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Telegrams : Phusis Lesquare London
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PENICILLIN: A STUDY IN CO-OPERATION

MUCH has recently been heard of co-operation between scientific workers of Great Britain and of the United States in physical research, and the successful outcome of the work which culminated in the production of the atomic bomb has been widely quoted as an indication of the value of such co-operative effort and the desirability of its continuation in the future. With the publication of the statement on the chemistry of penicillin which appears in this issue of *Nature* (p. 766), there is revealed the existence of another co-operative effort in research, directed towards a very different end. This publication may serve to correct the general but mistaken impression that scientific work during the War has been mainly concerned with the destruction of man. It is of some interest to consider the background against which this extensive collaboration in work on penicillin was developed and the implications which it carries for the future.

As soon as the potential importance of penicillin as a therapeutic agent had been demonstrated by Florey and his collaborators, intensive chemical work on the substance was initiated in Florey's own laboratory and in the Department of Chemistry at Oxford. From the time of the formation in 1942, at the instance of the Ministry of Supply, of the General Penicillin Committee, which was charged with the duty of doing everything possible to increase production of penicillin, other academic and industrial laboratories in Great Britain were drawn into the work and a considerable measure of co-operation was achieved in this country.

As the work on the constitution of penicillin proceeded, and as the formidable difficulties of large-scale microbiological production of the substance were realized, the question of the development of a synthesis acquired considerable urgency, and through the Medical Research Council steps were taken to make the collaboration between British chemists engaged on the problem more intimate and effective. For this purpose the Council set up a Penicillin Synthesis Committee (under the chairmanship of Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford), which included distinguished chemists from both academic and industrial organizations working on this subject. By this time it had become apparent that, owing to the difficult situation in Great Britain, and to the greater resources of labour, material and technical knowledge of microbiological methods in the United States, it was from America that really large-scale microbiological production of penicillin was first to be anticipated. That this anticipation has been realized is now a matter of common knowledge ; what could not be foreseen at the time was that the most hopeful expectations would be far exceeded by an effort in the industrial application of microbiology which is probably without parallel in the past.

The development of the national effort in the microbiological production of penicillin in the United States naturally involved American chemists in work

similar to that which had already been begun in Great Britain on the constitution of penicillin with a view to its subsequent synthesis. The potentialities of penicillin not only in matters affecting the health of the civil population but also in directly assisting military operations by controlling infection of wounds, and thus reducing disability, were fully realized both in Britain and in the United States ; this realization brought the recognition that work directed towards synthesis, which at that time seemed to offer the best prospect of the rapid production of the substance in large quantities, was a matter of the greatest importance to both countries.

Since this conviction was shared on both sides of the Atlantic, it was possible for the Medical Research Council to arrange with the Office of Scientific Research and Development in Washington, which itself was co-ordinating American work on penicillin on behalf of the United States Government, for the complete and up-to-date exchange between the two countries of all research information bearing on the synthesis of penicillin. Thus, the Penicillin Synthesis Committee of the Medical Research Council referred to above became a co-ordinating centre in Britain not only for all British research on the constitution and synthesis of penicillin but also for the complete Anglo-American collaborative effort. The statement which is now published gives an outline of the unequivocal results obtained in Britain and in the United States both before and during the operation of this collaborative arrangement, up to the middle of 1944.

Full assessment of the value of the chemical work which has resulted from the international co-ordination of research on this subject must naturally await the complete publication of the results, which it is hoped may not be long delayed. In the meantime, however, the impressive amount of this work is immediately apparent from the preliminary statement, which also brings to light other facts of interest. The first is the extraordinary and unexpected difficulty of the problem. The molecule of penicillin is not large, and, as the statement indicates, the general features of its structure are revealed by identification of the products of acid hydrolysis ; on the other hand, some of the transformations undergone by penicillin are not easy to explain and it is clear that there has been difficulty in reaching finality about its constitution. A measure of the magnitude of the problem is afforded by perusal of the list of groups both in Britain and in the United States which have participated in the work, and this list is itself a second matter of interest to which attention may be directed. Not only have some of the most distinguished organic chemists in both countries directed their efforts to the problem, but also every potentially useful physico-chemical and physical technique has been brought to bear on it. Never before indeed can there have been such a concentrated attack on the chemistry of a single compound. It seems that penicillin is almost as remarkable in the tenacity with which it holds the secrets of its molecular structure as it is in the biological properties which give it its peculiar importance.

