SIR FREDERICK GOWLAND HOPKINS, O.M., M.A., M.B., D.Sc., Hon. Sc.D., Hon. LL.D., Hon. D.Sc., F.R.C.P., F.R.S.

By the death of Sir Frederick Hopkins, which occurred in Cambridge on 16 May in his 86th year, Nutritional Science lost one of its great pioneers, and its *doyen.* He had long been recognized as the leading biochemist of his time; he was also greatly beloved as a man.

In discussing his life's work in another place,* I wrote that Hopkins's scientific renown was based on his explorations into at least four or five different avenues of biochemistry: lactic acid in muscle activity; the discovery of the amino-acid tryptophan, and the demonstration of its 'specific biological value'; his classical experiments on the need for accessory factors in normal diets (by which he is best known to the man in the street); and his isolation of the cell-catalyst, glutathione (which will perhaps prove scientifically the most significant of all his contributions). As he once himself half-humorously said, the scientist who wishes to become famous should first discern where the next important advance is likely to come, and should then take care to be the first to start work there himself! But what, with typical modesty, he refrained from acknowledging was his own uncanny instinct in scenting a trail and his rare experimental skill in following it up. He certainly started many a scientific hunt, from which great treasures have come, and are still coming. One reason perhaps was in his mode of approach. As an American pupil of his once remarked: 'The other lecturers in this University talk to you about the dope which is already known; "Hoppy" points out what we still don't know and still need to know.' The latter approach, in any lecture delivered by 'Hoppy' (the name by which he was always affectionately known, and was glad to be addressed), in his own inimitable way, could be the more invigorating of the two.

But 'Hoppy' himself would probably have been most proud to know that, in the eyes of his fellow workers, his greatest contributions were those which would not appear in *Who's Who* or the official records: that he had inspired and encouraged generations of younger men, so many of whom are now to be numbered among the most eminent leaders in the world of medical and scientific learning—it would be invidious even to begin enumerating them; he would be glad, too, that it was appre-

* *The Lancet,* 24 May 1947. This obituary is, by permission, largely based on the Biographical Memoir contributed by the writer to that journal.

ciated that he was the founder of the world's most distinguished, and almost its earliest, great School of Biochemistry, which has spread its influence all over the world. Hopkins's charm of manner, and natural modesty of disposition, were proverbial. Unusually slight in build, he had nevertheless an unmistakable dignity of carriage and, indeed, a handsome presence, which at once commanded notice. Ever kindly and approachable to all, devoid of the slightest particle of 'side', he won the affection and respectful admiration of his subordinates from highest to lowest.

Born in Eastbourne in 1861, Frederick Hopkins lost his father when a small child. The confinement of school life did not appeal to one of his inquiring and roaming outlook and, after being privately educated, he was for a short time, at the age of 17, placed with an insurance company in the City. His own bent, however, had always been scientific, and he soon determined on other courses. In turn he assisted Dr Percy Faraday Frankland at the Royal School of Mines at South Kensington, attended lectures at University College, became an Associate of the Institute of Chemistry, and then received an appointment as analytical chemist under Sir Thomas Stevenson, the Home Office analyst and medical jurist at Guy's Hospital. He was considered at one time as destined to succeed Stevenson, but wisely decided to join the medical school at Guy's and become medically qualified. This early scientific discipline as an analyst, combined with his interest in living things, provide perhaps the clue to his later achievements. For, on the technical side, his investigations consisted essentially in applying the scientific skill, resource, neatness and precision of the expert analyst to the processes of separation, isolation and identification in the immensely complicated chemistry of living matter.

Hopkins's scientific papers possessed a literary distinction and distinctiveness, being customarily cast in the form of a persuasive narrative, subtly phrased, and with something of the black-and-white contrasts of a Macaulay.

It is perhaps possible to trace a continuity throughout Hopkins's, at first sight, extremely varied researches. As a youth he had been interested in natural history, especially in lepidoptera (his first publication was a note contributed at the age of 17 to a naturalists' magazine), and his first researches were concerned with a pigment in butterflies' wings—a fascinating problem with some unexpected connexions, and to which he returned in later life. The pigment proved to be a uric-acid derivative, and this led him to devise an improved technique for estimating uric acid. Interest in uric acid focused his attention on the supposed influence of dietary protein on uric-acid output—and so began the experiments with purified proteins and artificial diets.

