NATIONAL ACADEMY OF SCIENCES

HOWARD A. SCHNEIDERMAN

1927—1990

A Biographical Memoir by

LAWRENCE I. GILBERT

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Biographical Memoir

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February 9, 1927–December 5, 1990

BY LAWRENCE I. GILBERT

HOWARD SCHNEIDERMAN passed away on December 5, 1990. His loving wife Audrey was at his side when he lost his courageous two-year battle against leukemia. Dr. Schneiderman, an eminent developmental biologist, academician, and university administrator, was, at the time of his death, chief scientist and senior vice-president for research and development at the Monsanto Corporation. Dr. Schneiderman was the epitome of a master teacher. His contagious enthusiasm elicited the very best from undergraduates, graduate students, and postdocs, many of whom have become world leaders in science. Several months after his death two memorial services celebrated his life; one took place at Washington University in St. Louis and the other at the University of California at Irvine. The conclusion reached by all who knew Howard well agreed with my personal feelings: Howard Schneiderman was a "mensch." According to the *American Heritage Dictionary*, a mensch is "a person having admirable characteristics, such as fortitude and firmness of purpose." It is a word derived from the Yiddish and middle high German and certainly one that pays tribute to his personality.

Howard was born in Brooklyn, New York, to Louis and

Anna Schneiderman, Anna being director of education for the American Jewish Congress when she died in 1950. In 1953 his father remarried, and in Howard's own words, "I acquired three attractive stepbrothers." Howard Schneiderman adored his father and looked back on his childhood with fond memories. As a young boy he enjoyed the same frivolities in Brooklyn as I did in the Bronx, namely playing stick ball, stoop ball, and ringaleevio, and went through the same Hebrew lessons that ended with a bar mitzvah at the age of thirteen.

Howard attended the Brooklyn Ethical Culture School, since both of his parents had been associated with the Ethical Society. Although it was a financial burden to his parents, Howard enjoyed the school with its small class sizes, and both his intellect and imagination prospered. During eighth grade all students were expected to write a small book, and, as if prophetic of his future, Howard chose the topic of life and evolution. He spent many days at the American Museum of Natural History in New York compiling data for his book and came to know the works of Lamarck, Cuvier, and Darwin. He attacked the problem of obtaining the information for this project in a manner later typical of his preparation of a research project. As he describes it in his unpublished autobiography, "When I first went to the museum, I would look at an entire hall. The exhibits were often arranged in the halls by periods in evolutionary history. I had only about three hours to spend at the museum on any day and so I was selective about the material. I examined the 30 or so items in an entire hall and picked out 5 or 6 that I wanted to discuss in the book. I tried to select the ones that seemed most important, based on the amount of space that the museum devoted to it. I took all the notes, made sure that the pages were num-

bered, and identified the items that I wanted to include by making marks along the edge of each page. If I was uncertain about a word, I would look it up and, if possible, use a simpler word. I did my best to make my chapters brief because I had to write each page of the final book in my own hand." My own memories of Howard as a scientist indicate that these habits he developed at the age of thirteen formed the basis of his research philosophy as an adult, since he was one of the most meticulous thinkers I have ever known.

During the last several years of his life, when he was suffering with leukemia and had undergone chemotherapy, radiation, and a bone marrow transplant, Howard put his life in order. Among his most cherished items was his stamp collection, which he cataloged with his home computer during those last months. His interest in stamp collecting began when he was about seven years old, and as an adult he used a similar paradigm in expanding his collection as he did in his science and in his eighth-grade writing project. "I picked a particular group of countries or a particular group of stamps in which I was especially interested and put together as complete a collection as I could afford. I tried to obtain stamps in beautiful condition and constantly tried to improve the quality of my collection. I kept close track of what I bought over the years and made a detailed inventory of every purchase since 1961. It is about 180 pages long, 30 lines to a page, and lists all of the stamps, collections and auction lots that I have obtained." His collection was more than simple collecting as most of us envision it. "My stamp collection is like a time machine for me. I sit down and look at it, see all the notations, some from childhood, a few from my father. I feel a sense of continuity. It has been a most rewarding

and intellectually stimulating hobby." Knowing Howard Schneiderman was a most rewarding and intellectually stimulating experience for those of us who were lucky to have him as a friend.

