An American Physiologist Abroad: Francis Gano Benedict’s European Tours

Elizabeth Neswald

1. Nutrition Science

Nutrition emerged as a special field of physiology in Germany in the late 1850s, when three former pupils of Justus Liebig – Carl Voit, Theodor Bischoff and Max Pettenkofer – began studying the metabolism of dogs and humans. Their experiments cast doubt on the established nutrition theory of Liebig, and they introduced precision measurement, analysis and apparatus, the methods of the new German physiology, into nutrition and metabolism research. In the 1880s, a pupil of Voit’s, Max Rubner, finally proved what Emil Du Bois-Reymond, Hermann von Helmholtz and their circle of physiologists had been proclaiming since the 1840s – that the energy conservation law applied to living organisms, or, at least, to dogs.

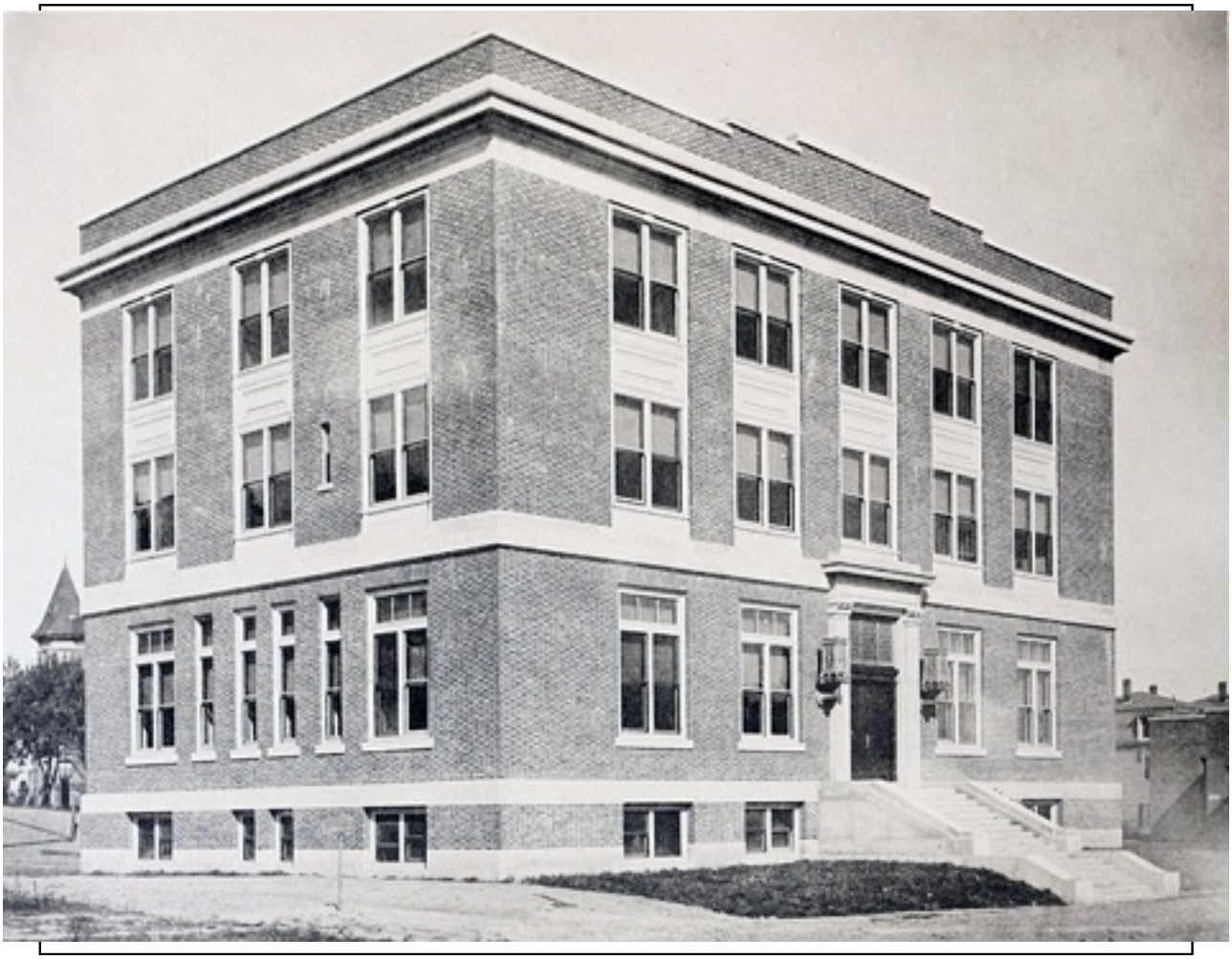
By the 1870s, physiology was an apparatus-based discipline. It required instruments that could rarely – if at all – be found in the United States and training in the skills to use them. American students of chemistry, physiology and medicine had long flocked to the well-equipped and established laboratories and universities of Germany for basic and specialized training. Central instruments for metabolism research were the respiration apparatus of Voit and Pettenkofer, which measured metabolism indirectly through measuring carbon dioxide production; the animal calorimeter, which measured the body’s heat production; and, after Rubner’s experiments, the combined respiration calorimeter, which measured all of the body’s input and output. The laboratories of Rubner and Voit in Berlin and Munich became popular destinations for medical students and physiologists interested in learning about the latest metabolism research and how to build and use its complex apparatus.

