and fingerprinting (eg., generation of probes, forencic medicine, anthropologic studies)**
6. **Evaluation of biomarkers of environmental exposure (eg., DNA adducts, chromosome abnormalities)**

In developed countries, this technology is generally available at universities, biotechnology companies and/or health care institutions. However, the existing resources at these institutions may not be sufficient for epidemiologic and public health applications, which are generally based on larger sample sizes than those required for basic scientific investigations. Thus, improvements in the availability of advanced biotechnology would facilitate the development of molecular epidemiology in many areas of industrialized countries.

In developing nations, the situation is much different. Inferior facilities, inadequate technology transfer and a lack of technical training are responsible for the limited availability of advanced biotechnology. These problems also exists in certain areas of developed countries. To increase technological resources in such regions, approaches such as effective technology transfer and better access to needed reagents and supplies would improve the potential for molecular epidemiology.

Training in molecular epidemiology

Training in molecular epidemiology is also required for the development of the field.[1,2] This includes basic knowledge of human and molecular genetics, molecular biology, the principles of epidemiology and the methods of public health practice. In developed countries, there are currently few formal graduate courses in genetic and molecular epidemiology. In addition, there is little integration of training among schools of basic science and public health institutions. Thus, educational opportunities in molecular epidemiology are not widely available. The situation could be improved through the inclusion of lectures on genetics, molecular biology and epidemiology in courses at the undergraduate and graduate level. This would expose students to the principles of the disciplines involved in molecular epidemiology. In addition, formal and short courses in molecular epidemiology could be developed in industrialized nations.

In developing countries, programs in science and public health are not prominent. In addition, many individuals who study abroad to gain experience in these areas do not return to their countries. Thus, in developing countries, training in molecular

epidemiology is not available. Several approaches could be employed to improve these deficiencies. Short courses and workshops in developing nations may well suit the needs of individuals interested in this field. Moreover, the incorporation of molecular epidemiology into existing training programs, such as the International Clinical Epidemiology Network (INCLEN),[3] or the Field Epidemiology Training Program (FETP),[4] funded by the World Health Organization and the Centers for Disease Control, may be very useful.

Assessment of existing training opportunities

a. *Survey* of *U.S.* and *Canada*

Existing training opportunities in genetic epidemiology and molecular epidemiology in the U. S. and Canada are formally being assessed by a survey sent to the directors of Departments of Epidemiology, Departments of Preventive Medicine and Departments of Human Genetics. The purpose of this survey was to identify existing or planned courses, seminars, etc., in genetic and molecular epidemiology in the United States and Canada, and to determine what was included in their curricula. A secondary goal was to develop a catalog of information regarding such programs, for placement on the INTERNET on the Molecular Epidemiology Home Page, which is part of the Global Health Network Home Page.[5] The INTERNET address of the Molecular Epidemiology Home Page is http://www.pitt.edu/~kkr/task.html.

Although data collection is not yet complete, it appears from preliminary analyses that approximately 40% of the Departments of Epidemiology in the U.S. and Canada have formal courses or training programs in molecular or genetic epidemiology. However, similar opportunities appear to be less widely available in Departments of Human Genetics and Preventive Medicine, with formal courses/ programs in approximately 30 % and 28 %, respectively.

b. Molecular Epidemiology Training Program at University of Pittsburgh

The Graduate School of Public Health at the University of Pittsburgh has developed a formal training program in molecular epidemiology, based on collaboration among the Department of Epidemiology, Department of Environmental and Occupational Health and Department of Human Genetics. Table 2 illustrates the areas of expertise in each department, which represents a wide spectrum of activities in infectious and chronic diseases, as well as human genetics. The foundation of the Molecular Epidemiology Training Program is a strong didactic series, including a six credit Molecular Epidemiology Core Curriculum and 22 related electives. In addition, students are required to serve a one-semester rotation in each participating department. Finally, outstanding research opportunities with a diverse and experienced faculty are available for research topics in the three departments. More information about this program may be obtained from the authors (J.S.D).

