NEWER ASPECTS OF THE NUTRITION PROBLEM

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Introductory Remarks
By George B. Pegram
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It is our pleasure to be assembled this evening to hear as the Chandler Lecturer for the present year a gentleman who is widely known among chemists as a pioneer in the very remarkable developments of our knowledge that have been brought about through the study of food accessories such as vitamins.
I have the honor of introducing Professor Frederick Gowland Hopkins, of Cambridge University, England.

Medal Address
Newer Aspects of the Nutrition Problem
By F. Gowland Hopkins

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NUTRITIONAL STUDIES AS A BRANCH OF APPLIED CHEMISTRY

The study of nutrition is most productive when it is followed as a branch of applied organic chemistry. As such it doubtless suffers certain disadvantages. It calls for workers fully acquainted with the technic of the chemical laboratory and possessed of all that is special in the chemist’s mental equipment and mode of thought. Yet it calls for the application of these possessions in a region which is perhaps more remote from the chemist’s experiences during his training than are any other of the many regions in which his science is applied. The successful pursuit of biochemistry, of which science nutritional studies form a part, calls for a second discipline. The young chemist having received his primary training must be content to become next something of a biologist; he must know enough about animals and plants to appraise the problems which their organization presents; he must acquire a biological outlook.

Chemistry is a basal science underlying the practice of so many human activities that a large proportion of those who start with a chemical training must ultimately add to their equipment other kinds of expert knowledge before qualifying for their life’s work. It is a pity that so few up to now have chosen biological qualifications. Hitherto, the primary training of most of those who have investigated biochemical problems has been biological or medical. Such workers have done very well, but as knowledge progresses it becomes more and more necessary that at least some of the work should be done by those whose chemical knowledge is primary and not secondary.
But I have referred to certain disadvantages suffered by biochemistry and you will think of one of them. It has hitherto been difficult to point clearly to a professional (as distinct from an academic) career for the young man who thinks of devoting himself to the subject. Only in connection with medicine has it hitherto offered professional opportunities, and medical qualification is often first demanded of its votaries. This state of affairs is rapidly altering. Medical practice can and will in the future be helped by workers whose training has comprised something less than a complete medical course. Biochemical knowledge, moreover, is being sought in many unexpected quarters. The scientific representatives of a firm that manufactures explosives on a great scale asked me some time ago to supply them with a biochemist. At first it seemed difficult to know why; but the explanation was simple enough. There is, or was, some anxiety about the supply of glycerol. Fats which used to be hydrolyzed are now being used intact in all sorts of fresh ways, and there is less glycerol as a by-product. Hence a desire to develop the methods by which it is produced by microorganisms, and the biochemist gets an opportunity. This is but one illustration. I can say with certainty that, in Great Britain at any rate, there is a demand for professional biochemists which is greatly in excess of the present supply. This I find satisfactory, for if a profession opens up we shall find it easier to obtain workers who during one period at least of their career will help advance the science itself.

Need for Organic Chemists in Biology

I find it difficult, when addressing an audience composed largely of chemists, to avoid a propagandist attitude: because it is so very desirable that a proportion of our young chemists, greater than heretofore, should devote themselves to biological problems. I will confess that I am at the moment thinking in particular of organic chemistry. For it seems to me that on the whole the tendency has been for those who have especially qualified as physical chemists to devote themselves to biology rather than their colleagues who are more particularly accustomed to think in terms of molecular structure. Now no student of the plant or the animal can do otherwise than offer a hearty welcome to the physical chemist. He is now providing knowledge for which a whole generation of biological workers has been waiting. But if it be supposed that the application of the methods of physical chemistry, elegant and precise as they are, or the physical chemist's particular way of looking at things, is going to take us more directly and quickly into the secret habitation of life than other forms of chemical study; in particular if it be supposed that considerations of molecular structure are not essential to an understanding of living processes—then, I am sure, such suppositions are wrong.

