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SELMAN ABRAHAM WAKSMAN
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A Biographical Memoir by

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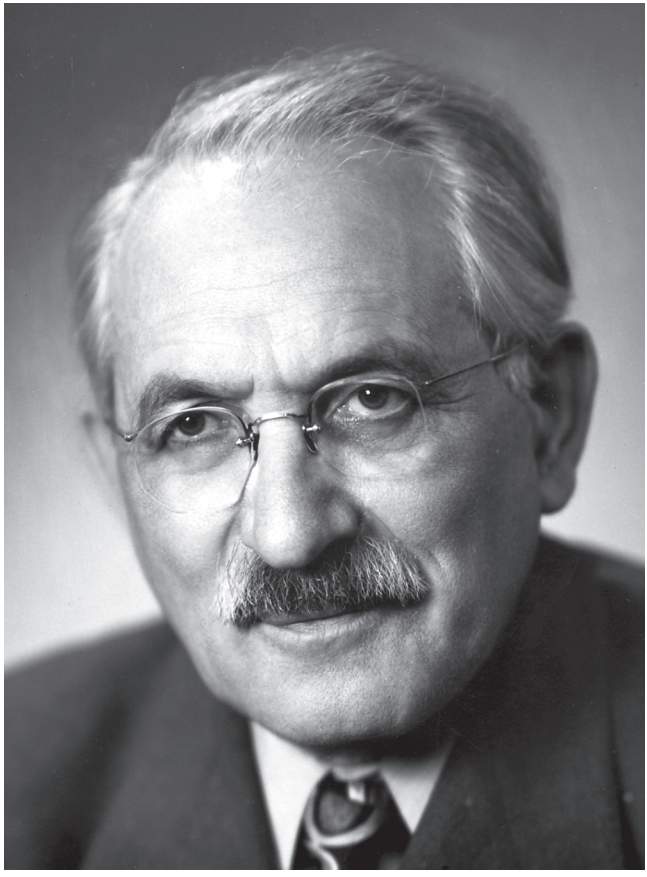

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Selman A. Waksman

SELMAN ABRAHAM WAKSMAN

July 22, 1888–August 16, 1973

BY ROLLIN D. HOTCHKISS

MANY GIFTS HAVE COME to humanity from Selman Waksman's energy, enthusiasm, and passion for science. These came about through the development of valuable antibiotic substances discovered in his systematic researches on microbial components of the soil. With extraordinary humanism and philanthropy he used the royalties that resulted from the commercial development of these "miracle medicines" as further contributions to society. He donated a major part of them to create institutes and endow foundations that continue to support international fellowships and grants beneficial to science and medicine. All of this without having the advantage so many scholars have had: early family or local role models demonstrating the qualities and traditions of academic science and research.

Selman Abraham Waksman was born and raised in the rural Ukrainian town of Novaya Priluka. Remaining in that remote town on the steppes until age 20, he certainly could not have dreamed of the triumphs and obstacles that lay ahead. His father made a modest living tending and renting some small houses he owned. His mother was a capable manager of her own dry goods business, developed while the father was away on years of military service. The youngest of eight intelligent and pious sisters, she energetically strove

to lead a rational and useful life in the fine Jewish tradition. Starting with an impressive and accomplished grandmother, this matriarchy was clearly proud of the stirring ambitions of young Selman. As an only surviving child, he was loved and supported in his tendency to outdo, rather than rebel against, the standards of his community. Probably their backing was responsible for the easy, confident way he approached personal relationships and decisions later in his career.

Intellectual stimulation of a general sort there was; Waksman for some years studied the Bible and Talmud and the history of the pious Jewish people and their enthusiasm for learning. From the age of 10 he was continually involved in tutoring other less able students in their academic weak spots. Simultaneously he availed himself of tutors to speed his own advance. His autobiography (Waksman, 1954) gives us a proud and nostalgic recollection of the influences in his youth that moved him toward a career in the study of life processes. The rich black soil of his native town and the surrounding villages supported a teeming agricultural life that he could not have missed. He may not have done much practical work in it, but he was perceptive in developing an early, incompletely formulated curiosity about such chemistry as goes on in the fertile soil.