Towards the end of the century Hopkins had been called to Cambridge by Sir Michael Foster, then Professor of Physiology, to develop chemical physiology (as it was then called), and he remained in Cambridge for the rest of his life. His first great discovery there was the isolation and identification with S. W. Cole in 1901 of the amino-acid, tryptophan (Hopkins & Cole, 1901 *a, b*, 1903), and later with Edith G. Willcock he published one of the earliest researches on nutritionally essential amino-acids showing that zein, an incomplete protein of maize, could be improved nutritionally by the addition to it of tryptophan (Willcock & Hopkins, 1906-7).

Animal feeding studies of this kind with purified diets soon convinced Hopkins, as

they had convinced others before, that normal growth could not be sustained on the known major constituents of diets, and that still unidentified 'accessory food factors' were needed in addition. But Hopkins went one step further than any of his predecessors in suggesting that these accessory factors present in *normal diets* were one and the same as the substances needed to prevent *deficiency diseases.* As he put it in a lecture to the Society of Public Analysts in 1906:

'In diseases such as rickets, and particularly in scurvy, we have had for long years knowledge of a dietetic factor; but though we know how to benefit these conditions empirically, the real errors in the diet are to this day quite obscure. They are, however, certainly of the kind which comprises these minimal qualitative factors that I am considering' (Hopkins, 1906).

It was very appropriate, therefore, that a good many years afterwards, when the new view had become firmly established, Hopkins was to share a Nobel Prize in Medicine with Eijkman who had been the first in 1890 to produce a deficiency disease (beriberi) experimentally and to recognize (along with Grijns, 1901) that it was due to the lack of something from the diet.

Hopkins's famous paper in the *Journal of Physiology* (Hopkins, 1912) ('Feeding experiments illustrating the importance of accessory factors in normal dietaries') did more than anything to convince his contemporaries of the truth of the then still heretical doctrine that man cannot live by fat, protein and carbohydrate alone, but that organic accessories are necessary. After this, progress was rapid, although Hopkins himself published relatively little more on the subject; the 'vitamin hypothesis', as it was at first, grew into a reality.. .and the number of vitamins still grows!

In the meantime, Hopkins's association in Cambridge with a leading expert on muscle physiology, Dr W. M. Fletcher (later Sir Walter Morley Fletcher, first Secretary of the Medical Research Council), led to their collaboration in the celebrated study which helped to clarify the phenomenon of the production of lactic acid in muscular activity.

Returning to his interest in accessory factors, Hopkins turned his attention to the sulphur-containing substances in food, and eventually traced the *sulphydryl reaction* back to its source. By 1921 he could announce the isolation of the 'autoxidizable constituent' of the cell, which he named glutathione. In 1929 he established its precise constitution as a tripeptide. From glutathione, followed other important studies relating to tissue oxidation.

In all, he published around 100 papers, including scientific communications, presidential and inaugural addresses, etc.

One of Hopkins's last public appearances was at the inaugural meeting of The Nutrition Society in Cambridge in 1941, when he gave an inspiring Introductory Address, in which he looked back over the past half-century's work and concluded by blessing the new venture.

Despite declining health and a growing loss of sight in his last years, he retained his intellectual vigour and all his kindness and personal charm and magnetism.

In his early days at Cambridge Hopkins had been Supervisor of Medical Studies at Emmanuel College, but in 1910 his election into an honorary 'Prelectorship' in

Physiological Chemistry at Trinity College enabled him to devote his time more fully to his own subject of biochemical investigation and teaching. In 1902 a University Readership in Chemical Physiology had been created for him and in 1914 a special Professorship in Biochemistry; and in 1921 he became the first holder of the Sir William Dunn Chair of Biochemistry and head of the associated Sir William Dunn Institute. He was an original member of the Medical Research Council and the first Chairman of its Accessory Food Factors Committee, a member of the Advisory Committee on Nutrition, set up by the Ministry of Health, as well as of many other commissions, committees and official bodies. He was elected a Fellow of the Royal Society in 1905, with Fletcher gave the Croonian lectures in 1915, and became President of the Royal Society in 1931. He was knighted in 1925, was Chairman of the British Association in 1933 and Vice-President of the Chemical Society in 1921. Among his numerous honours and distinctions may be counted the Royal Medal (1918) and the Copley Medal (1926) of the Royal Society, the Baly Medal of the Royal College of Physicians (1915), the Society of Apothecaries' Medal (1928) and the Albert Medal of the Royal Society of Arts (1934), and above all the Order of Merit (1935) and the Nobel Prize for Medicine (1929).

He is survived by his life's comrade and helpmate, Lady Hopkins, who before their marriage in 1898 was Jessie A. Stevens. Their son, Dr Frederick Hopkins, is a physician, and their two daughters Mrs Barbara Holmes and Mrs Jacquetta Hawkes are well known for research and publications in Biochemistry and Archaeology, respectively.

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