Table 2. **Areas** For Training in Molecular Epidemiology at the Graduate School of Public Health, University of Pittsburgh

Department of Epidemiology	Department of Environmental and Occupational Health	Department of Human Genetics
Aging	Carcinogenesis	Clinical genetics
Cancer	Chemopreventive therapy	Cytogenetics
Cardiovascular disease	Molecular toxicology	Gene mapping
Diabetes	Mutagenesis	Genetic counseling
Obesity	Occupational disorders	Quantitive genetics
Osteoporosis	Pharrnacogenetics	Statistical genetics

c. *Short* Courses and Workshops *in* Molecular Epidemiology

Another approach to training in molecular epidemiology is based on the organization of short courses. Three such programs are currently under development. The first short course will be held in Mexico City, Mexico in August, 1996, and is sponsored by the Mexican Scientific Committee of the International Molecular Epidemiology Task Force (IMETAF).[1,6] This is practical-theoretical course, which is being coordinated by the Department of Immunogenetics at INDRE and the Dirección General de Epidemiológia in Mexico City, as well as the Department of Epidemiology at the University of Pittsburgh. The duration of the course will be one week; it will consist of lectures in the mornings, and laboratoty demonstrations and informal working groups in the afternoons. The latter will focus on specific health problems, and will provide an opportunity for in-depth discussions of issues covered by the morning lectures.

A second short course will be held in Buenos Aires, Argentina in April, 1997. This activity will be sponsored by the Argentinian Scientific Committee of IMETAF,[1,7] and will consist of lectures, as well as laboratoty demonstrations during a three day period to provide an introduction to molecular epidemiology for clinicians, researchers and public health professionals.

The third course will be held in Beijing, China. This is also an IMETAF-sponsored activity,[1] and will be organized by the Chinese Academy of Preventive Medicine in Beijing, and the Department of Epidemiology at the University of Pittsburgh. It will be a one week training course, consisting of morning lectures and afternoon laboratory demonstrations. However, it will be specific to insulin-dependent diabetes mellitus (IDDM), and will permit the initiation of the molecular IDDM epidemiology project in China.[8] This course is planned for Fall. 1996.

Synopsis

The revolution of molecular biology has, and will continue to have, a dramatic impact on science, medicine and our society. It is also greatly impacting the field of epidemiology, as evidenced by the recent development of molecular epidemiology. This new discipline not only requires the availability of advanced biotechnology, but it also necessitates the development of formal and informal training opportunities in molecular epidemiology. Currently, such programs are not widely available in industrialized or developing countries. However, it is hoped that the approaches being implemented by the International Molecular Epidemiology Task Force will contribute to the development of training programs in molecular epidemiology, a field which represents one of our major challenges for the 21st century.

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References

1. Dorman JS, **Gorodezky** C. Molecular epidemiology: Advanced biotechnology and public health training for disease prevention. (submitted).
2. Dorman JS. On behalf of the International Molecular Epidemiology Task Force. Molecular epidemiology and DNA technology transfer: A program for developing countries. In: Standardization of Epidemiologic Studies of Host Susceptibility. J.S. Dorman (ed.), Plenum Press, New York, NY, 1994, pp. 241-255.
3. Higginbotham N. Developing parinerships for health in social science research: The International Clinical Epidemiology Network (INCLEN) Social Science Component. Soc Sci Med. 1992;35:1325-1327.
4. Music SI, **Schultz** MG. Field epidemiology training programs: New international health resources. JAMA. 1990; 263:3309-3311.
5 **LaPorte** RE, **Akazawa** S, **Hellmonds** P, Boostrom E, Gamboa C, Gooch T, Hussain F, **Libman I,** Marler **E,** Roko K, Sauer F, Tajima N, **Villasenor** T. Global public health and the information superhighway. BMJ, 1994; 308:1651-1652.
6 Development of Molecular Epidemiology in Mexico. Bulletin of PAHO, 1994; 28:86-87.
7. Programa de epidemioiogia molecular en la Argentina. Bol Ofi. Sanit Panam, 1995;118(4):372-373.
8. Dorman JS, Kocova M, **O'Leary** LA, **Kramer MK, Trucco** M. Case-control molecular epidemiology studies: Standards for the WHO DiaMond project. In: Standardization of Epidemiologic Studies of Host Susceptibility. J.S. Dorman (ed), Plenum Press, New NY, 1994, pp.89-99.