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A Basis for the Formulation of Policies on Health Science and Technology in Latin America[1]

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Concern over the organization of scientific activity is of relatively recent vintage in Latin America. During the 1950s, countries such as Brazil and Argentina created national research agencies, but these were directed mainly toward the organization and development of research groups, usually in university settings. Relating scientific activity to socioeconomic development was not an explicit objective.

Only in the late 1960s, largely at the initiative of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the Organization of American States (OAS), was it first recognized that science and technology were development issues in Latin America and that explicit policies on scientific and technological development should be spelled out and adopted. Within this context, it seemed clear that these policies should be formulated by central agencies, which should also be responsible for coordinating national science and technology systems.

During the 1970s new agencies of this type were created in almost all the Latin American countries, generally under the ministries of planning, and existing agencies were modified in response to the new trends. At the least, this often involved changing agency names and locations as well as transfers of responsibility from the ministry of education to the ministry of planning.

Beginning in the late 1970s but mainly in the 1980s, data began emerging that indicated expectations for state planning and organization of science and technology were not being met. Advances had been made toward creating a scientific and technical infrastructure in some sectors and countries, but in no case had it been possible to establish a real science and technology system that would permit free flow of information and technology between the various entities involved in research, development, and

[1]Edited version of a contribution published in Spanish in the *Boletín de la Oficina Sanitaria Panamericana*, Vol. 116, No. 2, February 1994. Because this text is intended to serve as a basis for discussion, the bibliographic references and most of the empirical data supporting the ideas expressed have been omitted. The ideas contained in this presentation arose out of discussions by the Ad Hoc Subcommittee of the PAHO Advisory Committee on Health Research comprised of Jaime Lavados, Jacobo Finkelman, Eduardo Martínez, Adolfo Martínez-Palomo, and Francisco Sagasti.

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production of goods and services. Science and technology policies, which continued to be oriented toward bolstering supply, failed to become public policies that were submitted to public debate and articulated with general development policies. The State continued to be practically the only source of demand for scientific production and the only entity involved in execution and funding of that production. (Almost 80% of the spending on science and technology in Latin America comes from the State.) Funding for the sector never reached 1% of the gross national product, which was the target set for the end of the 1970s.

In the mid-1980s the drive to reduce public outlays, a principal ingredient of the adjustment policies implanted in Latin America, found the science and technology sector to be a vulnerable target. The sector has never achieved true social legitimacy, having been isolated from other sectors of society. Because of its great dependence on state resources and the improbability that any other source of funding will emerge in the short run to ensure the levels of investment needed, the survival of the scientific and technical infrastructure created in earlier years is now threatened. As a result, the Latin American countries' future prospects for renewed development may be compromised.

Debate on these issues and on the course of action to be taken is more necessary now than ever, as much to preserve the incipient infrastructure erected thus far as to achieve recognition of the fact that the science and technology sector has a crucial role to play in alleviating the socioeconomic crisis in the Region. Clearly, however, this debate cannot be based on repetition of old formulas, both because they have failed in the past and because the rapidly changing context makes it imperative to rethink the role of science and technology in the light of new circumstances.

In particular, the science and technology policies in force in the mid-1980s, in addition to being slanted toward the supply side, were framed within the context of economic development models based on import substitution, the comparative advantages of abundant raw materials and cheap labor, protected national markets, and a leading role for the State in development. Such conditions are not very encouraging for the development of science and technology, since import substitution in protected markets can be—and has been—accomplished through the importation of already developed and sometimes obsolete knowledge and technology, without concern for maintaining competitive levels. Given the radical changes that have taken place in this frame of reference, however, it is essential to ask what role science and technology should play under new conditions. The aim of this presentation is to make a modest contribution toward answering that question.

