



Irwin C. Gunsalus

1912–2008

BIOGRAPHICAL

Memoirs

*A Biographical Memoir by
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NATIONAL ACADEMY OF SCIENCES

IRWIN C. GUNSALUS

June 29, 1912–October 25, 2008

Elected to the NAS, 1965

Irwin C. Gunsalus, known everywhere as Gunny, served science in many ways—as a researcher, an inspiring teacher, and a scientific leader. He was born near Blunt, South Dakota, a few miles from the Missouri River and 15 miles from the nearest town. In Gunny's own words in the article "Learning" (2003): "I was born there, in a farm cottage, with the help of a midwife, on June 29, 1912. My birth was not recorded with the state until my enrollment at Cornell required a certificate." From this remote corner of the Midwestern prairie, Gunny started his long and distinguished career.

The beginning of Gunny's education was a portent of the strength and uniqueness of his later career. Again in his words: "Father's aged riding horse, persuaded with sugar, took me and my older sister to a one-room school house, two and a half miles across the pastures...This was my first-grade education." For the rest of grade school, high school, and two years of college Gunny lived in Brookings, where, he wrote, "I spent much time independent of supervision." Before enrolling at Cornell, Gunny attended South Dakota State College for two years. At Cornell he studied bacteriology, earning a bachelor's degree in 1933, a master's degree in 1937, and a Ph.D. in 1940. He remained at Cornell until 1947.



Photography by Ilimi Studio, 1983

A handwritten signature in black ink, which appears to be "Hans Frauenfelder".

By Hans Frauenfelder,
Stephen G. Sligar,
and Ralph S. Wolfe

While at Cornell Gunny began a research program on bacterial metabolism. Professor Sherman had amassed a stock collection of lactic acid bacteria, and from this collection Gunny chose to study *Streptococcus faecalis*, a nonpathogenic organism that was easy to grow. To cultivate species of lactic acid bacteria it was necessary to add complex components, such as a yeast extract, to the cultivation medium. Gunny began to investigate the requirement for yeast extract by developing specific assays that required a component of yeast extract. He first studied the need of enzymes in *S. faecalis* and *Escherichia coli* for a factor required for amino group activation on amino acids. The active component was



1966 Oxygenase meeting in Tokyo.
Gunny is the fourth from left in front row.

found to be vitamin B₆, and Gunny was involved in working out its structure as pyridoxal phosphate.

A second investigation Gunny began at Cornell was to answer the need for a component of yeast extract for the oxidation of pyruvate by enzymes of *S. faecalis*. Study of the “pyruvate oxidation factor” consumed more than a decade of Gunny’s research, including work at Indiana and Illinois, and the necessary ingredient was eventually identified as lipoic acid. The new coenzyme was chemically synthesized at the DuPont

company. The study of coenzymes was at the forefront of research on metabolism at the time Gunny was developing his research program. In 1947 Gunny moved to Indiana University.

In 1950 he was recruited to join the department of bacteriology at the University of Illinois. The president of the university, George D. Stoddard, in response to much criticism about the poor state of the bacteriology department, had made the decision to make it the best such unit in the country. He gave his provost four full professor lines and one assistant professor line to do the job. Within the space of three years the new department head, Professor H. O. Halvorson, appointed Sol Spiegelman (molecular biology), Gunny (biochemistry), and Salvatore Luria (virology). Virtually overnight President Goddard saw his ambition for the department realized. Gunny played a commanding role in setting high departmental standards for course development, for graduate student curricula, and for his own research program, which was at the cutting edge of research on bacterial metabolism.

In 1955 Gunny became head of the biochemistry division of the department of chemistry, presaging the start of a long period of notable achievement for the department. The late 1960s saw two transformations that would have a major impact on multiple fields. Gunny had already fashioned an illustrious career unraveling biological transformations that are critical to all cells. The enzymes that carry out these metabolic steps often contain organic cofactors. As noted earlier, Gunny was a pioneer in defining the

role of lipoic acid, pyridoxyl phosphate, and other coenzymes. Being a microbiologist, he used chemical and biochemical approaches in addition to the powerful tools of genetics.

