The Biophysicist

History and Philosophy of a Biophysics Department

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Prologue: not an ordinary biophysics department

In the 1970s, at the Department of Biophysical Sciences of the State University of New York at Buffalo, Professor Fred M. Snell and his students were working on developing a global climatic model that included the coupling of the optical properties of the atmosphere to the surface temperature (1). They included studies of the sensitivity of the climate to the variation in aerosol optical density, atmospheric carbon dioxide, and the solar constant. This was not an ordinary biophysics department of the times.

Early history of the Department of Biophysics, University of Buffalo

The department was established in 1959 as part of the Medical School of the University of Buffalo after extensive negotiations between Dr Marvin L. Bloom; Dr Snell, who was then at Harvard University; and the Dean of the Medical School. Dr Bloom was "a leader of the 'Participating Fund' an organization of alumni that raised money to support the School," as described by Dr Robert Spangler (personal communication, 31 October 2021), interim chair of the department between 1970 and 1977. "The fund contributed substantially to the start-up costs of the department."

At the time, there were only 5 other biophysics departments in the United States. On 11 July 1958 during these negotiations, Dr Snell wrote to Dr Bloom and Dr Hermann Rahn, chair of the Department of Physiology (personal communication, Robert Spangler, 31 October 2021): "I feel that this may be an ideal way to promote and strengthen the quantitative physical sciences in our medical curriculums, and thus lend to a stronger scientific foundation for medicine." He went on to say: "Since biophysics appears to be less hampered by defined boundaries and limits imposed by tradition on the other more established disciplines, it is of especially great importance that any individual who might undertake to lead such a department be granted the positive unhesitant freedom to develop the department in those areas determined by his considered judgement."

In September 1958, the chair of the Department of Biological Chemistry at Harvard and recipient of the President's Medal for Merit in 1948, Dr A. Baird Hastings, wrote to Dr Douglas S. Riggs, chair of the Department of Pharmacology at the University of Buffalo: "First of all, I

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should like to congratulate the University of Buffalo School of Medicine on being far-sighted and planning for the establishment of a Department of Biophysics, at this time. There is no doubt in my mind, but biophysics will develop and occupy a place among the basic medical sciences, as does biochemistry today."

Alan Burton and the essence of biophysics

Professor Alan C. Burton at the University of Western Ontario Faculty of Medicine considered Galvani, Helmholtz, and Faraday as the early and great biophysicists, whose tradition had been continued by A. V. Hill, the 1922 winner of the Nobel Prize in Physiology or Medicine (2). He considered them as great biophysicists "not merely because they happened to use the tools of physics to investigate the problems of biology. But because they shared a faith that the phenomena of life were governed by 'physical' laws, as well as by 'chemical' and 'physiological' principles, and that these physical laws would ultimately be found to be identical with those operating on the inanimate world . . . . They were biophysicists because they thought about the biological behavior they observed in terms of the laws of physics and of mathematics, just as the biochemists thought about the same phenomena in terms of chemical laws" (2). Professor Burton was one of the consultants to the School of Medicine in Buffalo during the formation of the Department of Biophysics. Dr Rahn, in a 1979 letter to Dr Robert Spangler (personal communication, 31 October 2021), indicated that it was Professor Burton's visit to Buffalo that persuaded the dean of the School of Medicine, Dr Stockton Kimball, to set up an independent Department of Biophysics.

A. V. Hill: "Why biophysics?"

It was only 3 yr before the Department of Biophysics was established at the University of Buffalo that A. V. Hill wrote his groundbreaking *Science* article titled "Why Biophysics?" as part of the series "Lectures on the Scientific Basis of Medicine" (3). Regarding what biophysics is, "the emphasis must clearly be on the *bio*," Hill stated, "on function and structure viewed through physical spectacles and investigated by physical ideas and methods." In a rather humorous tone, he wrote: "One thing it clearly is not is a second-rate branch of physics, a haven of refuge for indifferent physicists. It does not consist of teaching physics to medical students. It is just as unsuited—and some may think this a hard saying—to people who know no biology as to those who know no physics." He went on: "With all these qualifications about what biophysics is not, may I try to define what it is: as the study of biological function, organization, and structure by physical and physicochemical ideas and methods." And regarding "Why Biophysics," he wrote: "To give biophysics a name and personality, to endow it with a few centers where it can be specially practiced, to realize that its recognition implies much more than just mixing up biologists and physicists (good as that is) will draw in recruits to a science that in 20 years or so may have the same importance to biology and medicine as biochemistry has come to have today." Thus, the University of Buffalo Department of Biophysics came to being in this scientific environment on 1 July 1959 (Fig 1).

