NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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NATURE

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CONDITIONS FOR THE PROMOTION OF RESEARCH

THE report entitled "Science : the Endless Frontier" which Dr. Vannevar Bush has presented to the President of the United States and which, it is understood, will be the subject of important legislation in the near future, is of profound interest to scientific workers in Great Britain as well as to those in the United States. The report, a summary of which appears on p. 130 of this issue, owes its inspiration to a request of President Roosevelt last November, and a sentence from his letter is fittingly quoted as striking the keynote of the report : "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness and drive with which we have waged this war, we can create a fuller and more fruitful employment and a fuller and more fruitful life". The proposals of the report represent in fact a definite attempt to mobilize for peaceful purposes the scientific effort which has proved so effective in war, and to secure that both the range and resources of scientific research are adequate, and the necessary personnel available over a long-term and not merely a short-term period.

Recommendations for the achievement of such objectives could not but fail to attract attention generally, but the most cursory reading of the report reveals how much ground is covered which is common with discussions which have been proceeding in Great Britain during the last few years on the organization and endowment of research. Many of the arguments which Dr. Bush and the distinguished committees on which he called for advice adduce in support of the recommendations of this report are equally valid in regard to the expansion and encouragement of research in Britain, and it is clear from the reports of the four committees that British experience has been in their minds in formulating their findings. The Medical Advisory Committee under Dr. W. T. Palmer, for example, clearly arrived at its recommendation for the establishment of a National Foundation for Medical Research as an independent Federal agency after reviewing the place both of the Medical Research Council and of the University Grants Committee in fostering medical research in Britain.

While the report is undoubtedly inspired by President Roosevelt, much of the ground has clearly been prepared by the surveys previously conducted by the Science Committee of the National Resources Committee on the relation of the Federal Government to research, and by the National Research Council for the National Resources Board on industrial research. Indeed, the findings and somewhat tentative recommendations of the former report published in Washington in 1938 under the title "Research—A National Resource. 1. Relation of the Federal Government to Research" re-appear essentially in those of Dr. Bowman's Committee on Science and the Public Welfare ; they have obviously prepared the way for the recommendations for the creation of a National Research Foundation and for strengthening and expanding after the War the research carried on directly by the Federal Government. Dr. Bush's report, however, differs somewhat in scope: the questions arising out of research in social sciences and the humanities are excluded; but on the other hand, the question of medical research is surveyed as already indicated and the place of the universities and colleges is considered, not merely as centres of research but also from the point of view of supplying the trained workers required for an adequate programme of scientific research.

Broadly speaking, it may be said that the strategy of research advocated in this report is to provide the universities and colleges and research institutes with adequate resources for fundamental research, to ensure that the fullest freedom of inquiry is adequately safeguarded, to provide scholarships and fellowships sufficient to ensure the supply of scientific talent required both in fundamental research and in Government service and industry. It is also proposed to extend the organization of research under direct Government control on lines indicated by experience with the Office of Scientific Research and Development to secure support for research in such fields of acute public interest as military problems, agriculture, housing, public health and medicine, which is meagre or intermittent because of lack of interest from private sources or because the demands for capital investment are too high for private provision. There is in fact no suggestion in the report for planning fundamental research. The creation of a single over-all agency for the discharge of Government responsibilities in these fields is intended rather to ensure that no important fields of applied research are neglected, that adequate supplies of trained workers are continuously recruited and that fundamental research is adequately endowed. If those conditions are fulfilled and the free exchange of scientific knowledge fostered, both within and across the national frontier, it is held that there is no risk that the continuous advance of fundamental research will fail to provide the new knowledge upon which depend progress in the war against disease, and the attainment of a higher standard of living.

The emphasis thus placed on free inquiry and on the fullest possible interchange of scientific knowledge is one of the most striking features of Dr. Bush's report. That emphasis is of course to be found in many of the reports on scientific and industrial research which have appeared in Great Britain during recent years; but no other report has yet emphasized so clearly and emphatically the necessity for lifting the existing restrictions on the publication of new scientific knowledge accumulated during the War. Although the report of Dr. Irwin Stewart's Committee on the publication of scientific information is the shortest of the four appended to Dr. Bush's report, it is not the least important, and it has strong claims on the immediate attention of all scientific workers.

During the War, we have been living to a considerable extent on our scientific capital, for men of science who would normally be extending the frontiers of knowledge have instead devoted their efforts to the application of scientific knowledge to the development of new and better equipment, processes and materials for war purposes. Many such new scientific discoveries as have been made are now classified as confidential or secret, and war-time restrictions have prevented the wide dissemination of the kind of information upon which science, education and industry normally build. Scientific workers engaged on war projects have acquired new knowledge in specific fields, but they have not been given access to similar acquisitions by their colleagues in other fields.

One of the first tasks which Dr. Bush considers should be undertaken is that of extending the broad base of scientific knowledge available to all scientific workers and lifting, as soon as military conditions permit, even the limited restrictions on publication of new knowledge in the fields of medical research which the Secretaries of War and the Navy imposed during the first year of the existence of the Office of Scientific Research and Development. This, moreover, is not a matter that concerns the United States alone. Dr. Stewart's committee points out that some of the information which should be released is possessed jointly by the United States and its Allies, and release in that country should be co-ordinated with release in other countries. The establishment within the National Academy of Sciences of a board to control the release and prompt publication of certain scientific information has previously been proposed, and such a central agency affords the best means of handling the international aspect also with the minimum of delay and friction.

This is not the only indication in the report of the importance which is attached by Dr. Bush and the committees he consulted to free and full publication as a stimulus to scientific research. Dr. Stewart's Committee urges specifically that, besides adopting a liberal policy in permitting the release of scientific information as soon as it is apparent that it cannot be turned against us in the present War, the proposed board, and also Government administrators, should encourage investigators to publish the results of their work in fields thus released. Financial support for such publication is advocated not only by this Committee but also by Dr. Bowman's Committee in its recommendations for Government support and sponsorship of international scientific congresses and the like, and for exploring the possibilities of scientific attachés in improving scientific communication. More particularly, after glancing at the question of library aids, Dr. Bowman's Committee refers to the need for Government assistance in dealing with the temporary problem of filling the serious gaps in collections of important European scientific periodicals in American libraries caused by the War, and to the probability that Government assistance will also be required in regard to the abstracting of scientific and technical literature.

Already in December 1940, when the Science Committee of the National Resources Planning Board issued its report on industrial research, the support by scientific societies of the publication of abstracts of the technical literature was becoming increasingly burdensome and inadequate in several branches of science in face of the rapidly expanding amount of technical literature published. That report suggested that an excellent means of Government contribution to industrial research would be proper provision for systematic and complete publication of abstracts of scientific and technical literature. The Bowman Committee makes no fresh recommendations on this matter, but its reference to the existence of this and of translating and bibliographic problems indicates the importance which American opinion attaches to such matters, and to the thoroughness with which in the post-war years tactical means for the efficient spread and effective utilization of scientific knowledge are likely to be explored and developed in the United States.

As has been indicated, the full success of American policy in this field cannot be achieved in isolation, and that alone would be sufficient reason for singling out this feature of the report for special mention at the moment. However, apart altogether from this question of the removal of war-time restrictions on publication, industry itself in the United States has generally been more disposed to encourage publication than industry in Great Britain. A more enlightened and generous attitude in this respect was strongly urged in the report on industry and research issued in October 1943 by the Industrial Research Committee of the Federation of British Industries, and has been powerfully supported on other occasions by Lord McGowan, Dr. P. Dunsheath and Mr. S. Courtauld. There can be only the warmest welcome for the emphasis on the free and unimpeded exchange of scientific information by publication and in other ways which characterizes this report.

If American strategy in the matter of research, as indicated by this report, appears to be simple, there can be no mistaking the thoroughness with which the correct tactics are being worked out; and the proposals of the report deserve close study by all those concerned with the post-war organization of scientific and industrial research in Great Britain. The report of Mr. H. A. Moe's Committee on the discovery and development of scientific talent, with its long-term plans aimed at ensuring an adequate future supply of engineers and scientific workers by discovering and developing scientific talent in American youth, and its immediate plans to make up in part the deficits resulting from the War, should not be disregarded by those concerned with demobilization and retraining, or with post-war plans in Britain for the expansion and development of the universities and technical colleges. When all allowance is made for the differences in economic and social conditions between the United States and Britain, the factors which determine whether or not a scientific career will attract and hold a sufficient proportion of the ablest minds of each generation are largely independent of geography, and measures or tactics which succeed in one country are likely to be effective elsewhere.

Broadly speaking, the proposals go further towards providing the Government of the United States with a fact-finding and policy-making instrument for science than anything yet set up elsewhere. The suggested National Research Foundation has much wider powers and functions than the central research board proposed last year by the London Chamber of Commerce in its report on "Scientific Industrial Research", and still more than those of the scientific advisers to the Ministry of Production. As a means of co-ordinating policy and developing and applying tactics, it should be a far more effective instrument than the limited powers which in Britain reside in the Lord President of the Privy Council, whether through his responsibilities in regard to the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council or as president of the Scientific Advisory Committee of the War Cabinet. Moreover, there is in Britain at present no means of co-ordinating scientific research on matters appertaining to defence as is provided by the Division of National Defence, and in its absence not only is there risk that long-range research on such matters may not be prosecuted adequately, but in particular that new weapons or forms of warfare which are not clearly the business of any one of the three Services may be neglected. Likewise nothing in the present structure in Britain remotely fulfils the function of the proposed Division of Publications and Scientific Collaboration, despite the work that has already been done by the British Commonwealth Science Committee set up by the Royal Society. Similarly, while some of the functions proposed for the Division of Scientific Personnel and Education might be discharged in Britain by the Appointments Department of the Ministry of Labour if effect were given to the recommendations of Lord Hankey's Committee on Higher Appointments, there is no single body with quite such wide powers or which could exercise the same influence in seeing that no important fields of knowledge are left uncultivated.

While, therefore, little in the proposals or the reports which Dr. Bush has transmitted to the President of the United States has not, so far as relevant to British conditions, found expression in the debate on scientific and industrial research which has proceeded here during the last two years or so, there is considerable difference in emphasis. Moreover, the proposals outlined tend to bring out more clearly some of the weaknesses in the research structure of Great Britain and to indicate measures required, even if those to be applied here are not necessarily those best suited to American conditions. In some respects British organization is clearly ahead of American practice at present, at least so far as Government organization itself is concerned; but the publication of this report, apart from the introduction of any legislation to implement its proposals, should give a marked stimulus everywhere to both thought and action in a field where they are much needed. Not merely is it desirable that we should be ready to co-operate appropriately, where joint action is required, in the removal of restrictions and the fostering of the exchange of information and of personnel. In the field of defence the United Nations Organization will also make it necessary to provide adequate means of co-operation in regard to research on new methods and weapons of warfare and national defence. The war on disease is supremely a task for international co-operation in research, both for treatment and preventive measures. Nor can we neglect to take account of what the United States and other industrial countries are doing to encourage research in industry, if we are to rectify the neglect with which some fields of British industry have been charged in the past, and to attain the industrial efficiency essential for the achievement of our plans and hopes for social security, for full employment and a higher standard of living.

THE RURAL PURSUITS OF PRESIDENT JEFFERSON

Thomas Jefferson's Garden Book, 1766–1824, with Relevant Extracts from his other Writings

Annotated by Prof. Edwin Morris Betts. (Memoirs of the American Philosophical Society, Vol. 22.) Pp. xv+704+36 plates. (Philadelphia: American Philosophical Society, 1944.) 5 dollars.

To most gardeners, I suppose, the name Jefferson suggests that most delicious of dessert plums that was raised by Judge Buel of Albany, New York, the year before Jefferson died. This is a fitting memorial to one who in addition to his activities as ambassador, governor, Secretary of State and President, was both an accomplished naturalist and devoted gardener. Barton, the botanist, who named the genus *Jeffersonia* in Thomas Jefferson's honour, stated "In the various departments of science, but especially in Botany and Zoology, the information of this gentleman is equalled by few persons in the United States".

The "Garden Book", which is the subject of the work under review, begins with an entry for March 30, 1766, a record of the flowering of the purple hyacinth, and ends with the year 1823, but during those fifty-seven years the entries vary greatly in number and extent. During Jefferson's considerable absences abroad no entries occur, and in the total the printed transcriptions of the actual diary occupy only about one hundred of the seven hundred of the present work. The rest of the text is made up of extracts from Jefferson's correspondence, garden entries from other of Jefferson's memoranda and numerous notes. The whole comprises an interesting commentary on the gardening and farming of this period and reflects the personality of an observing and exact mind.

Perhaps the most unusual feature, remembering that the garden book was compiled considerably more than a century ago, is the quantitative character of so many of Thomas Jefferson's notes. Thus he tells us that 2,500 of his early peas filled a pint measure. It required one hundred of his strawberries to fill half a pint, whereas to-day less than twenty would probably be required to occupy the same volume. Again we read that it took Julius Shard three minutes to fill a two-wheeled barrow and a minute and a half to take it thirty yards. In the same manner he records the amount of water required for mortar and the quantity of vinegar yielded by his grapes. His calendar of the flowering times and the intervals between planting and maturity are similar expressions of a precise mind that was concerned with the efficiency of the mould board of a plough at one period and at another was concerned with the average length of the stride of a horse.

It is obvious from a perusal of these pages that Jefferson had a great love of trees and indeed he wrote that "planting trees has always been my passion inasmuch that I rarely planted a flower in my life". Nevertheless, he obviously had an eye for a good herbaceous flower, and the list of plants which he bought from James Lee of Hammersmith when he visited England in 1786 included three specimens of that exquisitely beautiful lily *Lilium canadense*.

Although he was familiar with the renowned gardens near Paris, it was the English school of garden design that aroused his greatest enthusiasm. After his return from England he wrote "the gardening in that country is the article in which it surpasses all the earth".

But if gardening was to this distinguished man of affairs his chief hobby, it was equally true that farming was one of his prime occupations. He clearly recognized what is too often forgotten, that horticulture and agriculture are branches of a common stock that require for their successful development to be nourished from diverse fields of knowledge. Of agriculture he wrote, "it is a science of the very first order and counts among its handmaids the most respectable sciences, such as Chemistry, Natural Philosophy, Mechanics, Mathematics generally, Natural History, Botany".

On his own farm, which covered an area of five thousand acres, more than eleven hundred acres were cultivated and he adopted a seven years rotation with two years of red clover, then crops of vetch and buckwheat, followed by wheat with folded sheep on turnips in the autumn, maize and potatoes, rye and clover. Jefferson evidently believed that the atmosphere was responsible for the restoration of soil fertility, and held that the advantage of manuring is that it will do more in one than the atmosphere would require several years to do. It was his farming activities that led him to devise a mould board that reduced the resistance to ploughing, to experiment with the germination of clover seed on moistened cotton and to determine the value of sowing devices in terms of the amount of seed required which showed that two-thirds of that sown by hand was wasted.

His attempts to introduce rice and olives into South Carolina were but isolated instances, of economic species, among the many endeavours which Jefferson made, often with success, to add to the range of exotic species grown in America.

When we add that he was a pioneer in the development of contour ploughing in the New World and recognized its great value in relation to erosion, it will be obvious that his activities in the rural sciences had a marked influence on their development beyond the limits of his own State. If the pages of this book are something of a patchwork in which the constituent fabrics are of diverse texture and significance, it is equally true that they epitomize the changing fashions and developments of half a century and the colourful occupations of a lifetime. The preparation of the work was made possible by the Penrose Fund of the American Philosophical Society, but it is to the labours of Prof. Edwin Betts that we owe the annotations without which the volume would have lost a great deal of its value, both as shedding light on the preoccupations of a versatile mind and on the horticulture and agriculture of the period.

E. J. Salisbury.

ANTHROPOLOGY OF PORTUGUESE TIMOR

Timor Português

Contribuïções para o seu estudo antropológico. Por Prof. A. A. Mendes Corrêa. (República Portuguesa, Ministério das Colónias: Memórias, Série Antropológica e Etnológica, 1.) Pp. 240+53 plates. (Lisboa: Imprensa Nacional, 1944.)

PROF. MENDES CORRÊA gives us an ethnological account of a region about which not very much is known—the Portuguese part of the island of Timor. The greater part of the book is devoted to a study of the racial characteristics of the Timorese, based on unpublished anthropological investigations of Fonseca Cardoso, on a study of natives of Timor brought to the Portuguese Colonial Exhibitions of 1934 and 1940 and on a collection of several hundreds of photographs by a former governor of the colony, Alvaro de Fontoura.

Several writers on Timor have commented on the diversity of physical types among the inhabitants. Prof. Mendes Corrêa makes a classification into four major types which he calls Proto-Malay, Deutero-Malay, Melanesoid and Vedda-Australoid. Except in one region (the Bunak) he finds the Proto-Malay type more or less predominant. He identifies this type with the "Indonesian" type of Deniker.

The author examined the proportions of these four types in different linguistic groups. Our information about the languages of Portuguese Timor was until recently exceedingly scanty and unsatisfactory, and Prof. Mendes Corrêa has not been able to make use of the recent study of this subject by Capell[1]. This study has shown the existence of a number of languages that are quite definitely not Indonesian and not Austronesian (Malayo-Polynesian), but resemble in certain characteristics what are called the Papuan languages. He regards them as "pre-Indonesian". Bunak, mentioned above, is one of them. He also finds that the Indonesian languages of Timor fall into two distinct groups, and those of the eastern part of the island (the Portuguese portion) apparently have closer affinity with the languages of the eastern part of the Indonesian region where it is difficult to draw a line between Indonesian and Melanesian.