In the main, though not of course exclusively, the physical
chemist in biology is engaged in a study of the colloidal apparatus in which the dynamic events of life occur and in carefully and precisely defining a group of circumstances which conditions those events. We could, however, picture a physical system, composed of colloids similar to those which exist in the living cell, endowed with a characteristic structure, and in contact with electrolytes at a particular hydrogen-ion concentration, which would closely resemble a living unit when viewed from a purely statical standpoint; but unless what is ordinarily called metabolism occurs in such a system it is dead. Now metabolism consists in the continuous process of a set of organic chemical reactions in dynamic adjustment. Until our knowledge of these reactions and of their mutual relations is complete, our knowledge of living tissues will remain incomplete. This knowledge cannot come without continued thought and experiment on the lines of what we are accustomed to call organic chemistry. This applies to biochemistry as a whole, and not least to that branch of it which comprises the study of nutrition.

There is of course one method of estimating the nutritional needs of the body which avoids consideration of chemical details. They may be dealt with from the standpoint of energetics. Indeed, as the last century closed, the facts of nutrition were coming to be viewed more and more exclusively from this standpoint. The criterion of an efficient dietary was apparently destined to be its caloric value, and, with one qualification, which seemed then to be lessening in significance, its caloric value alone. The chemical standpoint, in so far as it envisaged details, seemed to be losing its practical importance.

**Successes and Limitations of Calorimetry**

Those years saw a remarkable development in the technic of human calorimetry. The accuracy with which the energy exchanges in the body came to be measured gave rise in the minds of all students of nutrition to a sense of real accomplishment and to a feeling that, in addition to certain theoretical conclusions of great interest, calorimetry was making available, perhaps for the first time, information of a really quantitative kind to serve in practical guidance. The vague standards based upon statistical studies of the habits of the communities could at last, it was felt, be checked, and if need be corrected, by data which were in the truest sense scientific. What, in terms of energy, are the basal requirements of the body? What the caloric equivalent of various forms of mechanical work? What the efficiency of the human body as a machine? What the relative value of foodstuffs as sources of muscular energy? All these and kindred questions were being answered or the methods for their future solution made clear as the last century closed. They are, indeed, still being investigated, and with increasing accuracy, chiefly in the country where they were first seriously dealt with. For American workers
Graham Lusk, Benedict, Dubois and others are continuing the work of Atwater and Rosa, and are obtaining quantitative data which can be so controlled as to carry their own inherent proof of striking and even startling accuracy. The investigations are extending into the domain of pathological metabolism, and there I am convinced will have important bearings. Calorimetry as applied to human beings is an American science, and this country should feel the utmost pride in what it has accomplished. It is, in fact, impossible to overestimate the theoretical and practical importance of the data of human calorimetry. My only contention is that they are, and must always remain, insufficient for complete knowledge. In a limited sense calorimetry applies the methods of thermodynamics to the study of the body and its results share the advantage of conclusions reached by these methods in other branches of science. They involve quantitative statements which will remain true however our view may change with regard to the mechanism underlying those manifestations of change which permit easy measurement. The thermodynamic method is however sometimes like a blind man’s stick. It carries us safely along a path which we cannot see, but fails to show us how we may best reach our ultimate goal. When there is complexity of a kind which cannot be reduced to statistics, the method of thermodynamics is apt to fail us. The human body obeys the laws of thermodynamics when, for this or that good reason, it is surely perishing!

Without, therefore, underestimating for one moment the value of thermal studies as applied to nutrition, I think it must be admitted that they in themselves can never constitute a sufficient guide for the progress of knowledge.

**Importance of Structural Chemistry**

Anyone, at any rate, who will trouble himself to appraise the nature of the progress which the detailed studies of the last twenty years have contributed to our views concerning animal and human nutrition will not doubt what I have said earlier as to the importance of thinking in terms of organic chemistry. Up to the end of the last century, thought about the chemistry of living beings scarcely employed considerations of molecular structure, or employed them, at any rate, in a very limited sense. Now, as the result of twenty years’ progress, all concerned are doing their best to think in terms of structural chemistry; with the result that vague views about metabolism are giving place to clearer conceptions from which must follow a better understanding of the nutritive needs of the body.