Whether or not we are ultimately to learn that the collaborative research on penicillin has led to success, the announcement that such a collaboration has been possible at all is an event of considerable significance. A few years ago it would have been quite inconceivable that a project with such possibilities of commercial development could have been the subject of pooled research, involving a completely free interchange of information, between a group of organizations such as those listed at the end of the statement ; this list includes, for both Britain and the United States, academic laboratories, government research institutions and the research departments of industrial firms which are normally commercial competitors. Those who have knowledge of the working of the arrangement are aware of, and have been impressed by, the complete loyalty with which all participants have observed the conditions of co-operation.

Even if it be admitted that such a collaboration in research on a subject of potential commercial value could only have been arranged under the special conditions prevailing in war-time, when the motive of commercial competition is submerged by that of defence of the country, the evident success of the temporary arrangement is certainly a good omen for the future. It becomes increasingly clear that for the advance of science in any country, particularly perhaps for the advance of chemistry and physics, a closer co-ordination is desirable than has hitherto existed between the research work which is done in universities, government institutions and industrial laboratories. Of the difficulties which have stood in the way of such co-ordination in the past, the greatest is probably the inevitable difference of outlook induced by the necessities of commercial practice. This has tended to set up a barrier between the academic research worker whose traditions demand free publication of all results and free interchange of information with his scientific colleagues, and the industrial research worker whose first duty is to the interests of his own firm. With the resumption in peace-time of normal commercial practice, this difficulty will necessarily reappear and it is useless to minimize its seriousness. Nevertheless, even the temporary breakdown of the barrier by a collaborative arrangement such as has operated during the last few years in the field of penicillin chemistry can scarcely fail to exercise a lasting effect for the good. On one hand, the academic participants will have had an opportunity, such as could not otherwise have been afforded to them, of learning something of the quality of research work which is carried out in industrial organizations, and they will certainly thereby have acquired a greater respect for this work ; on the other hand, it may be hoped that the industrial research workers may have become more impressed than they formerly were with the very real benefits which may be derived in scientific work from free consultation and discussion with colleagues. If such a conviction were established, it would probably also result in a change of policy in the direction of prompt and complete publication of scientific results from industrial research laboratories to the maximum extent consistent with adequate

protection for development ; no move could be more favourable to the recruitment of able scientific workers to industry than an increase in the opportunities afforded to them for publication and, through this, for the development of a scientific career.

If the collaborative research on penicillin has been effective in starting a move in the directions indicated, this may ultimately be counted a contribution to the advancement of science as important as the actual scientific work for which the collaborating parties have been responsible.

SCIENCE AND MYSTICISM

The Physical Basis of Personality

By Prof. V. H. Mottram. (Pelican Books, A.139.) Pp. 126. (Harmondsworth and New York : Penguin Books, Ltd., 1944.) 9*d*.

IN this book the reader will find a stimulating discussion of known facts about heredity, genes, endocrine organs and related biological conceptions. The terminology of these conceptions is freely used nowadays, often without a clear understanding of its meaning. It is therefore important that this meaning should be precisely understood. For this reason alone this book should be read.