The final chapter of the work under review deals with the position of the Indonesians in general and the Timorese in particular in a systematic classification of races, admitting that the available data are not all that could be desired. The author remarks that the current view of the ethnology of the Malay Archipelago is that the existing peoples are the result of a succession of waves of migration from Asia, and suggests an alternative hypothesis by which Timor, and Insulind in general, may have been a region in which an original human stock has been differentiated into divergent types. On this hypothesis, he writes, "we are induced to see in the Proto-Malay of Timor the representative of ancient human stock in evolution. Neither truly Europoid, nor Mongoloid, nor Negroid, nor Veddo-Australoid, but with characters that are common to several stocks well differentiated at present, he appears to us nowadays as a sort of synthetic type, generalized and undifferentiated, of Palaeontology; not as a mosaic, or a crucible for admixtures that are geographically and socially inconceivable in such a remote isolation, but as a 'central type', or rather a truly 'primeval type', of an evolution still at work". "In Insulandia, instead of an area (as has been conjectured) of intense blending of races from the most varied origins, . . . what confronts us is rather, to all appearances, a primeval centre of ethnical differentiation."

In any attempt to judge the evidence for or against this hypothesis suggested by the author, the ethnologist must take into consideration the evidence from linguistics as well as that from physical anthropology. The presence in the mountains of the interior of Timor of peoples speaking non-Indonesian languages, and the existence of a diversity of Indonesian languages some showing affinities with those to the east and others with those to the west, seem to show that there must have been considerable movements of peoples into Timor at some time in the past.

The present work will be welcome to ethnologists and anthropologists as a study of a region about which our information is scanty. There are maps and many photographs. For those who do not read Portuguese easily there is a section in English (pp. 179–215) giving an abstract of the first seven chapters and a full translation of the final chapter.

A. R. RADCLIFFE-BROWN.

[1] Capell, A., "People and Languages of Timor", *Oceania*, 14, 191–219, 311–337; 15, 19–48.

MEDICINE AND MANKIND

Medicine and Mankind

By Arnold Sorsby. (Thinker's Library, No. 104.) Pp. xii+116. (London: Watts and Co., Ltd., 1944.) 2*s*. 6*d*. net.

THIS is an abridgement of Prof. Sorsby's fuller work of the same title (Faber and Faber, 1941). More than a hundred years ago it was realized by the pioneer reformers who laid the foundations of British public health that the maintenance of health and the effective treatment of disease were much more than a question of doctor and patient. Man is a social organism and must be studied in relation to his environment. It is more advantageous to the community, for example, that a thousand cases of typhoid fever should be prevented by safeguarding the water supply, or by the detection of a carrier of the typhoid bacillus, than that cases of the declared disease should be treated successfully. The lesson has not been readily learned either by the medical profession or the public. When within the last decade medicine became more scientific and the experimental researches of the laboratory were applied at the bedside, the tendency was to regard the patient as a subject for biochemical investigation rather than an individual with an environment, which frequently enough was responsible for, or favoured, the existence of his malady.

The achievements of preventive medicine, particularly in nutrition, tuberculosis and industrial disease, are inculcating a more comprehensive view, while the foundation of chairs of social medicine at Oxford and Birmingham denotes a further advance in this direction. This aspect of medicine, which regards health and disease as an unstable physicochemical balance constantly responding to changes in the outer world, is well developed in Prof. Sorsby's little book. To this end he employs a wealth of medical examples relating to the genetic, endocrine, nutritional and toxic characters of disease. The book is a little difficult for the non-medical reader, but the author assists him by providing a useful glossary of medical and scientific terms.

A. S. M.

A PLAN FOR RESEARCH IN THE UNITED STATES

THE report of Dr. Vannebar Bush, director of the Office of Scientific Research and Development, to the President of the United States, now published under the title "Science—the Endless Frontier"*, was prepared in response to President Roosevelt's letter of November 17, 1944, asking for recommendations on four specific points. The four questions asked were, first, what could be done, consistent with military security, and with the prior approval of the military authorities, to make known to the world as soon as possible the contributions which have been made during the war effort to scientific knowledge ; second, with particular reference to the war against disease, what could be done to organize a future programme of work in medicine and related sciences ; third, what could the Government do to aid research activities by public and private organizations ; and fourth, could an effective programme be proposed for discovering and developing scientific talent in American youth, so as to ensure the continuance of scientific research on a level comparable to that attained during the War. In his letter of transmittal, Dr. Bush states that he interpreted these questions to relate to the natural sciences, including biology and medicine, and the report includes as appendixes the reports of the distinguished committees on which Dr. Bush called for advice and on the findings of which his own recommendations are based.

The main recommendation for implementing the general finding and conclusion of the report that the Federal Government should accept new responsibilities for promoting scientific research and the development of scientific talent in youth is the creation of a National Research Foundation. The Foundation proposed would be responsible to the President and to Congress, while assuring complete independence and freedom for the nature, scope and methodology of research in the institutions receiving public funds and retaining discretion in the allocation of funds among such institutions. Such responsibility, Dr. Bush urges, is the only means of maintaining the proper relation between science and other aspects of a democratic system, and he considers that a government programme of support for scientific research and education must be based on four further principles : stability of funds over a period of years to enable long-range programmes to be undertaken ; the agency administering such funds should consist of citizens selected only on the basis of their interest in, and capacity to promote, the work of the agency ; the agency should work through contracts or grants to organizations outside the Federal Government and should not operate laboratories of its own ; and support of fundamental research in colleges, universities and research institutes must leave the internal control of policy, personnel, and the method and scope of the research to the institutions themselves.

Accordingly, the Foundation proposed would consist of nine members appointed for, say, four years, and selected by the President in virtue of their interest in and understanding of scientific research and education. They would appoint a chief executive officer as director, and establish initially five divisions, covering medical research, natural sciences, national defence, scientific personnel and education, and publications and scientific collaboration. The function of the Division of National Defence would be to support long-range scientific research on military matters, leaving to the Services research on the improvement of existing weapons. The Division of Scientific Personnel and Education would be responsible for the support and supervision of the grant of scholarships and fellowships in science, while that for publications and scientific collaboration would be responsible for encouraging the publication of scientific knowledge and promoting international exchange of scientific information. In this field the powers of the Foundation would include the provision of financial aid for international meetings, associations of scientific societies, and scientific research programmes organized on an international basis. Emphasizing that the success of the Foundation in promoting scientific research will largely depend on the co-operation of organizations outside the Government, Dr. Bush suggests that while in its grants to, or contracts with, such organizations the public interests must be adequately protected, the organization should be left with adequate freedom and incentive to conduct research. Normally, the public interest would be adequately protected if the Government received a royalty-free licence for government purposes under any patents resulting from work financed by the Foundation. There should be no obligation on the research institution to patent discoveries made as a result of support from the Foundation, and no absolute requirement to assign all rights in such discoveries to the Government. Legislation should leave to the members of the Foundation discretion as to its patent policy, so that patent arrangements could be adjusted as circumstances and the public interest require. Rough estimates given in the report provide for an expenditure of 33,500,000 dollars in the first year, rising to 122,500,000 in the fifth year. Of this total, five millions, rising to twenty, are for medical research, ten each for the Divisions of Natural Science and National Defence, rising to fifty and twenty millions, respectively, and seven millions rising to twenty-nine millions for the Division of Publications and Scientific Collaboration.

In arguing for these recommendations, Dr. Bush points out that without scientific progress the national health would deteriorate, the nation could hope for no improvement in its standard of living, or for increased employment, or indeed maintain its liberties against tyranny. As yet, however, there is no national policy for science, and the Government has only begun to utilize science in the nation's welfare. No government body is charged with formulating or executing such a policy, nor is any standing committee of Congress devoted to the subject. There are areas of science in which the public interest is acute, but which are likely to be cultivated inadequately if left entirely to private support, and we are entering a period when science needs and deserves increased support from Government funds. The colleges, universities and research institutes are the centres of fundamental research and the wellsprings of knowledge and understanding. So long as they are vigorous and healthy, and their scientific workers free to pursue the truth wherever it may lead, new knowledge will flow to those who can apply it to practical problems in government, industry and elsewhere. Many of the lessons learned in the wartime application of science can also be profitably applied in peace, and the rigid controls imposed for security reasons should be removed to restore free-

* "Science: the Endless Frontier". A Report to the President by Dr. Vannevar Bush. Pp. ix+184. (Washington : G.P.O., 1945.)

dom of inquiry and the healthy competitive scientific spirit so necessary for expanding the frontiers of science. Scientific progress on a broad front results from the interplay of free intellects, working on subjects of their own choice as dictated by their own curiosity to explore the unknown.

Discussing next the war against disease, Dr. Bush insists that striking advances in medicine during the War have been possible only because of the mass of unapplied scientific data accumulated through fundamental research in many fields before the War. Progress in combating disease depends on an expanding body of new scientific knowledge, and any extension of medical facilities must be accompanied by an expanded programme of medical training and research. The need for broad and fundamental studies is stressed, since progress results from discoveries in remote and unexpected fields of medicine and the underlying sciences. Government initiative and support for the development of newly discovered therapeutic materials and methods can also reduce the time required to bring the benefits to the public. The primary place for medical research is in the medical schools and universities; but the traditional sources of support, largely endowment income, foundation grants and private donations, are diminishing. There is no immediate prospect of a change in this trend, and research costs have steadily risen. Industry is only to a limited extent a source of funds for fundamental medical research, and to maintain the progress in medicine which has marked the last twenty-five years, the Government should extend financial support to such research in the medical schools and in the universities, through grants both for research and for fellowships.

Under the heading "Science and the Public Welfare", Dr. Bush emphasizes first the imperative necessity, from the point of view of national security, of more, and more adequate, military research in peace-time. This is primarily a responsibility of the Government, and it requires a permanent, independent civilian-controlled organization, having close liaison with the Army and Navy and the clear power to initiate military research which will supplement and strengthen that carried on directly under the control of the Army and Navy. Equally, scientific research is essential to achieve the goal of full employment; a nation which depends on others for its new fundamental scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill.

From the figures collected by Dr. Isaiah Bowman's Committee on this question, Dr. Bush concludes that expenditure on scientific research by American industry and the Government—almost entirely on applied research—has almost doubled between 1930 and 1940. Whereas in 1930 this expenditure was six times as large as research expenditure of the colleges, universities and research institutes, by 1940 it was almost ten times as large. Moreover, while the research expenditure of the colleges and universities increased by one half during this year, that of the endowed research institutes slowly declined; and accordingly Dr. Bush urges that to enable the colleges, universities and research institutes to meet the rapidly increasing demands of industry and Government for new scientific knowledge, public funds should be used to strengthen their resources for fundamental research. Beyond this, the Government could encourage industrial research by amending the internal revenue code to remove present uncertainties as to the deduction of research and development expenditure as current charges against net income; but while it is also important that the patent system continue to serve the country in the manner intended by the constitution, Dr. Bush recommends that specific action with regard to the patent law should be withheld pending the submission of a report on that subject. Meanwhile, the Government should take an active part in promoting the international flow of scientific information, and in this connexion, in addition to sponsoring international scientific congresses, Dr. Bowman's committee advocated the establishment of international fellowships and, as an experiment, the appointment of scientific attachés serving in selected United States embassies.

Dealing with the means for providing an adequate supply of scientific talent, Dr. Bush believes that the United States has drawn too heavily for non-scientific purposes upon the great natural resources which reside in its trained young men of science and engineers, and that with mounting demands for scientific workers both for teaching and for research, the United States will enter the post-war period with a serious deficit in trained scientific personnel. If ability, and not the circumstance of family fortune, is made to determine who shall receive higher education in science, constantly improving quality should be assured at every level of scientific activity. To meet the immediate deficit the Armed Services should comb their records for men who, prior to or during the War, have given evidence of talent for science, and make prompt arrangements for appointing those who remain in uniform, as soon as militarily possible, to institutions where they can continue their scientific education. They should also see that those who study overseas have the benefit of the latest scientific developments. To encourage and enable a larger number of young men and women of ability to take up science as a career, as well as gradually to reduce the deficit of trained scientific personnel, there should be adequate provision of undergraduate scholarships, graduate fellowships and fellowships for advanced training and fundamental research.

Details of such a programme providing 24,000 undergraduate scholarships and 900 graduate fellowships are worked out in the report of the Committee on the Discovery and Development of Scientific Talent, of which Mr. H. A. Moe was chairman, forming Appendix 3 to Dr. Bush's report. This report covers both long-term and short-term plans, and includes some analysis of the loss of able students to higher education, and data on training of personnel for science and technology.

Finally, Dr. Bush, pointing out that scientific workers have been diverted to a greater extent than is generally appreciated from the search for answers to the fundamental problems on which human welfare and progress depend, urges the necessity of promptly lifting security restrictions to the diffusion of scientific knowledge. In view of the need for co-ordinated policy, he recommends the establishment of a board consisting equally of scientific workers and military men, to decide upon the release of information from military classification and to control the release for publication of scientific information which is now classified. Measures which will encourage and facilitate the preparation and publication of reports should be adopted forthwith by all agencies, government and private, possessing scientific information released from control.

The greater part of the published report is occupied by the four appended reports of the Committees already mentioned. In addition to those of the Moe and the Bowman Committee, these include the report of the Medical Advisory Committee, with Dr. W. W. Palmer as chairman, and the report of the Committee on Publication of Scientific Information, of which Mr. Irvin Stewart was chairman. The longest of these reports is that of Dr. Bowman's Committee, and this report contains a wealth of information of interest to scientific workers. In addition to points already mentioned, it stresses four important changes in existing practices as desirable to increase the effectiveness of research done within the various departments and laboratories of the Federal Government. First, since the most important single factor in scientific and technical work is the quality of personnel employed, establishment of a separate branch of the Civil Service in the United States for scientific and technical positions is recommended. Second, there should be a general up-grading of positions and salaries in the scientific service, with careful selection of new talent; third, appropriations to the principal government scientific departments should be made in lump sums for broad programmes of research extending over several years; and fourth, a permanent science advisory board should be created to consult with government agencies and to advise the executive and legislative branches of government as to the policies and budgets of government agencies engaged in scientific research.

Besides the appreciation of the national research budget, this report gives an analysis of research expenditure in American universities and colleges, and details the more important general principles on which grants to universities should be based: the funds supplied to the universities should be used for the support of significant research with special emphasis on the position of the universities as the chief contributor to pure science; the board allotting the funds should assure itself that the universities have competent and adequately trained personnel to guide the studies; the grants should be made in such a way as to avoid control of the internal policy of the universities, leaving them full responsibility for the administration of the grant after it is once made; and a constant effort should be made to improve the general level of research in institutions of higher education. A further appendix to this Committee's report directs attention to problems of library aids, including inter-library co-operation, abstracting and translating, bibliographic and reference services.

STRUCTURE, DEGENERATION AND REPAIR OF NERVE FIBRES*

By J. Z. YOUNG, F.R.S.

NERVE fibres have become greatly elongated for their function of conduction, but each yet remains essentially a bag, surrounded by a membrane, with the nucleus separated in a special region, the nerve cell body, at one end. It is difficult to obtain a true representation of the immense disproportion between the length and breadth of these cells. The cell body of a mammalian motor fibre is an irregular star-shaped structure about 1/10 mm. in diameter. Attached to this is the axon process which is 1/50 mm. in diameter or less, and yet often as much as 1 metre in length. Even in the very shortest peripheral nerve fibres, the axon is 1,000 times as long as it is broad. In very many motor fibres in man the disproportion is 10,000 times. But some of the longest sensory fibres, more than 1 metre in length, are less than a tenth of the thickness of these motor fibres and the disproportion here must often approach one million times.

The really astonishing thing is that the cell body exerts a very immediate influence along this extended fibre attached to it. If a nerve fibre be cut, however far from the centre, the isolated peripheral portion will begin within a few hours to show differences from the central part. Ultimately the isolated part will wither away and disappear, whereas from the central end new processes will be put out. How does the nerve cell body produce its control along such a very narrow thread? Investigation is fortunately helped by the fact that not all nerve fibres are so very small. Giant nerve fibres are found in some cold-blooded animals, reaching a diameter up to 1/10 mm. in fishes, rather larger in some crustaceans and worms. Much the largest nerve fibres of all are found in the squids, where they range up to 1 mm. in diameter and are very suitable objects for analysis and experiment.

Since nerve fibres serve to conduct messages, it is perhaps natural that we should tend to look upon them as wires. The analogy of telegraphic communication is almost too strong to be resisted; but it is in many ways misleading. The inside of a nerve axon is not a rigid structure but a viscous fluid. The large fibres of the squid show this most clearly, for when they are cut across, the contents come flowing out from the end. That the substance of a mammalian nerve fibre is also liquid, or at least can be made to flow, is shown by the experiment of crushing it, say with forceps, and then immediately fixing by immersion in alcohol and making suitable microscopic preparations. The material will be found as large masses on either side of the crushed region, from which it has been driven. There is now reason to suppose that not only is the material of the axon liquid, but also that it can flow down the fibre during life. If a mammalian nerve be cut or crushed and the ends examined one hour later, the material of the axons will be symmetrical in the two stumps. But by five hours after the operation the two ends can be distinguished: the axon material reaches more nearly to the cut surface in the central than in the peripheral stump. By the second day the material at the central end is already pouring out into the gap, the central axons becoming reduced in volume. This outpouring suggests that there is a pressure within the fibres which must originate within the cell body. Weiss[1] has recently shown this pressure very clearly by constricting a nerve, which leads to a damming up of the axoplasm central to the constriction. If the cuff is then released the material soon flows forward again. We do not yet know how fast the flow normally proceeds. There may be a continual leak over the surface of the fibre, but the internal movement must be at most very slow, and no doubt the behaviour is very far from that of a true Newtonian liquid.