The high school Howard attended—the Fieldston School in Riverdale, New York—also was an Ethical Culture Society school. Although he did not take biology in high school because he had learned high school biology on his own, he did take chemistry and physics as well as four years of math. In addition to academics, he joined the football team and learned to fence. His Quaker math teacher recommended Swarthmore College, and he followed her advice and entered Swarthmore in the summer of 1944. Eight months later he joined the Navy and entered Columbia University as a midshipman in the Navy V-12 Program. Howard looked back on those days with great pleasure and felt that the most exciting courses he took at Columbia were those given by Professor Nagel in symbolic logic. He was discharged from the Navy in mid-1946 and returned to Swarthmore that fall with a deep interest in the classics, but during his junior year he entered an honors program in math and natural sciences with emphasis on biology. He studied embryology with Ruth Jones; comparative physiology with Knut and Bodil Schmidt-Nielsen and Per Scholander; and evolution and systematics at the Philadelphia Academy with Ruth Patrick, George Gaylord Simpson, Theodosius Dobzhansky, and H. Ratcliffe Roberts, among others.

In the summer of his junior year, Howard went to Arizona with Knut and Bodil Schmidt-Nielsen to study the water metabolism of desert animals. That summer was the start of his lasting love of the desert. The time he spent in the desert resulted in his first publication in 1948 and a lifetime of wearing those strange leather ties (bolas) and

boots—the cowboy look. This was Howard's first experience as a research scientist. Working with the Schmidt-Nielsens, who investigated how desert animals such as kangaroo rats and pocket mice manage to go their entire lives without drinking water, was an experience he recalled fondly. Many times he said that he learned how to conduct science by watching people who knew how to do science. "By listening to the questions they asked each other and by asking a lot of questions myself, I learned about the desert and desert animals from people who worked at the experimental station and who were deeply informed about the desert."

Howard Schneiderman was always a great observer of both nature and people, and during his time as an undergraduate he came to know a great deal about the ecology of the desert, as well as the physiology of mammals inhabiting that niche. He always had a great intellectual curiosity, and one of the wonderful things about him was his ability to expound on various subjects of biology, including ecology and evolution, as well as his major emphasis on physiology and developmental biology. After graduating from Swarthmore in 1948, he studied the parasites of large and small animals in the Grand Teton National Park and thus began his interest in that area of the country. It was during that summer that he established "a lifelong love for the Tetons," and it was with great happiness that he reflected on his backpack trips with his wife and two children, Anne and John.

Howard Schneiderman began graduate school at Harvard University in 1948 and conducted his doctoral dissertation research under the direction of Professor Carroll Williams. He finished his doctorate in four years, presented a thesis entitled "The Metabolism of Metamorphosis in the Cecro-

pia Silkworm," and spent an additional year as a postdoctoral fellow in Williams' laboratory, working on the discontinuous respiration of silkworms. During that five-year period he wrote a number of interesting and important papers in the area of insect biochemistry, but no incident in the research laboratory was as momentous and important to Howard Schneiderman as was his meeting with Audrey MacLeod in 1949; they were married in 1951 at the Brooklyn Ethical Culture School.

Howard and Audrey had a wonderful relationship over a period of about four decades, and, in the opinion of this writer, Audrey was a vital force in Howard's success as a scientist and administrator. As he put it, "Audrey is a talented writer, enormously intelligent, endowed with fantastic common sense, sensitive and empathetic yet strong and single-minded. She hasn't an unkind bone in her body and has been a wonderful companion and fantastic help to my career over the years." Having known Audrey Schneiderman for 35 years I can only say that, if anything, the above is an understatement. While on a personal tack, it should be noted that the Schneidermans had two children. Anne, who received her Ph.D. in neurobiology from Harvard Medical School, completed postdoctoral work at Yale, and is presently an assistant professor at Cornell University. (This is coincidental since, as will be noted subsequently, Cornell was the first institution at which Howard Schneiderman held an academic position.) Their son John was an undergraduate at the University of California at Irvine and received a master's degree there. John is a professional lutist, a lecturer in the Early Music Program at the University of California at Irvine, and instructs students in the guitar, lute, and banjo.

