Nutritional Biochemistry and the Discovery of Vitamins: the Work of Elmer Verner McCollum

The “Vitamine” Hypothesis and Deficiency Diseases

Studies on Experimental Rickets. XXI. An Experimental Demonstration of the Existence of a Vitamin Which Promotes Calcium Deposition

The Effect of Additions of Fluorine to the Diet of the Rat on the Quality of the Teeth
(McCollum, E. V., Simmonds, N., Becker, J. E., and Bunting, R. W. (1925) J. Biol. Chem. 63, 553–562)

Elmer Verner McCollum was one of the giants of nutritional biochemistry. He was born and raised in Kansas and attended the University of Kansas. His studies were initially directed toward medicine, but he eventually decided that chemistry better captured his interests, and he completed his work for a Masters degree in chemistry at Kansas. He was accepted into the Ph.D. program at the Sheffield Scientific School at Yale. One of his classmates at Yale was Stanley R. Benedict, the subject of a previous JBC Classic (1).

McCollum completed his Ph.D. work in 2 years and, given the lack of university positions, stayed at Yale for another year working with T. B. Osborne and Lafayette B. Mendel on problems of plant protein composition and diet. This work was influential to McCollum’s career, and Mendel helped McCollum secure a faculty position at the University of Wisconsin. (The work of Osborne and Mendel was the subject of a previous installment of JBC Classics (2).)

On arrival at Wisconsin, McCollum was assigned to the famous heifer project. Three groups of heifers were fed restricted diets from single plant sources: wheat, corn, and oat. A fourth group of animals was fed all three plants. The animals fed all three plants did remarkably better, but there was no satisfactory explanation for the difference. McCollum decided that “the most important problem in nutrition was to discover what was lacking in such diets” (3).

He decided that nutritional studies would benefit from using small animals with short lifespans. He started with a colony of wild rats he had captured himself, but these quickly proved unsatisfactory, and he persuaded his Dean to allow him to purchase 12 albino rats even though the purchase was with his own funds. This colony of rats was the first established in the United States for nutritional studies (3).

McCollum first proposed that the nutritive failure of certain diets was due to a lack of “palatability.” He proposed that if a diet could be made to taste good with flavor additives and the animals induced to eat larger quantities, the diets would be adequate. This hypothesis, and the supporting data, were criticized by Osborne and Mendel who demonstrated that plant protein diets were not adequate unless protein-free milk was added as a supplement. In some of their papers, Mendel and Osborne suggested that McCollum had been careless in some of his experiments (3). This criticism was no doubt painful especially coming from his mentors at Yale. McCollum acknowledged this error and rededicated himself to more careful analyses including an analysis of the growth-promoting factor(s) in protein-free milk, which then led to the isolation of the first known fat-soluble vitamin, later to be called vitamin A.
In 1916 McCollum and C. Kennedy, concerned with the growing confusion about nomenclature for dietary factors, proposed an alphabetical designation preceded by a notation of the solubility of the factor, thus fat-soluble A and water-soluble B. This was the beginning of the common nomenclature for vitamins.

In 1917, McCollum accepted the position of professor and head of the Department of Chemical Hygiene, later Biochemistry, in the newly formed School of Hygiene and Public Health at Johns Hopkins University. He had a distinguished research career supplemented by great public service including service on many government boards and panels and international nutrition organizations. Through his research and public service, McCollum, probably more than anyone, influenced human dietary policy and practices. In a commentary on his life, Time magazine stated, “He has done more than any other man to put vitamins back in the nation’s bread and milk, to put fruit on American breakfast tables, fresh vegetables and salad greens in the daily diet” (3).

McCollum was involved in many policy debates including one over the best strategy to fortify bread. He had shown, and publicized, that white bread was nutritionally deficient. With the development of synthetic vitamins, it was proposed that bread and flour be enriched with thiamin, niacin, and iron. This effort was lead by the Food and Nutrition Board of the National Research Council. McCollum was a member of the Board but disagreed and was strongly critical of the recommendation because supplementation with such nutrients failed to make up for all the losses suffered during milling wheat. As a result of his disagreement with the other members of the Board, his Board colleagues changed his status from Board member to panel member. As a panel member he was not invited to any of the Board meetings (3).

The McCollum papers reprinted in this installment of JBC Classics are intended to represent a career. The first paper describes the controversy of the time about the “vitamine hypothesis” and also presents the kind of data characteristic of nutritional studies for many years. The second paper details the discovery of a growth substance distinct from vitamin A, later known as vitamin D, and necessary for bone formation. The third paper describes the role of fluoride in preventing tooth decay and eventually led to the widespread addition of fluoride to water supplies and toothpaste and a dramatic reduction in the frequency of dental caries in the United States.1

1 Harry G. Day was a student in McCollum’s department at Johns Hopkins. He, along with his students and colleagues at the University of Indiana and collaborators at Procter and Gamble, developed stannous fluoride as the first fluoride supplement for toothpaste, i.e. Crest.
McCollum was a member of the *Journal of Biological Chemistry* (JBC) Editorial Board and, in 1927 and 1928, President of the American Society of Biological Chemists (ASBC).

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REFERENCES
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