Perhaps only those, who, like myself, have had to talk to students about such matters for five-and-twenty years, can fully realize how much the clarification of thought has progressed.

**Modern Conceptions of Protein Metabolism**

Especially, of course, is all this true in connection with the
nutritive functions of protein. So long as we had to fit into our mental picture of what occurs in living tissues the hypothetical behavior of a complex molecule of which we knew little, and conceived of it as being oxidized, or otherwise utilized as a complex whole; oppressed therefore by the feeling that its very complexity would remove the processes involved from the domain of clear chemical presentation; so long as all this was the case we had to think in intellectual blinkers about the functions of protein. But simultaneously with the beginning of the present century, progressive work began which has changed the outlook. We have come to know that the complex molecule is built up of some twenty structural units, each a chemical species, but all belonging to the same chemical genus. We know the structure of each of these amino acids and realize that among them unity of type is combined with great diversity in structural detail, the unity and diversity being equally significant for the student of nutrition. We know, moreover, that the process by which we liberate these constituents from the protein complex in the laboratory—the process of hydrolysis—is identical with that which occurs in digestion. We know finally that in the alimentary canal this process is very completely carried out before adsorption of material occurs; so that the immediate phenomena of nutrition begin not with a supply of protein as such, but with a supply of amino acids. When we eat protein we consume, in effect, not one substance but twenty, and each of these may have quite special functions in nutrition. All-important to present and future progress is the fact that they are substances of known molecular structure. It is impossible, of course, for me to deal historically with this advance in knowledge. I have been instructed to narrate personal experiences, and though it may be unfair to others I will confine myself to illustrations drawn from such experiences.

I can claim that some eighteen years ago my imagination (doubtless like that of many others) was greatly stirred by the facts then becoming available. It seemed to me essential for the understanding of protein nutrition, and for the analysis of the factors concerned in the maintenance of nitrogenous equilibrium, that the relative nutritive importance and ultimately the precise fate of each individual amino acid should be determined separately. In 1906, in conjunction with Miss Edith Willcox (now Mrs. Stanley Gardiner), I published results of some experiments which illustrated the special nutritive importance of the indole nucleus contained in tryptophan, an amino acid first separated from protein a few years earlier by S. W. Cole and myself. Incidentally these experiments indicated that an amino acid may be used, not alone for the building up of tissue proteins, but also immediately and directly for more specific purposes. It is important when approaching studies of metabolism and nutrition to realize in advance that more than one path of change may lie before any particular unit
in the food eaten. The results of the unambitious pioneer research just mentioned, in so far as it bore upon the importance of the indole nucleus, have since been confirmed by myself, and abundantly by others, on more conclusive lines. The fact recently demonstrated by Kendall, at Rochester, Minnesota, that the all-important active principle of the thyroid gland is an iodine derivative of indole has shown us one probable reason for the importance of a supply of tryptophan in the diet. This is only an illustrative instance of the special functions which may be subserved by individual parts of the protein molecule.

The circumstance that an animal can be normally nourished when, instead of intact protein, it receives a complete mixture of amino acids has greatly assisted studies meant to determine the relative nutritive importance of the different molecular groupings in the protein molecule. The original amino acid mixture obtained by digesting any normal protein may be fractionated, and this or that constituent may be withdrawn from the mixture before it is supplied to the animal. Ultimately, by so withdrawing a particular unit and observing the effects of its withdrawal, we may not only measure its importance but also obtain information as to any special functions it may subsist.