Early faculty members

Early faculty members of the department were David Harker, known for determining the crystal and molecular structure of ribonuclease, the first protein structure that was solved in the United States in 1967 (4), and the head of the Biophysics Department at Roswell Park Memorial Institute, Sidney Shulman, Richard Spencer, Carl Moos, C. Richard Zobel, Dorita Norton, and Monte Blau. Fred Snell also recruited Robert A. Spangler and John R. Border from Harvard as postdoctoral fellows. The department had a strong theoretical inclination directed at the analysis of membrane structure and function, which was strengthened by the recruitment of Professor James Danielli, a

Fig 1. The Buffalo Biophysics Department in 1960. Front row: G. Burke, M. Mandato, B. Melton, E. Helffenstein, B. Stein. Second row: S. Woldring, G. Moore, T. Schwartz, R. Spangler, R. Karpick. Third row: C. Moos, J. Border, S. Shulman, U. Rifé, F. Snell

pioneer in membrane biophysics, to head the Center for Theoretical Biology. The Center was conceived of and promoted by Fred Snell and the Dean of Pharmacy, through university approval. Dr Danielli's group developed the framework for detecting life on Mars, which was the foundation of the requests for applications from NASA for the Viking missions. Fred Snell served as the editor of *Biophysical Journal* (1966–1969) and *Progress in Theoretical Biology* (1966–1972). Faculty that further strengthened the theoretical approaches of the department, by now called Biophysical Sciences, included Robert Rosen, Shinpei Ohki, Robert Rein, and Howard Pattee, who were also members of the Center. The importance of this approach to biology and biophysics was recently emphasized by Paul Nurse, the director of the Francis Crick Institute, who called for modeling "the molecular and cellular component involved in a biological phenomenon, to allow analysis of dynamic behaviors and interactions" (5).

Nobel laureates in Buffalo

Sir John Eccles, Nobel Laureate in Physiology or Medicine in 1963, was recruited to the department jointly with Physiology; he worked on the function of the cerebellum. A future Nobel Prize winner in Chemistry (1985), Herbert Hauptman, who developed direct methods in crystallography by invoking prior structural knowledge, joined the Medical Foundation of Buffalo and the department in 1970.

Studying living systems to study life

Mathematical biophysicist Dr Rosen foresaw the necessity of knockout genes to study how a living system worked several decades before this method was implemented. This "followed directly from his contention that to study life one has to study living systems, not dead ones," as Dr. Allen Rosenspire, a former student of Dr. Rosen, noted (personal communication, Allen Rosenspire, 31 March 2022). Professor Donald C. Mikulecky, a member of the department between 1965 and 1972, who worked on irreversible thermodynamics and membrane biophysics, described Rosen's contributions to science as follows: "There is one controversial idea around which everything Rosen did was centered: he once said that modern molecular biology is populated by people who insist that something be dead before they study it. In that respect, 'molecular biology' is an oxymoron. There is no life at the molecular level. The scientific community did itself a disservice when it allowed that term to become one of its banners. It is, at best, molecular biochemistry and biophysics, if one understands that these two fields have no direct link with the study of life" (5). Furthermore, "Rosen's abstraction . . . sacrificed the machine-like structure that is so central to everything done in science and looked at an abstract version of the organization that is necessarily thrown away in the Newtonian Paradigm as it systematically reduces the system to something that physics can handle" (6). This early philosophy is reflected in the editorial by Paul Nurse: "Theorists can find fertile ground in considering the flow of information through living systems, which can help them to make better sense of the flood of biological data" (5). Nurse pointed out that the papers of Bill Hamilton, John Maynard Smith, Barbara McClintock, and Francis Crick are "permeated with richly informed biological intuition" and concluded that "students will be better motivated and will feel more inspired if they are taught that biology has ideas—and that they are worth talking about." The same holds true for biophysics. Eve Marder has pointed to the "challenge of creatively marrying the rules of mathematics and physics with what is known of fundamental biological principles" (7).

