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FLORENCE RENA SABIN

1871—1953

A Biographical Memoir by

PHILIP D. MCMASTER AND MICHAEL HEIDELBERGER

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Biographical Memoir

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Florence P. Sabini

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November 9, 1871–October 3, 1953

BY PHILIP D. McMASTER AND MICHAEL HEIDELBERGER

ON APRIL 25, 1925, the National Academy of Sciences elected to its membership, for the first time in the sixty-eight years of its existence, a woman. She was Dr. Florence Rena Sabin, Professor of Histology in the Johns Hopkins Medical School, the first woman to be a full professor in that institution, and also the first woman to be President of the American Association of Anatomists.

It is to the credit of Florence Sabin that, by her life, her manner of working, and her scientific integrity, she was able to convince the university administrators of this country that a woman can be quite as capable as a man in the pursuit of research in the pure sciences. By her example she did more than any other person to open the careers of scientific investigation in laboratories, medical schools, and hospitals to women. Besides this, as we will endeavor to outline, she lived several unique lives, some concomitantly, some in sequence. Hers were not the lives of a Dr. Jekyll and Mr. Hyde, however, since she served Medicine, Science, Public Health, and even Politics, all to their great advantage.

Part of the significance of her life and her first two careers has been pointed out in Edna Yost's *American Women of Science*.

"For the young woman of the modern day, one of the chief interests of her story lies in the fact that if Dr. Sabin had been able to read, at sixteen or twenty, this very story about what some American woman of science was to be able to accomplish by 1940, she would have had no idea that she possessed within her the capacities for the accom-

plishments recorded. The answer as to why she has been able to do what she has done lies, in-so-far as it lies in any single answer, in the quotation she has chosen for her bookplate—fifteen words credited to Leonardo da Vinci centuries ago—“Thou, O God, dost sell unto us all good things at the price of labour.”¹

On November 9, 1871, fifty-four years before her election to the Academy, she was born in Central City, Colorado, the daughter of George Kimball Sabin and Serena Miner Sabin.

Just before the Civil War, the discovery of gold was reported near her birthplace not far from Denver. The find brought many men to the region, indeed so many that a line of stagecoaches was established to transport them. Among these men was George Kimball Sabin, born on a Vermont farm, the descendant of a Huguenot, William Sabin, who had come to Rehoboth, Massachusetts, in 1643. George Sabin's father had practiced medicine in the country, and the son seems to have leaned in the same direction, but in 1860 he gave up the idea of following the medical profession and left for Colorado to become a mining engineer. At this time Serena Miner was teaching school in the South, but during the Civil War she moved west to teach in a small school in the little town of Blackhawk, Colorado, where she met and married George Sabin in 1868. There were two children, Mary and Florence. In Central City this family lived in a small two-story house placed on the side of a steep hill, so that a stone retaining wall was needed to keep the ground in front from washing away. Their life must have been primitive, for water was peddled from door to door and stored in two large barrels. We are told by Florence's older sister, Mary, that a stairway led up from the dining room to a door which opened onto a bridge extending from the upper story to the side of the hill on which stood a barn for a cow and horses. No plumbing, no gas, and no electricity were in this house, which is still standing but now has these luxuries. When Florence was only four the family moved to Denver, to allow the older child to attend school, but even there, so this older child

¹ Quoted by the kind permission of the publishers, J. B. Lippincott Co.

has reported, life was crude and both children could recall the fear with which they used to watch Indians marching single file down the street.

Three years later Florence's mother died, and for the next year both children went to a boarding school, Wolfe Hall. Still later their father took them to the home of his brother, Albert R. Sabin, in Lake Forest, Illinois, where they attended a private school for two years. In the summers they traveled, with an aunt, to their grandfather Sabin's farm near Saxtons River, Vermont. At the age of twelve Florence was left in the home of her grandparents, while her sister Mary returned to Illinois.

In January, 1885, the family's eastern background asserted itself, and both sisters were placed in a boarding school, Vermont Academy, in Saxtons River, where the teaching was reputed to be unusually good. Both sisters received an excellent preparation for college, and four years later Florence entered Smith College, where her older sister had been for two years. There they lived together, not in a dormitory, but in a private house near the college.

Florence seems to have developed an early interest in science while she was still at school, since in college she took a course for the degree of Bachelor of Science, which she obtained in 1893. Mathematics and the laboratory attracted her most, and her work in both was of the highest order.

Little is known of the development of her talents, but it is certain that her life in college was free from hardships and stresses so often found in the lives of many famous persons. She tutored other students in mathematics, but this did not constitute an occupation arising from need. It has been pointed out by Edna Yost that Florence Sabin's life should offer comfort to those who inwardly feel no certainty of high intellectual gifts but only a will to work, for in high school and early in college she seems to have had no inkling that she was to become a medical research worker or a scientist, still less one of the great woman scientists. Instead it would seem that her well-educated parents felt that she should have as good an edu-

cation in the East as could be afforded. Consequently there was no struggle for an education. However, as has happened to many who have subsequently found themselves in experimental medicine, a course in zoology afforded the spark that kindled her interest in biological science.

It seems quite certain that at this time, if not earlier, she developed one of her best-known traits, a burning desire to strive for equal rights for women and to demonstrate that trained women could be the equals of the best-trained men. This attitude, of which more will be said later, may well have decided her choice of medicine as a career. A significant event, however, undoubtedly played an important part. While Florence Sabin was still in college the plans for a Johns Hopkins University School of Medicine, a school to excel all others in this country or abroad, had been delayed for want of sufficient funds. In the year 1890 a group of ladies headed by Miss M. Carey Thomas, later to become the President of Bryn Mawr College, and Miss Mary E. Garrett, both of them daughters of Trustees of the University, founded "The Women's Fund Committee" to gather money for the project, provided that women should be admitted to the school as well as men. By 1893, the year of Florence's graduation from Smith College, half a million dollars had been raised, most of it furnished by Miss Garrett, and the Johns Hopkins Medical School was opened to both women and men. We do not know, but it seems likely that the possibility of entering this medical school of the highest standards, on an equal footing with men, may have influenced Florence—already engrossed in zoology—to decide upon medicine as her career. Perhaps, and again we do not know, this happening was purely fortuitous.

We do know, however, that lacking the necessary funds for four years of medical education, she accepted an offer from her old school Wolfe Hall, in Denver, to teach mathematics. Two years later she returned to the East and served for a year as an Assistant in Zoology in the Biology Department at Smith College, and that summer, 1896, she worked in the Marine Biological Laboratories in Woods Hole.

At the end of the nineteenth century women were not accepted in the medical schools of the great universities. Although there were women's medical colleges, it was extremely difficult to obtain an internship after graduation. The opportunity for a woman to enter the Johns Hopkins Medical School overcame all these difficulties. Thus fortune played into Florence Sabin's hands, and in October, 1896, she began her first year as a medical student.

Her years of teaching, her excellence in mathematics and science together with her high standing in college, qualified her for entrance, much to her heart's content—as an equal of the men.

THE FIRST CAREER: MEDICAL STUDENT AND INVESTIGATOR

The First Great Influence: Dr. Franklin P. Mall. In an effort to obtain an outstanding faculty, the founders of the Johns Hopkins Medical School selected, among others, a man who happened to exert the greatest and most lasting effect upon young Miss Sabin. He was Dr. Franklin Paine Mall, the school's first Professor of Anatomy.