THE CONTEXT

Something that has been most striking in the latter years of the 20th century and that has had repercussions in virtually every corner of the world is the accelerated transformation of productive structures. The introduction of new technologies, raw materials, and ways of organizing production is giving rise to what has been called the "dematerialization of production." Indeed, the mastery of new technologies has redefined patterns of competition between countries and has strengthened the importance of the marketplace, since the rapid obsolescence of processes and products has made it essential that large investments in research and development be recovered quickly. Thus, for example, if a microelectronics product has an esti-

mated average life of four or five years, a seven or eight year investment in research and development must be amortized over two or three years. Other consequences include closer university-business relations, with early privatization of research findings even at the most basic level, and strengthening of international mechanisms for the protection of intellectual property.

Even as competition becomes more intense, alliances are being built between countries and companies to facilitate access to innovations, and megamarkets are being created that place science and technology at the center of international relations and promote a globalization of economic activity. These changes in the area of productive infrastructure have been coupled with changes in the political context—notably the disappearance of so-called "true socialism"—and the incorporation of countries into the market economy, so that international relations today are much less influenced by lingering remnants of cold war ideology.

The internationalization of capital, labor, and the market is a universal phenomenon from which Latin America has not been excluded. Agriculture, traditional industries, services, and consumer demand in the area have been affected by this process, which has hastened the decline of the development models that prevailed until recently. Those models, which never succeeded in promoting development or political stability or the solution of serious social problems, are now being replaced by more market-based models, the hallmarks of which are promotion of open markets, with reduction of the importance of national markets in the orientation of development policies, and reformulation of the role of the State with a marked trend toward deregulation, privatization, and reduction of the state apparatus.

These changes in the basic characteristics of prevailing development models have led to parallel changes in the orientation of policies—from an emphasis (albeit often only rhetorical) on the promotion of growth and the distribution of wealth to a focus on crisis management and "adjustment." The welfare state as the driving idea behind social policy is disappearing, with little apparent concern for the social consequences of such a change. At the same time, significant developments are taking place in the political sphere—including establishment of democratic regimes in most Latin American countries, emergence of new forms of organization for civil society, greater freedom of expression for minority and culturally subordinate groups, and decentralization of decision-making and resources.

Strongly conditioned by these economic, social, and political factors, as well as by the health services' utilization of technologies that have a strong impact on mortality in some age groups, the health situation in the countries of Latin America continues to be generally characterized by progressive aging of the population and a predominance of mortality from chronic degenerative diseases and accidents—trends that denote processes known as demographic and epidemiologic "transitions." Unfortunately, Latin America cannot count on reliable information systems or indicators sufficiently sensitive to detect short-term changes in health conditions brought on by deterioration of living conditions. Despite this lack of precise data, however, it is readily apparent that differences in the morbidity and mortality profiles of diverse social groups have persisted and in some cases become more marked; deaths and other consequences of violence are mounting; the incidence of diseases that had been on the decline, such as malaria and tuberculosis, is rising; and

diseases that were considered no longer a threat, such as cholera, are reappearing. All of these are consequences of the social deterioration that has occurred at the same time as Latin American societies have evolved toward demographic and epidemiologic profiles that resemble those of the developed countries.

With respect to health care organization, major trends toward health system decentralization have been noted, with the municipal level bearing greater management responsibility. Despite widespread discussion of the importance of taking a comprehensive, intersectoral approach to health problems, "public" health practices continue to be limited largely to selective care for high-risk groups by means of relatively simple technologies (vaccines, oral rehydration, dietary supplementation, etc.). Another important trend of this kind is toward diversification of health care delivery and financing modalities, with marked growth of the private sector. This had led, among other things, to a greater division of health service clientele and significant changes in medical practice; for example, health professionals have less control over their own work process, which increasingly responds to the logic of costs, benefits, and investment returns.

Finally, in the midst of all these changes—which have not been entirely positive in terms of equity and social justice—the right to health as one of the basic rights of citizens is being accorded growing formal recognition in new constitutions and other legal instruments, as well as in the political activities of social movements and state institutions.