2. The Carnegie Nutrition Laboratory

In 1902, steel magnate and philanthropist Andrew Carnegie established a foundation to address what he perceived as a deficit in American basic research productivity. One of the areas that the Carnegie Institution of Washington decided to support was research into human nutrition. The CIW intended to appoint Wilbur Olin Atwater, who was America's leading nutrition scientist, a former student of Voit, and constructor of the first respiration calorimeter for humans, as director of its nutrition laboratory. When Atwater became severely ill, they appointed his assistant, Francis Gano Benedict, in his place.

Dr. Benedict holding a lecture at the Rudolf-Virchov-Clinic, Berlin 1932

Throughout 1906, Benedict negotiated with the Carnegie Institution and looked for an appropriate site for his lab. He finally decided on Boston, where he had the Carnegie Institution purchase property adjacent to Harvard Medical School. The climate in Boston was well-suited for metabolism experiments and through the proximity to Harvard he hoped not only to share some of the medical school's infrastructure such as heating and electrical systems and libraries, but also for a steady supply of clinical subjects for his experiments as well as an abundance of medical students keen to participate as experimenters and as experimental subjects. Benedict was officially appointed director in 1907.



The Nutrition Laboratory at Boston, MA (from: Biodiversity Heritage Library: Carnegie Yb 7, 1908, plate B)

Benedict was in an enviable position. He had generous funding to build a new laboratory entirely from scratch and according to his specifications, that is, not only to equip it but also to decide on furnishing and design, the distribution of rooms and workspaces in the building, the placement of utilities and special facilities. In order to do this, he decided to investigate and evaluate the different possibilities of laboratory design, instruments and experimental techniques. Despite a growing number of university laboratories in the US, in 1907, the most productive and best equipped physiological research labs were still found in Europe.

3. The Foreign Laboratory Visits

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On his first tour Benedict visited the largest and most well-known laboratories for metabolism research, especially in Germany. Many directors of Central European labs had trained with Carl Ludwig.

Benedict belonged to the generation of American scientists who had received laboratory training in Germany. As Atwater’s assistant in Wesleyan and Storrs, he had also learned to appreciate international communication and exchange. Already during negotiations for his directorship of the Nutrition Laboratory he recommended that it approve funds for his international travel. By the end of his tenure as director of the Nutrition Laboratory in 1937, Benedict taken seven tours of Europe, each lasting about four months and including dozens of laboratories involved in metabolism and other physiological researches. The reports of these visits offer a written and photographic panorama of European physiology laboratories and record the changing constellations of laboratory dominance both within Europe and internationally from 1907 to 1933. Benedict writes as a participant and an observer, as an

anthropologist analysing European academic cultures and as a strategist, whose career, prestige and research are intertwined with a private funding organisation and its ambitions.

