Proceedings of the symposium on science policy and biomedical research

Unesco
CORRIGENDUM

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In the above-named publication, recently sent to you, the attached corrected title page should be substituted for the original version.
Proceedings of the symposium on science policy and biomedical research

organized by CIOMS
with the assistance
of Unesco and WHO

Unesco House
Paris, 26-29 February 1968
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The Unesco series "Science policy studies and documents" forms part of a programme "to collect, analyse and disseminate information concerning the organization of scientific research in Member States and the policies of Member States in this respect", authorized by resolution 2.1131 (b) adopted by the General Conference of Unesco at its eleventh session in 1960 and confirmed by similar resolutions at each subsequent session.

This series aims at making available to those responsible for scientific research and development throughout the world factual information concerning the science policies of various Member States of the Organization as well as normative studies of a general character.

The country studies are carried out by the governmental authorities responsible for policy making in the field of science in the Member States concerned.

The selection of the countries in which studies on the national scientific policy are undertaken is made in accordance with the following criteria: the originality of the methods used in the planning and execution of the national science policy, the extent of the practical experience acquired in such fields and the level of economic and social development attained. The geographical coverage of the studies published in the series is also taken into account.

The normative studies cover planning of science policy, organization and administration of scientific and technological research and other questions relating to science policy.

This same series also includes reports of international meetings on science policy convened by Unesco.

As a general rule, the country studies are published in one language only, either in English or French, whereas the normative studies and the reports of meetings are published in both languages.

The present publication comprises the complete proceedings of the Symposium on science policy and biomedical research organized by the Council for International Organizations of Medical Sciences with the assistance of Unesco and the World Health Organization, which was held at Unesco House, Paris, from 26 to 29 February 1968. The text has been checked by the Council for International Organizations of Medical Sciences, assisted by Professor Moshe Prywes, Rapporteur.

An Introduction outlining the origin and aims of the Symposium is followed in turn by the opening speeches, the exposition papers by "invited speakers" selected from among the participants, and reports of the discussions on each of the three topics of the Symposium, namely:

1. Institutional structure and organization of medical research.
2. Integration of biomedical research policy in the overall planning of science and technology.

The last part of the publication presents the conclusions unanimously adopted at the closing session on 29 February 1968.

Annexes show the agenda and the list of participants, and also the comments advanced by some of the participants on the working papers submitted for their examination.

It is hoped that the publication of these Symposium Proceedings will constitute a practical and effective form of assistance to organizations in different countries responsible for formulating and implementing at the national level a science policy which is both dynamic and well balanced.
INTRODUCTION

1. HISTORICAL BACKGROUND

The science policy programme of Unesco reached a very active stage in 1952-1953, with the study of the organization of research and of the scientific and technological potential of Member States of the Organization wishing to make their research activities known internationally. Thus as long ago as 1955, the first world meeting of Directors of National Centres for Scientific Research was held in Milan, with representation from more than thirty countries.

At that time, the majority of the scientifically advanced countries were just beginning to set up the government structures responsible for formulating their national science policy. The developing countries, for their part, were rapidly acceding to political independence. Thus on all sides there arose the problem of national development which we now recognize to have resulted from two simultaneous phenomena, namely growth and change, both of them influenced decisively by the application of scientific and technological knowledge.

Leaving the economists to study the questions involved primarily with growth, the scientists were destined to devote themselves to the process of change in contemporary societies under the combined effects of discoveries and inventions, and of their practical applications, on the lives of the people.

In 1963, at Geneva, there was held the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, known as "UNCSAT".

The 1,600 or more scientists gathered together at this Conference, including specialists in all disciplines and coming from all parts of the world, recognized from the start the important part played by the transfer of technology to the developing countries. But they were even more firmly in agreement as to the necessity for all countries to introduce progressively the conditions required for indigenous development by the rational application of science and technology. This was also the principle on which Unesco based its position and its vocation. In this way, a striking confirmation was provided for the first of the recommendations resulting from the study made by Professor P. Auger in 1960, and published by Unesco, on "Current trends in scientific research" - namely, that national science policies should occupy a place of highest priority in the deliberations of governments.

At the operational level, science policy calls for the development of the national scientific and technological potential, and for the application of the creative and assimilative forces thus rendered accessible for cultural, economic and social objectives. These are the two principal aspects of a true governmental science policy.

It is with this very object of promoting the national science policies of its Member States, as well as encouraging intellectual co-operation between the specialists of the different countries, that Unesco has included as a permanent feature in its programme the convening of meetings devoted to problems such as the organization of scientific research and its application to development. A dozen meetings of this kind have been held since 1959, in various parts of the world.

During these meetings it has become evident that the formulation of a national science policy assumes the existence of adequate institutional structures. In the majority of countries the need is to establish an organization responsible for formulating on behalf of governments a national science policy fitting in with the other aspects of development, and for ensuring the implementation of this policy.

Moreover, it has also been recognized that within the domain covered by the science policy itself it is necessary to co-ordinate the sectorial research plans and programmes and to assign relative weights to their importance in relation to the global research effort of the country. With the intention of bringing out more clearly the problems thus raised, Unesco has undertaken to promote the organization of a series of symposia, starting with biomedical research.

This is the framework within which it is proper to consider resolution 2.11 adopted by the General
Conference of Unesco at its fourteenth session (1966) and the corresponding work plan, which states "A seminar on the integration of biomedical research policy into overall national planning in science and technology will be organized by the Council for International Organizations of Medical Sciences, under a contract with Unesco and in close liaison with the World Health Organization." (para. 647 of the Approved Programme and Budget for 1967-1968).

While Unesco has a primary and essential part to play within the United Nations family in assisting to establish the governmental structures responsible for formulating science policy at the national level, it has only limited responsibility in the various sectors of applied research. Responsibility for those sectors within the United Nations system devolves on the various competent specialized institutions such as the World Health Organization, for example, in the case of medical research. As a natural consequence of this responsibility the World Health Organization is sharing with Unesco the sponsorship of the present symposium.

The general character of the organization of the Symposium was examined and approved by the Executive Committee of CIOMS at its 41st Session (March 1967). In the course of subsequent consultations between CIOMS, WHO and Unesco the topics and aims of the Symposium were finalized, and it was decided that the Symposium should be held at Unesco House, Paris, from 26 to 29 February 1968, under the title "Symposium on Science Policy and Biomedical Research, organized by CIOMS and sponsored jointly by Unesco and WHO".

2. TOPICS OF THE SYMPOSIUM

Three main topics were selected for the Symposium, namely:

(i) Institutional structure and organization of medical research (1)

- the definition, characteristics and types of medical research;
- the institutions responsible for carrying out medical research;
- the financing of medical research;
- the co-ordination of medical research.

(ii) Integration of biomedical research policy in the overall planning of science and technology

- the biomedical research policy;
- the integration of the biomedical research policy into the overall plan for science and into the overall socio-economic development plan (desirability of, and procedures for, integration, determination of the proportion of the functional science budget to be allocated to biomedical research).

(iii) Problems of science policy and legislation arising from medical advances:

- influence of medical sciences on man and on society in general
- the problems of the environment;
- the human individual and the species.

3. AIMS OF THE SYMPOSIUM

The principal result expected to be obtained from the confrontation of points of view expressed by the participants at the Symposium was a set of general directives, on the following points:

- the creation of bodies entrusted with the task of formulating and implementing policy in the field of biomedical research, and of ensuring their liaison with the government structures;
- the relations that should exist between the planning of national development - mainly in the social sphere, relating to public health and hygiene - the science policy of the government, and the national priorities selected in the field of biomedical research;
- the role of governmental science policy bodies as regards the ethics of science in relation to present-day morals and legislation, particularly in spheres involving biology and medicine.

4. PREPARATION OF THE SYMPOSIUM

CIOMS invited to participate in the Symposium a number of eminent specialists in the field of medical research and scientists entrusted with high responsibilities for the science policy of their countries: Professor J. Bernard (France) kindly agreed to be Chairman. Three "invited speakers" were selected from among the participants (see Annex I) to prepare working papers on the three topics of the Symposium, and present these papers in the discussions. The other participants were invited to communicate their written comments on the topics of the Symposium, if they so desired.

(1) It may be recalled here that CIOMS organized a conference on this topic in London in 1954. The report of that conference was published under the title: "The support of medical research", London, 4-8 October 1954 (Blackwell Scientific Publications, Oxford, 1956, 170 p.). Moreover, the U.S. National Institutes of Health (NIH) organized at Williamsburg, in the U.S.A., in 1965, an international symposium also on this topic, entitled: "Symposium on national policies for biomedical research: structures and processes for policy development". The report of the Symposium was published by NIH.
Dr. Florkin:
It is my pleasure to open this meeting today. Firstly I should like to thank Unesco, whose distinguished representatives, now with us, have put in so much work in preparing the symposium, for entrusting a large part of the organization to CIOMS.

CIOMS believes that the subject to be discussed by the distinguished personalities assembled here is of major importance. Unesco has shown its broad vision by indicating its belief that science policy cannot attain full development without making the medical and biomedical sciences an integral part of this policy.

I should also like to thank WHO for a further proof of its confidence in CIOMS shown by the presence here of its representative, Dr. Btesh, who has kindly agreed to spend a few days with us.

In addition, thanks are also due to Dr. Fattorusso who, together with Mr. Y. de Hemptinne and Miss N. Visart de Bocarmé, has contributed so much to the organization of the Symposium.

Finally, I must convey my sincerest thanks to Professor Jean Bernard who has consented to preside at this exchange of views, and I now relinquish the Chair to him.

Mr. de Hemptinne:
In the name of the Director-General of Unesco, I welcome you to this house, which I hope you will regard as your own.

As you know, the initiative for this Symposium stems from the fourteenth session of Unesco's General Conference in November 1966. In formulating the Organization's science policy programme, it was decided to hold an international symposium on the integration of biomedical research policy in the overall planning of science and technology at the national level. Similar symposia will also be organized for technological and agricultural research. Such activities well illustrate the purpose of Unesco's science policy programme, which is to co-ordinate scientific research with social and economic development at the level of governmental activity.

Unesco's science policy programme has two aims: international co-operation and collaboration in this new discipline which is still finding its way; and technical assistance to the developing countries to help their governments in introducing this activity.

Holding the opinion that the discussion should be completely free, Unesco asked CIOMS to organize the Symposium. I wish to thank that organization, and particularly the President, Professor M. Florkin, and the Executive Secretary, Dr. V. Fattorusso, for accepting this task. Thanks are especially due to the World Health Organization which, together with Unesco, is sponsoring this meeting and whose representative at this meeting, Dr. Btesh, is in charge of the Office of Planning and Co-ordination of Biomedical Research at Geneva.

The conclusions of the Symposium will be published by Unesco and will serve as a guide to the Organization in assisting its Member States to formulate a real science policy which will take account of biomedical research and the benefits it can bring to the nations and to all mankind.

Finally, I wish to thank Professor Jean Bernard, who has to be Chairman at this meeting, and also the General Delegation for Scientific and Technical Research in France which has given us the benefit of its good advice during the organization of the Symposium, and has delegated one of its officers, Mr. Dietrich, to be with us today.

Dr. Btesh (WHO):
WHO is extremely happy to join with Unesco in sponsoring this meeting.

WHO is especially interested in medical research on account of its importance at this time, when there are difficulties in the way of its full development. Unesco and WHO refrained from organizing this meeting directly, in order to make discussions as free as possible from governmental or political pressures. Entrusting the organization to CIOMS was for us a guarantee of the objectiveness of approach and we thank CIOMS for having accepted this task. We thank Unesco for having initiated this programme, and we thank you.
Mr. Chairman, for having agreed to Chair this meeting.

Dr. Bernard:
Among all the different kinds of scientific research, medical research is probably the most important and most difficult. For a long time it has been the most retarded and least respected; both its importance and its difficulty arise from its object – Man. This retardation and mistrust are due not only to the inadequacy of methods but also to a kind of timidity, as if Man was disturbed by being both the subject and the object of this research, and to a misapprehension as to its priority, because all research is in vain if Man's health is not assured. Medical research is essential and existential. It is sustained by Man in sickness and inspired by the basic sciences. Progress of a basic discipline and sometimes a discovery made, for example, in physics, makes it possible to cure a patient.

Having been held back for so long, medical research is currently suffering from the ill effects of a too rapid growth. Structures are outdated almost before they are established, credits become insufficient almost before they are granted and the conditions of work, and even of the lives, of researchers are endlessly changing.

Clearly, this Symposium must be based on a forward-looking viewpoint. Although this anticipatory approach is always uncertain, and particularly so in our field, it is the only one that has any sense. The situation of Man two-thirds of the way through the Twentieth century is very different from that at the beginning of the century. He is buffeted between the ills he has created and those he expects, crushed by the automobiles he himself has built, smashed by the atoms he has released, and yet on the brink of discovering the fundamental secrets of molecular science. One of the essential objects of medical research is to help this same man to find his equilibrium between what is permanent and what is new.

Medical research has become a function of the State, and this demands the reconciliation of conflicting, or apparently conflicting, conditions: the requirement for freedom of the research worker and the necessary planning of public health; the need for an increase in the medical research budget and the difficulty, or impossibility, of reducing the budget of other research areas; the need to develop medical research and the fear that the development and results of this very research will overtax national resources. This fear is serious and well-grounded. At the present rate of development, by the end of the century it will be difficult to support the progress of medicine with public funds. Medical research must aim more vigorously at preventive medicine and this aim should be one of the main preoccupations of this Symposium.
FIRST TOPIC

INSTITUTIONAL STRUCTURE AND ORGANIZATION OF MEDICAL RESEARCH

Dr. Bror Rexed

MEDICAL RESEARCH - DEFINITIONS

The discussion of biomedical research must begin with some kind of statement of the definition of what this research really is. I don't think one should pursue this subject too far, because it is to a certain extent futile to try to say whether some kind of research is basic or applied. For some reasons it is interesting to have the possibility of distinguishing free research from directed research, basic research from applied research or some other varieties that you might have. In the final assessment I think, however, the limits are so vague that this kind of discussion really doesn't lead you very far. I will use as working definitions in my discussion three separate kinds of research, without saying that they are very logically defined.

The first kind is what is usually called basic or fundamental research; this means research arising out of problems which the scientists feel to exist independently. I would restrict this, just for working purposes, to those kinds of research that are conducted in laboratories. This kind of free fundamental or basic research is the most theoretical one, the one where things really start, where ideas grow and where sometimes very original ideas go deep back into the structure of science. This kind of research sometimes, though not very often, also really revolutionizes other forms of research.

From small and rather inexpensive efforts in this area very big efforts can follow on the applied and clinical side. Look for instance at the very recent situation of molecular biology; the breaking of the genetic code cost relatively little compared with what big science can cost. All these important basic researches have, I think, cost only a few million dollars, but the importance is so far-reaching that we cannot yet understand it. It will change our attitudes to many kinds of clinical research. It will influence practical work we hope, some day, in the field of preventive care. We don't really know at present how these researches have affected us or will in the future affect us. I think this kind of research can be called either medical research, since it is done in medical institutions, or biological research. I think this is the area where you can most appropriately use the term biomedical research.

The second kind of research is what one might loosely call clinical research. With this term I designate simply medical research that is concerned with and conducted "around" patients. I say "around" patients because I include here several sub-varieties - laboratory research in the hospital, for instance, microbiological, chemical and physiological research must be included here; even if the researchers never see the patients, their work is centred around the patients and their diseases. Another example is the research conducted in the wards directly on human beings. It may be the surgeon's experimentation when he tries out an operation for the first time on a patient, or it may be instrumental studies involving the use of instruments on human beings, for instance clinical physiological and chemical studies of the heart, necessitating the attachment of many kinds of instruments. It may also take many other forms. I notice that this kind of clinical research is changing very rapidly. It used to consist largely of external observation of the patient, and that is still of course of great importance; I don't think we should undervalue this form of research. Without close observation and great experience it will not be possible even in the future to define symptoms and diseases. But today we can also use heavy and intricate instrumentation in conducting this research, so that the patient is not merely an item in the observation, but the centre of experimentation. This involves not only many physical and technological problems, but also problems of ethics.

There is also the statistical type of clinical research, i.e. summing up large numbers of cases, and processing the statistics to determine the epidemiological situation and problems. Here statistical, sociological, psychological and other methods are combined.

All this research I call clinical. It is centred
around patients, sometimes in laboratories, sometimes in the wards. Of course we may also call it simply biomedical research. However, that doesn't really serve any great purpose, since a biologist would find it very difficult to penetrate deeply into this research. The clinical scientist must really be a doctor, for he has to deal with patients, take responsibility for patients and handle them in one way or another. Biologists, physicists and engineers may be included in teams dealing with clinical scientific problems, but if they are so included they have to work under the medical responsibility of a doctor.

The third kind of research of interest is what I would call technological medical research. This is the type of research that is conducted with a technological approach, to develop products used in operations around the patient or on the patient. I call it technological research because it forms part of the research of an industry, particularly the pharmaceutical industry. This research is done not only for profit or production reasons, but also because of the large-scale findings, permitting analysis or possible remedies. It is a big job and a job that enters as a very natural thing for an industrial firm. Industries, to be growing and competitive in this new world, have to be very enterprising. They have to be aggressive all the time, they have to discover new possibilities and be the first to introduce them into new kinds of production. Research on pharmaceutics is flourishing in this kind of competitive environment. I notice that during the last twenty years practically all the great advances in pharmaceutics have been developed in industrial laboratories. I don't mean by this that university laboratories have not been important. Indeed they have, but when you come to the stage where you try to develop something with the direct idea of getting a pharmaceutical remedy in your hands in a short time, industry has been much closer and much more interested than professors in universities.

There is another industry growing up very rapidly too, concerning itself with this kind of question and this is the medical technological industry. Since research and medical care are becoming so difficult, complicated and dependent on instruments nowadays, we can see a new industry coming up, an industry developing in the first line, of course, instruments and equipment for all kinds of diagnostic and therapeutic research. But also special requirements in the treatment of the patient demand instrumentation, for instance radiological work and physical therapy in modern forms. To this must be added artificial heart and artificial kidney operations in surgical and internal medical treatment. I think there are many new areas developing here. Also in daily hospital work technology will become significant, for instance in the control of patients, in the automatic laboratory, in the whole area of hospital equipment. This kind of industry, active in medical technology, that I have just been trying to characterize, is developing very fast, especially in such countries as the United States of America and Japan. I think industry is showing a very lively interest in this area also in many other countries, especially of course, in developed countries where there are already mechanical and electronic industries as well as highly developed technological and biochemical knowledge and a good medical care system. All these developed countries are very favourably placed for this kind of industrial approach, and industry in such countries is showing a great interest in these questions just now.

INSTITUTIONAL LEVELS

Bearing in mind these three areas that I have tried to sketch, when we go on to the next question, namely, the institutions responsible for carrying out medical research, we will find that various kinds of institutions would have to be created to be able to take care of these different types of medical research.

You can see in any country that the research organization has three levels. The first is operational, i.e., laboratories in universities and research institutes, hospital wards, and industrial laboratories etc., where research work is actually going on. At this level you find examples of all three distinct kinds of research I have just been speaking of. This level is distinct from that of the organizations which are guiding or administering research.

The second organizational level is that of the councils and associations deciding priorities to a certain extent within a particular field. They have money to spend on various projects in various areas. Thus the second level is a sort of executive grant spending level. Sometimes these organizations also have laboratories of their own. This is the case, for instance, in France, where the Centre National de la Recherche Scientifique has large-scale laboratories. At the same time that Centre also, to a lesser extent, supports research in other places. The USSR Academy of Medical Science is also such a two-level institution. In fact its structure is even more complicated since it goes up to what I call the third level. It has laboratories of its own, however, and is spending money outside these institutions.

The third level is the governmental level - the level of the President's Science Advisory Committee in the United States or corresponding organizations in other countries. There are - as I have already mentioned - other possibilities at the first and second levels. The second level can also be organized in a way that is typical in the United Kingdom, where you have councils, for instance a Medical Research Council. This Council has its own institutions, such as the Mill Hill Institution, but it supports very largely research in universities, for instance through research groups. These groups have a more or less permanent structure
but they do not have permanent accommodation. Instead, they are housed in the universities. The Medical Research Council also uses money for outside research and gives grants to researchers in the university institutions. The organization constituted by the National Institutes of Health in the United States is another example of two-level organization. It has a very fine research institute of its own where theoretical and clinical work is combined. There is also a hospital inside the Institute. The organization is also an executive grant distributing body of great national importance.

In my country, being a small country with limited economic resources, we have only a few big separate research institutions. We work mainly with university institutions. At the second level - the executive grant-giving level - we have however a double organization. We have an office of the Chancellor of the universities, giving budgets and regular research funds to universities, and we have a Medical Research Council, channelling a certain amount of free money to research groups like the U.K. Council, or to top-level grants for scientists working in university institutions.

Concerning these three areas, I think money ought to come to the scientists through different organizations. The first one, the fundamental level of mainly theoretical research, has to be attached to the university, to a large extent, at least in small countries. It is a matter of history, tradition and feeling, whether you have special theoretical medical research institutes in a university or you combine them with biological institutes. But since research is always very stimulating, and raises its acolytes to a higher level of activity, it is good for a university to have active scientists conducting research there. It is also good to have special medical research institutes in medical faculties, just for recruitment, even if they are theoretical and even if sometimes biologists are drawn into them and are working inside the medical faculty.

The clinical work has to be done in relation to the patient. It is an open question whether all wards in university hospitals should have research to some extent. In most instances I think, however, this kind of research will be much of the observation and statistical type. Very elaborate modern, technically very delicate research, is best concentrated in certain medical wards, which have to be strengthened compared to the ordinary hospital clinic. Given special personnel and laboratories, specialists fall for this kind of research. Hence the organization of modern clinical research will to a large extent be the business of leading institutions at the second level. They will have to find the strategic points where these active research groups can be created inside the hospital structure and they have to provide them with additional money and staff.

Technological research, pharmaceutical research and medical technological development, are at least in mixed economies - the responsibility of the industries. It is of course, important to have basic research and clinical studies going on in this area too. It is vital for the medical care system to have functioning and effective pharmacological institutions in the university because, in the first place, there are many very fundamental questions which are easier handled there and which demand very great originality. Even if the findings don't immediately develop to pharmaceutics, something will perhaps come out later on. A second aspect is of course that of control. I don't think you can let the production, the control and all knowledge about pharmaceutics be solely in the hands of a private economy, in any country. You must have some body in the public service, of equivalent competence to - so to speak - stand up to the knowledge and competence of industry, for control purposes. And unless you already have effectively working institutions of the same level of competence they need not be of the same size, and they need not do industrial development work. They must however have the quality which makes them competent for a dialogue with industry and which can be used by governments for control purposes. The main work in the development of pharmaceutics, seeing what it costs and how complicated and risky this business is, must however be mainly the responsibility of industry. I am speaking here of what is called a mixed economy, where we have a privately owned industry and a government sector that is not primarily interested in production apparatus but is concerned with powerful means to direct the economic development. But even if we change this picture to the Socialist countries I think we are in somewhat the same position, because their economy is also important and the industry that produces the pharmaceutics will have to advance. The question is, where the work for advancement shall be done. Partly it has to be done in industry, partly it has to be done in university faculties just as I indicated for the mixed economy. Perhaps the pattern of interest will be somewhat different, but I think the problem of finding a new pharmaceutical product is just the same in a mixed economy as in a Socialist country, and the kind of mental and technological work that goes into the effort is much the same.

What I have said here of pharmaceutical products will also, I am sure, be applicable to other kinds of medical equipment and medical care instrumentation. Only if you get advanced technological industry interested in this process will you get fast development of products, which can be mass produced and therefore easily available. I think the question is now, how far is the governmental interest - from the third level - going to be shown? That depends on the inclination of the government to interest itself in industrial production. Most countries nowadays tend to be more and more interested in industrial production, since obviously this is the basis for their economic growth. But it is still an open question how a government should proceed to help, stimulate and force industry to advance, because this is a very complicated question,
It is a question of knowing the market, knowing production costs, knowing a great many things which do not easily come to a governmental organization. If the government is in control of industry the question is simple in one way. In a mixed economy it is not so simple. We work with different kinds of ideas here. In many countries development research foundations or special collaborative institutions are responsible for the contact between the government and the industry. They will also put industry into close contact with universities, and in such a way stimulate a more rapid feedback from university to industry than would otherwise be the case, and so on.

I think this kind of effort from governments in the industrial areas of medical research can only be supplementary. It is a sort of stimulant and a stating of needs, and therefore also sometimes an investment on the part of governments. But the large-scale effort must come from industry itself. That is because it is so costly that any large-scale industrial research work would make very large new demands on the taxpayers if it were to be only supported by governments. In Sweden, for instance, the research going on, and paid for by, private industry costs about as much as that which is paid for by the government. If we in Sweden were to develop large-scale industrial research with governmental money, I think it would mean that the government would have to double its research expenditure. Otherwise the effort would not be very important seen in relation to the total effort the industry is already putting in. Therefore, in this third level of medical research the government will have to play a stimulating role, the role of handing over well-trained personnel and the role of stating the needs. It will not however be the true leader of this kind of research or the main payer for it.

It follows from this kind of reasoning that it is very difficult to think of one organization at what I have called the second level of institutions to take care of the executive work of providing funds and handing over priorities to all these institutions. I rather believe there should be several organizations, several leading institutions at this level, some of them - but not all - under the control of the government.

FINANCING RESEARCH

I find it difficult to think of financing research simply as a matter of sharply dividing a given big sum of money for different purposes. I think that in any science policy system you are trying to satisfy some needs of the country. You want to defend yourself, so you have to develop arms; that is however not only to produce them, you have also to introduce new ideas for arms development. There are illnesses in the country; you want to combat them, so you develop medical research. Some of it is quite far away from the immediate treatment of the patient, but still you see it in this context. Some is quite close, like clinical research or what I have called technological research. The need is however difficult to make very precise, and so you must have a loose organization for your activities.

I find it useful to try to see the research needs in a functional context. This would lead me to think what is the theoretical biomedical basis for the research in medicine. I find it quite possible to use for that purpose as much as we can spend in the country, really, if we can find personnel for it. The question is not, however, to find the maximum that is available, but to determine the minimum. I would fix this minimum at the figure necessary to maintain satisfactory quality in the medical training organization and also in the health system. You must also have leaders trained in medical research, otherwise you cannot absorb new knowledge. This, I think, is a serviceable even if loose definition of the minimum.