Howard Schneiderman began his professional academic

career as assistant professor of zoology at Cornell University in 1953, where he taught comparative physiology and cellular physiology. His studies in those early years were on insect respiration and insect spiracles, as well as wound healing and some aspects of developmental biology of the giant silkworm, *Hyalophora cecropia.* It was at this stage of his career that I was privileged to meet him in the spring of 1955. I was a prospective graduate student after spending four years in the Navy and had decided to attend either Princeton or the University of California at Berkeley for my doctoral studies. I walked into his office at Cornell, where he was removing the brains of giant silkworm pupae, and he looked up at me with his captivating smile. We talked about biology, and he enticed me with his contagious enthusiasm for his research, academics, and life in general. This enthusiasm never left Howard Schneiderman, even during the last years. I didn't know anything about insects, didn't really want to do my doctoral dissertation on insects, but, in the end, accepted a teaching assistantship at Cornell after turning down full fellowships at Berkeley and Princeton. It was a personal decision because of the man Howard was, and I have never regretted that decision!

His closest colleagues and friends at Cornell at that time were Marcus Singer, a world authority on amphibian regeneration, and F. C. Steward, who had pioneered plant tissue culture. Naturally, both served as members of my doctoral committee when I began my studies at Cornell in the fall of 1955. One of the things I remember so vividly about those years at Cornell other than going with Howard Schneiderman into the woods to "bag" trees to raise silkworms, was the fantastic effect he had on undergraduates. They were highly motivated, worked all hours of the night,

and were among the brightest young scientists I ever met. They included Robert I. Levy, who at one time was head of the National Heart Institute; Judith Willis, who is currently chair of the Department of Zoology at the University of Georgia; Mordecai Blaustein, a prominent physiologist in the Department of Physiology at the University of Maryland Medical School; Charles Kurland, professor of molecular biology in Sweden; and many others. Over the past three decades I have never met another faculty member who approached Howard Schneiderman's ability to train and motivate undergraduates. During those years at Cornell, Howard and I worked on the insect juvenile hormone, and we continued to collaborate after I left in 1958 to take a faculty position at Northwestern University.

During his tenure at Cornell, Howard became imbued with the spirit of the Marine Biological Laboratory at Woods Hole and taught the invertebrate zoology course. He was a meticulous lecturer both there and in the university classroom, preparing every lecture in the most methodical manner and with every word on the pages before him. However, when Howard Schneiderman lectured either in class or at professional functions, one always had the feeling of spontaneity and excitement. Since I was his teaching assistant at Cornell, I know that he was one of the finest teachers of undergraduate and graduate students in the country. It is of interest that he taught in the invertebrate biology course at Woods Hole since he had taken that course in the late 1940s, and he considered it one of the great achievements of his career to be selected to teach there. Later he became a trustee of the Marine Biological Laboratory when James Ebert was head, and his professional life was influenced to a great degree by the lab and the people he met there. From 1959 to 1960 he worked with Sir Vincent

Wigglesworth at Cambridge. It was during that period that Howard Schneiderman, as a young scientist, became acquainted with some of the most respected and influential scientists in Europe, including Sir James Gray, Lord Victor Rothschild, Max Perutz, David Keilin, Joseph Needham, and Sir Richard Southwood. In addition, he noted, "I also had memorable dinners at various Cambridge colleges with C. P. Snow, E. M. Forster, and C. S. Lewis."

In 1961 Howard moved to Western Reserve University to assume the chair of the Department of Biology, where his administrative abilities came to the fore. He developed the Department of Biology into one of the most outstanding in the United States by recruiting such individuals as Boris and Harriet Ephrussi, Bodil Schmidt-Nielsen, and Michael Locke. During the summer of 1965, while at Woods Hole, he spent some time with Ernst Hadorn of the University of Zurich and learned the new methodology developed by Professor Hadorn for the in vivo culture of *Drosophila* imaginal discs. At about this time he converted his research emphasis from silkworms to the fruitfly *Drosophila melanogaster.* He continued to work on silkmoth hormones during this period at Western Reserve but also published an important paper with Peter Bryant on the use of x-ray-induced mitotic recombination, which permitted the clonal analysis of cell lineage, growth, and determination of the imaginal leg disc of *Drosophila.* This was an important experimental paradigm, and Howard Schneiderman and his colleagues used this clonal analysis to analyze cell lineage, growth, and determination in all of the imaginal discs of *Drosophila.* Indeed, a later paper with his student Cliff Poodry, on the ultrastructure of the developing leg imaginal discs of *Drosophila,* became a Citation Classic. His work with John Postlethwait, another of his graduate students, on pattern

formation and determination in the antenna of the homeoeotic mutant of *Drosophila* was also extremely well cited.