4. Building the perfect laboratory

When Benedict undertook his first tour of European laboratories, the primary goals of his travel were clear:
“In making this tour, the first thought was to secure all possible suggestions regarding the interior equipment of laboratories especially fitted for investigations in metabolism, calorimetry, and physiological chemistry. The second important commission was […] to become familiar with all existing apparatus for studying gaseous exchange, animal calorimetry, and general methods of research into human and animal nutrition.” (Benedict, vol. 1, p. 1)

Benedict described in great detail the set-up of these laboratories, directing his attention at seemingly trivial points such as the placement of water faucets and gas cocks, the materials covering tables and floors, the arrangement of cupboards, drawers and workspaces, that find little mention in most laboratory descriptions but can greatly affect the flow of experimentation. Significantly, he did not aim to model his new laboratory in Boston on any particular European lab, but instead viewed as many alternatives as possible, in order to combine them into an ideal nutrition laboratory. Creating the best laboratory for metabolism research in the world could only be done on the basis of the most suitable equipment and design, and Benedict visited these labs with the intention of collecting the best ideas, to realise them in one place, in a building still under construction.

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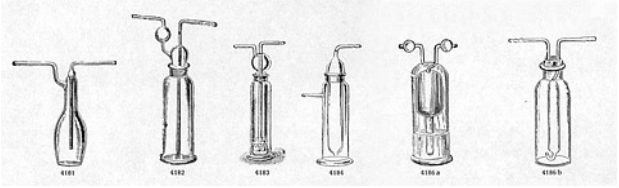
Laboratory design and laboratory organisation continued to interest Benedict throughout his tours, as he considered the advantages and disadvantages of dedicated rooms or open workspaces, hierarchical or independent research structures, tight oversight or delegation of tasks and questions. Although Benedict developed his own model of laboratory governance for his large, non-university research institution, by applying a comparative perspective to dozens of laboratories over a quarter of a century, his reports identified numerous factors that could affect the success or failure of a particular lab in regard to the realisation, duration and effectiveness of its research programme.

5. Accumulating Instruments and probing tacit knowledge

Crucial for the ideal laboratory was that it have the best, most reliable and most accurate equipment and apparatus. Benedict had excellent technical skills. By the time he was appointed director of the Carnegie Nutrition Laboratory, he had already proven his ability to build complex and precise apparatus for metabolism research and to successfully use it in experiments.



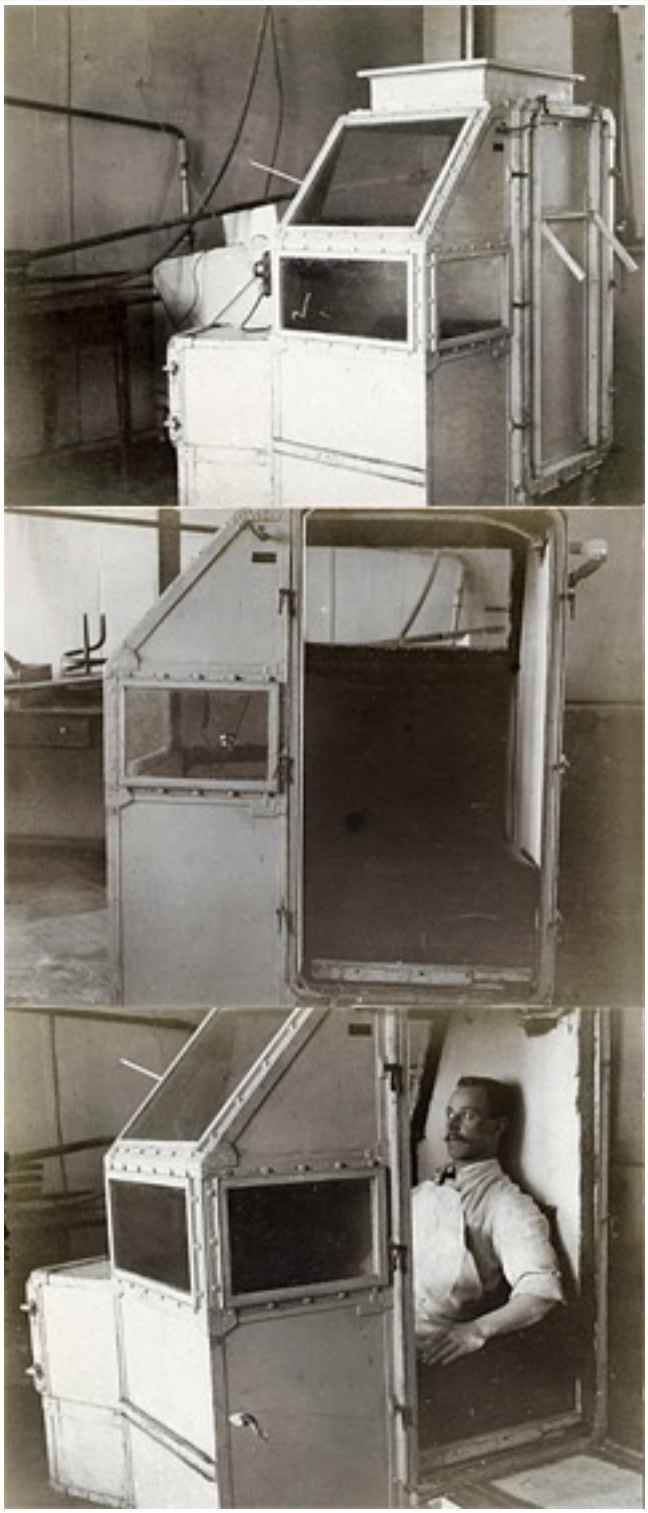
A selection of gas-washing bottles, taken from: Bauer, Felix. 1912. Laboratoriums-Apparate- und Utensilien. Hamburg, p. 195

