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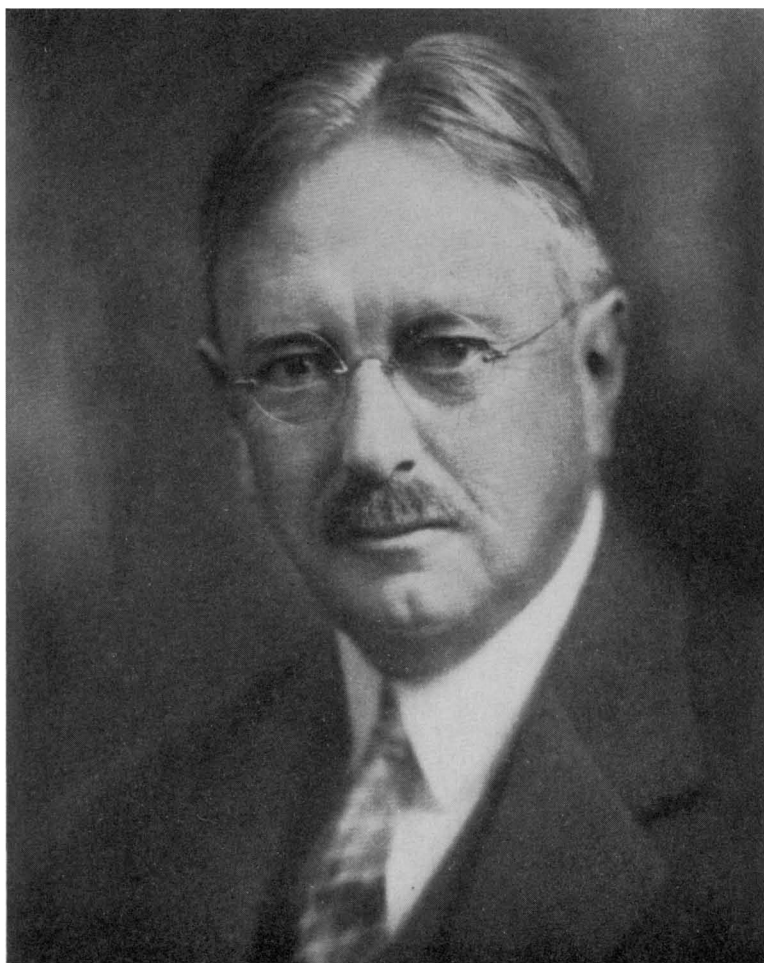
GRAHAM LUSK

1866—1932

BY

EUGENE F. DU BOIS

PRESENTED TO THE ACADEMY AT THE AUTUMN MEETING, 1939



Graham Lusk.

GRAHAM LUSK

1866-1932

BY EUGENE F. DU BOIS

The great life work of Graham Lusk was inspired by his father and by his teacher, Carl Voit in Munich. When Lusk returned to America he strove for an orderly development of the science of nutrition. His own discoveries, though of considerable importance in themselves, served chiefly in illuminating the whole field. In the light shed by his own experience he was able to judge the value of the work of others, interpret, synthesize. He was devoted to the science of nutrition and in time he brought order out of chaos. His work fell in the period of great developments in chemical energy transformation before the studies on the vitamins changed the whole trend of investigation. It does not matter how relatively important the vitamins may be. They do not in any way diminish the absolute importance of the metabolism of foods and the energy requirements.

Graham Lusk was admirably equipped to develop a field of science in our country. He was endowed with boundless enthusiasm, a fixity of purpose and a clear vision of his ideals in research and scientific education. For the attainment of these ideals he employed every resource. He was supported by his family traditions, his position in the social life, aided by his buoyant personality, his gifts as a lecturer. All of these were subordinate to the brilliant idealism that dominated his life and governed his success.

Lusk did not make discoveries in metabolism as important as those of Rubner, but it is doubtful if the importance of Rubner's discoveries would have been realized had it not been for Lusk. He never announced startling findings that set the scientific world agog, bringing a harvest of publicity and medals, but his quiet work often disproved those very experiments and theories that had won renown. Medals are given for the announcement of new discoveries. The man who shows the discoveries are wrong gets no medal; nothing but the satisfaction that he has helped to guide his group of fellow investigators out of a desert

beset with dangers. Lusk liked to set things straight and I doubt if any man enjoyed more heartily a good controversy. He would gird his loins and plunge into the fray, followed by his students who loved to watch him in combat. He fought fairly, retaining the friendship and admiration of his opponents.

It would be impossible to appreciate the career of Graham Lusk without a knowledge of his family background. The first of the family in this country was Stephen Lusk, who migrated from Scotland to Wethersfield, Connecticut, in 1702. The family was distantly related to Sylvester Graham, after whom Graham bread was named. The Lusks remained in Connecticut for many generations and the stock represents well the prosperous, educated natives of that state.

His grandfather was Sylvester Graham Lusk, his father, William Thompson Lusk, who was born in Norwich in 1838. His mother was Mary Hartwell Chittenden of New Haven, a thoughtful, cultivated, intellectual woman. Her father, Simeon Baldwin Chittenden, who married Mary Elizabeth Hartwell, was the seventh generation descended from William Chittenden, an original settler of Guilford in 1639. Simeon Chittenden was a prosperous merchant who lived most of his life in Brooklyn, an alert, aggressive man of great energy, conservative and charitable in his gifts. He served as Congressman for seven years.

Graham Lusk resembled his father, William T. Lusk, a practitioner of medicine, several generations ahead of his time. William T. Lusk went to Yale for a year, but left to study chemistry and physiology for two years in Heidelberg and one year in Berlin. In 1861 he rushed back to this country and volunteered in the army where he was in the thick of the fighting until 1863, retiring with the rank of captain and assistant-adjutant general. His war letters (1)*, published privately by his family, are written with humor and vigor and make excellent reading. After leaving the army he studied medicine at the Bellevue Hospital Medical College, an institution in which he, and later his son, taught for many years. Soon after his graduation he married and went abroad for study in Edinburgh, Vienna, and Prague. When he

(1)* This and similar numerical references are to the titles listed under "Other References" and "Tributes" at the end of the memoir, pages 141 and 142.

returned, he practiced medicine for a year in Bridgeport, Connecticut, and it was in this city that Graham was born. In 1866 he returned to New York where he practiced medicine, devoting particular attention to obstetrics. In 1869 he was made Professor of Physiology and Microscopic Anatomy in the Long Island College Hospital. In the winter of 1870-71, at the request of Dr. Oliver Wendell Holmes, he delivered a course of lectures on physiology at the Harvard Medical School (2), being the first lecturer in this subject who gave experimental demonstrations. This course was very successful and he was offered the chair by Harvard a few hours after he had accepted the professorship of Obstetrics and Diseases of Women and Children at the Bellevue Hospital Medical College. Although William T. Lusk became famous as an obstetrician, he never lost sight of his training in physiology. His well-known book, "The Science and Art of Midwifery," which appeared in 1882, was written with physiology as a background. It went through four editions and was translated into four languages, French, Italian, Spanish, and Arabic. The senior Lusk published many papers, the most prophetic being, "Origin of Diabetes with Some New Experiments Regarding Glycogenic Function of the Liver."

William T. Lusk practiced medicine from the standpoint of a man trained in physiology and research, well acquainted with the best laboratories and clinics in Europe. He was surrounded in New York by physicians of the old school, all but a few of these ignorant of the fundamental sciences. It was an era of bitter controversies and open warfare between the faculties of the various medical colleges. With his army training, he was a good fighter, sometimes impulsive, but just and magnanimous, and a generous antagonist. Graham Lusk, until the age of thirty-one, was in close touch with his father and always revered his memory. His example was constantly in his mind and he strove to reform medical education so as to give the students the training and point of view that had made his father a leader in his profession. Graham Lusk was as fearless as his father and fought just as strenuously in any cause that needed his support. He lived to see the medical profession in his city grow out of the belligerent attitude of his youth and he himself helped

to eliminate personalities and jealousies, and bring the discussion to a consideration of policies rather than politics.

Graham Lusk was born in Bridgeport, Connecticut, on February 15, 1866, the family moving to New York for permanent residence a few months later. His mother died when he was five years old, leaving three other children, Mary Elizabeth, who married Cleveland Moffett, William Chittenden Lusk (3), who became a prominent surgeon in New York, and Anna Hartwell Lusk, who is still living. His father married again in 1876 and the only child of this union, Alice, married Dr. John Clarence Webster.

Graham prepared for college at the Berkeley School. At the age of sixteen to seventeen he travelled in Europe. He entered the School of Mines, Columbia University, from which he received the degree of Ph. B. in 1887. On account of an increasing deafness, his father persuaded him to give up the idea of the practice of medicine and he went abroad, intending to study chemistry and physiology under Hoppe-Seyler. In Munich he visited von Winckel, the obstetrician who was a friend of his father. He had never heard of Carl von Voit until Winckel gave him a card of introduction, and it was a pure piece of luck that he became his pupil.

In a delightful address, "Carl von Voit—Master and Friend", delivered in 1930, Lusk describes his student days in Munich.