It is a question of ambitions when the government decides how much it wants to spend on research. We have however to remember that we are conducting medical research in an international context. There is a very big international research effort going on and the research is of importance to every man and woman on the planet. The same kinds of facts apply to any patient in any country. Scientific knowledge is really freely interchangeable, most of it, anyway. There are sociological and psychological aspects which do not satisfy these criteria but these are not too important. Thus any country has to decide how much of this work it wants to develop itself and how much it wants to take over from outside.

Coming back to the case of Sweden, I could say that we produce something less than 1% of the world's medical knowledge. This is not much when you consider the total effort, but it is quite good for a small country. Therefore we should never think that if we have a disease problem it is absolutely necessary for us to solve it ourselves. We could never have that ambition, but we must be ready to accept the diagnostic or therapeutic solution the day it appears in some other country. We must also have people who know enough to see that the solution is there and qualified personnel to be able to take over and adapt the new knowledge to our own situation.

I stress very strongly that the question of financing medical research is of great international importance. At the same time I am convinced that we could not fix a certain sum as being necessary for medical research at the national level. In a way this is a very good situation, for a science policy body to have a certain minimum volume to keep up. This probably means that we must spend rather a lot of money on university and related research. Much of this money must however be kept free, so that we can switch it between our different scientific workers. Therefore we can look more for quality in Sweden rather than quantity.
It is more important for a small country - and perhaps if you look at the whole world's effort, most countries are small - to take proper care of the good people we have, and to give them really good support - among other reasons, because they will attract good workers and then produce new points of excellence in the country. We must always be ready to go into new lines of research, even though we may not work very deeply in all fields.

In a sense it follows from what I have said that it must be hard for any one agency to co-ordinate over the whole of this spectrum. I don't even know if it is something to wish for, because the question here is one of how best to promote advancement in reality. We think co-ordination will promote advancement, as it will reduce duplication of work, etc. Duplication is generally negligible, in my opinion. It is even good, because you must have somebody to criticize what other people do. However, when the information system among scientists is working well I think they tend to avoid duplication. No scientist would like to do what somebody else has already done, unless he has a special purpose for repeating the work.

Finding the best road to advancement means that you have to compare the proposals coming from below. The scientists find the new avenue along which they want to go and they see the new possibilities; I think that the most interesting possibilities can only be seen by the most original scientists. From the government policy side we have a general feeling of needs. We try to face them as squarely as possible and know that somewhere in the middle we have to meet. The science policy makers have to define the needs and try to find out if there are institutions and ideas enough to satisfy these needs.
DISCUSSION OF TOPIC I

Dr. Bernard:
I want to thank Dr. Rexed for his presentation and open the discussion by suggesting we examine the definition of medical research.

Dr. Chagas:
I agree that the definition we have been given can be a basis for work and food for thought, but I am afraid that to give full acceptance to this pragmatic definition is a step this meeting is not able to take. As an example of the importance implicit in accepting it, I should like to ask where research in as essential a subject as medical education would be placed?

If we accept the notion of a unitary concept of research, which is most important, since modern medical research is associated with all branches of science, including mathematics and physics, we see that the current trend of non-medical science policy is to make a division which does not correspond to this definition.

Dr. Aujaleu:
I also subscribe to Dr. Rexed's definition as a basis for work; at the same time I am interested in the frontier of biological and medical research. Where does basic research begin in relation to physics and chemistry? Is immunology an integral part of medical research? This clarification of the limits of biology and medicine is useful for practical purposes, in so far as it determines the financing agency.

I have reservations about extending the term "biomedical research" to all medical research. The object of medical research is an understanding of health and it is dependent on sociological and economic factors. Medical research cannot be absorbed entirely by biomedical research.

Dr. Btesh:
I accept the classification but I would like to add to it one additional type of research. Dr. Rexed spoke about the fundamental laboratory research which he calls biomedical research. He spoke of clinical research with its sub-classification of clinical observation and experimentation, and then technological research.

I would like to add the fourth group which is operations research in medicine. This is extremely important especially from the public health point of view and I would like that type of research to be recognized as research and to be so designated.

Dr. Bloch:
I am particularly happy that Dr. Rexed has included clinical research in his classification because I think it is most important that this area of medical research be stressed and helped. Since most of us here are, I believe, medically qualified, I am not offending anybody in saying that medicine as a real science has only come of age recently and that many methods which have been employed through the ages were not strictly scientific.

Now with so many problems facing medicine today, a new science has developed clinical research, which is a young science and which has to learn the scientific methods when experimenting in man. And this is where the great difficulty comes in because, as Dr. Rexed has already stressed, we are faced with problems of an ethical nature, with human problems which present themselves in few, if any other, branches of science. And I think it is quite important that organizations such as this should stress the necessity of developing this new science which is at the basis of the scientific application of scientific findings to man.

Dr. Handler:
I think that the most important thing is the similarity of definitions presented. This empirical and pragmatic approach is justified since it facilitates discussion and at the same time permits an understanding of the literature. I consider - and this is also the approach adopted by the National Institutes of Health in the U.S.A. - that clinical research is applied research as reflected in all the literature; it is undertaken by and is the responsibility of a clinician and should be performed on patients or biological material in the laboratory. This pragmatic definition has the advantage of avoiding more complex elaboration while conforming to scientific reality.

We should not be disturbed by the difficulties that arise through the definitions of research, since they are the cost of progress. Science has gone sufficiently far to be organized.

Dr. Prywes:
Dr. Rexed's remarks are important firstly because we are discussing science policy from a biomedical angle, and also because we have to link this with the teaching and training of research workers. In order to achieve this, we must study the best environment for assuring the future quality of research as affected by the level of training of the research workers. At this time we are witnessing the fusion of medical and biological sciences as well as technology, which is being achieved by awarding degrees covering several areas. More medical centres are being built where all three are being studied under one roof and in full integration. This is the way biomedical research should be constituted. Moreover, we now witness the creation of joint medical and science faculties (at ULM, in Germany) or even joint medical and engineering schools (in the Netherlands). It is not by pure coincidence that the Massachusetts Institute of Technology (U.S.A.) has been seriously considering the
establishment of a medical school within its own framework.

We should bear constantly in mind the importance of our decisions, especially in view of the wide publicity they will receive. I refer in particular to the developing countries where the structures are not based on a historical tradition, and where there is limitless curiosity and confidence in the judgements of the more advanced countries, but especially in the judgements of international organizations and meetings like ours. I want to underline the empirical nature of our definitions which we should use only with extreme flexibility.

The problem of government interference in scientific research does not arise in Israel, where the faculties and universities antedated the establishment of the State. However, we should remember that this interference increases with the extent of financial aid. If there is little communication between scientists and politicians, much of the difficulty is due to the fact that they do not understand each other's language. Reading the Congressional Hearings in the U.S.A. and discussions between representatives of the National Institutes of Health and politicians is a fascinating lesson in this regard.

Dr. Rexed: The only justification for a definition is that it facilitates discussion. We could in fact simply say that the definitions of applied and basic research have been developed in the past, not taking into account the evolution of science.

I agree with Dr. Prywes that it is quite possible for things to evolve to the point where medical and biological research become fused, and that the frontiers of the faculties and the disciplines cease to be of importance, leading to a complete readjustment of our structures. Biology and medicine will become part of a larger field of study which will include areas of agriculture and the prevention of pollution.

How can we assure the standard of medical faculties in the developing countries? Should we keep them separate and wait for the desired level to be reached, or a priori positively encourage the fusion which will certainly come about in the developed countries? I am not very certain what is more important for the developing countries. We should perhaps develop the clinical aspect, in terms of clinical research, and allow these countries to take over the prevention and treatment of their own problems. The training of research workers plays a major rôle and a certain minimal university level is required to ensure the standard of research and the development of a scientific approach.

Dr. Chagas: Mr. President, I should like to discuss the institutions responsible for co-ordination and the problems of financing, dealing in particular with the problems of the developing countries.

Regarding the application of science and technology in these countries, it is very hard to formulate definitions, or even criteria. The Advisory Committee for the Application of Science and Technology to Development of the United Nations Economic and Social Council has studied this question and has distinguished four groupings of developing countries, with subdivisions in the medical area which are even more significant than in the area of the application of physics, chemistry and technology.

Should the developing nations undertake medical research, and if so, why? This problem arises not only in this branch of science, but is even more acute in the technological sciences which lead on to industrialization. Dr. Rexed has already answered positively. Medical research is necessary, but it should be controlled by stipulations regarding the quality of research. There is also the ecological factor - medicine cannot be transplanted in the absence of a certain minimum level of development and local ability.

Where and how should this research be carried out? It would be best if medical research in the developing countries were carried out mainly, and even exclusively, in the universities and medical faculties for several years to come.

In many Latin American countries - Brazil, Chile, Colombia, Venezuela - there is a university reform movement embodying some of the concepts raised at this symposium. In Brazil, for example, we intend giving the basic research institutes all the functions of teaching and research which are the privilege of the basic chairs in our faculties. In the established faculties this trend is meeting considerable opposition from the professors of clinical medicine, but in the young faculties, such as Brasilia, total integration of medicine and basic science has been achieved. The problem of medical research is complicated in Latin America, as in France, by the demographic and democratic movements. The urgent need for doctors has made certain government circles turn the medical faculties into massive technical colleges where quality is sacrificed due to the urgency of the demand. Where university organization is not flexible enough to permit the massive and rapid training of doctors and medical research simultaneously, experience shows that the only solution is the establishment of specialized or interdisciplinary medical centres designed for training doctors of medical or biomedical sciences, associated with a university.

Leaving the level of the implementation of research for the level of planning and co-ordination, we should define the body responsible for the functions of the national research councils in the area of medicine. Should we establish a national council for medical research, or create an intermediate body consisting of a medical sciences section of the national research council, whereby the assistance awarded to the medical section would be based on biology or chemistry? This is a complex issue, and in a country such as Brazil, which is typical of many developing countries, we should not attempt to solve it by a single formula. The
important thing is to be able, at the highest government level - the ministries and the president - to defend the position, the needs and the aims of medical research.

The definition of medical science policy has the advantage, particularly important at an intermediate stage, of associating medical research with scientific and technological research. There would be an increased potential of material and personnel, and there would further be the possibility of utilizing the multidisciplinary aspect of the research council and medical research, as well as the experience acquired by the research councils. This scheme is not applicable to all the developing countries, but should be studied by those which possess a university infrastructure, experimental centres and co-ordinating agencies for science and technology but lack auxiliary services and general understanding.

The development of pharmaceutical research is crucial for the developing countries. If there is such research, it never extends to industry, due to the insufficiency of investments.

Dr. Bloch:
We should recognize the important role of public opinion in medical research. The taxpayer, through his elected representatives, gives his opinion on which areas of research ought to be subsidized. The public has the right to be informed, which is essential in order to be able to draw conclusions based on the facts.

What role will the scientists be allowed to play in the future of science, in the light of Clemenceau's claims that war was too important to be left to the generals? Should decisions concerning research be left to the politicians only? We should specify and define the position of the scientist, keeping in mind that he should spend more time in laboratories than in committees.

Dr. Naffah:
I want to mention two points concerning the developing countries. Firstly, there is the question of establishing laboratories under responsible scientific organizations. In countries where a national council for scientific research has been set up and granted consultative and executive powers, it has often neglected to establish its own laboratories. This causes a marked brake on scientific development, the training of research workers and the liaison between laboratories.

Secondly, there is the psychological and social effect of medical research in these countries. To counter the innate mistrust of the public, and sometimes the leadership, in national scientific achievements, rapid scientific results are needed, for which it is very difficult to obtain the necessary investments. Research workers with a recognized status, and laboratories belonging to the research agency, would be two powerful arguments in favour of budgetary allocations.

Dr. Aujaleu:
The unity of research is fundamental, we have all recognized this. Instead of dispersing our efforts we should therefore try to bring biomedical research workers together in the same research organizations and the same advisory committees. It is no doubt sometimes difficult to bring clinicians and fundamentalists together, but it is essential to ensure the unity of medical research and the unity of the organizations responsible for it.

As regards the execution of research, I do not think the university could be considered as a body responsible for medical research. The university is responsible for higher education, and this is inseparable from a certain amount of non-programmed research. But this does not mean that the university can be placed on the same footing as organizations designed to conduct oriented and programmed research, such as INSERM (the National Institute for Health and Medical Research) and CNRS (the National Centre for Scientific Research) in France. However, these research organizations do of course use the services of the same university research workers, and their efforts complement those of the university.

In the general orientation document, the functions of specialized biomedical research organizations were mentioned, and the following functions were suggested:

(a) construction and financing of their own laboratories;
(b) providing grants for outside laboratories belonging to other ministries or organizations;
(c) financing interdisciplinary research programs on priority objectives.

This strikes me as an unsatisfactory formulation, since (c) is not comparable with (a) and (b). In reality there are only two functions, those indicated under (a) and (b); (c) is merely one way of executing certain research, and may be effected either by the organization constructing and financing its own laboratories or by the organization making grants to outside laboratories. This being said, it remains true that both functions (a) and (b) are equally essential. It would not be desirable for one organization to monopolize medical research and refuse to support such research except in its own laboratories. While it is essential that medical research organizations should have their own laboratories available, permitting them to choose the fields for their main efforts, these organizations should nevertheless extend their support to research projects financed by the university, in particular: supplementary funds of this kind may be quite modest but still of decisive value. It remains to determine the respective shares of the two kinds of support - the answer will depend on the particular circumstances in each country. In the case of the organization which I direct, 65% of the financial resources are assigned to our own laboratories and 35% to outside laboratories.

As regards the private sector, this is, by
definition, not under our control. Hence, if we are
to preserve the so desirable liberty of the private
sector, it is difficult to contemplate tying it up to
given sectors of biomedical research. Much has
been said about pharmaceutical research. The
pharmaceutical industry is a typical private indus-
try, aiming at making profits. In view of this, there
would be great difficulties in the way of tying phar-
maceutical research to publicly supported research,
which is essentially not concerned with profits.
Another hindrance in the way of co-operation is the
fact that some university people are afraid of being
suspected of too close contacts with the pharmaceu-
tical industry, and there is the further obstacle con-
stituted by the absence of information regarding the
amount of funds devoted to research by the pharma-
cutical industry.
The question has been asked, whether the State
should take an interest in pharmaceutical research
and research on medical appliances. We should bear
in mind here that whenever it is desired to ob-
tain beneficial results quickly, private industry is
more successful than the State. Hence it is in rela-
tion to research whose results are not of immedi-
ate importance that the intervention of the State is
mainly justified. This is often the case as regards
research on medical appliances, whereas it is pri-
ivate industry that has produced the most strik-
ing results in the field of pharmaceutical research.

Dr. Handler:
I was pleased to hear Dr. Aujaleu show how France,
particularly since Napoleon, has been a rational
country. Unfortunately, this rationalism is not to
be found so often in other countries, particularly
mine, where we are less reasonable in our way of
seeing things. Dr. Aujaleu has spoken of the ad-
vantages, for those responsible and for research
itself, of this centralized organization. I think this
question should be settled less by the scientists than
by the politicians. I am aware that the way science
and research are organized in my country is a kind
of historical accident, and there is no relation be-
 tween what is done and what would have been done
had we been rational,
We have heard of the relatively low cost of re-
search on the genetic code compared with the results
it will bring. The cost is not as low as it would ap-
pear at first, since it includes the sum total of all
research that has gone before it. If we take pre-
vious research into account, the understanding of
the genetic code appears as the apex of a fantastic
pyramid.
In a centralized system, after a government de-
cision the subsidies flow from the control office to
the laboratory; in this way the Health Minister sup-
ports medical research. In the U.S.A, the various
government agencies receive requests from all the
research institutions, and an exchange system is
established to the benefit of everyone. This is simi-
lar to a political system where the lines of force
are the result of the activities of certain political
groups, public or national, each of which considers
it has a task to perform and feels responsible to-
wards the bodies dependent on it. It attempts to
obtain the maximum from all the institutions on
which it can make demands. Thus, the national in-
stitutions are responsible for 60% of the expendi-
tures in medical research.

This brings me to the point made by Dr. Bloch
about the paramount rôle of the public. Public opin-
ion is a function of society and it is its task to say
what it expects from those who are, by definition,
at its service. We must, therefore, educate pub-
lic opinion so that it can form a valid idea of scien-
tific priorities. The greatest progress has been
made in the area of technology and public health,
and not in actual medical research. We have failed
to educate our politicians or public opinion suffi-
ciently for them to comprehend how far we still are
from the goal we have set ourselves. Instead, we
are opportunistic. We haven't explained to the
public and to Congress how far we are from being
able to do what we would like to do. The difficulty
is to show the public that, as in the case of cancer,
the knowledge we have acquired often comes from
areas of research not basically aimed at cancer.
In scientific and medical research it is impossible
to foretell the implications of a research project.

Having failed in this task of information, re-
search has to pay heavily for it; the tons of scien-
tific articles offered as a justification for the money
expended do not convince the politicians and public
opinion, since they do not amount to a cure, which
we promised.

As for the possibilities of research within the
framework of the pharmaceutical industry, it is
ture that the industry has carried out research, dis-
covered medicines, and proposed a pharmacopoeia
and methods of cure; on the other hand, we in the
public sector are not always in a position to prove
the relationship between the sums requested and
the results obtained.

I am afraid that I cannot agree with Dr. Aujaleu
on the rôle of the university. Everything that the
private sector cannot undertake should be handled
by the university just as, in the Middle Ages, the
Church did not limit itself to the spiritual life, but
was involved with the whole range of man's activi-
ties - hospitals, teaching, welfare, etc., and what
today would be called non-profit enterprises. I
think that in today's world the university has re-
placed the Church in this context. The university,
at all levels, has the obligation to be aware of these
problems and to serve today's and tomorrow's so-
ciety; it must maintain its studies at as high a le-
vel as possible, but at the same time be cognizant
of the world's practical problems.

It is not enough for the universities to teach
theoretical physics; they should also have engineer-
ing schools. Our sociologists should not only think
in terms of mathematical models and study totemism
among South American tribes; they should also
deal with the problems in our own cities which are
tion was found to be impossible, and basic and applied research should be carried out in the Academy and its institutions, while applied medical research should be controlled by the Ministry of Health. This separation was found to be impossible, and basic and applied research are now carried out simultaneously in each institute.

Dr. Aujaleu made some very apposite remarks about the particular traditions of different countries. The situation varies in each national context. In Romania, several years ago, it was thought that basic research should be carried out in the Academy and its institutions, while applied medical research should be carried out in each institute. For a long time we have held that we could not have medical faculties if they were not in the vicinity of a hospital, the faculties are also responsible for treating people and delivering medical care to the community. There is a point where the requirements of basic research are intimately connected with clinical research and the role it can play in the treatment of man. In the world of tomorrow this necessity will be forced on the universities.

In discussing the pharmaceutical industry, it has been said that it is able to finance research more easily than the taxpayer. This is a false presentation of the problem; even if the industry supports research, this does not reduce the taxpayer's role. The important thing is that in certain countries, history and tradition are compatible with effectiveness and the question of profitability need not enter. In the U.S.A., the pharmaceutical industry is going through a difficult period due to the increasing control that is being exercised. It has to prove not only that the new drugs are not harmful, but also that they are effective and do not duplicate existing drugs. The investment in pharmaceutical research is so large that only the large firms can survive (in the U.S.A., about ten) and even those will rely on universities to do the basic research.

As for the problem of information, my feelings are mixed on this subject. No single human can absorb the volume of existing information, nor follow its rhythm. The important thing is to make sure that valuable knowledge is not lost, but that is another question.

I do not think that the vast amount of information presents any difficulty to the scientist. It is the administrators who are worried; the scientists know where and how to find what they want. Communication between distant branches is rare and there is nothing that can make any significant improvement in this area. It would be easy to use computers to record all the information and return a precise answer, but they would emit an indigestible mass of information. This is not as serious as it sounds since the scientist can always use the telephone to find out what he hasn't read.

Dr. Bîlbîie:
Dr. Aujaleu made some very apposite remarks about the particular traditions of different countries. The situation varies in each national context. In Romania, several years ago, it was thought that basic research should be carried out in the Academy and its institutions, while applied medical research should be controlled by the Ministry of Health. This separation was found to be impossible, and basic and applied research are now carried out simultaneously in each institute.

Dr. Handler:
Why complain if the system works? You spoke about a more rational system, but I don't see why. If a system works, it is rational. If you use the word rational in the sense of logical, you have to prove that with the same budget and the same elements you could get better results with another system. This would be interesting for your politicians to know, but I think it would be hard to show!

Dr. Rexed:
I would never advocate changing the system. I simply said that if we had only had one institution in the U.S.A., we should never have had so much money. So much money has been available only because there are a large number of institutions with varied responsibilities. The budget is the result of steps taken by Congress, not by the President. The President can suggest but it is Congress that decides, and perhaps people outside the United States do not appreciate this enough. There is a series of congressional committees, each with a strict relationship to a certain agency, and interested only
in this agency. The President's Office of Science and Technology and the Bureau of Budget try to see the totality, but Congress doesn't. Hence the size of the total budget, for which we are grateful.

Dr. Rexed: You have explained how Congress decides the budget for institutions, but eventually it is the President who decides. He has to accept budgetary proposals, and therefore he has an overall view. Congress, due to the bias of its committees, has a vertical viewpoint regarding the institutions, whereas the Bureau of the Budget has a horizontal view. The fact that the committees do not have an overall view will save them from the risk of unjustified attack. For ten years Congress has approved credit allocations higher than those proposed by the President. Special decisions are required for far-reaching action, and it is normal that the institutions should be in the lead in this field - atomic energy, space flights, etc. Other countries with the same objectives in mind (the U.K., France, etc.) have had to resort to the same organization.

The way things are, I think that the situation in most countries is different from the situation existing with the great powers, and we could recommend them to follow what was laid down in 1954 at the Conference organized by CIOMS on the support of medical research. Countries establishing second-level research organizations should create medical research councils, since these have been seen to be satisfactory wherever they are utilized, and have the advantages of flexibility and of being able to collaborate with the private sector or the universities. There is probably a great difference between the councils and the academies in those countries where one of them plays an administrative rôle. In the USSR there is an academy of medicine, and similar academies are to be found in the other Socialist countries where the situation is more or less the same, except that for historical and economic reasons evolution has tended toward independent research institutes. Of late, however, I think that this formula has been abandoned in the Socialist countries in favour of the universities and independent research. This, I feel, is the result of specific conditions; with limited resources and urgent health needs it was necessary to concentrate money in independent research agencies and leave the universities to take care of training. Since then, research has extended beyond these agencies and has taken hold in the universities (USSR, Czechoslovakia).

I wonder whether a country can support research in a unified manner in every area, permitting the integration of biology and theoretical and clinical medicine. In Sweden the Medical Council supports theoretical and clinical research, but in fact there is little difference between what is done in the biological laboratories and the medical research laboratories. In order to remodel this situation it would be necessary in Sweden either to take basic theoretical research out of its present framework and combine it with biology, or to remove biology from the council of natural sciences and merge it with medicine, establishing a biomedical council. However, people are very conservative, and prefer to maintain existing structures, while permitting certain interpretations. I think we should take up the recommendations made in 1954 and combine the national structures for science policy at the three functional levels, namely: (1) planning, decision and control; (2) co-ordination, encouragement and financing of scientific and technological research; (3) execution of research.

In countries with second-level organizations, they are generally either science academies or council (or centres) of scientific research; for medicine there is often a national council for medical research. This structure could be a great improvement especially in countries which are not yet organized. I think the first thing would be to have a medical research council which could make reasonable scientific judgements and hold discussions with the government regarding its requirements.

I agree with Dr. Handler on the function and importance of the American universities, and we in Europe have a lot to learn from them. Up to now our view of the rôle of the universities has been narrower and less liberal. Most people were unable to benefit from this type of education, and research work was not considered of great interest and the scientists led isolated lives. Research within the universities will play an important rôle in industry; we should try to develop good relations between them. I am not necessarily suggesting that the universities should take up development projects, but there are vast areas of applied work resulting from the contact between industry and the universities, and thanks to this the latter have a better idea of the field they are working in.

Dr. Servit: We have just seen the problems of science policy in a country as large and as rich as the U.S.A.; these problems are a little different in a Socialist country of more modest dimensions. The organization of medical research policy in Czechoslovakia stems from the country's history.

After the end of World War II medical research was predominantly carried on at the medical faculties. Only after 1945 it also left the university campus when its further progress was strongly influenced by the establishment of medical scientific institutes of the Czechoslovak Academy of Sciences, as well as of the Ministry of Health and finally the setting up of research institutions in the nationalized pharmaceutical industry. These three bodies, together with the medical faculties, comprise the network of biomedical research. All research is

* My contribution has been worked out in collaboration with Dr. Riha, member of the Science Planning Division, Czechoslovak Academy of Sciences,
financed by the State, either directly (from budget) or indirectly (industry).

The total expenditure on research in medicine amounts to 4.7% of expenditures on all the research and development activity in Czechoslovakia and 4% of the expenditure on health care.

The Health Ministry deals with clinical and epidemiological research and also with the important problems of public health. In the last ten years expenditures of the research agencies in the framework of the Health Ministry have increased by 7.8% annually, while during the same period expenditures in public health have only risen by 2.5% annually.

Research activity at the faculties of medicine is an inseparable part of the education process and therefore it is of interest to all fields of medical sciences. We think it necessary to extend the funds and to revise the education commitments at the medical faculties so that every teacher devotes 25-30% of his work capacity to research activity. In view of the character of medical research at the university, the distribution of resources should be decentralized. The funds allocated to the Ministry of Education from the national budget are distributed amongst the universities, and the rector decide on the amounts to be given to the faculties; the faculties are free to use these funds.

The institutes of medical research of the Academy of Sciences deal mainly with theoretical research oriented on the perspective requirements of health care and those of the development of the theoretical branches of medical sciences in Czechoslovakia. Besides, many institutes of the Academy are involved in medical research indirectly: the importance of medical research in the context of the Academy is due to increase as a result of the global effort being made by the Academy of Sciences. The Presidium of the Academy decides on the resources to be devoted to medical research.

