

Profile of David H. Baker

Like countless others during their youth, nutritionist David H. Baker received dinner-table lectures from his mother about the importance of proper nutrition. “She always said, ‘Eat your carrots, it’s good for your eyes.’ She even convinced me to eat liver because of the iron and protein,” he recalls. Unlike other recipients of that lecture, though, young Baker took it to heart. Not only did he eat his liver and carrots, but he also developed the desire to understand why he should be eating these foods. “As I was growing up, I always had this interest in getting all the nutrients I needed, even though I didn’t always know what the nutrients were,” he says.

What Baker did not know then, he certainly knows now, due in no small part to his own research efforts. Over the past 40 years, Baker, Professor of Nutrition at the University of Illinois at Urbana–Champaign since 1967, has contributed to the fields of animal and human nutrition, particularly in elucidating the dietary requirements and effects of vitamins, minerals, and amino acids. His work has helped improve the quality of livestock feed, led to the production of chemically defined diets for use in animal research studies, and increased the understanding of diseases caused by vitamin and mineral deficiencies. Many institutions have recognized the value of Baker’s work, including the University of Illinois, which named Baker a University Scholar in 1986; the U.S. Department of Agriculture, which presented Baker with the Distinguished Service Award in 1987; and the National Academy of Sciences, which inducted Baker as a member in 2005.

As Baker illustrates in his Inaugural Article published in a recent issue of PNAS (1), many nutritional mysteries remain to be solved. In the article, Baker recaps some of the major advances in nutritional science during the 20th century and poses a set of “15 vexatious questions,” as he describes them, dealing with amino acid nutrition and metabolism.

Vaulting to Excellence

Baker grew up in Waterman, IL, a small farming town of approximately 1,000 people, 60 miles west of Chicago. Baker credits his mother, Lucille, an English teacher at the time, for much of his current success. Apart from her advice on the nutritional value of certain foods, she fostered his reading and writing. “Beginning at age 6 or 7, she took me to the public library once each week,”



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he says, “and encouraged me to read and learn new words.” Baker’s colleagues often marvel at his ability to write clearly, concisely, and easily, where first drafts are generally close to final drafts. “I actually enjoy writing. For me, it’s pleasure rather than work. When we have exciting research findings, I can hardly wait to put pen to paper,” says Baker.

Although he appreciated the valuable education received at home, athletics were where Baker focused his interest and excellence in high school. “I was a sprinter on the track team, and I also played basketball. I even won our conference pole vault when I was a sophomore in high school,” Baker recalls. “That was back when we didn’t have the flexible poles. You had to use a straight pole and land in a pile of sand. . . . I don’t think I really became serious about academics until about the end of my junior year in high school,” he says, “when I decided that I’m probably not going to make a living playing basketball.”

After graduating from high school, Baker entered the University of Illinois in the fall of 1957, with the send-off message of his father, Vernon, echoing in his head: “Make your life count.” Initially, the transition from a small high school—his graduating class totaled approximately 30 people—to a large university threw Baker for a loop. “I was pretty naïve and walked around campus my freshman year wondering if I was qualified to be here,” he recalls. To further complicate his first semester, Baker

became ill with the Asian influenza virus that had broken out of China the previous February and had become a global pandemic. “I was spaced out for about 3 weeks,” he says, during which time he began falling behind in his studies. “Eventually I went in to see the dean to talk about whether I was in the right college,” Baker says, “and the guy told me, ‘Well, if you have to drop a course . . . you probably don’t belong in this university.’”

Initially, Baker thought that the dean might be right, so he dropped out of college and began working at a men’s clothing store in downtown Champaign. But as he spent his days hanging up sport coats and slacks, he began to reconsider his decision. “I realized that I had done well, quite well actually, on the entrance exams, and I was placed in all these advanced courses from high school,” he says. So, Baker reentered the University of Illinois in the spring, “and armed with a lot better knowledge of courses that I should be taking, etc., etc., I got straight A’s. So, at that point, I decided I belonged,” he says.

There and Back Again

Baker excelled in the remainder of his undergraduate days, earning a bachelor’s degree in animal science in 1961. “I found my niche in terms of being fascinated by nutrition and metabolism,” he says, “what actually happens when you ingest foods and nutrients, and how they’re used, and how the body works, and what goes on in the liver and muscle, and all those kinds of things. I just couldn’t get enough of it. I was just absolutely enamored by it.” Some of his professors recommended that he consider applying to graduate school and becoming a researcher, although Baker himself was not convinced. “I had the wrong concept of research. I had the idea that research people were all strange people with thick glasses and lab coats that never knew how to interact in the world,” he says.

Instead, Baker thought about pursuing a more socially interactive career. “I thought, ‘I probably would like to teach,’” he says. But as he completed his master’s degree in nutrition at the University of Illinois, he became involved in research and discovery and realized that he liked research. “I decided that previously I had the wrong

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impression about research,” he says, “and I began to think, ‘Well, maybe I can be pretty good at this.’”

Baker indeed became quite good at research, and when he received his Ph.D. in nutrition in 1965, he was eager to continue in academia. Some of his advisors cautioned him, however, that although there were “choice” academic jobs, there were also dead-end jobs in academia, and they recommended that he wait until a good opportunity presented itself. “At that time, the right position wasn’t available,” says Baker, “and then along came Eli Lilly and offered me probably the best position in industry that you could have possibly sought at that time.” For the next 2 years, Baker worked as a senior scientist at Eli Lilly’s Greenfield Laboratories (Greenfield, IN). He enjoyed and profited from his time in the private sector but was somewhat unhappy with the constraints of working for a pharmaceutical company. “I had a lot of ideas that I thought could benefit mankind or the animal industry, and I couldn’t pursue them because they were either not profitable or not patentable for the company,” he explains. So Baker continued to keep an eye out for any potential academic opportunities. “I wanted to do comparative nutrition,” he says, “not specialize in any species but use whatever animal was ideal to solve the problem. If an excellent position came along where I could do that, I would take it.”