Student–faculty interactions in the Department

The philosophy of the Department of Biophysical Sciences had several angles. Student–faculty interactions were sincere and personal, students being considered as colleagues early on. The atmosphere among students was friendly and noncompetitive. Department picnics at the Snell–Spangler jointly owned cottage in Holland, NY, or gatherings at the Spangler house in Amherst, NY, were an institution. Students were known to go trick-or-treating at some professors' homes, or visit Fred Snell's geodesic dome house outside Buffalo. To attend parties at Fred Snell's home in the winter, however, required bundling up in coats as he was adamant about keeping his house at 55 °F to conserve energy. When students asked Fred what biophysics is, he would respond with a mischievous smile, "Biophysics is what biophysicists do!"

Research projects as qualifying exams

A unique aspect of the department was the strong research emphasis of the qualifying exams before students embarked on their doctorate projects. This involved reports in 2 different research areas and a major "Summer Project," which usually lasted a lot longer than the summer, with its accompanying report. On occasion, the report could be submitted for publication. Students could be very well versed in academic subjects, but perhaps some did not have the mindset for research, discovery, and perseverance.

Student-run seminars that explored beyond biophysics

Part of the philosophy of the department, as well as the university at the time, was to enable students to organize their own academic activities. Thus, in addition to the regular departmental seminars on Wednesday afternoons, the students had their own seminar series. Seminar topics

included the philosophy of biology and the structure of scientific revolutions. Having invited Professor Ilya Prigogine for one of these seminars before he received the Nobel Prize in Chemistry (1977), the students received preferential treatment from Dr Prigogine when he readily accepted their subsequent invitation after he received the Prize, when he was receiving many invitations as a speaker around the world. The students also foresaw the contributions of Dr Raymond Damadian to magnetic resonance imaging and invited him for a seminar before the award of the Nobel Prize in this field became highly controversial. Dr Jonas Salk, who developed the first polio vaccine, was also a guest of the department students. Although in the 1970s the competition for grants was not in the forefront of graduate education, the Department of Biophysical Sciences students invited Professor Leonard Weiss from the Roswell Park Memorial Institute, who alerted the students to write the abstract of any grant proposal as the postal address, to ensure that the right people got to review it (personal communication, Allen Rosenspire, 31 March 2022).

What has happened since the late 1970s?

Starting in the late 1970s, the department increased its emphasis on experimental biophysics, rather than theoretical biophysics. This action may partially have been a consequence of the increased availability of funds from the National Institutes of Health, for example in the recruitment of faculty with National Institutes of Health grants. Some members of the department described these developments as a shift from caring about intellect and the program to minding the pocketbook and to harbingers of decline. Nevertheless, until about 2000, Buffalo biophysics was still strong, albeit small, and had strong intellectual foundations.

In 1998 the Department of Biophysical Sciences was merged with the Department of Physiology, whose grant support had been decreasing. Thus, bringing the well-funded biophysicists into a joint department would potentially attract a new chair. The Duke University cardiologist Dr Harold Strauss was recruited for this position, and 11 new faculty were appointed over the next 10 yr, only 2 or 3 of whom could be identified as biophysicists. Both the old and the new merged departments being part of the School of Medicine, it was surprising that the Medical Biophysics course was dropped from the medical school curriculum. Despite these changes, the graduate program in Biophysics continued to train many doctoral and postdoctoral students who now have independent careers in academia and biotechnology.

With subsequent chairs, the focus of the department continued to shift away from biophysics toward physiology and neuroscience. This shift was accompanied by a disinterest in biophysics even in grant review panels, as well as in students, faculty, and deans, who became interested in other approaches to biomedical research. The current faculty ascribed the decline of biophysics as a medical discipline in Buffalo to the rise of empirical qualitative science and the failure of theory, as well as internal factors, including the merger with Physiology and the lack of support by deans and chairs. It is unfortunate that the brilliant enthusiasm of the founders of the department was not sustained by subsequent generations. Because 3 of the prominent biophysicists in the department, Dr Anthony Auerbach, Dr Frederick Sachs, and Dr Malcolm Slaughter are nearing retirement age, the resurgence of biophysics at the medical school is not likely. It is encouraging, however, that the Department of Physics at the North Campus in Buffalo has been hiring faculty who work at the interface of physics and biology.

Epilogue

The period between the mid 1950s and late 1970s was an exciting period in the history of biophysics during its early days, and the Department of Biophysical Sciences at the State University of New York at Buffalo. The importance given to students and to understanding the place of biophysics in the world of biology and science was most likely unprecedented. Hopefully, and despite the apparent decline, there are, and will be, biophysics departments around the

world that adopt the broad perspectives that the students and faculty tried to develop in Buffalo in the 1960s and 1970s.

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