HEALTH SCIENCE AND TECHNOLOGY IN LATIN AMERICA

Before outlining the specific situation of health science and technology in the countries of Latin America, it is worth examining some general features. In addition to the organizational problems already mentioned (including weaknesses in the chain of production, distribution, and utilization of knowledge, and the sector's vulnerability owing to the fact that research activities have traditionally been executed and financed mainly or exclusively by the State), scientific production in Latin America is limited, concentrated, and (with rare exceptions) of unsatisfactory quality. According to a report by the Inter-American Development Bank based on data from the Institute for Scientific Information (ISI), in 1984 Latin America accounted for only 1.1% of the articles listed in the ISI data base and only 0.6% of the bibliographic references—percentages lower than those recorded for such individual countries as Belgium and Israel. In addition to being limited and little-known, Latin American scientific production is also quite concentrated. According to the same report, during the period 1973–1984 five countries (Argentina, Brazil, Chile, Mexico, and Venezuela) were responsible for around 90% of all publications. Moreover, this concentration appeared to be increasing during the period, with the percentage corresponding to those five countries rising from 87% in 1973 to 91% in 1984.

The same general features are found in the more limited area of health research. According to the aforementioned ISI report, of the articles published in all scientific fields in Latin America between 1973 and 1984, 55% dealt with health research. The traditional dominance of health research diminished somewhat during the period, dropping from 60% in 1973 to 42% in 1984, while the share of other fields increased, that of physics alone growing from 9% to 20%. This appears indicative of a trend toward diversification of scientific activity.

Although Latin America has achieved some successes in biomedical research (for example, development of vaccines and new diagnostic methods utilizing techniques from the field of biotechnology) and in public health research (e.g., development of new epidemiologic approaches), applied health research in the area continues to be seriously inadequate, both quantitatively and qualitatively, for addressing current problems. Indeed, the problems stemming from social, demographic, and epidemiologic changes—the impact of altered living conditions upon health, the political and economic implications of decentralization and privatization of health services, the mastery of new technologies, and other pressing issues—call for the existence of a scientific community with the technical and organizational capabilities to produce the knowledge needed. Unfortunately, from all appearances Latin America is still a long way from having the capacity to respond to problems of such complexity.

With support from PAHO, a study was conducted in six countries (Argentina, Brazil, Chile, Cuba, Mexico, and Venezuela) to determine the characteristics of research projects under way (in 1987–1989) and of scientific production (in 1972–1989) in the health field. The findings showed (a) marked predominance of the individual (biomedical and clinical) approach, as opposed to the population-based approach, in more than 80% of the projects under way; (b) limited research on technological innovations (which accounted for some 5–6% of the projects); and (c) predominance of the medical and biological sciences (which accounted for more than 90% of the projects under way), with little participation by the social sciences and engineering fields. With regard to this last finding, a clear correlation was observed between the area of research and the profession of the investigators, most of whom were physicians or biologists.

Despite these observations, the magnitude and speed of changes that have occurred over the last two or three years (especially in sectors where the State is or was important), the incapacity of existing scientific and technical information systems to detect short-term changes, and the heterogeneity of situations in the various countries have made it very difficult to determine precisely what is happening to research in the context of the development models being applied in the countries of Latin America.

In some countries there seems to be a rapid deterioration of research institutions and of investigators' working conditions, with intensification of the "brain drain" (both externally to other countries and internally to other more prestigious or profitable activities). In other countries, however, there appear to be signs of a diversification of sources and mechanisms for financing science and technology activities—for example, the growth of university-business consortiums and diversification of the subject matter and types of health research. The proliferation in some countries of so-called nongovernmental organizations, that are often of high scientific quality and have strong outside ties, seems to be another recent and significant development.

A more thorough and objective evaluation of the current evolution of science and technology (and also of health science and technology) remains to be done, but it seems evident that most of the countries continue to lack clearly defined and coherent public science and technology policies oriented toward socioeconomic development. The following section reaffirms the idea that the formulation of such policies is necessary and possible, and suggests some of the principal elements that should serve to orient them.