Although the substance of the nerve fibre can flow, there is considerable regularity of organization of the molecules within it. Evidence of such regularity is seen in the form of 'neurofibrils' in its substance, and also in the birefringence of the axoplasm. The

* Substance of a Friday Evening Discourse delivered at the Royal Institution on March 16.

biochemist is now becoming more familiar with such states of crystal-like organization of proteins within a liquid, for example, in the case of the virus proteins, and it is interesting that there is evidence that a large part of the proteins which can be extracted from squid nerve fibres shows some resemblance to virus and nucleo-proteins. Moreover, in suitable circumstances, axons will contract into spirals, giving figures which recall chromosomes. The nerve fibre, then, like other living tissues, shows a considerable degree of regularity of its component molecules. It is possible that this regularity is preserved under the influence of the pressure down the fibre, just as the substance of some 'dilatant' liquids becomes regularly arranged and solid under stress. It is not surprising that there should be an elaborate arrangement of the molecules which make up the substance of the nerve fibre, to ensure the proper ordering of all the processes which make it able to conduct, and recharge it after it has conducted.

Around the axon of many vertebrate nerve fibres is another liquid material, the myelin, with regular lamellæ of phosphatide and protein molecules. This is not continuous over the whole surface but is broken into segments by gaps, the nodes of Ranvier. Covering each segment of myelin is a thin, fenestrated veil of protoplasm, the cell of Schwann, with a nucleus near the centre of the segment.

These viscous liquid substances which make up the nerve fibre are all enclosed in a more rigid tube, the neurilemma. They do not, however, remain in stable equilibrium within it, like liquids filling a tube of glass, but show a distinct tendency to develop an unduloid outline and to break into round or oval drops. This behaviour is characteristic of a cylinder of liquid under surface tension. Since the theoretical work of Thomas Young and of Laplace, and the practical as well as theoretical demonstrations of Plateau, Rayleigh and Darling, it has been known that a cylinder of liquid remains stable only if its length is less than its circumference. Plateau showed this by experiments with soap bubbles, and the same phenomenon is seen every day in the drops on a spider's web or the annoying irregularity of a coat of varnish applied to a wire. If the liquid is of high viscosity, the maximum stable length of the cylinder may be increased by many times, but is still finite.

Remarkable unduloid outlines are often seen near the ends of nerve fibres which have been cut and immediately fixed in alcohol. If fibres are teased out in a suitable salt solution, they usually show an unduloid outline along their whole length. Moreover, the waves are related to certain cracks in the myelin known as the incisures of Schmidt-Lantermann, which are always found at the troughs of the waves, as if they were produced by the straining of the lamellæ of the myelin by the stress put upon them in assuming an unduloid outline.

Perhaps even more interesting is the evidence of the operation of surface tension in the degeneration of the peripheral portions of the fibres after a nerve has been cut. In the fibres of rabbits' nerves, the break-up begins to be apparent during the second day after the severance. First the unduloid outline becomes more marked and then the myelin breaks into ovoid segments, shorter than the original segments of Ranvier. The process goes on so slowly that in a nerve taken at a suitable time all stages can be seen. A thin neck is formed at the point of constriction, and when the break finally occurs a small intermediate droplet is often left between the two neighbouring segments. Sometimes still smaller secondary droplets lie on either side of the main one. This is exactly the behaviour seen when droplets divide under surface tension. Darling showed the neck droplets very clearly by photography of the separation of a drop of liquid falling slowly through another liquid of almost equal density.

While this break-up is going on in an isolated piece of nerve, there are probably also many other changes in the physical and chemical properties of the substances concerned. But it seems reasonable to suggest that the primary change which constitutes the degeneration of a nerve fibre is a breaking up under surface tension of the viscous liquid cylinders of axon and myelin into shorter segments and ultimately into spheres. We can then go on to suggest that the cell body normally opposes this tendency of surface tension to break up the fibre by blowing it up from the inside. We have already seen that there is good evidence for the existence of a pressure within the axon, and this may well be the agent which presses the contents against the more rigid tube wall and thus maintains the cylindrical form. If the material of the axoplasm shows dilatancy it is possible that it is normally kept rigid under the pressure and only breaks up when it becomes more liquid after the pressure is removed. The tendency to form an unduloid outline is, however, present all the time, and perhaps manifests itself, even during life, in the formation of the incisures of Schmidt-Lantermann. When a nerve fibre has been severed, the head of pressure is cut off and the surface tension gradually causes the fibre to divide.

At this point the physicist will want to ask all sorts of questions, particularly about the relationship between the surfaces of the myelin and the tube in which it runs. It might seem that if the liquid contents altogether fill the tube there should be no break-up of the cylinder into ovoids, just as the mercury does not, usually, break up in a thermometer. But the tube around a nerve fibre differs from the brass, glass or rubber tubes with which we are familiar in that its wall is permeable to water and salts, and it seems likely that a cylinder of liquid fatty material will not remain stable within such a tube, since water can run in to fill the spaces produced when new surfaces are formed by the unduloid. But we must leave this and many other such questions for the physical chemists, and before we pass to consider the functioning of a nerve merely note that this hypothesis gives the possibility of a very elegant explanation of the genesis of the nodes of Ranvier. If the myelin is a viscous liquid it will tend to form, as it is laid down during development, not a continuous cylinder but very long drops. When an animal is young its myelin segments are short, the initial periodicity being about 150 μ. Though this is certainly very long for a droplet of 3 μ in diameter, it is not impossible if the myelin is a very viscous fluid and enclosed in a tube. Ranvier himself, when he described the nodes, suggested that the myelin is included in the Schwann cell as the drop of fat is in a fat cell. It seems that his analogy may be very near to the truth.

This examination of one aspect of the composition of nerve shows the lines on which one can proceed in trying to give an account of the structure of a nerve fibre. It will be seen that some progress can be made towards a description in terms of the categories of the fundamental sciences. We can begin to know the chemical composition of the parts, substituting moderately exact and general terms such as phosphatide and protein for peculiar ones such as myelin or neurilemma. This is already a great advance, but we can go a little further in indicating how these liquid substances are held in their state, which is not one of equilibrium, by a pressure originating from the nerve cell body. Of course, the physicist will wish for very much more precision in all this, and it is much to be hoped that he will help us to provide it. The histologist can only show the lines along which he believes that it may be sought.

So far we have scarcely touched on the fact that a nerve fibre only remains as it is because it has a function, that is to say, it plays a part in the maintenance of the life of the whole body. Its function is, of course, to conduct messages : from sense organs to centres and back again, thence to muscles. There is much evidence that the message is propagated by the discharge of the previously charged surface of the nerve fibre. A difference of electrical potential, the resting potential, exists between the inside and outside of a fibre, and it has long been suggested following Nernst and Bernstein that this arises as a result of the permeability properties of the surface membrane. If the fibre was permeable to potassium but not to anions, then the former, migrating away from the surface, would form a layer held by the attraction of the residual charge left by their departure. The effect of 'stimulation' is then suggested to be to increase the permeability, allowing a leak which produces a flow of current through neighbouring regions. This current itself stimulates other parts of the surface and so the process propagates.

The inside of nerve fibres, like that of other cells, certainly contains much potassium. By analysis of the contents of single squid nerve fibres, exact estimation has been possible and it has been shown that there is more than thirty times as much potassium inside as out. However, there is considerable evidence that the nerve does not work as a simple diffusion battery. There is still much uncertainty as to the actual potentials involved and as to the permeability to the various ions. Steinbach and Spiegelman[2] have recently shown that the squid fibres are quite freely permeable to sodium, though this does not usually occur within them. It has been shown that during activity potassium does leak out of nerve fibres[3], and application of potassium to the outside of a fibre reduces the resting potential[4]. However, the relationship between potential and the logarithm of the potassium concentration is not always linear as would be expected on the theory, and Shanes[5] suggests that the effect of the potassium may be at least in part to depress the respiratory processes necessary to maintain the potential.

One of the great difficulties of the subject has been that most of the data of nerve physiology have been obtained by the use of bundles of nerve fibres, whereas the verification of the hypothesis evidently requires exact knowledge about the conditions during activity of a single fibre. In the years immediately before 1939, further very direct evidence on the subject was accumulated by the use of the nerve fibres of the crab and especially those of the squid, which are so large that a wire can be inserted inside them. Hodgkin and Huxley[6] and Curtis and Cole[7] have shown that there is, in fact, a large 'resting' potential difference across the surface, which is not seriously interfered with by the presence, even for many hours, inside a fibre, of wire as large as a quarter of its diameter. This certainly suggests that the battery is essentially at the surface. The action potential produced by the activity of a limited section of the membrane between inner and outer electrodes can be recorded and shown to be identical whether the fibre is stimulated at one end or the other. However, one of the most unexpected results has been the demonstration that the action potential of a single stretch of membrane recorded in this way is diphasic, and not simply an abolition of the 'resting' potential. No explanation of this is yet forthcoming.

Other data obtained from these squid fibres provide further evidence of the changes which occur during excitation. Thus Curtis and Cole[7] have shown that during the passage of the impulse there is a fall in resistance across the membrane, coinciding with the peak of the action potential spike. There is thus now very strong evidence of an actual surface change during excitation. But Cole and his collaborators have gone further yet in studying the electrical characteristics of the surface by the application of direct and alternating currents across it. They have revealed that the nerve membrane acts as a rectifier, that is to say, presents very different resistance to inward and outward current flow. This is not surprising in view of the very marked asymmetry of concentration between inside and outside. More unexpected is that there is an element present which has the electrical characteristics of an inductance, that is to say, the potential difference across it is proportional to the rate of change of current. We usually associate such effects with magnetic fields, and it is at first a little difficult to accept the idea of an inductance in a liquid system such as a nerve fibre. But there are several ways in which it can be understood as a property of a layer of regularly arranged molecules, such as we have every reason to think exists at the surface of a nerve fibre.

This work then gives us direct evidence that there are changes at the surface of a nerve fibre at the moment of activity. Other workers have produced equally direct evidence that the electrical current which flows as a result of this change is actually the agent that stimulates neighbouring points and thus sets up a disturbance which is propagated. Fortunately, there is already available a large body of evidence about the circumstances in which an electrical current excites a nerve, built up by the labours of many able experimenters from v. Kries and Lucas onwards to the more recent work of A. V. Hill and his school[8]. Using this work as a background, Hodgkin[9] was able to show that the activity of a region of nerve does in fact produce an increase of excitability in front of itself. He did this by cooling or compressing a single nerve fibre of a crab until it just failed to conduct. He tested the excitability of the region beyond the block during the time immediately after the arrival of an impulse at the block, and found that a far smaller electrical impulse than usual was then necessary to excite the fibre. This demonstrates that the transmission along the fibre is by means of these electrical currents flowing in front of the active region. Moreover, Hodgkin also showed that, as would be expected, raising the resistance outside the fibre lowers the rate of conduction, whereas decrease of the resistance increases it.

This abundant evidence makes it very likely that the hypothesis is correct in its general outline, though much remains to be done to make it satisfactory. The degree to which it is successful may be judged by a recent attempt by Offner, Weinberg and Young[10] to produce equations for a circuit equivalent to that of the nerve on these assumptions. The data of Cole and others provide physical measurements for the constants of these equations, and the measure of the completeness of the hypothesis is that these equations predict the conduction velocity of a nerve fibre such as that of a squid with remarkable accuracy. Further, such considerations suggest that the decreased internal resistance provided by increase of diameter of nerve fibres will lead the conduction velocity (c) to grow larger with increased fibre diameter (d), but only slightly, the predicted relationship being $c = kd^{-1/2}$. Pumphrey and Young[11] measured the conduction velocity of a number of squid fibres of various diameters and found approximately this relationship, the data giving $c = kd^{-0\cdot 6}$ as the best fit. Evidently increase of fibre diameter is a very poor means of obtaining rapid conduction. Indeed the squid with its immense and cumbrous fibres, of a millimetre in diameter, can only reach a conduction velocity of 25 m./sec. This is where the myelin sheath comes in. Nerve fibres covered with a thick layer of myelin conduct much faster than those without it. Thus the earthworm or the prawn obtains a rate approaching that of the squid by the use of fibres of only one tenth of the diameter, but surrounded by myelin layers. Among vertebrates the same method has been further perfected, so that among cold-blooded forms such as the frog rates of 50 m./sec. are obtained with fibres only 20 μ in diameter. For a full understanding of this effect of the myelin we shall have to await further investigation of single medullated fibres, which is only beginning to be technically possible.

From this very brief sketch it will appear that we already know a good deal about the functioning of nerves. We now have a moderately good general theory to describe the method of response and conduction, using the basic categories of physics and chemistry. This is a big step from the special theories from Descartes onwards, which treated of a particular nervous flow. But what we know is scarcely more than enough to stimulate our appetites and remind us of our ignorance. There are many intriguing facts which cannot be fitted into the general picture at all; for example, v. Muralt has recently shown by a most elegant method that a nerve fibre leaks aneurin when it becomes active. Again, for some years it has become increasingly plain from the work of Dale and others[12] that the method by which a nerve message produces an effect in a muscle or other organ at its end is the production of tiny amounts of very active stimulating substances such as acetyl choline. How the production and action of this substance is linked with the conduction of the nerve impulse is a most baffling problem. One cannot help suspecting that the answer will be found in the events which go on in the molecules of the nerve surface.

We have now seen that it is indeed difficult enough to give a general account of the composition, degeneration and function of the nerve fibre. But far worse problems present themselves when we try to describe its history, how it comes to exist in its present state, ready to function. Indeed, no exact treatment of these general embryological and evolutionary problems is yet possible. But we have no right to suppose that it never will be achieved, and it is interesting to make a preliminary attempt to examine the forces by which a nerve fibre is brought to its adult functioning state. One difficulty about exact study of a developing organism is that it is so small that quantitative experiments are hard to perform. This difficulty can partly be overcome in the case of nerve fibres by studying the processes by which they undergo regeneration after injury, for these constitute a kind of development in the adult state. We have seen that after a nerve has been cut across, the axons and myelin break down in the peripheral stump, and are ultimately removed. New axoplasm is put out from the fibres of the central stump and flows back into the tubes left after the degeneration. Along these they may be led back to make connexion with sensory or motor endings similar to their original ones. Thanks largely to the work of Weiss[13], we now understand something of the forces which lead these regenerating streams along suitable surfaces.

Before a new fibre is fully remade, it must acquire the diameter and myelin sheath which it possessed before. We have recently been studying the factors which control the diameter reached by the new fibres. Our first hypothesis was that the size of the parent fibre determines that of the new one, large central making large peripheral fibres, and vice versa. It proved that there is an effect of this sort, and also an influence of the size of the peripheral tube in which the fibres run. But the most powerful factor is one we had not expected to find. New fibres that become connected with the periphery, muscle, gland or sense organs in the skin, become larger than others which fail to become so connected[14]. This means that of the many fibres which enter the degenerated stump, those that make connexion increase, apparently at the expense of the rest. This increase with function should perhaps have been expected. Muscles and glands are well known to show such a functional hypertrophy, but it is a measure of the danger of the analogy of telegraph wires, to which we have already referred, that we had not in fact expected to find that conductors get bigger by functioning. Of course, it is now necessary to analyse the effect much further, and to find out exactly how it is produced, whether by connexion alone or by functioning after connexion. Quite intriguing prospects open if it be true that use increases the volume of nervous tissue. Atrophy of the brain by disuse may be more than a conception of the schoolboy and the comic papers. There is, indeed, already evidence of this. Conversely, exercise and practice may produce skill partly by actually increasing the size, speed and synchrony of conduction in the nerve fibres. However, these are speculations which must be tested in the future.

We see then that a nerve fibre consists of substances the properties of which can be largely defined in physico-chemical terms and which are subject to physico-chemical forces. However, these substances are not in a state of equilibrium, but are maintained in a steady state as part of a complicated system, the organism. The whole elaborate organization of the animal only remains intact because of the functioning of its parts. The special function of a nerve fibre is conduction, and if the nerves conduct wrongly the organization is seriously impaired or actually destroyed. We see this only too clearly in the useless limbs produced by severance or damage to nerves. With no fibres to conduct a sense of pain the fingers are often burned by a cigarette or at the fire. Survival has only been possible because by the processes of development we are given nerve fibres, and all the other organs, with the correct function. This process of development can itself partly be described in terms of physico-chemical forces. We have seen that during nerve regeneration we can discover how the new fibres are formed when the material emerging from the central stump makes contact with the Schwann cells emerging from the peripheral. We can examine quantitatively the forces of pressure and attraction which produce the outgrowth. Again, the size of the new fibres is determined partly by that of the parent fibres, partly by the peripheral tubes into which they enter. But we found that another factor also very much influences the fibre size, namely, whether functional connexion is made or not. Here we see a tendency —not easily referable to ordinary physical and chemical forces—to develop in such a manner as shall be suitable for the preservation of the whole system.

Indeed, this tendency is present, if we look a little closer, behind and in addition to all the physical forces which we have been discussing. The nerve fibres only grow as they do and conduct as they do because during long ages suitable substances for this purpose have been collected together. This has been the work of that same tendency to act in a manner which ensures preservation, assisting the equally fundamental tendency to increase by growth, which is the driving force of evolution. Each type of organism produces more like itself, but not exactly like. What we should perhaps call a tendency to vary also plays a part, by ensuring a continual supply of new types to meet the needs of a changing world.

So we find that we can begin to apply the methods of physics and chemistry in biology, and thereby obtain solutions of our problems which are both more exact and more general than can be reached in biological terms alone. But such methods do not serve to describe all of the phenomena which are presented by the living organism. Unless physicists are prepared to say that their science discovers in all matter tendencies of self-preservation, of increase, of multiplication, and of variation, we must say that these are the special characteristics of living organization, which it has preserved since life first appeared long ago.

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OBITUARIES

Dr. P. Pelseneer

Paul Pelseneer, who died in Brussels on May 5, 1945, was well known to a wide range of scientific men through his connexion with the International Association of Academies and with the International Research Council (now called the International Council of Scientific Unions) which was founded in its place in 1919. But he will be especially remembered by zoologists for his extensive knowledge of molluscs, ranging from embryology to parasitism, and above all for his anatomical work on this group.