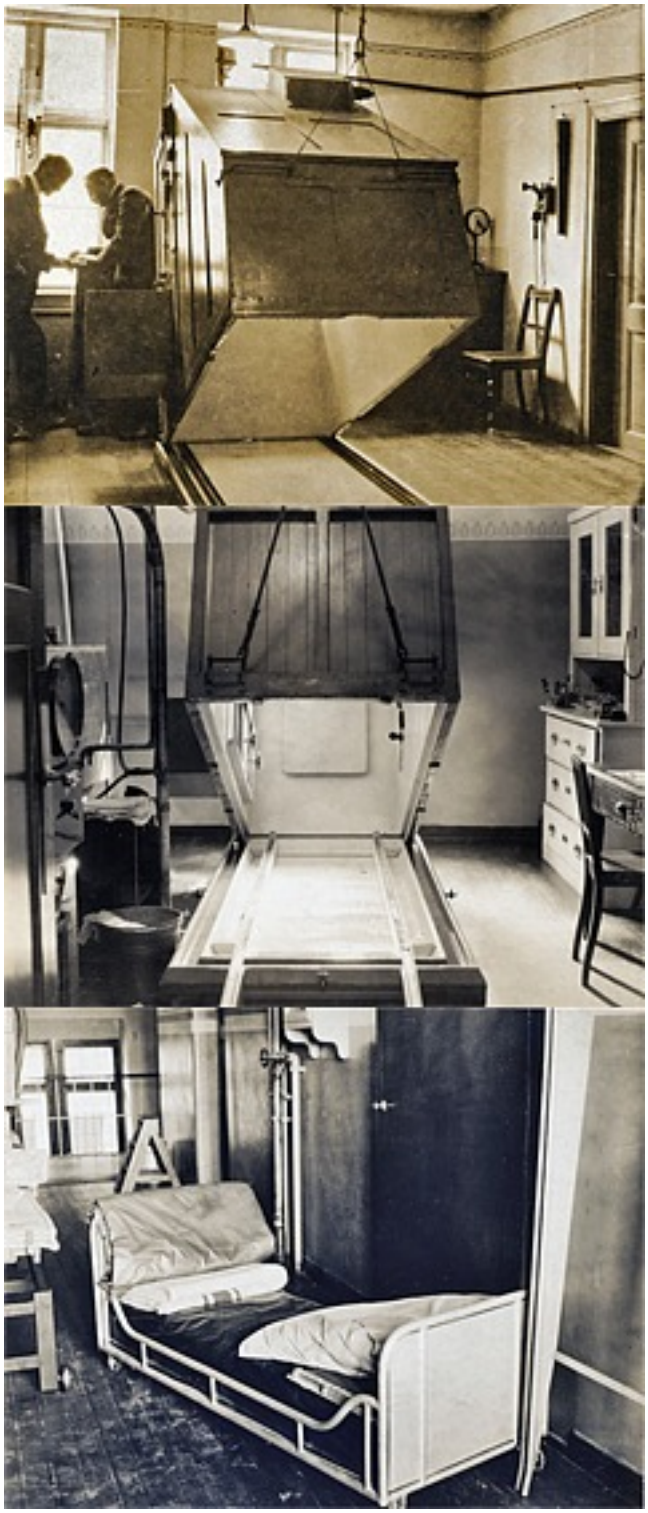
His tours of European physiology laboratories enabled him to familiarize himself with the various kinds of apparatus that he would not have had the opportunity to see in the United States. He could find out what apparatus and techniques had proven reliable in experiment and which ones were new and in the testing stage, inspect a variety of minor equipment such as stoppers, flasks and thermometers, and consider what equipment and apparatus could be useful for his own purposes, find out who made it, and, if the price was right, order it for his own laboratory.