Gunny enlisted the help of E. J. Corey in developing the tools to identify the metabolism of terpenes by microbial species. In this process, he discovered an enzyme that broke down atmospheric dioxygen and added a hydroxyl group to the substrate. The bacterium that carried out this reaction was isolated from the “boneyard creek” that flowed through the Illinois campus. Through heroic work, Gunny showed that this transformation was carried out by a

heme protein, termed cytochrome P450, a small two-iron, two-sulfur ferredoxin protein (termed putidaredoxin), and a flavoprotein containing FAD as a prosthetic group. Using the power of microbiology, Gunny and his colleagues were able develop the genetics of the *Pseudomonas* organism as well as to generate extraordinarily large amounts, measured in whole grams, of each of these enzyme components. This result became critical as the spectroscopic techniques being advanced in the chemistry and biochemistry departments demanded enormous quantities of material.

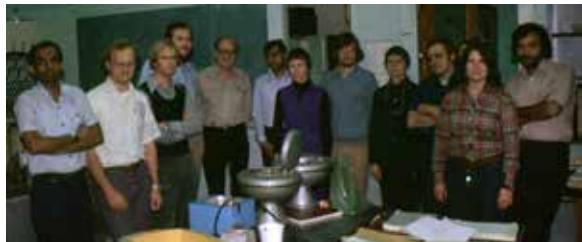
Across Green Street, which separated Gunny’s bailiwick from the college of engineering and its physics department, an equally important revolution was emerging. A group led by Hans Frauenfelder and Peter Debrunner was using the then-new technique of Mössbauer spectroscopy to study iron-containing physical systems. A student, Roger Cooke (later a professor at the University of California-San Francisco), asked if he could study proteins. The answer was yes, even though the physicists did not know what proteins were.

Cooke’s studies led to a growing interaction between the biochemistry and the physics groups. But there was a problem: language! The verbiage of spin physics and nuclear energy levels was unintelligible to the average biologist and biochemist. Likewise the tools of microbiology, enzymology, and basic chemical assay were not a comfortable



The Department of Biochemistry in Urbana. Gunny’s faculty hires: Bill Rutter, Ed Conrad, Woody Hastings, Fin Wold, Lowell Hager, Gregorio Weber, John Clark, Herb Carter.

part of the physicist's vocabulary. Gunny and Frauenfelder solved this problem by instituting weekly—and sometimes daily—meetings of all members of their research group where there was but one rule: No question is too simple, too stupid or unimportant. The meeting did not conclude until everyone understood what was being presented.



Gunny's laboratory in Urbana circa 1974.

The joint Mössbauer work on putidaredoxin led to flash-photolysis studies extended to low temperatures. The goal was to understand the dynamics of Gunny's favorite protein, P450. The researchers quickly realized that P450 was just too complex to be unraveled. Gunny was asked to find a simple and fully understood protein for the physicists to use. After a few days he suggested myoglobin, the protein responsible for storing oxygen in muscles. Myoglobin was available commercially in gram quantities. His choice may well be part of the universal acceptance of myoglobin as the "biological hydrogen atom"



The Department of Biochemistry, 1974.



Gunny doing his favorite thing: Drinking wine!
On his porch in Urbana.

for physicists. The contact between biochemistry and physics continued for many years and led to the acceptance of biological physics as a vital component of physics. Gunny deserves a great deal of credit for building this bridge.

Gunny, like everyone else at Illinois then, was forced to retire at age 70—in his case, this occurred in 1982. But passive retirement was not for Gunny, and he accepted the position of assistant secretary general of the United Nations and founding director of the United Nations International Center for Genetic Engineering and Biotechnology in Trieste, Italy, and New Delhi, India. His next adventure was to conduct ecological studies of the Gulf of Mexico for the U.S. Environmental Protection Agency. Twenty-six years after his “retirement,” Gunny passed away in his home in Andalusia, Alabama, in 2008.