In the curriculum of medical schools, as generally arranged, anatomy becomes the student's first course. Dr. Mall, then only thirty-one years of age, had graduated from the University of Michigan and had studied three years in Germany with the embryologist His and the physiologist Ludwig and in this country for some time at Clark University. He had then become Professor of Anatomy at Chicago before coming to Baltimore. It is necessary to say something of Mall's philosophy of teaching in order to understand Dr. Sabin's success because she was first influenced by Mall and, later, she carried on with his methods. While in Germany, Mall had become convinced that all students, especially students of anatomy, should be allowed to work out their own salvation by being treated as fully responsible, independent adults. Mall sought to inspire the exceptional student with the investigative spirit, and to accomplish this end he never directed his students, either in study or research, to such a degree as to deprive them of the excitement of original dis-

covery. Such teaching requires men whose own research has shown them the pleasure of discovery and the incentive to further research that follows from it. Mall's philosophy found a ready adherent in Florence, already trained by her courses in zoology in college and by her three years of teaching before coming to the medical school.

One can hardly overestimate the great influence that Mall had upon her, and it can only be appreciated by reading the admirable biography of him that was written by her nearly forty years later and more than fifteen years after his death. In this book, entitled *Franklin Paine Mall: The Story of a Mind*, his aims, described by her, accord completely with those she developed and championed later in life. It becomes clear from this book that Mall was her model. For example, she wrote in her preface: "The writer worked for twenty years under Mall; four years as a student, one as a Fellow, and fifteen years on his staff. Her start in research as a medical student and her opportunity for a career in scientific medicine she owes wholly to him. The theory of education outlined in these pages was thus learned directly from Mall." To anticipate further for a brief moment, she contributed, at Mall's request long before his death, to the well-known Keibel and Mall's *Manual of Human Embryology*.

To return now to the youthful Florence Sabin. While still a student in Dr. Mall's department she began her first investigation into the structure and function of the medulla and the mid-brain. In this work models were constructed from serial microscopic sections of these regions of the central nervous system of a newborn infant. Reproductions of these models were used for many years in teaching at several medical schools. Later, shortly after her graduation, she published her first work, *An Atlas of the Medulla and Midbrain*. This accurate work has stood the test of time, and by many of her colleagues has been considered to be one of her best contributions.

In spite of much time in research she carried on her studies well, and, as she neared graduation, it has been said by those who were younger students that she was pointed out to them as an extraordi-

nary person. Nevertheless, she never seems to have asked—then or later as a faculty member—for any favors because of her sex. She always considered herself on an equal footing with the men.

Following her graduation she received one of the greatest of opportunities for a woman doctor at that time, an appointment as an intern in the Johns Hopkins Hospital. This she accepted, but during her internship she realized that research and teaching held a greater appeal than the practice of medicine. However, there were no staff positions at that time for women in the medical school. Here again, however, her interest in the progress of women and the excellence of her work had attracted the attention of the altruistic group of ladies in Baltimore who had made possible the opening of the medical school. With the consent and encouragement of Dr. Mall, they created a Fellowship in the Department of Anatomy for Dr. Sabin. Here she began, under the best of auspices, many years of work in a new field, the development and the structure of the lymphatic system. Almost at once one of her first papers obtained for her the Prize of the Naples Table Association, which maintained, in the Zoological Station at Naples, a position or "Table" for the promotion of scientific research by women. It was given "for the best scientific thesis, written by a woman embodying new observations and new conclusions based on independent laboratory research." Within four years after her return to Baltimore Dr. Sabin was given the rank of Assistant, Associate, and then of Associate Professor of Anatomy. During this period a series of published papers brought her to the attention of the medical scientists throughout the world and established her reputation as an investigator of the first rank. By 1917 she was appointed Professor of Histology, the first woman to obtain a full professorship in the Johns Hopkins Medical School.

Nevertheless, the way to success was not simple. Her work began at a time when the anatomy of the smallest lymphatic channels and their relationship to the tissue spaces was little understood. Late in the nineteenth century many investigators believed that the finest branches of the arterioles became so small that blood cells could not

enter them although the liquid plasma could. These branches, and even smaller vessels, then called the *vasa serosa*, were supposed to transport the liquid plasma to the lymphatics. Others thought that hollow connective tissue cells served this function. Some held that the ends of lymphatics remained open to allow fluid from the tissue to pour into them after its escape from the blood. Only a few thought that the ends of the channels were closed. At this time, too, embryologists were in disagreement about the way in which the lymphatic system develops. Dr. Sabin was able to write: "When I began my work, it was the accepted theory that lymphatics arose from the tissue spaces and then grew toward the veins," although, she added, both Langer and Ranvier had expressed the view, many years before, that the lymphatic plexus grows outward from the veins by means of extensions of endothelium. However, their work had been done with relatively large pig embryos (about 90 mm. in length) and their views were not generally accepted since, as Dr. Sabin and others pointed out, the lymphatic system in pig embryos of that size is so well developed that it might almost be considered as adult in form. Accordingly she set herself to throw light upon these questions by studying the development of the lymphatic channels in very small pig embryos. By refined and difficult techniques, she succeeded in injecting these vessels with colored or black materials in embryos as small as 23 mm. in total length. These preparations indicated to her that the lymphatics develop in a manner opposite to that generally supposed, and much as Langer and also Ranvier had suggested. That is to say, they arise as buds from the veins and grow outward as continuous channels by a process of further "budding."

Most of the other workers in this field employed serial sections of the fixed and dehydrated tissues of embryos for the study of the development of the blood and lymphatic vessels, and from these sections they reconstructed models of the tissues. In these reconstructions, the lymphatics seemed to arise from isolated connective tissue spaces lined with endothelium. To clear up the opposing views, Dr.

Sabin combined the injection method with the technique of reconstruction from serial sections. For example, after filling the right jugular lymph sac and the lymphatics leading to it with colored materials (either Prussian blue or India ink), the lymphatics, in an embryo pig 27 mm. in length, looked like continuous channels extending outward from the jugular sac. Next, reconstructions were made from serial sections of this injected plexus and also from similar sections of the same area of the other side of the embryo, a region which had not been previously injected.

The plexus that had been filled with colored material could be reconstructed almost wholly, and showed lymph channels connecting with each other. The reconstruction of the uninjected side showed what appeared to be unconnected lymphatic spaces. Apparently the tiny connections between the uninjected, and consequently empty, lymphatics of the second reconstruction had failed to show up in the serial sections, whereas, when these channels were previously filled with colored material, the connections were rendered visible. The evidence obtained from many similar preparations indicated that only by previous injection of the lymphatics could their development and growth be properly understood.

In short, by this and her other work, Florence Sabin demonstrated that the lymphatics arise from veins by sprouts of endothelium, and next that these sprouts or buds connect with each other as they grow outwards from the veins toward the periphery, so that the entire system is derived from already existing vessels. Further, she showed that the peripheral ends of the lymphatics are closed and that they neither open into the tissue spaces nor are derived from them. These findings were later confirmed by Dr. Eliot Clark, who was able to observe the development of lymphatics in the transparent tails of tadpoles.

The reports of Dr. Sabin met with opposition from those who held the view that tissue spaces developed into lymphatics. The controversy became sharp, but her view, owing to the excellence of her observations and to her firm counteropposition, prevailed. Through

it all she showed herself as willing and able as any man to fight for a good cause, an ability that came to full employment forty years later in her third career as a worker for the reform of the Public Health Laws of Colorado. As she put it forcibly in a paper in which she defended her work against a number of critics: "The facts are correct and have been verified, the reasoning was correct and has been justified."