The research at the institutions of the pharmaceutical industry is mainly determined by the needs and possibilities of the pharmaceutical industry, particularly by its market and investment trends. These institutions are directly financed by the pharmaceutical firms, which receive no subsidies from the State except for assigned research projects. Planning of medical research in Czechoslovakia is carried out on two levels. The first one is organized in terms of the functions of the theoretical and clinical branches of medical science and the institutions of the Health Ministry, the medical faculties and the pharmaceutical industry share the responsibility for it. On the second level, the integrated or complex topics for which it is necessary to refer to several areas of medical science, and to various research institutes and centres, controlled by different authorities (Health Ministry, Academy, faculty, etc.), are considered. This level is the responsibility of the Scientific Council of the Academy, with power to establish a prospective long-term project.

These two planning structures are imposed on our country by its size, its cultural level and the divergence between its national needs and the unity of sciences as an international activity. Czechoslovakia cannot depend on the results of its own research efforts in the field of public health and medicine, and has to use international results. This means that all the medical branches are maintained at a certain standard as much in terms of methodology as of theory.

Even though we think these two patterns are useful for our country, we are not satisfied with the results of the application. The need to integrate medical research with other sciences is constantly growing. The forms of co-operation and individual contact remain important and the invisible college should never be neglected.

Dr. Chagas:
I should like to return to the developing countries and point out that the disadvantages which are implied as being restricted to the developing countries could apply just as well to many developed countries (brain drain, lack of status of the research worker, etc.). The problems relating to medical research policy in the developing countries will be studied in greater detail later on in our discussions. We can say, in summing up, that every investment in these countries is made for the short term; medical research does not belong to the realm of immediate profitability.

The exodus of research workers, the brain drain, is an equally acute problem in the developing countries and in Europe. A study carried out in Brazil has shown that this "haemorrhage" is due neither to political pressures nor to the lure of higher salaries, but solely to working conditions. We see here the close relationship between the progression of medical research and the economic problems of development.

A characteristic of developing nations is their faith in medical research and the power of medicine as a factor in social development. Medical knowledge has always been an ideal in every society. The problem of research in these countries is an economic one, due in part to the fact that development is considered something that can be achieved by immediate industrialization or steps which yield immediate profits. This makes it difficult to obtain funds for medical research. The important fact for developing countries is not that they are obliged to live on foreign funds, but that the foreign origin of these funds suggests certain options.

Even if the new countries, which are not hampered by tradition, are sometimes able to make innovations in the structures they have established (e. g. Brasilia), they are restricted by the funds at their disposal. It is a classical saying that you invest too little in what you need and too much in what is successful. The mechanisms used for encouraging research are very primitive since in these countries research is considered an amateur affair. There is no professional conception of
research, which is thought of as an additional element in society but not integrated in it. Thus, in addition to economic difficulties, there are problems that could be easily overcome through information.

Dr. Prywes:
For the last few years, wherever we go and whatever we deal with, we are faced with the problem of the developing countries, and the significance and importance of medicine, public health, teaching and research in these countries. The subject has been discussed by the United Nations during the Geneva Conference in 1963 on the Application of science and technology for the benefit of the less developed areas, and at the ECOSOC Advisory Committee on the application of science and technology to development which has regular sessions.

In previous years, the Western countries spoke of the developing nations, but of late a new generation has arisen in those countries that views these problems from a different angle. Which countries can in fact be called "developing"? The definition certainly depends on the world situation; there are countries which are called "developing" on odd days and "developed" on even days. The problem is to find a satisfactory definition; even in the large and rich countries, such as the U.S.A., there are regions that may be called "developing", or even "underdeveloped", where war against poverty is a very first priority.

There is no master plan of Western origin applicable to the health problems of the developing countries. Just as in medical research, we should not commit the mistake of using the semantics that developed over hundreds of years in the West as a criterion for developing countries. This attitude is dangerous and we cannot help these countries to solve their own problems if we merely hand them the conclusions we ourselves have reached. I have already said that this Symposium can be useful if we do not limit ourselves to describing the medical organization in our countries, but attack its weak points as we see them in specific areas. It may be that many developing countries could learn more from our mistakes than from our blueprints.

I should like to return to the role of the universities in research, since there are no basic differences in this field in different countries. Above all, the universities are responsible for training and teaching. In some countries, however, there is thinking to the effect that the universities could fulfill additional functions without detracting from their task of teaching. In fact, the differences we find are not due to the image each country has of the world, but are functions of time, i.e. the state each country is in. You find the same elements everywhere, the scientist on the one hand, who wants to do research, the man in the street who wants improved medical services, and the politician in the middle who acts as the bridge between the two and urges on the scientist to give the public what it wants. This relationship between the scientific community, the public and the political set-up is similar in any country.

One of the troubles of the developing countries is the method of financing. Superb laboratories are constructed in one country just because a neighbouring country has them, and this is done without any survey of local scientific talent. First-class equipment is often left idle due to the lack of personnel. It is said that the politicians are responsible for these plans, and will be, it seems, for some time to come.

In the developing nations, the organization of research is best assured under the auspices of a university, which is the only centre of scientific manpower. This, however, does not always happen. The establishment of a National Institute of Public Health in Ghana outside the university has put medical research in that country ten years back. In Turkey, a group of enthusiastic young teachers established a new medical school which became one of the most advanced in the world. Above all, no solution can be guaranteed to succeed - it is men who decide, and irrespective of framework or inadequate facilities, enthusiasm will lead to success.
NATIONAL SCIENCE POLICY

The general orientation document raised, in outline form, a series of questions concerning "Integration of biomedical research policy in the overall planning of science and technology" and also briefly considered partial answers to these questions. Today, we can but extend these partial answers but cannot hope to find complete answers.

It is not my intention to present a detailed treatment of this subject. Rather does it seem appropriate to place these matters in general perspective and provide a framework for our discussions.

As national expenditures for research and development have mounted in the past two decades, in almost every nation there has developed a growing literature concerned with "National Science Policy". Invariably, it is recognized that both applied research and development, directed to perceived societal needs and established goals and fundamental research in which questions are directed to nature should be significant components of governmental activity. Inevitably, such discussions become concerned with the development of rational mechanisms for allocation of resources among the components of these endeavours. It is clear that it is possible to develop a philosophic approach to such problems but, regrettably, it is impossible to develop a satisfactory formula which will provide quantitative answers.

The notion of a single national science policy is intrinsically without meaning. The conduct of research, the development of technologies, and the application of the understanding and technologies thus derived to human affairs has become the very business of government. Science, the mother of knowledge, thus becomes among the most important of national resources; the adventure of scientific research also becomes the main access of a nation to the determination of its future and the manner in which this is given support is an expression of the drive and ambition of an entire nation. Accordingly, science policy and overall government policy become almost one and the same: planning for science becomes amongst the most meaningful aspects of planning for government in the large. But, by that token, there can be no single national science policy except in so far as it relates to those measures necessary to assure as vigorous and comprehensive as possible a national effort in all aspects of fundamental scientific research and to assure the training of future generations of investigators. Beyond that, there must be planning and budgeting which relate clearly to national goals—planning for health, for defence, for transportation, for communication, for agriculture, for education, for upgrading industrial technology, for improving the quality of life in the cities or on the farms, for exploration of space or of the ocean, etc. Within each of these rubrics it becomes pertinent to ask what fraction of the total relevant expenditure and effort should be utilized for research, both fundamental and applied, and for development. It is the aggregated sum of all such categorical expenditures, plus any specific expenditures made in the name of science itself which then properly constitutes the national science budget. And it is the sum of the planning which led to such a budget which constitutes national planning for science.

Such an approach will probably result in greater total appropriations for scientific activity than might result were there a single co-ordinated science budget developed by subfractionating a national predetermined appropriation for all of science. This pragmatic approach is not intentionally crass. Rather does it give appropriate expression, in the budgetary planning process, to the needs of the society which supports science and to the bases for such societal support. In this sense, the seeming premise underlying today's discussion, the supposition that it is both appropriate and necessary to plan the integration of biomedical research policy within the framework of overall planning for science and technology becomes but a half truth.

This does not, however, lead to quite the simplification of the planning process that one might hope. The chief complexity in such planning arises from the fact that each decision must be taken in a
multidimensional framework with widely differing value weightings and so interconnected that each decision appears to affect every other decision. Let us examine this problem in somewhat greater detail.

The conduct of fundamental research is a hallmark of modern civilization that gives purpose and direction to our society and to the individuals of which it is composed, creates a sense of national adventure and contributes to the tone and quality of life for all citizens of the communities within which such an enterprise is fostered. It has been said that science today "bears much the same relation to contemporary civilization that the great artistic and philosophical creations of the Greeks did to theirs, or the great cathedrals did to mediaeval Europe. In this sense, not only does it serve the purposes of our society, it is one of the purposes of our society". At the same time, there is hope and historical justification for the belief that the information the understanding, the concepts, and the techniques so derived will find application in programmes more specifically directed to immediate social purpose.

If considered in isolation, the nature and magnitude of the fundamental research enterprise in any nation need then be sufficient only to assure such cultural impact on the tone and quality of life of the community. Funds for its support, therefore, would properly be competitive with funds for the support of the performing arts and the humanities, for example. If this research is performed in institutions of higher learning, then its magnitude must also be commensurate with the educational purposes of such institutions. Faculty and students need be meaningfully engaged in asking questions of both animate and inanimate nature with sufficient intensity to maintain their intellectual powers, to assure that the education of the next generation is lively, sophisticated and au courant with progress in the relevant disciplines. Were these, then, the only meaningful criteria, support for fundamental research, in almost every society, would be provided grudgingly, would undoubtedly be minimal even with respect to these limited goals, and could quite appropriately be charged against a national budget for culture and for education, respectively.

But because, in every nation, scientific progress is essential to a wide variety of additional purposeful and more specifically defined goals, society, quite logically, will support a considerably larger national scientific enterprise in which these further expenditures will be charged against other components of the national budget. By this line of reasoning, the hypothetical question, "What fraction of the national science budget should be allocated to biomedical research?" loses all meaning, because, in truth, there is no national science budget. Rather there are budgetary allocations for health, for education, for agriculture, for upgrading industrial technology, for urban redevelopment, for defence, for exploration of space or of the ocean, etc.

Within each of these rubrics some fraction of the total expenditures should be utilized for research and development. And there is no reason why this fraction should be constant among the major budgetary components. In any case, it is the sum of all such expenditures, plus any specific expenditures actually undertaken in the name of science itself which then properly constitutes the national science budget. Necessarily, the gross allocation of funds and resources to these major social goals is achieved by appropriate political decisions.

Patently, it will not suffice to construct a national science budget by the simple aggregation of such appropriations. Each operation within the entire endeavour must be viewed in several dimensions, and this requires the existence of an office, high in the councils of government, with the capability and authority to provide assurance that maximal progress has been assured towards each of the relevant goals. This is complicated by the fact that a single investigator in a university setting is, simultaneously, engaged in his part in the scientific-cultural endeavour, and in the scientific training of the next generation, while he also is engaged in research directed to some social goal such as the understanding of schizophrenia, seeking an effective anti-viral agent, or pursuing solid state physics with a view toward microminiaturization of electronic components. This office must assure that, in the aggregate, the budget neither exceeds national capacity in terms of available scientists and physical plant nor allows these to go idle, optimizing utilization of these valuable resources. It is the obligation of this office to be certain that the totality of the endeavour also assures continuing progress and national capability in the specific scientific disciplines, which, in larger nations, range from molecular biology and surgery to materials science and astrophysics. To be most effective, such an office must have meaningful input early in the budgetary planning process, yet it should not serve as a planning body making either financial allocations or specific research assignments to be accepted by the operational units of government organization. In the main, research plans and accompanying budget requests should arise in the scientific operational units.

PRIORITIES IN NATIONAL SCIENCE PLANNING

Such a planning body, however, should have established broad priorities for the overall scientific enterprise and its oversight of the planning process should be accomplished within such a framework. Foremost among these priorities should be the assurance that, at all times, future generations of investigators are being adequately trained and that their numbers bear reasonable relationship to rational projections of the future magnitude of the national research endeavour. Second priority should
probably relate to the vitality, stability and growth of the organized institutions which, in that nation, have been created to serve these scientific ends. Almost universally this will include the universities: frequently, however, it will also include large, autonomous laboratories. Third priority might well be given to assuring that as many scientific disciplines as possible are so supported as to assure a substantial current national effort and future capability. Note that these are all priorities for science itself: they are concerned with the character of the present and the assurance of a national capability for tomorrow. Despite the nature of budgetary process which we have already considered, the distribution and allocation of resources, reckoned in terms of national social goals, should properly be given fourth priority since successful advancement toward these goals is possible only if the first three priorities have been successfully managed. It becomes the obligation of the central planning body, therefore, to relate these priorities, formulated in terms of the scientific endeavour, to the political realities which have given shape to budgetary allocations.

In a nation where the total support of science is organized as it is today in the United States - only a small fraction of total financial support for research and development will be expected to be appropriated in the name of science itself. Both the central planning body and the operational agencies must then recognize the need to fund fundamental research through appropriations made for categorical social purpose. Under these circumstances, one class of scientific expenditure then finds itself even more remote from the central planning body, therefore, to relate these priorities, formulated in terms of the scientific endeavour, to the political realities which have given shape to budgetary allocations.

As we have noted, it is the obligation of the central planning body to relate available resources of trained scientists and facilities to the allocations made in terms of broad national goals. In American experience, one of the chief attributes of a successful national scientific venture is to increase the national appetite for yet further scientific endeavour, generating an ever increasing need for trained scientists. By all available indications, a similar situation obtains in the Soviet Union. The magnitude and existence of the so-called "brain drain", however, indicates that other nations have not yet successfully invented social forms and institutions which provide adequate opportunity for the scientists, engineers, and physicians they have educated.

The problem of allocating manpower and facilities appropriate to the various national goals is somewhat less difficult than it might seem on initial examination. The competition is lessened by the fact that both the types of trained manpower and facilities appropriate to progress towards each national goal vary considerably. Whereas research and development activities appropriate to national defence, domestic technology, space or oceanographic programmes require large numbers of electronic engineers as well as physicists and chemists, in the main, biomedical research still leans largely upon physicians and those trained in the life sciences. Only a relatively small number of chemists, physicists and engineers can usefully contribute at the present stage of the development of the health sciences. In this sense, therefore, planning for the future of a national biomedical research endeavour can be conducted relatively autonomously. The important decisions are determination of the total appropriation for health purposes and the fraction of that appropriation which shall be allocated to the research component.

BIOMEDICAL RESEARCH POLICY

When we turn more closely to examination of national biomedical research policy, we discover in effect, a smaller scale version of the decision-making problems of the totality of the national scientific endeavour. Almost universally, nations have recognized the need for prosecution of medical research and have accepted the proposition that financial support of this endeavour is a proper function of the central government. That decision constitutes the paramount element of policy making.

Having taken that decision, it becomes necessary again to establish priorities and make allocations. And again, a relatively loose "semi-planning" concept appears to be appropriate. A central body must have an overview of the medical research enterprise, exercise an early input into the planning process and participate in determination of the broad programme objectives which will define the allocation of resources. But again, the germinal ideas must, in large measure, come up to the planning body from individuals and organizations below if the programme is truly to be successful. And again the same general set of priorities would appear to be overriding: research training for the future, strengthening of institutional mechanisms and forms, establishment and maintenance
of strength in the relevant scientific and clinical disciplines and lastly directed research endeavours with specific health objectives in view.

Thus, in health, as in the total scientific endeavour, the objectives which are most readily comprehensible politically, must, in truth, be given fourth priority in planning.

Were the problems simple and easy of solution, or if one could be sure that a massive infusion of money and resources could assure markedly accelerated progress toward a cure for cancer or schizophrenia, a successful treatment for schistosomiasis or prevention of atherosclerosis, these priorities might be inverted. But since, patently this simply is not the case, planning must be of long-range character, thereby determining the priority rank order.

Even the most broadbrush planning of such an endeavour requires understanding of the tasks which lie ahead. In all likelihood, the relatively easy medical triumphs probably lie behind us. The increases in longevity and decreased mortality tables over the entire life span which have been enjoyed by the developed nations largely reflect improvement in economic well being, in the general quality of life, the simple elements of hygiene, more adequate clothing, shelter and food for that portion of the world's population which has partaken of these benefits. The medical research community can make little claim to contribution to these great accomplishments, indeed, they do not even reflect advanced understanding contributed by the "human" or social sciences. Rather have they been the consequence of the industrial, agricultural and scientific revolutions and their respective contributions to the nature of human societies.

Even the genuine triumphs have been achieved by application of knowledge which was, essentially, empirically obtained rather than the consequence of deep fundamental understanding. Surely this was true of the triumphs of antibiosis, prophylactic vaccination, hormone replacement therapy, successful management of traumatized individuals, and the surprising success of cardiovascular surgery. Abolition of acute vitamin deficiency states in some parts of the world, e.g., of pellagra in south eastern United States, or of rickets and scurvy in Europe, really reflected improved economic factors far more than they did enhanced medical understanding. While the pharmaceutical industry provides today's physician with an ever-expanding armamentarium of useful drugs, these provide no cures, but only supportive therapy, however effective it may be. I must remind you that there is not a single instance for which one can provide an acceptable and useful description. In molecular terms, of the biological structure on which a specific drug is actually operative, nor a truly convincing rationale of its modus operandi, regardless of how useful the drug may be. Consider, for example, aspirin, atebrine, digitalis, cortisone or the contraceptive progestins. Indeed, quite the converse has frequently been the case: for example, much of current knowledge of bacterial cell walls derives from attempts to understand the mechanism of action of penicillin. As a biochemist, I would be much happier, more sanguine about the future, had this history occurred the other way around. Nevertheless, the power of modern science to gain understanding which then permits definitive problem solving is everywhere in evidence and we must pursue this course. As we give thought to the ills which beset man, even in the most comfortable and affluent environments he has yet attained, it is clear that current understanding of normal human biology and of the pathogenesis of almost innumerable chronic disorders is insufficient to provide a basis for the rational development of regimens to cope with, much less cure, neoplastic disorders, atherosclerosis, the arthritis, several hundred hereditary disorders, to say nothing of mental retardation in the young or the major and the minor psychoses. Accordingly, it is imperative that civilized man continue in his attempt to understand himself and the disorders to which he is subject. There is no guarantee that such efforts will be successful in the long term, but it is also patently true that if there are no such efforts, the biological limitations of man as we now know him, will be visited upon our descendants. 

But there can be no clear-cut prescription for guiding such endeavours. At this level, planning can do no more than provide resources and support for talented scientists who will pursue their own bents, always exercising skilful opportunism, i.e., periodically reassessing their own efforts to be certain that, at all times, each addresses himself to the most important single problem which, in his judgement, presently appears to be susceptible to analysis with the intellectual and physical tools in hand, and to which his own training and inclination have suited him and to be certain that he is taking maximal advantage of understanding and techniques provided both by his and other scientific disciplines.

PRIORITIES IN MEDICAL RESEARCH PLANNING

The breadth of this underlying fundamental research endeavour, in any given nation, must be dictated by its own resources. All embracing, comprehensive research programmes are today possible in only a handful of nations. This derives from the fact that, with only a few notable exceptions, modern science flourishes only where there has been gathered a minimal critical, intellectual mass. Accordingly, after providing a sufficient range of trained scientists to assure the general education of the next generation, frequently it is necessary to focus the research and research training endeavour on a relatively restricted number of areas.

In the United States, fundamental biomedical research occurs preponderantly in the university-based medical schools where it is associated with
the training of both future practitioners and biomedical investigators. As modern medical research becomes more sophisticated both scientifically and socially, it is increasingly apparent that the classical four-year medical education followed by specialty residency training is insufficient to the needs of the modern investigator. This has led to the genesis of diverse programmes for strengthening the education of the medical investigator in one of the scientific or social scientific disciplines.

The second priority related to strengthening of the institutions in which the biomedical research programme is to be lodged. Outside the United States, for example, in the Soviet Union, the research endeavour has become principally a function of autonomous research institutes. These are responsible neither for education nor for any large fraction of the delivery of medical care. The American history may be of some interest. Three decades ago, medical schools were lodged in universities, engaged in minimal research programmes and had but incidental responsibilities for the delivery of care in hospitals which were not directly under their own management. Commencing two decades ago, the research endeavour began to grow at a substantial rate. Most recently, by national consent, we are attempting to vest in the medical schools a major responsibility for the delivery of care to the community and for assuring the quality of medical care in communities remote from the university-based medical centre. Thus, it is now national policy that the diverse medical goals of our society are to be served by focusing the research and educational endeavours within a single medical school-hospital complex which has markedly expanded responsibilities for the delivery of health care. In this single setting, the investigator, teacher, student and practitioner come together: hopefully, this catalyzes fruitful interactions in which the activities of each enrich the experience of all. Research endeavours are brought into sharper focus. Education becomes less empirical, patients fortunate enough to present themselves to such an institution receive the best of medical care and the health problems of the society are paraded before student, teacher and investigator. These organizations have become the loci of medical research and serve also as the primary interface in the transfer of new knowledge into medical practice. They are - or should be - the repository of medical excellence. This pattern is not placed before you as a recommended model. Rather have I dwelt on it to indicate that each nation should consciously appraise this problem and make deliberate decisions in full awareness of their implications. Whatever the actual decision, second priority should be accorded efforts to assure the strength of the chosen institutions in which the main thrust of the nation's research is to be located.

Third priority was accorded to maintenance of strength in the underlying scientific biomedical disciplines. However, as we have noted, beyond the minimum which is essential to the general educational process, clear decisions are required. Where funds suffice, it would be of utmost value to maintain research competence in a highly contributory fashion in all relevant disciplines. Where this is not the case, as in most smaller nations, it would be most rational to give emphasis to those fundamental disciplinary efforts which will strengthen the more applied programmes to which high priority has been accorded.

Finally, having assured the vitality of the underlying educational and research programmes and of the necessary institutions, planning then requires allocation of resources in terms of social problems: the major chronic diseases, infection and infestation, nutrition, mental health, bio-engineering, hospital management and improved techniques for the clinical care of the acutely ill, population control, and the social problems of man in a changing society.

Choice and decision-making at this level should be accomplished jointly by biomedical scientists and representatives of the public. When functioning in this role, the scientist must display the same skilful opportunism which, hopefully, he employs in his laboratory. It is for him to state when the stage has been set and the time is right to embark upon a substantial enterprise directed, for example, at the design and construction of an artificial heart, therapy for schizophrenia, prevention of atherosclerosis or a screening programme for hereditary disorders. In concert with his lay colleagues, he can and should meaningfully participate in the allocation of national resources in terms of these major medical problems. In a rational world, one might expect that such allocations would reflect the incidence and severity of these disorders or problems themselves. But it is extremely unlikely that the scientific preparation required will come available at equal and concurrent rates. Accordingly, the biomedical scientist must participate in these determinations, indicate when opportunities have presented themselves and thus determine where and when to mount a large national effort.

Surely the scientists of developing nations will urge focusing upon acute indigenous problems rather than the chronic disorders which occupy the attention of the more developed areas. Schistosomiasis, trachoma, malnutrition and malaria readily come to mind. Attention to reproductive physiology and the biological and social aspects of population control are nowhere more important than in nations of the tropical and subtropical belts. Such programmes can achieve huge social benefit both in classical ethical humane terms and by rational cost/benefit analysis. As such, they stand in contrast to many recent and future successful accomplishments in the management of the chronic disorders which occur in the later year of human life. Success results in yet larger and prolonged expenditures for continued care, frequently in considerable excess of the diminished or vanished...
earnings potential of the patient. Nevertheless, no intrinsic value can be placed on human life, and this course must continue.

Most importantly, the time has come to broaden the scope of the term "biomedical research". As we have indicated, to be sure, there is yet much to be done along classic lines. But daily it becomes ever more clear that the overriding problems of man are adequate nutrition, population control and the wretchedness of the ordinary man in an urban setting. A smaller nation, which perforce must limit its endeavours, would be wise to give highest priority to efforts directed at improvement of the food supply and at management of the future size of the population. All urbanized nations must give increasing attention to the physical and mental effects of crowded, noisy, polluted, highly competitive but drab existence, particularly on ageing populations.

This will require vastly greater, more sophisticated emphasis on behavioural and sociological science which must be embraced in medical planning if purely biological control of chronic disease is to be a meaningful endeavour.

Finally, it should be clear that this system of priorities is not congruent with any system of budgeting. It is a means of stocktaking, of assessment of national effort. Patently, a single transfer of funds may, at one and the same time, support training and research in immunology, strengthen a medical school, and directly contribute to a programme designed to eradicate bilharzia. But the planners and decision-makers should overtly recognize that fact and utilize the funds at their disposal to achieve maximal progress toward each of their objectives according to some loose national plan.
DISCUSSION OF TOPIC II

Dr. Bernard:
I want to thank Dr. Handler very much for his remarkable exposé. I hope the world he has described will soon come about. Concerning the past, he rightly stressed that success is due more to economic progress than to what the doctors have done; regarding the present, research workers should constantly revise their work and, as for the future, the main priority is to be ready for tomorrow.

Dr. Bloch:
As pointed out by Dr. Handler, medical progress alone is not always solely responsible for significant changes in disease patterns. Take the decline in tuberculosis mortality as an example. Only in recent years has medical progress been involved and if the secular curve of the steadily reducing mortality were plotted against the use of soap, there would also be positive correlation. And this has little to do with medical progress!

What Dr. Handler has to say about the developing countries is important. While one cannot tell scientists what they should do, it is more meaningful if they deal with problems in the context of their own countries. In the United States of America, the scientists and the public speak more or less the same language. The best example of this is agriculture. In India, 79 per cent of the population work on the land and the results are appalling; in the United States of America, only 11 per cent are engaged in agriculture and the government pays farmers for not growing certain crops. This shows what can be done when research is directed toward the needs of society.

We must realize, however, that success can also be expensive by bringing problems that require financial aid and additional research. We help create these problems but evade the responsibilities they bring. Basically, it is a question of the division of work, and we should not forget how things were in the past. The doctor did not deal merely with health and healing — he held an important position within the family and was directly concerned with the results of his work. This link has totally disappeared today.

Dr. Florkin:
Dr. Handler has stressed that biomedical research policy can be based on promises made to the public and that politicians can be convinced of the ultimate value of science to mankind. This issue had been argued from Cyrano de Bergerac to Condorcet, who introduced this concept to American thought. A recent example of the amazing nature of this system can be seen in the President of the United States' announcement, made before even the biochemists were notified, of the synthesis in vitro of DNA in an isolated enzymatic system.