Pelseneer was born in Brussels on June 26, 1863, and graduated at the University of Brussels. He was a research worker at the laboratories of Naples, Villefranche, Roscoff and Wimereux. From 1888 until 1918 he held a professorship in the Ghent Teachers' Training College. In 1919 he was appointed permanent secretary of the Royal Academy of Belgium (of which he had been elected a member in 1899), a post he held until almost his last days.

Pelseneer was well known in Britain, and proud of having worked with T. H. Huxley on *Spirula* in 1894; their joint work was published as one of the *Challenger* reports, to which Pelseneer had already contributed accounts of the Pteropoda and of the anatomy of deep-water molluscs. The best text-book on Mollusca is that written by Pelseneer for Ray Lankester's "Treatise on Zoology", of which it forms part 5 (1906, translated into English by Gilbert Bourne). He is responsible for the arrangement of bivalves on a primary basis of gill structure, that is now found in most general works on zoology; it was put forward in 1891, modified in 1906, and his final views are to be found in his report on the anatomy of the *Siboga* lamellibranchs in 1911. In his early studies on the nervous system of gastropods, he showed that orthoneury does not exist in the group Euthyneura, but that the animal has undergone torsion and then untwisted sufficiently to show no chiastoneury. Much of his work is stimulating reading, always clearly expressed, wide in outlook, well illustrated and fresh with new ideas.

One can only refer briefly here to the quantity of work Pelseneer accomplished, which included such divers subjects as the relation of the osphradium to the visceral ganglia, the eyes of bivalves, hermaphroditism, sinistrality, the effect of temperature variation on larvæ, the relative proportion of the sexes, regeneration, hybridism, the chemical composition of the shell, trematode and copepod parasites. His fame rests primarily on his important contributions to morphology, classification, phylogeny and evolution. Late in life he collected into one book, "Essai d'Ethologie zoologique d'après l'étude des mollusques" (662 pages. Brussels, 1935) a concise and monumental survey of almost all that is known of the habits, relations and environment of molluscs, enriched by his own wide research experience. Undoubtedly he ranks as a great zoologist and one of Belgium's greatest scientific workers.

R. Winckworth.

Prof. E. Barclay-Smith

Prof. Edward Barclay-Smith, emeritus professor of anatomy in the University of London, died in London on July 5, aged eighty-three. Educated at Brighton College and at Downing College, Cambridge, he graduated M.A. and M.B. in 1890 and M.D. in 1893. Choosing anatomy as a career, he served as demonstrator to Alexander Macalister and was later University lecturer in advanced human anatomy at Cambridge. His faculty for close and accurate observation, his gift of graceful yet forceful exposition, and his remarkably sound and meticulous knowledge of general and topographical human anatomy, established his reputation as a teacher. In 1915 he was appointed professor of anatomy in the University of London, holding the chair at King's

College until 1927, when, upon retirement, he was created emeritus professor. He served King's College and the University of London with selfless devotion, his professional eminence and administrative abilities earning fitting recognition. He became dean of the medical faculty in 1920, a member of King's College council in 1925, and a fellow of that College the same year: he represented King's College on the committee of management of its associated hospital, acted as chairman of the University of London Board of Studies in Human Anatomy, and was chairman and secretary of the Board of Intermediate Medical Studies. Much appreciated as an external examiner, he served in that capacity the Universities of Cambridge, Durham, Manchester and Birmingham, and was representative of the Royal College of Physicians upon the Conjoint examining board.

A teacher rather than an investigator, Barclay-Smith contributed little to anatomical literature, but incorporated his wide and exact knowledge in "Buchanan's Manual of Anatomy", of which he was joint editor. His abiding and scholarly interest in the history of anatomy and anatomical nomenclature was manifested in various little memoirs—gems of erudition—upon classical and neo-classical anatomical terminology.

To the welfare of the Anatomical Society he devoted years of disinterested, unremitting labour, an Argus in its interests and a most gentle Nestor to its younger members. Joining the Society in 1893, he served for many years on its council and on the editorial board of the *Journal of Anatomy*, was joint recorder of *Proceedings* 1925–31, treasurer 1931–37, and secretary 1919–38, declining the honour of the presidency that, as secretary, he might the better serve his fellow members. The Society's travelling fund, designed to encourage and enable junior provincial members to attend the London meetings, was Barclay-Smith's anonymous foundation. Indeed, the Society owes more to him than to any other, and its present flourishing state is perhaps his truest memorial.

Barclay-Smith's personal qualities—in particular his gentle patience, his unassuming bearing, his winsome charm and his genuine concern for the welfare of his fellows—endeared him to a wide circle of friends, colleagues and students, by whom he was beloved, and by whom his memory will be always cherished.

A. J. E. CAVE.

NEWS and VIEWS

Engineering at Queen Mary College: Prof. E. H. Lamb

PROF. ERNEST HORACE LAMB retires from the chair of civil and mechanical engineering at Queen Mary College, London, at the end of the present session. He has occupied this chair for thirty-two years, having succeeded the late Prof. D. A. Low in 1913. At the time of his appointment, the Engineering Department at East London College (as the College was then called) was rather small and the laboratory equipment meagre and ill-housed. Prof. Lamb set to work at once to develop an engineering laboratory that should be more worthy of the College and of the University. Permission was obtained to extend the laboratory buildings, and a new hydraulic laboratory had already been erected when the War of 1914–18 interrupted the development programme. From September 1914 until April 1919, Prof. Lamb was away from the College on war service, but as soon after his return as possible he continued the work of development. With the help of the late Principal Hatton, he obtained a grant for equipment of £11,000 from the London County Council and also some useful presentation plant, notably a complete boiler and accessories from Babcock and Wilcox, so that by the end of 1923 the laboratories had been rearranged and re-equipped with modern plant for the study of hydraulics, heat engines and strength of materials. He also designed and equipped an instrument-making department which served the science and engineering departments of the College.

The undergraduate school of engineering at Queen Mary College has grown considerably under Prof. Lamb's direction. In addition, much valuable research has been carried out on temperature distribution and thermal stresses in internal combustion engines, propagation of flame in compression ignition engines and on many other investigations. He has always taken a special interest in the application of theory to those elastic and dynamical problems which are so important in high-speed machinery. Prof. Lamb was a member of the University Board of Studies in Civil and Mechanical Engineering and served as its chairman in 1923. He was also a member of the Faculties of Science and Engineering. From November 1924 until November 1928 he was University Dean of the Faculty of Engineering, and thus occupied this important post when the new statutes under the University of London Act, 1926, were being drafted. He was elected a member of the Senate as representative of the Faculty of Engineering in May 1928 and remained a member until 1934, giving most useful service on the Academic Council and many sub-committees of the Senate.

Prof. Edmund Giffen

DR. EDMUND GIFFEN has been appointed to the chair of civil and mechanical engineering at Queen Mary College, in succession to Prof. E. H. Lamb. Dr. Giffen had a lengthy practical training with Messrs. Harland and Wolff, Belfast, and took his degree in mechanical engineering at the Queen's University, Belfast, later proceeding to M.Sc. He served for thirteen years at King's College, London, first as lecturer and later as reader in mechanical engineering. In this period, he carried out considerable research work, mainly in connexion with injection processes in compression ignition engines, in collaboration with Prof. S. J. Davies, gaining the degrees of Ph.D. and D.Sc.(Eng.) in the University of London. He was active as a member of College and University Boards and served as chairman of the Board of Examiners for the External Engineering Degree. Since 1940, he has been director of research at the Institution of Automobile Engineers' Laboratories, Brentford. During this period, he has been responsible for a great development in the work of these laboratories and has issued important publications, particularly in connexion with the use of gas-producers. In his career he has thus combined experience of practice, of research, of teaching and administration, and his return to university life will be greatly welcomed.

British Agricultural Attaché at Washington and Agricultural Adviser at Ottawa: Mr. A. N. Duckham, O.B.E.

PROF. ROBERT RAE, agricultural attaché on the staff of His Majesty's Ambassador to the United States of America and agricultural adviser to the High Commissioner for the United Kingdom in Canada, will shortly be returning to Britain. He will be succeeded by Mr. A. N. Duckham. Mr. Duckham has been serving as director of the Supply Plans Division of the Ministry of Food, having joined that Department at the beginning of the War. Among his earlier appointments were those of secretary and manager to the Northern Ireland Pigs Marketing Board and research officer to the Bacon Development Board. He has travelled extensively in Europe and North America to examine the economics of animal husbandry. He acted as adviser to the United Kingdom delegation to the Hot Springs Food and Agriculture Conference in 1943 and was a member of the Food and Nutrition Committee of the interim Commission set up by that Conference and also chairman in the United Kingdom of the 1943 Food Consumption Levels Enquiry Committee of the Combined Food Board. Mr. Duckham took Part I of the Natural Sciences Tripos at Cambridge, and holds the Cambridge diploma in agricultural science with distinction in animal husbandry; he is a research medallist of the Royal Agricultural Society. His published work includes reports on agricultural topics and "Animal Industry in the British Empire" which were issued by the Oxford University Press in 1932.

British Iron and Steel Research Association: Dr. C. F. Goodeve, F.R.S.

THE steel industry in Great Britain has recently announced plans for large-scale re-equipment; in addition, it is to establish a central organization for research, to be known as the British Iron and Steel Research Association, which will be under the direction of Dr. C. F. Goodeve, formerly reader in physical chemistry at University College, London, and since 1942 assistant controller for research and development at the Admiralty. Dr. Goodeve has stated that the present intention is for the industry's own research centres to operate in association with teams already working in the universities, as at Sheffield, Cambridge, Swansea, Glasgow, London, Birmingham and Newcastle. The Association will have its headquarters in London, and it will work through a number of divisions and committees, each serving a particular aspect of the steel industry's interests. In this way it is hoped to ensure that problems of the industry reach the research laboratory promptly and that the results of investigations are properly applied. The Research Association will also collaborate with technical bodies studying the raw materials of the industry such as coal and refractories, and will bring together users and makers of steel for the discussion of common problems. It is stated that the industry will contribute up to £250,000 a year to the new Research Association, the total revenue of which is expected to be about £400,000 a year.

National Certificates in Metallurgy

THE Iron and Steel Institute, the Institution of Mining and Metallurgy and the Institute of Metals have joined forces to establish, in co-operation with the Ministry of Education, a scheme for Ordinary and Higher National Certificates in Metallurgy for part-time students who are engaged in industry or other pursuits connected with the science of metallurgy. The certificates will be awarded to students taking approved grouped courses of instruction at certain technical colleges and schools in England and Wales and reaching a certain standard in the final examinations. Examinations will be conducted by the college or school authorities, but syllabuses and examinations based on those of the City and Guilds of London Institute, Department of Technology, or the regional examining unions may, at their discretion, be submitted. The Ordinary National Certificate will be awarded on the results of senior part-time courses, which will usually occupy three years. They will be adapted to the needs of students who have had full-time continuous education up to the age of 15 or 16 or have completed satisfactorily an appropriate part-time course. Senior courses will include adequate provision for chemistry, physics and mathematics; metallurgy will be introduced at appropriate stages and engineering drawing may also be included. The Higher National Certificate will be awarded on the result of advanced part-time courses. These will be suitable for students who have already gained the Ordinary National Certificate or who have reached a corresponding standard and will normally cover at least two years of part-time study. The courses will provide for more intensive study of various branches of metallurgy and will aim at reaching, within the limits of the subjects covered, the standard of university work.

Certificates will be signed by the presidents of the Iron and Steel Institute, the Institution of Mining and Metallurgy, the Institute of Metals and, on behalf of the Minister of Education, by the Principal of the technical college or school at which the award has been gained. Thus the National Certificates will have a professional and national, as well as a local, value. Higher Certificates which record success in specialized foundry subjects will be countersigned by the president of the Institute of British Foundrymen. It is hoped that the possession of a national certificate in metallurgy will foster in the holder a desire to join one or more of the various institutions whose members are concerned with the study, production and use of metals. In the case of those institutions whose membership involves professional qualifications, the holding of a Higher National Certificate will be of assistance in obtaining admission. The formation of a new professional Institution to be known as the "Institution of Metallurgists" and covering all branches of metallurgy is now nearing completion. Membership will be dependent on the production of suitable evidence of qualification as a metallurgist, and it is believed a Higher National Certificate in Metallurgy will be accepted as qualifying the holder in part for the appropriate grade of membership. Further information on the scheme for national certificates in metallurgy can be obtained from the secretaries of the participating institutions or from the principals of technical colleges or schools.

Pharmaceutical Chemistry, Past and Future

MR. H. BRINDLE, chairman of the British Pharmaceutical Conference meeting in London on July 18, gave an address on the origin and development of

[None of the vacancies in these columns relates to a Man between the ages of 18 and 50 inclusive or a Woman between the ages of 18 and 40 inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.]

UNIVERSITY OF LEEDS
DEPARTMENT OF MATHEMATICS

The Council invites applications for (i) a Lectureship in Applied Mathematics, and (ii) an Assistant Lectureship in Applied Mathematics. Duties to begin on October 1 if possible. Further particulars of either post, including information in regard to salary, may be obtained from the Acting Registrar, The University, Leeds, 2, who will receive applications for the appointments on or before September 1.

RADIUM CUSTODIAN

A deputy Assistant Radium Custodian (female) is required in the Radium Department of St. Bartholomew's Hospital, E.C.1, to begin duty in January. Salary £175 to £200 per annum. Applications from suitably qualified persons should be sent to the undersigned from whom further particulars can be obtained.

C. C. CARUS-WILSON,
Clerk to the Governors.

UNIVERSITY COLLEGE OF HULL

Temporary Assistant Lecturer required in the Department of Physics from October 1. Salary at the rate of £350 per annum. Particulars may be obtained from the Registrar to whom applications must be made by August 18, 1945.

UNIVERSITY COLLEGE OF HULL

Assistant Lecturer required in the Department of Mathematics from October 1. Salary at the rate of £350 per annum. Particulars may be obtained from the Registrar to whom applications must be made by August 18, 1945.

Petroleum Laboratory in London area requires MALE ASSISTANTS for Laboratory work and for operation of small experimental plants on shifts. Applicants must be prepared to work shift. Age 30–35 (younger if discharged from, or not required for, Forces). Experience of this kind of work or in gas and chemical industry essential. Minimum educational standard of matriculation. National or Higher National Certificate an advantage. Emoluments £420 per annum or more according to experience. Applicants must be of full British parentage.

Applications, which must be in writing, stating date of birth, full details of qualifications and experience (including a list in chronological order of posts held) and quoting Ref. No. Q.N.410, should be addressed to the Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2.

The Board of Greenkeeping Research require two Advisory Officers, commencing salary £450 to £500 according to qualifications and experience. Applicants should hold a recognized diploma or degree in agriculture or horticulture, preferably with grassland or botanical experience. Both posts will come under the Board's Staff Pension Scheme and the successful candidates will be required to co-operate in the general work of the Station which will include some teaching and demonstrating.

Applications, stating age, qualifications and past experience, accompanied by copies of two recent testimonials and the names of two personal referees, should be in the hands of the Director, St. Ives Research Station, Bingley, Yorkshire, by August 14.

Applications are invited for the position of DIRECTOR OF RESEARCH at the British Schering Research Institute, Alderley Edge, Cheshire. Applicants should hold high qualifications in chemical research with particular reference to its application to medicine and should possess administrative ability. A medical qualification would be regarded as an advantage but is not essential. Commencing salary will be not less than £1,200 per annum and will depend on qualifications and experience. Participation in existing superannuation scheme is a condition of the appointment. All replies, which will be treated in strict confidence, should be sent before August 18 to: The Chairman, British Schering Research Laboratories Limited, Alderley Edge, Cheshire.

Technician (male or female) required, qualified to undertake routine haematology and clinical biochemistry in a London hospital. Preference will be given to applicants holding the Associateship or Fellowship of the Institute of Medical Laboratory Technology. Salary according to experience. Applications, stating full particulars as to experience, age, etc., accompanied by two recent testimonials, should be addressed to Box C.W., c/o Street's, 110 Old Broad Street, E.C.2.

Wanted: Recent Graduate in Science, preferably with General Honours Degree, to train as Teacher of Dental Students in Technological Subjects. Burnham Scale. Apply to the Dean of the Turner Dental School, University of Manchester, Manchester, 15.

The Faraday Society

6, Gray's Inn Square, London, W.C.1

A General Discussion on

OXIDATION

will be held at

University College (University of London)

on

Thursday, 27th September, 1945—
from 11 a.m. to 1 p.m. and 2.30 p.m. to 6 p.m.

Friday, 28th September, 1945—
from 10.30 a.m. to 1 p.m. and 2.30 p.m. to 6 p.m.

Arrangements will be made for luncheon and tea to be taken at University College.

PRELIMINARY PROGRAMME

General Introduction by the President.

Part I: Electron Transfer Reactions. Introduction by Prof. M. G. Evans.

Part II: Oxidation of Hydrocarbons.

(*a*) Low Temperature: Introduction by Dr. Geoffrey Gee.

(*b*) High Temperature: Introduction by Prof. H. W. Melville.

Further details will be available shortly from the Secretary of the Faraday Society, 6, Gray's Inn Square, London, W.C.1.