"My first interview with Voit was disappointing. I could not enter his laboratory for a year. I must first hear his lectures, taking his practical course (in which a dozen students stood up for two hours and watched the professor make experiments), and take anatomy under Rüdinger and histology under Kupfer. This was quite as it should have been, though it was hard for me to realize it at the time.

"Voit's lectures were a delight to me. He read them from a text. If he wished to interpolate matter there was no change in the smoothness of delivery; he spoke as though the new ideas were being read from manuscript. He was very short-sighted and only on rare occasions raised his eyes from his manuscript. This happened if he heard a noise in the room; he stopped, glared at his audience, his eyes flashed fire, a few enraged words followed, and then the lecture went on as peacefully as though nothing had happened. The class never forgot the lesson; it

knew its master. True to the German form, the presentation of the scientific facts was always preceded by a short description of the historical development of the subject. . . .

"The Munich of the day of which I speak was a simple old-fashioned German town. The first summer that I spent there I lived on the Karlstrasse, having taken a room above a beer hall at five dollars a month. The good Frau who rented the room gave me a roll without butter and a cup of coffee in the morning for five cents. When my friend, I. N. Phelps Stokes, the man who has written of New York City the most notable history of a city ever produced, joined me for a month, a second bed was put in the room and the cost was raised by five marks a month. That made a rental charge for a furnished room of \$3.10 apiece a month. Out of the window we could see the Munich cab drivers who patronized the beer tap below and who ate the same coarse rye bread which they fed to their horses. . . .

"Professor von Winckel was notably kind to me. I went to his home to dinner often on Sunday noon when the unmarried and married children and the grandchildren gathered around a bountiful table. They were all my good friends. I attended a large entertainment there. I got into a dispute with a German about the relative beauty of German and American women. 'Ah,' said he triumphantly, 'the woman now entering is the most beautiful woman in the room. Have you any like her in America?' 'She is an American,' replied I. 'Impossible,' exploded the German. He turned to inquire of his neighbor and the argument stopped. It was Frau Hanfstengel, who had been a Miss Sedgwick, of Stockbridge, Massachusetts. . . .

"Munich, the Isar Athens, which had been the home of Liebig and Wagner, and was then the adopted home of Ibsen, Munich with its Frauenkirche, its distant view of the snow-covered mountains of the Tyrol, its companionable people, this was the true soul of Germany to me, and I sought to understand it and be absorbed by it.

"After a year of probation I entered Voit's laboratory, and in 1888 he gave me a problem on diabetes to investigate. Curiously enough, in 1871 in volume I of Maly's Jahresbericht, is recorded under the index head Diabetes an abstract of an article by my father. So in each decennium for sixty years articles bearing the family name have appeared on this subject.

"The professor having outlined the problem, his assistants gave me every necessary help. Herr Seidl, the town baker, prepared a batch of zwieback and then prepared crisp gluten bread which was free from carbohydrate. For the first period my daily diet consisted of coffee, steak, 500 grams of zwieback,

butter, and with each of the two main meals a pint of wine. After three days the zwieback was replaced by an amount of gluten bread, the nitrogen content of which exactly corresponded to that in the discarded zwieback. The 500 grams of zwieback daily gave me the subjective sensation of having deposits of glycogen in the brain, whereas the gluten bread in its turn tasted like wall paper. Dropping the carbohydrate in the zwieback, but continuing the nitrogen intake at its previous level by ingesting gluten bread, led to a great increase in protein metabolism and demonstrated the protecting power of carbohydrate over such metabolism. The article concerned with this work was written entirely by Voit and appeared in the *Zeitschrift für Biologie* under my name. When I remonstrated and told Voit that his name should be there also he replied, 'Da ist es—' 'Aus dem physiologischen Institut zu München.'" Dr. Welch read the article at home and spoke to my father about it. I felt exalted.

"At Columbia my instructors had been of two types, gentlemen who were good teachers who did not know very much, and rather rough people who knew a great deal. In Munich, for the first time in my life, I had found a teacher who represented a highly developed form of culture which was both intellectual and personal. . . .

"The laboratory, with Wilhelm Prausnitz and Max Cremer as first and second assistants, was a happy, friendly place. One day I burned my hand with ether. To relieve the pain a servant was sent to buy cocaine which cost \$1.75. I offered to pay for it, but money was refused. I was told I had done so much for the state that state funds would care for me in this trouble. What had I done for the state? I had given sugars, including some levulose, at that time a rare sugar which I had prepared myself, to divers rabbits, and had analyzed their livers for glycogen and their intestinal tracts for sugar. This was a new conception of service for the welfare of the state. It determined my attitude that qualified workers who would give their time to research should be given every laboratory aid humanly possible. . . .

"Voit never attended scientific meetings or congresses except the meeting of the local scientific society, at which the members could take supper and at which all drank beer during the proceedings. Only through his *Zeitschrift für Biologie* did he rub shoulders with the world. Once shortly after a violent polemical dispute of his with Pflüger I happened to be in Bonn and met Pflüger through the influence of an American woman, the daughter of William Walter Phelps, one who had married Franz von Rothenberg, one of Bismark's lieutenants and who, retired, was then the financial agent of the Prussian government by whom

the professors were paid. Pflüger appeared to me to be German of the highest type and in many ways reminded me of Voit himself. He was willing to admit privately that sugar might arise from protein in metabolism, but in his literary productions in *Pflüger's Archiv* at the time he was violently against the proposition.

"When I saw Voit a few days later he was dumbfounded to learn that Pflüger had received me, knowing whose pupil I was. He told me I had been in the lion's den. When I said that Pflüger would admit the possibility of the production of sugar from protein he replied that the lion would soon become tame.

"Voit always manifested the greatest interest in a new discovery. The figures were 'sehr schön,' he would say. My colleague Jackson has poked fun at me for talking about 'a perfectly beautiful experiment.' I think this must be the unconscious translation of 'ein sehr schöner Versuch,' words so often used by Voit.

"Voit, when I first knew him, was fifty-five years old, medium in size, keen-eyed, alert, with a quick walk, of quiet, dignified, courteous bearing. He knew that he was the founder of modern metabolism research, and yet he was in many ways as simple as a child, as simple as a German scholar of the old school, I might have said. After I had been in Munich three years he, in greeting my father, held out both his hands, exclaiming, 'Und das ist der Papa.' He invited me to dinner with the words, 'We have said to one another we must have Herr Lusk meet us in the family, and you will come, will you not?' Of course I went. One of the daughters served the dinner. The first assistant in his laboratory had never been asked into his home. Later Mrs. Lusk and I were always invited to dine with the family whenever we went to Munich. . . .

"I have a few old letters which I have translated and which illustrate better than my own words the causes of Voit's influence over me. There is constant emphasis on scientific work."

Space permits the quotation of only one of these, written on the occasion of Voit's seventieth birthday.

"Munich, Sept. 26, 1901.

"Dear Colleague,

"You had the goodness and friendliness to remember my seventieth birthday by contributing to the marble bust given me by my pupils and also by writing a paper 'Ueber den Phlorhizindiabetes,' for the *Festschrift* of the *Zeitschrift für Biologie* which was dedicated to me. It was a great pleasure for me that my old students, who since 1863 have grown to a

great number, thus recognized my efforts and showed their devotion. You are one of my most faithful and most grateful pupils, and it gave me much pleasure to find you among those who participated. I have read with great interest your valuable contribution, especially your proof that sugar does not arise from fat in phlorhizin diabetes. From this I have again seen that you are independently capable of expanding the work which I began and of promoting science. I thank you affectionately for the love and the good which you have done me and I beg you furthermore to preserve your love for me.

“Ihr getreuer alter Lehrer

“CARL VOIT.”

Voit died on January 31, 1908, aged seventy-seven years. He suffered from a diabetes of long standing.

Lusk received the degree of Ph. B. in chemistry from von Baeyer in the University of Munich in 1891. He brought back to America all that was best in Voit's laboratory and with it a long heritage, almost an apostolic succession. One of his pupils dedicated a book on basal metabolism (4)

To

Graham Lusk

Pupil of Voit

Pupil of Liebig

Pupil of Gay-Lussac

Pupil of Bertholet and Laplace

Pupil of Lavoisier

Perhaps the most important thing that Lusk brought back from Germany was the memory of one sentence. The incident is described only in a brief autobiography, which according to his directions was to be confidential until his death—“About this time (1891) my father and I called on Voit in the Munich laboratory. Voit, in talking with him, recounted the celebrated names in German physiology, Du Bois-Raymond, Ludwig, and others; mentioned those of his own age, Heidenhain, Pflüger; stated that the quality of men was deteriorating, that Englemann, recently appointed at Berlin to succeed Du Bois-Raymond, was a very good physiologist but no proper successor to the chair formerly held by Johannes Müller, and that of promising men

of forty years of age there were none; then he added, 'perhaps your son will become one.' I recall these words because I was not at that time, at the age of twenty-five, conscious of having any capacity for planning any piece of creative work, and also to illustrate how the confidence of a beloved and admired teacher may stir the ambitions of a young man. I have never repeated this story to anyone."