The tours provided an opportunity to assess different versions of the same type of apparatus and different methods and techniques of measurement, experiment and analysis, as they were realised in the different laboratories. This allowed him to compare them with one another and with his own respiration apparatus and the equipment he was familiar with from the Wesleyan and, later, the Carnegie laboratory. Most importantly, Benedict was also aware that tacit knowledge was crucial for an experiment to succeed and that written descriptions of instruments or experiments would always leave out vital information (Benedict, Vol. 2, p. 1). Only by visiting other labs, inspecting their apparatus, watching it in action (if possible) and learning techniques and methods from experimenters familiar with it, could another experimenter be reasonably sure that there was a good basis for comparing his results with

theirs and that differences in results were not simply an effect of differences in technique and apparatus.

Comparison of four different types of the Jaquet respiration chamber (Overview)





Grafe, vol. 1, p. 105, (1923)
General View
Jaquet, vol. 1, p. 54, (1907)
next apparatus (right)
next view (both)
next apparatus (left)

Once the Nutrition Laboratory became established, Benedict regularly invited foreign and domestic researchers to Boston to conduct research and receive training in the use of apparatus devised by himself and his assistants. Teaching other researchers his techniques was a method of publicising his lab and increasing its scientific prestige.

6. Networking and Exchange

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Click on portrait to see the complete photograph.

Benedict’s foreign travels enabled him to develop extensive personal and professional networks, and they facilitated the exchange of scientific ideas. The tours provided a way to find out what research was in process at the different laboratories or awaiting publication, in order to avoid unnecessary duplication, and they were an opportunity to disseminate the achievements, research plans and publications of the Carnegie Laboratory. In this way, the Carnegie Laboratory marked its place within the international research landscape and staked its claims. Benedict also used the tours to promote the methods and apparatus of his laboratory as international standards.

By visiting the laboratories, Benedict, who was naturally gregarious, could also introduce what he called the “personal element” into his professional interactions. Rivalry, polemic and petty jealousies were not unique to nutritional physiology but they were detrimental to communication and thus to cooperation between individuals and their labs across national and international boundaries. As a foreigner and an outsider in regard to European academic structures, Benedict was in a unique position to move between laboratories and national traditions and to mediate across the lines of dispute.

7. (Re-)Building an International Community in Physiology

Benedict had originally planned to visit European laboratories every three years, but World War I and the political animosities in its aftermath prevented his return until 1923 (although he did send his assistant, Walter Miles, on a tour in 1920 to assess the situation). In that year, the International Physiology Congress, held in Edinburgh, attempted to end the pariah status of German scientists and reintegrate them into the international physiology community. Benedict had by that time, through his cultivation of the “personal element”, established an extensive network of personal-professional friendships. During his laboratory visits, he lobbied various physiologists to attend and was thoroughly pleased with the polite and friendly interactions between the scientists of nations still on uneasy terms. Science seemed to show the way forward in the political arena.

Professor Petrén (with the Derby hat) of Lund, Sweden, and Dr. Boothby (seated next to him) of Rochester, Minnesota, at the Congress meeting at Upsala, 1923

In his résumé of the Congress, Benedict reported, “Personally I received a great deal of stimulus and innumerable suggestions, and above all a belief that the most extensive and best founded advancement for international amities could well come from scientific societies” (Benedict, vol. 4, 1923, p. 235).

The war had affected physiology in other ways as well. When Benedict took his third European tour in 1913, his last before the war, the Carnegie Nutrition Laboratory was well established in the international arena, and Benedict visited the European labs as one with equal standing. Although the Nutrition Laboratory was affected to some degree by the wartime conditions, the affect was comparatively minor. Research continued, apparatus were built and perfected. In Europe, in contrast, most research had come to a halt or was directed to areas directly relevant to the war, such as reaction times or food substitutes. Physiologists had been recruited as physicians, laboratories had been turned into hospitals and instruments had been dismantled for their raw materials. Much of the financial and material infrastructure of European physiology had been destroyed. Broken equipment and out-dated apparatus could not be replaced, new equipment could not be purchased, and many labs could not even afford journal subscriptions to at least keep abreast of research developments. In post-war Germany, inflation meant that nutrition researchers could not afford to feed themselves, let alone invest in food for research, and dogs were needed for protection, not experiments.