Dr. Handler:
The incident you refer to was in fact a historical accident. The important point here was that the President could announce an important scientific discovery at a press conference. In our society, scientific activities have become news, but this does not imply that the people have rejected other values. On the contrary, I think that society is today richer in values, as interest in the arts is also increasing. People need a goal and this interest in science is genuine.

Dr. Servit:
I want to say a few words on the subject of the specialization and disintegration of science, particularly in medicine.

In the last decades we have witnessed an increasing specialization in all the fields of science, and this process goes hand in hand with its disintegration into sub-branches in which narrowly limited partial problems are investigated. The reason for this usually is the extremely specialized methodology.

This phenomenon is not so urgent in medical branches as in the others since the common denominator of all the branches of medicine is Man. But this phenomenon is intensively felt in contact with the adjoining branches: with psychology, sociology, numerous branches of biology, but mainly so in collaboration with all the branches of technical sciences. It also is one of the reasons for the various "anthropological" trends in philosophy. Everywhere — in medicine too — we feel strongly a lack of synthetic experts, capable of critically surveying the broad sphere of science. Differently broad "boundary spheres" arise between the individual branches and some uncovered "interdisciplinary spheres" too.

The disintegration is beginning to affect the pedagogical process as well as the medical faculties — thus at some universities the lectures on internal medicine or on physiology are divided into partial courses of cardiology, nephrology, gastroenterology, etc., where lectures are read by different specialists.

Science is aware of the adverse consequences of this process. The attempts so far made to solve this situation are of two types: to establish complex research teams, and to form interdisciplinary branches aiming at bridging the interdisciplinary gaps. As far as medicine is concerned, it will evidently be necessary to educate synthetic experts capable of following the broad spheres of medical sciences. They will be very useful mainly in the pedagogical process and in the management of science.

The involved problem affects not only science itself, but also the science policy in a broader sense.
A choice is necessary to determine where the maximum effort should be made, and the scientist is not alone in this matter - political power and public opinion also decide. An example of political and public choice can be seen in the creation of an institute for multiple sclerosis research which the scientists were not entirely in favour of, preferring to deal with neurological and virological problems. Thus, my first comment is that the social problems become the greatest difficulty once the tools are provided.

My second comment concerns Dr. Handler's opinion that recent progress is due to economic development; this economic development has been made possible largely by the advance of medicine, and not only by machines. In the developing countries, the health of the population is an essential factor affecting economic development.

Thirdly, it has been said that the small countries should restrict themselves to nutrition and birth control. Switzerland is a small country, but I would not venture to tell the Swiss to stick to such limited activities.

Finally, I want to say that I do not find the United States' President's announcement of a scientific discovery so remarkable. The interesting thing is that he spoke of a basic discovery that the general public could not have understood properly. In my opinion, this is proof of the maturity of the American public and this may explain many things about the development of research in the United States of America.

Dr. Prywes:
I want to return to the subject of biomedical research and the problem of old people and the chronically sick. In a general way, we can say that by promoting biomedical research, we are helping to increase the proportion of old people in the world, and this will influence our work. If we are to discuss the moral and ethical aspects of this as our third topic, we should now determine our goals and decide how far we wish to proceed. Contraception will have a considerable influence on tomorrow's society, and as the birth-rate falls and the proportion of old and chronically sick people increases the structure of society will change.

What will be the main tasks of medicine if and when half the population consists of old people? Even though we will be able to make progress in the study of congenital diseases, this means that we will increase the number of people kept alive suffering from chronic diseases and degeneration. This trend is becoming more evident all the time but are we taking it into account when we establish medical faculties, hospitals, etc.? If the study of genetics continues its present trend, man may live to the age of 150 or 200. This will necessitate a total revision of our ideas of average age, retirement and pensions; it brings into focus the problem of mandatory retirement at universities, for example, even when there is no suitable replacement.
There is also another aspect of the relationship between medical research and the type of society. In certain sectors it is hard to attract students to specialized studies such as chronic diseases, mental diseases, retarded children, etc., and we have to consider how to train people for these tasks.

Science should not merely explore the unknown, but should also exploit the known, especially in the developing countries. It is said that if some of these countries had possessed the means to tackle their basic problems, they would have solved 80 per cent of them by now. However, if the problem were merely financial, it would be quite easy to deal with it. In fact, the main difficulty is lack of communication, and we have not yet found the medium that would enable us to transmit the information available for the needs of the developing countries.

At the last conference on medical education at New Delhi, it was suggested that medicine has become so complex that it is impossible for a doctor today to know all the means that have been made available. On the other hand, it is also true that there are many simple treatments that can be given by less highly trained auxiliary personnel. We must reconcile ourselves to the necessity of forming such groups that possess limited knowledge but are able to reach large sections of the population; and this is also the responsibility of medical scientists and leaders. Our profession has to determine what should be done in economic and social terms to cope with this flaw, since we are concerned with prevention as much as cure.

Dr. Rexed:
Dr. Prywes' views are very profound; however, to take an example from chemistry, if you change a specific situation, you disturb the balance, but eventually a new equilibrium is established. For this reason, an increase in the incidence of chronic diseases, for example, will not continue forever - eventually a new balance will be found. In the case of the pill, there has been no significant change in natality; there are simply less illegal abortions. Regarding old people, nearly all our investments during the last three or four years have consisted of giving them the best possible care, and the next step will be to make them happy.

It is a terrible thought that we have the means to fight the diseases in the developing countries but do not use them. I do not hold the scientists responsible, although our discoveries produced this situation. We cannot be blamed if our discoveries are not exploited - it is the responsibility of society. In this case, it is less important to provide technical help than it is to remodel the structure of society. This cannot be achieved by us - Unesco, WHO or Sweden alone. I feel that Unesco is doing this indirectly, since improving the level of education has an effect on all the other aspects of society.

Dr. Handler's position is important, since on the one hand he opposes planning, because he holds it impossible to conceive a single national science policy, but on the other hand he would like planning and budgeting to deal in an integrated manner with health, defence, transport, agriculture, education, etc. Thus, we could put research into a functional framework, develop a systems analysis to include all economic possibilities - availability of manpower, desired production - and obtain thorough rationalization. We would achieve long-term planning integrated with this analysis within the context of our science policy. Research consists of a number of activities connected functionally, and thus it is necessary to change the volume of these activities according to requirements, in a long-term perspective, as has been successfully done with national defence. The head of government would maintain a consultative scientific committee which would have an overall view and be able to distinguish problems of immediate interest, whereas long-term planning should deal with basic research projects. We must insist on the fact that basic research is indispensable in order to maintain certain norms in teaching and education, since it is part of the educational process in the universities. We must also ensure that the norms and standards are maintained for the future. The developed countries should do more in this respect and not limit themselves to their own region and immediate concerns.

As to the developing countries, if we follow Dr. Handler, we should establish medical schools and faculties at university level to train the necessary personnel. It is impossible for us to train them in the developed countries and send them home again; the kind of medicine we teach is not the kind they need, and in addition, during their stay away from home, the students lose contact with their own people and problems. It is very difficult to persuade them to return. Hence research should be established from the beginning; even those countries whose limited economic resources prohibit expensive research can tackle certain problems of major importance.

Dr. Servit:
Dr. Prywes had said that medicine today is too complex to be fully grasped by one man. This is a problem of the over-specialization of medicine, and even of its disintegration. I think the problem is not so much whether we can understand everything as to know how and where to select what is necessary, and how a doctor, in specific circumstances, can find out what he needs. This is a question of training linked with the science policy of each country.

Dr. Bloch:
Dr. Prywes rightly spoke of the agonizing problem facing us in those cases where there are cures which, for financial reasons, we do not apply. Sometimes the physician is faced with the alternative of treating a large number of patients with insufficient doses of drugs or only a few with the right regimens.
Dr. Rexed said we should build universities in the developing countries. I agree with him, but we should also train the professors so that they will know what to do when these universities are ready. We know of universities which have a budget but do not know how to utilize either the money or the buildings. From a medical viewpoint, I think it is an over-simplification to hold that tropical countries should deal only with tropical diseases, etc. These are only additions to the illnesses that affect mankind everywhere - heart diseases, cancer, etc. Should the developing countries specialize only in the most abstract and esoteric problems? The Indian physicist Bhabha asked whether a country as poor as India should pay for the luxury of atomic research installations: he thought yes, because this was a way of creating spirit and esteem, a means which would allow the population to accord a kind of dignity to science and research.

I shall return for a moment to the biochemical research and to the role of industry in this field. I was pleasantly surprised that this topic was not ignored here, since WHO hardly even recognizes the existence of the pharmaceutical industry in this respect. Let us consider first those pharmaceutical firms based on research, the purpose of which is to produce new and better products and not merely large quantities of known products. There are only a limited number of large firms which maintain real research laboratories, and more of the smaller firms are about to disappear for lack of the necessary means for research, but there are also factors external to the industry which render research more expensive and thus contribute to this development. As science becomes more and more refined, the research becomes more and more complex and sophisticated.

The parameters of knowledge have multiplied. In addition public opinion concerning health problems has changed greatly, and people are now aware of what they are entitled to, and even feel that they should get health service free. I am not discussing whether or not this is justified. While the cost of medicines has remained more or less constant, the methods of treatment have grown far more costly. Eventually we reach the stage where we want medicines to be as cheap as possible in order to treat as many people as possible. This affects the very structure of those industries which have to make considerable investments for their research and development. With reduced profits and the threatening erosion of the patent protection the economic structure of these industries would undergo such modifications that the industry, in its present form, would have to cease to exist and would have to look for other fields where the return on investments is more certain.

Some countries have a different attitude. The antibiotics field in the United States of America reached its present high level partly because research costs were borne by the government. I think the State should help the industry when research costs are excessive, rather than discourage research by special taxation.

In industry-university relations, we can distinguish between developing and developed countries. From this viewpoint, France or England are developing countries and, in fact, I know of only two countries where this problem has been satisfactorily settled - the United States of America and Switzerland, where relations between the industry and the universities are healthy and natural and permit flow in both directions and growth of both the industry and the universities.

Dr. Chagas: It is a state of mind that creates the social consciousness. As Professor Handler said, biomedical research calls for flexible planning - planning of resources, and also the integration of this planning in the overall science policy. In the developing countries, the initial effort should be directed to the training of research workers. In those countries also the need for free and oriented fundamental research activities must be borne in mind. In fact it is essential that those countries should be abreast of the latest research, as Bhabha said. It is equally important to study the special problems arising in particular regions. Thus the science policy for the medical field must be both realistic and to the point. Above all, the mechanical imitation of foreign institutions for teaching and research should be avoided. The activity of different societies should in fact be related to their ecology.

As regards industry, there is no doubt that its participation in research is useful and desirable. It must always be borne in mind that medicine and agriculture are basic to development in the developing countries.

There has also been mention of the profitability of medical activities, in other words, medical research is considered in an economic context, which implies that it is possible to estimate the money value of a life. This is "economism"; it is an unacceptable attitude. Medical research must be considered in a human context. Another problem concerns the financing of biomedical research. The inflationary process which is characteristic of the developing countries constitutes one of the most inhibitory factors for research. An international effort should be made to carry out case studies on ways of employing more effectively the funds placed at the disposal of biomedical research.

Dr. Naffah: Dr. Bloch has clearly brought out the regrettable tendency to mis-state the problem of medical and biological research in developing countries. If we are agreed that our recommendations should be relevant to the real situation in the countries concerned, it must first be recognized that there is no standard pattern which is valid for all the developing countries.

Without going into erudite distinctions or hair-splitting terminology, I consider that when we speak
of developed and developing countries we are referring
to scientific development. The only yardstick of
scientific development is the number and quality
of research workers and research units, together
with the funds available. Such development gen-

erally goes hand in hand with industrial growth and
power consumption.

In a country such as mine which is both small
and developing, there are nevertheless a large
number of research workers and several research
units. Many countries are in the same position,
but since conditions are never identical there can
be no standard solution.

For countries in this category an urgent pri-
mary requirement for biomedical research, before
drawing up priorities, is to improve the infrastruc-
ture for clinical research. This infrastructure
should produce a scientific climate capable of stimu-
lating the vocation for research; it is both the point
of departure of research and its source of energy.
The allocation of funds should satisfy both this
highly expensive requirement and the adoption of
priorities.

Outside onlookers tend to consider the prepara-
tion of complete and strictly accurate statistics as
a necessary preliminary to the adoption of priori-
ties; they also tend to restrict priorities initially
to problems concerned with public health, which
are largely the result of socio-economic conditions,
for example water pollution or cases of parasitosis,
which are not envisaged from the aspect of basic
research with regard to the immunological or other
problems they may raise.

A priori this is a highly defensible point of view.
If, however, it were strictly applied, it would dis-
courage research workers and result in their emi-
gation, since the preparation of statistics calls for
considerable time. Nor is there any real need for
such delay since doctors know roughly what is the
frequency of diseases. Did the advanced countries
wait for statistics before embarking on research?
Research workers would also be forced to abandon
sectors in which they have acquired valuable expe-
rience in foreign establishments, and would have
difficulty in simultaneously maintaining and impro-
ving their level in techniques which they have already
assimilated. The result would be emigration and
a levelling down to the lowest level. Again, in the
absence of concrete results within a reasonable
time-limit, political leaders tend to lose interest
in research.

In our view, even with limited resources, it is
necessary to act without delay. The primary ob-
jective should be to hold on to one's research work-
ers by trying to link their specialities with what is
known about their country's specific problems. To
begin with, existing research units should be used
to meet practical needs. New units can then be
formed, at which stage research workers must be
given a proper status in order to attract expatriates.
The research programme should initially be adapted
to current possibilities; later it should be possible
to choose specific fields by training research work-
ers in priority sectors.

It is my opinion that the adoption of a partly
pragmatic and partly planned approach of this kind
would ensure efficiency, taking into account politi-
cal, economic and human realities. Curiously
enough it is similar in certain ways to the situa-
tion obtaining in the United States of America as
described by Dr. Handler. It is necessary to get
under way rapidly, and to follow up with appro-
priate flexible organization and planning.

Research should not be limited throughout the
developing countries to the biomedical and agri-
cultural fields alone. In the advanced countries
development is seen and experienced as a whole,
but this is not the case in the developing countries,
which have no tradition of scientific organization.
As the basis and lever for development, research,
including industrial research, should be considered
as a whole. Medical science policy should thus be
integrated into a general science policy.

The availability of experts or the possibilities
for training them should provide the basis for de-
cision. Human potential is the decisive factor.
Each country should therefore be considered sepa-
ately in the light of its possibilities. At the
training level, what is valid for medical and agri-
cultural research is at the same time equally valid,
for example, for industrial research. If priority
is accorded to the former there is a risk of over-
long delay in promoting industrial research and
thus of aggravating a country's disadvantage vis-
à-vis the developed countries.

Dr. Rexed:
I want to explain that I did not recommend taxing
the pharmaceutical industry; I only raised this
point because it was mentioned in the general intro-
duction document.

The industrial pharmaceutical research is
strongly directed towards new products. In most
countries with a mixed economy, the industry is
not subsidized which means that if it wishes to put
a new product on the market the research costs
have to be included in the production costs. The
richer countries have firms that can bear these
costs, but in the poorer countries basic research
is almost exclusively in the hands of the universities.

This leads me to disagree with Dr. Bloch on
government assistance to the pharmaceutical in-
dustry. In the case of aeronautics and space in-
dustries, we can understand the government sharing
the costs, but pharmaceutical products, involving
very specific research and precise benefits, are a different matter. Furthermore, it would be
dangerous for the industry to be subjected to govern-
ment control. It is impossible to compare an in-
dustry operating with government support such as
space or defence, with a competitive industry,
since they are structured differently.

We should not request government aid for the
pharmaceutical industry, but endeavour to improve
relations between the industry and the universities and research centres dependent on the State through the Ministry of Education. In the experience of my country, the vitality of this sector is a function of its contacts with the university.

I do not exclude government assistance in the initial stages. In the case of the production of medical equipment, the State should perhaps help to launch these industries, on the understanding that they are to become self-supporting at a later stage. In some countries where international competition threatens local production, the government provides certain subsidies, but we have rejected this facile solution in Sweden. Instead, there are development funds that can provide the industry with sufficient help to get under way.

In biomedical research we need to have a firmly established industry, and if a certain product cannot be supplied economically, aid should be provided. In fact this is an extreme example, since the industry should be allowed to operate in a healthy climate. In the developing countries, where we wish to develop industrial power, we must be careful to avoid establishing non-viable industries.

Dr. Bilbie:
The integration - or non-integration - of biomedical science policy in the overall science policy is a functional problem related to the particular situation in each country. Taking the general system, with three levels, the manner of integration will depend on whether at the second level - the level of co-ordination - there is to be one organization or several. The essential thing is to obtain objective judgements, at the co-ordination level, on the soundness of the executive machinery and the results achieved. This will depend on the membership of the second-level organizations. The dangers referred to are due to personalities, not to the system. There should be a rotation of scientists in these bodies, one advantage of which would be to lead the scientific medical community to participate in the formulation of science policy and to understand its role better.

Dr. Prywes:
Regarding the collaboration between industry and the university laboratories, I should like to comment on what Dr. Bloch and Dr. Rexed have said. Much has been said about the integration of the pharmaceutical industry, but what is true of this industry applies to the others also. In the United States of America, things have evolved out of a long tradition of research conducted within the industry. The United States of America has produced excellent scientists, who have found their place in the universities or research agencies and for various reasons, including dynamism, have found their way into industry.

We do not have a firm as big as CIBA nor a man as distinguished as Dr. Bloch, so we tried to obtain a subsidy for the pharmaceutical industry to train a sufficient number of good biochemists. Although we received $2 million three years ago, nobody touched it. The professors of pharmacology, preoccupied with obtaining personal credits that would enable them to carry out "their" research, were not interested in a common research objective that would permit the government to promote research in the area of pharmaceutical production. The industry is completely private, and we are ready to offer scholarships for research workers with PhD. degrees to work in factories and thus form a nucleus of research workers. University-industry contacts are never made on the initiative of the professors.

I want to mention the international financing of research and the origin of the financial arrangements operating between the donors and the recipients. Research must be adapted to the needs of the community on whose behalf its results are to be applied. For this we require men and laboratories. The countries supplying the aid do so in their own interests. In the United States of America there is a system of subsidies known as "institution grants", whereby an American institution receives financial aid to work in a certain area of science. We are all aware of how much money the United States of America spends on promoting research in many countries of the world; this kind of activity is generally in the form of a project. Sometimes the programme and budget of the project are larger than those of the recipient institution. For example, a small project in Israel could easily receive up to $100,000 from an American institution, private or governmental, but this could mean that a department specializing in this field could receive a larger allocation than fifteen other departments. Foreign aid may thus distort the balance of the university budgets, and in addition, the money thus granted is often of no use.

In our school there is no department of genetics and to establish one would cost $100,000, which could not be obtained through foreign aid. On the other hand, it is easy to get $300,000 to study an epidemiological problem connected with some ethnic groups. This is because the donor institute requires something that cannot be done in the United States of America. It is a tragi-comedy.

Dr. Bloch:
I apologize to Dr. Rexed for attributing certain remarks to him that he did not make. I was not suggesting that the aeronautics and space industries were good examples of what could be done in the pharmaceutical industry. I indicated what the government was doing in certain sectors that it wished to activate and remarked that the funds provided permitted the industries to obtain the know-how that would enable them to use the additional funds that are privately available to them for more complex research. Obviously, the industries and, to some extent, the public are the original sources of these funds, which come from taxes.
Concerning medical research. I should like to draw your attention to the CCNSC's (Cancer Chemotherapy National Service Centre) programme which aims at finding drugs effective against cancer. The government has initiated an important scheme, which allows manufacturers to get their prospective products screened free of charge, providing that if they prove to be effective the government will be able to obtain them under favourable conditions. A similar programme has been launched in the United Kingdom, where one of our laboratories collaborates with the United States national institutes of health to determine the metabolism of various drugs. We believe that the industry should be able to provide for its own survival and recover the necessary research expenses with sufficient financial profitability to encourage it to launch new products on the market.

As Dr. Prywes said, the industry must attract scientists and, for this purpose, create a satisfying atmosphere. The time has gone when the university was an ivory tower; in the world of today everyone, including university teachers should be aware of current problems and scientists need to feel themselves an integral part of the family of man.

Dr. Handler:
I should like to answer some of the comments on my paper that have been made during this session.

Firstly, with regard to the rôle of industry, let me note that I am a member of the board of directors of a large company. In the United States of America the directors of a large company are responsible for corporate profits, but they need scientists to explain to them the technical aspects of production and assess the value of investments in research, in other words, to translate science into business concepts. This is very necessary since, for example, the research budget of the company I serve is larger than that of the medical centre of Duke University, of which I am also a member.

There is another link between industry and the university, more common in the United States of America than in the rest of the world, namely, the rôle of professors as consultants to industry. Most universities now permit professors to act as consultants for the equivalent of one day a week, and during this day they can earn as much as their university salary. The industry also benefits from this scheme, since in this one day a professor can contribute as much as if he were fully employed. This exchange has also helped to disabuse the universities regarding the world of business and has brought the scientist face to face with the real world and its problems.

Dr. Prywes pointed out that with the system of American aid, it is harder to get $100,000 to establish a new institute than to get $300,000 to study the dentition of Yemenite children. We are aware of this anomaly at home also: the law was not made to guarantee the financial equilibrium of research institutes but to further teaching as much as possible. Sometimes we have to bypass the law.

I think that basic research can be carried out even in the smaller countries, even though the research programmes may not be very ambitious. In fields such as oceanography or atomic physics, for example, where huge financial investments are required, this is not possible, but even one man can do medical research. An example of this is M.J. Monod who, for a few years accomplished first class work with the same kind of equipment that Pasteur used.

I want to say a few words on what society is prepared to finance. We spoke of the allocation of resources amongst different areas, and mentioned that national defence and transportation get more than health, and physics more than biology. The real problem is to know what society wants and, at the same time, what it can pay for. With individuals as with societies, our ambitions and hopes are always higher than the means we have to attain them. We want to devote much to health because of the value we attach to human life, but we must know how to invest. Let us not forget that is an indispensable stimulus to research; as soon as our scientists and technicians stop asking for more money, space and equipment, we shall have reached an unhealthy saturation level.

We should realize the limitations of cost-benefit analyses. In the United States of America economists who run these analyses always conclude that research is unprofitable and should be stopped. They only understand economics and do not see how much we have improved and enhanced the quality of the world we live in.

There is a trend to reduce expenditure and effort in basic research performed by industry. The rationale is that even the large laboratories cannot do all the research required and they are beginning to wonder whether they are deriving any benefit from their own basic research. On the other hand, their total research expenditures are rising due to the volume of applied research and development. The only laboratories not taking this line are the Bell Telephone Laboratories, which are the best in the whole world, in my opinion.

Dr. Prywes spoke of the students' lack of interest in the study of chronic diseases. This does not worry me at all. The important thing is that this lack of interest shows that our present state of knowledge does not allow them to work effectively in this field. Since we cannot apply our knowledge of molecular biology to certain dystrophies, the student will prefer a more useful area to work in. A research worker is certainly attracted to what is new and interesting, but also to what has direct application.
Our times are characterized by an extraordinary progress in medical research and in the practice of medicine. As a matter of fact, medicine is moving at such a rapid pace, that many of the dramatic changes it is undergoing have not been perceived, just as the challenge and the responsibility they have created are not in the foreground of our preoccupations.

The changes we observe in nosology are due, in part, to the progress of medical care and preventive medicine itself, but also to the ecological conditions the industrial era has created, and to its implications in human health. These two causes combined have created a challenge which requires energy, ingenuity and persistence if we want to preserve a situation in which Man can enjoy life at its best.

To this, another challenge is added - and probably this one lays a still greater responsibility on the medical profession, that of analysing the ethical implications for the future of Man of the everyday advances of medical research, so that it can be used for the greater benefit of mankind without retarding progress or affecting adversely the human condition.

Let us describe briefly how we envisage the causes of the difficulties the medical scientist encounters as a consequence of the social, scientific and technological evolution of our time. I should begin by saying that attention has hitherto been drawn mainly to the more material aspects of social evolution during the last fifty years in which our current amazing technological adventure has taken place, and that, except for a few far-seeing thinkers, consideration of the individual has been pushed aside, as if science and technology did not have as their ultimate and sole goal, to provide for his future and to assure his happiness.

The obsession with technical progress has been a handicap in the effort to convince our society that health cannot in any way be dissociated from the social and ecological conditions making up Man's environment. Not even the medical profession has understood this, as we see, for instance, when we study the educational system of the great majority of the medical schools, where main emphasis is laid on the application of the new technology - the usefulness of which should by no means be underestimated - at the expense of the knowledge of the social effects or, more precisely, of the ecological conditions - senso lato - in which human life evolves.

But, as already stated, one of the consequences of social progress and of scientific and technological development, acting jointly, has been to give to modern nosography a different aspect from that which it has had for centuries.

This has given rise to problems and queries and to answer them a new knowledge and a new attitude are needed. We are far, nowadays, from the rather oversimplified, though historically significant concept according to which the cause-effect relationship, the object of research, could be represented unequivocally by the pathogenic agent and the disease. Medical advances have in fact hastened research, and introduced into it a new methodology. This new approach to modern medical sciences is more than justified. It is only necessary to see how different the picture is today, compared to that confronting someone interested in medicine less than thirty years ago.

Vaccination chemotherapy, the development of clinical biochemistry, the improvement of our knowledge of endocrinology, psychopharmacology, the development of auxiliary medical services, the use of psychological treatment, progress in surgery, new sources of radiation and their quantification, automation, medical engineering, and many other specialties have made it clear that great advances have been achieved in the quest of health.

At the same time, the campaigns against major endemic diseases, such as malaria and yellow fever, conducted on a world-wide scale in a new spirit of true internationalism, have drastically reduced these centuries-old scourges, giving a new dimension to the struggle of Man against disease.

In the light of these achievements it was natural
to believe that medical science, by itself, had definitely prevailed, or was about to prevail, over disease. This is a valid conclusion, when one considers isolated individuals who have directly benefited from this progress or when one chooses certain criteria for evaluation. It is, furthermore, supported by the success of the afore-mentioned campaigns.