Lusk's friends in Voit's laboratory were Max Cremer, Erwin Voit, Carl's brother, Fritz Voit, Carl's son, Otto Frank, and W. Prausnitz. He came to know well many other pupils of Voit, Max Rubner, Friedrich von Müller, W. O. Atwater and E. P. Cathcart. Except for a brief period during the war, Lusk kept up a constant correspondence with Germany and made many visits to the laboratories. Although he had numerous friends in all the countries of Europe, his closest contacts were with Germany and England.

When Lusk returned to America he was appointed instructor in physiology at Yale University, was advanced to assistant professor in 1892, and to professor in 1895. As head of this department he was given a very small salary, but fortunately did not depend on this as his grandfather S. B. Chittenden had, a few years previously, left him with sufficient means to relieve him from any early financial struggles. Russell H. Chittenden quotes a letter written by Lusk to a friend under date of February 2, 1931.

"When I was twenty-five years old I found myself the head of a department of physiology at a salary of \$300 per annum with an allowance of \$150 annually for apparatus. The department consisted of one room in the old building at 150 York Street. Here Dr. L. C. Sanford and I brought up some pigs on the bottle and here the phlorhizin work on rabbits was started. I did all the cleaning and I mopped up the floor myself. . . . Later a new laboratory building was built in the yard of which I had an entire floor . . . and at last I had someone to wash dishes. Here phlorhizin brought new information from dogs. . . . I never had an assistant while I was in New Haven. My salary and that of the other professors had been raised to \$500 before I left. . . . In New Haven my life was one of peace for seven years."

Life must have been pleasant in New Haven for he had many friends and enjoyed the opportunity for riding and driving. His reputation was increasing and it is not surprising that in 1898 he was called to the chair of physiology in the New York University and Bellevue Hospital Medical College in New York City, an institution with which his father, who died in 1897, had been long connected. On December 20, 1899, shortly after coming to New York, Graham Lusk married May Woodbridge Tiffany, daughter of Louis C. Tiffany, the artist and designer of glass. He was fortunate in a devoted wife who sympathized heartily with his ideals and enjoyed the academic life and the many visits to the research centers of Europe. Lusk's home at first at 11 East 74th Street was a center for physiologists of all nations and the dinner parties at this house did much to cement the bonds between the laboratories of our country and Europe. It was in Lusk's library that two important societies were formed, the Society for Experimental Biology and Medicine in 1903, and the Harvey Society in 1905. The Lusks took their vacations in the Adirondacks and later at their beautiful summer home at Syosset, Long Island, adjoining the large estate of Mr. Tiffany. There were three children, William Thompson Lusk, Louise, wife of Collier Platt, and Louis Tiffany Lusk.

Here in his native town, New York, Graham Lusk found greater opportunities, better equipped laboratories, and the stimulating task of instructing large numbers of students. In an address, "Scientific Medicine—Yesterday and Tomorrow", written in 1919, he describes the status of clinical medicine at the end of the last century. He quotes a letter from his life-long friend, Theodore Janeway, then twenty-seven years old. The younger Janeway had hopes that in coming to teach at the Bellevue school "he could take some part in the advance of true medical knowledge and not merely diffuse what is already known." He concludes his letter:

"I trust it will be possible for me to keep in touch with your work and Dr. Dunham's next winter and especially with your enthusiasm, and that I may be able to persuade the students to

regard symptomatology as the physiology of the 'sick life'. It will certainly be a most interesting experiment from my side."

Lusk goes on to say :

"This letter gives no picture of New York medicine as it was then. One should remember that Meltzer, at the time, was a practicing physician, snatching such moments of rapture as were his when he drove down Fifty-Ninth Street, tied his horse to a lamp post near the P. and S. and, with his coachman who acted also as laboratory servant, entered the dingy recesses of that college and ascended to the laboratory of physiology, there to perform some fundamental experiment, perhaps one on the nature of shock, for example. At that time Herter had just undergone metamorphosis from a specialist in nervous diseases into a physiologic chemist. Park had established a modern laboratory in the board of health. But besides this there was little to encourage the adventurer into clinical science. As matters of fact be it recorded that a few years later the medical faculty to which Janeway was attached refused him a teaching position in Bellevue Hospital, though the salary belonging to the position had been raised from outside sources, and the same faculty held a solemn, special meeting to discipline me because I had publicly before the students expressed opinions favorable to the Johns Hopkins Medical School.* These were days when there appeared to be no future for clinical science, days in which there was almost no intellectual, social or financial influence making for its welfare. And yet we in this country, since that time, have made great headway in this direction, not on account of the influence of any special men, but because the principle that the primary mission of a medical school, 'to take some part in the advance of true medical knowledge and not merely to diffuse what is already known,' is everlastingly right."

Graham Lusk must have been a vigorous crusader even in these early years. He was in his home town, surrounded by influential friends, steeped in the best traditions of German science. He was always fearless, ready to combat single-handed a great foundation or faculty of a medical college. One can picture his amusement and gratification when he was solemnly rebuked in a faculty meeting for having praised the work of a

* One of Lusk's contemporaries has pointed out that Lusk was impatient in his efforts to reform clinical medicine. He tried at times to push men when their teachings were so far above the heads of the students that they could not be appreciated. There were probably a good many factors in this protest from the faculty.

rival institution. He considered this one of the highest honors he had ever received.

At the Bellevue Medical College he was happy in his association with Theodore Janeway, E. K. Dunham, W. H. Park, George B. Wallace, John Mandel and Arthur R. Mandel. He was perhaps unhappy in the attitude of the heads of the clinical departments of his own and other medical colleges who were products of the old school. Fortunately he had good assistants, P. G. Stiles, A. R. Mandel, A. I. Ringer and John R. Murlin. He secured a small Pettenkofer-Voit respiration apparatus for the study of dogs with phlorhizin diabetes. He continued his work on carbohydrates, employing as a tool his discovery in New Haven, that in the glycosuria produced in dogs by the administration of the drug phlorhizin the D:N ratio was 3.75. In other words, the dogs excreted in the urine 3.75 grams of dextrose for every gram of urinary nitrogen. Since one gram of nitrogen in the urine indicated that the dog had metabolized 6.25 grams of protein, this meant that a little more than half a gram of carbohydrate could be formed from the metabolism of one gram of protein. Later he found that different amounts of dextrose were derived from the different amino acids which constitute the protein molecule. It required extreme care to secure complete phlorhization of the dogs and exclude the dextrose derived from stolen food or glycogen stored in the liver. Lusk's whole life was plagued by experimenters whose phlorhizin technique was faulty.

Some of the work published in this period was so far in advance of its time that it was neglected. For example, in a paper with Mandel, published in 1903, he said, "The calories lost in urinary sugar in diabetes are compensated for by the increased proteid metabolism. In a diabetic dog, whether he be fasting or fed on meat alone or on fat alone or on meat and fat together, no more fat is burned than in the same dog when he is normal and fasting."

This was a fundamental discovery neglected by practically everyone except Lusk and his pupils. The literature on diabetes for many years was filled with calculations based on the food consumed, not the food metabolized. It was about ten years

later that others began to grasp this idea. E. P. Joslin, at the memorial meeting to Graham Lusk held in 1932 (23), through a natural error, mistakenly ascribes this concept to one of Lusk's pupils working on human diabetes under Lusk's direction. Joslin says: "He who runs may read that, despite all your elaborate formulae, it is not what a diabetic patient is supposed to eat or does eat, but what the calorimeter proves that he burns which counts. Any doctor who has once fully grasped that idea will make few errors in the dietetic treatment of his diabetic patients."

In another paper describing the influence of cold and moderate exercise on the sugar excretion in phlorhizin glycosuria, in 1908 Lusk says: "It is therefore apparent that an amount of work capable of more than doubling the fat metabolism has no effect whatever on the sugar output in a case of total phlorhizin glycosuria. Hence sugar is not derived from fat in metabolism." Further on he says, "This discussion does not exclude the possibility that after *large* fat ingestion a certain quantity of dextrose may be formed from the quickly absorbed glycerine component of fat. But this result has never been seen in this laboratory." Lusk held this opinion until his death. He and all his pupils fought vigorously the theory that in diabetes glucose could be formed from the metabolism of fatty acids.

In another paper on phosphorus poisoning in dogs (1907) fever was produced and the metabolism was raised "perhaps on account of the fever and perhaps on account of the specific dynamic action of the increased protein metabolism."

At this early period Lusk had established the main facts in the metabolism of diabetes and fever. He had investigated with Mandel a case of human diabetes of maximum severity and had confirmed on man his discoveries made on dogs. Although he had never studied medicine, he knew more about diabetes than any physician. In November 1908 he delivered his Harvey Lecture on Metabolism in Diabetes, treating the subject from the viewpoint of the intermediary transformations of protein, fat and carbohydrate. Using eighty-three references he gave a condensed review of the important studies in this field, discussing particularly the severer manifestations of the disease.

In this lecture were laid down the principles which directed the laboratory and clinical studies of diabetes for the next two decades.