When Benedict returned to Europe after the war, he considered himself both a “scientific diplomat” and an “emissary of knowledge”. The Carnegie Nutrition Laboratory had emerged from the war as the internationally dominant laboratory in metabolism research, and with it, its apparatus, techniques and methods. Much had changed since Benedict’s apprenticeship visit of 1907, and travel to Europe was no longer a necessity for an American physiologist. As he concluded in 1929, “one of the deciding factors in taking up another tour to Europe would be not what the Nutrition Laboratory would receive but what the Nutrition Laboratory could give,” (Benedict, vol. 6, 1929, p. 306-7). Throughout the 1920s it exported and donated instruments, apparatus, publications, funds and lectures on the latest American research; Benedict personally intervened in foreign science policy by writing letters to European governments in support of specific labs and researchers, and he continued to invite European physiologists to the Carnegie Nutritional Laboratory, where they could learn to use the new techniques and apparatus that had been tested and perfected in Boston in the years that had been lost to European nutrition physiology.

MEGHÍVÓ

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208. ÜLÉSÉRE.

TÁRGYSOROZAT:

PROF. F. G. BENEDICT (BOSTON): Neuere Stoffwechseluntersuchungen an Menschen und Tieren.

Kérjük az érdekeltekkel közölni!

Farkas Géza
elnök.

3590-1926. — KIRÁLYI MAGYAR EGYETEMI NYOMDA, BUDAPEST.

SOCIÉTÉ MÉDICALE DE GENÈVE

La Société Médicale est convoquée :

Mercredi 22 septembre, à 20 h. 30 précises, Clinique médicale.

Conférence du Prof. BÉNÉDICT, Directeur du « Nutrition Laboratory » de Boston :

Etudes récentes sur le métabolisme humain et animal.

Le Secrétaire : Dr J. GOLAY.

P. S. — Vu la notoriété du conférencier et l'importance du sujet traité, vous êtes priés d'assister nombreux à cette séance.

Physikalisch-medizinische Gesellschaft

IX. Sitzung

am Donnerstag, den 7. Oktober 1926, abends 7¾ Uhr
im Hörsaal der medizinischen Klinik, Luitpoldkrankenhaus.

Prof. F. G. Benedict, Direktor des Ernährungslaboratoriums, Boston, als Gast: Neuere Stoffwechseluntersuchungen an Menschen und Tieren.

Würzburg

= Studierende sind zum Besuch der Vorträge eingeladen. =

Außerordentliche Sitzung
der
Berliner Physiologischen Gesellschaft
am
Freitag, den 22. Oktober 1926, abends 8 Uhr
im großen Hörsaal des Physiologischen Instituts der Universität, Hessische Str. 3/4.

Herr **Professor Benedict** (als Gast):
„Neuere Untersuchungen über den Stoffwechsel des Menschen und der Tiere".

Gäste willkommen.

Atzler, I. Schriftführer,
Invalidenstraße 103a.

L. S.

Het Bestuur van het **Nederlandsch Instituut voor Volksvoeding** noodigt U uit tot het bijwonen van een voordracht:

Recent Studies in Human and Animal Nutrition

door

Prof. Dr. FRANCIS BENEDICT,

Directeur van het Nutrition Laboratory of Carnegie Institute of Washington (Boston).

Deze voordracht zal plaats hebben op **Vrijdag 5 November te half acht,** in de groote collegezaal van het **Laboratorium voor de Gezondheidsleer, Mauritskade 57.**

Namens het Bestuur,
E. C. VAN LEERSUM.

Het Bestuur der Medische Faculteitsvereeniging heeft de eer U uit te noodigen tot het bijwonen aan de lezing, welke Prof. F. G. Benedict uit Boston zich voorstelt voor de Vereeniging te houden op Maandag 1 Nov. 1926, des avonds te 8 uur in de coll. zaal 't Physiol. Lab.

Onderwerp: Recent studies in human and animal metabolism.

Groningen

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Report of a Visit to Foreign Laboratories (1926/27), Box 6.

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