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EDITORIAL

The Food Group

SIR JOHN ORR in his Jubilee Memorial Lecture told us that in what we call the civilized countries of Europe, the United States, and the British Dominions, the diets of between 25 and 50 per cent of families fall below the standard necessary to maintain efficiency. The health and physique of about one third of our population is far below what it might be. Ignorance and carelessness are partly responsible, but the main factor is poverty.

We gather that one third of this nation could be made more efficient physically and mentally if the food of the nation could be available in better quantity and quality. Can we as a nation afford this huge volume of inefficiency? Could any chemical manufacturer afford so uneconomic a condition of his plant and machinery? Taking the lowest point of view, it is probably true that the prosperity of the nation depends on the efficiency of the inhabitants. "Not houses finely roofed or the stones of walls well-builded, nay, nor canals and dock-yards make the city, but men able to use their opportunity." The Food Group of the Society is doing a useful piece of work in studying the great number of problems connected with food and in publishing papers by experts in its Journal and in the annual volume of its Proceedings. The second volume of Proceedings has just been published; it is a valuable contribution to the great mass of literature on the biochemistry of food that accumulates every year, for it gives us in a convenient and readable form summaries of several researches on the great problems of diet. The first volume of these Proceedings was an experiment; it was so successful that the second volume has been authorized and under the editorship of Dr. Theodore Rendle has made its appearance. The majority of the papers included in this volume were published in CHEMISTRY AND INDUSTRY. Readers need not assume from this fact that such papers were inferior in importance to those published in the Society's Transactions. They were published in CHEMISTRY AND INDUSTRY in several instances because in this journal it is possible to publish at short notice a paper that has not been read but will be discussed at a meeting a few days thereafter. The second volume of the Proceedings is about the size of the first volume and contains rather more than a hundred pages of the same size as this journal. Twenty-two papers read before the Food Group or the Nutrition Panel of the Food Group are included in the volume together with a few brief articles in lighter vein that appeared in our columns on the occasion of some noteworthy paper or visit.

It is sad to read about the visits of the Food Group to Holland and Denmark and to think of the unhappy fate of those countries. It is a miserable experience that our colleagues are now enduring; we shall do our best to give them such help and sympathy as we can and in due course prosperity will again visit them. The history of many countries throughout many centuries shows that in spite of cruelty, destruction, and all the ravages of war there are great probabilities of recuperation. Athens was rendered uninhabitable by Xerxes and the terrified population had to leave the city that was so dear to them; shortly afterwards the Greek fleet won an important naval engagement and after a comparatively brief interval the exiles returned and soon the city reached its greatest state of importance and magnificence. The command of the sea is not to be despised even at the present time. A large part of France and the whole of Belgium were savagely treated during the last Great War; in spite of the terrible destruction of life and property it was not long after the war that prosperity returned. Spain and many other countries give examples that show that so long as faith and hope exist the calamity, terrible as it is, will not endure for ever.

Food Science in the Future

We publish in this issue the Jubilee Memorial Lecture delivered by Sir John Orr in London on January 10, in Liverpool on February 2, and in Glasgow on March 1. It is a most important address and deserves very wide publicity, a greater publicity than can be attained by this Journal alone.

By what means it should be brought to the notice of members of Parliament, Lord Mayors and Mayors, Provosts, County Councils, Town Councils, and the country as a whole we do not know but we think that, even at the present time, it deserves a greater circulation than any paper that we have been privileged to publish during recent years. It deals with the main principles of the great food problem of this country and avoids those technical and scientific details that can only be understood by those who have been trained in biochemistry. There is not a paragraph in it that cannot be read by every intelligent man and woman. There are few people, however well educated, who will read this paper without learning something new, who will not find some well-known facts better expressed, in simpler language, than ever before, and from which they can draw abundant conclusions of great importance to the nation. Such a general survey is in our opinion much needed, for as Sir John points out the present volume of research on the biochemistry of food is too vast to be assimilated even by biochemists. More than three thousand papers on this subject, giving the results of original research, are published every year; the segregation of chemists into relatively small groups with common interests, prevents them from exercising the influence that is essential if the results of their labours are to be applied for the improvement of the nutrition of the people.