In the introduction to this discussion Lusk gave a quotation which coincided so closely with his own views that it may be considered as the guiding principle of his life work. He said, "Some may question the right of a laboratory man, a physiologist, to present to medical men a scientific discussion of a diseased condition. In defense I can only quote to you the stirring words of Magendie, written in Paris as long ago as 1836, as an introductory to his 'Elements of Physiology'; a copy of which I inherited from my father's library. Magendie said: 'In a few years physiology, which is already allied with the physical sciences, will not be able to advance one particle without their aid. Physiology will acquire the same rigor of method, the same precision of language and the same exactitude of result as characterize the physical sciences. Medicine, which is nothing more than the physiology of the sick man, will not delay to follow in the same direction and to reach the same dignity. Then all those false impressions which, as food for weakest minds, have so long disfigured medicine, will disappear.'"

In 1909 Lusk was invited to take the chair in physiology at the Cornell University Medical College on 28th Street and First Avenue, New York City, two blocks away from the Bellevue Medical College. These two groups of medical teachers had split apart in 1898, as a result of some internal quarrel. William Mecklenburg Polk, Lewis Stimpson, and W. Gilman Thompson had secured an endowment from Col. Oliver Hazard Payne and had persuaded Cornell University to establish a medical school in New York City. By 1909 Graham Lusk's reputation and influence in American medical education had placed him at the head of his field and Cornell offered him every facility he could desire, including funds for the construction and maintenance of an Atwater-Rosa-Benedict respiration calorimeter. At the same time Cornell decided to cut down the number of students and admit only those who had completed the requirements for a college degree. With many regrets at severing his

official connections with Bellevue Medical College, Lusk accepted the chair at Cornell, taking with him his laboratory associates, John R. Murlin and A. I. Ringer.

In 1906, while still at Bellevue Medical College, Lusk had published the first edition of his famous book, "The Elements of the Science of Nutrition," dedicated to "Carl von Voit, master and friend from whom the author received the inspiration of his life's work." This contained three hundred and twenty-six pages. The second edition in 1909, four hundred and two pages, third edition in 1917, six hundred and forty-one pages, fourth edition in 1928, eight hundred and forty-four pages. Inasmuch as the importance of the material discussed in these successive volumes remained fairly uniform, the increasing number of pages in twenty-two years gave a good index of the development of the science during the period of Lusk's greatest productivity.

The first edition was largely devoted to the work of the German investigators and in it particular attention was paid to the fundamental discoveries of Carl Voit and Max Rubner. Rubner was a voluminous writer but his style was so difficult that even the Germans shun the task of digesting his works. Lusk had the training and patience which enabled him to recalculate Rubner's tables and set forth the findings in clear perspective so that they became available not only to the English-speaking world, but also to many Germans who read the English more easily than the original. The book rapidly became the standard textbook on nutrition, and what is more important, a source book for all who wrote on the subject. The reason for this is well expressed in the preface—"The aim in the present book is to review the scientific substratum upon which rests the knowledge of nutrition both in health and disease. Throughout, no statement has been made without endeavoring to give the proof that it is true."

Lusk's methods in preparing the four editions of this book may well serve as an example for all writers on scientific subjects. Material was collected every year and almost every week. There was no ghost writing, not even the delegation to others of the task of looking up references. Lusk was able to afford a large, private library, probably one of the most complete

libraries of nutrition ever assembled. He subscribed to all journals bearing on the subject and kept the bound volumes on shelves within easy reach. He had a large collection of reprints and a fair number of historical works. He read carefully everything of importance in English, German, and French, and knew enough of the Italian and Scandinavian languages to get the gist of the matter. Every worthwhile report was recalculated and often he was able to find many important facts that had been overlooked by the writers who did not possess his background. Abstracts were written in longhand on large sheets of yellow paper and many tables were copied. When it came time to prepare the manuscript, the material was again written in longhand. Only when it had been completed was it turned over to his secretary. Every reference and every figure was checked. There were extraordinarily few errors in his publications.

All who visited or worked in his laboratory remember the picture of Graham Lusk at his large desk, surrounded by journals, writing on the large sheets of yellow paper. His deafness was a protection and he did not realize your presence until you came close to his desk. You hesitated to disturb him, but if the matter were urgent you could attract his attention by twirling the revolving bookcase at his right hand. He responded invariably with a smile and cheerfully gave his valuable time to your own immediate problem. Investigators from all parts of the world came to his desk and if they so desired, he went over their tables and manuscripts, figure by figure, word by word. Then he would give freely his best ideas for new experiments.

Of course there were many interruptions. If he were running a calorimeter experiment, he could snatch at most half an hour between weighings. He had many conferences with his laboratory associates and with his pupils. His lectures to the students were prepared just as carefully as his publications.

In 1906 at the time of the first edition there had been relatively little fundamental work in this country on metabolism in health and still less on metabolism in disease. The second edition in 1909 contained more American references but did

not differ greatly from its predecessor. It was this edition that was translated into German by Hess in 1910. The third edition, published in 1917 and reprinted several times and revised in 1923, is much larger. The pessimistic remarks about the lack of interest in metabolism in the clinic are replaced by a note of optimism in this preface.—“Laboratory methods to explain the inner processes in disease have been applied to hospital patients for thirty years or more in Germany. In the United States great advances have lately been accomplished in this direction. If such investigations are still further promoted by their discussion here, this writing will not have been in vain.”

In the same preface he thanks his laboratory associates, Murlin, Du Bois, Ringer and Gephart, and goes on to say: “It is furthermore a privilege to recognize the great influence which a personal acquaintance with such men as F. G. Benedict and S. R. Benedict, Cathcart, Chittenden, Cremer, Dakin, Folin, Halliburton, Hopkins, Kossel Levene Magnus-Levy, Lafayette Mendel, Friedrich von Müller, von Noorden, Rubner, E. Voit and Zuntz has had upon the conceptions of the subject of nutrition as set down in this book.” In the preface to the fourth edition he added A. V. Hill and A. E. Taylor to this list. Lusk visited the European laboratories frequently. Every physiologist who came to America visited Lusk.

The third edition was much larger than the second, giving more space to the history of the science and to food economics. The laboratory studies of American investigators began to occupy a relatively large share of the pages. Many gaps made evident in previous editions were filled by the work of Lusk and his pupils. This was only natural as the yearly preparation of lectures to students brought forward questions that could be answered by experiments in the laboratories adjoining the lecture hall. Charts from Lusk’s own careful work made many problems clear.

The fourth edition, published in 1928, is an expansion of the third, bringing the subject up to date. Lusk intended this to be the final edition. It still had a large sale ten years after its publication. No book has taken its place. It is the “Bible”

of the nutritionists. One finds throughout the literature its sentences and paragraphs slightly disguised by paraphrasing.

John R. Murlin was with Lusk as first assistant when he transferred to the new institution. In his review of Lusk's work (12) he writes:

"The move to Cornell University Medical College, only one block distant on First Avenue, in 1909 brought enlarged opportunities for prosecution of a program of research which had been forming in Professor Lusk's mind while he was revising his 'Science of Nutrition.' The second edition made its appearance coincidentally with this move to Cornell. During the summer of this year, while alterations for the laboratory at Cornell were in progress, Lusk went to Europe in order to put the finishing touches to his revision, and while there, on the recommendation of his first assistant who was working in the nutrition laboratory of F. G. Benedict at Boston, resolved upon the construction of a small respiration calorimeter of the Atwater-Rosa-Benedict type, suitable in size for study of the energy metabolism of dogs or of small children. What he desired most of all to investigate was the specific dynamic action of the amino acids. Dr. H. B. Williams, already a member of the department of physiology at Cornell, went to Boston and studied the construction of the calorimeter. J. A. Riche, trained by long experience in Benedict's laboratory, was engaged to operate the new calorimeter and assisted Williams in its construction, a large part of the mechanical work being done by these two men. Together with Professor Lusk they formed a research team of unusual ability, and the precision with which dependable results on this difficult problem were turned out was the result of clear comprehension of the physiological factors, combined with high technical skill. Williams, however, left soon to accept an appointment at the College of Physicians and Surgeons, Columbia University.

"The first work in the order of publication accomplished by the calorimeter was a paper by John Howland on the energy metabolism of sleeping children. Lusk had very generously set aside his own program to give Howland this opportunity, which had much to do with making him professor of pediatrics at Washington University and, a year later, at Hopkins. This work at the same time demonstrated the remarkable efficiency of the calorimeter which Williams had built."

When Lusk was abroad in 1909 I happened to be working with Borden S. Veeder under Brugsch in Kraus' clinic in

Berlin. Our problem was the estimation of the total metabolism in diabetes. One morning word passed through the laboratory, "Der Graham Lusk kommt heute," but, of course, his name was pronounced "Grah-ham Loosk." Veeder and I were busy with the large Pettenkofer-Voit chamber when Lusk came to our room accompanied by the respectful group of professors and dozents. Rather naïvely we started to demonstrate the apparatus, but Lusk in his charming manner let us know that he had been working in his own laboratory with the same type of respiration chamber. The next year in America, when Veeder and I were struggling to write our first scientific paper, Theodore Janeway sent us to Graham Lusk, who spent hours recalculating our tables and teaching us the principles of writing a scientific report. I have seen him give this same priceless help and stimulation to a hundred or more young men and I am sure that every one of them remembers his example when in turn younger men come to him. Lusk's influence spread geometrically, not arithmetically.