It can however be contended, at least partly, when one considers the evolution of certain other diseases in regard to which a too great sense of security has given place to one of frustration, and even defeatism. This is, for instance, the case of venereal diseases in developed countries, and chemotherapeutical campaigns against tuberculosis in less developed ones. The incidence and apparently irresistible increase of the former during recent years, which has been more or less continuous and general, shows how, side by side with biological problems such as microbial resistance to antibiotics, the significance or morals, of habits and even of ecological conditions, must be taken into consideration in the control of many diseases.

Thus, the recent upsurge of venereal diseases in some industrialized countries may be attributed, in part, to the abuse of contraceptive pills. The irreducible body of patients still suffering from pulmonary tuberculosis at the end of the best organized and conducted chemotherapeutical campaigns undertaken in the dense human agglomerations so frequent in the developing countries, seems to indicate that, together with purely biological factors, economic and social ones play such a rôle in conditioning the disease that they must be overcome before success can be attained.

Other similar examples could be found. They would indicate the full dimensions of the responsibility medicine has to bear in relation to the health of Man. They emphasize the fact - I would say the truism - that the health of mankind depends as much on the social and economic parameters of his life, his ethics, and the environment in which he lives as on his genetic heritage and on his biology, i.e., the satisfactory synchronization of his body functions, from the cells to the whole organism - functions whose perturbation, disruption or failure are responsible for disease.

This statement, encompassing all the significant variables at play, should be taken as a guide to our reflections on the interaction of social evolution and the medical sciences. It affects the science policy for medical research. It must also be considered in relation to the problems arising from the development of new research and methods.

The conclusion is that Man's health, perhaps even his survival, cannot be considered solely in terms of his individual life but must be viewed in the framework of a complex in which social economic and ethical factors are as important as the biological ones. This, I believe, is the way to establish the safeguards which are necessary to protect Man from misuse of the scientific discoveries he has achieved.

Medical science thus has responsibilities of many different kinds. It has to deal with the problems resulting from its own evolution, such as the appearance of a new nosology. It has also to concern itself with new situations produced in Man's environment by the aggressive action of the technological era, for example, by pollution. It must, furthermore, prefigure the implications, on the individual and on the community, of the new knowledge and the new methods it has created, hence the need to establish moral codes and preventive legislation. These responsibilities involve scientific, economic and ethical components, frequently impossible to analyse in isolation.

Let us examine briefly to demonstrate these responsibilities, the most acute effects of the technological age on human health. In generic terms, these effects are produced by "environmental pollution", defined as "the unfavourable alteration of our surroundings, wholly or largely as a by-product of Man's action, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitutions, and abundances of organisms. These changes may affect Man directly, or through his supplies of water and of agricultural and other biological products, his physical objects or possessions, or his opportunities for recreation and appreciation of nature". (1)

Pollution from various sources is one of the greatest dangers threatening mankind. It may become the greatest one if not checked in time, and is already one of the predominant preoccupations of preventive medicine.

It must be emphasized right away that even a superficial examination of this definition shows that the health hazards of environmental pollution increase with industrialization and urbanization, and are thus different in developed countries and in the less developed ones.

Pollution, above all water pollution, exists also in less developed countries. But it is different in quality, being mainly microbiological, and not chemical, as in the industrialized countries. Incidentally, I should like to point out that the danger of pollution in the developing countries is much greater, due to the fact that their national efforts, for whatever reasons, have been concentrated on immediate aims of short-term economic value, and hence industrialization has not been accompanied by a simultaneous counter-balancing effort in which the pre-existing health problems might have been overcome, and the new ones attacked at once.

Another aspect of the problems we are trying to illuminate arises from the terrific increase of urbanization experienced all over the world. The disturbances it produces cause disease and abnormalities in human behaviour. Let me incidentally

(1) "Report on restoring the quality of environment", Panel, President's Science Advisory Committee - Washington D. C.
express my concern over one of the most striking factors observed in relation to this problem: it is the slowness with which knowledge diffuses from theory to practice, from research to operational action, thus delaying sometimes irreparably, the execution of essential corrective measures. Had we been more attentive to the ideas expressed by men who, like Le Corbusier, tried to develop urbanism to suit human requirements, and we probably would not be facing now some of the problems of the "inhuman city" which, according to René Dubos, encourages a situation in which eventually half of its population will be attending to the physical and mental ailments of the other half.

Thus medicine, in exercising its beneficial functions, now faces the duty to defend Man from many types of aggression unsuspected a few years ago. Some consequent on the progress of medicine itself, others arising from our present technological age. There is need for a plan according to which Man and his community will be protected by adherence to certain principles or by legal arrangements of various kinds.

As regards the latter, one fears that only the most obstructive consequences of our industrial age are being tackled, and these only on a small scale by ad hoc measures.

Take, for instance, the case of pollution: protective legislation is being passed here and there, but it is far from being a comprehensive effort. There are still no international standards for its measurement, and, in many countries, not even the necessary conditions to enforce its use. I may add that many of these legislative steps will remain ineffective for years and years to come, since, as pointed out two centuries ago by Montesquieu, the effect of a law will be felt only when it corresponds to the custom of the people. We have to seek elsewhere for support.

The education of the public is the first phase of this search. Radioactive contamination of the biosphere, for example, if it has not been stopped, has at least been partly controlled, and this has certainly been done by the pressure on the government authorities exerted by the outcry of the world scientific community, well aware of the dangers it could involve.

To cope with the future, however, we must have the knowledge and the will to undertake a huge task: that of defining the authentic human goals. Most unhappily, this attitude has not, as yet, received general acceptance. In the same way as, during the "Belle époque", a small fraction of mankind, entrenched in its own economic stability, tried to convince the majority of the people that life had reached a state of perfect equilibrium, soon however to be shattered by the First World War, part of society today, dazzled by technological progress, is convinced that research pursued to the full may - "per se" - transform into reality the highest Utopian dreams. Thus it avoids looking outside the picture of its conquests. Day by day, though, the mirage is being partly dispelled, and Man seems to be unable to apprehend firmly, to co-ordinate and to control for his own benefit the progress he has attained through his own inventions.

This becomes particularly serious in the field of medical science and of its applications. Accepting the view that medical research is responsible for the protection of Man against the dangers he is facing, we must first try to discover a common ground by determining all the different facets of the problem, and how far and in what ways it has affected medical research; only when we reach agreement on this will we be able to introduce the protective measures we are considering.

In my opinion, the trend of evolution of our society since the establishment of the industrial age, has been such that it lost sight of its primary aims and mistook the means it has created for its actual goal. The taming of economics "per sé" became the definite answer for social development, which, in consequence, lost its harmony. At first, interests of the individual were of necessity entwined with those of the community to which he belonged, but later on, the interests of economic groups entirely usurped those of the average citizen.

I should like to introduce at this point a personal experience which supports my point of view regarding the purely economic slant given to modern development. When, as its Secretary-General, I organized the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, a vast effort with which the United Nations opened its "Development Decade", I had to fight in order to secure due space in the agenda for health and medical research. I also had to resist pressure tending to emphasize the anti-economic consequences of health campaigns, such as the one undertaken against malaria. These two actions were naturally attributed to a bias arising from my medical training and background and not to the conviction that the rôle of any human action should be to improve the human condition.

The attitude I had to fight is, however, changing rapidly, as a consequence of the recognition that "the economy has to be considered as a system composed of interacting and interdependent elements, in which health is one variable".

This new approach to the consideration of health in the context of development resulted from pragmatic considerations, when it became clear that, in economic growth, the so-called marginal values play an important part, at least as important as capital and revenues resulting from labour. As a consequence, human resources, which include the improvement of education and health, were integrated into economic planning.

But it must not be thought - and this is important from the medical point of view - that this attitude represents a new upgrading of the concept of Man. It is rather the better utilization of Man in the process of social evolution, in which he no longer holds the unique position that used to be his.
This loss of Man's identity, of his unique value in nature, is reflected in much of modern thinking since the teachings of Heidegger, and pervades many aspects of modern thought. It is of the utmost significance when we analyse the problems produced by the new developments of medical research. In fact, some of the more crucial problems medical research is confronted with are those involving the question of how far can Man influence his own personality, as a purely conceptual entity, and in the practical sphere, how far can one man intervene in the existing identity of another.

It is clear that the concept of the inviolability of Man, which introduces the requirement of consent on every occasion in which his body is involved, is a fundamental issue in regard to the points we are discussing.

In fact, when we consider how the position of Man in the world has evolved, we see that during a first period, the theological age, he was dependent on God. This made him subject to supernatural powers and not responsible for his own fate. With the rationalist age, which gave rise to humanism, human life became the centre of the world. This is where we want to keep it. Finally, in the techno-economic period in which we are now living, Man has again lost his individuality and the control of his own achievements.

The question one would like to ask cannot be answered. It has moreover already been presented in other terms: will Man be able to overcome his subjugation by the techno-economic era, and thus enjoy the new life it may produce? The answer would involve a set of ethical and moral problems which we are unable to solve at present. However, the techno-economic age brings with it a taste for efficiency and progress which may profoundly influence medical research in the near future.

It would be vain to stress again here the recent progress of medical research in various fields such as human genetics, brain research and surgery, where tremendous strides have been made by medicine as a consequence of the contribution provided by basic research in physics, chemistry, biology and cybernetics.

Let us admit that in these fields we have reached a state where it seems to many medical scientists that further progress must depend on experiments on Man. Thus experimentation "in anima nobili", hitherto considered as exceptional, apart from tests with drugs, is forcing its way into the position of an absolute necessity. The danger to be feared - disturbed as we still are by examples from the recent past - is that it may become experimentation "in anima coacta".

Hence it must be stressed that, from 1946 onwards, important initiatives have been taken to control the misuse of medical progress in research. The Nuremberg Code of August 1947 was followed by the Declaration of Geneva, written in the spirit and according to the letter of the Hippocratic oath and adopted at the General Assembly of the World Medical Association in 1948. It was afterwards included in the International Code of Medical Ethics of the World Medical Association. More recently, at Helsinki in 1964, the same Association improved on the Nuremberg Code, and adopted a new one embodying the basic principles established at Nuremberg, as well as the ethical guidelines already accepted generally by the medical profession.

Meanwhile, the progress of biology and of medical research has made it imperative to establish new legislation in order to safeguard the basic Hippocratic principles, traditionally respected by the medical profession. Its necessity must be recognized as the result of progress in the transplantation of organs and other medical techniques, which involve many ethical problems, some of them difficult to formulate precisely. Laws have been introduced in many countries; others will follow. Reading them, however, one sometimes receives the impression that they are merely compromise formulas between ethical principles to which the majority of doctors still adhere, and the daring steps already taken in many research centres and hospitals.

The establishment of this legislation has forced the revision of many concepts in medical thought and even in the metaphysical approach to Man's existence. The most objective question facing us is that of the determination of death, which is so extremely significant in the realm of organ transplantation, and not less so in the domain of medical economics. We should also be inclined to stress the concept of the beginning of life.

We should now like to discuss in somewhat more detail the ethical and legal problems involved in transplantation, as these are so topical, and probably more pressing than those associated with other fields of medical research.

Examined superficially, the problem seems to be primarily a medical one, and rather simple. In fact, it is extremely complex, and can be solved only with the help of physicians, lawyers, philosophers, theologians, and such. The determination of a physical indication, or set of indications, which disappearance would constitute the legal definition of death, has been the criterion used for centuries.

The advances in our knowledge will certainly give rise to much discussion regarding the determination of a choice of indications which would enable us to say, by common agreement, when death occurs. These indications should afford proof of "the principle of irreversible lesions inconsistent with survival". It remains only to define which indications prove this irreversibility. In quoting this definition, however, I only want to point out how difficult the problem is in fact, since the definition itself involves the use of the expression "survival", which is the antithesis of what it sets out to define. But for purposes of legislation a definition has to be reached as soon as possible, as at present its vagueness renders it useless.
and it may be used as an argument in either direc-
tion, i.e. to raise obstacles in the way of all trans-
plantations. or to facilitate their wider use.

Another relevant observation refers to the guide-
lines for transplantation practice, which legislation
everywhere has unanimously enforced. This is
more than encouraging, and places strong emphasis
on the need to obtain the spontaneous consent of the
living donor, and of the recipient.

There are, however, other points of significance
which are of particular interest for certain types of
transplants, whether in the quest for standardiza-
tion or as permanent points of dissension. Thus, in
the particular case of heart transplants at present
causing so much excitement, one of the first re-
quirements is to define its real clinical indications.
as well as the moment when this treatment should
be attempted. Both these points are of interest in
relation to the unavoidable economic implications
any new form of treatment brings with it.

Without enunciating any judgement on the merits
of the attempts undertaken recently, it may never-
theless be stated that the observation of the intim-
a of the aorta of one of the patients showed clearly an
advanced state of vascular process of a degenera-
tive character, certainly extended to the whole vas-
cular system. This fact gives rise, naturally, to
pressing ethical questions.

For instance, we should like to know for how long
in that particular case, life could be prolonged,
or in general what kind of assurance the patient
should have before authorizing certain steps. But
in the case of human heart transplant another fact
must be brought to light. I will not speak of the
extraordinary effect it had on the general public;
this is easily understandable as it concerns a sci-
entific feat that benefits the common man, and in so
doing has a greater appeal than any glamorous ven-
ture of space science. I refer to the saving of a
human life. which had weighted so little in the last
thirties. This was the dream of medical science
to fight and defeat death.

But the point I want to stress is the emotional
reaction I found everywhere even among medical
practitioners and other cultured people to any en-
deavour to analyze without bias, in the light of
medical knowledge or ethical principles, the surgi-
cal attempts so widely publicized.

This shows how careful one has to be in the en-
forcement of legislation on new forms of transplanta-
tion, how necessary it is to do a thorough and com-
prehensive study of all the elements involved so as
to bring to light the whole set of implications these
new methods carry with them.

Let me now glance for a moment at the field of
brain research. Recently, a round table run by the
organization which is responsible for our present
meeting dealt with the problem of research on the
human brain; such research can be done very
thoroughly by electrophysiological methods. The
problem is, however, far from being exhausted,
extent by the decline of the position of Man considered as the centre of gravity of our civilization.

This demands new legislation, which can be enforced only when clear concepts and definitions can be established, by the joint efforts of physicians, biologists, jurists, theologians and philosophers. The ethical problems involved in human experimentation are far from being explicit. They must be carefully studied and recognized, the more so since we see that the present progress of medical research is leading to a point where decisions will have to be taken in such a way that progress is no longer used for tyranny and oppression, but to protect the most important of all our values - human dignity.
Professor Hersch:

In the moral, social and philosophical problems facing medicine today, we see the gradual emergence of an idea that even ten years ago would have been considered reactionary and obscurantist - the notion of limitation.

I recall growing up with the idea that, in medicine, neither research nor medical care could admit the existence of obstacles that would be for ever insurmountable. The researcher's duty was to go on advancing endlessly, and difficulties had to be overcome. Today, and this stood out in Dr. Chagas' remarks, we are finding limitations within ourselves. We have reached the point that cannot be passed without actually contradicting ourselves. For example, doctors know that, though they cannot confer immortality, nevertheless they can prolong human life. Until recently, the value of this objective was considered beyond question and any means to achieve it was accepted without argument. Today, we can ask ourselves whether we should prolong human life in all circumstances, and what this really means. Is it necessarily a good thing? If so, for whom and for what purpose? Anxiety increases, particularly among doctors, as the answers to such basic questions become blurred while, at the same time, medical power continues to grow. Many doctors already feel that there are some decisions they cannot make by themselves.

In the case of heart transplants, there are certain questions falling strictly within the competence of the doctor, such as the evaluation of the chances of success and the nature of the operation. On the other hand, there are problems that are not strictly medical, particularly the relation between the surgeon and the donor. Even if everything possible has been done to keep the donor alive, there is nevertheless a moment of time when the doctor sees the donor both as a means and as an end. If it is known that the donor is about to die, he is reduced, while still living and while still receiving care, to being no more than a means to something else. This is a situation unprecedented in the history of medicine.

I think these problems are outside the sphere of medical training and practice in the strict sense. They involve ethical and legal values, and in those fields the doctor cannot work things out alone. At the present time it appears that the doctors are not guided by any definite public opinion, nor are they always in agreement among themselves.

A further point is that the recipient-donor-doctor relation cannot be regarded as a closed circuit. The diffuse consciousness of oneself and others, which is basic to human conduct, has evolved within society over a period of thousands of years; it represents a most precious capital which has been gradually accumulated. It is because of this that we are horrified at the crimes perpetrated by the Nazis, not just in our hearts, but throughout our physical being. It is possible that new techniques, as they spread and gain general acceptance, will blunt this sensitivity. We should then be faced with irreversible phenomena, whose consequences cannot be foreseen; we must therefore be very vigilant. It is a "social affectivity" which is at stake.

Dr. Handler:

Dr. Hersch, are you referring to all transplant operations or only to heart transplants? Does what you have said about transplants apply, for example, to kidneys also, or are you disturbed by the fact that it is the heart?

Professor Hersch:

Let me answer you. The problem is not about hearts or kidneys. The possibility of heart transplantation proves that the essence of the human being is not concentrated in this organ. However, we should be gravely in error if we were to assume that there is no unity in man; this unity is everywhere, including the heart. If we could recompose a human being out of new organs, who would he be? We are forced to consider the problem of the unity of the "I".

Dr. Handler:

Thank you. Technologically speaking, I do not think this is a very serious problem. I do not think we shall be performing this type of operation for much longer - what we need to do is to make an artificial heart; this would be no more unpleasant than any other kind of prosthetic aid. I agree that what differentiates a heart transplant from other organs is the death it evolves. But this type of problem is only temporary.

Professor Hersch:

Can we allow the surgeons to experiment in the meantime?

Dr. Handler:

I think it is preferable. I would draw your attention to a far more serious problem - genetic heredity. Genetic problems exist in many forms, even the possibility of fertilizing human beings in test-tubes. This will be feasible in fifty years time. We use artificial insemination on animals today, and it has overturned our traditional ideas, even though we try to ignore it. This problem will be with us when the problem of heart transplants will have disappeared.

Dr. Bernard:

I should like Miss Hersch to consider these two points: on the one hand there is the real unity of the human being, and on the other his view of it.
There is nothing to prove that this unity resides in the skin, the kidneys, etc. Perhaps it is localized in the nervous system. Nevertheless, it exists and so does man's image of himself.

Now, I think there are three dangers - the first is vagueness and imprecision, the second is science fiction, and the third is to speak only of heart transplants. We cannot avoid these dangers but we can try to limit them.

The first thing to consider is the influence of environment on man and the most remarkable aspect of this is that the different environmental factors that we know have been gradually accumulated. Thus, to take a model from my own discipline, man today suffers at the same time from blood disorders connected, for example, with parasitosis among the primitive forest people, deficiency anaemias among populations based on mono-culture, and then the disorders related to the radiations or chemicals of industrial civilization.

Medicine plays a major rôle in the environment. To take another example from my discipline, for the last ten years we have succeeded in not losing a single haemophilic. This means that these people, who formerly lived only to the age of ten, are now able to marry and have daughters who transmit the condition and seriously increase the number of haemophilies in countries such as Scandinavia, the Netherlands, France and the U.S.A. Where this disease is most common.

Dr. Handler has rightly said that in twenty or thirty years we shall be able to manufacture life. At this time we are asking the academies to define death for us, an extraordinary situation, since our notion of death changes as medicine progresses. In a few years it has changed from heart stoppage to three flat electroencephalograms. When we are able to differentiate undifferentiated cells, there will be nothing to stop us replenishing the brain with them and then we shall have to reject a definition that will have been valid for only twenty or thirty years.

Miss Hersch said there was no hope for immortality. I respectfully beg to differ - there is plenty of immortality already, of cells in culture, transplanted organs, genetic immortality.

However, the most important problem concerns the human personality, and there are at least three definitions that come to mind: the first, and most doctors accept this, is that it is the nervous system. Since brain transplants are at present an unrealistic hypothesis, we can say that the transplantation of other organs does not affect the personality. There is a second view, however, that holds that it is not only the brain that determines personality, that if we consider the close connexion between the extreme refinement of groups of red cells, white cells, tissues and the personality, it becomes difficult to believe that essential glands such as the hypophysis, the ovaries and the thyroid do not play a rôle in the personality. We have also heard a third view - that of the social environment, whereby every contact and every change modifies the personality.

Dr. Chagas quoted Montesquieu's saying, "Laws are only the expression of customs", but I am not certain that medicine can make decisions on the strength of public opinion alone. It must speak for itself, and there must be some kind of co-operation between scientists and general opinion.

Dr. Btesh: After hearing the previous speakers, I would say that the relations between the medical world and society in general define, and also influence, the future of medical research, particularly as regards human experimentation. In my opinion there are decisions that should not depend on the individual research worker. We have created structures that allow the researcher to know in which direction he should strive, and provide directives that will help him further the progress of medicine. In today's world, the organization of medical research has tried to find answers to these problems. According to the new rulings in public health, research grants are only given in certain criteria are respected. In WHO, where we have a considerable research programme, the Director-General has recently appointed a committee to study the moral and technical problems of the projects we are running. From now on, every project, whether or not it originates from WHO, has to be examined by this committee from an ethical viewpoint after it has been approved by the technical committees. Even publications in WHO Scientific Bulletin have to go before this committee.

Our group has now to tackle what in my view is the most essential topic - the ethical problems of research. Our recommendations must state that, whatever the nature of the structures adopted, they must include a body responsible for the ethical and moral aspects. It is not our duty to propose hard and fast rules, but we have a duty to insist on such a body.

Dr. Bibbie: The modifications undergone by our natural environment are the results of industrialization, the exploitation of natural resources, modernized agriculture, urbanization and demographic, economic and social processes of which we are both witnesses and agents. Most scientists have made praiseworthy attempts to stem or limit the harmful effects of these activities on human life, both present and future. There is still much to do, for example in the field of techniques for detecting cancerogenic substances in the air or in foodstuffs, or combating water pollution. These activities should be intensified in every country, and the results embodied in national legislation and international standards.

Since we are here under the joint auspices of Unesco, WHO and CIOMS, we should consider this problem. To what extent are the scientists and research workers engaged in those areas of
Concerning the unity and integrity of the human personality, I was especially interested in the conclusions of the round table organized by CIOMS on the subject of biomedical science confronting the dilemma of human experimentation. This document should be better known. The history of medicine is filled with struggles and difficult periods; there have been impostors and frauds; we have made mistakes; but we can boast of men of great moral integrity and conscience such as Pasteur, Claude Bernard, Metchnikov, Charles Nicolle, Ricketts, etc., who in their time had to make agonizing decisions. The doctors of today, in every place, are proving their own moral quality also. Unesco should collaborate with WHO and CIOMS in bringing out an anthology of the ethical thinking of the great physicians of history, which would be both a testimony to the past and a guide to present and future action.

Dr. Florkin:
Firstly, the report of the CIOMS round table is currently being printed in French and English. We have also considered publishing the kind of medical anthology that Dr. Bilbie envisages, to illustrate the nature of medical tradition.

Dr. Bilbie:
I should like to mention the example of Professor Nicolai Minovici, in Romania, who studied himself the mechanism of death by asphyxiation through hanging.

Dr. Bernard:
I am sure that this anthology will be excellent but I am afraid that the views of great doctors of the past will not help us in the new and difficult problems we are faced with today.

Mr. de Hemptinne:
Dr. Bilbie asked whether we should wait for the first harmful effects before taking action. We agree that the role of science policy is to provide scientists with the means they need, and we are also in general agreement as to the fact that scientists participate in the solution of important problems through the mechanism of science policy. We have not yet fully comprehended the problem of tackling noxious side-effects. Chemists have for long known Le Châtelier's law which states that every disturbing action brings about a restoring reaction. The anxiety caused by the atom bomb is perhaps due to the fact that people have realized that such a chain reaction does not contain its own restoring reaction.

Dr. Bloch:
I have a question for Dr. Btesh. What exactly did you mean when you said this committee should realize the importance of the problem and make certain recommendations?

Dr. Btesh:
I did not suggest we make rigid recommendations but I think that, whatever structure and policy we adopt, we must create a means of regulating the ethical aspect of these problems.

Dr. Bloch:
There are no rules that can replace the individual responsibility of the physician and no one can formulate regulations that release an individual from the dictates of his own conscience. In the last resort the physician has to decide what is right.

Dr. Chagas:
To return to the subject of environment, we see that industrialization is an expression of Man's lack of respect for nature.

Dr. Aujaleu:
We should not be surprised that Man pollutes his environment to the point where it is no longer capable of supporting life. This is a general phenomenon in all animal and vegetable life. However, we are in the position where we can prevent pollution, or reduce it to acceptable levels, and the role of research workers and doctors in this situation is to show the authorities how to achieve this and how much it would cost to do so.

We have to determine the position of the doctor in those cases where people who would previously have died at an early age, such as haemophils, idiots, etc., now, thanks to improved medical treatment, reach the age where they can reproduce. We have no choice but to give them the best available treatment, whatever the consequences. To do otherwise would be a breach of our professional ethics. We should if possible try, with the help of relatively simple means now available, to prevent them from having children.

There is an analogous problem - the attitude towards comas, where people are kept alive in a purely vegetative state, even when the brain is dead. I was not disturbed by this until I realized that these people were being kept alive in order to provide organs for possible transplant operations. This procedure raises the gravest moral problems.

When a man is sick, experimentation can be to his advantage, and it is up to the doctor to decide whether the risks the patient is exposed to are greater or smaller than those of the sickness itself.

The situation changes when we experiment on healthy people, and we are faced with an insoluble paradox: the legal aspect as against the medical aspect. A few years ago I had to formulate a law on the subject of immunization, involving healthy subjects who were injected with certain substances in order to obtain from them a serum for medical purposes. I had to promise that the subject would
be made fully aware of all the risks he was exposing himself to, both during the experiment and for the rest of his life. I am certain that if doctors were to observe the letter of this law and explain to potential donors all the possible dangers resulting from this immunization, we should not get one single donor. Thus we have to rely on the conscience of the research worker.

Professor Hersch:
I want to take up some of the points that you have raised. First, a question for Dr. Btesh: how many people are on the WHO Committee, who are they, what is their training, and what are the basic criteria of the Committee?

Dr. Btesh:
The Committee consists of six people. The Chairman is one of the Assistant Directors-General of WHO; I am the Secretary of the Committee responsible for research co-ordination, and the other members are all medical people.