August, 1945

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pharmaceutical chemistry. He claimed that in days not long past all chemistry was pharmaceutical chemistry and all chemists were pharmaceutical chemists. Pure chemistry has emerged from it, but to-day many chemists are drawn irresistibly away from atoms, valencies, electrons, dipole moments, etc., to the chemistry of medicinal substances and thus back again to pharmaceutical chemistry. The alchemists were really neither chemists nor apothecaries, and they added little to knowledge of chemistry. The iatro- or medical chemists should be considered the first pharmaceutical chemists, for all who practised chemistry at this time were interested in the subject from the medical, that is, the pharmaceutical point of view. Their main aim was to prepare chemical substances for use in medicine, and their interest in chemistry as a science was distinctly secondary. Paracelsus was the first outstanding iatro- or pharmaceutical chemist, and he was followed by such as van Helmont, Agricola, Glauber, Scheele, Kunkel, Davy, Berzelius, Liebig, Wohler and Dumas, to name a few only who spent periods of their life as apothecaries.

The present course of training for the modern pharmaceutical chemist includes a fairly comprehensive study of synthetic drugs. These are increasing very rapidly in number and complexity. Thus since the publication of the "British Pharmacopœia" in 1932, seven addenda have been issued, and in these have been included about fifty entirely new synthetic organic drugs. These fifty which have been officially recognized constitute only a very small fraction of the total number which may be considered to have been actually introduced in the thirteen years which have elapsed since the "Pharmacopœia" was published. These facts raise great difficulties in the design of teaching syllabuses in the subject, for the lecturer has to consider carefully which should be taught and which can be omitted. Enough chemotherapy should be included to fire the students' imagination regarding its possibilities.

However limited his opportunities for carrying it out, any pharmaceutical chemist worthy of the name must have his mind directed towards research. There is a tendency to divide scientific research of all types into the two main classes of pure and industrial or applied research. Pure research is undertaken with no thought of its application. Its results may add to knowledge but it is not carried out primarily for any benefit which it may confer upon any individual, community or even mankind in general. Yet startling results have resulted from pure research; insulin and penicillin, two of the greatest life-savers science has ever produced, emerged almost accidentally during the prosecution of pure research. Pharmacy must be better organized in research activities. The existing research degrees in pharmacy will stimulate research, and now that more pharmacists are graduating in universities, pharmaceutical research is sure to expand. Grants in aid of such research are urgently needed. Some thirty branches of industry have autonomous research associations financed to some extent by the industry concerned but receiving aid from the Government. Although pharmacy may not be so large or so wealthy as these, and may not be able to support a research institution, it could assist by contributions which would be supplemented by government aid. A body for pharmacy similar to the Medical Research Council should be set up.

Conditioning of Plywood

Plywood has so important a future before it that any research which advances its durability is of importance. In Leaflet No. 65 (Utilisation) of the Forest Research Institute, Dehra Dun, India, a description with plan is given of a simple chamber designed by this Institute for the conditioning of finished plywood. It is pointed out that even thoroughly seasoned veneers pick up a certain amount of moisture from glue during the manufacture of plywood; it is necessary that this moisture should be got rid of, before the article is used, by a process termed conditioning. This process ensures the correct drying and setting of the glue, and prevents warping and buckling. Further, some of the softer hardwood timbers, like the Indian semul (*Bombax malabaricum*), and mango (*Mangifera indica*), are liable to blue stain and mould, and even attack by insects if not well conditioned. The drying room is fitted with steam pipes below the floor, and the sheets of plywood are stacked vertically on trolleys above it. There are inlets for the fresh air and outlet chimneys for exhausting the moist air. It is estimated that freshly manufactured plywood requires twenty-four hours for conditioning, and during this period its moisture content will decrease from about 20 to 8 per cent.

Institution of Electrical Engineers: Annual Report

According to the report for the year 1944–45 of the Council of the Institution of Electrical Engineers, total membership on March 31, 1945, numbered 26,665, of which 12,573 were corporate members; 2,639 elections to all classes of membership were made during the previous twelve months. During the year, 682 meetings were held in London and at the local centres. There were eleven ordinary meetings, the Radio Section held eighteen meetings, the Measurements Section eight, the Transmission Section seven, the Installations Section eight, and there were six informal meetings. There are ten students sections. Certain revisions of the by-laws have been effected during the year. The Council has set up a permanent Research Committee to advise in matters connected with electrical research. The Institution continues to be active in matters affecting national service, such as War Office correspondence courses, engineering cadetships, the education and training of students and graduates serving with the Forces, etc. A report dealing with "Part-time Further Education at Technical Colleges—including Courses for those returning from the Services" has been issued. Further substantial progress has been made in the work of drafting various codes of practice.

A committee of the Institution has been set up to prepare regulations for the electrical equipment of aircraft, and one is to be formed to deal with radio requirements for civil aircraft. Panels of lecturers are to be formed for the benefit of both young people and adults, and a series of skeleton lecture notes is being prepared for the use of speakers. This scheme is in addition to that already existing whereby senior engineers are enabled to address university engineering societies. An independent Professional Engineers Appointment Bureau has been set up to meet the needs of professional engineers seeking appointments and employers having staff vacancies to be filled. The Council has endowed a chair of electrical engineering at Cambridge for a period of years. Reference is also made in the Report to the Institution library and publications and to the benevolent fund.

Beit Memorial Fellowships for Medical Research

THE Trustees of the Beit Memorial Fellowships for Medical Research refer in their annual report for the year 1944–45 to the death of Lord Onslow, who had served as a trustee since 1928. They also put on record the great loss that not only they, but also the whole of medicine, suffered by the death of Sir Thomas Lewis. Sir Thomas was the first person to be elected to a Beit Fellowship when they were instituted in 1910; and he was a member of the Advisory Board at the time of his death. The Trustees accepted with regret the resignation of Sir Henry Dale and Sir John Ledingham (who has since died) from the Advisory Board; Dr. C. H. Andrewes, Prof. J. H. Gaddum and Prof. H. Himsworth have been elected to fill the vacancies. They noted with pleasure the election this year of Dr. H. D. Kay (fellow 1922–28) and Miss M. Stephenson (fellow 1914 and 1920–22) to the fellowship of the Royal Society.

The following elections were made: *Fourth Year Fellowship* (£500 *a year*): Dr. F. W. Landgrebe, to continue the study of the physiology of melanophore hormone and the nutritional factor responsible for the lethal effect of thiourea in rats (Materia Medica Department, Aberdeen). *Junior Fellowships* (£400 a year): Dr. J. F. A. McManus (Canada), to study the topography of lipine distribution in normal and pathological tissues (Department of Zoology and Comparative Anatomy, Oxford); and O. L. Thomas, to study thyroid activity, the pituitary phenomena found experimentally in thyroactivated animals, and the problem of neurosecretion (Anatomy Department, Oxford).

University of Durham: Appointments

MR. G. H. FORSYTH has been appointed to the chair of mechanical and marine engineering at King's College, Newcastle-upon-Tyne. Mr. Forsyth obtained first class honours in mechanical and marine engineering at the University in 1924, and in the following year proceeded to the degree of M.Sc. He was then employed for two years on research work with the North Eastern Marine Engineering Co., Ltd., and after a further period of three years spent at sea, he joined, in 1929, the staff of Lloyd's Register of Shipping, where he has been principal engineer surveyor since 1942. His published works chiefly concern investigations into causes of failure in marine engines.

Dr. David H. Valentine, University demonstrator and curator of the Herbarium and Museum at the Botany School, Cambridge, has been appointed to the readership in botany in the Durham Colleges. He was educated at Manchester Grammar School and St. John's College, Cambridge, where he held an open Major Scholarship in natural science. He took a first class in both parts of the Natural Sciences Tripos in 1932 and 1933, and was afterwards awarded a research grant and a studentship while working on induction phases in photosynthesis. In 1937 he was awarded the degree of Ph.D. for a thesis in plant physiology; and in 1938 he was elected a research fellow of St. John's College. During the War years he has been a temporary officer in the Ministry of Food, on work connected with vegetable dehydration, and visited Africa as the British technical member of the African Dehydration Mission. He has also done work, some of which is already published, on experimental taxonomy, with special reference to the British flora. In 1940 he was president of the Botanical Section and vice-president of the Cambridge Natural History Society.

Anglo-French Conference on Cosmic Rays

AN Anglo-French conference on cosmic rays will be held in the H. H. Wills Physical Laboratory, University of Bristol, during September 25–27, 1945. It is hoped that some ten French delegates will attend, including Prof. P. Auger, Prof. F. Joliot and Prof. I. Curie-Joliot. Physicists in England wishing to attend are requested to send their names to Prof. N. F. Mott, H. H. Wills Physical Laboratory, The University, Royal Fort, Bristol, 8. If accommodation is required in Bristol, early notice should be given; every effort will be made to arrange this, but it is hoped that visitors will make their own arrangements where possible.

Copies of *Nature* for Service Men

LIEUT.-COLONEL J. P. CASTLE, of the Directorate of Disposals, c/o British Embassy, Rome, A.P.O., C.M.F., asks if a subscriber to *Nature* would be willing to forward him his copy of the journal when he has finished with it. After the headquarters' staff of the Directorate of Disposals have read the journal, it would be passed to the Y.M.C.A., Rome, for distribution through the Association's organization to the troops. We suggest that any reader able to dispose of his copy of *Nature* regularly in this way should write direct to Lieut.-Colonel Castle. It may be recalled that the Services Central Book Depot makes bulk issues of secondhand magazines; copies handed in to any post office are automatically forwarded to the Depot post free, without any address being necessary. There are, however, no existing arrangements whereby copies of periodicals can be supplied to individuals through military sources.

Announcements

DR. O. R. GURNEY has been appointed Shillito reader in Assyriology in the University of Oxford as from October 1, 1945, or such later date as he is released from the Forces.

DR. MAURICE STACEY has been given the title of reader in biological chemistry in respect of the post held by him in the Department of Chemistry, University of Birmingham.

AN offer to establish a trust fund, the capital of which at the end of seven years is expected to be about £10,000, has been received by the University of Cambridge from Mrs. A. M. Sims. The income of the fund would be used to endow a Sims Empire Scholarship for research in physics, chemistry, mathematics, medicine, or any other subject which may be selected from time to time.

ON August 5 the B.B.C. is presenting the first of a new fortnightly series of programmes entitled "Science Magazine". In the first broadcast, listeners will hear an outline of the series as a whole. The programme will be illustrated by excerpts from the recorded opinions of Prof. F. G. Donnan, Sir Robert Watson-Watt, Prof. I. M. Heilbron, Dr. E. Hindle, Sir Howard Florey, Prof. J. D. Bernal, and Dr. C. D. Darlington. This series can be heard on alternate Sundays in the Home Service at 7 p.m.; there will also be a recorded repeat on the following Friday, again in the Home Service, at 4.45 p.m.

ERRATUM.—Dr. D. H. Hey has been appointed to the University chair of chemistry tenable at King's College, London, and not at the Imperial College of Science and Technology as previously announced by the University (see *Nature*, July 28, p. 108).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Penetration of Fast Nucleons into Heavy Atomic Nuclei

WITH the view of interpreting the disintegration 'stars' observed in photographic emulsion exposed to cosmic radiation, Heisenberg[1] developed a theory of the penetration of a fast nucleon into a heavy nucleus, based on the idealization of nuclear matter as a degenerate Fermi gas of nucleons, and on the assumption that the interaction between these constituent particles and the impinging nucleon can be represented by a simple central potential. As a justification of the latter assumption one may adduce the fact that the collision cross-section, computed by Born's method of approximation, quite generally tends to zero as the transfer of momentum in the collision increases. The energy distribution of the nucleons knocked out by the impinging fast particle, as given by this theory, turns out to depend sensitively on the range of the central potential, so that a comparison of this energy distribution with observation should lead to a fairly accurate determination of this range. Such a comparison has actually been carried out by Bagge[2] and Ortner[3], under the assumption that the law of force is of the type $e^{-\varkappa^2 r^2}$.

The result was very satisfactory, inasmuch as the range value found in this way coincided, within the limits of empirical errors, with that deduced from the much more precise evidence furnished by proton-proton scattering experiments. The question naturally arises, whether the same check would also be successful for other laws of nuclear force, for which the range has been determined from the proton-proton scattering data, in particular for potentials of the 'well' and 'meson' types. It is the purpose of this letter to point out that Heisenberg's theory is unfortunately not applicable in its simple form to nuclear potentials of those types.

This conclusion cannot be reached merely by investigating for such potentials the energy distribution of the ejected nucleons, for one will always get a definite answer to this problem for any law of force. But the inadequacy of the theory becomes apparent when one calculates the mean energy loss of the impinging nucleon per unit of path in nuclear matter. This quantity has also been computed by Heisenberg for the case of the $e^{-\varkappa^2 r^2}$ potential; and it is an easy matter, making use of a transformation of variables first proposed by Bagge[2], to extend the calculation to the case of a central nuclear interaction of the general form

$$\mathbf{V} = -\mathbf{J}.\mathbf{O}.w(\xi) \quad , \quad \xi \equiv \varkappa r, \qquad (1)$$

in which the operator $\mathbf{O}$ embodies the dependence on spin and isotopic variables and $w(\xi)$ the distance dependence (the parameter $\varkappa$ being a measure of the inverse of the range of force); the function $w(\xi)$ is normalized in such a way as to reduce either to ξ^{-1} or 1 for $\xi \rightarrow 0$, while the normalization of $\mathbf{O}$ is chosen so that its expectation value be unity in ^{13}S states of the pair of interacting nucleons: the constant $\mathbf{J}$ thus gives the 'strength' of the potential for such states. If ε denotes the energy of the impinging nucleon in units of Mc^2 and v the corresponding velocity, one finds for the rate of decrease of ε per unit of path

$$\frac{d\varepsilon}{ds} = -\frac{3}{2}\,\overline{\mathbf{O}^2}\,\mathbf{H}\,\frac{1}{\varkappa^2 r_0^3}\left(\frac{\mathbf{J}}{Mc^2}\right)^2\left(\frac{c}{v}\right)^2 \qquad (2)$$

In this formula, r_0 denotes the unit nuclear radius (the radius R of the nucleus of mass number A being $R = r_0 A^{1/3}$), $\overline{\mathbf{O}^2}$ is a suitable average of the operator $\mathbf{O}^2$ over spin and isotopic variables of the colliding nucleons (numerically $\simeq 0{\cdot}52$ according to the best data), and $\mathbf{H}$ is a constant characteristic of the law of nuclear force $w(\xi)$, defined by

$$\mathbf{H} = 2\int_0^\infty u^3\,\mathbf{F}^2(u)\,du, \quad . \quad . \quad . \quad . \quad . \qquad (3)$$

where

$$\mathbf{F}(u) = \frac{1}{u}\int_0^\infty w(\xi)\sin u\xi \,.\, \xi d\xi \qquad (4)$$

is essentially the Fourier integral coefficient of $w(\xi)$. It must be stressed that the same value is obtained for $\mathbf{H}$ whether one assumes the aforementioned Fermi distribution for the constituent particles of the knocked nucleus or treats these particles as being at rest and entirely independent of each other. This result is in conformity with a general property first enunciated by Williams[4], namely, that the mean energy loss per unit of path of a fast nucleon traversing a nucleus is independent of the mutual interactions and state of motion of the constituent particles of this nucleus.

However, the above formula (2) loses any meaning if the integral $\mathbf{H}$ does not converge. This eventuality will present itself, as shown by (3), as soon as $\mathbf{F}(u)$ does not decrease faster than u^{-2} for large u. In particular, it is immediately deduced from (4) that for the well type of potential: $w(\xi) = 1$ for $\xi \leqslant 1$, and $w(\xi) = 0$ for $\xi > 1$; and for the meson type $w(\xi) = e^{-\xi}/\xi$, $\mathbf{H}$ diverges logarithmically. [In the derivation of formula (2), the 'exchange' contribution to the collision cross-section was neglected. It is easily verified, however, that the inclusion of this effect does not prevent the divergence of $\mathbf{H}$.] In these instances, the divergence can be traced to the occurrence of an infinite field intensity (either at the boundary of the well or at the centre of the meson field of force), as a result of which the probability for a momentum transfer p, being proportional to $[\mathbf{F}(p/\hbar\varkappa)]^2$, does not decrease sufficiently rapidly for large p.

In view of Williams's theorem, the breakdown of the theory in such cases can, of course, not be ascribed to the use of the Fermi gas model, nor is there any cogent reason to doubt the legitimacy of Born's approximation in calculating the collision cross-section. But the use of a central potential to describe nuclear interaction is no longer justified for momentum transfers $p \gtrsim Mc$: recourse should then be had to a relativistically invariant field theory of this interaction. While such a theory cannot at present be developed in a consistent way, it is possible to surmise its probable effect on the energy distribution of the ejected nucleons. Thus, if one compares the empirical energy distribution with that derived from the theory for a meson potential with a range of force corresponding (by Yukawa's relation) to the mass of the cosmic ray mesons ($\simeq 200$ electron masses), one finds that the theory predicts much too large a proportion of very fast ejected particles: since a more refined theory, using meson field interaction, would (if it is to remove the divergence of $\mathbf{H}$)

tend to diminish the cross-section for large momentum transfers, it may be expected that it would lead to a better agreement with observation.

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A New Interference Effect

IN the course of a class experiment demonstrating the circular Haidinger fringes produced by monochromatic illumination of a thin film between silvered surfaces, it was noticed that coloured circular fringes could be seen if white light illumination was used. The effect is best seen by looking through the film (for example, a thin air film between silvered glass plates, or a thin mica film silvered on both sides) with the eye accommodated for infinity, at a strong point source such as a 'Pointolite'. For normal illumination, the point source is seen surrounded by several rainbow fringes, as in Fig. 1, while for oblique illumination, a sharp circular white-light fringe is seen passing through the source, with concentric rainbows inside and outside, as in Fig. 2. Unlike the usual monochromatic fringes, these fringes are not influenced by lack of accurate parallelism of the silvered surfaces. The sharpness of the white-light fringe improves with increase of the reflexion coefficient of the surfaces; with plates heavily silvered by the Tolansky technique[1], the fringe width is limited only by the size of the source.