Many of us who read this paper do not realize so definitely as we should that mental depression—which does not mean merely low spirits—is a characteristic of most of the deficiency diseases and is much more common among the children of the poorest classes than it need be. Evidence has accumulated in the last two decades that shows that, even in the wealthiest classes, physical and psychological well-being could be greatly increased by improved feeding. Conditions are already improving. In the United Kingdom there has been a remarkable improvement in the national diet in recent years. This improvement has been accompanied by a great reduction in the gross forms of deficiency diseases, such as rickets, scurvy in infants, and xerophthalmia, a reduction of about fifty per cent in the infant mortality rate and the tuberculosis death rate, and an increase in height of about two inches in children leaving school. In spite of this the health and physique of about one-third of our population is far below what it might be. Sir John tells us that the enormous powers which science has released can be used to wreck the present civilization. They could also be used to build up a new and better civilization, but they cannot be used for this end unless scientists themselves realize their enormous responsibilities and unite in a common endeavour to use their influence to have "the advancement of real knowledge" applied "for the benefit of human life." If they do that, they can guide the world to a better future, planned in accordance with truth to which alone scientists acknowledge allegiance.

So let us do what we can to attain this end in a civilized determined way, not like Hitler, in hope to merit Heaven by making earth a Hell!

The Faraday Society

The recent discussion on the hydrogen bond was duly held and we hope at an early date to publish a proper account of it. There is an informality about the Faraday Society that is quite refreshing; the President sits in his presidential chair smoking a pipe; the assistant secretary sits on the platform smoking her cigarette; professors interject brief speeches that only occupy two or three minutes; a lady doctor of science is prevailed upon to forget horses in order to explain the protein molecule, and so on. We will not anticipate the report of the various papers that were read and discussed; this will appear in a later issue.

The hydrogen bond that we listened to is often a link consisting of an oxygen atom, a hydrogen atom, and then another oxygen atom; we use the word "atom" in quite a non-committal way. *X*-Ray analysis enables you to define the positions of the oxygen atoms; spectroscopists and dipole experts can do something to define the position of the hydrogen atom; long experience may attain to something. *Vide*, Robertson, Milton, *et al.*

A few of the chemists appear to make or to have made assumptions about the length and strength of the bonds connecting two atoms that are not exactly confirmed by modern experimental evidence. As if a carpenter were to assume that height and width could always be denoted by an odd number of feet and never by an even number. A rectangular window in our study is in fact eight feet high and four feet wide; in some modern scientific language that we have in mind it would probably be described as in a state of resonance between two rectangular windows, one nine feet by three and the other seven feet by five. Possibly ingenious explanations would be given to explain, when, why, and how the two imaginary windows came into theoretical existence. At any rate some of the speakers in the discussion and some of the statements in modern text-books lead us to believe that an honest endeavour is being made to reconcile what are now unwarranted assumptions with unwelcome measurements. Intermediate sizes do not trouble our local builder and we are not quite convinced that they cause any particular difficulty to Nature when she hurls together casual atoms to make a crystal; let them fit in, large and small, as best they can, like passengers in an excursion train, she seems to say.

We may have got the whole thing wrong in our head and are casting ill-founded dispersions on kindly people, but allow us to state that we have at odd times appealed to chemical friends for advice as to the chemist's creed; the answer is usually that they do not quite know, but nearly do, and that we ought to discuss the matter with those best qualified to judge, who are mostly in the United States. Others have referred us to sundry modifications of the well-known Hamiltonian equations

and have then said they must hurry away to deliver a lecture.

It is of no consequence that the editor of this journal should know the truth about resonance, but there are hundreds of chemists who are also in a state of darkness and the rays that might penetrate the editorial skull and furnish a dim light might really illuminate the more sensitive creatures.

Young Men in the Government

In his maiden speech in the House of Commons just after the end of the last war Major Walter Elliot made a plea for younger men in the Government of the country. We have, he told the House, been governed by a lot of old men with hot heads and cold feet who pushed us into the war and then sang " we don't want to lose you but we think you ought to go."

Major Elliot was then (in 1918) about thirty years old. Five years later he was given a junior post in the Government and has served continuously, with the exception of two brief spells of Labour Administration, since rising to become the Right Honourable Walter Elliot, Minister of Agriculture and Fisheries, Secretary of State for Scotland, and subsequently Minister of Health. A few years ago he was considered very much in the running for a future Premiership, but as Minister of Agriculture his light was considerably dimmed under the bushels he failed to produce.