Professor Hersch:
Is it desirable that this Committee should consist exclusively of doctors? I think we should discuss this. Now, Dr. Bernard spoke of immortality and this terrifies me. There are many who think that Man, as thought of in the Nineteenth century, is about to disappear. There are certain characteristics that we consider as essential in the human being: an immortal being in the medical sense would no longer be a man. Infinite duration superimposed on finite duration would totally change the human condition, together with its structure and conception of time. It would mean the end of Man as we know him.

Dr. Bilbile's examples of professional heroism do not seem very convincing to me. We know that there are doctors capable of acts of heroism, but this does not mean that the medical profession as such will fight for the integrity of the human body and of life. The doctor who deliberately contracts cholera demonstrates an attitude toward his own life and body which could result in the kind of suicide actions which we sometimes witness in wartime, and which have nothing in common with the ethical and cautious approach to medicine we have been discussing. In any case, this does not prove that we can rely exclusively on the moral sense of the doctors.

Dr. Bloch mentioned the problem of personal responsibility. I do not think that it can ever be eliminated, and furthermore, I think it is never eliminated by any law. A situation can always arise when it is our duty to break the law. We have to try to establish agreement first among doctors and then between the doctors and public opinion, in order to obtain a common viewpoint. It is paradoxical that in this age of weak social cohesion, when pluralism has reached a peak, we seek answers to fundamental questions of life and death without the possibility of appealing to a recognized medical and moral authority. In this difficult situation, the principle of individual responsibility should certainly be preserved, but it does not appear to be sufficient. It seems to me that the doctor himself, if he is conscientious, should desire assistance - guidance, in his day-to-day work and its problems, so that he is not continually worried by problems of conscience, or subjected to what one of our medical speakers has termed "the erosion of the moral sense".

I realize how difficult it is for a research worker to set limits to his own activities; but I am wondering whether, at this point, it is avoidable.

Dr. Prywes:
The proceedings of the last conference on medical ethics, held in Paris two or three years ago, and our present discussions prove how much we are all disturbed by the unexpected progress of science and medical experimentation.

I agree with Miss Hersch that neither doctors, as such, nor associations of doctors, medical institutions and organizations have the right to claim that they alone can decide on a problem that affects every aspect of human existence - moral, religious, ethical, etc. If we, as experts, are disturbed, imagine the state of our students. When I was a student, medical ethics were part of the course, but I do not think this subject is still taught.

The time has come to reconsider this problem, since today students in their second, third or fourth year are engaged in medical research. Unfortunately, the problem has not received the attention it deserves. Ethics should be taught not only to medical students, but also to those studying biological sciences, who, although they are not planning to become doctors, will have to face the same moral problems when they are engaged in medical research.

Dr. Rexed:
If we cannot assure the patient that he can go to his doctor or to a hospital with confidence, we shall bring about a crisis entraining the gravest consequences. We are aware that to further science we must take risks, but we have to know how far we can go.

In the presented paper, the environment was discussed. We may ask at what point a collective risk, such as pollution, requires action to be taken when we are unaware of the risks we expose people to. A body in Sweden, dealing with pollution, has identified 500,000 components in our chemical environment. We permit people to take individual risks - we do not prevent people from smoking or drinking even though we know the dangers involved. If we exclude individual risks, the doctor should intervene when the danger is likely to affect society in general. Where should we draw the line? We have to restrict ourselves to studying those risks related to experimentation and research,
involve the integrity of Man or of the population.

Modern research and medicine represent a greater risk than classical medicine, and often the patient is not aware of this. I think we should not allow experiments to be made simply for the sake of research as distinct from the benefit of the patient. An example of this is the case of a psychiatrist in Sweden who showed sadistic films to young children to see what their reactions would be. As a result of the ensuing outcry, it was decided that all experimentation that could overstep permissible limits was to be approved by an ethical committee created by the Caroline Institute. We should let the teaching body know that the situation has become so complex that experiments on humans are not to be considered without previous discussion. For this reason I cannot agree with Dr. Aujaleu and Dr. Bloch that it is enough to let every doctor follow his own conscience. It would mean placing the doctor in situations too difficult for him to manage.

The world should realize that genetic experiments are as potentially dangerous as atomic armaments and require equally clear and precise legislation.

Another major problem is the frontier between life and death, and this is of particular importance for surgeons performing transplant operations. We know that transplanted organs have a better chance of not being rejected if they come from living donors. Some people think that a kidney taken from a person who has just died is better than one taken from a still-living donor. Perhaps this will soon apply to the heart and liver also. Professor Chagas has said that we must reject the classical notion of death. Should we perhaps revise our idea that stoppage of cortical activity is synonymous with death? As donors in heart transplants, we can for instance discuss patients with massive cerebral haemorrhages - is the patient considered dead in this case? In Swedish law the definition of death does not include the cessation of brain activity, only of cardiac activity, although it is evident that in a short time one brings about the other. In Sweden it would be illegal to remove the heart from a patient who had suffered "brain death", and it has been asked whether the law should not be changed in this respect. A working group set up by the National Board of Health and Welfare, consisting of physicians, internists, cardiologists and lawyers, decided that it was not necessary to change the law. We feel that it is essential for people likely to be affected by this situation to decide; if a new definition of death were to be rejected by public opinion, it would set off a crisis of confidence.

In this context, we encounter the problem of the optimal life-span. Modern equipment, such as the pacemaker, can increase the chances of survival, and in cases of prolonged coma we can justifiably ask whether the individual is actually alive. If the patient is considered incurable, should we allow him to die? There have been comas of six months that were reversible, and we must take care to prevent our patients from thinking that they will not be adequately treated in cases that might seem desperate at first but are not really so.

Dr. Florkin:
I want to say a few words on a subject that has not been mentioned in some aspects of this discussion. We all agree that doctors are not always above reproach. There have even been instances of evil conduct, and I am referring now to the Nazi doctors; but we must remember that they behaved in such an immoral way because they abandoned the medical tradition in favour of a philosophical-political viewpoint. We must never forget that the medical tradition defends the human being in our society; if a doctor behaves badly, his colleagues will immediately warn him. This point was overlooked by Miss Hersch; doctors are not an irresponsible group, preoccupied by experimentation and making discoveries. We can state objectively that doctors as a whole possess a high morality, and this is a guarantee for the defence of the individual.

Dr. Servit:
The conscience of the doctor, and conscience in general, is not something mystical; it is formed gradually and is subject to evolution. One of the most striking characteristics of our world is that it is in a process of rapid evolution, which may even be too rapid, and Man is unable to adjust himself to this process physically or morally. Medicine is developing so quickly that we are faced daily with problems which we are not capable of resolving. Only by collaborating with philosophy, psychology, sociology and other disciplines will we be able to tackle these problems.

Dr. Chagas:
Dr. Florkin said that doctors were the defenders of the sick. I would go further and say that they are also the defenders of the normal man. This concept is, I think, basic to the formulation of a medical policy.

I am not completely in agreement with Dr. Aujaleu and Dr. Rexed. Pollution control should be an integral part of any medical policy and I shall illustrate my point with the case of the contamination of the biosphere by radioactivity. When I was on a committee for the study of radiation, I felt that there was a divergence of opinion between the physicists and chemists, who constituted a majority, and the doctors. If the latter had not taken a firm stand, it would have been very difficult to convince the former of the dangers of radioactivity. This applies to other areas of pollution also. I think Dr. Aujaleu is too optimistic in holding that the pollution problem has been resolved from a scientific angle. If this is the case, it is certainly not so economically or socially, and this is also true of nutrition. A recent document produced by WHO shows that there is no standard method of
measuring even the most common forms of pollution, which makes it impossible to establish any kind of international language.

I have always worked on animals and am very much in favour of vivisection, since it teaches students and researchers to respect the object they are working with. I do not believe it is possible to graduate to "human vivisection" - if I may call it that - without a first-class moral preparation.

If we wish to create a scientific morality, it must be essentially forward-looking, whereas our moral conception up to now is based on certain old-established values.

I am uneasy about having absolute confidence in the doctor's conscience, since I have had personal experience of colleagues who placed scientific expedience and the desire for experimentation above the health and well-being of the patient. A young collaborator of mine was only persuaded by scientific arguments to refrain from making testicular biopsies for cytogenetic examinations.

Finally, I would say that we should not make any recommendations, since the theme is too broad, the time too short and it is not our objective. We should restrict ourselves to discussing the problems and stressing the importance of the constitution of the Committee for Ethics presented by Dr. Bitsh and Dr. Rexed as a satisfactory formula.

Dr. Handler:
After the eloquence and wisdom of the speeches we have heard, I feel like a voter who has listened to all the candidates in the election campaign and agrees with all of them.

Generally, there are important questions, profound questions, and a few that are both important and profound. Society tends to deal with the important ones, whilst the profound ones it does not, and cannot, settle, since they reach down to articles of faith and vary with each culture. Today we are discussing the kind that are profound and important, and that is difficult, but there is no alternative. I might add that I myself tackle important questions while those I consider profound I leave to others.

The term "medical ethics" covers a wide range of notions, and I think it would be advisable to find a more limited and precise definition, to be used as a guideline for the doctor in medical practice. Research requires a special code of its own; the main criterion is that it should be good science, with a specific aim and purpose. I am upset by some of the reports on heart transplantation I have read. I do not consider them good science, and the men who carried them out should have known in advance what was going to happen, since it was obvious that the whole problem was one of immunogenetics. One of our rules here should be never to carry out research on humans unless there is no other way. We should never subject humans to experiments that can be performed on animals.

On the subject of pollution I agree with Dr. Aujaleu that we know how to eliminate pollution in the cities, just as the automobile industry knows how to reduce noxious exhaust fumes. We do not enforce these measures, for financial reasons. Similarly, water pollution could be prevented, and almost every factory using river water could return it cleaner than when they took it, but the public would have to agree to pay for this purification in the price of the product. Much costly research would have to be carried out on the effects of pollution in our environment; basically, it is a question of how much people are prepared to pay for the quality of the air they breathe and the surroundings they live in.

The problem of genetics has been with us since we began using insulin. Diabetes is a polygenic disorder - I think it involves six genes - and in the past children died from it. This is no longer so, but now we discover that these genes are spreading throughout the population, because we keep the patients alive. When insulin loses its effectiveness, we are no longer able to help these patients whom we originally saved by insulin, and they suffer from all kinds of cardiovascular diseases. In order to help the minority we have allowed these undesirable genes to spread.

Man is the first species to be in a position to modify its genetics; we have fettered the natural selection and we should not take this lightly. In the last few decades, natural selection has ceased to apply, survival of the fittest is no longer the rule, and the sickly and weak are kept alive and procreate. This is not necessarily bad - it depends on whether we look at this development from the viewpoint of the individual or of future society.

We are faced with the problem of choice when we have to determine priorities for the use of large, expensive equipment, such as an artificial lung, stimulator, etc., and this is the other side of the medal of progress.

Our whole cultural heritage has led us to regard human life as sacred (I use this religious term since I know of no other more suitable). How are we going to continue, and what decisions shall we make? These are not problems for the next century, but for the next fifty years, and this is the most frightening question ahead of Man. The future of the human race is too important to leave to the physicians alone and will have to be decided by Man himself.

Dr. Bloch:
I am not suggesting that there should be no regulations to govern this important field. I want to underline the fact that the existence of even the best rules do not release the individual from responsibility. The example of prolonged reversible comas should make us aware of the shortcomings of any rules we set up and should caution us on the question of transplanting organs.

If the control of experimentation is necessary, lack of control could be disastrous. There are examples in medical history where absence of
controls led to negligence and a feeling of false security.

Professor Hersch:
Nothing could be further from my thoughts than to accuse the medical profession of immorality. All I said was that doctors are men who, as many of you have also pointed out, do their best and take their profession seriously. Theirs is a heavy responsibility, and that is why it seems to me that the people who need most help in the extremely grave decisions they have to take are the doctors. It is hard to take such decisions alone, and they themselves should bring about a kind of unanimity or common viewpoint within the medical profession and, if possible, within the society of which they constitute a part. As men, they are social beings, and like everybody else they are subject to the influences, fashions and temptations of their time.

Today the strongest temptation is research: we unfortunate patients in need of a doctor wonder whether the time will come when the whole medical profession will consist of researchers and there will be no doctors around to care for us. Again, despite the ethical demands of their calling, the concentration of medical personnel in the cities proves that the profession is following the general trend towards urbanization, notwithstanding the shortage of doctors in the rural areas. Thus the doctors have not escaped from the universal pressures. If they are not completely in agreement among themselves as regards certain dramatic new situations, this is quite normal; but they should work out a common point of view.

Dr. Naffah:
I do not think the idea of conscience excludes the existence of a body that can decide on certain subjects connected with research, to be composed of clinicians, research workers and non-medical personnel.

I have the feeling that doctors have abrogated the right to decide on research involving the consent of donors. It is impossible to make distinctions between one life and another. The research workers tried to surround themselves with councils, and when the decision returned to them, they adopted an empirical point of view.

For a doctor, death can only mean biological death. We cannot base ourselves on the deterioration of human values, the personality, and there can thus be no question of ending a prolonged coma, however prolonged it may be. Obviously the question arises in the case of a "surpassed" coma, but brain death can only be established by the introduction of deep cortical electrodes, and the danger of implanting deep electrodes makes it impossible to establish any criteria. I agree that we have to educate and inform the public on these issues in order one day to reach a clear solution.

Dr. Chagas:
A question that seems to have been insufficiently discussed is urbanization, which has grave implications for human existence.

Dr. Prywes:
I would like to take up a point suggested by Miss Hersch's remarks. We understand and accept the idea that this problem of human living should be discussed by doctors and scientists, and also by those interested in social progress. Progress in biomedical research is only a small part of a problem shared by all scientists.

Progress today is making us redefine our notions of life and death. As countries become independent, they become involved in wars they would never have imagined before; new, sometimes artificial, frontiers have become barriers to understanding and walls of mistrust and hate; revolution, dictatorship and terror so well known to old countries become a way of life in the new countries. Another example of progress is literacy; and this is certainly a good thing. However, in a free society people can read and write whatever they want, and become subject to bad influences as well as good ones. The development in transportation has resulted in the terrible toll of deaths and injuries from accidents, which is now one of the major mortality factors. The problem is not only the physical death of the victims, but also a major problem of human behaviour in today's technological society.

Hence we cannot speak only of physical life and death - there is also moral life and death. The demographic consequences of urbanization have repercussions on all those who live in the big cities, which abound in examples of mental deterioration or "moral death" of young and old people alike.

What I have said about progress here applies to all the other areas of human development. A symposium at which philosophers and sociologists could meet with doctors and discuss the problem together would permit us to examine the results of progress in our own and all other fields of human endeavour. The problem is of a comprehensive nature and should, therefore, be dealt with comprehensively.
I. INTEGRATION OF BIOMEDICAL RESEARCH POLICY IN THE OVERALL PLANNING OF SCIENCE AND TECHNOLOGY

1. Scientific research and the technological development it makes possible constitute the principal mechanism whereby mankind can shape its future. The nations of the world exhibit a continuum with respect to current development of scientific capabilities. There are both small and large countries which are seriously underdeveloped in this regard, others which are partially developed and a smaller group which have attained sophisticated, vigorous scientific enterprises. The qualitative nature of these endeavours, today, is not so much a matter of national size as national history. Nevertheless, inevitably the great cost of modern science must necessarily restrict the scope but not the quality of a nation's scientific endeavour.

2. In the same manner, science itself represents a continuum. Biomedical science today, as never before, rests on foundations in physics, chemistry, mathematics, as well as the behavioural and social sciences. Accordingly, if the biomedical research endeavour in any nation is to be sound and productive, it must be closely associated with equally sound and productive efforts in the relevant scientific disciplines.

3. The national life of any country reflects the quality of the health of its people, which in turn is dependent on the quality of its health services. In their turn, modern medicine, like agriculture, demands a continuing, vigorous research endeavour if the quality of the services they render is to be equal to national needs, regardless of other considerations.

4. Therefore, it is imperative that each nation engage in a national biomedical research programme of a magnitude commensurate with national capabilities and needs. This is essential if a nation expects to develop research and development programmes in other areas which make for further economic and social progress.

5. The primary requirement of any nation is the continuing development of an adequate educational system, the products of which will find their place in all areas of national endeavour. Not only the scientists of tomorrow but all citizens require an education which will make them scientifically literate. From this base, it becomes possible to develop physicians, engineers, scientists, technicians, as well as educators, businessmen, administrators, legislators, etc., all of whom are required to ensure the future.

6. The manner in which a nation plans its scientific endeavour need not necessarily reflect the governmental structures whereby it implements those plans. Nevertheless, implementation of such plans can be successful only when a nation possesses carefully designed institutions and mechanisms capable of such implementation. These arrangements may certainly vary among the nations.

7. Increasingly, the utilization of science for the achievement of national goals and purposes has become the very business of government. Accordingly, it becomes ever more important that careful attention be given to national planning for the scientific endeavour. Whereas a sound national endeavour in fundamental scientific research is imperative to the success of its programmes of applied research and development, most of government planning for science must actually relate to planning for national goals with respect to health, agriculture, education, defence, commerce, etc., as these have been identified by appropriate public bodies.

8. Total planning for science thus represents the aggregation of the individual science plans for each of these essential elements of the total National Development Programme.

9. The generation of an overall national

(1) The conclusions have been adopted at the closing session, Thursday, 29 February 1968. They are presented here in three parts, each of them concerning one of the three topics of the Symposium.
science plan therefore must commence with the development, by properly qualified individuals, of sub-plans for science directed towards the goals identified in the National Development Plan. Within each such sub-plan, there should be appropriate recognition of the rôle of basic research, applied research and development.

10. Inevitably, the sum of such science plans will exceed national resources in available funds, physical plant and scientific manpower. It is then required that a central planning body review these plans with a view toward their reconciliation and the establishment of national priorities. In so doing, this body must give primary emphasis to those activities which will contribute to the long-range national future.

11. The overall science plan so generated should assure an adequate educational system at all educational levels, including universities and professional schools, assure that each of the scientific disciplines is adequately represented and nourished, assure of a future supply of all types of trained individuals in numbers commensurate with national aspirations, and assure that the institutional forms for the accomplishment of research and development have been generated and strengthened, for example medical schools, engineering schools, technical schools and research institutes. In each of these aspects of national science planning, primary emphasis should be accorded to the quality of the endeavour. Beyond that, having planned and budgeted for the aforementioned needs, there is required: (a) a budget for the direct support of research in each of the scientific disciplines and (b) a budget for research directed to applied problems. In a nation in which the primary requirements have been assured to some degree, the budget directed to applied purposes may grow as national resources permit.

12. It will be clear from this description of its functions that the members of this central planning organization must be unusually well qualified in one or more of the scientific and technical areas for which the group bears planning responsibility.

13. To be most effective, such a body must have meaningful information early in the budgetary planning process, yet it should not itself either make financial allocations or specific research assignments to be accepted by operational research units or institutions. In the main, research plans and accompanying budget requests should arise from the scientific operational units.

14. Although such a planning structure appears eminently appropriate to those nations which already possess substantial scientific resources, it may not be feasible in the very first phases of national development which are invariably characterized by limited scientific manpower.

II. INSTITUTIONAL STRUCTURE AND ORGANIZATION OF BIOMEDICAL RESEARCH

15. Unity of biomedical research: Biomedical research should be regarded as research focused on problems of individual health and of public health from the point of view of both prevention and cure of diseases and of social and psychological problems associated with health problems.

16. Need for a pragmatical classification: Within this unity which constitutes biomedical research, it is possible to distinguish: research arising from fundamental sciences, which is likely to have long-term application; clinical research on patients, based on advanced and rigorous scientific methodology; research on public health, such as epidemiological and operational research (including ecological and ethological research); technological research aimed at the development of new drugs and of appliances embodying the latest results of physical and chemical science.

The above list demonstrates the difficulty of fixing rigid boundaries between medical research on the one hand and fundamental biological research and socio-demographic research on the other. The boundaries between the three above-mentioned fields of research, and within these fields, those between the classical disciplines and sub-disciplines, are no longer desirable. In any event, whatever rigid departmentalization still exists, it should not be allowed to interfere with the process of conducting research.

17. Institutional organization of biomedical research: Analysis of various institutional systems has demonstrated their diversity, a diversity which is not deliberate, but is due largely to a historic and cultural evolution peculiar to each nation, and is also influenced by the political and economic structures of each country.

18. Three systems were compared:
(a) the system in which the funds appropriated for the attainment of various national goals, and made available to more than one government agency, are then contributed to the support of medical research in several institutions;
(b) the planned system with a rather clear delineation of communications and objectives, based mainly on the utilization of specialized institutes;
(c) finally, the system adopted by most West-European countries, based in the first instance on universities, but also on centralized research organizations which support and sometimes orient the work of universities.

Whatever the system used, there will be, in principle, a three-level structure similar to that described by Unesco based on the findings of its
world survey, (1) with certain differences arising from the political organization of each country:

First level: general planning at government level;
Second level: planning in the different disciplines and co-ordination at the level of specialized national science councils;
Third level: the execution of research, which devolves on the institutions.

19. Attention was drawn first to the need for a co-ordination level. The diversity among the bodies located at this level is very marked (National Centre for Scientific Research, National Foundation for Scientific Research, Academy of Sciences, National Council for Scientific Research, etc.). Due to the character of medical research, it is desirable to create a special council for biomedical research.

This scientific council for biomedical research, at the second level, is needed both for informing the central science planning body and the government (first level) of the priority requirements of biomedical research, and for transmitting and interpreting to the executing organizations (third level) the directives issued by the government, keeping within the limits of the financial resources allocated to biomedical research.

20. At the operational level (third level), research is conducted in:
(a) universities and university hospitals, which undertake the following tasks:
training and finishing of research personnel so as to ensure the availability of a continuous supply; maintenance of an adequate level of good quality scientific research in all disciplines, this being the only guarantee for the quality of training given to the students and future research personnel; this implies provision of an assured and sufficient basic budget independent of the financing of special projects. In addition, there should be supplementary finance to facilitate the prosecution of certain research in accordance with the traditional vocation of universities or the special competence of certain university researchers, taking into account the national priority requirements;
(b) the activities of the specialized scientific institutions complement those of universities in the fields accorded priority by the leading national science policy-making bodies;
(c) organizations having industrial and commercial status. Research directed towards the development of products useful in relation to health (drugs and diagnostic, therapeutic and research equipment) is conducted mainly in laboratories belonging to industrial enterprises, public or private, which may also play a part in the training of research workers.

21. The research tasks will be satisfactorily carried out to the extent that contacts are established between the three categories of bodies, which should complement and assist one another. This is particularly desirable as regards the relations between the universities and the industrial enterprises.

22. Special attention has been paid to the developing countries. The same general principles apply, but it is necessary to take into account the particular situation of each country and to avoid copying too closely the pattern provided by the advanced countries. The importance of biomedical research for those countries is not confined to the direct benefits resulting from the research, but also has an educational value of the highest order. For the developing countries, it is of the first importance to establish and improve their universities so that they can train their research workers there.

Simultaneously, it would be necessary to create co-ordinating organizations to define the scientific needs and possibilities. Bearing in mind the scarcity of resources, the identification of priorities will be all the more essential and will have to be carried out by those countries in the light of their resources in qualified manpower and finance.

As regards the specialized research institutes, it is desirable that they be established within or in very close association with the universities. Institutes already in existence should be integrated with the universities or should, at least, establish very close relations with them.

It would also be desirable to encourage the establishment of research centres belonging to industry in the developing countries. This is only possible, however, if favourable conditions are ensured.

23. One of the best ways of assisting biomedical research in the developing countries would be to afford them access to a documentation centre employing the latest technological methods. Much emphasis was laid on the importance of contacts and information, at the international as well as the national level. This should be relatively easy to arrange, since biomedical research is a universal field with no secret implications.

III PROBLEMS OF SCIENCE POLICY AND LEGISLATION ARISING FROM MEDICAL ADVANCES: INFLUENCE OF MEDICAL SCIENCES ON MAN AND ON SOCIETY IN GENERAL

24. Scientific and technological progress has

led to a considerable increase in the responsibilities of the medical profession as regards its relations with society in general and with the individual in particular.

Consequently, medical research has to adapt itself to new situations and maintain intact its traditional respect of human values and the ethical principles deriving from them.

These new situations raise problems in relation to the human environment, to populations and to the individual.

(a) Man's environment

25. It is not wise to wait for the appearance of harmful effects of the applications of science and technology before studying the manifold consequences of the secondary effects produced by these applications.

26. The bodies controlling the national science policy of different countries have the responsibility to foresee the appearance of these harmful effects, and to direct the competent scientific and legal institutions to study them jointly, with a view to formulating appropriate recommendations to place before governments, legislators and the public.

27. In this connexion, it would undoubtedly be desirable to undertake, at the international level, and in a prospective manner, the formulation of a kind of "Code of scientific and technological responsibility", as happened in connexion with the world threat of radio-active contamination. Scientists engaged in medical research should participate in this activity, for it is up to the medical world to test and check the reality of the menaces threatening the health of mankind and the future of the species.

28. Similarly, it would be desirable to encourage research aimed at defining more exactly, and standardizing internationally, the limits of tolerance and the degrees of harmfulness of polluting agents of all kinds.

29. The establishment of a stable and viable environment for mankind raises problems which are capable of being solved by modern technology. The measures which will be necessary will involve considerable expense, with regard to which the community will be directly concerned. However, these problems and the justification of the expenditures will not receive the attention of the responsible authorities until interdisciplinary scientific research has determined the critical threshold levels of this environment.

(b) The individual and the species

30. The progress of scientific research is continually reviving the moral problems facing the scientific community; this situation is particularly acute in medicine, since in this field research is conducted both on man and for his good.

31. The medical profession bears an additional responsibility by virtue of the fact that the behaviour of doctors unquestionably exerts an influence on the moral senses of society, and that, by tradition, doctors have a decisive part to play in the maintenance of man as a permanent value directing their efforts, which may not be subordinated to any other value.

32. Faced with the magnitude and complexity of the moral problems raised by the progress of medical research, and because this research has a direct influence on the future of the species and of the individual, it appears necessary to provide researchers in biomedical sciences, and practitioners, with guidance in regard to their professional activities. In this connexion, it is suggested to extend the experience of certain countries which have created, in association with biomedical research centres, "Committees on medical ethics" composed of doctors, whose rôle is essentially preventive.

33. The constitution of a representative national body which would include doctors, specialists in related sciences and jurists would provide an additional guarantee for the observance of medical ethics.