Perhaps I may be pardoned if I also use my own case as an example of Lusk's indirect as well as direct influence. In 1905 I had finished my third year in a New York Medical School, not Lusk's, untouched by Lusk's teachings and almost untouched by physiology. That summer Theodore C. Janeway, one of the instructors at Bellevue Medical College, offered at St. Luke's Hospital the first clinical clerkship ever given in New York. I am sure that he wished to experiment in teaching clinical medicine along the lines that he and Lusk had discussed so often. He certainly succeeded in implanting in us the idea of pathological physiology as a basis for the study of the patient. Again, early in 1909, when I was about to sail to France to study bacteriology, I happened to meet John Howland, the brilliant young practitioner of pediatrics, who had only a short time before come under Lusk's influence. He advised me very emphatically not to study bacteriology, but to go to Germany and learn something about metabolism, which was becoming the most important field in clinical medicine.

It takes a long time to build and test a respiration calorimeter and it was not until 1911 that Lusk's preliminary report was

made. In 1912 there began to appear in the *Journal of Biological Chemistry* the famous series of papers on animal calorimetry. Number XXXIX, the last with Lusk's name as an author, was published in 1930, but the series is being continued by his associate, W. H. Chambers. Throughout all these years the technique has been practically uniform. The same dogs have been studied several years. Each report fits in with the other reports as part of an orderly campaign of investigation. The calorimeter gives a wealth of detail, measuring in hourly periods the grams of carbohydrate, fat and protein metabolized, the total heat production, heat storage, heat of vaporization. Analyses of urine and blood throw light on the intermediary processes. Never in metabolism have there been such complete studies.

First the effects of the ingestion of meat in large quantities were determined, then the various amino acids, carbohydrates, fats, mixtures of these. Later the influence of the glands of internal secretion was investigated and always the baffling problem of the cause of the specific dynamic action of foods, the stimulation of metabolism that follows the digestion of all foods but especially protein and carbohydrate. Later there were many experiments with dogs working in the calorimeter on a treadmill. Often the Lusk method of phlorhization was used as the key to the maximal production of glucose from protein and the various amino acids.*

Meanwhile Lusk had not forgotten his interest in clinical medicine. P. A. Shaffer, the biochemist, and Warren Coleman, the clinician, both teachers at the Cornell Medical College, had

* The first paper of the Animal Calorimetry series, by John Howland, was published in 1911 in the *Zeitschr. Physiol. Chem.*, 74, 1-12. During Lusk's life time there were 1432 calorimeter experiments. Between the time of his death and July 1939, 693 additional observations were made in the same calorimeter. The following members of Dr. Lusk's department of volunteer workers whose names do not appear in his bibliography, contributed to the Animal Calorimetry series, published in the *Journal of Biological Chemistry*, 1912-1932:

Gertrude Fisher, Mary B. Wishart, F. A. Csonka, Einar Langfeldt, Sophia A. Taistra, M. Ringer, R. Weiss, M. Wierzuchowski, S. M. Ling, S. S. Waddell, J. A. Mandel, A. T. Milhorat, H. Ellis, C. Wilson, Folke Nord, O. H. Gaebler, Margaret A. Kennard, H. Pollock.

The calorimeter technician was James Evenden. All calculations were checked by Lusk's indispensable secretary, Miss Phillippena Schaub who was devoted to his interests during the whole of his period at Cornell.

made important studies in the metabolism in typhoid fever. In 1911 Lusk secured funds for a study in the respiratory metabolism of typhoid, and E. F. Du Bois was given an appointment at Bellevue so that he could assist Coleman. After some preliminary work on the absorption of food in typhoid fever and the respiratory metabolism, using a Benedict unit respiration apparatus, Lusk felt justified in asking for the transfer to Bellevue Hospital of the Russell Sage Institute of Pathology. This had been established in 1903 by a gift from Mrs. Russell Sage, and had been devoted to studies in pathology at the City Hospital on Blackwell's Island. Unfortunately there had been difficulty with the city politicians and work had to be discontinued. Lusk was one of the directors in 1912 and the fellow members of his board gladly adopted his suggestion of building a respiration calorimeter and establishing a metabolism ward in Bellevue Hospital, adjacent to the teaching wards of Cornell Medical College. In 1913 Lusk was appointed Scientific Director, Du Bois, Medical Director. Since that time the yearly income of twelve to sixteen thousand dollars has been devoted to the study of metabolism in disease, one of Lusk's chief interests since 1899. The calorimeter for patients was built in 1912 by Riche and Soderstrom and on March 13, 1913 Lusk himself was the first experimental subject. His metabolism, supposedly basal, was probably too high in his excitement over the realization of one of the dreams of his life. The protocol of the experiment (5) records dryly, "G. L. physiologist, large frame, slightly adipose. Has taken but little exercise during the last few years. Health good. No recent illnesses. Physical examination negative." His height was 175.5 cm. (5 ft. 9 in.), his weight 78.42 Kg. (175 lbs.).

Lusk in 1915 wrote the first paper of the clinical calorimetry series describing "a respiration calorimeter for the study of disease," and took an active part in guiding all of the papers up to No. 50, published the year of his death. As in the case of the animal calorimetry series, the papers are continuing along the lines he so carefully planned. In the experiments on man the technique was almost the same as in the dog experiments. Often the two calorimeters would be working on the same problem.

After every experiment in the hospital the record sheets would be taken to Lusk's desk and the findings critically discussed. Almost every afternoon Du Bois walked home with Lusk, talking over plans for more work, trying to absorb Lusk's views on metabolism, medical education and life in general.

The studies of the Sage staff were devoted first to the basal metabolism of normal controls, the surface area of the body, typhoid fever, and then diabetes, guided by a classical article of Lusk's on the diabetic respiratory quotient. Later many other diseases were studied with the aid of visiting clinicians of New York and other cities.*

In addition to the animal and clinical calorimetry series, Graham Lusk published many papers on intermediary metabolism. He dealt with the amino acids, glycogen, alcohol, phlorhizin-glycosuria, the specific dynamic action, diabetes, acidosis, undernutrition and the endocrines. In 1910 he was particularly interested in the removal of the glycogen stores in the body by means of shivering. He kept his plan secret, and one morning the laboratory staff was horrified to see him submerged in a tub of water full of cakes of ice, while an assistant was measuring his respiratory metabolism.

Throughout his life Lusk was striving continually for the betterment of medical education and his addresses and writings on this subject were vigorous. He was ahead of his time, and he knew it, and he was sorry that he had to tread on the toes of many of his personal friends, but he never faltered. At first, he was whole-heartedly in favor of the so-called "full-time medicine." Later he modified his views when he felt that the pendulum had swung too far.

During the World War his attention was naturally drawn to

* Collaborators in clinical calorimetry series. Papers 1 to 50, 1915 to 1932. Clinical Calorimetry papers, 1 through 32, published in the *Arch. Int. Med.*, 1915 to 1922; papers 33 through 48, published in the *Jour. Biol. Chem.*, 1923 to 1932; papers 49 through 53, published in the *Jour. Nut.*, 1938. J. A. Riche, G. F. Soderstrom, F. C. Gephart, E. F. Du Bois, W. Coleman, Margaret Sawyer, R. H. Stone, D. Du Bois, A. L. Meyer, F. W. Peabody, F. M. Allen, J. C. Aub, J. H. Means, J. B. Murphy, D. P. Barr, W. S. McCann, R. L. Cecil, H. B. Richardson, E. H. Mason, W. S. Ladd, A. M. Michaelis, S. Z. Levine, W. S. McClellan, A. Biasotti, R. R. Hannon, H. J. Spencer, E. A. Falk, V. Toscani, V. R. Rupp.

food economics, and he wrote both scientific and popular articles on food in war time, paying particular attention to the caloric needs of children. When the United States entered the war, he offered his services to the Government, and was sent to England and France as one of our two food experts. In an article on R. H. Chittenden (1929), he writes:

“In the winter of 1918 Chittenden and I went to Europe as members of the Interallied Scientific Food Commission under instructions from our Government to reduce the food requisitions upon the United States to a minimum. The Food Committee of the Royal Society had adopted 3000 utilizable calories per day as the requirement of an average man doing an average day’s work, and at the Paris meeting of the Interallied Commission their representatives were inflexible in holding to this position. Before one of the meetings, while walking over the Pont Royal, which took us to the left bank of the Seine, Chittenden said to me, ‘Lusk, we are here to aid these suffering peoples to the maximum of our power.’ A few minutes later he said before the startled commission, ‘If you will not hear us we might as well go home.’ This led to the unanimous adoption of a modification of statement that read: ‘It was agreed that in case this ration could not be provided, a reduction of not more than 10 per cent could be borne for some time without injury to health.’”

Lusk enjoyed his stay in the war zone and his association with the nutritionists of the allied countries. One of his chief contributions was a chart of the caloric requirements of the different trade and age groups, and it was he more than anyone else who secured for adolescent children a food allowance equal to that of adults. Although everyone knows that children eat more than their parents, the older textbooks had fixed their allowance on body weight rather than on the needs of the developing organism. There were millions of children in France, England, and especially Belgium, who were indebted to Lusk for the privilege of normal growth.