Sharing the representation of youth with Mr. Elliot was, among others, Mr. Oliver Stanley, now aged 44, who since 1931 has risen on sundry achievements to higher posts. In the last seven years he has been successively Minister of Transport, Minister of Labour, President of the Board of Education, President of the Board of Trade, and finally Secretary of State for War. Mr. Oliver Stanley is still considered a possible runner for the Premiership in spite of the fact that in office he has not shed so much lustre as was hoped.

Mr. Hore-Belisha again was for some time a " possible " for the Premiership. In a brief flash of unaccustomed modesty Mr. Hore-Belisha refrained from giving his age in reference books. He is, however, known to be about 45 years old. He too has held Government appointments since 1931 but after achieving great personal notoriety as Minister of Transport he has hardly maintained his place in the running.

These examples must not, however, be taken as proof that young men in Government are not a success. Mr. Eden at 43 and Mr. Duff Cooper at 50 have staged " come-backs." Mr. R. S. Hudson at 44 is rapidly establishing a reputation and Mr. Malcolm MacDonald, son of Ramsay MacDonald, has at 39 achieved a very high reputation both in the Civil Service and in the House of Commons as an administrator of considerable ability. Oddly enough Mr. MacDonald's reputation has been gained purely by efficiency and sticking to his job. He has indulged in no personal publicity nor has he quarrelled with colleagues in higher places and thus gained popular applause. So long as men of his calibre continue to join the very pleasant and reasonably lucrative profession of politics it is still possible to place some hope in the future of this democratic form of government. But it is certainly an invaluable aid to progress in it to have chosen one's parents well.

The late Lord Salisbury did his best in foreign as in home policy to " think chemically " as he expressed it, making proper deductions from known facts. He said : " In this country there are only two extremely important appointments. One is that of Prime Minister, the other that of Foreign Secretary. For the rest any fairly competent person will do." It must not be inferred and we do not wish to imply that the recent appointments made by Mr. Churchill are in the main those of only fairly competent persons. And we do not believe that in this country the majority of our Ministers love their country for the spoils it gives.

In every great occupation there are givers and takers ; those who give as much as they can and those who take as much as they decently can. This is true of politics ; there have been and are to this day many poor and many wealthy statesmen, politicians, and civil servants who gladly serve their country to the best of their ability, with the highest motives and principles, taking in return the minimum necessary to enable them to do their work to the best advantage and to maintain their due influence. No one thinks that the last two Prime Ministers or our present one do their work for the sake of securing any financial reward.

There is a fine passage in the Iliad, familiar to some of us, in which one of the princes of Lycia asks why he and his companion have seats of honour, and feasts, and great estates, orchards, and corn-fields. Because of this it was their duty to fight in the front rank of the battle. Friend, he said, if escape from the battle would enable us to become immortal and retain our youth and strength it would be different, but as countless varieties of death are always hard by, that we cannot escape, let us go forward and do our best. Lord Carteret, afterwards Earl Granville, at the end of many years of service to his country was lying on his death-bed in 1763 considering the preliminaries of the treaty of Paris and a friend asked him why he troubled himself about such matters. He repeated in the Greek the passage we have referred to and then composed himself for a peaceful death. If we mistake not he was the father-in-law of Lord Shelburne who befriended Priestley in his young days.

This spirit of duty persists to this day ; it is threatened ; the Germans do not wish the French and the Britons to love France and Great Britain. We shall, in spite of Germany, continue to love our countries and to save them from the unhappy and regrettable fate that has befallen some of the small countries who thought their neutrality and their innocence would be a protection. There is no safe course for most of the neutral countries ; the nearest approach to safety is for them to combine together and prepare to be attacked and to attack. It used to be said : thrice-armed is he who knows his quarrel just, but four times he who gets his blow in fust. If any of us now alive ever trust again to the word of Germany we shall deserve what we get, and we shall get it. We say this chiefly to the young, for the youth of a nation are the trustees of posterity.

FOOD SCIENCE IN THE FUTURE

JUBILEE MEMORIAL LECTURE

By SIR JOHN BOYD ORR, M.D., D.Sc., LL.D., F.R.S.