Dr. Sabin next attempted—since she had shown that lymphatics arise from endothelium of veins—to study the origin of endothelium itself. Having completed this study, which is too specialized in nature to be reported upon in this short memoir, and having already demonstrated the development of lymphatic vessels from endothelial sprouts, she next investigated the growth of blood vessels and the origins of the blood cells stemming from endothelium. Her previous work had been carried out, as already mentioned, by injections of colored substances into the lymphatic channels and by the use of serial microscopic sections of dead tissues. For the next work she used living tissue and the early methods of tissue culture which had just been devised by Ross Harrison. She was able to watch cellular growth in the "hanging drop" preparations and to see under the microscope the development of the earliest blood cells in explanted bits of the blastoderm of the chick embryo. She reported that on the second day of incubation of such cultures only red cells could be seen coming from the endothelial walls of the blood vessels. By the third day white cells appeared arising partly from new cells that differentiated from mesenchyme without becoming part of the vessel's lining.

There followed one of her many trips to Europe, this time to Leipzig and other German laboratories. Upon her return, she devised various techniques for the further study of preparations of living cells and for methods of staining them, while alive, with certain innocuous dyes. These methods of "supravital" staining became a most useful research tool for many workers, and they were employed in laboratories throughout the world. With this technique

certain types of living cells, that could not be distinguished in the living state from one another at that time, took up her dyes; and the characteristic differences in the intracellular distribution of the dyes enabled workers to identify many of the cell types and to study some of their functions under normal and diseased conditions. Among these cells there appeared certain mononuclear units termed "monocytes," of which more will be said below. Her experiments indicated that these cells were involved in tissue reactions against infectious agents, particularly the tubercle bacillus. Accordingly, Florence turned her attention to the cellular defenses of the body against disease, and for the prosecution of this work a grant was given her in 1924 by the National Tuberculosis Association.

By this time the work began to bring her honors. She was elected to the presidency of the American Association of Anatomists, a recognition which paved the way, in the following year, 1925, to membership in the National Academy of Sciences, at that time the only woman so to be honored.

From this short sketch it can be seen that during the years at the medical school her research had moved from purely descriptive studies of structure and of morphology of the nervous system and of cell types to more complex investigations of the development and physiology of living tissues and the functions of living cells. Her work with living monocytes began to lead her further, to a wish to understand the role of these cells in the complex mechanisms of the total defense of the body against infections; a subject which carried her to a second career in pure research, unburdened by teaching, and, forty years later, to her third career as a reformer of the public health laws and a fighter against tuberculosis in Colorado.

But first a word about her as a teacher.

HER LIFE AS A TEACHER

In the meantime Dr. Sabin had become even better known as a teacher than as an investigator. At the outset of her teaching career, while still young and a Fellow in the Department of Anatomy, she

exploited her advantageous opportunity, that of being one of the first instructors to meet the first-year students as soon as they entered into the study of medicine. She, who had already captured the spirit of adventurous research from Dr. Mall, stimulated in these young men and women an interest in basic research, and she applied Mall's methods so well that she was able to influence, and to choose, many of the exceptional students to engage in original investigation in her department, while they carried on their regular studies. The many sides of her character, especially her scientific integrity, must have appealed to these students.²

It has been said that in her earlier years at the medical school she was rather formal, the result of early shyness of which there was no remaining trace as she grew older. Each year her reputation as a teacher increased, and her talks to the first-year students came to resemble a postgraduate course, since they attracted many upper-classmen and faculty members. She was as completely absorbed in her work as any teacher or professor might be. This characteristic may be illustrated by a story that has been told of a seminar in which a student had presented a patient with the diagnosis of apraxia, because he put his food, about to be cooked, directly into the fire. Hearing this, Dr. Sabin questioned the diagnosis, saying that just that morning—while thinking about her work—she had broken an egg directly on the stove with no pan for it. Her former students also say that—although she exhibited when young certain traits that might be considered somewhat masculine; for instance, objecting, as she did, to having men hold doors open for her—she was not a domineering woman at all. She was fond of stimulating discussions upon almost any serious intellectual topic, but especially those concerning the advancement of equal rights for women. Of course she

²For the picture of this part of Dr. Sabin's life, her "first career" as both a teacher and an investigator, the biographers lean heavily upon many pages of information generously given by some of her outstanding former students and other associates, now well known in their own fields. We are particularly grateful to Dr. Charles A. Doan, Dr. Lawrence Kubie, Dr. Kenneth Smithburn, and Dr. George W. Corner.

backed the suffragettes, but in this she was by no means a reformer. She simply stood, with a certain rocklike firmness, for the independence of all persons and an equality of opportunity for women.

Because of her later scientific eminence and integrity, because of the fact that she later became so well known as an exponent of new methods of teaching, because, still later, she became such an excellent public health officer and a proponent of new public health laws, as will appear presently, her influence for the improvement of the lot of women was immense. She accomplished much more by the example of her work than she could have as a mere advocate of reform, however vocal.

Both as a young woman and as an older teacher and adviser she was capable of making strong friendships. Early in her career she became something of a daughter to Dr. Mall. As soon as her students came to know her they found a warm-hearted woman, intensely human, always interested in her friends and in any liberal movement aimed at the betterment of human existence. As she grew older her feminine characteristics became more apparent. Students who showed an interest in extramural or nonmedical problems were promptly invited to dine with her and with her other friends. At such times, as described by all who received invitations, she showed a phenomenal flair for social entertainment in her home, a love for and skill at the art of cookery, and a knack for the preparation of dinners which would be "difficult to surpass in any place in the world," but carried on at times with fun and a pleasant burlesque of the exactness of scientific techniques. Some of her students or co-workers have described themselves as squatting on the kitchen floor with a long-handled fork and stop watch turning steaks exactly every third minute, on the dot of the 180th second; of scalding the dishes afterwards and cleaning them as though they were to be used for the next experiment in the laboratory.

During this period of her career her combination of sociability, domesticity, and scientific ability enabled her to establish an intimacy with her co-workers seldom found in the usual teacher-student rela-

tionship, and this intimacy, in turn, created opportunities to inspire them with her enthusiasm for research. Most of her eagerness to foster the student-teacher relationship, and her enthusiasm for it, must have been quite natural to her, but undoubtedly her earlier experiences in Germany engendered both. There, in the late nineteenth century a spirit of academic freedom flourished, and the great physiologist Ludwig, with whom Mall had studied, set an example of friendly generosity. Through Mall's influence, Ludwig's attitude found reflection in Florence's proverbial generosity to students and colleagues alike. Although she had to plan and actually carry out much of the work for the inexperienced first-year students, she left the fruits of the work for them. Many of her students have mentioned her inexhaustible energy that enabled her to do much of the dull routine work of the laboratory so that the younger men would have more time for research. When they offered to help with the routine she would regularly refuse, saying, "You are young, you need time for study and research."

Before long, her natural warmth and interest in other people and their ideas gave rise to an intimate relationship with the progressively changing groups of students at Baltimore who were introduced to research by her, and this relationship, once established, was maintained for life. Yet, in spite of this there remained a reserved formality. First names were not used. Nevertheless, fun was not lacking; not only at her home where the many dinners were cooked, but at the laboratory. There is a tale, for example, of a Saturday afternoon when hundreds of cheap plates in which cross sections of brains had been stained were set up in the cellar and shot to pieces to the noisy joy of all.