I have myself tried the effects of withdrawing certain amino acids besides tryptophan. If for instance an animal be given as its sole nitrogenous nutriment, the amino acid mixture deprived of hystidine and arginine, nutrition fails. It promptly becomes normal again when these two units are restored to the food. The first of these substances contains the iminazole ring, and the second gets its special stamp from the existence of the guanidine group in its molecule. Now it is remarkable that, though the absence of both these amino acids from the food supply is fatal, the absence of either alone is well borne by the animal, and experiment shows that one can take the place of the other in metabolism. Considerations of molecular structure make it easy to understand why this may well be the case and the body in this case clearly takes advantage of certain possibilities which are obvious to the chemist.

\[
\begin{align*}
\text{Histidine} & \quad \text{Arginine} \\
\text{CH} = \text{N} & \quad \text{CH}_2\text{N} = \text{H} \\
\quad \text{CH} & \quad \text{CNH}_2 \\
\text{CN} = \text{H} & \quad \text{CH}_2\text{HN} \\
\text{CH}_2 & \quad \text{CH}_2 \\
\text{CHNH}_2 & \quad \text{CHNH}_2 \\
\text{COOH} & \quad \text{COOH} \\
\end{align*}
\]

Similarly a deficiency of tyrosine may be compensated by a
larger supply of the closely related phenylalanine; and there are probably similar cases. Such facts help to throw light upon the equipment of the tissues as laboratories: they must also be borne in mind when we are estimating the nutritive value of any particular form of protein.

Considerations of molecular structure made it probable that arginine and histidine might well be the precursors of the purine bases which are characteristic constituents of the nucleic acids found in all tissue cells. Led by the strucctional suggestions, Ackroyd and the writer some years ago tested this matter by feeding experiments, and obtained evidence to show that the suggestions were fulfilled. Arginine and histidine seem to be the special raw material for the synthesis of purines in the body.

On the other hand, there are constituent groups in protein which are certainly of much less nutritive importance than those discussed. Especially would this seem to be true of those amino acids which have a relatively simple constitution—the aliphatic substances, for instance, with a normal chain of carbon atoms. I have myself found, for instance, that if glutamic acid, aspartic acids, and hydroxyglutamic acid recently identified by Dakin be all removed from the amino-acid mixture, animals can maintain themselves quite well upon the residual amino acids. The contrast between the fatal effects of removing tryptophan, which constitutes some two per cent only of a normal protein, with the almost negligible effects of removing the amino acids just mentioned, which may represent perhaps thirty per cent of the protein, is sufficiently striking. There is little doubt that the difference is due, not to the fact that the tissues can dispense with any protein constituent necessary to their normal chemical make-up, but rather to the range of synthetic possibilities within the body. When deprived of a supply of certain amino acids, it can synthesize them for itself; the synthesis of others is not within its powers.

Very interesting is the knowledge, incomplete as yet, which we possess concerning the chemical changes which individual amino acids actually undergo in the body. The fate of each is individual because its molecular structure is individual. I could indeed better illustrate the truth of my opening contention concerning the importance of structural considerations in biological chemistry if we were considering intermediary metabolism rather than nutrition in the more limited sense. The few facts I have put before you will, however, illustrate it sufficiently.

The outcome of the recent advances in knowledge concerning the chemistry and metabolism of protein when viewed from the standpoint of practical dietetics is in the main this: We cannot any longer be content to speak of the body's demands for "protein" in unqualified terms. The balance of individual amino acids, the relative amount of this or that acid, may be, we know, very different in different proteins, and this difference may markedly
affect the relative nutritive value. For the future we must in this connection think of quality as well as quantity.

What we know about the functions and fate of the other basal foodstuffs, the carbohydrates and fats, illustrates equally well the importance of structural considerations in biochemistry. But with these I cannot deal.