CONCEPTUAL BASES FOR FORMULATING HEALTH SCIENCE AND TECHNOLOGY POLICIES

Health science and technology is a field of social activity. "Field" here refers to the "set of processes and actors that intervene in the manufacture, distribution, and use by society of a particular type of product. This field has its own laws, participates in the totality of the social structure, but at the same time is governed by a specific modus operandi."[3]

Clearly, the field of health science and technology, conceived of in this manner, long ago ceased to be limited to research carried out essentially by physicians in the area of health services. The "demedicalization" of health research has been accompanied by a broadening of the range of issues studied and a diversification of disciplines, approaches, types of research, professional backgrounds of the investigators, institutional settings in which research is conducted, etc. This greater complexity of the process for producing health knowledge has been associated with greater complexity of the processes for disseminating, utilizing, and regulating application of such knowledge.

The expansion and diversification of the health science and technology field and the complexities of its regional and world scenario create new problems for policy formulation. Notwithstanding these problems and the diverse situations of the countries involved, regional integration (integration of the production and utilization of knowledge and technologies) and the overcoming of "false dilemmas" could become common foci serving to orient health science and technology policies.

Regional Integration

As already mentioned, the current dynamics of the science and technology field are prompting formation of new alliances intended to facilitate the development and mastery of new technologies, ensure expansion of markets, etc. No country, regardless of how developed it may be, is capable of dealing by itself with problems such as environmental issues or the control of epidemics like AIDS. If this is true of the developed countries, it is all the more true of the countries of Latin America, given the magnitude of the problems they face. Hence, the development models that are being adopted in Latin America are assuming that the limits imposed by national boundaries are overcome and are urging globalization of policies, commonly from a perspective of regional integration.

Integrating Production and Utilization of Knowledge and Technology

The relative failure to create science and technology systems that will permit a free flow of knowledge and technology among research institutions and the producers of goods and services is often cited as one of the most serious shortcomings of the science and technology development policies adopted in the past by the countries of Latin America, policies that were oriented toward strengthening the supply side. Such policies probably bore considerable responsibility for isolating the small scientific communities that existed and for the relatively insignificant contribution of science and technology to the development of the countries involved.

[3]Canelini NG. *Ideología y cultura.* Buenos Aires: Universidad de Buenos Aires; 1986:18. Cited by Bloch C. *Bases técnico-metodologicos para fundamentar una estrategia de cambios en los SILOS.* Rosario: Centro de Estudios Sanitarios y Sociales; 1990. [Mimeographed document].

The creation of open, competitive societies and the resolution of social problems, including health problems, require that advances made through research and development be allowed to flow freely to the institutions that can apply them for the benefit of society. In order for this to happen, it is necessary, as noted above, to strengthen the ties between those involved in research, development, and production, so that they can jointly identify problems and devise ways of addressing them. It is also important to create mechanisms that will encourage the development and transfer of knowledge and technology—for example, legislative standards facilitating technology transfer agreements and contracts, creation of technological parks, availability of venture capital, etc.

Overcoming "False Dilemmas"

In the past, divergent opinions regarding the orientation of science and technology development policies in Latin America have given rise to heated debate. However, both the historical perspective and the new circumstances now prevailing indicate that most of the disagreements concern "false dilemmas" that should be overcome. Some of these false dilemmas are as follows:

Whether or Not to Establish Priorities

Supporters of the "autonomy of science," who see any attempt at setting priorities as a threat to that autonomy, have disagreed and still disagree with those who would orient scientific activity toward the fulfillment of certain objectives. In fact, this vaunted "autonomy" has never existed, except in a very relative sense, because science, particularly as it has become more institutionalized, is strongly conditioned by a series of factors related to the material life of the societies in which it occurs. In addition, those external factors that influence the orientation of scientific activity (whether in organized or "spontaneous" fashion) are not the sole or definitive influences. Indeed, the dynamics of science are also influenced by internal factors that make the potential for development at a given point in history dependent on the cognitive advances made in previous periods.