34. Further, it would be desirable that countries which have not yet done so should establish legislative standards such as:

(a) definition of a criterion of death in accordance with present-day knowledge in medical science, and resting on a sign of irreversibility that has never been found to be false;

(b) proscription of the sale of human organs, tissue and media.

35. With a view to arousing the international scientific community to problems of medical ethics, and to giving them the opportunity to express themselves freely, it is recommended that there should be constituted, under the aegis of a non-governmental international organization such as the Council of International Organizations of Medical Sciences (CIOMS), a permanent study group to explore in a prospective manner the moral problems raised by medical research, with the object of creating gradually, by international approval, a moral scientific responsibility.

It is a matter of immediate urgency that firm moral positions should be established at the international level, with the objects of safeguarding in particular the genetic heritage of the species and the moral integrity of the individual while at the same time not impeding the normal progress of research.

Advances in the field of medicine actually tend to increase the number of individuals carrying transmissible genetic defects. Thus on the one hand it is important to intensify genetic research, while on the other hand care must be taken that such research is not exploited at the expense of the individual human being. These reservations apply particularly to certain brain operations.

36. The supporting structures envisaged
above (Committee on medical ethics, representative national body and international group) would in no way abolish the responsibility of the individual medical research worker confronted by new problems.

The participants in the Symposium regretted that relatively little importance was accorded to ethical medical instruction in the existing university system of most countries.

In this connexion, they recommended that the responsible authorities should examine carefully the possibility of developing throughout the medical studies the different types of instruction in medical ethics, oriented towards moral problems which nowadays have to be faced both by the research worker and the practitioner.

37. Independently of any reference to morals or philosophy, the participants recalled that the international scientific community acknowledges a criterion of fundamental "scientific morals", in other words, scientific research aiming ultimately at serving man and carrying the promise of advancing knowledge.

This implies, inter alia, that biomedical research on man should only be undertaken with the greatest reserve and with the sole object of maintaining the health of the individual concerned, thus excluding biomedical research on humans conducted with the sole object of increasing scientific knowledge.

38. The participants emphasized that it was important for various reasons to disseminate positive and objective information to the public.

Such information is necessary firstly in order to create among the public an atmosphere favourable to scientific research and, secondly, in order to create progressively a collective consciousness enabling it to face its responsibilities.

Further, the participants denounced the evil influence produced by pseudo-scientific, tendentious and sensational information.
ANNEX I

AGENDA

1. Opening of the meeting
2. Approval of the Agenda
3. Election of a vice-president and a rapporteur
4. Discussion of First Topic: Institutional structure and organization of medical research
5. Discussion of Second Topic: Integration of biomedical research policy in the overall planning of science and technology
6. Discussion of Third Topic: Problems of science policy and legislation arising from medical advances; influence of medical sciences on man and on society in general
7. Resolutions and recommendations
8. Closing of the meeting
ANNEX II

LIST OF PARTICIPANTS

Dr. M. Aujaleu
Directeur général, Institut national de la santé et de recherche médicale
Paris, France

Dr. J. Bernard (Chairman)
Chaire de clinique des maladies du sang
Faculté de Médecine
Hôpital Saint-Louis
Paris, France

Dr. V. Bîlbîie
Consiliul National al Cercetării Stiinţifice
(National Council for Scientific Research)
Bucharest, Romania

Dr. H. Bloch
Director of Research, CIBA Aktiengesellschaft
Basle, Switzerland

Dr. C. Chagas (invited speaker)
Ambassador, Permanent Delegate of Brazil to Unesco
Paris, France

Dr. P. Handler (invited speaker)\(^{(1)}\)
James B. Duke Professor, Chairman, Department of Biochemistry
Duke University Medical Center
Durham, North Carolina, U.S.A.

Dr. J. Naffah
Professor at the French Faculty of Medicine
Beirut, Lebanon

Dr. M. Prywes (Rapporteur)
Chairman of the Department of Medical Education
Hebrew University-Hadassah Medical School
Jerusalem, Israel

Dr. B. Rexed (invited speaker)
Director-General, Socialstyrelsen, National Board of Health
Stockholm, Sweden

Dr. Z. Servit
President, Scientific Board of Medical Sciences, Academy of Sciences (CSAV)
Prague, Czechoslovakia

CIOMS

Dr. M. Florkin, President of CIOMS
Université de Liège, Laboratoire de Biochimie
Liège, Belgium

Dr. V. Fattorusso, Executive Secretary

UNESCO

M. Y. de Hemptinne
Director, Science Policy Division

Prof. J. Hersch
Director, Division of Philosophy\(^{(2)}\)

Miss N. Visart de Bocarmé
Programme Specialist, Science Policy Division

WORLD HEALTH ORGANIZATION

Dr. S. Btesh
Director, Research Planning and Co-ordination

\(^{(1)}\) President of the National Academy of Sciences since July 1969.
\(^{(2)}\) Prof. J. Hersch resumed her Chair at the University of Geneva in September 1968.
ANNEX III

COMMENTS ON THE GENERAL ORIENTATION DOCUMENT (PSRB-1)

First Topic: Institutional structure and organization of medical research

by Professor H. Bloch

ad. 1. Definition:

While any attempt to separate biological from medical research is admittedly artificial and therefore unsatisfactory, the term of "biomedical research" seems to be unsatisfactory in the context of the present symposium because most of the topics discussed apply only to the medical side of "biomedical" research. It is the experimentation with man which creates special problems, and it is the preoccupation with human disease in all its contexts - medical, psychological, social, political - which sets it apart from all other biological research. While all medical research is biological research, the opposite is obviously not true. I would therefore prefer to talk about medical research wherever human physiology and pathology are being studied.

ad. 2. Responsible institutions:

Most of the quoted institutions and similar ones in other countries support applied as well as basic research, but a trend, which in my view is sound, exists to separate goal-directed medical research from basic biological research, the results of which may or may not be later applicable to human medicine. Such separation avoids the dilemma of scientific double standards between clinical and basic biological research and permits more fruitful efforts in applied medical research.

Discussions about the best organizational form in which government-supported research is administered appear rather futile because conditions vary so much from country to country and the establishment of general recommendations would therefore seem to be of questionable value.

ad. 3. Finance:

Here, too, to postulate generally applicable rules seems to be too theoretical as to be of practical value. However, I would propose an alternate solution to 3 (b), namely rather than to set aside a certain percentage of the total health budget for medical research, to earmark a very small percentage of the total defense budget of each country for medical research. Medical research would be enormously better off, and the military would hardly notice it!

I would like to take issue with proposal 3 (c). Is it not unrealistic to characterize the pharmaceutical industry as "the great beneficiary of medical research"? It is a matter of record that much of the significant therapeutic progress of the last twenty or thirty years is due to industrial research. Industrial research is an integrated part of overall medical research. Scientific progress is a give and take and every step forward is based on previously acquired knowledge. Just as nobody would question the greatness of Newton's contributions because he achieved them, in his own words, "by standing on ye shoulders of giants", it seems unjustified to claim that the industrial pharmaceutical research has taken more from medical research than it has given to it. To single out the pharmaceutical industry for a special taxation is not only unjustified, it is also politically unrealistic. Government-supported research is financed by taxpayer's money to which the pharmaceutical industry contributes substantially. Moreover, it is a well-known fact that in most countries the pharmaceutical industry has for many years and on a voluntary basis contributed significant sums of money to academic research in the fields of medicine, chemistry and biology. A special taxation over and above that of other industries would almost certainly bring the voluntary contributions of the pharmaceutical industry to a standstill. These contributions are useful not only for their cash value, but because the donors, being accountable only to themselves and not hampered by administrative red tape, enjoy more freedom in making grants than government-controlled granting institutions, e.g. in Switzerland, the four largest pharmaceutical industries together are donating at present approximately $3 million per year to free extramural academic medical research. They are
willing to take chances and often help young research workers in establishing research programmes to the point where they qualify for support by government granting institutions.

ad. 5. Developing countries:

This might be an appropriate occasion to discuss in some depth the problem of medical research in and for developing countries. Much is presently being tried with varying results.

Should scientists from developing countries be trained in more advanced countries, or should research and training centres rather be set up in developing countries?

Should foreign governments and private industries be encouraged to set up centres in developing countries?

Is there a place for advanced research in a developing country where there are so many obvious and less sophisticated problems to be solved?

Should a scientific structure in these countries be built up "from the top to the bottom" or rather be reconstructed "from the bottom up to the top"?

Where scientific research centres exist in developing countries, what can be done to ease their existence and free them from the many impediments and obstructions which are put in their way by their own governments and administrations? There is a real danger that foreign academic institutions as well as private investigators, after an enthusiastic initial period, will turn their backs in despair because of the ever-increasing difficulties created by local politics.

Finally, is it conceivable that developing countries would form international groups to carry out research projects which are beyond the personal and financial resources of any one single country?
Let me say at once that I do not advocate the synoptic planning attempted by the systems analysts, or the balanced growth which is frequently taken as a prime desideratum, but, instead, recommend that those, who plan a national medical research enterprise exercise skillful opportunism as they stimulate the growth of the system by relatively disjointed increments.

At first approach such planning seems simple. A small nation with limited resources of funds, facilities, and manpower need merely decide which is the most important biomedical problem in its part of the world and then direct those resources to solution of that problem. An economically well-developed nation, with substantially greater resources, might consider simply giving the entire system free rein in the expectation that its scientists will attack those problems which are important and approachable experimentally. Later, in retrospect, one might assess what had actually been accomplished. But neither approach is really acceptable. All the considerations which have been raised with respect to the allocation of some fraction of a nation's total resources to the biomedical research enterprise are equally appropriate when one attempts, in turn, to fractionate that enterprise. Accordingly, the problems posed by biomedical research in the smaller or less-developed nation are more simply managed than are those of the more complex nations. One cannot but feel that control of schistosomiasis or of frank malnutrition, for example, where these are endemic, is of overriding importance. Surely these much more properly command the attention of those concerned with the public health in such areas than do the more universal problems of heart disease, cancer or genetic disorders.

For those responsible for decisions under such circumstances, I have but one counsel. Every research enterprise flourishes best when the group which is so engaged attains some meaningful, critical mass. Hence, a nation with one or two medical schools should seriously consider the possibility of developing only a limited number of research groups, each addressed to a problem of maximal concern to that nation and each large enough and so equipped and financed as to afford some prospect of success. Such success will not only have immediate relevance to the public health of the area but will effect a marked enhancement of morale and create an intellectual and political climate of richer opportunity for subsequent endeavours.

Only a handful of major clinical triumphs, such as the eradication of pellagra, penicillin therapy for syphilis, general antibiotic therapy, treatment of arthritis with steroids, and the recent accomplishments of vascular surgery, have, in the United States, served as catalysts which have opened the public purse for support of biomedical research. Those nations which, of necessity, can at present expect to mount only relatively more modest biomedical research enterprises may find it best not to engage competitively in those aspects of medical research which are under intensive investigation elsewhere. I do not mean to imply that individual scientists in smaller nations cannot successfully compete, for example, in molecular biology. Nor do I suggest that the scientists of the emerging nations must mark time for decades as they retrace from its beginnings the long evolution of medical research. Quite the contrary. The scientist born in one of the emerging nations but trained in one of the older laboratories and with access to current literature need suffer no handicap save the limitations of his own talent and of the resources which his society places at his disposal. Nevertheless, unless he can be joined by a sufficient group of competent colleagues, I believe he will best serve his own ends and those of his nation by addressing himself to a problem of unusual significance in his own locale.

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INTERNAL AND EXTERNAL PRESSURES

The 2nd NIH International Symposium on Biomedical Research has emphasized the concept that, for science generally, two significant sets of pressures determine the allocation of resources: pressures which arise from within the scientific community and those which arise from without (1). This concept is equally applicable to the allocation of resources within the biomedical enterprise. The pressures from without are easily identifiable. They include the general aspiration to free man of cancer, of heart disease, of infection, of malnutrition, of fears in the night; society expects, and quite rightly, that much of the total research effort shall be directly devoted to these ends. They include the expectation that the biomedical community will operate an educational system which will produce physicians in sufficient numbers to provide adequate care for all members of society. They include the expectation that those engaged in research will reproduce their kind in numbers sufficient to assure an adequate continuing supply of individuals who will pursue medical science. And it is gratifying to recognize that they include a growing expectation that man will intensify not only his exploration of the universe in which he finds himself but his exploration and understanding of himself.

The internal pressures, generated by the research community itself, are less widely experienced but, unless modified more likely to give direction to the conduct of research. For example, if left to its own devices, a substantial segment of the biomedical community is likely to eschew the immediate problems of disease. Some may enjoy the esthetics of enzyme kinetics, while ignoring metabolic disease; others may explore viral genetics, while ignoring the consequences of viral infection. Or, some wisp of the Zeitgeist may lead many to examine the mechanisms of carcinogenesis while none seek insights into the bases for schizophrenia. In some, the scientific community continues to press for the vitality and expansion of the relevant scientific disciplines and for biological research at its most fundamental levels, preferring to defer direct attack upon overt disease until in its view, the stage has been adequately set. In general, I share this approach.

It is the obligation of those charged with the responsibility for what is euphemistically called "planning for science" to be aware of both types of pressure, to admit that each is a valid criterion for decision making, and to recognize that neither set of pressures, along, constitutes a sufficient basis for national decisions.

THE EXTREME VIEWS

To be sure, each extreme view has had its exponents. At one extreme are statements such as that by Michael Polanyi (2), who argues, "No committee of scientists, however distinguished, could forecast the further progress of science except for the routine extension of the existing system. The pursuit of science can be organized, therefore, in no other manner than by granting complete independence to all mature scientists. The function of public authority is not to plan research but only to provide opportunities for its pursuit. To do less is to neglect the progress of science. To do more is to cultivate mediocrity and waste public money." The adherents of views such as this are numerous, and history documents their claims. Indeed, in only a handful of instances has organized society recognized a major problem and directed to it the scientists who found an appropriate solution.

In this country, for example, our Public Health Service recognized the threat posed by pellagra in our Southeast and dispatched Joseph Goldberger to investigate the problem. His triumph is now history, but it is rather ironic that, having prejudged the nature of the problem, the Public Health Service dispatched a bacteriologist to address himself to what proved to be a nutritional problem. And if this tale has any moral it is that the triumph reflected the genius of the investigator rather than the wisdom of those charged with allocating the then meagre resources of the United States Public Health Service. How many instances of societal planning of successful major advances in the elucidation of human biology or in the understanding, prevention, or treatment of disease can one add to such a list? The development of Atabrine, understanding of the etiology of retrolental fibroplasia, the development of antiviral vaccines, and control of insect-borne diseases are among the relatively few such major, planned accomplishments. The development of new drugs by the laboratories of the pharmaceutical industry, an arm of organized society, must also be included.

On the other side of the ledger - that of the unplanned accomplishments which we owe entirely to the imagination and initiative of individual investigators - is virtually every other major advance in man's understanding of himself and of the disorders to which he is subject. Surely this history indicates that the criteria for research support which arise from within the scientific community are generally valid. In fairness, however, let it be said that large-scale public support of research and the opportunity to "plan" are recent phenomena and this judgement must be held in abeyance.

Nevertheless, many concur with Hogben (3), who said, "To get the fullest opportunities for doing the kind of work which is worthwhile to themselves, scientific workers must participate in their responsibilities as citizens. Among other things, this includes refraining from the arrogant pretence that their own preferences are sufficient justification for the support which they need. This pretence, put forward as the plea that science should be encouraged for its own sake, is a survival of Platonism. Science thrives by its applications.
To justify it as an end in itself is a policy of defeat.

Such statements engender much controversy - and properly so. Patently, modern society supports the laboratory of a scientist not so that he may amuse himself but, rather, in the hope that his activities will, in some measure, make possible realization of one of society's own expectations. To be sure, these expectations include, broadly the advancement of knowledge, but this ranks well below the hope that the scientist's findings can soon be translated into some practical end. Accordingly, in this country we have attempted to manage a national enterprise which provides opportunity both for the scientific giants whose research, freely undertaken, results in "quantum jumps" in our understanding and for those scientists who seek to exploit such understanding in the common interest.

In our own time it has become apparent that planned science - here I use the term planning rather broadly - is feasible. There have been no planned breakthroughs, nor are there likely to be any. But there can be and there has been planned exploitation of such breakthroughs. Not even Fleming planned his astute observations, but the subsequent effort required to produce penicillin and to determine its structure was most effectively planned. Society did not plan Enders' observations of viral propagation in animal tissue in culture, but society did plan the large programme which supported the development of effective antiviral vaccines. Society did not plan the observations which led to the strong suspicion that elevated concentration of serum lipid is related to the development of atherosclerosis and myocardial infarction, but society can and does plan the effort necessary to validate that conclusion and to develop means for alleviating this disorder. Watson and Crick were free scientists, engaged in a problem of their own choosing, but society could and did plan to support the broad-scale effort required to amplify their hypotheses, in the hope of bringing understanding of those phenomena which underlie genetic disorders of man, viral infectivity, and perhaps cancer.

But the administrators of science must not plan the doing of science. They can but plan opportunities for the doing of science and hope that talented, competent investigators will avail themselves of such opportunities. Effective planners may not do less and should not do more.

PLANNING A RESEARCH ENTERPRISE

It becomes apparent that, in attempting to plan a national biomedical research enterprise, one must view the enterprise while simultaneously considering each of a series of seemingly independent parameters. Among these are the various diseases which ravage mankind, perhaps the organ systems of which man is built (liver, kidney, brain and so on), the continuing vitality of each of the related scientific disciplines, and the integrity of the academic institutions in which much of the research is to be performed. One must weigh the relative importance of research done on man himself and research performed on animals or model systems; of research in the laboratory and research in the field; of research in areas clearly identifiable as "biomedical" and research, essential to an understanding of life, in tangentially related disciplines; of the support of research and the support of training for the future conduct of research; of the support of research and research training and the support of education in clinical medicine; and of hosts of seemingly lesser parameters. Each of these parameters is relevant to each decision concerning the planning and funding of individual research programmes.

At this point one might visualize the development of a matrix in which each parameter has a weighted value and is brought to bear on each decision; this would be an idealized version of the approach of the operations or systems analyst. Successful development of such a matrix would seem to suffice for the total planning operation, and all one would then need to know would be the total appropriation to be made available by the State in any one year; all other decisions would then be automatic. This is an exaggerated version of what Charles V. Kidd has termed "allocation in multiple dimensions". In the exaggerated form here presented it is rather horrendous to contemplate and, no matter how conscientiously or painstakingly developed, is guaranteed to yield many decisions which time will prove to have been incorrect.

In a limited sense, however, the principle does have merit. Those charged with planning responsibility must indeed be aware of the various criteria which are meaningful in the decision process. They must assure society that none of the meaningful parameters have been neglected, although they cannot possibly guarantee that a perfect balance among them all has been assured. Indeed, such balance is not even necessarily desirable.

Happily, in the real world, matters can proceed more easily and more successfully than the novice in planning might have thought. No nation has actually engaged in such detailed allocative planning. In most instances planning has been done, rather, in a single dimension. Resources have usually been allocated by disease or by discipline, or, in nations with university grants systems, have simply been apportioned among universities and other appropriate institutions. But for our purposes it is important to note that the other dimensions do exist, whether they are planned for or no. Each research project which is supported, or for which support has been denied, has relevance in virtually every possible planning dimension. And, in annual retrospective examination, it is imperative that the operation of the system be examined in as many dimensions as possible, so that, if necessary, corrective action may be taken. One can hope in
this way to assure that certain broad priorities are operative. Probably highest among these is the assurance that, at all times, a future generation of investigators is being trained and that their number bears some reasonable relationship to the desired future magnitude of the national research enterprise. Second priority might be given the assurance that all the disciplines currently meaningful on the biomedical scene are given sufficient support to assure a vigorous national effort. Third priority might relate to the vitality of academic institutions and of individual laboratories. In fourth place might be the distribution of resources by disease categories, ranked in the order of the severity of such disorders in a given community. The fact that it is this fourth priority which is frequently given most obvious expression relates to political considerations rather than to the internal logic of the system.

It will be evident that in a nation confronted with a planning problem of this magnitude there already is a system in being which can be retrospectively examined and corrected. Indeed, much of what is called planning is essentially remedial in that it seeks to rectify apparent errors rather than move toward planned objectives. Planning proceeds from an existing base, and each proposed increment to the existing system can be considered rather readily from the multidimensional standpoint.

ALLOCATIONS AND ADJUDICATIONS

These thoughts, lead, then, to consideration of the actual process whereby one establishes allocations within a budget and then adjudicates the competing claims of individuals or institutions within some category of that budget. Patently, this cannot be done in an information vacuum. The establishing of allocations is the more complex task, as it demands a weighing of the values of the internal and external pressures. These pressures certainly vary among nations, and in any one nation they must vary from time to time. In any case, they can only be designated as weak, strong or paramount. Thereafter one requires real data descriptive of opportunities: knowledge of the number of competent investigators interested in a given area, of the physical facilities, of the number of students in training, and of the cost of doing business in a typical research group; and, most importantly, an assessment of the "state of the art" in each subfield of research endeavour - that is, an informed guess concerning when the time is right, conceptually and technologically, to increase significantly the level of effort in a given research area. Evaluation of this information and appraisal of the scientific field should permit tailoring of the demands of the scientific community to the interests of society. They yield a crude determination of the relative magnitudes of support to be given, for example, to fellowship programmes, arthritis or dental research, genetics or pathology, clinical or basic research.

Such considerations are particularly germane to those components of the system which are properly called "small science" - science in which the individual professor or senior investigator and his coterie of junior colleagues are the meaningful productive and budgetary unit. Whether he works in a government-operated establishment or in a university where his work is supported by a national research grants programme is inconsequential. When the funds available are less than those requested by the scientific community (and this should always be the case, else excessive funds have been provided), competing requests can be evaluated only on the basis of intrinsic scientific merit - that is, the competence of the investigator and the imagination, soundness and feasibility of his proposal. The evaluation can be made only by a jury of his peers, drawn from a national panel of experts. To be sure, they may share his enthusiasm for his discipline but they are not rivals, on his local scene, for prestige, salary, space or influence. It is the lack of this evaluative process which is the cardinal weakness of a university grants system and of other purely bureaucratic administrative devices. Conversely, it is the operation of this evaluation system which is the best guarantee that society will get its money's worth.

Proposals for "big science" are rare in biomedical research. They must be examined closely both for their intrinsic value and for the harm they could do the rest of the system through imposing a drain on manpower, facilities, or funds. By and large they are foreign to the university biomedical community and, if they are desirable at all, their operation is a proper function of government or of a contractor-agent.

The greatest advantage of incremental planning is the fact that such planning makes it possible to seize previously unforeseen opportunity. And it is here that the quasi-mathematical approach to total planning falls most seriously, since it does not take into account the manner in which science itself grows. Let us consider this in some detail.

BALANCED AND UNBALANCED GROWTH

There is a great temptation for those engaged in planning to attempt to project systems of "balanced growth". Indeed, "balanced growth" has been the acknowledged objective of most of those who plan a nation's economy, its weapons systems and its support of science generally as well as its support of biomedical research. Although planners frequently recognize that they cannot realize this ideal, this so-called balanced system is the proximate objective of their development programmes. As noted by Hirschman and Lindblom (4), the basis for this ideal is a "faith in the existence of basic harmonies similar to the Greek belief that the truly beautiful will possess moral excellence as well". It seems opportune, therefore to direct to
your attention a recent series of papers which have taken striking exception to the concept of planning balanced growth of a large enterprise and have advocated in its stead a process which has been called "disjointed incrementalism".

Because the analogies are pertinent to the problems here considered, it seems appropriate to summarize the views of various members of the group who advocate this process. For example, Hirschman (5), an economist, has offered as the basic defence of unbalanced growth the concept that an economy's resources should not be considered as rigidly fixed in amount. He argues that more resources or factors of production will come into play if development is marked by sectoral imbalances, since these will arouse private entrepreneurs or public authorities to action. In the present context, there are many analogies. For example the existence of a large pool of investigators who lack facilities for their activities constitutes a pressure which, ultimately, will result in the construction of new and more adequate facilities. The appearance of large numbers of young men and women desirous of training in biomedical research results in pressure which leads to the development of fellowship and training programmes. Recognition that a temperate bacteriophage can disappear into the genome of the host bacterium, be reproduced with that genome for many generations, and then reappear in vast numbers under adverse circumstances prompts many investigators interested in the nature of the viral origin of cancer to take a new tack in their explorations. As Hirschman has said, to the extent that the imbalance is self-correcting through a variety of mechanisms, unbalanced growth may propel the economy forward jerkily but also more quickly than by planned, balanced expansion.

Klein and Meckling (6), students of development policies for weapons systems, allege that a given development is both less costly and more speedy when marked by duplication, confusion and lack of communication among people working along parallel lines. They argue against early attempts at integrating subsystems into a well-articulated, harmonious general system. They advocate, instead, the full exploitation of fruitful ideas regardless of their fit to some preconceived pattern of specifications. The principal basis for this attitude is the very fact of uncertainty. They note that the final configuration to be developed is, in any case, unknown, and that knowledge increases as some of the subsystems become articulate. Knowledge about the nature of any one subsystem increases the number of clues concerning the desirable features of another, just as it is easier to fit in a piece of a jigsaw puzzle when some of the surrounding pieces are already in place. What is important is to develop the pieces, one can adjust them to each other later. This view argues for maximum support of the current enthusiasm for molecular biology even though its immediate clinical application seems remote, and for vigorous follow-up of clues to the possible viral pathogenesis of cancer even though the major psychoses remain enigmas and relatively few biologists seem to be immediately concerned with their elucidation. Similarly, it argues for full support of all the competent scientists in our midst, even though this results in overcrowding of their laboratories.

Lindblom (7), who has been concerned with general aspects of policy making, takes as his point of departure a denial of the general validity of an assumption which is implicit in most of the literature on policy making - that there exists sufficient agreement to provide adequate criteria for choosing among possible alternative policies. This assumption is often questioned in contemporary social science, yet many of the most common prescriptions for rational problem solving follow only if it is true.

Conventional descriptions of rational decision making include the following steps: (i) clarification of the objective or values; (ii) survey of alternative means of reaching objectives; (iii) identification of consequences, including the side effects of by-products of each alternative means; and (iv) evaluation of each set of consequences in the light of the objective. However, Lindblom notes that such synoptic attempts at problem solving are not possible when, for example, clarification of objective founders on social conflict, when required information is not available or is available only at prohibitive costs, or when the problem is simply too complex for man's finite intellectual capacities. Most importantly, it does not logically follow, Lindblom argues, that when synoptic decision making is extremely difficult it should nevertheless be pursued as far as possible. Hence he suggests that, in many circumstances, substantial departures from comprehensive understanding are not only inevitable but desirable. I cite his thesis in detail because the analogy to me seems so close.