His development of the Department of Biology was made possible by a million-dollar grant from the Ford Foundation, another example of Howard Schneiderman's willingness to place his personal research aspirations second to those of the organization he served. To his scientific disciples, this was an important lesson in selflessness. The Ford Foundation application was to set the stage for many analogous projects during his career. Perhaps a few quotes from Professor Schneiderman regarding his strategy for the Ford Foundation grant will further illustrate his personality and ability. "I called up various people who had previously dealt with the Ford Foundation and learned from them what was important in an application. I got various colleagues to prepare drafts of specific sections. To obtain consensus, I calmly had lunch with colleagues who were anxious to be part of the proposal. After all the spade work was done, I put the proposal together, wrote it out, used scissors and scotch tape to glue sections together and had a secretary type it. In this process, I would first write a detailed outline of what I wanted to accomplish. All the time I was preparing the proposal, I was thinking about the people who would read it. What kinds of things can I put in the proposal that everybody else and his brother won't put down also? What can I put that's different, that's unique?" Interestingly, the grant from the Ford Foundation was ultimately an important parameter leading to the merger of Case Institute and Western Reserve University into Case Western Reserve University.

After eight years in Cleveland, the Schneidermans moved to the University of California at Irvine, where Howard became head of the Department of Organismic Biology,

later called the Department of Developmental and Cell Biology. Three months after his arrival Howard became the third dean of the School of Biological Sciences. Only after a great deal of work involving the faculty and administration did the Developmental Biology Center become a reality. It was modeled after the Developmental Biology Center that Howard and Marc Singer had established at Western Reserve. The center at Irvine was almost totally concerned with *Drosophila*, amphibians, and *Hydra*. At Irvine, Howard continued to attract excellent postdocs and graduate students. Both Peter and Susan Bryant had moved with him from Case Western Reserve University; Peter Bryant presently directs the Developmental Biology Center. Others included the Madhavans and a number of individuals from Ernst Hadorn's laboratory.

During his time at Irvine, Howard Schneiderman was personally involved with a series of publications on the dynamics of cell growth and determination in various imaginal discs of *Drosophila*. Especially noteworthy was the series of papers with Peter Bryant, John Postlethwait, and Cliff Poodry on various aspects of this topic. He and Peter Bryant published a very useful review in *Nature* in 1971 on the genetic analysis of development mechanisms. Together with Mary Bownes and Thomas Cline, the Irvine group demonstrated the rescue of a female lethal maternal effect mutant, "daughterless," by cytoplasmic transplantation into embryos. Meticulous studies on the role of abdominal histoblasts with Madhavan and Roseland answered some basic questions regarding the role of these cells in the development of the pupal and adult abdomen of *Drosophila*. During his time at Irvine, Howard Schneiderman became deeply interested in the ethical and social implications of advances in life sciences. Until becoming ill, he lectured extensively on the

moral dilemmas posed by such questions as whether our genes are private, the responsibilities of insurance companies in insuring individuals with a high-risk disease, and the ownership of rare genes.

In 1975 Howard Schneiderman was elected to both the National Academy of Sciences and the American Academy of Arts and Sciences. Two activities with the National Academy of Sciences were particularly important to him. The first was his 1984–88 service on the Council and Executive Committee of the Government-University-Industry Roundtable, and the second was as chairman of Working Group III. The latter was organized to promote new research alliances among universities, industry, and government. These activities became a large part of Howard Schneiderman's life, but as far as activities with the Academy are concerned, he took great pleasure in playing what he considered to be a small role in persuading Donald Bren to donate $6 million worth of land for the Western Center of the National Academy of Sciences—the Arnold and Mable Beckman Center. It is appropriate that this important edifice is situated directly adjacent to the University of California at Irvine, which was so important to Howard for many years. During his time at Irvine as dean of the School of Biological Sciences, Howard recruited a large number of very bright researchers and planned curricula to educate undergraduate majors in the breadth and modern aspects of biology, but he was always interested in the entire university as well as the School of Biological Sciences. He played a vital role in having the university require that all undergraduate majors in biology take two years of humanities courses. Howard always believed that an individual was not truly educated unless he or she had a breadth of knowledge and did not specialize solely in one segment of higher education.