It has already been said that she considered herself to be on an equal footing with the men of the faculty. Indeed, since the head of the anatomy department was shy and sensitive and she was forthright, staunch, and ready at all times to take action to assure the progress of whatever she felt to be right, it fell to her to act as the buffer in the inevitable rivalries that arose, on high levels between

academic departments, or on lower levels in the clashes of personalities, even among janitors and cleaning women. To the latter she showed a friendly benevolence which resulted in her becoming not only their confidante but often their financial benefactor as well. She took over all local problems of the laboratory and solved them with dispatch, whether it became necessary for her to extort an apology to the wife of the janitor from one of her group who had created an undue litter on the laboratory floor, or, on the higher level, to settle an old feud between two departments of the school concerning which one should teach the anatomy of the brain, a subject beloved by both.

Her interest in active teaching was surpassed only by her concern for education in general and for medical education in particular, especially for women. She frequently voiced her opinions in talks or speeches made when receiving some prize or honorary degree. Some of these talks appeared as leading articles in the weekly journal *Science*. For example, when asked to address the graduating class of the Woman's Medical College at Philadelphia, she chose for her topic, "The Extension of the Full-Time Plan of Teaching to Clinical Medicine." The opportunity gave her the chance to affirm her profound faith in the fitness of women, not only as practitioners of medicine, but as scientific medical investigators, even if married. She pled their cause as one of the next steps in the feminist movement and urged educated married women to take their share in professional work. In this talk she stressed, too, her conviction that all who teach in a profession that is constantly changing should contribute to that change by becoming investigators. She urged a shift "in interest by the leaders of the medical profession from the application of knowledge to the cure of disease to the study of the problems of disease." In her view, research—by focusing the minds of the ablest men in the profession on the problems of advance in medicine in contrast to the practical application of knowledge—could lift teaching to a higher plane.

Five years later she elaborated her views upon the relationship of

research and teaching in medical schools before the Committee on Research in Educational Institutions of the American Association for the Advancement of Science. She urged the professor-investigators, as also did many others, to perpetuate themselves by stimulating the brilliant students to become teachers and workers in research, thereby furnishing the medical schools with worthy future faculties which would carry their share of the burdens involved in the progress of medicine. Noting that some believed that no student should engage in investigative work, while others felt that all should do so, she asked: How should one introduce a student to research? Clearly, she said, the exceptional student can do more than the average, for whom the curriculum is arranged. He can find time for research, which should be encouraged, but only if he shows a strong bent for it. Some insisted that the students' scanty knowledge of what had gone before would prohibit research, but Dr. Sabin insisted that this difficulty could easily be overcome if the instructor, instead of smothering the student with a mass of facts, simply indicated the direction in which the important facts seemed to lead, since original minds, adapted for experimentation, do not revel in the analyses and classification of masses of detail but in looking forward. Indeed she pointed out that many of the most successful investigators did not analyze the previous literature until their work was already well under way, and that, for the student, the beginning of a problem often served best to stimulate and give purpose to later reading.

On the other hand, she asked, why advocate research for all? Does this not confuse the purposes of a medical education with the requirements of work for a degree of Doctor of Philosophy? Only a certain percentage of medical students need more than the knowledge of the methods of science, not training in experimentation itself, and only the exceptional student can obtain both. The teacher, she concluded, should be given complete freedom to decide how to furnish a few professional research workers for the progress of medicine. The intellectual quality of the teacher would be the essen-

tial requirement for the presentation of medicine as a growing subject, and for the emphasis on new points of attack and on new ideas which would themselves aid the student toward research.

Florence practiced what she preached and accomplished the ends she described by "the charm of ideas." This she apparently found the most fascinating task of all teaching. The minds of the students were left free to judge the evidence of their work for themselves. Joint endeavor was seldom attempted for fear of degrading the student to the rank of a mere technician and of allowing him to fail to formulate his own ideas and to make his own plans. She insisted that, given the right teachers, the problem of who shall or who shall not do research will solve itself provided the teacher is left free.

Her success as a teacher showed itself in the large number of her students who later came to the front in research. Her career as a teacher was well summarized many years later, in 1951, at the dedication of the new Florence R. Sabin Building for Research in Cellular Biology at the University of Colorado School of Medicine, in an address given by Dr. Grover F. Powers, then Professor of Pediatrics at Yale University. During this ceremony at which, on her eightieth birthday, Dr. Sabin sat on the platform, as the newspapers declared, "full of years and honors," Dr. Powers said, in part:

"Dr. Sabin is a great teacher. The impact of her teaching upon pupils is to inculcate a love of scholarship, a high regard for learning, a fostering of the spirit of inquiry and of intellectual curiosity—for Dr. Sabin the ideal of great teaching is stimulation of the student to the love and pursuit of knowledge—kindling of the mind—up-surg-ing of the spirit! It occurred to few students entering medical school shortly after the turn of the century (and before) that a great teacher was other than one who presented information and facts in an interesting and entertaining manner. The first vigorous and disquieting impact of Dr. Sabin upon pupils was to dispel that concept; soon, however, as a result of her teaching and example it was found by many that minds kindled and intellects awakened were more to

be desired than minds well stocked with information, interesting and useful though it might be.

“In her own teaching career Dr. Sabin perfectly exemplified the characterization she herself gave of one of her own teachers and colleagues. Using her own tribute to Franklin P. Mall, we say of Dr. Sabin, ‘Her contempt for slovenly or dishonest work, her admiration of rigidly perfected technique, her encouragement of objectivity in study, her insistence upon familiarity with the bibliographic sources, her emphasis upon the duty and pleasure of extending rather than merely acquiring knowledge, her impatience with inaccuracy and with stupidity, her unswerving loyalty to the highest ideals of natural science—all were qualities that made her a working companion of inestimable value to the young men and women who entered the Johns Hopkins Medical School.’

“And thus, in very truth, is characterized the great teacher we salute today!”

THE SECOND CAREER: FULL-TIME INVESTIGATOR

By 1925 Dr. Sabin had reached a position of eminent distinction. Her great counselor and teacher Dr. Mall had died. The position of Professor of Anatomy and Head of the Department had not been offered to her; instead it was occupied by one of her former students. By this time, too, her cellular studies had begun to point toward an increased understanding of the total bodily defenses against infectious diseases, since the monocytic cells themselves seemed to take an important part in the defense against the tubercle bacillus. Dr. Simon Flexner, the Director of the Rockefeller Institute for Medical Research, who had long been interested in the humoral rather than the cellular mechanisms of defense against infections, concluded that a combination of investigations of both mechanisms was desirable. Accordingly, he urged Dr. Sabin to accept a position as full Member on the Scientific Staff of the Rockefeller Institute.

Although this meant a new life in New York City, away from her Baltimore associates and her many friends, she accepted, and on

May 1, 1925, a Baltimore newspaper carried a front-page column announcing the planned departure of Dr. Sabin, the following autumn, to the Rockefeller Institute, there to be the first woman to become a full Member of that institution. She was then Professor of Histology at the Johns Hopkins Medical School and the first woman President of the American Association of Anatomists. She had just added another "first" to her list. She was about to enter her second career, that of a full-time investigator.

