VITAMIN DISCOVERIES AND DISASTERS

History, Science, and Controversies

Frances Rachel Frankenburg

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Series Foreword

Contemporary Health and Living

Over the past one hundred years, there have been incredible medical breakthroughs that have prevented or cured illness in billions of people and helped many more improve their health while living with chronic conditions. A few of the most important twentieth-century discoveries include antibiotics, organ transplants, and vaccines. The twenty-first century has already heralded important new treatments, including such things as a vaccine to prevent human papillomavirus from infecting and potentially leading to cervical cancer in women. Polio is on the verge of being eradicated worldwide, making it only the second infectious disease behind smallpox to ever be erased as a human health threat.

In this series, experts from many disciplines share with readers important and updated medical knowledge. All aspects of health are considered, including subjects that are disease specific and preventive medical care. Disseminating this information will help individuals to improve their health, researchers to determine where there are gaps in our current knowledge, and policymakers to assess the most pressing needs in healthcare.

Series Editor Julie K. Silver, M.D.
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INTRODUCTION

We all know that we should eat a variety of foods, including dairy products and fresh fruits and vegetables, because these foods contain vitamins. This is so obvious that it hardly bears repeating, yet the discoveries of vitamins involve stories of adventure and heroism that are not well known. It is difficult today to realize how much courage and perseverance the scientists who discovered vitamins possessed.

Researchers in the 1800s believed that they could "make" food in the laboratory by mixing up the right combinations of fats, carbohydrates, proteins, water, and minerals. It seemed that nutrition had been mastered. Moreover, scientists were just discovering that bacteria caused illnesses. What could diet possibly have to do with illness? However, people and laboratory animals eating artificial diets did not survive. Plants, bacteria, and fungi make complicated molecules that are different from fats, carbohydrates, or proteins and could not easily be made in the laboratory. These products, which we need in very small quantities, are vitamins. Each vitamin has an irreplaceable role in the body's metabolism. Without vitamins, diseases such as scurvy and beriberi develop.

Investigations into these vitamin deficiency diseases were not simple. This was more than painstaking chemical work in a laboratory, although it was that too. The scientists involved often worked in dreadful circumstances and almost always had to face the ridicule of their colleagues, including the infectious disease specialists of the day. Some of these scientists, such as Edward Vedder, Albert Hess, and Robert Williams, refused to accept the inevitability of human suffering and were relentless in their pursuit of cures for illnesses. In this book, we will review the stories of these and other scientists and explain how vitamins, which today we take for granted, were discovered.

Some scientists had to work in secret. For example, in 1907, Elmer McCollum, a scientist from Kansas, and Marguerite Davis set up the first American rat colonies in Madison, Wisconsin. This was done in a clandestine manner because the dean of the agricultural college at Wisconsin disapproved of

experiments with rats. Their work led to the discovery of Vitamin A, or retinol.

Some scientists worked for decades, and some scientists had moments of insight. For example, Christiaan Eijkman was investigating the epidemic of beriberi in Indonesia. People with "dry" beriberi suffered from severe pains in their legs, making it impossible for them to walk. People with "wet" beriberi had heart disease, leading to swollen legs. Eijkman saw ill Indochinese chickens staggering around his compound and, in a flash of genius, noted the resemblance to beriberi and traced this to a change in their diet. This realization that a change in the diet could cause illness was a pivotal moment in the history of human health.

Eijkman was mocked for this insight, as was Joseph Goldberger, another inventive and persistent man. In 1914, the U.S. Public Health Services sent Joseph Goldberger to the South, where pellagra was endemic, to find the microbe that caused pellagra. Goldberger, an expert in infectious diseases, suspected that there might be a nutritional component to the illness. He arranged an experiment on prisoners in Mississippi, in which their diet was deliberately manipulated to cause illness. This trial was successful but was criticized mercilessly by physicians of the South who continued to blame a microbe.

In one of the more personal experiments that will be described in this book, William Castle at Harvard gave some of his patients who were ill with pernicious anemia meat digested by his own stomach juices. He concluded from this experiment that two factors were involved in the successful liver therapy of pernicious anemia. The factor in his stomach juice turned out to be cobalamin. This is another example of an experiment that makes us feel a bit queasy, that would without a doubt not be allowed to happen today, and that helped us to understand how vitamins work.

In the past, children in industrial cities or northern latitudes developed soft bones that bowed out under their own weight. By the beginning of the twentieth century, scientists knew that this condition, rickets, was associated with faulty mineralization of bone and was somehow associated with poor diet or lack of exposure to sunlight. Harry Steenbock in Wisconsin, Alfred Hess in New York, and Harriette Chick in London, also known as the heroine of Vienna for her work in that post–World War I city, showed that rickets could be prevented by either sunlight or cod-liver oil, an unlikely pair of treatments. These scientists were able to work successfully with two very different approaches to this strange situation and discovered Vitamin D, or calcitriol. Vitamin D is not actually a vitamin, as long as we are exposed to sufficient sunlight. Even though Vitamin D is in some respects not a "real" vitamin, it is the one vitamin in which large numbers of Americans may be deficient.