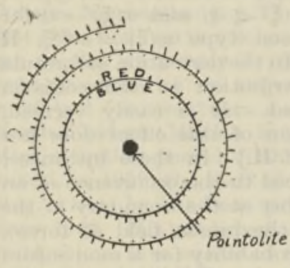

Fig. 1.

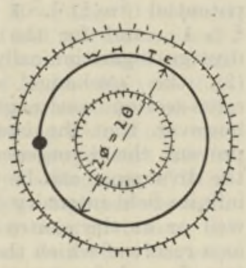

Fig. 2.

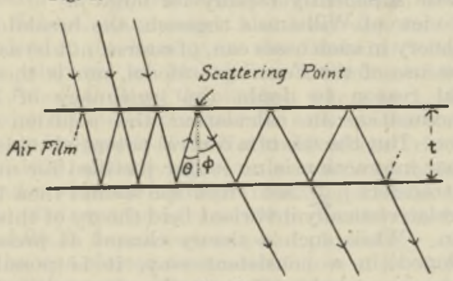

Fig. 3.

A similar effect in reflexion instead of transmission was first described by Newton and explained in detail by Stokes[2], who mentions that he tried unsuccessfully to observe the present effect in light transmitted through an unsilvered glass plate. We suggest the following explanation, similar essentially to that of Stokes. The fact that any illumination at all is visible off the line from the eye to the point source indicates that light is being scattered or diffracted from small irregularities in the silvered surfaces, and we suppose the fringes to be formed by light which has been multiply reflected at angle θ, then scattered, and again multiply reflected at angle φ (see Fig. 3). In the first series of multiple reflexions, light of wave-lengths for which

$$2t \cos \theta = m\lambda \ (m \text{ integral}) \quad . \quad . \quad (1)$$

is strongly enhanced in transmission; while after scattering, light of wave-lengths for which

$$2t \cos \varphi = n\lambda \ (n \text{ integral}) \quad . \quad . \quad (2)$$

is further strongly enhanced. If both (1) and (2) are simultaneously satisfied, then we have

$$2t (\cos \theta - \cos \varphi) = (m - n)\lambda \quad . \quad . \quad . \quad (3)$$

Thus for a given value of θ and for $m = n$, all wave-lengths for which (1) is satisfied will appear strongly for $\theta = \varphi$, producing the white fringe. For $|m-n| = 1, 2$, etc., these same wave-lengths will appear at slightly varying angles φ given by (3), producing the various rainbows (each will appear to be practically continuous if m is fairly large). The mechanism is, in fact, similar to that of the production of white-light fringes by light passed through two thin films of slightly different thicknesses (sometimes called Brewster fringes), except that in our case the second path difference is introduced in the same film after scattering.

It will be seen that the formula accounts qualitatively for the facts described, and measurements of fringe angular diameters, using an air film about $40\lambda_{Na}$ thick, have confirmed it quantitatively. Accurate parallelism is unnecessary since for $\theta = \varphi$, $(m - n) = 0$ for all values of t. Some further observations confirm this explanation: (*a*) If the silvered surfaces are accurately parallel and the 'Pointolite' is viewed against a background illuminated by sodium light, the usual Haidinger sodium fringes may be seen superimposed on the white-light fringes. It is then found that for certain values of θ (those satisfying (1) with $\lambda = \lambda_{Na}$) the system of sodium fringes coincides exactly with the white-light system. (*b*) If the 'Pointolite' is replaced by a point monochromatic source (for example, a small aperture in front of a sodium vapour lamp, with precautions to avoid all stray light), fringes are seen to appear in the usual positions of Haidinger fringes whenever θ satisfies (1) but are scarcely visible at other angles. (*c*) Close examination of the white fringe shows that it is made up mainly of bright spots; this supports the idea that scattering is from discrete irregularities in the silvered surfaces. It is perhaps significant that the silvered plates which best showed the effect had been exposed to Manchester air for some days, which may have increased the number of scattering centres; this point, however, requires further investigation.

A more detailed treatment enables calculation of the intensity distribution in the white-light fringe, and explains the sharpening of the fringe with increase of the reflexion coefficient of the silvered surfaces, just as in the case of monochromatic Haidinger fringes.

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Scaliness of Wool Fibres

According to a theory of milling which was developed some years ago, fabrics are capable of undergoing milling shrinkage only when some or all of the component fibres possess a surface scale structure, are easily deformed, and show perfect recovery from deformation[1]. It should, therefore, be possible to make wool unshrinkable by modifying its elastic properties instead of by the customary method of attacking the surface-scale structure. The truth of this deduction has been established in a number of ways[2,3,4]. Perhaps the most convincing is the recent demonstration that woollen flannel can be made unshrinkable by treatment with mercuric acetate or benzoquinone[4]. Both reagents increase the resistance of the fibres to deformation; both *increase* the scaliness of the fibres, as measured in soap solution by means of the lepidometer[5,6]. In the light of these results it was concluded that mercuric acetate and benzoquinone make wool unshrinkable by modifying the elastic properties of the fibres, and not by attacking or masking the surface-scale structure.

The scaliness measurements, on which the validity of the preceding conclusion depends, were carried out under conditions which reproduce the fibre-travel responsible for milling shrinkage: single fibres were suspended, root end downwards, from a tension-measuring device and rubbed longitudinally in soap solution between the rubber surfaces of the lepidometer. The maximum tension developed by the creeping fibre was taken as a measure of its scaliness. Precisely similar results are obtained when the scaliness of fibres treated with mercuric acetate or benzoquinone is measured by the older 'violin bow' method[7], which is, however, less satisfactory in being less closely related to milling conditions. It consists simply in determining the angle of tilt necessary to cause a 'bow' of fifty fibres to slide on a face cloth, first in the direction of the root end (θ_1) and then in the direction of the tip (θ_2), the scaliness (S) being defined as:

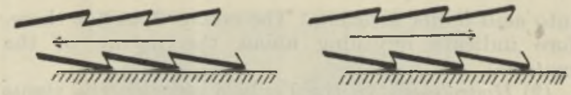
$$S = \frac{\tan \theta_2 - \tan \theta_1}{\tan \theta_1} \cdot 100.$$

The results obtained by this procedure are given below:

Treatment	Percentage shrinkage in area of fabric in milling	Scaliness of fibres in: Air	Scaliness of fibres in: Sodium oleate solution (0·2%)
Untreated	37·3	32·6	142
Mercuric acetate	4·4	31·2	182
Benzoquinone	20·2	31·4	>200

Thus, whether the scaliness is measured under static or dynamic conditions, whether it is measured on wool or rubber surfaces, the results indicate that the unshrinkability of fabric treated with mercuric acetate or benzoquinone is not due to reduced scaliness of the fibres.

The preceding results, like those given by the lepidometer, are in sharp contrast with those recently obtained by Bohm[8], and the most probable cause of the discrepancy is his use of a hard, inflexible surface —glass—for the friction measurements. Although Bohm's data are therefore of doubtful value in relation to the milling process, some explanation must be offered for his observation that the two coefficients of friction (towards the root and towards the tip) of fibres treated with mercuric acetate or benzoquinone are so nearly alike, whereas those of untreated fibres are far apart. A possible explanation is to be found in terms of Rudall's model[9], which was originally devised to explain why untreated fibres migrate when they are rubbed longitudinally between wet glass plates. A wooden ratchet was provided with rubber 'scales' as shown in the sketch. When the model was pushed towards the 'root' end on glass, the friction was less than when it was moved in the direction of the 'tip', owing to the different configurations adopted by the edges of the 'scales', as shown in (*a*) and (*b*), respectively. It is obvious that no such difference would arise on glass plates if the rubber were replaced by a more rigid material. Since cross-linking reactions increase the resistance of wool fibres to deformation, the differential frictional effect will be correspondingly reduced on glass, if the scales of the fibres behave in the same way as the 'scales' of the model. As has already been shown, however, the difference in friction would still be observable on flexible surfaces, and it seems likely that Bohm's observations are a measure of the effect of mercuric acetate and benzoquinone in modifying the elastic properties of the fibres.



(*a*) (*b*)

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May 26.

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Mechanism of the Feulgen Reaction

The Schiff reaction for aldehydes using the addition compound of sulphurous acid with fuchsine was applied by Feulgen for his well-known reaction for the localization of desoxyribosenucleic acid in cells. The specificity of this localization in the reaction has recently been questioned[1], and led to the series of investigations to be described, from which it is concluded that the reaction is essentially one of adsorption, and that nucleic acid is not necessarily concerned in the reaction. Normal, malignant and embryonic tissues of mouse, fowl and normal rabbit tissues, fixed by various methods, were used in the staining tests.

(1) *Colour of the stain.* It can readily be shown that though neutral fuchsine stains filter paper or sections bright red, the typical mauve colour is produced if the dye is used in weakly acid solution, as in the usual Feulgen method. Though the colour is washed out of filter paper by sulphur dioxide water, it is not removed completely from other materials such as newsprint, poor quality cotton wool, or alumina. Furthermore, a section stained bright red by neutral dye will show the typical Feulgen colour if dipped

into acid buffer solution. The colour does not therefore indicate anything about the nature of the material.

(2) *Hydrolysis*. In the Feulgen reaction the tissue is placed in $N/1$ hydrochloric acid for a few moments 'to hydrolyse the nucleic acid'. But acid is known to destroy much of the cytoplasm[2], though the nucleus remains intact for a longer time in the same circumstances. The method is, in fact, used to prepare free nuclei for analysis. An examination of finely minced tissues subjected to such treatment for varying intervals will leave no doubt that very extensive destruction of the cytoplasm occurs during hydrolysis, and will suggest that the localization of the stain in the nucleus in the Feulgen reaction may well be due to the fact that only a ghost of the cytoplasm is left after hydrolysis. Before hydrolysis both the cytoplasm and nucleus of a section stain mauve with acidified fuchsine, but after hydrolysis only the nucleus takes the stain; the appearance is then exactly the same as that of a normal Feulgen stain for such tissue.

(3) *Staining of chromosomes*. The Schiff reaction is carried out in solution. When a solid phase is present, as in the Feulgen reaction, complications due to adsorption may occur. If an adsorbing material is present which will disrupt the sulphurous acid–fuchsine compound by having a stronger attraction for the dye than the sulphurous acid, the mauve colour will reappear. This can be shown in a test-tube reaction by adding alumina to Schiff reagent, when the dye (in the coloured form) is adsorbed on the solid, even in the presence of a large excess of sulphur dioxide. As it is well known that chromosomes will adsorb and concentrate dye from a weak solution, this effect cannot be disregarded in the Feulgen reaction. In fact, the varying distribution of the Feulgen stain in chromosomes with heterochromatic regions is equally well shown by certain simple stains such as crystal violet, where only differential adsorption need be considered.

The degree to which adsorption acts in the Feulgen reaction can be found by adding a large excess of sulphur dioxide to the Feulgen stain, and staining as usual. Thus in one experiment there was more than forty times the wet weight of the section of sulphur dioxide in excess; even if the section were all nucleic acid, there was not enough to act with the sulphur dioxide present to liberate any colour. Nevertheless, a perfectly normal 'Feulgen reaction' was obtained. Similarly, if the section is pretreated with sulphur dioxide water before immersing in the stain, this sulphur dioxide will react with all the desoxyribose, and thus no further reaction can be expected when the section is placed in the decolorized fuchsine solution. In spite of the fact that no dye can thus be liberated by chemical reaction, here again a perfectly normal 'Feulgen reaction' results.

It seems clear, therefore, that neither the presence nor the location of the stain bears any relation to the presence or absence of either of the two nucleic acids, but can be merely a reflexion of the adsorbing power of the chromosomes. It should be noted that the adsorbing reactivity is only developed after hydrolysis. This different adsorbing power, with which is associated differences in the biological activities of the parts of the chromosomes, cannot therefore be proved to be due to differences in nucleic acid concentrations or different varieties of nucleic acid (ribose or desoxyribose types) by the use of the Feulgen reaction. For the demonstration of these adsorption differences in the chromosomes the use of acidified fuchsine on acid-digested material is more convenient than the complications of the Feulgen reaction using decolorized fuchsine.

All expenses in connexion with this work were borne by the British Empire Cancer Campaign.

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Viridin: a Highly Fungistatic Substance Produced by *Trichoderma viride*

The mould *Trichoderma viride* Pers. ex Fries is generally known to possess marked powers of antagonism to other fungi. It has been previously shown[1] that some strains of this mould produce gliotoxin. We have recently found a number of strains which produce another substance, which we propose to name 'viridin', characterized by remarkably high fungistatic activity.

Our viridin-producing strains of *T. viride* are characterized by the rapid production of a bright yellow colour in the culture medium, particularly in media containing nitrate, such as Czapek-Dox. In our experience, gliotoxin-producing strains of *T. viride* do not produce this pigment. We have found that if suitable pigmented strains are grown on thin layers of Weindling[2] or Raulin-Them medium, for four to six days at 25° C., the culture medium develops high fungistatic activity and may be diluted 2,000 times or more and still inhibit the germination of conidia of *Botrytis allii* Munn. The active material (viridin) has been isolated from such culture filtrates by extraction with chloroform, evaporation to dryness under reduced pressure, followed by crystallization from ethyl alcohol.

The viridin thus produced appears as colourless rod-like prisms, which decompose without melting at 217–223° C.; yields of the order of 45 mgm. per litre of culture filtrate have been obtained. The crystals contain no nitrogen, sulphur or halogens and give no ash on combustion. Analyses are given in Table 1.

Table 1.

%	Found	$C_{20}H_{16}O_6$ requires
C	68·3	68·2
H	4·7	4·6
OCH_3	8·9	8·8 (for one OCH_3)
Active H (Zerewitinoff)	0·5	0·6 (for two H)
CH_3 attached to C	3·5	4·3 (for one CH_3)
Molecular weight (depression of f.p. of bromoform)	331	352·2

Viridin is almost insoluble in ether and camphor and gives no coloration with alcoholic ferric chloride. It is optically active; for a 1 per cent solution in chloroform, $[\alpha]_D^{19}$ is $-222°$.

The addition of phloroglucinol and hydrochloric acid to a very dilute alcoholic solution of viridin gives a deep reddish-violet colour. This colour resembles that given by lignin with this reagent, and indeed we were prompted to try this reaction by a similarity between the properties of lignin and a substance obtained from viridin by reduction. By means of this test with phloroglucinol and hydrochloric acid, viridin may be distinguished from gliotoxin, which gives no colour.

TABLE 2.

Substance	Least concentration (μgm./ml.) preventing germination of *Botrytis allii* conidia
Viridin	0·005
Gliotoxin	3·0
Mercuric chloride	0·5
Di(ethylmercuri) hydrogen phosphate	0·025

Aqueous solutions of viridin at pH 3·5 prevent the germination of *B. allii* conidia at concentrations of the order of 0·005 μgm./ml. Results of a comparison with several known fungicides are given in Table 2. This high sensitivity to viridin is not confined to *B. allii*; *Fusarium* spp., *Trichothecium roseum* and *Cephalosporium* spp. have shown the same order of sensitivity, but a number of species of *Penicillium* and *Aspergillus* require concentrations of 3–6 μgm./ml. to prevent germination. Viridin does not appear to be markedly bacteriostatic.

Aqueous solutions of viridin are unstable, except at low pH. At pH 6·5, the activity of a 100 μgm./ml. solution is almost completely lost in one day, at pH 7·5 activity is lost instantaneously, but solutions at pH 3·5 are relatively stable. Gliotoxin shows a similar intolerance of high pH, but is more stable than viridin.

Some progress has been made towards the elucidation of the constitution of viridin. Work on its chemical and biological properties is being continued and our results will be reported in greater detail elsewhere.

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Abnormal Lignification in the Wood of some Apple Trees

FOR some years past, a condition generally referred to as 'rubbery wood' has been observed in many Lord Lambourne apple trees. A characteristic feature of this 'rubbery wood' is the flexibility of the affected shoots and branches, which allows them to be bent much farther than normal shoots before breaking, just as if they were composed of rubbery material. The affected branches usually taper very rapidly from base to tip. The cause of the trouble has not yet been established, but suggestions as to its origin have been put forward by several workers[1,2,3].

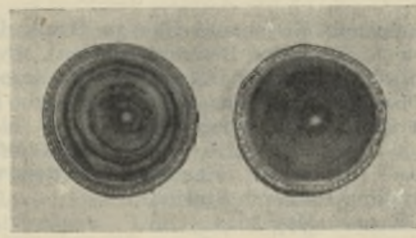

Fig. 1. MILLER'S SEEDLING. TRANSVERSE SECTIONS OF (a) NORMAL BRANCH; (b) 'RUBBERY' BRANCH. NAT. SIZE.

Histological investigations carried out at East Malling Research Station have shown that the flexibility of the stems is associated with a lack of lignification of many of the xylem fibres and vessels. Lignification appeared to be normal in one-year old lateral shoots from 'rubbery' branches, except for occasional small areas near the cambium. In older shoots, and in the main stems of one-year old trees, most of the summer wood was unlignified, the spring wood alone giving the usual reactions to lignin stains;

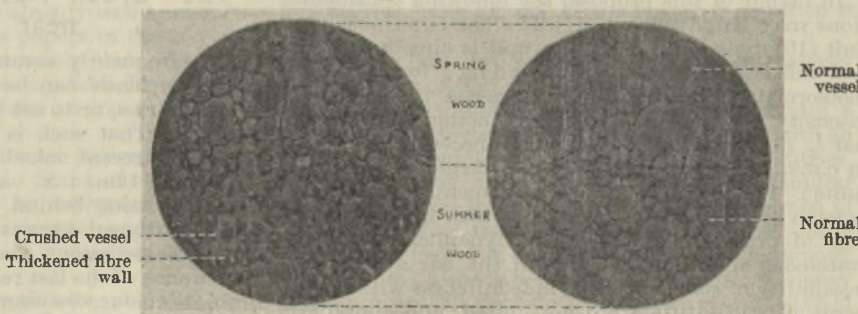

Fig. 2. LORD LAMBOURNE. STRUCTURE OF (a) 'RUBBERY' WOOD; (b) NORMAL WOOD. × 180.

but even the spring wood was found to be unlignified in some very severely affected shoots more than two years old. This lack of lignification can be seen by the naked eye when a cross-section of the wood from a living branch is suitably stained, for example, with a 0·5 per cent solution of phloroglucinol in concentrated hydrochloric acid. The pale unstained areas of unlignified tissue contrast with the red-stained normal wood; the phloem and pericycle fibres were normally lignified in all the affected specimens (Fig. 1).