With advancing years the history of nutrition became his chief hobby, almost his only hobby. He tracked down Lavoisier’s original respiration mask, and wrote articles on this great founder of the science of metabolism. He wrote on Liebig, Voit, Rubner and others. Delightful quotations were inserted at the head of each chapter of the fourth edition of the “Science of Nutrition.”

At the time of his death he had just completed a history of nutrition in the *Clio Medica* Series.

It must not be thought that Graham Lusk was merely a specialist in nutrition with a particular interest in metabolism in disease. He was above all a great physiologist and a great professor of physiology. His department was organized along broad lines. While his own lectures were confined to the physiology of digestion and metabolism, he was ably supported by associates who covered the rest of the field, Murlin, H. B. Williams, Carl Wiggers, D. R. Edwards, McKeen Cattell and others. He sent these men to work in other laboratories in this country and Europe. He took a keen interest in the large volume of important work in circulation carried out in his laboratory. There was a constant succession of research men sent to his laboratory from the United States and Europe. Most, but not all, came to work with Lusk himself. Perhaps the thing that gave him most pleasure was the large number of his own students who participated in the research of his department.

Graham Lusk was above the average height, as a young man quite thin, as an older man slightly overweight. His hair was brown, almost red, his eyes piercing with a humorous twinkle. He was quick in his movements, gesticulating effectively, full of life except when absorbed in reading or writing. In conversation he gave you his full attention. His deafness was not a serious handicap. He could hear you well if you raised your voice moderately. He loved conversation, talked easily and always entertainingly. An electrical appliance permitted him to follow lectures if he sat in the front row. It was a little difficult for him to hear all that was said at committee meetings or in general conversation, and his friends realized that some of his outbursts were due to a misunderstanding of statements. He could not always appreciate the sound of his own voice or laughter and when excited it would become high-pitched, vibrant and a little harsh. Ordinarily his voice was very pleasant; his laughter spontaneous and hearty. He laughed often for his spirit was happy. He was never depressed. He never really lost his temper but every few months he came near doing so when he encountered some injustice or heard or read a state-

ment which ran counter to his pet beliefs. His natural impulse was to take immediate action and the members of his staff figuratively tried to hang on to his coat tails until he cooled down.

Lusk was most easily excited by the problems of medical education and the controversial subjects of metabolism in diabetes, the derivation of carbohydrate from protein and fat, the specific dynamic action and the relationship of basal metabolism to the surface area of the body. He had great reverence for the ideas of Voit and Rubner and was inclined to take up cudgels when their doctrines were assailed although he realized fully that these two men were not infallible in all their findings. He was rather inclined to overestimate the importance of the work of his associates and pupils and often rushed impetuously to their defense. He never made his attacks personal. He seldom questioned technique but confined his criticism to theoretical interpretations. One such controversy with F. G. Benedict and E. P. Joslin dealt with the basal heat production in diabetes, which Lusk believed to be at about the normal level. Joslin in his article on Graham Lusk (23) has described this delightfully:

“Hot debates followed about the metabolism in diabetes. Was it increased or decreased? I even wrote a book about it and my experiments lasted so many years that the first ones, in the Naunyn Era of liberal diets showed what we in Boston interpreted as an increased metabolism and the second series, performed subsequently in the era of undernutrition, a relatively decreased metabolism. Neither laboratory quite hauled down its flag but listened to what Graham Lusk wrote when he disagreed with the Carnegie Nutrition Laboratory—‘Whatever of criticism may be found in the following lines, it is to be borne in mind that there was never any question of the absolute accuracy of all this work; the criticism regards only the interpretation.’ Don’t you see here that the fourth drawer in the Lusk Bureau of Standards was one of searching, constructive, but always just and friendly criticism.”

Another longstanding debate was with F. G. Benedict who was sharply opposed to the doctrine of Rubner that the basal metabolism of different animals depended on the surface area. This discussion waxed and waned for twenty years. Lusk had a great admiration for Benedict who was one of the four authors

most often quoted in the "Science of Nutrition," but he simply could not stand by and see his pet theory attacked. Even more serious was the doctrine of Macleod and his school in England and Canada that glucose could be formed from the fatty acids. Lusk and his pupils threw all their energies into combatting this conception. With all of the sharp differences of opinion there was no personal bitterness and Lusk retained friendship and respect. He always stopped short of the polemic.

It was a privilege to see him in action in discussion at physiological meetings. He was generous in his praise of good work, firm in his criticism of what he thought was wrong. As a rule he knew the literature better than the speaker. When Lusk and Meltzer were attending meetings in New York, the standards of papers were high, for it was well known that poor work would be greeted by plain words.

Lusk was as kind as possible with young men but fearless and almost relentless in his attacks on big game such as university faculties or government bureaus or large foundations. One of the best examples of his method is a letter to "Science" written in 1915. The following condensation and slight rearrangement is taken from Swift's "Influence of Graham Lusk on Medical Education." (25)

"It is impossible in any faculty to approach this subject without hurting the feelings of true and honorable men, men who deserve well of their country and who are not to blame for the present situation brought about by an altered trend of educational thought. It is, therefore, extremely difficult to speak of these matters without seeming to be both unkind and unjust. On the other hand, if no word is spoken, blame for cowardice is incurred. . . . The truth of the matter is that, as a country, we have produced few men in medical science. This is frankly because the teaching of medicine has not been in accordance with modern science. The staff of the medical department should consist of men, themselves devoted to medical science, capable of carrying it on, brought up in the air of it and blessed by the enthusiasm of it. Such men should be produced under the leadership of the professor of medicine. . . . Other remedies are only temporary palliatives. The medical school owes a duty to the public. Personal ambition, even though unconsciously exercised, should not be allowed to frustrate the fulfilment of the duty to the community which the college lives to serve. The schools are brought

face to face with the question whether their policy will be to advance along modern lines or stand still yet a little while."

In this and subsequent writings on the subject Lusk attacked the entrenched positions and precious heritages of many of his best friends in clinical medicine. It was he more than anyone else, with the possible exception of Welch and Abraham Flexner, who brought about the reform in the clinical departments of our best medical colleges.

Lusk spoke well at dinners and public meetings. He spent many days in the preparation of his material and always brought out something of significance. His delivery was clear and vigorous; his spirit and humor were contagious. The audience listened attentively for he had the gift of "letting himself go," speaking from the bottom of his heart. There was no "oratory" but something much more effective.

His lectures to the students were prepared and delivered with the same care. William S. McCann, one of his most distinguished pupils, who took the course in 1913, has described the lecture in his glowing tribute, "The Influence of Graham Lusk upon His Students." (22)

"The morning period in the physiological laboratory always began with a lecture. The Professor gave part of the lectures on digestion and all of the lectures on nutrition. His two assistants at that time, John R. Murlin and Carl Wiggers, made with him a trio that has rarely been surpassed in strength. In his lectures the Professor followed closely the text of his famous book which we kept open in front of us as a sort of syllabus. My old copy is abundantly underlined and annotated. Even today as I look at it the whole scene comes vividly to mind and I can hear the rising and falling cadence of his voice, now scarcely audible and again pouring forth with the vehemence of strong feeling.

Someone has said that if teaching consisted only of the imparting of factual knowledge then Universities might well have ceased to exist with the invention of printing. Graham Lusk's lectures provided superb examples of the reasons why the living voice has not given way to the printing press. There on the page before us were the facts tersely marshalled in logical sequence. Through our ears came interpolations of personal anecdotes which made those facts into a sort of aura of the living beings who discovered them. Lavoisier was our daily companion, as

were Carl Voit and Max Rubner, while Magendie and Claude Bernard appeared never less than once a week. . . . The more usual anecdote raised its subject to the heroic proportions of a legendary figure. The mind of Graham Lusk was a special Valhalla to which were conveyed dead heroes of the test tube or stethoscope: in it places were reserved for living heroes, for no man was more generous in appreciation of his contemporaries than was Lusk. In this legendary world Carl Voit was Woden, von Mueller was Balder, and Jove himself was not mightier than Rubner.

So in these lectures the prosy pages of his book became alive, and peopled both with common men and heroes. Just as the youths of ancient Greece, or our Teutonic ancestors, were inspired by the epic performances of their heroes, so we were inspired.

As we went about our own tasks in the laboratory we could see the Professor at his. The humblest task in an experiment was not beneath the professorial dignity. Did we not see him feed his dogs with his own hands? If a dog were to be catheterized in one of his own experiments the Professor did it himself. In his calorimeter room he worked as a member of the team making readings and weighings, checking the observations and calculations of his humbler subordinates, *and being checked by them*. A complete communism existed in that room for the duration of an experiment. One might see Soderstrom or 'Jimmie' Evenden vehemently arguing with the Professor about a technical matter, while he would stand in his characteristic judicial attitude with his chin encircled by his hand, or with his index finger beside his nose, gravely listening and sometimes nodding his head."