Apart from this point, however, the book is worth reading for the sake of its last chapter entitled "Recapitulation and Coda". If some readers reject the author's criticism of the determinist materialist philosophy which is so popular nowadays (again often without adequate understanding of its full implications), others will welcome the method which the author adopts of avoiding the pessimism and unhappiness which materialism so often brings. The way indicated is a mysticism reconciled with scientific discovery. It will not be everyone's way of meeting the philosophical challenges of science. At least one other way is available, namely, the lonely way expounded by Sir Charles Sherrington in his "Man on his Nature", which book Prof. Mottram highly commends. Commendable Sir Charles Sherrington's book most certainly is, in spite of its difficult style ; but it counsels a solution which the mystic could not adopt. For Sherrington there can be no leaning for counsel and guidance upon a higher mind or personality. Man must shoulder his burden alone ; and by acceptance of that "loftier responsibility", he is raised, in Sherrington's opinion, to "a rank of obligation and pathos which neither Moses in his law-giving nor Job in all his suffering could present".

This attitude, admirable though it is, requires for its acceptance a mind too subservient to logic and the scientific method to be representative of the newest developments of human intelligence. Much recent writing indicates this. To mention only one example, Dr. Clark-Kennedy, in his lecture on "The Art of Medicine in Relation to the Progress of Thought" (Cambridge University Press, 1945), has ably set out some of the reasons why science is not enough for the proper practice of the art and science of medicine. Mottram, in the book under consideration, and the others, ancient and modern, whose work he quotes, remind us of an experience less tragic, if no less difficult, than that indicated by Sir Charles Sherrington—an experience which has been variously called communion with an inner spirit or reality, the quest of the world-soul, submission to the absolute (which does not, be it noted, necessarily involve acceptance or even understanding of Hegelian philosophy), the search for the spirit of the whole or accordance with the inner necessity. Yet others, like McTaggart and Younghusband, have frankly and simply called it love. It is an experience which all of us may have if we will ; we may have it, too, without any very esoteric disciplines. Most men of science, in any event, will probably be able, if they are honest with themselves, to apply to their own experience Sir Olaf Stapledon's description, quoted by Mottram from Stapledon's "Saints and Revolutionaries", of that "very comprehensive act of attention, an attending to everything at once, or to the wholeness of everything at once" which brought to Stapledon "a tension of fervour and peace" and might easily, he goes on to say, be regarded, if he were less sceptical, as some kind of contact with God.

One way of experiencing this kind of emotion—and of doing so without necessarily excluding God—is to watch, in the circle of green light beneath a microscope, the ways, say, of the trypanosome which can, and inevitably will, if conditions are favourable, kill a Christ and a Hitler alike. The proper understanding of the conditions necessary for this entirely inhuman and amoral act requires an intellectual discipline, maintained for many years of close and exacting study, which the orthodox mystic can scarcely comprehend. The mere act of looking down a microscope will not provide it, though the microscope can, like the rites prescribed by orthodox mysticism, shut out the disturbances of the immediate surroundings and focus the attention. It can focus the attention, moreover, upon those small details which, both by their cumulative effects and their individual significance, reveal to the experienced mind a good deal which the philosopher, who looks at the landscapes of science rather than at their several components, cannot possibly apprehend. It can focus the attention, in addition, upon those minute inexactitudes which at once justify the disciplines of the scientific method and at the same time reveal its limitations. It can endow the observer with a "snail-horn delicacy of perception" which is essential to any effort towards the understanding of those wider landscapes which the philosopher seeks to delineate.

The remainder of the mystic procedure will come naturally to the man of science. The elimination of the self, so far as this is possible to the Adam in us, is habitual to the scientific worker, who cannot, unless he achieve some considerable measure of it, begin to work at all. To him also comes naturally that deep and essentially religious awareness of abstract beauty, which goes so far beyond the appreciation of beauty of form—the realization, in other words, of the difficult beauty of adaptation, evolution, development and obedience to natural law. The slow and inspiring growth in the mind of all that this kind of beauty implies comes only, during the years, from the disciplines of study, disappointment and refusal to escape into easier ways ; and these are disciplines as difficult as any that the orthodox mystics have enjoined. When knowledge is thus gained in any field of scientific work, and is related, as only the experienced man of science can relate it, to the same kind of knowledge won from the similar study of other aspects of the universe, then the mind experiences, in rare moments of