The foregoing makes it clear that the issue is not whether priorities should be established, or even whether scientific activity should be directed. Within the limits established by its intrinsic logic, scientific development is directed by the influences of the society wherein it happens. In other words, science is not above society; scientific activity does not occur simply at the initiative of independent scientists but rather in response to the demands of various sectors of society. The problem, then, is what type of demands these are, who makes them, and how they are posed to science by way of defining its course.

In the context of the development models currently being applied in Latin America, a widely held idea is that once market forces are given free rein, the needs of society will be expressed through the market. One need only "sound out" the market to know the direction to take. This idea is totally inappropriate for social sectors like that of health, where responding to the market alone would mean meeting the demands of only certain groups, thereby promoting an inequity that is ethically untenable.

Besides producing the knowledge needed to meet needs of the various social sectors, science and technology in Latin America should be adapted to the extremely competitive dynamics of scientific and technologic development at the global level. This implies acquiring the capacity to analyze trends and prospects for such development, evaluating

the potential existing in the Region, and defining the paths to take in a consensual manner with the actors involved. In other words, today more than ever it is necessary to overcome the false dilemma of whether or not to establish priorities and, with respect to the intrinsic and extrinsic factors that determine the development of science, to define these priorities, following the example of countries that have succeeded in making science and technology an integral part of their development programs.

Domestically Produced Versus Imported Knowledge

Another issue that has long hindered formulation of science and technology development policies in Latin America is whether to promote local production of knowledge or import it from elsewhere. Everything said above about the prevailing trend toward globalization of science and technology development and about the inability of any country, no matter how developed, to address the problems of the contemporary world by itself, indicates that this also is a false dilemma. In reality, the important thing is to acquire a capacity for gaining access to knowledge and technologies, regardless of where they are located, which implies developing channels of access and knowing the "rules of the game" for the transfer of those technologies. Of course, approaching the issue in this way does not diminish the importance of having a solid scientific and technical infrastructure in multiple areas, something that is indispensable for selecting, evaluating, absorbing, adapting, and developing knowledge and technology.

Basic or Development-oriented Research: "Push" or "Pull"?

The new dynamics of scientific and technical development have demonstrated that the division between basic, applied, and development-oriented research is an artificial one, and indeed that the dilemma over whether to promote the development of science and technology through basic research ("push") or development-oriented research ("pull") is irrelevant. Historical examples abound of an entire field of knowledge developing as a result of technical changes (for example, the development of thermodynamics as a result of the need to enhance the performance of steam engines) or as a result of "basic" scientific discoveries (such as emergence of the modern biotechnology industry out of findings in molecular biology). The essential need, as noted earlier, is to create a system linking all development levels and permitting the free flow and application of knowledge. The various forms of linkage that are flourishing in the developed countries between businesses and research centers are enhancing channels of communication, thereby facilitating early identification of possibilities for application of the most basic developments.

As already noted, this trend may lead to the early privatization of basic knowledge, hindering dissemination of that knowledge and, in the long run, compromising global scientific development. All this underscores the need for the countries of Latin America to strengthen their scientific infrastructure through achievement of a "critical mass" in the various scientific fields, so that science can remain current, follow its own development dynamic, and respond promptly to the demands placed on it.

These basic guidelines for science and technology development policies that seek to be congruous with current tasks are, generally speaking, also applicable to health science and technology. In the health sphere, of course, there is a dual need to respond to changes in the health situation and in health care by develop-

ing and incorporating new knowledge and technology that will make it possible to deal with the changes and, at the same time, take advantage of opportunities the sector offers for strengthening biotechnology, electronics, information science, and other technologies whose benefits can be extended to other areas of social life.