(Read before the Food Group on January 10, before a joint meeting of the Liverpool and Manchester Sections on February 2, and before a joint meeting of the Glasgow and Edinburgh Sections on March 1)

When I had the honour of being invited to deliver the Jubilee Memorial Lecture, I intended to devote it to a consideration of the abnormalities in the composition of body fluids in deficiency diseases and the possible relationship between these abnormalities and clinical symptoms. In the present state of our knowledge this is probably the most interesting and, taking the long view, the most fruitful line of research in the biochemistry of nutrition. It is one of the tragedies of the present war that, in Europe at least, these researches which were just beginning will be crowded out by food problems of more immediate practical importance. In the present circumstances it will be more appropriate to deal with practical problems. The new knowledge acquired in the last twenty-five years is of great potential practical value. If in the last ten years economic and political measures had been taken to have this new knowledge applied in practice in all countries, mankind might have been saved from the impending sufferings of the present war.

The direction of scientific research to practical needs is in accordance with the best traditions of science. The Royal Society was not established for the promotion of science for science's sake. According to the first History of the Society, it was "an enterprise for the benefit of human life by the advancement of real knowledge." The first members of the Society were economists as well as scientists and were concerned largely with seeking knowledge to improve technical processes and increase the output of various commodities. Many of their early papers dealt with the mining and use of coal. In the last half of the eighteenth century, when great advances in chemistry and physics were being made, scientists were themselves industrialists or closely associated with the new industries. Lavoisier, Berthollet, and Leblanc in France were working on the bleaching of textiles and metallurgy. Names like Black, Watt, Davy, Roebuck, Roscoe, and Wedgwood are associated as much with engineering, mining, and chemical industries as with science. Science and the new industries were so intimately connected that they were part of one and the same process of development. Many of these great pioneers of modern science, like Priestley and Benjamin Franklin, were fully alive to the beneficial effects which the wealth that the new science was creating might have upon human society. It is unfortunate for mankind that, as the great industries grew up, control passed from scientists to financiers. If the scientific influence could have been maintained and the industrial revolution developed in accordance with the original purpose of the Royal Society, we would have been spared the desolation of the slag-heaps and slums of the industrial areas and the modern problem of "poverty in the midst of plenty" which is the fundamental cause of the present war.

The frustration of science, of which we have heard so much in the last few years, is due to the fact that those in control of trade and industry and those who hold the executive power in State administration are either unaware of the contribution which science can make to the solution of economic and social problems or have an exaggerated fear of the sacrifices which existing interests would need to bear if science were applied for the benefit of the whole community. On the other hand, scientists themselves are so engrossed in the problems on which they are engaged that they show too little interest in the bearing of their work on economic and social problems. This is especially true of those working on the biochemistry of food. This has become such a vast subject that it is difficult for research workers to get a clear view of the general line of advance and the bearing of the advance on social needs. Over three thousand papers, giving the results of original research, are published every year. No single person can read the whole literature. Workers tend to confine their interest to their own particular line of research. This segregation of scientists into relatively small groups with common interests prevents us from exercising the influence we might have in getting the results of our labours applied for the improvement of nutrition of the people which is the only worth-while objective of our work. Let us consider today what the present position is in relation to that objective.

The results of the last twenty-five years' work have shown that many commonly occurring diseases, which were formerly of obscure etiology, are due to deficiencies in the diet. There is evidence to show that dietary deficiency is a predisposing cause in the case of certain infectious diseases of which tuberculosis is an outstanding example. We are only beginning to consider the psychological effects of malnutrition. Mental depression is a characteristic of most of the deficiency diseases and mental deficiency is much more common amongst children of the poorest classes, who are badly fed, than amongst children of the well-to-do classes. We cannot go so far as the American investigator who suggested that the term "mental deficiency" for children should be changed to "deficiency of fat-soluble A," but the work of Segar, Burke, and others strongly suggests that defective diet is the cause of retardation of mental

development and may have a permanent effect. The evidence accumulated in the last two decades has shown that even in the wealthiest classes, physical and psychological well-being could be greatly increased by improved feeding.

It was impossible to measure the extent of the food problem until we had a dietary standard which we could apply to diets in common use. It is impossible to set up an absolute standard because the requirements for any one constituent depend upon a number of other dietary factors and vary in different individuals. Thus, for example, the requirements for calcium depend upon the amount of vitamin-*D* in the diet, the amount of fat, the ratio of calcium to phosphorus; the requirements for vitamin-B_1 depend upon the amount of carbohydrate in the diet and, in some recent work on which we have been engaged in Aberdeen, we have found that there appear to be wide individual differences in the requirements for vitamin-*A*. These differences may be hereditary or may be due to the effects of long-continued previous deficiencies. Although it is impossible to state in terms of each of the food constituents the requirements for each individual, it is possible to state roughly a lower limit for any food constituent below which signs of deficiency will appear and a higher limit above which no signs of deficiency will appear, and, although the composition of foodstuffs varies, it is possible to set down a diet in terms of foodstuffs which will meet all the requirements of people who are not already in a pathological condition.