Probably his family expected that he would become a *malamed*, teacher of local youth, but his tutors and his father were aware of a big world outside, with larger projects. By the age of 20, after his mother's death, he surrendered his legacy in his father's modest house properties and moved to the larger centers, Zhitomir and Odessa. He passed several examinations for more advanced study, then following the example of some of his relatives, migrated to the United States in 1910.

Received in New York by a cousin, a chicken farmer in New Jersey, he was installed in their home and for a few

years performed useful work on the family farm. He soon enrolled at nearby Rutgers College, where he came under the influence of Jacob Lipman and Byron Halsted. The former advised an agricultural course rather than one in medicine, and proceeding on this line, Waksman took accelerated course work, spending the fourth year in research. Asked to assay the bacteria in culture samples from successive soil layers, he became drawn to fungi and eventually some regularly appearing pleomorphic, filamentous bacteria, the actinomycetes. These became an abiding interest and the focus of his master's degree thesis, which he received in 1916, and in his doctorate with H. Brailsford Robertson at the University of California, Berkeley. The little investigated actinomycetes continued as a subject in which he would become a major expert.

In 1916 he became a naturalized U.S. citizen. The move to California was also a wedding trip following his marriage to Deborah Mitnik, an accomplished vocalist and artist from his hometown who was affectionately known in the family as Bobili. She became a guide and spur for his cultural advances in the United States and internationally. Their devoted partnership remained steadfast and enriched the remainder of their lives.

It was necessary to supplement his graduate fellowship stipend, so he started to work for an industrial medical organization, Cutter Laboratories, which would set a pattern that proved useful later on.

Back at Rutgers Agricultural Bacteriology Department in 1918 his position was at first precarious. Needing to augment a meager income, he developed a comfortable cooperative association with the local industrial Takamine laboratory. Continuing research on the soil microflora, he described new thiobacilli (1922) that oxidize elemental sulfur. Exploring vigorously the actinomycetes and fungi, he analyzed

and reported systematically the life to be found in several soil environments of the New World (1916). In time he would redefine the bacteriology department as one of soil microbiology. Eventually his interest in natural chemical processes led him to studies of some modifications an investigator could impose on those soil processes.

In these still strenuous years a son was born in September 1919 and was loyally named Byron Halsted Waksman, after one of Selman's inspiring mentors. After some infant health difficulties the child would go on to become an active and capable student himself, and eventually an accomplished immunologist, carrying on the family tradition of service to medical science and to the public.

In 1924 after several years devoted to soil research the Waksmans traveled in Europe for six months. While there, Selman visited many important laboratories and institutes in France, Italy, Germany, and Scandinavia, discussing methods and research with many workers in soil biology and chemistry close to his field. His diary reported (Waksman, 1954, pp. 123-55) that while he met some impressive soil biologists, among them Sergei Winogradsky, then resident in France, others were not living up to that field's possibilities. He also briefly visited some important European biochemists. The Waksmans were welcomed in their native Ukraine, but found a depressing decay in conditions there. His wife, Deborah, having introduced Selman to a broader cultural life in New York, made sure that they visited important museums and concert halls in Europe. He returned to the United States both exhausted and stimulated by new possibilities he envisioned.

On the returning steamship he found young French biologist Rene Dubos, who was immigrating to the United States, and soon offered him a place in the Rutgers laboratory. This encounter was ultimately significant for both men.

The laboratory had now grown to be a rather popular training ground. In teaching the lore of soil microbiology Waksman had occasion to describe to the students the inhibitory interactions between organisms in the soil, probably presenting them as examples of "environmental" influence, complex and variable. Dubos became, by his nature, a thoughtful student in this field and began soon to look upon them more as discrete biochemical interactions. In any case, by 1927 the student was pursuing one-on-one effects of soil organisms in decomposing cellulose and was beginning an approach that would lead to modern antibiotics. Other steps had to be made, however.

Dubos, traveling to New York City especially to consult his countryman Alexis Carrel, was referred to Oswald Avery. The latter, at the Rockefeller Institute Hospital, was searching for something that would attack the capsular polysaccharide of a special line of pneumococcus (*Streptococcus pneumoniae*, Type III) that he had isolated. Hearing of the problem, Dubos immediately proposed that a soil bacterium could be found for the purpose. Hired by Avery for this study, he did succeed at Rockefeller in finding in soil such a culture. For a time this seemed of possible therapeutic use.