Gunny stories

There seem to be infinitely many Gunny stories; they are all true. They range from his interchanges with unenlightened wait staff, who usually fell prey to demonstrations of pique if they were less than accommodating or lacking in knowledge of oenology, to warm responses designed to elicit the highest performance from those he cared about. He would reiterate the “South Park” quote: “Family isn’t about whose blood you have. It’s about who you care about.” Best, however are those stories in which there is a lesson. How to travel throughout the world and always seem never to have to wait in line or miss the extra seat on the plane. For administrators, the mandate: “Just take the baton and conduct!”

While driving his car in Urbana Gunny never stopped at stop signs. Once, when riding with him, I asked why he did this. He replied, “I understand their purpose.”

Gunny’s philosophy was, “don’t do what you have to do until it has to be done.” This led to a life of deadline crises! His family and his associates were constantly being confronted with new and sudden changes of plans. One of his family members said to me: “Life doesn’t have to be like this.”

Gunny had high standards for red wine. Once at John Clark’s home he decided that the bottle of wine was inferior and poured the wine down the sink.

Gunny held fast to the adage that you should change your scientific direction every ten years: an important mandate, often forgotten, by today’s young scientists.



International Symposium on oxygenases and oxygen metabolism. November 11-15, 1981. Hakone, Japan. Gunny is seventh from the right in the front row.

Gunny set a high bar for admitting students into his laboratory. Believing that any successful scientist could sell his or her research, Gunny had a special procedure when it came to describing his research to a group of prospective graduate students. At the time it was customary for faculty in biochemistry to give a half-hour presentation of their

research to the first year students. Unfortunately, this was scheduled at 7:30 PM. Most of the graduate students would use the time before hand to down a couple beers at the local bar, Treno’s. By 7:30 many were already a little tired. Gunny would march in a few minutes late carrying a stack of the journal *Biochemistry*, and slam them down on the desk. He would pick up one and start reading the table of contents, making remarks about the authors or the science that only he could understand. Within a few minutes,



Gunny at the home of Marianne Grunberg Manago in Paris. The painting is one from her husband Armand.

one of the first year students would nod off. Gunny's response was instantaneous: He would pick up a chalkboard eraser and sling it at the offender's head! Then rage in an elevated voice about what it took to be a scientist and march out of the room. Needless to say, he never recruited a large number of graduate students: Only those who could see beyond the exterior and accept the challenge and opportunities of outstanding science.

One phrase Gunny used that is valuable in many aspects of life was: "Make it easy on

yourself." This is not to say be lazy, but rather to not put unnecessary obstacles in your path. He was a firm believer that, in many cases, people are their own worst enemies. Finally, Gunny held fast to the adage that you should change your scientific direction every ten years: an important mandate, often forgotten, by today's young scientists.

Gunny could transform research with a bottle of wine. In 1972 W. H. Orme-Johnson of the University of Wisconsin lectured at Illinois on the MoFe protein of nitrogenase, an enzyme thought to contain somewhere between 14 and 36 iron atoms. After the lecture Gunny phoned his junior colleague from across Green Street, Eckard Münck, and said, "I have a good bottle of wine for dinner. I think Bill [Orme-Johnson] needs somebody from physics to sort out the mess." This bottle of wine started a long-lasting collaboration and friendship between Orme-Johnson and Münck that led to the characterization of the novel clusters of nitrogenase via Mössbauer spectroscopy.

Gunny's name will not be forgotten at Illinois. In appreciation of his leadership, William Rutter endowed the Gunsalus chair of biochemistry. Rutter was a graduate student at Illinois and was later hired by Gunny as an assistant professor. The first holder of the chair was Stephen Sligar, who as a student worked with Gunny and with Gunny's students.

Gunny's impact on science and on his multitude of students and collaborators is clearly evident in the many contributions that were made to the special issue "I. C. Gunsalus" in *Biochemical and Biophysical Research Communications* 312:1-269 (2003). The contributions give a vivid picture of Gunny as scientist, teacher, organizer, leader, and friend. The contributions also show that his impact was not restricted to the United States, but extended to Japan, Germany, France and many other countries.

HONORS AND AWARDS

- 1949 Guggenheim Fellowship
- 1965 U.S. National Academy of Sciences
- 1967 American Academy of Arts and Sciences
- 1982 Selman A. Waksman Award in Microbiology, National Academy of Sciences
- 1984 Foreign Member, Académie des Sciences, France

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