We who hold academic administrative offices know that the fun is in building and developing a department or school by recruiting the very best scholars and teachers and taking delight when the job is almost done and one can harvest the incredible but intangible rewards. At that time, new challenges may beckon. I feel that Howard Schneiderman chose a new challenge when he left Case Western Reserve in 1969 at a time when the reputation of the Department of Biology and the Developmental Biology Center was at its zenith. Later he decided to accept the offer from the Monsanto Company in 1979 as senior vice-president for research and development and chief scientist as another, different sort of challenge. It was not without a great deal of soul searching and discussion with his closest friends that he accepted the position at Monsanto. I remember clearly the conversations I had with him when he complained that some of his colleagues thought it was close to a traitorous act to desert academia for industry. My reply was that the scientific community needed people like Howard Schneiderman to interface between universities and industry and who, indeed, have some power to ensure that cooperative projects are initiated. I like to think that my thoughts on the matter helped influence his move to Monsanto, because his years there were among the most productive of his career and, I think, among the happiest of his life.

His contributions at the University of California-Irvine were summarized succinctly by Chancellor Peltason at the March 1991 celebration of Howard Schneiderman's life when he said "Howard Schneiderman was an intellectual beacon for UCI. The fruits of his energy, enthusiasm and leadership are still very present on this campus." The comments at the December 1990 celebration of his life at Washington

University by his colleagues at Monsanto echoed a very similar theme. His intellectual brilliance and enthusiasm were certainly noted by everybody with whom he had contact.

At Monsanto he was able to convince management that the company must enter the age of molecular biology and recombinant DNA technology. Howard Schneiderman basically engineered the new Life Sciences Research Center (known around the company as "the house that Howard built") that Monsanto built in 1984 at a cost of about $200 million, a structure that houses more than 1,000 young scientists. The biotechnology program involving plants and animals is one of the best in the world, and by 1990 Monsanto had one of the most efficient internal biotechnology capabilities of any commercial company. A central focus of his interest was the potential advantages that biotechnology might bring to developing—and developed—countries, in terms of health care and a safer, reliable, and sustainable agriculture to feed an inevitably growing world population. In a speech in 1985 to the National Research Council's Agency for International Development, he concluded that "genetic engineering and its handmaiden, biotechnology, have initiated a profound revolution in science with enormous technological and social consequences. I suspect that we underestimate its pending impact on society and its durability as a scientific tool in the service of humanity. Indeed, we can argue persuasively that genetic engineering may be the most significant scientific and technological discovery ever made. . . . We, using nature's own methods, will have learned to persuade her to be a full partner in humanity's major enterprise, civilization." Although some of the fruits of the biotechnology advances at Monsanto have yet to be reaped, due to federal regulations, it is of

interest that recently the bovine somatotropin has been endorsed for use by the European equivalent of the Food and Drug Administration. A National Institutes of Health panel has already approved it, and it is simply a matter of time before this product and others are utilized by the benefactors of what Howard always termed "the second Industrial Revolution."

Another project close to his heart involved research in the area of pharmaceuticals. Howard Schneiderman was influential in the establishment of a health care division at Monsanto and eventually in the acquisition of the G. D. Searle Company in 1985. However, he realized that Monsanto could not develop a drug-discovery reputation internally. Therefore, he began discussions with the Washington University School of Medicine's administration, the goal being a collaborative research program. He investigated every aspect of Washington University School of Medicine and had a small Monsanto task force meet with university representatives. He worked with the faculty at Washington University to initiate a proposal that he felt would be acceptable to both the university and his colleagues at Monsanto. He did a complete rewrite and insisted that the venture be a real partnership, with the executive committee of the joint program being composed of equal numbers of Monsanto and Washington University personnel.