THE COMPONENTS OF A HEALTH SCIENCE AND TECHNOLOGY POLICY

It is not uncommon for science and technology policy in a given field to be confused with a list of research priorities suggested by experts. The limitations of this idea are evident when the foregoing remarks are taken into account. The basic fact is that besides setting priorities, a science and technology policy must necessarily incorporate a range of other elements. Some of those elements, seen from the specific point of view of the health field, are as follows:

(A) It is necessary to determine the principal health-related problems whose solutions require the development of new knowledge and which should therefore be the target of research efforts and resources. The definition of research priorities should not be viewed as the exclusive province of experts, since it is an eminently social activity involving a variety of actors with different interests and perceptions. As a consequence, this definition of priorities should be carried out in a setting that facilitates consensus-building. The purpose of science and technology policy is not to define the issue to be investigated by a specific project, as this must necessarily be done by the individual investigators on the basis of their accumulated knowledge, the tools available to them, and the way they perceive reality. Rather, the function of a science and technology policy is to point out a set of general, socially perceived issues that will provide a frame of reference for defining the goals of specific studies.

(B) Of course, the democratic and participatory process of identifying and delimiting issues includes a technical dimension. When it comes to setting priorities for health research, this technical dimension has traditionally been identified with whatever information can be derived from the morbidity and mortality profile. It is true that this profile provides a basic reference for the task, but it cannot be the only element taken into account. That is because the whole range of health issues cannot be expressed merely as a list of the most common diseases or causes of death, and also because there is no automatic correlation between health issues and health research issues.

(C) Inasmuch as the dynamics of scientific development depend on factors both internal and external to science, any policy on scientific development in a specific field such as health should take account of both internal and external factors. Seen this way, the priority issues in the field will be those located at the points where the internal and external factors converge.

In the case of health, the basic external factors are the characteristics of the health-disease process in a particular society. This process (which is subject to change) comprises the health situation and its determinants—including the living conditions of various population groups and the social response (by the health and social welfare services) to the health-disease profiles generated by such conditions. Such problems relating to health, living conditions, and social responses should be classified on the basis of their magnitude and severity, the potential effectiveness of interventions, existing knowledge of each problem, and the feasibility of research in the short, medium, and long terms.

Internal factors must also be considered. Although strongly influenced by its social surroundings, science possesses its own dynamic of development, which is determined by the knowledge that has been accumulated and by the questions that such knowledge generates. Recent years have seen the emergence of extremely dynamic fields that have acquired strategic importance—by virtue of their impact on other scientific sectors, their contribution to the solution of health problems, or their potential economic worth. Promoting and realistically guiding the development of fields such as biotechnology, molecular pharmacology, immunogenetics, health economics and sociology, and others is therefore an indispensable requirement for any health science and technology policy in any society.

(D) The research issues that deserve priority are those found at the point where the health-disease process converges with the most dynamic areas of scientific development. Nevertheless, having a list of priorities, no matter how well prepared it may be, is not synonymous with having a science and technology policy or with effectively implementing such a policy. In order for these things to occur, scientific activity must be promoted, taking into account the various processes that such activity comprises and their respective components. Principally, scientific activity includes the processes of research, transfer and incorporation of knowledge and technology, and the factors that condition these processes. Each of these elements possesses characteristics and idiosyncrasies, and special strategies are called for to ensure their articulated development.

(E) The process of research or production of knowledge involves, among other elements, very specific agents—namely, investigators with very specific training requirements and working conditions, specialized tools, and very specific materials with which the investigator must be thoroughly familiar. In addition, research is conducted in unique physical settings, such as research centers. In order to facilitate research on the priority problems identified, a science and technology policy should provide mechanisms for stimulating and orienting scientific activity, taking into account the particular characteristics of the aforementioned elements.

Similarly, in order for knowledge and technology to be transferred and incorporated into the production of goods and services relating to health and well-being, specific procedures and conditions must be fulfilled, and these procedures and conditions should also be envisaged in a science and technology policy.