In the unlignified areas the walls of the vessels and fibres gave the usual staining reactions of cellulose. The vessels had irregularly shaped walls and some had collapsed altogether (Fig. 2). The xylem fibres were more or less circular as seen in transverse section, with abnormally thick walls surrounding a very small central cavity. In general appearance they resembled the description of the gelatinous fibres of tension wood[4]. Their distribution within the stem was, however, different, since the bands of gelatinous fibres in tension wood have seldom been observed to pass round the whole stem, whereas in 'rubbery' wood they often did so.

A similar lack of lignification has recently been observed in 'rubbery' branches from trees of the apple varieties, Miller's Seedling, Dartmouth Crab and James Grieve. The affected plants of the first two varieties were growing near trees of Lord Lambourne known to be 'rubbery'.

In conclusion, we should like to thank Dr. T. Swarbrick (Long Ashton Research Station), Mr. G. M. Stuart (East of Scotland Agricultural College), and Messrs. Chandler and Dunn (Canterbury), who kindly provided some of the specimens.

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Pressure Units

THE recent communication by Dr. W. R. G. Atkins[1] directs attention to a considerable amount of confusion which still exists in statements of numerical results and constants. I suggest that one major change which is desirable is to adopt the bar as the unit of pressure in place of the millimetre of mercury.

In favour of this proposal the following considerations may be advanced: (1) The bar is an absolute unit (10^6 dyne cm.$^{-2}$). (2) The unit is already in use, and this use appears to be extending; for example, meteorological readings are expressed in millibars, intensity of sound in dyne cm.$^{-2}$, compressibility in bar^{-1}. (3) In calculations it is often necessary to work in C.G.S. units, involving the conversion of mercury units; for example, in measurements of surface tension or viscosity by methods which involve readings of pressure, and in thermodynamics. (4) The statement of results in terms of the bar avoids the possibility of some degree of indefiniteness when temperature and latitude are not stated, and simplifies statements by removing the necessity for specifying such conditions. (5) The present time presents probably the most favourable opportunity for making such a change, as a large number of new text-books, and revisions of older works, may be expected shortly. (The proposal would fit in with the suggestion made by F. H. Townsend[2] for a new system of high-vacuum units, which could be based on the millibar.)

Against the proposal are the following points. (1) Measurements of pressure are often (but not always) made by means of manometric pressure gauges. (2) A large number of physical and chemical constants are already calculated in terms of mercury pressure.

In answer to the first objection it may be suggested that as, for accurate work, it is necessary in any event to correct for temperature and gravity, no extra labour is involved, since the product of the density of the manometric fluid at a standard temperature and g would be a constant of the apparatus. It would appear to be as easy for an apparatus maker to graduate a mercury gauge in millibars as in millimetres.

With regard to the second point, the constants concerned include: (*a*) A comparatively small number of important constants, such as the gas constant for particular gases, and related constants, which could be converted very simply; for example, the volume per mol. of a perfect gas becomes 22,712 c.c. at one bar, instead of 22,415 c.c. at 760 mm. (*b*) A larger number of readings of vapour pressures, etc., where the measured constant is itself a pressure. Pressures given in reference tables would have to be converted to millibars, etc., and this labour might present the chief obstacle to the adoption of the proposal. (*c*) A very large number of constants, including the International Temperature Scale and tables of boiling-points, the values of which depend on pressure and are given for a specified pressure. In most cases there is no need to recalculate these quantities immediately—they can be quoted for 1·01323 bar instead of for "760 mm. Hg at 0° C. and lat. 45°."

Finally, for approximate conversion from units of mercury pressure to absolute units, it may be noted that 1 bar is equivalent to 750·08 mm. of mercury (approx. 75 cm.—a point which may interest those who teach elementary science).

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[1] Atkins, W. R. G., *Nature*, **155**, 361 (1945).
[2] Townsend, F. H., *Nature*, **155**, 545 (1945).

The 'Green Flash' at Sunset with a near 'Horizon'

IT is frequently assumed that the phenomenon of the 'green flash' can be observed only when the sun is seen to rise, or to set behind a distant land- or sea-horizon. That such is not the case, the following report of a recent naked-eye observation will confirm.

At 20h. 12m. U.T. on June 20, 1945, I observed the sun setting behind the horizontal roof-line of a building distant approximately 440 yards from the site of observation. Immediately prior to the disappearance of the last remaining segment of the sun's limb, its colour was seen to change from light orange-yellow, through yellowish-green, to a distinct, but pale, green. At the instant of disappearance I observed the rapidly diminishing bead of sunlight to assume a just perceptible blue-green hue. On account of the large parallax introduced by the short distance from the artificial horizon, it was possible to repeat the observation by standing on tiptoe. The complete sequence of colour changes occurred in a time interval estimated to last from one quarter to one half of one second. It was noted that each of the transient colours was markedly less saturated than those which I had observed against a distant land-horizon on several occasions during the summer of 1940 from the summit of Mount Hamilton, California.

A rough estimate indicated that the altitude of the terrestrial obstacle was rather less than one degree above the true horizon on a bearing due north-west. On the evening in question there was a light southerly wind with a cloud cover of 2/10–3/10 *Ci*, the sky in the direction of the sun being entirely free from cloud. Horizontal visibility was excellent; I estimated the range to be in excess of ten miles.

Using an opera-glass to screen off unwanted light, Whitmell[1] has reported an observation of the green flash with the 'horizon' distant only 300 yards, but I have not been successful in finding any reference to naked-eye observations over so short a range as that recorded in the present note.

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[1] Whitmell, C. T., *J. Brit. Ast. Assoc.*, **12**, 289 (1902).

VISCOSITY OF LIQUIDS AND COLLOIDAL SOLUTIONS

IN 1940 there was held in Moscow, under the auspices of the Academy of Sciences, a conference on "Friction and Wear in Machinery". At this conference it was decided to hold a further conference, in the following year, on "Viscosity of Liquids and Colloidal Solutions". This took place just before the German invasion and only a part of the proceedings (one volume) was published before the serious events of the first months of war made further publication temporarily impossible. The second volume finally appeared in a war-time format, in 1944 (Moscow and Leningrad: Academy of Sciences, 1941 and 1944).

The subject-matter is divided into four separate sections: (1) theory of viscosity of liquids; (2) viscosity of greases; (3) viscosity of molten materials at high temperatures; (4) viscosity of colloidal solutions. The first section is under the general editorship of Prof. B. V. Deryagin, the second of Prof. D. S. Velikovskiĭ and the third and fourth of Prof. M. P. Volarovich, who is already well known to British rheologists through his papers in the *Kolloid Zeitschrift* dealing with an extremely wide range of materials. The two volumes contain more than seventy papers in Russian; there are no summaries in other languages.

Typically, there was no divorce between theory and practice at the conference. Some of the papers are highly theoretical, with an advanced mathematical approach: others describe experimental studies on practical problems of immediate importance in industry.

Frenkel' provides two papers showing the relationship between current theories of liquid structure. There is also a short general note by Bachinskiĭ. Shirokov studies viscosity (η) as a wave phenomenon and deals with the theoretical aspects of heat conductivity. He also discusses the phenomenon of superfluidity, on which Kapitza provides an experimental paper on liquid helium; and Landau, a short discussion on quantum lines.

A theoretical study of the effect of magnetic and electric fields on the viscosity of anisotropic liquids and molecular orientation is given by Tsvetkov; and Chernyuk has extended the work of Sokolov and Sosinskiĭ[1] on the influence of static fields on the viscosity of organic liquids. In almost all the materials studied, there is an increase in viscosity with increasing field strength. Dombrovskiĭ shows marked increases in viscosity over a wide temperature range as a result of sound-wave and ultrasonic radiation. In the case of oils, Panchenkov increases viscosity by radiation with 'ultra-short' electromagnetic radiation and by electrode-less high-frequency discharge. The chemical factors concerned are discussed and precautions are described to prevent overheating resulting in cracking of the oil.

The temperature- and pressure-coefficients of viscosity are dealt with by a number of authors. Kobeko, Kuvshinskiĭ and Shishkin give $\log \eta / \frac{1}{T}$ curves for ether, alcohols and glycerine and many salt solutions (T is absolute temperature). On the whole, they conclude that existing theory is inadequate and that an entirely new theory of liquid structure is required. Ramaya gets remarkably good linearity plotting temperature- against pressure-coefficients for lubricating oils.

Liquid mixture laws are dealt with by many authors. Luchinskiĭ develops an extension of the Bachinskiĭ equation which proves satisfactory for chloroform-benzol and sulphuric acid-toluol mixtures. Frenkel' discusses the general theory, and Voskresenskaya, Ravich and Shternina its application to physico-chemical analysis. Udovenko distinguishes 'rational' and 'irrational' systems. For the former, isotherms can be resolved into two hyperbolic curves: for the latter the log η/temperature curve for the mixture shows no correlation with those of the components. Usanovich stresses the advantages of differentiating S-shaped mixture-curves, thus obtaining curves with simple maxima.

Single-figure expressions for viscosity-temperature cœfficients of oils are badly needed. The 'viscosity index' comes in for considerable criticism, especially from Peĭsakhodina, Shne'erova and Tarmanyan working at low temperatures. Velikovskiĭ discusses the use of the Walther equation. There is also a useful technological paper by Zherdeva, Vozzhinskaya and Fedose'eva. The history of the $\log \eta / \frac{1}{T}$ equation is given very fully by Volarovich in a general survey of the theory of liquid structure.

On the instrumental side, Volarovich provides a survey of viscometers for petroleum products, with an excellent bibliography of papers from many countries. It appears that Soviet workers are more familiar with British and American work than British men of science are with the Russian; and the need for a wider knowledge of the Russian language among British rheologists is here strongly evident. Golenev gives comparative data for viscometers of the Ostwald and Engler types, and Shvidkovskiĭ develops further the earlier analyses of Andrade and Chiong[2] and Andrade and Rotherham[3] on the Meyer viscometer[4], a hollow cylinder containing liquid, hung on a torsion wire. A capillary viscometer suitable for oil and the choice of oil viscosity standards are discussed by Pinkevich. Deryagin and Samygin measure the viscosity of polymolecular films of liquids by observing the movement of air bubbles in the annular space between concentric sealed tubes under varying intensities of centrifugal force. There are three papers by Trapeznikov on monolayer viscosity, one of which shows complex curves relating η to stress and log η to temperature for high alcohols. Limar' describes an apparatus to measure the pumping properties of oil and discusses the relation between these and viscosity; and Ramaya regards the viscosity of oil containing added substances as analytically composed of two parts, a Newtonian and a thixotropic component.

The second section, on grease, contains a number of excellent papers. Greases are such complex systems that it is hard to find any single factor to describe consistency even for comparative industrial purposes. The work of Arveson[5] and of Blott and Samuel[6] is widely quoted. Varentsov uses the Scott Blair[7] emptying tube viscometer. He plots the wall stress against $4/RT$ where R is radius and T is the time taken for the meniscus to pass unit length of the tube. This is simpler than the usual method of plotting, which involves the difference in the squares of the initial length of the column and that at the time in question. Even plotting log-log gives complex curves, and the use of the method is restricted to low pressures and for comparative purposes. Velikovskiĭ uses the same method. He prefers to designate the consistency of grease by its 'mechanical equivalent', that is, the viscosity of an oil which requires the same force to produce an equal rate of flow under arbitrarily fixed conditions. Varentsov also calculates a shear modulus (γ) from Philippoff's[8] modification of the Eisenschitz formula :

$$\eta' = \eta_\infty + \frac{\eta_0 - \eta_\infty}{1 + \frac{2}{3} \cdot \frac{P^2}{\gamma^2}}$$

where η' is observed viscosity; η_0 and η_∞ are limiting viscosities at low and high shear rates; P is pressure.

There are also a number of useful technological papers on the rheology of greases. Rebinder, Boguslavskaya and Moki'evskiĭ find that the yield-value is independent of capillary radius which serves as a useful criterion of consistency.

There has been considerable discussion between British and American rheologists on the nomenclature of consistency of non-Newtonian systems. Velikovskiĭ proposes to use the term 'internal friction' (*Vnutrene'e treni'e*) to describe the ratio of shear stress to rate of shear when this is not independent of stress or shear rate, but the symbol η is used for both this and (constant) viscosity.

The section on molten lavas, melts and slags is perhaps rather less interesting, the data consisting mainly of viscosity-temperature curves with little theoretical comment. Exceptions are papers by Volarovich, who discusses the relative merits of various viscometers for molten metals and silicates; Kozakevich, Leĭba and Komar' (binary and ternary mixtures of FeO, CaO and SiO_2); and Semik, who studies the effect of addition of bases on the anomalous viscosity of surface layers of steel foundry slags. There are four good papers on the viscometry (mainly rotational instruments) of molten glasses : Fromberg, Tsyplēnkova and Rabinovich; Oshchipkov and Rabinovich; Solomin; and Kumanin, Fizhenko and Zelichēnok.

In the colloid section, there are two excellent papers on theoretical rheology by Finkel'shteĭn and Chursin, and by Rebinder; the former deals with extensions to the Einstein equation and the latter relates colloidal structure to types of flow curves. On the technological side, Branopol'skaya has a good paper on the rotation-viscometry of flour doughs, and Ravich gets a linear relation between η of high fatty acids and iodine number. There are also papers on the rheology of high polymers (Kargin and Slonimskiĭ), casein (D'yachenko), bitumens (Korotkevich) and coal tars (Kustov and Khotuntsēv). Kulakov is already known to rheologists interested in peat, and he contributes a paper on the relative merits of capillary, rotation and ball viscometers for this material. The first two methods are preferred to the ball. Serb-Serbina and Baranov have articles on the influence of electrolytes on the viscosity of clay suspensions.

In so brief a survey, one can do no more than sketch in the outlines of the contents of these books: many papers cannot even be mentioned. It is a pity that the whole proceedings cannot be translated into English. The conference undoubtedly marked a milestone in the progress of rheology, and it is to be hoped that when the War ends, language difficulties will not hinder a closer co-operation and understanding between British, American and Soviet rheologists as well as workers in the smaller countries.

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[1] Sokolov, P., and Sosinskiĭ, S., *Acta Physicochim. USSR.*, **5**, 691 (1936).

[2] Andrade, E. N. da C., and Chiong, Y. S., *Proc. Phys. Soc. Lond.*, **48**, 247 (1936).

[3] Andrade, E. N. da C., and Rotherham, L., *Proc. Phys. Soc. Lond.*, **48**, 261 (1936).

[4] Meyer, O. E., *Wied. Annal.*, **43**, 1 (1891).

[5] Arveson, M. H., *Ind. Eng. Chem.*, **24**, 71 (1932).

[6] Blott, J. F. T., and Samuel, D. L., *Ind. Eng. Chem.*, **32**, 68 (1940).

[7] Scott Blair, G. W., *Koll. Z.*, **78**, 19 (1937).

[8] Philippoff, W., *Koll. Z.*, **71**, 1 (1935).

HEALTH RESEARCH IN INDUSTRY

THE health of the industrial worker has recently been the subject of a number of articles in the medical Press, and various aspects of it have been also discussed by medical societies. Attention has been directed to it by the endowment by the Nuffield Foundation of three university departments of industrial health; and the national importance of this field of study is further emphasized by the issue this year of two important publications. These are the second interim report of the Social and Preventive Committee of the Royal College of Physicians of London and the Medical Research Council's publication entitled "Health Research in Industry", which records the proceedings of a conference on industrial health held at the London School of Tropical Medicine during September 1944.

The report of the Committee of the Royal College of Physicians is part of this Committee's study of social and preventive medicine. Its first interim report dealt with the applications of this study in the hospital. This second interim report is the first step in the study of social medicine outside the hospital. As the *British Medical Journal* (194, Feb. 10, 1945) points out, this report fills a very obvious gap, because the Government's White Paper on national health does no more than state the present position of industrial health and does that in no more than one short paragraph and an appendix. If, says this second interim report of the Royal College of Physicians, the Government's plans for the establishment of a sense of social security are to succeed, industrial production must be efficient; and efficient production requires contented workers, and they cannot be contented unless they are physically and mentally fit. A third of the working years of most workers is spent in the places where they work, and their working and home life affect each other so profoundly that each individual's whole life must be considered.

This Committee prefaces its recommendations by a useful outline of the development of British industrial medicine. Existing industrial medical services apply only to a small proportion of industrial workers at their places of work. It is in the smaller factories that it is usually difficult to maintain good working conditions. Factory inspectors, both lay and medical, have done magnificent work, but four hundred inspectors (including the sixteen medical ones) and the two hundred whole-time and seven hundred part-time works doctors cannot adequately supervise the health of the 250,000 establishments covered by the Factories Act of 1937. The Factories Acts do not apply to many industries and to others only certain sections of them apply. Some large businesses and some transport services (for example, railways and docks) have their own works doctors ; but medical services are most deficient outside factories where they are needed most. Existing services are not adequately co-ordinated. Control is shared by the Home Office and Ministry of Labour, while the Ministries of Supply and of Fuel and Power have their own independent medical services, and other new Ministries may create theirs. A national comprehensive industrial medical service is required ; it should be organized on a regional basis as an essential part of the national health service, with ultimate responsibility vested in the Ministry of Health, although certain administrative and executive functions would no doubt have to be allocated to the Ministry of Labour and National Service, the Ministries of Fuel and Power and of War Transport and the General Post Office. The Committee hopes that the Government will not adhere to its temporary exclusion of industry from its national health scheme, which lays a just emphasis on the family as a unit for medical care and extends medical care to the home as well as to the place of work.