In later steps Dubos with Avery developed the concept of a Gram-positive core antigen of pneumococcus to be attacked. Again Dubos set out with *live* bacteria and soil samples to look for enriched growth of something destroying the pneumococci. Such an agent was eventually isolated (Dubos, 1939) and pursued as a wartime project. He identified the culture as *Bacillus brevis*. Joining the project, I isolated from the crude agent, tyrothricin, two crystalline polypeptides, tyrocidine and gramicidin, with different antibacterial properties. These were the first highly purified substances produced from a deliberate search for bacteria that inhibited growth of other bacteria.

It must be realized that there was an "unorthodox" feature in this finding: Ever since the time of Koch and Lister much emphasis in infectious disease had been placed on the necessity of avoiding contamination of infections by soil or other non-sterile matter. It was an escape from this categorical thinking to consider *using* a soil-derived culture to combat an infectious process! The careful medical investigators had not ventured that implicit step. Moreover, the unsystematic use of mudpacks in whimsical folk practice could never have led to it.

The excitement produced by this purposeful search by his former student gave Selman Waksman a clear stimulus to seek more examples. He soon organized an energetic search for preexisting antibacterial organisms in soil samples that was to continue for years with the help of dozens of collaborators. So was overcome a paralysis that had set in following the earlier somewhat analogous discovery by Alexander Fleming of an accidental contamination of bacterial cultures by an airborne inhibitory mold (producing penicillin). Although it had also been considered for therapeutic use, penicillin had not been produced in a stable useful form until wartime 1940.

The Waksman group did their screening by looking for growth inhibition zones around single colonies of a series of systematically isolated soil microbes on agar plates, growing under a variety of culture conditions (1940). Now they tested the inhibition on specifically targeted pathogenic bacteria, as Dubos had done. Government support for this work was sought but not granted, however through the help of A. N. Richards, support was obtained from the Commonwealth Fund. The group in the next few years described more than 20 new natural inhibitory substances, mainly from actinomycetes. Among them were streptomycin, neomycin, and actinomycin. Waksman proposed the now standard term

"antibiotics" for this class of natural growth inhibitors. In time countless more examples came from the commercial industries that sprang up, extending the searches. The roster continues to grow to the present day.

For Waksman the discovery of streptomycin in 1944 and its effect on the tubercle bacillus accomplished with the collaboration of A. Schatz and confirmation by E. Bugie was a rich and satisfying fulfillment of many of his personal and altruistic aims. Ever practical, he established effective and congenial relations with Merck and Company, which developed liquid culture methods for production of bulk quantities of the microbial products during World War II. Patenting and licensing the promising ones, notably streptomycin, provided funds, 80 percent of which was assigned to Rutgers University to support research and eventually an associated Institute of Microbiology. He also soon arranged to have animal tests and clinical trials carried out at the Mayo Clinic to expedite the possible use in treating tuberculosis. Of the 20 percent of license funds accruing in his own name, one-half was later consigned to a foundation for research support.

Throughout the 1930s Waksman had been acutely aware of the growth of fascism and anti-Semitism under Hitler. As one response he resigned from editorships in German journals. In addition he embarked on a study of marine bacteriology and did useful service in the study of fouling of oceangoing vessel bottoms for the U.S. Navy and Coast Guard. This was done through a connection with the Woods Hole Oceanographic Institution, which became a lasting link for him and his family in Woods Hole, Massachusetts. His work on humus conversion into peat in this period also served to give the United States an independent source of this interesting material.

In recognition of his energetic studies and analyses of soil microorganisms, he was elected to membership in the

National Academy of Sciences at the very outset of the antibiotic searches in 1942.