In the last five years, dietary standards have been set up. They are based on the data of experiments on animals and human beings, on clinical observations and on the results of dietary and clinical surveys. The British Medical Association diet at minimum cost; the Stiebeling standard, published from the Home Economics Division of the Department of Agriculture, U.S.A., and the standard for women and children drawn up by the Technical Commission appointed by the League of Nations, are the three authoritative standards. These were drawn up by different groups of people, no member of one group being a member of either of the other two. There is little difference in the amounts of the different food constituents provided by the three standards. These standards will doubtless be modified as further data accumulate, but it is unlikely that the modifications will seriously affect their usefulness as yardsticks to measure the adequacy of diets.

In the last five years dietary surveys, more or less complete, have been carried out in a number of different countries. When any of these yardsticks is applied to the data provided by dietary surveys, it is found that in what we call the civilized countries of Europe, the United States, and the British Dominions, the diets of between 25% and 50% of families fall below the standard.

Though our information on diets in common use and the health and physique of people using different diets is still scanty, there is evidence of a correlation between diet and health and physique. The investigations of McCarrison on native tribes in India and the enquiry on the diet and health of the Masai and Kikuyu, two tribes in Africa with different food habits, showed that the nature of the diet was reflected in physique and the incidence of disease. In our own country in the poorer half of the population, as family income falls, the diet becomes more deficient. As the diet becomes poorer, the incidence of deficiency diseases, infant mortality, and tuberculosis rises; stature decreases and there is some evidence that intelligence, or at least the capacity to use intelligence, also decreases.

These characteristics of an inferior race found in the parents of the poor tend to be repeated in their children. In the past they have been assumed to be hereditary. The correlation, however, may be more between environmental factors than between inherited genes. As a matter of fact, it is found that improvement in environment is accompanied by improvement in health and physique. This is strikingly brought out in an experiment in 1939 with Army recruits who were rejected on account of poor physique and physical disabilities; 834 of these ill-nourished rejected recruits were taken into a camp in Kent and received a diet which was estimated to cost 17s. 6d. per head per week. After a few months under the better environmental conditions, 729 were found to be fit for service and were actually accepted for the Army. Shapiro, in his recent investigation of the effect of environment on the Japanese, found that the children of emigrants to the Hawaiian Islands were taller than their blood relations who had remained in Japan, the males by, on an average, 4·44 cm. and the females by 4·23 cm. Accompanying the increase in height, there was a change in the ratios of bodily measurements. In the United Kingdom there has been a remarkable improvement in the national diet in recent years. Compared with 1913, the consumption of the "protective" foods in 1938 and 1939 was, on an average, more than 50% greater. Accompanying this improvement in diet, there has been a great reduction in the gross forms of deficiency diseases, such as rickets, scurvy in infants, and xerophthalmia, a reduction of about 50% in the infant mortality rate and the tuberculosis death rate, and an increase in height of about two inches in children leaving school.

There is an overwhelming mass of evidence, such as that to which I refer, showing that, although heredity sets a limit to the physical and mental development of each individual, the great majority of humanity are prevented by environmental conditions from reaching that limit. Until environmental conditions affecting health are made as good amongst the poor as amongst the well-to-do, it will be impossible to state the extent to which the poor physique, high incidence of disease, and other stigmata of poverty are inherited characteristics. The most important limiting factor appears to be food. As Le Gros Clark in his Presidential Address to the Anthropological Section of the British Association at Dundee pointed out, the human race is not static. Changes in nutritional factors produce changes in physical and mental characteristics. So far, we can only guess the extent to which the race could be improved by better feeding.