Baker was surprised when such a position came along in 1967 from his alma mater, the University of Illinois, which tried to recruit him to return. Baker remembers it being a tough decision to leave a well paying, comfortable industry position and enter an academic environment where he would feel tremendous pressure to excel. “I realized that coming back to where I did my Ph.D., that I not only had to be good, I had to be exceptional to overcome the stigma of [a] ‘Well, he’s just one of our former students’ kind of thing,” says Baker. He accepted the university’s offer, took a salary cut, and returned to Illinois as an assistant professor of nutrition. As it was with the first time he left the campus and returned, he felt right about the decision and thought that he was back where he belonged.

All Creatures Great and Small

Baker’s early work at the University of Illinois in the 1960s involved characterizing dietary requirements for amino acids in pigs and, based on these requirements, developing a purified amino acid diet (2, 3). “One of the things that I’m probably best known for is developing these chemically de-

finied diets—amino acids, pure vitamins, pure minerals—so you can make just about any nutrient deficient and study it,” he says. Over the years, Baker published additional diets for mice, rats, chickens, cats, and dogs (4–7), as well as a complete chemical diet for pigs, which can produce growth rates comparable to standard corn-soybean diets (8).

Along the way, Baker used his diet formulas to uncover interesting findings about the nutritional requirements of numerous animals. “A lot of my work has looked at nutrient deficiencies and also excesses,” he says. Some highlights of Baker’s research included identifying the amino acid derivative taurine as a dietary requirement for felines (9), showing that excess phosphorus reduces manganese absorption in chickens (10), and demonstrating that pigs can synthesize enough arginine in their bodies during pregnancy to meet dietary requirements, the first such finding for any

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species (11, 12). “We, myself and my Ph.D. student Bob Easter, who is now the dean [of the University of Illinois’ College of Agricultural, Consumer, and Environmental Sciences], fed pigs arginine-free diets throughout their 114-day pregnancy, and we measured nitrogen retention and looked at lactation performance,” says Baker, “and, lo and behold, absolutely no untoward effects.”

One of Baker’s most striking discoveries came in 1984, shortly after he completed a mini-sabbatical in Scotland. “While I was over there, I had more time to get into the literature and study some toxicology issues,” he says, “and I read that the main treatment for arsenic toxicity, across the board, was to use cysteine- or cystine-containing drugs.” When Baker returned to Illinois, he examined the effects of these drugs in animals because small doses of arsenic compounds such as roxarsone are added to feed for antiparasitic or growth purposes. He found that although these drugs work against inorganic arsenic, their use against pentavalent organic arsenic (e.g., roxarsone), which can be found in contaminated seafood or freshwater food, can actually make the toxic-

ity worse. Cysteine, though not cystine, can reduce pentavalent arsenic to trivalent arsenic, which is 100 times more toxic (13). This finding helped revise many toxicology textbooks and resulted in an outstanding paper award from Hoffman-La Roche.

In 1999, Baker reached the point of retirement, according to the state university retirement system. But “I had no intention of really retiring,” he says, “but from an economic standpoint it made sense. And so I said to the university that I would retire assuming I could keep my office, my lab, and any accumulated funds because I intended to keep working. Hopefully, the work would be at a reduced pace, which I’ve tried to do, but not always successfully.”

How Much Is Too Much?

In recent years, Baker has become increasingly involved in research and committees on human nutrition. “When I started out, I was probably thinking about pure animal nutrition and developing feeds that avoided deficiencies and excesses to make the diets more efficient. Then, as my program evolved, I thought more and more about how these animal models could be used to solve human problems,” he says. Baker has given several talks comparing the nutritional requirements of pigs with those of humans, because the two species are metabolically similar. Baker served on the Dietary Reference Intake Panel of the National Academy of Sciences Food and Nutrition Board in 2002, and, more recently, he has been involved in the International Council of Amino Acid Science, which explores the upper limits of amino acid intake, an area he sees as a growing concern.

“Increasingly, we are seeing amino acid supplements being used for athletic performance, or strength building, or whatever. Some people take arginine because they think it increases libido. And the question comes up, ‘How much is too much?’” says Baker. He notes that solid data do not yet exist for many of these supplements in terms of proper dosage, efficacy, or long-term effects, and he includes this area among his “15 vexatious questions” in his PNAS Inaugural Article (1). Baker’s laboratory has focused on sulfur amino acid metabolism over the past few years, and his studies show that these supplements are potentially dangerous. “We’re pursuing cysteine toxicity because it’s available over the counter. We have done some work where we surprisingly find that at about 7 times the minimal requirement you start getting death in either chicks or rats,” (14) he says, “and I see that

you can buy some of this stuff in the health food store, and some people think, 'Well, if one or two pills is good, then maybe six or seven is better.' It's pretty scary."

On a more positive note, Baker's foray into human nutrition has renewed

his involvement in competitive athletics, which he enjoyed as a youth. In 2001, Baker advised the University of Illinois football team on nutrition. "I've learned that athletes think about nutrition a lot, but many times they think about it wrong," he says. Although he will not

take much credit for it, Baker points out that the football team won the Big Ten Conference that year, perhaps providing a fitting example of the power of good nutrition.

Nick Zagorski, *Science Writer*

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