Because of the courage, intelligence, and persistence of the scientists reviewed in this book, we understand far more about the elements needed for a healthy diet than we did a hundred years ago. This understanding,

combined with technological advances in agriculture, food preservation, refrigeration, and transportation, has meant that vitamin deficiency diseases rarely occur in the developed world. The amazing stories of vitamin deficiencies of the past, and the discovery of their cures, are recounted in the following pages.

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Rats That Don't Grow and Have Sore Eyes: Vitamin A (Retinol), the Anti-Night Blindness Vitamin

Overview

In the early 1900s an agricultural scientist established secret rat colonies in Wisconsin. This project led to a series of discoveries. One of the first was that newborn rats grew best when fed on diets containing some animal fats. Without butterfat or cod-liver oil in their diet, the rodents grew poorly, became ill with infections such as pneumonia, developed inflamed eyes, and were likely to die. Japanese and Danish physicians discovered that children also needed to eat these fats to grow normally and remain healthy. The important substance in these fats turned out to be Vitamin A. In 1932 an English physician successfully treated children ill with measles with Vitamin A. This is because the immune system, which protects us from infections, and the skin and lining of many organs and tissues, depend on Vitamin A.

Vitamin A also allows us to see in dim light and plays a role in the production of tears, which lubricate and moisten the eye. For many decades, most of the interest in Vitamin A centered on eye ailments, such as night blindness and dry eyes. People without enough of this vitamin develop eyes that are so dry and ulcerated that the cornea can burst, leading to total blindness. An ophthalmologist studying eye problems in Indonesian children in the 1970s discovered that Vitamin A deficiency was also associated with infections and deaths. This finding astonished most physicians of the time but would not have been a surprise to earlier scientists or physicians.

Testing for Butterfat at the University of Wisconsin

Many discoveries in human nutrition came from research done in agricultural and veterinary laboratories. Much work was done at the University of Wisconsin, which had as one of its missions the improvement of the quality of cows and dairy products. Stephen Babcock (1843–1931), one of the great agricultural chemists from this university, grew up on a farm in Oneida, in

upstate New York. He studied chemistry at Tufts and Cornell. In the 1870s he went to Germany to study with pupils of Justus von Liebig (1803–1873). Liebig and his students had introduced new methods to the field of nutrition. They turned it into a quantitative science and used laboratory apparatus to calculate the exact percentages of protein, fat, carbohydrate, salt, and water that were needed in diets. This work supported the hope of some scientists: the liberation of our nutrition from actual food. In later years, Babcock would veer sharply from these interests.

Artificial Food

Food made in the laboratory promised to free people from depending on natural foods. It proved more difficult to reproduce foods in the laboratory than hoped. There were some famous catastrophic experiments. For example, in 1816, François Magendie (1783–1855) fed dogs on sugar and water. Their eyes dried out, ulcerated, and burst.

During a war between France and Germany in 1870, Paris was under siege, and its citizens, especially children, were starving. Milk and eggs were unavailable. A chemist prepared artificial milk by mixing fat in a sweet solution, but to no avail. Children died.

We now know that these artificial foods could not sustain life because of their inadequate protein and vitamin content.

Babcock received a doctorate in organic chemistry at the University of Göttingen and returned to the United States to work at the Geneva Experimental Station in New York. In 1888, he moved to the University of Wisconsin, where his first task was to solve a vexing problem for dairy farmers. The farmers were not able to sell their customers milk of consistent quality. The quality of milk depended in part on the amount of butterfat in the milk. Milk was sometimes watered down because the farmers were paid for the quantity, not the quality, of the milk. Customers never quite knew the quality of milk that they were buying. This was not helpful for the industry because it cast a shadow on all dairymen and their products.

Throughout the 1880s, many scientists around the world were working on the same problem: how to devise a simple and accurate way of measuring the amount of butterfat in milk. Babcock devised a simple method of doing this. He took a sample of milk and added sulfuric acid to it, which dissolved everything except the butterfat. He spun the milk sample in a calibrated bottle in a centrifuge or rotor-type machine, and the fat rose to the top. The fat layer in the centrifuged milk could then be easily measured. Milk became a more consistent product. Consumers knew what they were buying. Dairy farmers used this test to determine which of their cows or which type of feed yielded milk with the highest concentration of butterfat.

Babcock never patented this invention, believing that it belonged to the public. He later regretted this decision. By not patenting it, he lost control of