**Vitamines**

I will rather pass at once to a newer aspect of our knowledge concerning the nutritional demands of the body, and remind you of facts which more than any others illustrate the necessity, when we are seeking to define an efficient dietary, of considering the nature of the material, as well as the energy supply. I mean, of course, the facts concerning the accessory food substances, as I once ventured to name them, or (to use the more familiar name conferred on them by Casimir Funk) vitamines. As you are doubtless aware, the chemical nature of these substances is as yet unknown. Their properties cannot therefore at the moment be used to illustrate further my theme concerning the importance of molecular structure in nutritional phenomena, though I doubt not that once they are isolated the biochemist will have an interesting task in relating their action to their structure. But there are other reasons why I should speak to you concerning them. I have received credit—perhaps too much credit—as pioneer in their discovery. Ten years ago the time was ripe for the emergence of certain facts. They were in the air; and when, in the progress of science, this is the case, questions of priority lose their importance. I will however relate my own experiences.

During 1906 I was engaged in feeding animals upon mixtures of different amino acids, and of necessity had to employ synthetic foods. Starch, fats, and salts were added to the amino acids to complete the dietary. The first circumstance which set me thinking was the observation that animals prospered better when they were fed upon amino acids obtained by fully digesting tissues than when the source of amino acids was a separated and purified protein digested in the same way. Lean beef, for instance, gave better results than casein. At first one was inclined to attribute the differences either to the fact that the amino acid balance was better in the former, or to the presence in the tissues of familiar substances, such as lecithin, but I could not get confirmatory evidence for this supposition. The first strong suggestion that something special had to be looked for came not from my main experiments, but from their controls. In the latter the animals were, for the sake of comparison, given intact casein instead of the amino-acid mixture, the rest of the diet being the same. Now, for a long time these control animals grew very well and kept in good health. If growth was slow I put it down to the fact that a synthetic diet might in any case be somewhat unsuitable for an animal. From
a certain date onward, however, all the animals on casein began
to do badly. They showed no growth at all and their health
failed. After some time the reason occurred to me. For the
preparation of amino acids I used pure casein, but for the food
of the control animals a commercial article was used. On the
date referred to I had begun to feed these animals on a casein prep-
aration different from that which for a long time previous had
served as the protein supply of my laboratory. The new prep-
aration had just come on the market and in appearance seemed
a much better article; but there was soon no doubt that its use
was the cause of the failures. When put upon the old casein
supply all the animals grew again!

At first I was naturally inclined to think that the new pro-
tein had suffered some sort of denaturation during the course
of its manufacture, but that supposition suffered easy disproof.
When, earlier, I began experiments with synthetic diets I added
small quantities of meat extracts and extracts from yeast to
give flavor to the tasteless food. I was thinking then of the
animal's "appetite," as was natural, and as most people do when
they start such experiments. I quickly found, however, that
rats ate synthetic diets very well without such additions, and
at the time of the experience with casein just mentioned I had
ceased to use them. Nevertheless my memory at this time, if
not my notebooks, carried suggestions concerning the influence
of the extracts which led me to try adding them to diets con-
taining the new casein, with striking results. Growth was now
as good, and sometimes better than with the old casein, and
growth occurred, too, in animals which were eating no more, or even
less, than other individuals living on the pure casein diet with-
out addition and showing continuous loss of weight as a result.
The extracts powerfully affected nutrition. I now extracted
the old casein with various solvents and finally got a product
which behaved exactly like the new. When the substances
dissolved out were returned to the food, growth occurred as
before.\(^1\) I wasted next a good deal of time by trying the effect
of various familiar substances of determined nature known to be
in yeast; always with unsatisfactory results.

By this time I had come to the conclusion that there must be
something in normal foods which was not represented in a syn-
thetic diet made up of pure protein, pure carbohydrate, fats,
and salts; and something the nature of which was unknown.
Yet at first it seemed so unlikely! So much careful scientific
work upon nutrition had been carried on for half a century and
more—how could fundamentals have been missed? But, after a time, one said to oneself, "Why not?" The results of
all the classical experiments had been expressed in terms of the
known fundamental foodstuffs: but these had never been ad-

\(^1\) It is remarkable what a considerable proportion of the vitamins
present in milk is adsorbed by precipitated casein. A failure to recognize
this has often obscured the results of feeding trials.
ministered pure! If, moreover, the unknown, although clearly of great importance, must be present in very small amounts—again, why not? Almost infinitesimal amounts of material may have a profound effect upon the body, as pharmacology and the facts concerning immunity assure us. Why not then in nutritional phenomena? The animal depends ultimately upon the plant for the synthesis of materials which bulk largely in its food: there is no reason why it should not be adjusted so as to be in equal need of substances which the plant makes in small amount. Only if energy were the sole criterion of an animal's needs would this be impossible; but certainly it is not the sole criterion.