The extent to which malnutrition occurs and the reason for it have been much discussed in recent years. We can estimate the extent of it by comparing the

health and physique of people on poor diets with those of people on adequate diets. The results of the measurements by either of these methods are in agreement in showing that the health and physique of about one-third of our population is far below what it might be. Ignorance and carelessness are partly responsible, but the main factor is poverty. The results of all investigations show that in poor families consumption of the protective foods is correlated inversely with the retail price. Even though the poorest economized to the utmost in every other form of expenditure, they would still not have sufficient to purchase a diet on even the British Medical Association minimum standard. Rowntree in his economic enquiry fixed a diet below the British Medical Association minimum. To make it as cheap as possible, he eliminated liquid milk and butter. He found that there were several millions of the population whose purchasing power was so low that they could not afford even this low level of subsistence. If the results of research on food in the last twenty-five years are to be applied, the retail price of the protective foods must be brought within the purchasing power of the unemployed and poorly-fed working-class families with children.

The newer knowledge of food has been applied in therapeutics and in a half-hearted niggardly fashion to improving the diet of the poorest. But it has had little influence on our national food policy. In the last ten years the Government measures applied to food have been in the direction of limiting the amount to come on the market and raising the price. We who are engaged in research on food know that if the measures were designed in the interests of the 46 million inhabitants of this country, they should provide for an increase in the supply of protective foods and adjustment of the price to purchasing power. Either through lack of interest or through fear of giving offence we failed to bring the knowledge we have, with recommendations based on that knowledge, before the Government which, therefore, continued to legislate on the basis of nineteenth-century ideas of food requirements according to which, if people were not suffering from lack of calories and protein, they were sufficiently well fed.

The war accentuates food problems. The total national food requirements will be increased by between 5% and 10% and the need for maintaining the highest possible level of health and physical fitness among the civilian population is even greater than in peace-time. A war-time food policy has been devised by administrative officials with the assistance of the trades concerned. No use has been made of bodies, such as the Medical Research Council, the Government Advisory Committee on Nutrition, this Food Group of the Society of Chemical Industry, and the Agricultural Research Council, which have a knowledge of food requirements and the possibilities of increased home production. Thanks to the British Navy, which, relative to the enemy, is much more powerful than it was in the last war, there is no likelihood of there being any grave shortage of food so long as our foreign credits last. But Government control of the national food supply, necessitated by the war, afforded an opportunity for re-organizing the supply and distribution of different foodstuffs and adjusting prices to purchasing power so that it would have been possible for every family to have a diet fully adequate for health. If we had a policy based on national food requirements, irrespective of trade interests, we could apply agricultural science to increase home production of the right kind of food and the whole nation could have a diet adequate for health with one-third of the shipping space devoted to the import of food in peace-time.

There is not the slightest doubt we will win the war, but after the war there will be a period of unemployment, high prices, and social unrest. If we had a food policy which would provide every family with a diet adequate for health, we would be able to face the dangerous post-war period of dislocation with confidence and we would have taken the first and most essential step in post-war economic and social reconstruction. Those of us who are engaged in research on food might render a great national service by getting together and forming a body representative of those engaged in research on requirements, production, storage, distribution, and economics of food. After pooling all our information, we could outline a food policy based on scientific data. I believe that our politicians, most of whom have had neither time nor interest to acquire any scientific knowledge of food, would welcome the information and recommendations which such a body could give. The information and recommendations would certainly be welcomed by the people of the country who had begun to appreciate the health, economic, and political importance of food.

We are passing through critical times. The nineteenth century economic era is drawing to a close. Science has created real or potential wealth in abundance. The system is breaking down under the burden of this wealth which it cannot distribute quickly enough. When a system which was devised to facilitate the production and distribution of goods which humanity needs, is forced to save itself by destroying goods and preventing distribution, it is already doomed. The war of 1914—1918 and the economic crisis of 1930 arose from a collapse of the system which is in its death throes in the present war. Already three great nations in Europe in despair have rid themselves of the old system. Instead of setting up a better, they are being led back by Germany to a state of barbarism with a system of Government based on brute force and ruthless exploitation of the weak. With that system there can be no compromise. It must be utterly destroyed. But we have to consider what we will put in its place. We cannot go back to 1938, even though we wished. The only alternative to a prolonged period of chaos is a modification of our economic and social system, which will allow the almost inconceivable wealth both material and spiritual which science can create, to be applied to put an end to the economic distress of nations and the poverty of individuals and bring about the new age of plenty which is the only sure foundation for world peace. Our social and economic system must be rebuilt on a basis of scientific fact instead of on political theory. Scientists failed in their duty in the nineteenth century because they allowed themselves to become mere hirelings with no say in the use to which the knowledge

they were creating should be applied. It is not suggested that scientists should become politicians or administrators, but they should study the bearing of the knowledge they are producing upon social and economic problems and offer light and guidance for the solution of social problems. The enormous powers which science has released can be used to wreck the present civilization. They could also be used to build up a new and better civilization, but they cannot be used for this end unless scientists themselves realize their enormous responsibilities and unite in a common endeavour to use their influence to have "the advancement of real knowledge" applied "for the benefit of human life." If they do that, they can guide the world to a better future, planned in accordance with truth to which alone scientists acknowledge allegiance.