(F) In addition to the specific components making up each of the three basic processes comprising scientific activity (production, dissemination, and utilization of knowledge), general elements condition this activity. Among other things, these general elements include the entities that provide funding for scientific activity as well as those that manage such activity, supply scientific and technical information, train human resources, provide legitimacy, incorporate technologies, and enact laws and set standards in areas such as intellectual property. Because of their strategic importance, any intervention affecting these elements can have a powerful catalytic impact influencing the course of scientific activity.

(G) Diversification of research funding sources in Latin America is essential in order to increase available resources, involve other sectors in research activity, and reduce the current vulnerability of research activities stemming from their almost total dependence on public resources. Among other things, this implies creating incentives so that additional funding from other sources, particularly the private sector, can

be obtained and added to those available from other sources for science and technology activities.

(H) Strengthening science and technology management at all levels is another element critical for the overall development of scientific activity. At the national level, this means politically and technically strengthening the central agencies responsible for science and technology planning and administration, so as to enable them to formulate and implement policies that meet the needs of the moment. The same consideration applies to those institutions that carry out research, which besides improving their traditional administrative processes must develop new capabilities for mobilizing resources, establishing agreements with producers of goods and services, managing technology transfers, etc. At the level of health services, managing the incorporation of technology is a pressing need, not only to rationalize care but also to more clearly define the knowledge and technology needs of the health services.

(I) In the recent past the principal economic comparative advantages offered by the Latin American countries were abundant supplies of raw materials and cheap labor. In the new dynamics of development, these natural and demographic factors are becoming less important. Latin America's new comparative advantages should arise out of the process of development itself. These advantages will be closely related to the quality of the human resources in a society, which in turn will basically be determined by the levels of health and education in that society. Hence, the mastery of knowledge and technology is today a central element in economic and social development, one that requires ready availability of human resources at all levels with a capacity to access scientific information. In this context, the concept of human resources for scientific activity is not limited to the principal agents involved in the research process—the investigators—but encompasses all members of society who in one way or another are called upon to participate in scientific activity.

With particular reference to investigators, several Latin American countries made notable efforts during the 1970s to ensure specialized training for these human resources through the creation of master's degree and doctoral programs in almost all scientific fields and through the awarding of fellowships for study abroad. Unfortunately, this training effort was not accompanied by a clear policy for absorption of those trained, resulting in aggravation of the "brain drain" phenomenon and ultimately endangering the very survival of the graduate education structure previously created.

More generally, the development of human resources—both those directly involved with the production of knowledge and in a broader sense those involved in all spheres of social activity affected by scientific and technologic advances—is the central element of any science and technology policy in any field and the element which will ultimately determine the success or failure of that policy.

(J) As already noted, it is necessary to establish an ability to keep track of science and technology development trends, set up channels of access to those trends, determine social demands and pose them as issues to be resolved by science, and strengthen ties between those who produce and those who utilize knowledge so that knowledge will circulate more freely. All this implies strengthening the foundations, systems, circulation, analytical capacity, and evaluation of scientific and technical information. It also implies clearly defining standards and procedures—the "rules of the game"—for accessing and using information, despite the fact that this is a complex un-

dertaking, given the diversity of interests involved and the increasingly common phenomenon of privatization of knowledge.

Finally, it is essential to strengthen procedures for legitimizing scientific knowledge. The mechanisms traditionally employed by the scientific community in other countries to assess the quality of scientific production—for example, peer review (assessment or appraisal by colleagues of scientific projects and articles)—have not been fully developed in Latin America. Not only do these mechanisms need to be strengthened, but the capacity for assessing quality with regard to the usefulness and impact of particular knowledge and technology must be enhanced.