In New York she organized and directed a group of younger investigators, some of whom had been with her in Baltimore, toward the continuation of her studies on the role of the monocyte and other white blood cells in the defense of the body against infections, and toward a correlation of this work with already existing knowledge about the humoral defenses. This group's previous work had shown the cell known as the monocyte to be the precursor of the well-known giant cell typical of the body reaction to tuberculous infection in animals and man. While Florence was at the Rockefeller Institute her studies on tuberculosis went forward rapidly. She became a member of the Research Committee of the National Tuberculosis Association. This committee, instead of creating a research institute, wisely decided on a plan, almost unique in the procedures of medical research at that time, to integrate, under Dr. Sabin's direction, bacteriological, chemical, and biological studies on tuberculosis through cooperative investigations by workers in already existing laboratories. Florence and her co-workers became part of this inter-institutional program which included pharmaceutical companies, state and privately endowed universities, and research institutes both private and federal. In this way, with somewhat limited funds, one of the best examples of the now modern approach to a complex problem was begun, and nation-wide studies on tuberculosis were furthered. Throughout her years at the Rockefeller Institute she contributed, through this committee as well as by her fundamental researches, to a better understanding of the disease.

In short, after describing the well-known hard and soft tubercles

that are produced respectively by virulent or avirulent tubercle bacilli, she and her co-workers showed that many of the lesions characteristic of tuberculosis could be reproduced in animals by chemical fractions extracted from the organisms. For example, tests with lipid fractions isolated from tubercle bacilli by Dr. Rudolph Anderson, of Yale, showed that certain fatty and waxlike substances could be identified within the phagocytic cells, a finding that made it possible to detect with assurance the cells reacting to these substances and to observe the subsequent behavior of these cells as they dealt with the materials.

Each of the fractions tested induced vigorous cellular reactions. The lipids, especially a phosphatide, gave reactions resulting in tuberclelike groups of epithelial or giant cells. Waxes stimulated the proliferation of fibrous tissue. A fat, soluble in acetone, caused hemorrhage in tissues and stimulated an overgrowth of connective tissue cells and blood vessels. A polysaccharide fraction appeared, at first, to attract leucocytes but then to kill them. The proteins of the tubercle bacillus seemed to be responsible for fever and an increase and localization of plasma cells. Clearly the tissue changes were induced not by the bacteria themselves but by various chemical substances in them.

Among these reactions Dr. Sabin considered the response of the monocytes most significant, and although the view was at first opposed and even ridiculed by already established authorities, the clarity and weight of the evidence she brought to light eventually tipped the scales in favor of her hypothesis. In one of her papers she wrote that "cellular and immunological reactions in tuberculosis center around the functions of the monocyte." She found that the phosphatide of the tubercle bacillus, and also one of its fatty acid components, induced the maturation of monocytes from more primitive cell forms. The phosphatide was "phagocytized by monocytes, which in dealing with it, become epithelioid cells which are usually arranged in tubercles similar to the hard tubercles of the actual disease." These epithelial cells often developed into giant cells of the

Langhans type, cells that are characteristic of the lesions of true tuberculosis. She found "no evidence that the epithelioid cells dealing with the phosphatide return to the state of the original monocyte; rather, . . . after a long interval they died either singly or *en masse*, simulating caseation," another of the phenomena of the natural disease.

Besides the effects just mentioned, the proteins of the tubercle bacillus were shown by her group and by others to be the sensitizing substances, and, when combined with the fatty materials, to yield the counterpart of the allergy which was supposed, at that time, to depend on the infection itself.

These studies, carried on, of course, by many workers besides her own group, stimulated Florence's interest in the identification of the cells responsible for the formation of antibodies to infectious organisms. Her work with the monocytes had shown how these cells took up the antigenic substances. She turned next to a study of antibody formation, her last piece of basic research.

For many years before she began this work other observers had found that invading bacteria, carbon particles, and certain dyes are taken up by the lining cells of the blood vessels and by phagocytes of the reticulo-endothelial system, found chiefly in the lymph nodes, spleens, and livers of most animals. It was believed that these cells which took up foreign substances (antigens) formed antibodies. At this time a dark-red, coupled dye protein had just been produced by Heidelberger and Kendall, who had found it to be antigenic in rabbits. It was believed that this antigenic dye, if it could be seen inside cells after its injection into animals, would serve as a tracer to indicate something of the fate of antigens in general in the body and the way in which they might stimulate antibody formation.

Because of her long experience with cellular observations and the tissue reactions following the injections of foreign substances from the tubercle bacillus, Dr. Sabin was eager to make observations with this tracer antigen. An alum precipitate of this protein, after injection into animals, appeared in the reticulo-endothelial cells of vari-

ous organs and especially in the phagocytic macrophages. The particles of the antigen engulfed by the macrophages appeared in vacuoles within their cytoplasm. Next, the dye became separated from the protein and could no longer be seen. After a few days these cells began to shed their cytoplasm, and at the same time antibodies appeared in the blood. In every experiment the scavenger white cells of the blood took up the antigen, and many of these were in turn engulfed by the macrophages, as if the former cells played some role in bringing the antigen to the latter. Dr. Sabin concluded that the antigen was first rendered soluble in the cytoplasm of the macrophage where, in a second stage, antibody globulin was formed; later the antibody globulin and probably the normal globulin, too, were freed from the cell in the shed cytoplasm.

These excellent observations stand today, but, owing to their circumstantial nature, interpretation of them varies. Dr. Sabin appreciated that the shedding of the cytoplasm of these cells and the appearance of antibody in the blood merely coincided in time and might not be otherwise related. Under these circumstances the uptake of the antigen that she had observed might be only a first step, a preparation of the antigen for other cells that formed the finished product. Today this interpretation is the one that is most usually put upon the phenomena she described.

During this period as a full-time investigator Dr. Sabin had been associated for thirteen years with younger workers all of whom have since become well-known contributors to medical research. As one of them has put it, all were struck by her fund of energy, her enormous enthusiasm, and her great intellectual integrity.

The years in New York City were by no means devoted only to research. Life in New York was truly a great adventure. Her leisure hours were filled with agreeable cultural diversions, and her interests were varied. She loved flowers and took much pleasure in the theater and in symphonic music, and thoroughly enjoyed many informal evenings of chamber music played in her home by some of the best-known musicians of the time. She read widely, mostly nonfiction

and philosophy. Her breadth of interests increased all through her life. To illustrate, at the risk of anticipation: one of her co-workers has described a visit to her in Denver shortly before her death. She was found sitting before a television set—which was inactive—beside her on one hand a bowl of roses, on the other a volume of Freud, one of Einstein, Leo Stein's *Journey into Self*, Looney's *Shakespeare, Identified*, and Homer Smith's book on the development of man's religious ideas.

Nevertheless, in the laboratory in New York her energy for work never lagged. All through this part of her life, as later, she also exhibited the greatest enthusiasm not only for research but for public welfare; her eyes would shine and her face light up while discussing these subjects. Since she always advocated equality and equal opportunity for all, of either sex, scientifically, philosophically, or politically, she was therefore a true liberal. Another of her co-workers writes: "The great joy and pleasure which she derived from her work were like a contagion among those around her so that all were stimulated in much the same manner that she was. I have never known any other person to be quite so buoyed up by intellectual stimuli as she was. Dr. Sabin was one of those people who, however strenuous the previous day might have been, waked at the crack of dawn with great enthusiasm for what the day was to hold. She was nearly always the first one at the laboratory, and greeted every one with a *joie de vivre* which started the day pleasantly for all of us. . . . Despite the fact that she was the first to arrive in the morning, she was often the last to leave in the evening."