Lusk's scientific contributions were so highly technical that it is inadvisable in a brief biography to discuss them in detail. They have been well summarized by Murlin in his article in the *Journal of Nutrition* (12). Lusk in the 1928 edition of the "Science of Nutrition" gives eighty-five references to his own work but quotes Rubner twice as often. In a review, "Fifty Years of Progress in the Chemistry of Physiology and Nutrition in the United States 1876-1926," he mentions briefly his dextrose to nitrogen ration of 3.65 in the fasting and meat-fed dog under the influence of phlorhizin and the same ratio that he and Mandel found in a totally diabetic man. All the rest of his work he credits to his collaborators. Murlin has well described his painstaking search for the cause of the specific

dynamic action, that rise in metabolism which follows the ingestion of food. Proteins, fats, carbohydrates and products of the intermediary metabolism were studied in great detail year after year. At first he held Rubner's explanation that the increment results from the metabolism of the intermediary products themselves. Time changed his views as evidence was presented but he was never satisfied and finally returned to Rubner's theory. His experiments have always been source material for those who make calculations in this field and they will remain as standards until some new method of experimentation is discovered. Lusk never solved this problem to his own satisfaction although he was the man best equipped to find the answer to this riddle. His knowledge of the literature was enormous, his laboratory equipment the best in the world, his technique exact and constantly checked. Experiments were planned with the greatest care and few were wasted. Each one was directed to throw light on some specific question. He used relatively few experiments, basing his conclusions on a small number of reliable tests rather than on a mass of material treated statistically.

Graham Lusk with his background of scientific attainment and his forceful personality naturally assumed a position of leadership in the scientific circles of this country. He was one of the founders of the Society for Experimental Biology and Medicine (6, 7), and in 1914-15 its president. Close to his heart was the Harvey Society of which he was the founder, first president and the only life member of its council. His address at the twenty-fifth anniversary on August 15, 1930, records medical history:

"The story of the birth of the Harvey Society is a simple one. I was dining in the old Lusk home at 47 East 34 Street and sat next to Mrs. Anna Bowman Dodd. You will remember that it was she who wrote many years ago 'Three Normandy Inns.' The greater part of her life she lived in France; in Paris in the winter, and in a beautiful home at Honfleur on the Normandy coast in the summer. She has recently passed away at the age of about eighty. It gave her pleasure to the end to be told that she was the real founder of the Harvey Society. At the dinner to which I refer she said that during the winter she had attended a course of splendid lectures at the Sorbonne upon the subject of Roman law expounded by a brilliant Frenchman. It occurred

to me that if an educated American woman past middle life could be thrilled by lectures on Roman law, there must be physicians in New York who would be interested in hearing lectures on scientific subjects as expounded by scientific workers themselves. There was only one man with whom to go into conference on this subject and that was Dr. Samuel J. Meltzer. Meltzer had already used the library of my home at 11 (now 9 and rebuilt) East 74th Street, for in it a few years before, he had founded the Society for Experimental Biology and Medicine, sometimes for the sake of abbreviation affectionately known as 'The Meltzer Verein.' This was to be a society of scientific *workers*, and is today a notable feature of the Academy of Medicine. In response to a telephone call Meltzer came to see me immediately and, sitting together on a sofa, I outlined my plan. He said the idea was impossible; New York was a city devoid of scientific interests. The Academy of Medicine was not a scientific body and had no interest in scientific medicine. No one would come to the meetings and it would be futile to start such a movement.

A few days after this Meltzer called me on the telephone and said, 'You must call that meeting at your home.' I replied, 'But, Dr. Meltzer, you said the plan was impossible.' 'Ah, but I have changed my mind.'

So it came about that there met at my home on the anniversary of Harvey's birth, April 1, 1905, the following group of men: Meltzer, W. H. Park, E. K. Dunham, Ewing, Lee, Herter, Flexner, Wallace, T. C. Janeway, Levene, Opie, Abel of Baltimore, and Lusk. I outlined the plan. Everyone objected, using the same arguments which Meltzer now convincingly answered. His final words were, 'Never mind if no one comes except ourselves. We will wear our dress clothes, sit in the front row and show the speaker that we appreciate him.' . . . The society was made up of a group of young men. I remember giving a dinner of thirty to Professor Max Rubner, of Berlin, nearly twenty years ago, and he, surveying the table, said to me, 'You have no old men in America.' As far as our scientific group was concerned, this was then true. Scientific medicine in New York stood at the beginning of time."

The Harvey Society under Lusk's guidance was a great success from the very beginning. It is still simple, a series of seven or eight lectures every year, a published volume of these lectures. An invitation to lecture is one of the great honors bestowed in our country.

Lusk was a leading spirit in the Federation of Biological Societies. He was instrumental in founding the Society of

Biological Chemistry and was its president in 1914. He was a prominent member of the American Physiological Society. He was elected to the National Academy of Science in 1915 and took great interest in the meetings. He was in his element at the International Physiological Congresses held every three years as he had many friends among the physiologists of Europe. He had a great deal to do with the marked success of the thirteenth congress held in Boston in August 1929. After the members left Boston and made their way to New York he entertained 475 of these at his lovely country place at Syosset on Long Island. In 1928 he was one of the founders of the American Institute of Nutrition. He served on the editorial committees of various journals but never assumed the time-consuming duties of a chief-editorship. He belonged to so many societies and received so many honorary degrees that they have to be listed at the end of this article.

Graham Lusk was modest in regard to his own attainments but he knew perfectly well the strength of his position in the community. He had the security of family background, independent means, hosts of friends and pupils, a prominent academic position, high reputation as a teacher and scientist. In the twenty-one years that I knew him he never raised a finger for his own advancement, in none of his many battles did he ever ask a thing for himself. It is not surprising that eventually he secured almost all his objectives. He had an open mind and was ready to yield a point against which he had contended for many years once adequate proof that he was mistaken came to hand. His life was singularly devoted to science and he indulged in relatively few recreations except travel and mountain climbing. He enjoyed good food and good wine but always in moderation. When conducting a calorimeter experiment he did not have time for lunch. He walked a great deal in New York City and in the country. On Sundays he attended the Presbyterian Church under preachers whose breadth of religion was compatible with scientific thought. He seldom spoke of religion himself but consistently led a Christian life, loving and helping his fellow men. Politics interested him spasmodically and at times he was quite vehement on the subject but took no active

part in campaigns. Usually he was a Republican. Through his work in the Interallied Food Commission he developed great admiration for Herbert Hoover.

Lusk's outstanding characteristic was his capacity for friendship with men of all ages. His old friend George B. Wallace (9) has said of him: "He was of a genuinely friendly nature and had a great attraction for young men. Those men whom he accepted as friends he believed in implicitly and without reservation." He knew almost all the prominent physiologists of the world and they were his guests when they visited New York. In his beautiful tribute to the life and work of Max Rubner, delivered two months after Rubner's death and one month before his own death, he says:

"Great men are rare. They are worth knowing. They give impulse and stimulus to lesser men. They make the world more worthwhile for others to live in because of their presence in it. Max Rubner was the greatest man I ever knew.

The first time I met Rubner I called on him at his laboratory in Berlin . . . but I never really knew him until he visited me in the United States when he came over to attend the Fifteenth International Congress of Hygiene and Demography, which was held in Washington in 1912. He first visited me in my Adirondack camp, and we gave him a tent in which to sleep. . . . I gave a dinner in his honor at the University Club in New York. Nuttall, professor of hygiene at Cambridge, England, who had been his pupil, was seated on my left. He said to him, 'I expected to feel like a stranger in America, but I feel nothing of the sort, and when I talk to Lusk it is as though I were back in Munich.'

The last visit we made to Rubner was at his home at Pinszwang, a village in the Tyrol just over the Austrian border, a short distance from Füssen, and we thus fulfilled a promise made to him eighteen years before. He was in fine spirits and brought out some excellent wine of which he was very fond. He went with us in the afternoon to Füssen. . . . I can still see his distinguished figure standing at the end of the stone bridge at Füssen, as he raised his hat and waved it in farewell."

One of his laboratory assistants has written (16):

"Perhaps the chief service of Graham Lusk was his constant readiness to help younger men. There are hundreds of us who have gone to him with our problems, and we have always received his aid and inspiration. Not only the men who worked in his own laboratory but those from far distant parts of this

country and Europe are indebted to him for much of the best parts of their publications. Unless he himself had taken an active share in the conduct of an experiment he would never attach his name to a paper. Whenever he published with younger men his name appeared last and there were no heart-burnings in his laboratory over that coveted first position on the title page which is of value only to those men who would otherwise remain insignificant. On rare occasions, when he felt that a young man was insincere or totally unprepared for his task he would act firmly and promptly for the good of the scientific world. For all others he was full of encouragement and appreciation, and he cherished the enthusiasm of youth because he himself retained it to the last day of his life."

No one realized more fully the hazard which advancing age brings to a scientific reputation. In an address to students delivered in 1930, he says:

"There is one picture which I would like to present to you which belongs to the history of human progress, as illustrated by the criticism by Berzelius of Liebig and his reply; the criticism of Liebig upon Voit and its repercussion; with a brief reference to the opinion of Voit upon the younger generation. The story is the same, the inability of a man in the sixties to understand a young man or to suffer criticism from him."