A postwar European trip of five months in 1946 brought a series of opportunities to convey serious reports on the values of antibiotic treatments to eager and grateful medical audiences. It also provided a chance to visit son, Byron, who was on Army medical service in Germany. In addition he revisited the Soviet Union, where he established influential relations and gave well-received lectures in Moscow. However, after the ravages of war only a few of the old friends and relatives remained from his native Priluka. Near Paris he visited Serge Winogradsky, by then 90 years old, and began a process to secure the publication of that pioneer's collected works. It would eventually involve him in further financial support. Briefer repeats of this kind of triumphal visit would occur as he received something like 13 medals and awards from European countries within the next six years. Among them was the Emil Christian Hansen Award in Denmark and appointments to the French Academy of Science and the Legion of Honor.

In the United States he received many awards, including a Passano Foundation Award and a Lasker Award, a notable honorary degree ceremony at Princeton, as well as numerous medals from pharmaceutical and other societies. A more complete list of some 66 awards and 22 honorary degrees appears in the volume (Woodruff, 1968) organized by Waksman colleagues in Rutgers to honor his eightieth birthday.

Already in 1949 he had proposed to establish an Institute of Microbiology in association with Rutgers (Waksman, 1954, p. 277). This was formally achieved in 1951 and completed in 1954 with a dedication and symposium in which many eminent microbiologists participated. The institute was endowed and supported by the 80-percent assignment

of streptomycin patent royalties to Rutgers and has had a productive history through the years. Successive directors have been Selman Waksman, 1954-58; J. Oliver Lampen, 1958-80; David Pramer, 1980-88; and Joachim Messing, 1988 to the present. Each director redefined the mission policy and organization of what was renamed the Waksman Institute of Microbiology after the founder's death in 1973. As other endowed institutions have done, it has had to develop gradually more of its support from government sources during later years.

Although I was appointed for a term on the institute's Board of Advisors, the administration at that time did not have occasion to call upon us for more than official mail votes. My experience with the institute was accordingly by way of attending most of its symposia and conferences and observing from outside its stepwise movement toward a center for molecular biology and genetics.

INTERNATIONAL RECOGNITION—AND SHARING REWARDS

The great practical promise of streptomycin for tuberculosis and other infections led to the award of a Nobel Prize in physiology or medicine in 1952. There was much acclaim for the effort and patience expended in the development of the antibiotic treatments, and it inspired others to similar allied work. A broad public response to this award brought many additional honors, such as the Japanese Order of Merit of the Rising Sun and invitations from and contacts with colleagues in Europe and Asia.

The Nobel Prize did not diminish Waksman's conscientious effort to convey the knowledge and insight of careful scientific work. In the pre-Nobel period he published 16 books and monographs and in the two decades after almost as many more, most of them under his sole authorship. These were well-documented works, thoroughly covering the history

and essential science of their subjects. Whatever clerical help he may have had, it is clear that he had an ability to digest and assemble straightforward information from the published literature. In the later period several of his books were grateful biographies of his personal heroes, Sergei Winogradsky (Waksman, 1953), Jacob Lipman (who had advised him to enter agricultural and soil science rather than medicine) (Waksman, 1966), and the tragic Waldemar Haffkine (Waksman, 1964).

His papers on antibiotics continued unabated, although the pattern changed. Before the prize three-fourths of them were with coauthors; but after the prize a large number of historical reports and addresses were composed under sole authorship and delivered with inspiring enthusiasm and a considerable degree of pride. A similar pride, delivered nevertheless with sober modesty, characterizes his autobiography (Waksman, 1954), appearing in 1954 in the United States and later in translations in several other countries.

Now the honors and awards were coming at an increased rate. More details of these than can be accommodated here can be found in the jubilee volume prepared on Waksman's eightieth birthday (Woodruff, 1968). Royalty fees were also accumulating and largely donated in support of research. Merck and Company was always appreciative of Waksman and his associates' rights and they too proved public spirited in sharing commercial privileges at a time when the United States was at war.

I have worked with several of Waksman's associates, including Julius Marmur, Dorris Hutchinson, and Jack Fresco, and have known several others. Uniformly they displayed a warm respect, even admiration for the hard work and dependable good will of the "professor." There was also my lifetime of association with Rene Dubos, who differed considerably from Waksman in temperament. Yet never as we talked about

antibiotics did he more than suggest that the systematic repetition of empirical searches was not for him. Perhaps some other scientists of the intuitive type felt that Waksman's productive career was more characterized by systematic development of a few ideas than by "exciting" formulation of new ones.