Although during the thirteen years in New York Dr. Sabin remained primarily a laboratory investigator, she maintained a continuous growth in outlook as well as in achievement. Early in life she had been an outspoken feminist with few doubts about the feasibility of business or professional careers for women. As she grew older she acquired a deeper understanding of the complexity of a career woman's life and of its difficulties, chiefly the conflicting claims of a home life with those of a professional career. As a result

she came to view her own life as an exception. This must have been obvious to her, if for no other reason, because of the large number of honors, awards, and prizes which came to her from a variety of sources.

To illustrate the point it seems best to digress from the story of her career and to list most of these honors here, even those she received after retirement. Long before leaving Baltimore she had received early recognition from Smith College by the receipt of the Honorary Degree of Doctor of Science. Four years before leaving that city she was asked to speak as the representative of American women of science at a great reception for Mme. Curie held at Carnegie Hall in New York, and in her first year in New York she was elected, as already mentioned, to the National Academy of Sciences. A flood of honorary degrees came upon her: she received the Doctorate of Science fourteen times, first from Smith College, as just mentioned, and also from Mt. Holyoke, Wilson, Oberlin, and Russell Sage colleges, the Colorado State College of Education, the Woman's Medical College of Pennsylvania, and the universities of Michigan, Colorado, Pennsylvania, and Denver, as well as New York University, Syracuse University, and Oglethorpe University. Goucher College gave her the degree of Doctor of Laws, making a total of fifteen honorary degrees. The Colorado State College of Education showed its further regard for her by naming one of its buildings Sabin Hall.

Her honors were not only academic; many came to her because of her work in behalf of the advancement of women's rights and, at the end of her life, because of her eminence in public health reform. For example, first, as already mentioned, while she was still an intern in the Johns Hopkins Hospital, came the Fellowship of the Baltimore Association for the Promotion of University Education of Women, with a stipend of \$800 for study in the Department of Anatomy with Dr. Mall. Next, after she constructed her models of the brain stem, she received the \$1,000 prize of the Naples Table Association for the best scientific thesis embodying new observations and new conclusions based on independent research by a woman.

In 1929 came the *Pictorial Review's* \$5,000 Annual Achievement Award. Two years later she was selected in a nation-wide poll by *Good Housekeeping* magazine as one of the twelve most eminent women in this country. The following year, 1932, she received the National Achievement Award of the Chi Omega Sorority. Three years later (1935) her name appeared on Mrs. Carrie Chapman Catt's famous annual list of the nation's ten outstanding women. In the same year, the M. Carey Thomas Prize in Science, with an award of \$5,000, was given to her at the ceremony for the fiftieth anniversary of the founding of Bryn Mawr College. More will be said of this presently. These diverse honors came to her before her retirement in 1939.

Thereafter she received, in 1945, the Trudeau Medal, of the National Tuberculosis Association, given for "extensive studies of the physiologic activities of the chemical fractions of the tubercle bacillus," and two years later, at a fete at Rockford College, the first Jane Addams Medal for distinguished service by an American woman. Two weeks later, the National Conference of Christians and Jews offered its "Arts and Science" Citation jointly to Kate Smith, the singer, for the Arts and to Florence for Science, a partnership that gave her joyous amusement as well as sincere pleasure, and in the same year she received the Medal of Achievement from the University of Colorado. The following year, 1948, the American Woman's Association presented her with its award for the year 1947, a medal for eminent achievement. In 1949 there followed the Elizabeth Blackwell Award at Hobart and William Smith colleges for her work in medical science, and, four years later, an Elizabeth Blackwell Citation, at the New York Infirmary, for achievement in medical education. In the meantime, in 1951, the Lasker Award of the American Public Health Association came to her for "outstanding achievement in the field of public health administration." The same year saw her presented with the General Rose Memorial Hospital's medal for distinguished public service, but, most important of all, in that year too the Florence R. Sabin Building for Research in

Cellular Biology, part of the University of Colorado's Medical Center, was opened and dedicated to her. In the two following years the Sabin Award in Public Health was established in her name and she was given the Distinguished Service Award of the University of Colorado.

She was a member of many learned societies: the National Academy of Sciences; the American Association of Pathologists and Bacteriologists; the American Association of Physiologists; the American Association for the Advancement of Science; the National Tuberculosis Association; the Society for Experimental Biology and Medicine, of which she was a Counselor in 1932; the New York Academy of Medicine; the Harvey Society in New York; the New York Academy of Sciences, of which she became an Honorary Life Member; the Colorado State Medical Society; and the American Association of Anatomists, for which she served as Vice-President in 1908-1909 and as President in 1924-1926.

She belonged to the American Women's Association, the Colonial Dames, the American Association of University Women, and the Cosmopolitan Club, which extended to her after her retirement the rare privilege of living at its house, without dues, on all her annual visits to New York.

At various times in her careers Florence Sabin served on many useful committees and gave generously of her time and energy to their work. She served for years on the Editorial Board of the *Anatomical Record*. She accepted the National Chairmanship of the Finney-Howell Foundation for Cancer Control, and served as Chairman of the Health Committee of the Colorado Post-War Planning Committee, as President of the Western branch of the American Public Health Association, as head of the Committee on Health and Charities of Denver, as a member of the Committee of Awards for the Guggenheim Fellowships, and also on the Committee of the National Society for Crippled Children and Adults. She was a director of the American Society for the Control of Cancer, and Honorary National Commander of the Women's Field Army. In her name

there was created the American Association of University Women's Rocky Mountain Fellowship, the "Florence Rena Sabin Fellowship."

Most of these awards or prizes were clearly honors reserved for women; however, it seems worth while to stress again here the number of positions she obtained which were usually held by men, but which were occupied for the first time by a woman when she accepted them. She was the first woman to teach in the Johns Hopkins Medical School and the first to be appointed to a professorship. She was the first woman to become President of the American Association of Anatomists, the first to be made a Member of the Rockefeller Institute, the first to be elected to the National Academy of Sciences, the first woman Honorary Member of the New York Academy of Sciences, and the first recipient of the Jane Addams Medal. Other significant honors will be mentioned presently in considering Dr. Sabin's third career.

To return, now, from the preceding digression about her honors, to complete the story of her second career; she found time to give many lectures and talks, some to medical societies, others to various groups upon the receipt of some award. The enthusiastic and generous spirit shown in two of these talks, one presented before a medical group and the other to a mixed audience, was characteristic of her nature. In an address given in Denver, at the dedication of the Charles Dennison Memorial Library and the inauguration of the Henry Sewall Lectureship in Medicine, at the University of Colorado School of Medicine and its Hospitals, her own love of the adventure of research showed itself in almost every paragraph. From her ideas expressed in this talk it becomes clear, too, that her interest in the experimental pathology of tuberculosis had been aroused by Dr. Sewall, just as her early curiosity about the lymphatic system had been awakened by Dr. Mall.

In her response to President Park of Bryn Mawr, upon the receipt, in 1935, of the M. Carey Thomas Prize at the fiftieth anniversary of the founding of the College, she seized the opportunity again to carry on her campaign to further the acceptance of women

in scientific posts. In her desire to aid the cause she—although receiving the prize for being the outstanding example of an American scientific woman—with characteristic modesty never mentioned her own work but only that of others. All through this talk she showed her gratitude to those who had recognized feminine ability, and she cited the importance of women in American medical science by stressing the role that M. Carey Thomas had played, as an earlier President of Bryn Mawr, in preparing women for scientific careers and the part she had also taken, still earlier with Mary E. Garrett in Baltimore, in obtaining the admission of women to the Johns Hopkins Medical School on an equal footing with men.