WORKING PRINCIPLES

I have summarized the case for what may be called "semi-planning". What are the working principles of this approach? A few major notions are worthy of consideration. (i) An element of laissez-faire, with its attendant duplication and gaps, may well be desirable rather than abominable. (ii) Orderliness, balance and detailed planning may be more satisfying to the planners than to the society they serve; some matters probably ought to be left to what has been called "a wise and salutary neglect". (iii) It is unwise to specify detailed objectives in advance when the means of obtaining them are virtually unknown. (iv) A rational problem solver wants what he can get and does not try to get what he wants except after identifying what he wants by examination of what he can get. (v) Arrangements must be established whereby decision makers are made aware of, and can react promptly to, emerging
problems. (vi) Long-range planning is a valuable exercise, but long-range plans for a research enterprise which is the sum of many smaller research programmes are of dubious validity.

These principles, taken in part from Hirschman and Lindblom (4), approximate a real world which is almost invariably characterized by unbalanced, not balanced, growth. It is the above-scale salary offered to the new appointee which is the surest guarantee of an increase in the scale. It is the existence and success of the National Science Foundation which provides the platform on which stand those who argue for establishment of a National Humanities Foundation. Instances of the principle that imbalance results in pressure for a correcting growth are commonplace. And these same principles seem entirely germane to the planning of a national biomedical endeavour which is as inherently sporadic and random as is the natural growth of science itself. Indeed, the hallmark of the competent investigator is that he seeks constantly to identify the most important problem which can be attacked with the technology currently available and limits his goals accordingly. But his attention is continually given also to developments within his own and related disciplines. He is quick to apply new information, new techniques, new apparatus. In short, he brings to research his imagination, his knowledge and his technical know-how, and he combines these with what may best be described as a "skillful opportunism".

In my view, those responsible for the management of a national enterprise which is the sum of such individuals must do likewise. They must continually assess the major parameters of the enterprise for which they have responsibility, continuing the attack on the major public-health problems, insuring the vitality of the classic scientific disciplines and recognizing the emergence of new ones, ensuring the training of new investigators and practitioners and safeguarding the health of the medical schools and universities. The total system may then be nourished and made to grow, but by disjointed increments. For example, given a 10 or 20 per cent increase in total funds, one should almost never expand support, across the board, of all existing programmes by this 10 or 20 per cent. Instead, one should take advantage of significant, albeit unplanned and unexpected, new knowledge of human biology or pathology, of the work of new investigators as it appears, of new approaches, new drugs, new apparatus, new facilities, new architecture, and newly awakened public interest, always utilizing the skillful opportunism characteristic of the individual investigator.

Goals may be set only in the broadest terms of ultimate objectives - for example, a general homotransplantation, effective cancer chemotherapy, a rational management of viral infections, genetic transformation as therapy for hereditary disorders or the prevention of atherosclerosis. And one can, in a general way, plan for the tasks ahead by providing the necessary physical plant, stimulating activity in biomedical engineering, and providing a sufficient number of specialized facilities such as animal colonies, hyperbaric chambers, and libraries. It is highly doubtful that the planner can wisely do more; he will fail in his responsibilities if he does less. And he must ever be mindful that the planning of science must be left to the working scientist.

References
1. A. M. Weimberg, Minerva 1, 159 (winter 1963); 3, 1 (winter 1964).
2. M. Polanyi, ibid., 1, 54 (autumn 1962).
The incentive to do medical research stems from many quarters which - although united in purpose - are nevertheless becoming more widely separated from one another in this era of specialized disciplines and organizations.

Had the question on whose responsibility is medical research been put to the early denizen of my home town, Theophrastus Bombastus Paracelsus, he would undoubtedly have given a simple and straightforward answer, to wit: Medical research is my responsibility and that of my peers. And the position did not basically change until perhaps a century ago, when the special medical disciplines and all the basic medical sciences, including biochemistry, came of age. Meanwhile, the catalogue has become much longer since epidemiology, public health, population control, nutrition, radiobiology, genetics and many other disciplines including aviation and space research have been added to the areas of scientific endeavour from which medical research takes its cues.

Today, medical research is not only the preoccupation of the medical schools and science faculties of universities, it has become a noble prerogative of private and public research institutes, of defence establishments, of national governments and international organizations, of charitable institutions and foundations and, last but not least, of a highly developed pharmaceutical industry whose livelihood depends almost entirely on medical research.

But let me return to the question: Whose responsibility is medical research? And another question which follows logically: To whom are those engaged in medical research responsible?

The latter question is easy to answer. Since all research costs money, those who carry out research are responsible to those who finance it: the government agencies, the international organizations, the private foundations, the university administrations, the industrial managements, the stockholders and the taxpayers.

In evaluating the research for which they are paying, the donors will of course consider the degree of excellence of the work performed. But in medical research, there enters a second consideration which would not apply in, say, mathematical research. It is the usefulness of the results. By definition, medicine is an applied science or, better, is an application of science to the art of medicine. It is expected to produce results which, over and above the accumulation of knowledge, should turn out to be directly beneficiary to man. While this may not always be openly acknowledged, it is nevertheless a fact. And it is likewise a fact that money is much easier to obtain from government, from charities, and from industrial managements for research which promises practical results.

We should note then that most medical research is goal-directed. It should produce results providing better understanding of physiopathological processes, improved diagnostic techniques, more effective therapy, better prophylactic measures - in short - it should alleviate the burden of sickness and provide the basis for longer and happier lives.

We need not discuss here whether medical research is necessary or not. Professor McMichael has answered this question unequivocally two years ago at a similar conference here in London. Medical research is necessary and will never end. But
the responsibilities for carrying it out are divided amongst those qualified and equipped to do it. Epidemiology and preventive medicine appear to be the primary responsibility of governmental institutions such as Ministries of Health or Public Health Services, and of international bodies such as the World Health Organization. The purpose of this research is the improvement of the collective state of health of populations and their protection from damaging environmental agents. This sort of work is based on large numbers of observations on large numbers of people often distributed over wide geographic areas. It requires substantial funds, many collaborators, and large organizations. The excellent BCG trials carried out by the MRC in the U.K., the Framingham Study, or the current investigations into the consequences of cigarette smoking are investigations of this kind.

The research devoted to obtaining basic information on the pathophysiologic disease processes, on their recognition and - perhaps - their cure has traditionally been the task of universities and medical research institutes. Personally, I feel that the university is the best place for academic research and if more research institutes find their way into closer associations with universities, it will be to the mutual benefit of both.

By their very nature and the economic basis on which they are founded, the research laboratories of the pharmaceutical industry are predestined to assume the primary responsibility for that part of therapeutic research which, in the widest context of the term, may be called chemotherapy. It is an uncontested fact that over the past fifty years the bulk of our chemotherapeutic armatorium, the large majority of all effective modern drugs have emerged from the laboratories of the pharmaceutical industry around the world. It is also a matter of record that nowadays these laboratories are probably the only ones geared to perform the demanding and sophisticated development work which an active chemical compound must undergo in order to become a useful drug.

Finally, the main responsibility of the foundations and charitable funds may be seen in financing research projects which, by their very nature, do not really fit into any of the three aforementioned categories, or in supporting scientists who deserve to be given an opportunity to prove themselves, but who, for one reason or another, present too great a risk to be readily supported by government or industry. Private foundations being accountable only to themselves and not to the public can afford to take greater chances than is possible for official agencies or industrial management. Moreover, the total funds which are at the disposal of private foundations are so small in comparison to the enormous amounts of money spent by government and industry that in order to preserve their identity and their creativeness as donors the foundations should choose different and somewhat unorthodox objectives for their munificence. In addition, they are unhampered by administrative red tape and therefore free to give quickly wherever the need is greatest.

Having tried to separate the various subjects of medical research by their nature and to allocate certain areas to certain sponsors, I must now hasten to say that such separation is highly artificial and unrealistic. Research in the life sciences is an indivisible whole and seemingly unrelated results may suddenly become meaningful in a different context. Chance observations and their intelligent pursuit are still one of the main sources of real progress.

The scientific community is a tightly knit, interdependent group. The more freely it communicates and the more closely it co-operates, the better it is for all concerned. I consider it a very happy state of affairs that in some countries such as Switzerland and the United States, there exists a free and open communication and collaboration between the universities, the government institutions and industry. This open-door policy has proven highly fruitful and profitable for all concerned. It permits the universities to make use for their teaching and research of the large pool of talent, know-how and the material resources which the industries and government possess. And it allows the industrial research laboratories to partake of the manifold opportunities which the academic community has to offer. Wherever universities and research-based industries have found one another, they have developed real symbioses where - like in any true symbiosis - it is no longer possible to decide whether a partner is giving more than he takes. My own home town, Basle, is a case in point. But there are many more, and such happy relationships are by no means restricted to the life sciences.

To an outsider, it seems rather a pity that in some other countries similar conditions do not seem to prevail and it is not difficult to see why more intimate and fruitful associations have so far failed to develop there. On the side of the industries, the failure is due to regrettable over-secrecy, and on the academic side to a certain aloofness which looks down at what they call applied research. For both attitudes there seems no place left in our time. The application of science has moulded the world in which we live and it will continue to do so. Should the university fail to assume a more active part in this exciting enterprise, it would simply become an odd curiosity, an ivory tower on a desert island. And should industry fail to understand that it is no longer feasible to lock up secrets for any length of time in closely guarded laboratories, or to isolate industrial scientists from the rest of the scientific community, they would soon lose all their good scientists and be left behind with stale and worthless secrets.

Any government who tolerates the mere co-existence of their universities and industries without actively prodding them into close co-operation
is allowing to lie fallow a rich potential of scientific possibilities, to the detriment of the country's academic future and of its industrial development.

In order to play their part in medical research, the universities must be adequately financed by public funds and the industries must be able to thrive on a sound economic basis, since - in contrast to all other institutions - they must provide their research funds from their own earnings.

From the financial point of view, pharmaceutical research is a long-term investment. It takes an average of something like five to seven years of developmental work for a new drug to pass all the rigid tests which are required before it can be marketed. The majority of experimental drugs never reaches this stage, and some which do never become profitable, because the diseases they cure are rare, or because the patients who need these drugs are poor people from poor countries who just cannot provide such elementary items as food for the hungry and medicines for the sick. But without a reasonable relationship between research investment and overall profit the industry can no longer afford the heavy research expenses, and it is the few successful drugs which must finance the entire expensive establishment.

As we are all aware, drug prices today are under heavy attack all over the world. Mostly, these attacks are politically motivated, although some serious criticisms emerge also from the medical world. This is not the place to enter into a discussion on this subject. Suffice it to say that, should these attacks continue to become more vicious and be followed by political actions seriously menancing the economic basis of the pharmaceutical industry, the resulting losses would not only affect the industries themselves, the hundred thousands of people whom they support and the countries where they pay taxes and from which they export, but also the basic medical sciences as well as medical therapy to which the pharmaceutical industry has made continuing and significant contributions almost since its very beginning.

It is often said that basic research is the task of academic institutions, whereas industrial laboratories are the realm of applied research. Frankly, I do not like this distinction. First of all, I have not found a satisfactory definition of what is basic and what is applied medical research. As I mentioned before, all medical research has - by definition - practical implications, simply because its results may sooner or later be applied to medicine, i.e. to the prevention of illness and to the art of healing the sick. Take the work of Pasteur. We would be at a loss trying to determine whether it is more outstanding for its contributions to our basic knowledge of the characteristics of the living cell or for the benefits that preventive as well as curative medicine were able to draw from it. Or take the antibiotics. Their therapeutic value is obvious, but they were of at least equal significance to the progress of molecular biology and modern genetics. Some of them, like actinomycin and puromycin, have no place in therapy, but they became indispensable scientific tools. The same is true for aldosterone, which was synthesized in our laboratories and for which no therapeutic use has been found as yet. Or take the beautiful piece of work on interferon production by RNA, which has just been published from Dr. Tishler's laboratory and which is probably still far away from practical usefulness. Antibiotics and steroids are excellent examples of the fruitful cross-fertilization which may occur between academic and industrial research and it would be an idle task trying to decide which of the many steps leading to the end result were basic and which were applied.

May I then summarize that medical research is the responsibility of the entire community of life scientists. Their work is financed by government, industry and private charities. Certain areas of research are primarily incumbent on each of these groups according to their resources and the nature of the problem, but the entire and, despite all the progress, still formidable task must be tackled by a concentrated and integrated effort of all who are qualified to contribute.

Let me, in conclusion, touch upon two points which have some bearing on our subject. The one concerns medical research in developing countries. These countries have a tremendous need for medical research intelligently applied to their problems. The problems are highly specific for these countries, not so much by their medical and scientific nature, but by the socio-economic context in which they present themselves. It seems an urgent task worthy of the very best brains of these countries to work on the solution of their problems in their own way, i.e. with their own people, in their own countries and with their own methods, which is the only way in which they can be solved. In many far away places, this country has done excellent work by creating local institutions of learning and research and by training people on the spot to tackle their difficult tasks with modern scientific methods. This approach seems ever so much more successful than training large numbers of scientists from developing countries in Europe or America and then sending them back after many years during which they have become spoiled and estranged from their own culture.

The second point concerns the consequences for our society of the advances of medical research. They have often been enumerated and you know what I have in mind: The population explosion; the overaging of our population; the survival of an ever increasing number of creatures whose life can only be preserved by complicated technical devices; the yet unknown dangers resulting from the wide use of powerful and specifically acting drugs; and the challenge to physical and mental health resulting from a technical environment which is rapidly changing our world into a new, unnatural habitat of man.
I leave out from this enumeration the even more frightening aspects of technical progress which today are still in the realm of science fiction, but which tomorrow already will be hard realities: The possibility to tamper with the genetic make-up, to influence at will man's personality and character, and other like prospects denoting the increasing power of medical science.

Only occasionally and in a random fashion are life scientists today concerned with these consequences of their own endeavour. I suggest that they can no longer shun the obligation to become involved and that this aspect of medical research is the responsibility of all those who by their own successful research actively contribute to the very creation of these problems.
PROPOSITIONS

1. Scientific and technical progress is transforming man's environment, the relations between man and that environment, and between man and his own powers, with increasing speed and irreversibly.

   In the past, the main object was to accelerate this process. Today, the process has acquired its own momentum, an acceleration independent of the action of man, who is trying, perforce, to adapt himself to it as best he may. Man is, with sovereign might, transforming his natural environment, but he seems to be losing control of the transformation he is bringing about, and frequently fails to guard against its consequences, to delimit its extent and depth, or even to keep it set in the same direction. The destined courses of nature have been overcome and replaced by fates determined by man's power, which seem henceforth to leave him a choice only as regards details. Thus "development" is unanimously considered to have become "the destiny of all". It is both idle and criminal to question it. At the most, an attempt is made to incline it towards what is still regarded as being "human".

2. This accelerated process gives rise to problems decisive for every aspect of human life. The very terms in which problems are stated are transformed in the act of stating them. We are continually coping with crises, and arriving too late. Emergencies constantly thrust into the background what really matters.

   Let us take for example birth and death. The fact that we can now postpone death and reduce the number of births entails a radical change in day-to-day life, in the population, social structures, economic relations, psychological outlook, the sense of the present, and the symbolic and religious nature of the beginning and the end. While we are wondering about the transformation of family structures, the very nature of the family is changing out of all recognition. When solutions are found, they are applicable to yesterday's problems, and we have to hasten on to solve today's. How in these circumstances can we find the time to reflect on the significance or value of the new powers themselves? For example: experts having established that the optimum population for a given area is represented by the figure $X$, every effort will be made to keep it at that level by limiting the number of births, while prolonging individual life as much as possible. But we can see at once how ambiguous are such notions as "preferable" or "implicit values" in such a process, which implies a general ageing of the population.

3. The purpose of the process as a whole is supposed to be the service of man and of human life. But it entails consequences bringing with them the gravest threats to human life and its environment. It is likely, at the same time, to subjugate man to its own acceleration, thus shutting progress into a vicious circle devoid of meaning.

   The nature of man and of human life is such that it provides scarcely any unequivocal criteria by which the process claiming to be in man's interest can be clearly evaluated. Man himself, in fact, is truly man only in the service of something else, which it is for him personally to choose and to will. It is probably one of man's distinctive characteristics that he is able to hold life, and therefore death, relatively light in comparison with the object on which he has set his choice and his will. Not only is he capable of this; he is indeed disposed to do so. Life is very far from being what he is most loth to renounce. This accounts, I would argue, for the fact that he has no hesitation in proceeding along a path of progress which, while it makes possible the prolongation of life, nevertheless threatens very large groups of human beings with dangers of extermination, of which the atomic bomb is only one of the rather more sensational examples. The chief point, however, is that the process of this advance is becoming
so intensive and all-pervading that the relation between means and ends is liable to be reversed. If the object of man's choice and will becomes the very process which was intended to serve them - in more practical terms, if the planning of science, education and culture is done by reference to the criteria of what are the best conditions for technical productivity, if attention is concentrated on training the men best equipped to produce the goods they consume - then men become the means, and the process, the end.

In the medical sphere, for example, on the basis of what is already being done, we can easily imagine a set of operations which would get rid of everything that, in individuals, "disturbs" or "upsets" an ideal psychophysical state which would be known as "health", and would be judged by the ability to produce and to consume in accordance with the requirements of the process of "progress".

4. The new scientific and technical powers, which are liable to poison the human environment, and which make it possible to interfere with the physical organs, the conscience, and - one day soon - the heredity of man, set on contemporary society an unprecedented duty of supervision and vigilance. New risks, concerning humanity as a whole, call for ethical reflection and legal formulation on a world scale.

The law, obviously enough, has set standards only for types of human behaviour which were known and recognized as possible. Today, acts of all kinds have become possible, which no one could ever have foreseen and for which, therefore, no one has ever legislated. Among the acts which are possible today, it is precisely those which bring the greatest power into play, those whose consequences for the human environment or for man himself are most decisive, that are beyond the bounds of law, in the uncharted sphere of force and arbitrary choice, and also, very often, in areas where moral issues are doubtful, where contradictory or inadequate standards clash.

Medicine can no longer dissociate itself from the external conditions of life, the relationships between environment and health, now that these "external conditions", this "environment" are very largely the direct or indirect products of man's work. It must necessarily combine with the jurists to keep these "conditions" within the limits required by health. At the same time, the transplanting of organs, the replacement of tissues or blood, surgical operations on the brain, action on the glands and, through the glands, on personality, temperament and affectivity, the drugs of all kinds used in psychiatry, the various operations whereby consciousness itself, and heredity - perhaps not today but at least tomorrow - can be influenced: all these new powers call for a moral and legal study which must be the responsibility of doctors and of society as a whole.

But interventions of this sort have results which are not only medical. Whether he is a doctor or not, a man does not have the same feeling when faced with a being whose inner substance remains a mystery to him as he does when dealing with one whose mechanisms he fully understands and which he can take apart, put together, or transform as he wishes. Whatever mechanistic theories he may profess, no one treats his child or his dog as he treats his adding machine or his computer. But the growing powers of intervention that surgery and medicine are acquiring, the growing specialization and technicality of the most efficient forms of treatment, are tending more and more to turn the patient, in the doctor's eyes, into an object which he knows and can manipulate by technical means, whose personal inviolability is first overlooked in principle, then denied in theory, and at last ousted from perception by feeling or moral sense. At that stage it is the "moral fibre", in the words of certain great practitioners, which gradually becomes deadened in certain doctors, and is replaced by the passion for research or for technical triumphs. Little by little, with the deadening of the "fibre", ethical requirements are liable to become less exacting throughout the medical profession and to be impaired throughout the whole population. "The sense of humanity", implanted in our physical and moral affectivity, which has been slowly elaborated in the course of thousands of years, may perhaps not be indestructible.

5. The need to face universal threats calls for a creative evolution in the law. The old inter-State international law will tend to become increasingly a law generally applying to the universal community of men, kept up-to-date thanks to the general information of the public and revised as necessary thanks to the creative imagination of jurists, scholars, statesmen, sociologists and philosophers.

To the extent that scientific and technical civilization is tending to become universal, bringing with it new powers which are outside the bounds of traditional law, the new threats hanging over mankind as a whole must also be parried for the world as a whole. The new law, breaking loose from national State structures, will have to buttress, to rationalize, define and strengthen the threatened "moral fibre", thus helping to implant and build up, in the universal society which is developing, a common respect for what is, in man, irredusable human. Instead of appearing as a survival of the past, care for humanity can thus become the source, the criterion and the raison d'être of future changes.

Man, the be-all and end-all of scientific and technical progress, is not a mere biological or social product. He gives meaning to the process, in that he is a being capable of forming himself and of assuming responsibility for what he is. He does
not allow himself to be reduced by definition, by prediction, or by analysis.

The necessary ethical reflection and legal formulation will thus have a twofold purpose: to determine the conditions and the limits within which scientific and technical progress remains in the service of human life and safeguards the environment essential to it; and to protect the human being, his integrity and his potential, against interference which would destroy his unity, and against the excesses of planning.

6. In the biomedical sciences, the first aim should be to ensure the essential conditions for life and for physical and mental health. But even here, the unity of man and all the levels of his existence is so strong that we immediately come up against essential problems of ethics, with contradictory and conflicting requirements of all kinds.

We have seen above that the rapid transformation of the conditions of life is continually forcing us to deal with the most urgent problem first. The most urgent always seems to concern the conditions of life and of physical health. The rest, we think, will come later. But in the case of man, it is not possible to consider the conditions of physical life and health as distinct from his being as a whole. No "healthy life", however rational and justified, could be the ultimate rule for him, without depriving him of his humanity. Nor is it possible to say where its effects stop. Family planning, for example, influences not only the population of an area, the economic balance of families, and the health of mothers, but also, among other things, the mother's view of the relation between her right and her affection and, more intimately, between the sexual act and the child. Now these latter implications are not amenable to planning as such, because they remain unforeseeable, being matters of individual freedom. They may have remote consequences which it would be dangerous to overlook.

Surgical transplants are increasing in numbers and becoming more and more daring. They, too, give rise to unprecedented problems at various levels. At present, when a surgeon attempts a heart transplant, doctors, the public, journalists and radio commentators limit their questions almost exclusively to whether the operation will succeed and the patient survive. Only incidentally do they sometimes wonder what precautions have been taken with regard to the donor, who was the victim of an accident: has everything possible been done to save him? Categorical assurances have been given on this subject. Some doctors have raised objections. In their view, these attempts are premature, since problems of molecular biology which are decisive in ensuring that the new organ is tolerated have not yet been solved, they consider that the element of experiment here is excessive, when compared with the hopes of cure.

There are, however, many other problems as well. For example, supposing that one day such transplants can be carried out almost always successfully, where will the "breakdown" and "reconstruction" of the human being stop? What will become of his "unity", his "integrity", the irreducible quality of the self that says "I"? It is true that it is as ridiculous to locate this "I" in the heart or in the brain as to locate God physically in the sky. In this respect, the successes of contemporary science do not compel the mind to accept any form of materialism or atheism: they merely entail a purification of the symbols by which man seeks to form a mental representation of God without an image, or of human freedom. Nevertheless, the "I" entity is still inseparable from a "unity" of the sentient, active body. If the main organs of the body become interchangeable, the "I" is liable either to fade away or to take refuge in a pure disincarnate spirituality. And if the "I" disintegrates, who or what profits from all this labour, all this science, this technique, these transplants?

In the end, what or whom are we trying to keep alive?

Again, even if it is accepted that everything possible has been done to keep the donor of a transplanted organ alive, it none the less remains true that, at the sight of the victim, the hope of using his heart must have gleamed in the mind of the surgeons. They made their preparations. They took samples of tissues and compared them while the potential donor was still alive. Though still alive, this human being, whatever may be said, was no longer, for the doctors, exclusively an end in himself, a being to be saved, but a means to ensure the life of another. Once such an attitude is accepted as justified, recognized, and becomes general, for what new horizons are the ethical sensibility, the moral fibre, of a society bound?

Finally - and very significantly - when the "I" disintegrates, when the feeling of duty towards an "I" is blunted or blurred, death loses its clear definition. There are now degrees of death, the criteria are uncertain, and we are told that we now need "a new definition". But this "definition" will not be given with a view to circumscribing an absolute event, an irremediable scission, but with a view to making surgical transplants possible, with certain limits.

Then, however, the whole ethics of medicine, and the whole social significance of life, and of murder, are swept into a zone of instability. All that is then possible is to rely (as our society, incidentally, tends to do in every field) on the incorruptibility of the individual and on his absolute moral sense - even while, at the same time, the substratum of that moral sense is contested - and leave it to him to work out each time, in the stress of emergency as it were, where the line is to be drawn between licet and nefas, between what may and may not be done.
PROBLEMS TO BE CONSIDERED (Examples)

1. The environment:

The destruction of nature; air and water pollution; human action affecting climatic and meteorological conditions; the size of towns, their lay-out, their use, plans for family housing. All these represent for man choices whose influence will be more and more decisive, not only for people's culture, or absence of culture, but also for their health and their life.

2. The unity and integrity of the human person

(a) The individual: individual modifications which cannot be transmitted.

How far can surgery go in the replacement of organs, blood, etc? What are the rights of the patient? Of the donor?

How far can psychiatry go in its operations (drugs, electric-shock treatment, lobotomies, etc.), whether for the purposes of research, therapy, or prophylaxis, involving modifications in the workings of the brain? What rights and safeguards does the patient have in this field?

(b) The population: individual modifications which can be transmitted.

How far is it permissible for us to interfere with the genetic characters of man? Does such action give a further dimension to man's mastery over his own fate, or does it, beyond certain limits, become a denial of it?

In the case of hereditary defects, what are the rights of society for protecting the future of the race? What are the rights of the individual? Where are the decisive criteria to be found?

These are only some examples. A vast, unexplored, and only partially glimpsed field is opening up for ethical and legal reflection. Here the medical sciences are inextricably involved in all contemporary research and techniques, and moreover in something which will always be beyond their scope. They can neither stand aside in isolation nor refuse to submit to the general questioning. What is at stake is man and the meaning of the whole human adventure.
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