There was one unfriendly legal action, brought by former coworker Albert Schatz, who declined to surrender some of the rights in streptomycin development to Waksman, demanding personal payment for his participation. Let us suppose the case originated within familiar bounds: the pride of an able young associate having overcome technical obstacles and successfully maneuvered part of the routes to solution. This was a time when the contributions of young associates were just beginning to get more recognition. In such situations the contributions of the experienced senior advisor, which can include the underlying planning and facilities for the project, its initiation, timing, and quite likely a substantial part of the special methodology, all can be disregarded by lawyers conducting a "nuisance" claim. That was an element of this case; it gave Waksman great distress and was only "settled" by a costly and practical compromise (Waksman, 1954, pp. 279-85). In consequence he felt that justice obliged him to use still more of the royalties to give unsought bonuses to his entire staff and coworkers. This gesture in turn earned even more of their general loyalty and goodwill.

How may we evaluate Selman Waksman's scientific career? It seems to me that his most outstanding trait was his patient, driving energy directed toward altruistic goals. His personal skills in the realms of morphology and nutrition of a wide range of microorganisms were put at the service of an active curiosity and a retentive memory. He accomplished much in looking into the natural biological processes going on in the soil. In most of this work he remained close to nature:

to constructs and theories that emphasized interactive and ecological relationships. In the laboratory he sought the findings from *organisms in a context* that were the intellectual product of a naturalistic outlook. He maintained a lively interest and goodwill toward his coworkers and behaved as a benevolent sponsor and guide to them. With tireless energy and insight he was an early and successful innovator of what is now called technology transfer.

Another vector for growth was always active; in spite of some limitations in his biochemical background he sought, supported, and learned from chemically skilled coworkers. He consciously strove for analysis and understanding of chemical and physiological descriptions of soil processes, but his most notable successes were in finding and describing valuable microorganisms. That may be because most of his projects began with a broadly framed naturalistic question.

In fact, he acted as a sponsor not only for microbiology but almost as much for microbial biochemistry. He was impressed by the scientific work of Cornelius Van Niel, which (like Kluyver's and Winogradsky's) took account of chemical processes going on in populations within a complex environment. So far as I know, his main contact with Van Niel's concepts came from the literature and through coworkers who followed that interest, Robert Starkey and Jackson Foster. He clearly wanted to encourage advances in this field. Such a motivation showed strongly in his grant efforts as well as in membership proposals for the National Academy of Sciences.

What stands out above all else is that coming from a modest rural background, Selman Waksman felt grateful and with great humanity wanted to repay society by thoughtful and constructive contributions to science and health and, furthermore, by freely reporting them to the public.

A FAMILY—MANAGED BENEVOLENCE

In 1951, as royalty income accumulated, Waksman established the Foundation for Microbiology by assigning half of his 20-percent personal royalties over for its support of research efforts to benefit society and humanity. Rene Dubos and Harry Eagle were invited to join as cofounders. Later he arranged the formation of Waksman foundations in France, Italy, and Japan that could expend patent income from the world areas where it accrued for the support of scientific work in or near those areas.

Asked to serve as a trustee of the U.S. Foundation for Microbiology when Rene Dubos withdrew in 1959, I was fortunate to see firsthand some of the impulses and insights that Selman Waksman applied in science administration. One soon realized that although he proudly allowed his name to be associated with some of his benevolent actions, that pride was accompanied by a realistic self-appraisal and true modesty.

The charter program obliged us to expend most of the annual income from the patents for streptomycin and neomycin in support of scientific endeavor. Our board of about five or six microbiologists usually met at Essex House on Central Park South in New York City for a congenial dinner and work session. At a typical trustee meeting the colleagues would be joined by a few associates, such as for several years A. Dudley Watson, Waksman's financial advisor (followed by Max H. Schwartz), and perhaps some secretarial help, besides the board secretary. The group met in a short cocktail session at which members greeted and exchanged news with one another. Waksman, however eager he may have been to get on with the serious work of the foundation, always provided a good dinner with sumptuous choices. Afterward, as the conversations began to move into a con-

vivial mode, he would call for the business session. He tried the experiment of conducting part of the business before the dinner, but modern life schedules made that almost impossible.