So my faith grew in the existence of a previously unrecognized type of nutrient.

At this period I spent much time in the endeavor to isolate from yeast extracts an active substance with definite chemical properties, but wholly without success.

The experimental period that I have been describing was, for me, in one particular, unfortunate. I experienced periods of continuous success in maintaining growing animals upon purified dietaries after the addition of very small quantities of fractionated yeast preparations, but they were interspersed with occasional failures which shook my confidence. Only when milk, in small amounts, formed the addendum did failure never follow. The explanation is now clear. The protein and carbohydrate used in my experiments were thoroughly purified and standardized, but for fat I used lard. But lard, as many experimentalists now know to their cost, is a variable fat. What I was adding or withholding in my early experiments was vitamine B alone. I taught myself nothing about vitamine A, which is associated with most animal fats. The amount of it in commercial lard varies greatly; and I have no doubt that when my animals did well the lard they consumed contained enough of it; while when they did ill the lard was deficient in this particular.

I was on safer ground in using milk, for though milk is not especially rich in vitamines it always contains both A and B. When, therefore, at last, I ventured on publication it was mainly my experiments with milk that I described in proof of the existence of accessory food factors.

A great step forward was made in 1913 when McCollum and Davis made it clear that there are at least two vitamins—those just mentioned—concerned in nutrition; for we have since learned how great is the nutritive importance of fat-soluble A, of which the existence was then demonstrated. It seems to me fair to say that a recognition of the importance of a factor associated with fats was implicit if not explicit in papers published at this time by Osborne and Mendel, and their experiments in proof of this appeared close on the heels of McCollum's now classic publication. Such fundamental matters could not
indeed long escape the organized and intensive work which was being done at the American centers of activity.

I have given you a brief account of my own early experiences in this domain (never having told about them before) because I was assured that you would care to hear it. I fear you may have found it trivial, though the period it deals with contained some thrilling moments for me.

It would have been more useful, I imagine, if I had attempted to give you a critical appraisement of the present position of our knowledge of vitamines. To attempt one now would be unwise, for to be of use it would take much time. Advances have been real during the last year or two, but chiefly in matters of detail. Perhaps no considerable advance can now occur until a vitamine has been isolated in pure form and its constitution determined. I am sure that this will be no very distant accomplishment.

If indeed there be any in this audience who feel skeptical with regard to the whole question of vitamines or at any rate with regard to their practical importance (there are still some skeptics in my own country!), I feel that I am qualified to ask them to reconsider their attitude. Apart from the many hundreds of experiments I have made myself, I have seen the work which is being done upon the subject at some of the chief centers of activity. I can testify to the care and effort which is being put into the study at the Lister Institute and at University College, London. I have recently paid illuminating visits to the departments of Drs. Osborne and Mendel at Yale, and to that of Dr. E. V. McCollum at the Johns Hopkins University. In each and all of these centers one finds thorough organization and a properly critical atmosphere. The technic used in the study of vitamines has now been developed till, in its own special way, it is exact and reliable. All concerned have to talk and write under the disadvantage which arises from the fact that the actual nature of these substances remains unknown, but in spite of this a great amount of real knowledge of practical value is being accumulated.

Between the experiments on animals and actual human experience there are, as you know, links enough. The absence of one particular vitamine from the food is the whole and sufficient reason for the occurrence of human scurvy, the absence of another forms the main factor in the etiology of a second disease, beriberi, the absence of a third plays at least a large part in the induction of rickets. But if extreme deficiency in such factors results in actual disease, who shall say how much vague ill health may follow upon relative deficiency? That is the consideration which gives importance to this newest chapter in the science of nutrition.