THE ROLE OF SOCIAL ACTORS

In recent years scientific activity in the health field has been limited essentially to the work carried out by two main actors: the State as the funding agent and the scientific community as the executing agent (in the case of health, this community has been limited mainly to physicians). The lack of participation by other actors has contributed to science's lack of social legitimacy; and this, together with a reduction of resources from the only source of financing, the State, now threatens the very survival of scientific activity.

Withdrawal of the State as the leading actor or driving force in development, intensification of democratic tendencies, strengthening of participatory mechanisms, "demedicalization" of health research—these are some of the developments that have contributed to involvement of new actors in formulation and implementation of public policies and, as a result, to a change in power relationships.

In this context, the key to moving from a science and technology policy that is strictly theoretical to an effective public policy with social legitimacy is to successfully involve, from the preparation stage onward, the gamut of actors who play a part in the production, dissemination, and utilization of knowledge.

The social actors in any activity do not exist *a priori* but emerge in the course of the activity. In the case of health science and technology, proposed changes are doing more than merely adding new actors; rather, they also envisage altering the roles of the traditional actors—including the State, investigators, producers of goods and services, health professionals, and others who have been accustomed to power relationships and ways of working together that are now shifting.

In the past, state intervention was justified largely by the State's role as a funding agent. In the new context, the State, without relinquishing this important role, should cultivate a capacity to promote expression of interests and perspectives by the various social actors involved and to encourage collective decision-making about the course of action to be taken. Thus, the legitimacy of the State in this area should derive not only from its role as a source of funding but also from its capacity to enlist a variety of actors and its leadership in protecting the public interest.

Of course, where scientific policy is concerned it is not valid to think that the market can legitimately express all social needs, or that it suffices to meet the demands expressed through the market. Moreover, in the case of extremely heterogeneous societies (and particularly with regard to health), it is ethically unacceptable to meet only market demands, as this will tend to aggravate existing inequalities. Because of diverse living conditions, each population group has a par-

ticular profile of priority health needs, problems, and research issues that do not necessarily find expression through the market. Hence, an additional rationale for state involvement in development models where the logic of the market plays an important role derives precisely from the State's commitment to equity and from whatever action the State can take that will promote adequate social responses, overcoming distortions caused by the logic of the market.

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Smallpox Virus Destruction Advised

At a meeting in Geneva last September, the WHO Ad Hoc Committee on Orthopoxvirus Infections recommended that the last remaining stocks of the variola virus, which caused smallpox before that disease's worldwide eradication in 1977, should be destroyed. The international group of experts selected 30 June 1995 as the tentative date for the destruction, allowing the World Health Assembly to consider the decision in its May 1995 meeting. The material to be destroyed is currently stored at the Centers for Disease Control and Prevention in Atlanta, Georgia, United States of America, and in the Institute for Viral Preparations in Moscow, Russian Federation. The Committee also issued recommendations on the procedure for destroying the virus and for certifying its destruction.

Cloned fragments of the variola virus genome, which are not infectious, will be maintained for research purposes. The Committee also recommended that 500 000 doses of smallpox vaccine be kept by WHO in case of emergency and that the vaccine seed virus strain be preserved.

In reaching its decision, the Committee weighed the potential risks of the virus's escape against the potential scientific benefits of retaining it. Destruction of the last two remaining variola virus stocks was first proposed in 1986, but with the recommendation that the genetic blueprint of the virus first be analyzed and archived. A WHO Technical Committee that met in January 1994 was satisfied that that task had been completed and that, if the need were to arise, accurate diagnostic tests could be conducted. Nevertheless, announcement of the recommendation to destroy the virus triggered controversy in the scientific community. Some argue that the destruction will preclude future studies of the virus (although research can continue on the cloned DNA fragments and the gene sequence information). In addition, it has been pointed out that unknown repositories of variola virus may exist. By widely publicizing the decision and seeking the review of the WHO Governing Bodies, the Committee hopes that a broad consensus will be reached.

Source: World Health Organization. Scene is set for destruction of smallpox virus. Geneva: WHO; 9 September 1994. (Press release WHO/65).