All was not work. Expressions of love and admiration came to her often. One among these was noteworthy. Only a few days before Dr. Sabin left the Rockefeller Institute to retire, her colleagues arranged a surprise dinner. Two of her associates paid a visit to her home and told her they had come to take her out to dinner at the famous Rainbow Room of the Rockefeller Center, a restaurant which she had never seen. She was not even suspicious until she was ushered into a room just below the Rainbow Room, filled with about forty of her former students and friends, all bound to her by ties of warmth and affection. There were six tables, each with an empty chair at its head, and Dr. Sabin took one course at each. During this dinner one of the eulogies described her as a hostess and provider of fabulous dinners, and her scientific career was briefly reviewed by the President of Johns Hopkins University, Isaiah Bowman, and by others.

Florence responded extemporaneously in a talk which illustrated, to all, her selflessness and her continued enthusiasm for the scientific career. After illustrating how her work was related to that of many others, she said: "The most interesting thing about it all is that, in the last few weeks, I have just discovered that everything I have been doing in these last few years is all wrong." This was said, of course, with tongue in cheek, but the remark illustrates her lifelong belief that both negative results and positive findings constitute

the real progress of knowledge, not merely the startling discoveries of a few.

Several days later she left New York to take up residence in the West. Probably no investigator or teacher had ever left a more devoted group of students and colleagues. She carried with her the belief that satisfaction in life stems largely from work and activity. Accordingly it was foreordained that her retirement could not last. She was striding at the time, without knowing it, into a third career, and, although her entry into the new work was altogether unselfish, toward more honors and more esteem.

THE THIRD CAREER: PUBLIC HEALTH

Upon her retirement from the Rockefeller Institute for Medical Research in 1938 Florence Sabin went to Denver to live with her older sister, Mary, a retired teacher of mathematics in the Denver high schools, who was required to live in Denver by city statute in order to enjoy her pension. Happily this did not entirely sever Florence's ties with the East, for she not only continued an active correspondence with her numerous friends there but returned at least once a year during her service as a member of the Advisory Board of the John Simon Guggenheim Memorial Foundation (1939-1947) and the Advisory Committee of United China Relief (1941-1953).

In the meantime, the long connection of her family with Denver, her many friends of long standing in that city, and her immense reputation speedily brought her into contact with research workers and their projects at the Medical School of the University of Colorado. She was also made an honorary member of the Denver Tuberculosis Society and was appointed to the Board of Directors of the Children's Hospital in 1942, on which she served as second vice-president in 1945 and 1947 and as third vice-president in 1946. Through these activities she became acutely aware of the archaic nature at that time of Colorado's laws relating to public health and the primitive methods for the enforcement of such laws as there

were. With her still tremendous energy and clarity of vision she allied herself with a number of public-spirited citizens who had been fighting for better conditions under the leadership of Dr. Lloyd Florio but had won no support in the State Legislature as late as 1945.

In 1944 Florence was appointed to Governor John Vivian's Post-War Planning Committee and became chairman of a subcommittee on public health which soon was known as the "Sabin Committee" and was unique in its accomplishments. Its very active secretary was Herbert D. Moe, of the State Health Department. According to Mark Henry Harrington, at that time President of the Denver Tuberculosis Society and long an active worker for better health conditions in the city, Florence was an excellent chairman, presiding with vigor and dispatch, but always giving the other members full opportunity to speak their minds. Following a change in the State's administration, the work of this committee was actively supported by the new Governor, W. Lee Knous, who called Florence "the atom bomb." After intensive work, the committee, aided by Harrington, William McGlone, later Chairman of the State Board of Health, and Hubert Henry, all attorneys, drafted a legislative program, the "Sabin program," consisting of six bills. These measures (1) provided for a complete reorganization of the State Health Department, (2) allowed adjoining counties with limited resources to receive federal, state, or local funds in order to organize district health services, (3) set up a State Tuberculosis Hospital, (4) increased the per diem allowance for hospitalized indigent tuberculous patients, (5) established for the first time a strict control of brucellosis, then rampant among the cattle of Colorado and consequently a serious problem in public health, and (6) gave authority to the State Department of Public Health to receive federal funds under the Hill-Burton Act for hospital construction.

Then began the long fight to have these measures passed. In this there were some differences between members of the committee, as Florence did not support the bill for the state tuberculosis hospital,

apparently believing that this could come later and that insistence upon it would weaken the chances of passage of the measures she considered more fundamental. However, she became the leading spirit in the struggle for passage of the others and, regardless of weather or season, went to every one of the sixty-three counties of the state campaigning for the bills. Illustrative of her activities during this period is the following item from the *Colorado Springs Gazette-Telegraph* of April 7, 1946: "Dr. Sabin . . . will speak on 'Public Health in Colorado' at a meeting at 8:00 P.M., Tuesday, at the Fine Arts Center . . . under the auspices of the Business and Professional Women's Club. . . . Other clubs invited to attend include Altrusa, American Association of University Women, Soroptimist, League of Women Voters, Young Women's Christian Association, Business Women's Club, and the National Society of Secretaries." The article also included a short biographical sketch and portrait.

On one trip to address a mass meeting at Steamboat Springs her car was forced to turn back for tire chains by a blizzard. In spite of the cold and poor visibility she insisted on making the trip and actually arrived in time to make the principal speech. On such occasions, and there were many, when asked how she felt, she would always reply, "Fine as silk" or "Warm as toast," and she would telephone reassuringly to her sister as soon as possible. These far-flung local meetings were often followed by "post-mortem" stocktakings by the central committee, and Florence enjoyed these sessions in the smoke-filled room and had her drink with the men.

The picture of this stocky, indomitable, sincere, honest, knowledgeable, and famous elderly woman scientist campaigning vigorously for modern health laws caught the fancy of the public and served to dramatize the fight for their passage. In this the newspapers of Colorado played a large part, and many of them not only actively supported the campaign but delighted their readers as well with picturesque stories of its heroine and her energetic pursuit of every means of advancing the bills. In the state-wide elections of

1946, candidates for the legislature who had opposed her program or had not supported it were defeated in county after county, and even in the race for the governorship the winner, W. L. Knous, was the candidate who had most strongly advocated the proposed bills.

Many visits to state legislators then had to be made. Florence became a very effective lobbyist and spent much of her time in 1947 working directly with the lawmakers. Some of the politicians feared her because of her direct and energetic approach, but more and more became her loyal supporters and backed her strongly in the final sessions. Several of the key legislators were invited to attend the meetings of her executive committee. If any legislator asked her a question she was unable to answer, she immediately went to the State Department of Health and took back all information obtainable. As she herself said: "We got the facts and told people about them." In her work Florence had the effective, active support of the Denver County Medical Society, the Colorado State Medical Society, and the Denver Tuberculosis Society.

The first tangible outcome of all this effort was the passage of four of the bills in 1947. The one for the establishment of a State Hospital for Tuberculosis failed to pass, as did also the bill for the control of brucellosis. However, Florence continued her fight for the latter, trying her best to work with the stubbornly resistant representatives of the cattle and dairy industries, and eventually, two years later, a compromise bill was passed in order to effect some improvement in the situation with regard to dairy cattle.