A courteous and patient taskmaster, Waksman as president took the chair, handing out the requests we were to consider. He would not indicate his personal judgments until all committee members had expressed theirs. Then he gave his own opinion and we would move toward a group decision. On those occasions when the other trustees disapproved of an application he might show a generous inclination to offer a small token payment as a "consolation" award. So sometimes we would have to insist that this was "sending the wrong signal" and only inviting a new modified request, although at other times that was exactly what we wanted to get.

The foundation handled scores of small grants, especially those providing funds for purposes likely to be limited or omitted from government research grants. It could help in funding small conferences on specialized topics, or for young scientists to travel to conferences. An abiding problem in Waksman's own experience had been the wish to present high-quality photographs of fungi and ascomycetes, etc. Therefore, he always noticed when the researches involved little known organisms. A subsidy for biological illustrations in color could often be raised, even and especially for little known microorganisms. Part of our funds might be assigned to the Cold Spring Harbor Laboratory, the National Academy of Sciences, and sometimes to the Weizmann or Technion institutes in Israel for distribution in support of programs they conducted. Support was also given for a Waksman Lectureship in microbiology, administered by the National Academy of Sciences. For years we supported fellowship

programs and Latin-American professorships given by the American Society for Microbiology.

Of course, a favorite intention of most donors is to give "catalytic" support to a project that seems just to be emerging from obscurity. I think this was at times accomplished by influential efforts of such members of the Board of Trustees as Harry Eagle, Kenneth Thimann, or Harlyn Halvorson to ferret out such opportunities.

The Foundation for Microbiology throughout its history always maintained a strong family involvement. Selman Waksman remained president for its first 19 years, retiring in 1969. Byron Waksman was a trustee from 1968 and president from 1970 for thirty years before Frederick Neidhardt took charge in 2001. In the meantime Deborah Waksman served as trustee from 1957 until her death, respectful of the science but naturally paying more attention to the social and educational aspects of the research supported. At later points the grandchildren have become trustees and officers of the Foundation. The trustees have also been augmented by one or two in number and in scope by appointment of distinguished microbiologists and biologists. I believe it has continued to serve the principles of its founder in a most enlightened way.

It deserves mention that Deborah Waksman not only encouraged the scientific supports that her husband bestowed but also in her own name made donations on behalf of the arts. For a number of years she offered music fellowships at Douglass College, a women's branch of Rutgers, and made donations to Albert Einstein College of Medicine, Brandeis, and Hadassah. She arranged musicales in their family home for several years, and a high honor came when she sang for the Schola Cantorum.

On one occasion I happened to arrive at a Foundation meeting well ahead of the out-of-town members, so Waksman and I conversed a while, then at the window I looked out upon Central Park in the growing dusk. Seeing the Wollmann Skating Rink, a small lighted rectangle, several blocks north, lighted up with its evening crowd of enthusiastic skaters, I remarked that the Wollmanns had "done a great thing for New York City folks" in establishing the concession. Waksman seemed excited by my remark and asked me to point it out to him—then subsided into thoughtful reverie, peering long at the sight. I feel confident in claiming that he was, for long moments, impulsively thinking something like, "I'm fond of New York, too; how could I do something like that?" That conception of his blend of emotional and practical generosity is based on long acquaintance with his humanity.

His wife, Deborah, was largely responsible for his affection for New York and its culture. Her awareness of his position in science assured her commitment to dignity in their audiences with several heads of state and royalty and other attentions of society. Nevertheless, on one occasion this cause seemed to be threatened. At the Nobel ceremony in Stockholm's Town Hall, in 1952, seated between the Swedish King and his brother, her formal gown got caught up on the King's chair and he sat down on a fold of her skirt. Discomfited—up on a dais!—she could hardly converse with Prince Wilhelm about poetry until he, observing her nervousness, asked what was troubling her. She confessed to him her difficulty. With a laugh he proceeded to speak quietly to his brother, the King. The latter then laughed, discreetly released her skirt and said quietly to her, "Why didn't you poke me in the ribs?" Then he quickly charmed her by extolling the praises of the Nara shrines in Japan,

where the Waksmans were about to travel. This memoir from Deborah's own notes (D. Waksman, 1952) of the great ceremony suggests to me that the King's disarming humanity reassured her with regard to her husband's similar disregard of his own eminence.