Everyone will agree with this Committee's strong plea for much better medical care for smaller industries, such as hotels, restaurants, shops, offices, the building trade and agriculture ; and for recognition of the fact that occupational disability and disease cause only a fraction of the total illness of the workers, who lose about fifteen times as many working hours as the result of non-industrial sickness and accident as they lose from industrial causes of disability ; this estimate excludes, moreover, the considerable effects of subnormal health. Much preventable disease is due to factors operating outside the place of work, such as bad housing, economic stress and lack of health education. Continuous medical investigation is necessary and the co-operation of the management is important. Rehabilitation, which has figured largely in the medical Press recently, is emphasized by this Committee, which strongly support the Government's White Paper on Workmen's Compensation (Cmd. 6551), which would do much to establish rehabilitation as part of the national health scheme.

In its discussion of the planning of the education of medical men for industrial health work the Committee refers to its first interim report, repeating that the medical student is not expected to become an expert on occupational diseases, but should understand the social problems involved and should recognize the effects of fatigue, overwork, monotony and other factors causing ill-health in industry ; he should therefore visit factories and should have good and bad working conditions demonstrated to him. Here the reader of this report is reminded of the Goodenough Report on Medical Schools (*Nature*, **154**, 315 and 322, Sept. 9, 1944). The family doctor should, the Committee of the Royal College of Physicians thinks, be trained as a part-time industrial medical officer, and periodical refresher courses on this subject should be available for him. More extensive training is planned for whole-time industrial medical officers ; this should not be too specialized and should not be taken until two years after graduation and after one year of general practice. Consultants and specialists should be subject to the criteria for the recognition of consultants and specialists laid down by the three Royal Colleges.

The section on research with which this report concludes links it with the Medical Research Council's publication mentioned above, which outlines the development of the Industrial Health Research Board of the Medical Research Council. The Committee of the Royal College of Physicians commends the work of this Board and its parent organizations and wishes that work to continue. The Board should, this Committee thinks, tackle problems of national significance and also problems which cannot be undertaken by other research organizations. Fundamental research should not be neglected ; it should be done by the university departments of industrial health which are now being created, and these should correlate their work with that of the Industrial Health Research Board and with that of the local factory department. Coordinated with all these there should be, in each local administrative area set up under the national health scheme, a division for field investigation.

The work of the Industrial Health Research Board was reviewed at the conference mentioned above by Sir Edward Mellanby, secretary of the Medical Research Council. Sir Edward commended another review of it by Dr. Schelling in the *British Journal of Industrial Medicine* (**1**, 145 ; 1944). Reconstituted in 1942 by the Medical Research Council, the Industrial Health Research Board was given the study of the whole field of industrial medicine and disease, and it is expected that it will act in an advisory capacity in relation to all the problems being studied by the Medical Research Council itself. The Medical Research Council has organized much work on industrial health. During the War much research has been done for all the Fighting Services, and many of the principles learned during this work can be applied to industry. As examples of this application Sir Edward referred to the work done on blood transfusion, on traumatic shock, and on the problem of fitting men to the machines which they have to use and of fitting the machines to the workers.

The problem of recording causes of sickness absence in industry is fundamentally important. The Industrial Health Research Board's Report No. 85 (1944) deals with this problem, while Report No. 86 (1945) records a study of certified sickness absence among women in industry. Certified sickness absence for two or more days was studied in five munition factories, but uncertified sickness absence, which may or may not be genuine, was excluded. Other reports on this subject are to follow and they will include the views of the workers themselves. Other problems being studied are night work, atmospheric pollution in filling factories, new methods of sampling T.N.T., the efficiency of dust-sampling instruments, lighting problems and the incidence of psychoneurosis. Another example of the work of the Medical Research Council which has valuable applications to industry is the valuable report recently issued on the treatment of burns and scalds (Med. Res. Council Spec. Rep. Ser., No. 249, 1944. H.M. Stationery Office, 4*s*. net). This work records the conclusions drawn from observations made during recent years by the Medical Research Council's Burns Unit working at Glasgow Royal Infirmary. Another unit is working at Birmingham on infections to which injured industrial workers are liable.

The work of the Department for Research on Industrial Medicine, which was set up at the London Hospital by the Medical Research Council, was described to the conference by its director, Dr. Donald Hunter, who also edits the *British Journal of*

Industrial Medicine. An article by Dr. Hunter on industrial poisons was reviewed in *Nature* of April 1, 1944, p. 412; but Dr. Hunter pointed out that industrial poisons form only a relatively small part of the field of industrial medicine. His department is also studying the effects of inhalation of asbestos and other dusts, the 'dead hand' from which users of pneumatic tools often suffer and the effects of some of the appalling industrial noises, such as that which has made generations of boiler-makers deaf. Dr. Hunter also discussed rehabilitation, pointing out that many jobs can be done by men with chronic disease of the heart, lungs and nervous system and quoting Henry Ford's remark that there are more jobs in industry for men with one arm than for men with two.

The views of enlightened managers were given to the conference by Lord Forrester, managing director of the Enfield Cable Works, Ltd., and a distinguished worker in industrial and social fields, who emphasized the importance of a healthy environment for the workers and of a right integration of industry with the community to which it belongs. Research into management and the teaching of management are also required. Research teams composed of young men are essential and Lord Forrester suggested problems for them. One of these is the problem of posture in industry. The position of the operator is considered in the construction of tanks and aeroplanes, but surprisingly little attention has been given to it in industry. In the discussion which followed Lord Forrester's address, Sir Wilfrid Garrett, chief inspector of factories, told the conference that a committee has recently been appointed to study this problem. Lord Forrester thought that we need a better system of keeping industrial health records. We should abandon all systems of calculating working time in hours per day or week; we should think in terms of at least a year. Shift work is another problem requiring study; the worker should have the right kind of food, and time and leisure to eat it in suitable surroundings. Sanitation and hygiene are of high significance; yet the very important question of lavatory design is almost universally ignored. The town planner, the industrialist and the industrial health expert must get together to study the problem of the environment of industry itself. The smoking chimney and similar sins must go. Loss of green sward has important effects on the health of the people. Industry need no longer disfigure the land, or pollute its atmosphere and rivers; nor need its physical appearance be an abomination.

The point of view of the trades unions was put to the conference by Mr. G. A. Isaacs, general secretary of the National Society of Operative Printers and Assistants and president of the Printing and Kindred Trades Federation, chairman of the Workmen's Compensation and Factories Committee of the Trades Union Congress, and a member of the Royal Commission on Workmen's Compensation. He pointed out that the trades unions have studied industrial health for many years and gave examples of the improvements which they have achieved by their own efforts. He did not wish it to be thought that he was complaining about the work of the Home Office and Factory Department of the Ministry of Labour, which had, he insisted, done good work and had often acted when the Trades Union Congress had little information; but they had not the complete research organization which the trades unions considered essential. Research should have ample money, staff and equipment. Eradication of industrial health risks was required, not mere recognition of and compensation for them. Prompt, accurate and scientific decisions were required as to what were and what were not occupational diseases; such decisions should not be subject to argument in a court of law. The worry caused to workers by industrial injuries had been revealed in conferences called by the trades unions. Workers would always willingly help research. Mr. Isaacs suggested that more work was needed on the effects of industrial fumes and dusts, on ventilation and lighting, on the effects of monotony, fatigue and noise and on the risks of welding. He stressed, as Lord Forrester also did, the need for communicating the results of research to the workers themselves in language which they could understand.

At the final session of this conference Dr. K. J. W. Craik described the work of the Cambridge Unit of Applied Psychology, of which he was director until his untimely death on May 7. This Unit has been studying problems arising from the needs of the Services, but some of the principles learned during this work can be applied to industry. There are, for example, the problems of suiting the job to the man, suiting the man to the job and improving performance. The problem of suiting the man to the job includes the study of the design of machinery and instruments and their lay-out and illumination by maps, panels and so forth. The position, forces and gear ratios of handles, levers and other forms of control are being studied, together with methods of getting the best results in jobs of a boring but responsible nature. The effects of fatigue, discomfort and noise and the intellectual aspects of industrial work also need study. This Unit has attached to it an Industrial Research Board team which has devised tests of mechanical ability and of performance and other qualities; it is studying night vision, the capacities of blinded officers, problems of the special senses and temperamental differences in the ability to control machinery. For the study of the improvement of performance it has invented devices which will be useful in industry after the War. A new type of recording system has been invented for the tracing of causes of absenteeism, sickness and accidents, and this is being established in a group of coal mines and in two factories. This Unit hopes for the collaboration of the National Institute of Industrial Psychology and other bodies doing similar work and with managers, safety officers and medical men. The Unit has a scheme by which factories send to Cambridge representatives who can be trained there to study their problems in their own factories.

It will be clear from this brief summary of the contents of the important publications mentioned that carefully thought-out plans exist for the amelioration and eventual eradication, wherever this is possible, of industrial health risks. It is evident that the workers will help industrial health research by every means in their power and that the medical profession and many managers are no less eager to solve this national problem. Not the least important of its many aspects is the one to which Sir Edward Mellanby referred. Much valuable information was obtained in the interval between 1918 and 1939, but this information was largely left unnoticed until the present War began. Then its value became widely recognized and industrial health research is now considered essential. Sir Edward warned us that this may be only a war reaction. We must, he insisted, see to it that all who are concerned with industry do not cease, after the War, the efforts they are now making to create an efficient industry based on the health and contentment of the industrial worker. G. LAPAGE.

USE OF TREES AND SHRUBS AS FOOD FOR CATTLE

IN many parts of the British Empire, the feeding of excessive numbers of low-grade stock has become a serious problem, not only for the forester but also for the agriculturalist. In an article in the *Indian Forester* (Civ. and Milit. Gazette, Lahore, Dec. 1944), J. A. Wilson, of the Madras Forest Service, discusses the place of fodder from trees and shrubs in the "Agricultural and Forestry Economy of Madras", a problem to which many of the newly founded soil conservation committees in the Colonies and elsewhere will have to give serious consideration.

It has been the practice in India in the hot-weather season and during serious famines to look to the forest for fodder for the villagers' often large herds of a very low type of cattle; the animals browsing on the trees, shrubs and young regeneration. "In common with the rest of India," Mr. Wilson writes, "the cattle population of Madras is excessive; especially is this so in dry areas and areas of reserved forest, where cattle of low efficiency and little value can eke out a living at extremely low cost. . . . The concentration of scrub cattle in such areas, combined with the extension of agriculture to absorb waste lands, previously at the disposal of the cattle, has resulted in the complete denudation of grass cover over vast areas, except during the relatively short monsoon period. In the reserved forest of the dry districts also, the pressure of the grazing animals is high, and marginal areas are for the most part badly overgrazed. While the agriculturalist provides for his utility animals during the hot weather he cannot afford to do so for his scrub animals. From February onwards therefore they have to depend on whatever cheap fodder they can pick up." From March onwards trees and shrubs put on new foliage, and the forest by the dual acts of browsing and lopping has to suffer to keep this low-grade stock alive.

It has long been the aim and the policy of the forest officer in India to bring to an end this gradual degradation and impoverishment of the forests, annually overgrazed under more or less direct orders from the civil government. The necessity, in the economic gain, for this long-continued practice is now being called in question, and not in India alone. More up-to-date management of the cattle is being considered, based on a sound soil and water conservation policy in all dry districts; improved pasture management over extensive areas of grazing grounds, involving a limitation of the head of cattle using the area and rotational closing; the storing of surplus monsoon fodder in hayricks and barns or by the preparation of ensilage.

In *La Forêt Quebecoise* (**9**, Jan. 1, 1945, Quebec), after an interesting account of the advent from Europe to New York and eventually to Quebec of the elm disease and the large loss of trees sustained, an author has a most valuable article on this question of forest pasturage under the title "Méfaits du paturage" with some excellent illustrations, which demonstrate his contention that unchecked grazing and browsing in a forest means its ultimate extinction owing to the impossibility of maintaining successful regeneration to replace the old trees. "La Forêt," says the author, "ne peut servir de paturage et rester en même temps productive. Soumise à cette pratique désastreuse elle abandonne infailliblement sa fonction principale qui est de produire du bois ou de la sève, et elle ne fournit en même temps qu'une pâture de bien pauvre qualité."

ELECTROMECHANICAL ANALOGIES

ELECTROMECHANICAL analogies and their use for the analysis of mechanical and electromechanical systems form the subject of an interesting paper (*J. Inst. Elec. Eng.*, **92**, Pt. 2, No. 52; April 1945) by Dr. A. Bloch. After some introductory remarks which outline the problem and special features of its treatment, the author explains how the complex notation and the impedance concept can be applied directly to the analysis of mechanical systems. This leads naturally to the first or 'direct' method of constructing an electrical 'model' of a mechanical system, where a mechanical force is represented by a voltage, and a mechanical impedance, that is, the ratio of a force to a velocity, is then represented by a proportional electrical impedance. In this analogy a mass is represented by an inductance. It is shown that this representation, when established for one particular frequency, is valid for all other frequencies.

There exists a perfectly consistent alternative method of constructing such an electrical model in which all these correspondences are replaced by their dual counterparts and which is therefore called the 'indirect' or 'inverse' analogy. A mechanical force is here represented by an electric current and a mechanical velocity by a voltage. Accordingly, a mechanical impedance is then represented by an electrical admittance of proportional magnitude; in particular, a mass is represented by a capacitance. This analogy has the advantage that it enables a circuit diagram of the electrical model to be copied from the diagram of the mechanical system, if this be drawn in accordance with certain conventions. The circuit diagram found by this method is the dual of the circuit found by the first method; and as it is a routine procedure to draw the dual of a given network, the second analogy may also be useful when utilizing the first type of analogy.

The paper supplements the development of this method by showing how levers fall into the general scheme of this geometrical correspondence if they be interpreted as auto-transformers. It also shows how the circuits of both these analogies may be found with advantage by an alternative method, that of a 'method of successive generalization' of simplified systems—again without the need of establishing the equations of performance of the system. When the circuit of the inverse analogy cannot be drawn in a plane without crossing between its branches, certain difficulties arise the solution of which is dealt with in a separate paper to be published elsewhere.

Combined electrical and mechanical systems are next discussed in the paper. If the mechanical system is represented by an electrical model, then the electromechanical converter which links it to the electrical system can usually be replaced by a passive electrical four-terminal network (provided the right type of analogy be chosen for constructing the model), and in this way a purely electrical system is reached. The type of analogy to be chosen is the direct one if the electromechanical converter utilizes the action of the electrostatic forces, and the inverse analogy if the converter utilizes electromagnetic forces. Two appendixes give examples of the application of these methods to the treatment of purely mechanical and of electromechanical systems.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

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LECTURER IN ORGANIC CHEMISTRY, and a LECTURER in either ANALYTICAL CHEMISTRY or PHYSICAL CHEMISTRY—The Registrar, King's College, Newcastle-upon-Tyne (August 11).

TEACHERS (2) OF MECHANICAL ENGINEERING SUBJECTS to Higher National Certificate standard, in the East Ham Technical College—The Chief Education Officer, Education Office, Town Hall Annexe, Barking Road, London, E.6 (August 11).

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REPORTS and other PUBLICATIONS

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Medical Research Council. Special Report Series, No. 252: Hæmoglobin Levels in Great Britain in 1943 (with Observations upon Serum Protein Levels). By the Committee on Hæmoglobin Surveys. Pp. vi+128. (London: H.M. Stationery Office, 1945.) 2*s*. net. [47

Research: a Review of the Possibilities of Research as a Spare-time Occupation for Higher Degrees and other Purposes. (Publication No. 7a.) Pp. 16. (London: Advisory Bureau for Research, 1945.) 1*s*. 3*d*. net. [57

Recommended Technique for making Fillet Welds in the Downhand, Vertical and Overhead Positions. (T. 13a.) Revised edition. Pp. 8. (London: British Welding Research Association, 1945.) [137

Freshwater Biological Association of the British Empire. Scientific Publication No. 10: On Statistical Treatment of the Results of Parallel Trials with special reference to Fishery Research. By H. J. Buchanan-Wollaston. Pp. 55. (Ambleside: Freshwater Biological Association, 1945.) 2*s*. 6*d*. [177

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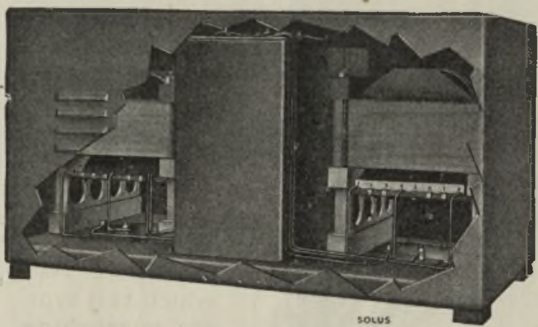

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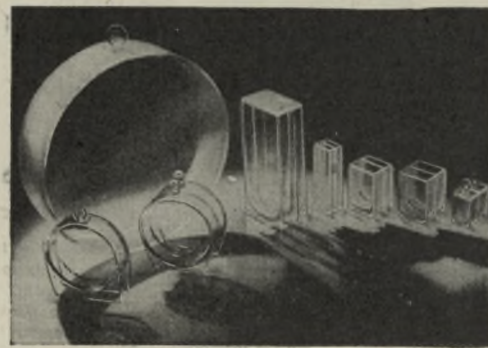

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