He tells the story of Berzelius and Liebig and continues:

"An attack on Voit's work by Liebig came about 1870 when Liebig was sixty-seven and Voit was thirty-eight years old. Voit was stung to reply. Perhaps, by recalling the story, it may be instructive to bring out this historical cleavage between the thoughts of an older from those of a younger generation. It needs no emphasis on my part to impress you with the fact that if some of you of the younger generation are not better trained than the masters of an older generation, then further scientific advance will not be possible. And I here recall the words of one of our great American medical prophets, Samuel J. Meltzer:

"I shall continue to work as long as I live. There are only two things which could stop me. If any one said to me, 'Meltzer, your work is no longer good,' then I would stop. Or if anyone said to me, 'Meltzer, you can no longer understand a young man,' then I would stop also.'"

Next comes the story of Liebig and Voit:

"A generation later, when Voit was about sixty, I heard him say that there were no good young men of forty in Germany

at a time when Rubner, Kossel, and Hofmeister were that age. One of these men has written me that modern workers deal only with *Kleinigkeiten* (small things). Historically speaking, there is an age disability in his judgment of the young when a man is over sixty.

"In three successive generations in which the younger man was forty and the older man sixty there was a lack of appreciation of the real ability of the younger man. Berzelius criticised Liebig; Liebig criticised Voit; Voit did not fully appreciate Rubner."

Finally, applying the lesson to himself, Voit's pupil, he speaks of his own criticism of Macleod's book, "The Fuel of Life." He concludes:

"But such a book as that of Macleod has a high value, since it constitutes a challenge to do productive work. Macleod is a man of the highest personal character, of high scientific achievement, but, as we have learned today, this is not protection against the destruction of theories evolved through misplaced reliance upon erroneous or incomplete experimental evidence. The words of old Voit come to me, 'It makes no difference *who* is right so long as the truth be found.' I realize that, from the historical standpoint, I am treading perilous ground in daring to criticise the work of one younger than I am."

Again in 1932, shortly before his death, he said to Lafayette B. Mendel, "I can well recall the words of criticism that I have often uttered somewhat violently, when I was in my thirties and forties, about persons whom I regarded as antiquated and reactionary medical teachers of my present age. I shall therefore endeavor to avert a similar fate for myself at the hands of the present-day youngsters by retiring." He had reached the age of sixty-five which was the retiring age in his university. It so happened that in this very year the Cornell Medical College, after a long period of striving, had completed its magnificent new building in association with New York Hospital, made possible by the legacy from Payne Whitney. Lusk had taken an active part in the planning of this affiliation and it represented one of the greatest accomplishments of his life's work in medical education. As the old building on 28th Street was abandoned he appeared as one lost without the prospect of teaching and research. He felt so strongly about it that he would not speak of

his future or accept the offer of rooms where he could work. Can anything be harder for a man who is still active in mind and body than to terminate abruptly a distinguished career? Lusk's heart and soul were in his work. There was no one in his field with his ability or knowledge or breadth of experience. Still he believed that the retirement system was necessary and wise in spite of its cruelty.

Within a few weeks of his last duties as professor of physiology, while still in excellent general health, it became evident that he would have to submit to a serious operation. Complications developed and he died on July 18, 1932. His life work had been completed. He had won his main objective in his fight for medical education. He had made scientific discoveries of permanent value. One of his greatest contributions was his textbook. Of this A. J. Carlson (26) has said: "If there be any one book having had a wider and more penetrating influence on medical research in this country than Lusk on the Science of Nutrition, I do not know it. If there be, to date, by the pen of any other one man in any language, a better discussion of the whole scope of the science of nutrition, I have not seen it."

Even greater was the example of his own life and character. It has made a profound impression on his pupils and associates. Thus Murlin when he introduced Lusk at a public lecture spoke as one of a large multitude when he said: "For fourteen years your chairman was associated with the speaker as pupil, assistant, and colleague and he now states from the heart that he has never known a man who combined in so happy a way the solid merits of the scientist with all that is finest of courtesy, kindness and culture in a true American gentleman."

TITLES AND HONORS

Columbia University, School of Mines, Ph.B., 1887
University of Munich, Ph.D., 1891
Yale University, Honorary A.M., 1897
Yale University, L.L.D., 1908
University of Glasgow, L.L.D., 1923
University of Munich, Honorary M.D., 1927

MEMBERSHIPS

Fellow, Royal Society of Edinburgh
Corresponding Member, Imperial Society of Physicians, Vienna
Member, National Academy of Sciences
Representative of United States, Interallied Scientific Food Commission,
1918
Corresponding Fellow, National Academy of Saxony, Leipzig
Member, Deutsche Akademie der Naturforscher zu Halle
Associate Member, Société Royale des Sciences Médicale et Naturelles,
Brussels
Associate Member, Société de Biologie, Paris
Honorary Member, Des Moines Academy of Medicine
Honorary Member, Physiological Society of Great Britain
Honorary Member, Physiologische Gesellschaft of Berlin
Corresponding Member, Preussische Akademie der Wissenschaften
Foreign Member, Royal Society of London
Member, American Physiological Society
Member, Harvey Society
Member, American Society of Biological Chemistry
Member, Society for Experimental Biology and Medicine

KEY TO ABBREVIATIONS USED IN BIBLIOGRAPHY

- Amer. Jour. Med. Sci.—American Journal of the Medical Sciences
 Amer. Jour. Physiol.—American Journal of Physiology
 Amer. Jour. Pub. Health—American Journal of Public Health
 Amer. Med.—American Medicine
 Amer. Mus. Jour.—American Museum Journal
 Amer. Textbook Physiol.—American Textbook of Physiology
 Ann. Med. History—Annals of Medical History
 Arch. Int. Med.—Archives of Internal Medicine
 Biochem. Zeitschr.—Biochemische Zeitschrift
 Biol. Med.—Biology and Medicine
 Boston Med. & Surg. Jour.—Boston Medical and Surgical Journal
 Bull. N. Y. Acad. Med.—Bulletin of the New York Academy of Medicine
 Bull. Soc. chim. biol.—Bulletin de la Société de Chimie Biologique
 Canada Med. Assn. Jour.—Canadian Medical Association Journal
 C. R. Acad. Sci.—Comptes rendus hebdomadaires des séances de l'Académie des Sciences
 Deutsches Archiv. klin. Med.—Deutsches Archiv. für klinische Medizin
 Ergeb. Physiol.—Ergebnisse der Physiologie biologischen Chemie und experimentellen Pharmakologie
 Gaz. d. hop.—Gazzetta des hôpitaux civils et militaires
 Ind. Eng. Chem.—Industrial and Engineering Chemist
 Johns Hopkins Hosp. Bull.—Johns Hopkins Hospital Bulletin
 Jour. Amer. Chem. Soc.—Journal of the American Chemical Society
 Jour. Amer. Dietet. Assn.—Journal of the American Dietetic Association
 Jour. Amer. Med. Assn.—Journal of the American Medical Association
 Jour. Biol. Chem.—Journal of Biological Chemistry
 Jour. Mus. Nat. Hist.—Journal, American Museum of Natural History
 Jour. Nutr.—Journal of Nutrition
 Jour. Pharmacol. Exp. Therap.—Journal of Pharmacology and Experimental Therapeutics
 Jour. Physiol.—Journal of Physiology
 Jour. Wash. Acad. Sci.—Journal of the Washington Academy of Sciences
 Med. Clin. N. Amer.—Medical Clinic of North America
 Med. Rec.—Medical Record
 München med. Wchnschr.—Münchener medizinische Wochenschrift
 New England Jour. Med.—New England Journal of Medicine
 N. Y. Med. Jour.—New York Medical Journal
 N. Y. State Jour. Med.—New York State Journal of Medicine
 N. Y. Univ. Bull. Med. Sci.—New York University Bulletin of Medical Science
 Physiol. Rev.—Physiological Review
 Pop. Sci. Mo.—Popular Science Monthly
 Proc. Amer. Physiol. Soc.—Proceedings, American Physiological Society

- Proc. Inst. Med., Chicago—Proceedings of the Institute of Medicine of Chicago
 Proc. Nat. Acad. Sci.—Proceedings of the National Academy of Sciences
 Proc. Soc. Exp. Biol. Med.—Proceedings of the Society for Experimental Biology and Medicine
 Proc. XVII Intern. Cong. Med.—Proceedings, XVII International Congress of Medicine
 Sci. Mo.—Scientific Monthly
 Skan. Arch. Physiol.—Skandinavisches Archiv für Physiologie
 Trans. Coll. Phy., Phila.—Transactions, College of Physicians, Philadelphia
 Trans. XV Intern. Cong. Hyg. & Demog.—Transactions, XV International Congress of Hygiene and Demography
 Yale Jour. Biol. and Med.—Yale Journal of Biology and Medicine
 Yale Med. Jour.—Yale Medical Journal
 Zentralb. Physiol.—Zentralblatt für Physiologie
 Zeitschr. Biol.—Zeitschrift für Biologie
 Zeitschr. physiol. chem. Hoppe-Seyler's—Zeitschrift für physiologische Chemie

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