Selman often told a story about quizzing a pharmacist from whom he, unrecognized, had purchased some bandages treated with tyrothricin (Dubos's antibiotic mixture), asking what that medication was. Receiving the answer, "Some sort of coal-tar derivative," and amused, he came back with, "Is that so?" To this, the self-important response was, "This must be quite over your head!"

On a number of occasions around the time of his retirement in 1958 and after Selman phoned from New Jersey to my laboratory in New York, inviting me to join him for a drink and dinner. When I could accept, the two of us would meet at an open cafe or bar in the Rockefeller Center or Times Square regions, start conversing, and then walk or taxi to another of his favorite midtown spots. I suppose these occasions were at times when his wife was away or otherwise occupied. Our relaxed and congenial conversations over a cocktail, rarely two, covered several topics in microbiology and what some of our colleagues were doing in science. I might express some enthusiastic opinions about research topics and such work as I was familiar with at Cold Spring Harbor, but probably typically tentative and cautious ones about people. Neither of us had much capacity for "small talk." Nor do I think he had an agenda, such as sounding me out for a post in his institute, since I made no secret of my satisfaction with my role at Rockefeller Institute at that time. Rather, I believe, he was moving out of his specialty toward the chemistry that he always admired. Usually he would propose with obvious pleasure a dinner, perhaps at Lindy's on Broadway. Often he would reminisce there in

a serious, logical, and unromantic way about his past. At such times one could see clearly how straightforwardly and sensibly he viewed his own life and science.

Such logical "down-to-earth" expression was characteristic of most of Waksman's scientific exchange. He gave the impression that what mattered were the practical ways and means of experiment and what could in fact be achieved. Some interpreted this as a sign that he did not care or perhaps know much about theory. This was not true, but microbiology at that time was almost necessarily an empirical science.

A memorial and symposium in honor of Selman Waksman was held at the Institute of Microbiology at Rutgers on October 13, 1973, following his death on August 16th. Byron Waksman opened the session with brief messages from absent friends and recollections of the quiet ironic natural humor of his father. Oliver Lampen, director of the institute, testified warmly of the generous management modes exerted by the great teacher. So did Max Tishler of Merck and Company, admiring the combination of idealism and great practical sense that had enabled Waksman to develop the effective interaction with industry that brought out the fruits of the scientific work. Sir Ernest Chain, chemist of the penicillin Nobel Prize winners, expressed a passionate European's recognition of the arduous career that had produced so much.

Honoring the hundredth anniversary of Selman Waksman's birth in the humble lost village in the steppes, a celebratory symposium was held in 1988 at Rutgers, at which several distinguished colleagues spoke on their perspectives of the status of microbiology, and his influence upon it.

Selman Waksman was buried in the cemetery at Woods Hole, Massachusetts, after a more private ceremony. I treasure the message his loved and devoted Bobili wrote me from

the depths of her loss, in thanks for my comments about Selman in a letter to her at this time. She followed him only about a year later.

It is a comforting thought that the contributions of this great and pragmatic humanist and student of nature will endure for a long time in a changing world. They will do so, because they were based on assiduous work on something as universal as the soil, and because he erected from it a technology that in his and other hands has given us so many of our magic medicines. Moreover, as a generous discoverer, he was able to inspire associates and to implant his ideas and vision to a talented family that clearly is continuing his altruistic traditions of serving the common good into the twenty-first century.

I AM GRATEFUL to Byron Waksman and Douglas Eveleigh for reading this manuscript and for their generous help in improving its accuracy at some points. There are archives covering other aspects of Waksman's life. At Rutgers there is a Waksman Soil Microbiology Laboratory preserved at Martin Hall, Cook College, North Brunswick, New Jersey. Many family archives are held presently by Byron Waksman at 14 Cowdry Lane, Woods Hole, Massachusetts. The National Academy of Sciences Library also maintains a Selman Waksman archival file.

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