While the newer knowledge which has grown up on the lines that I have briefly and incompletely indicated has undoubtedly important practical bearings, those engaged in the work should
doubtless use caution in their relations with the public. We should keep a sense of proportion. It would be wrong, for instance, or so it seems to me (I have heard the contrary opinion expressed) so to exaggerate the importance of the fat-soluble vitamine as to teach that vegetable fats which do not contain it should disappear from the market. Fat, as such, is after all a valuable and necessary food of which it is none too easy to maintain a supply. We should rather show how such fats are to be supplemented properly whenever they form a considerable part of the public supply.

Again, although there can be no doubt that the fundamental phenomena of nutrition are the same in all mammals, there are specific differences which we should not forget in applying our laboratory results. Deficiencies are felt more immediately and directly by the small animals on which so many of our experiments are done than by larger species with slower metabolism. We may consequently tend to exaggerate the general importance of this or that factor. We should not, I fancy, make too much of the "biological value" of proteins in connection with human nutrition until more observations have been made upon human subjects. The most favorable balance of amino acids may be different in different species; though as a matter of fact the weight of evidence is against this possibility. At any rate, we must remember that physiological adjustments may be made during long periods of use and custom which could not occur during the relatively brief duration of an experiment. In connection with the part that food deficiencies may play in the causation of human diseases, we should bear in mind that a clinical condition is usually more complex than conditions observed in the laboratory as the result of varying a single factor.

Nevertheless, as I have already said, there exist many links of evidence to show that laboratory results are fully paralleled in human experience, and evidence of this sort tends to increase. There is at any rate no fear of exaggerating the importance of the newer outlook when the rearing of children is in question. If one had to sum up in a sentence what constitutes that newer outlook, I would say that it is a fuller recognition of the fact that quality is as important as quantity in all that concerns nutrition. But "quality" must be read in a new sense, a sense sufficiently defined by the facts I have been discussing.

I referred earlier to the literal fact that human calorimetry is an American science. It seems to me as I think of those who are engaged in the study of nutrition on the fresh and extended lines that, unless we who work elsewhere work very hard, the new science which is developing will come into the same category.
Presentation of Chandler Medal

By George B. Pegram

COLUMBIA UNIVERSITY, NEW YORK, N. Y.

There are certain names that stand for whole periods in the existence of institutions, epitomize epochs of development and accomplishment. No such name at Columbia stands for more than Chandler. Reaching from the foundation of the School of Mines in 1864 to the present and covering nearly half a century of labor and responsibility in active connection with the development and progress of scientific work at Columbia, his great personality has built itself into the structure of this University in so intimate a fashion that the keenest analysis could not separate it out. It was, therefore, a most appropriate action for a group of his friends to present to the Trustees of Columbia University a sum of money constituting the Charles Frederick Chandler Foundation, the income from which is to be used to provide each year a lecture by an eminent chemist and to provide a medal to be presented to the lecturer in public recognition of his achievements in science. The previous lecturers on this Foundation have been L. H. Baekeland, Sc.D., W. F. Hillebrand, Ph.D., and W. R. Whitney, Ph.D.

On the recommendation of a University committee, the Trustees of Columbia University have awarded the Chandler Medal for this year to Frederick Gowland Hopkins, F.R.C.P., F.R.S., F.I.C., F.C.S., Fellow of Trinity College, Honorary Fellow of Emanuel College, Cambridge, Member of the Medical Research Council, and of the Consultative Council to the Minister of Health, Professor of Biological Chemistry, Cambridge University.

Professor Hopkins, this medal is presented to you in public recognition of your pioneer and valuable researches in biochemistry, particularly in connection with food accessories, such as vitamins, and your public service on the Medical Research Council and the Consultative Council to the Minister of Health.