More difficult was selling the entire idea to the management of Monsanto, but, in his usual enthusiastic manner and with all the possible data one could command, Howard obtained the support of each of the influential individuals at Monsanto. In 1982 Monsanto and Washington University signed the initial five-year $23 million agreement, which is exemplary among university/industry collaborations and continues to the present. When commenting on the suc-

cess of the program, he noted, "To be sure there was scientific excellence; that was necessary but not sufficient. What was also necessary was mutual respect and trust. In discussions between the two institutions, the social contract took precedence over the legal contract. There was a willingness to work for a durable relationship rather than for a quick fix."

Even after this historic program was initiated, Howard Schneiderman continued to develop close research collaborations between Monsanto and other universities such as Oxford and Rockefeller universities. He became one of the leading and most vocal advocates of alliances between university and industry, and he presented exciting, compelling, and intellectually tantalizing lectures at many institutions, including my own, on the virtues of such relationships. He emphasized the fact that the government must be involved in some way or we were going to lose the "second Industrial Revolution" to foreign countries. I know that his lecture in Chapel Hill inspired all of us. It wasn't long afterwards that he became ill and fought the great battle against leukemia.

Howard Schneiderman himself summarized, to my mind, the key to his success at Monsanto and, indeed, to his success in his university positions and as a human being. The single element according to him was "truth in packaging." He told it as it was. His views on various issues were well known and easily understood because, as he notes, "I use declarative sentences, not the future less-vivid conditional!"

Howard Schneiderman was an individual honored in many ways. He was elected to office, was appointed to editorial boards, presented memorial lectures, was elected to both Academies, was a member of the National Science Board by presidential appointment, held several honorary doctor

of science degrees, and held an endowed chair. In 1990, just a few months before his death, he was the recipient of the prestigious Gregor Mendel Gold Medal, presented to him by his old friend and colleague Frantisek Sehnal on behalf of the Czechoslovakian Academy of Science. The legacy he left, however, was much greater than the awards he received. He instilled in those of us who worked with him a zest for science, a curiosity about nature, a love of life and family, and courage during adversity. In our discussions he noted many times that if he had his life to live over he wouldn't live it any other way. The scientific community will forever have a void in its core because of the loss of Howard Schneiderman. All of us who were fortunate enough to have known this extraordinary man have gained a great deal. We will always miss him.

MUCH OF THE MATERIAL in this memoir was taken from an unpublished autobiography written by Howard Schneiderman during the last two years of his life. He knew that he was dying and, in his own inimitable way, got "his affairs in order." He wrote a 45-page autobiography, cataloged his beloved stamp collection on the computer, and helped to recruit his successor at Monsanto. An incredible individual!

I thank Audrey Schneiderman and Doris Gilbert for their superb editorial work on drafts of this memoir.

HONORS AND DISTINCTIONS

1975 Member, National Academy of Sciences
1975 Fellow, American Academy of Arts and Sciences
1975 D.Sc. (Honorary), La Salle College
1982 D.Sc. (Honorary), Swarthmore College
1984 D.Sc. (Honorary), University of Toledo
1986 D.Sc. (Honorary), University of Massachusetts at Amherst
1989 D.Sc. (Honorary), Washington University at St. Louis
1989 LL.D. (Honorary), Clemson University
1989 UCI Medal, University of California, Irvine
1990 Gregor Mendel Gold Medal, Czechoslovakian Academy of Science
1966–69 Jared Potter Kirtland Distinguished Professorship, Case Western Reserve University
1973 Distinguished Faculty Award, UCI Alumni
1983 Founders Memorial Award, Entomological Society of America
1988 Distinguished Leadership Award, Marine Biological Laboratory, Woods Hole, Massachusetts

SERVICE (SELECTED)

1964–66 President, Society for Developmental Biology
1966–72 Trustee, Marine Biological Laboratory, Woods Hole, Massachusetts
1975–81 Member, Assembly of Life Sciences, National Academy of Sciences
1980–86 Member, Expert Committee on Biotechnology, Organization for Economic Cooperation and Development
1981–90 Member of Board, International Society of Developmental Biologists
1981–90 Member, Board of Trustees, Missouri Botanical Garden
1984–88 Member, Council of Government-University-Industry Research Roundtable, National Academy of Sciences
1987–92 Member, National Science Board, by Presidential Appointment and Senate Confirmation
1988–90 Member, Board of Trustees, Carnegie Institution of Washington
1988–90 Member, Board of Directors, Life Sciences Research Foundation

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