SOME ASPECTS OF CHEMOTHERAPY

By DR. W. H. LINNELL

A summary, prepared by the author, of his paper read at Cardiff before a joint meeting of the South Wales Section of the Society and the local section of the Institute of Chemistry on December 8, 1939

Chemotherapy should include a consideration of all remediable agents of a chemical nature: anæsthetics as well as bactericides, antipyretics as well as the organic arsenicals. The restriction of the subject to substances which combat an invading organism is purely artificial.

Many new chemotherapeutic agents owe their origin to work done on some natural substance which possessed a therapeutic value. The isolation, characterization and synthesis of the active principle is accompanied by enquiries concerning the biological reactions not only of the active principle itself but also of many intermediate products and chemical "copies." Thus much knowledge is gained of the effect of a large number of chemical groupings.

This type of work is well illustrated by the antimalarials. Progress is always slow until the infection concerned, or a similar one, can be induced in experimental animals. In malaria the discovery that canaries and Java sparrows could be used to evaluate substances capable of controlling the parasite at two different stages of its life history was of paramount importance. Canaries are used for substances which affect the parasite in the same manner as quinine (schizontocidal) and sparrows for compounds like plasmoquine which attack the gametes. First the relative activites of the various natural cinchona alkaloids were explored, followed by a consideration of those compounds which could be prepared from them by chemical means, such as the alkylhydrocupreines and the *apo*-bases. It thus appeared that neither the 6-methoxy group in the quinoline nucleus nor the vinyl group of the quinuclidine nucleus were essential, but that chemical alteration (esterification, oxidation, reduction, etc.) of the secondary alcohol serving as a link between them resulted in complete loss of activity. The position of this group relative to the nitrogen of the quinuclidine nucleus appeared to be critical. Antimalarial activity had been noticed in methylene blue and in salvarsan, and attention was turned to the former on account of the difficulty of synthesizing substances related to quinine. Increase of activity was obtained by substituting one of the dimethylamino groups in methylene blue with a more complex basic chain of the type, $-NH\cdot R\cdot N(alk)_2$. This chain was then introduced into position 8 of the 6-alkoxyquinoline nucleus and into the 5-position in 2-chloro-7-alkoxyacridine, producing plasmoquine and atebrin, respectively. The former compound is gametocidal, whilst the latter affects the schizonts, as does quinine. Much information has been obtained concerning the results of lengthening or branching of the basic chain and of altering the nature of the alkoxy groups. In such ways as these, knowledge has been gained and may be utilized in further endeavours. The only essential requirements for antimalarial activity appear to be the quinoline nucleus and a basic group.

The introduction of prontosil into medicine may be rated as the biggest achievement of chemotherapy and in this instance no natural drug formed the starting point. Prontosil and soluble prontosil are azo dyes formed from *p*-aminobenzenesulphonamide, and have made possible the cure of such scourges as puerperal fever—they are predominently streptococcicidal. Shortly after their introduction in 1935 it was found that the active agent was the *p*-aminobenzenesulphonamide produced from them by reduction. Over 200 derivatives or relatives of this molecule have been made and tested from which it appears that the nitrogen must be *para* to the sulphonamide group; that substitution in this nucleus is dystherapeutic; that the hydrogens of the amino group may be replaced with some degree of freedom; and that the hydrogens of the sulphonamide may be replaced only by certain groupings. Extension of the application of such compounds to other streptococcal infections, and to pneumococci and gonococci infections has occurred, and attempts have been made to discover the best compound for each specific job. M and B 693—one of the hydrogens of the sulphonamide group replaced with 2-pyridyl—has thus become established in pneumonia. Another nucleus, *p*:*p*'-diaminodiphenylsulphone, has been found to be effective and bids well to open a new chapter in this story.