Now that the bills were passed, the principal task became one of implementation. This was never fully done because of the failure of the State Legislature to follow through with sufficiently large appropriations. However, a beginning could speedily be made, aided by a survey of health conditions in the State which had been carried out in 1945, under the direction of Dr. Carl E. Buck, then Field Director of the American Public Health Association, and financed by the Commonwealth Fund. Dr. Roy L. Cleere, who had for many years been Secretary to the State Board of Health and executive

officer of its Division of Public Health, was appointed executive director of the Colorado State Department of Public Health, and, under the "county and district bill," set about encouraging counties to organize district health divisions. The first such unit comprised six counties in northeast Colorado, and a second district was created in the San Juan Basin in the southwest portion of the state.

After passage of the bills and the completion of a health survey of the city of Denver, sponsored by the Denver Tuberculosis Society, Florence was appointed Chairman of an Interim Board of Health and Hospitals of Denver by Mayor Newton in the autumn of 1947. As a public service, and at the suggestion of Dr. Florio, she later resigned from the Board and allowed herself to be named by the Mayor as Manager of the Denver Department of Health and Welfare, but donated her salary of \$4,000 to the University of Colorado Medical School for research. The Denver General Hospital, one of the principal activities of the Department, was, however, actually run by a Director, Dr. J. P. Dixon, who was legally responsible to Florence, as was also the first Director of Health, Dr. Florio, during the period of his leave from the University. The interim arrangement lasted three and one-half years, until 1951, when a new City Department of Health and Hospitals and a Department of Welfare were legally created by an amendment to the city's charter, voted by its citizens. Dr. Sabin was, of course, named Chairman of the new Board of Health and Hospitals but resigned the office a year later, continuing only as a member under Harrington's chairmanship. An indication of her activities during this period is given by the following quotation from the March 1, 1951, issue of the *Rocky Mountain News*: "Dr. Florence Sabin yesterday began marshalling forces behind the proposed water pollution control act aimed at attacking the filth and stench of Colorado's sewage-laden streams." And again on November 3: "Dr. Sabin . . . was the force and spirit behind the Tri-County chest X-ray campaign a couple of years ago." This and other measures resulted in halving the death rate from tuberculosis in the city in two years.

On November 9, 1951, Florence celebrated her eightieth birthday, and on December 1 the School of Medicine of the University of Colorado observed the day by officially dedicating its new Florence R. Sabin Building for Research in Cellular Biology, in which her portrait adorns a wall, and by a birthday dinner at which she was presented with a bound volume of letters from her many friends, students, and associates.

Unfortunately, from this time on Florence was able to give less and less attention to public activities because of the time and care she wished to give her rapidly failing sister. The strain of this loving service was, however, a severe one. In the opinion of a local medical friend, this could have been a direct cause of the cardiac decompensation, pneumonia, and other complications that resulted in a critical illness. While recovering slowly from this, Florence—always an ardent Dodger fan—settled down before her television set to watch the World Series game of October 3, 1953. She never knew the outcome, for as she sat there a heart attack ended her life.

When her will was opened it was found that this, too, was in character, for it provided that her estate, after her sister's death, be turned over to the Medical School of the University of Colorado.

Of the many newspaper articles and editorials that followed her death, two may be briefly quoted. The *Denver Post* termed her the "First Lady of American Science," and the *Rocky Mountain News* quoted Mayor Newton, in his expression of the city's grief, as saying, in part: "She was learned, she was wise, she was humble. She loved the world and every living creature in it."

As marks of esteem the new Sabin School, in Denver, has been named in honor of the two sisters, Florence and Mary. A bronze bas-relief of Florence has been placed in the Denver General Hospital, and she appears, among seventeen women, in a wooden panel, "Pioneers of Progress," carved by John Rood.

As is well known, each state in the Union may be represented in National Statuary Hall, in the Capitol at Washington, by two statues. The first from the State of Colorado is a bronze statue of

Dr. Florence Sabin, by Mrs. Joy Buba, of New York City. It was formally presented by the State of Colorado to the United States of America, on February 26, 1959. A replica will stand in Denver in the building of the Colorado State Health Department. Finally, the University of Colorado Press published in 1959 an excellent, comprehensive biography, *Florence Sabin: Colorado Woman of the Century*, by Elinor Bluemel.³

³ In the compilation of this section, the writers wish to acknowledge with gratitude the cooperation of Dr. Roy L. Cleere, Dr. Lloyd Florio, Mr. Mark H. Harrington, Mr. Henry Swan, and Dr. Henry Swan, all of Denver, Colorado; Mrs. Elinor Bluemel, of Englewood, Colorado; also the help of Miss I. T. Aulls, of the Denver Public Library, and of Miss Norma Johannis, of Dr. Cleere's staff.

CHRONOLOGY

- 1871 Born at Central City, Colorado, near Denver.
- 1875 Moved to Denver.
- 1878 Death of her mother.
- 1879 Attended a boarding school, Wolfe Hall, in Denver.
- 1880-84 Lived in the home of an uncle, Albert R. Sabin, at Lake Forest, Illinois; attended private schools and spent her summers in the East on her grandfather's farm at Saxtons River, Vermont.
- 1885 Entered the Vermont Academy at Saxtons River, Vermont, graduating in 1889.
- 1889 Entered Smith College, Northampton, Massachusetts.
Chief interests: Zoology and Mathematics.
- 1893 Degree of B.S. from Smith College.
- 1893-95 Taught mathematics at Wolfe Hall, Denver.
- 1895-96 Substituted for an Instructor in Zoology in the Biology Department at Smith College.
- 1896 Spent the summer at the Marine Biological Laboratories, Woods Hole, Massachusetts.
Entered the Johns Hopkins University School of Medicine.
- 1897 Her first publication while still a student (see bibliography).
- 1900 Degree of M.D. from the Johns Hopkins University.
- 1900-01 Served as an intern in the Johns Hopkins Hospital.
- 1901 Awarded a Fellowship by the Baltimore Association for the Advancement of University Education for Women, to work in the Department of Anatomy of the Johns Hopkins School of Medicine, under the direction of Professor Franklin Paine Mall.
Published *An Atlas of the Medulla and Midbrain*.
- 1902 Assistant Instructor in the Department of Anatomy.
Published papers on the origin of the lymphatic system.
- 1903 Awarded the Prize of the Naples Table Association.
- 1903-05 Associate in Anatomy.
- 1905-17 Associate Professor of Anatomy. Further publications on the origin of the lymphatic system and of blood vessels.
- 1910 Honorary degree of Sc.D. from Smith College.
- 1917-25 Professor of Histology in the Department of Anatomy in the Johns Hopkins School of Medicine. The first woman to be elected to a full professorship in that institution.
Researches on the origin and functions of white blood cells and connective tissue cells.
- 1924-26 The first woman to become President of the American Association of Anatomists.

- 1925 Appointed a Member of the Rockefeller Institute for Medical Research: the first woman to be a full Member of that institution.
Elected to the National Academy of Sciences: the first woman member.
- 1926 Degree of Sc.D. from the University of Michigan.
Member of the Research Committee of the National Tuberculosis Committee, coordinating the research of her group and others.
- 1926-38 Researches on the pathology of tuberculosis.
- 1929 The Annual Achievement Award of *Pictorial Review*.
Degree of Sc.D. from Mt. Holyoke College.
- 1931 Degree of LL.D. from Goucher College.
Named as one of America's twelve most eminent living women by a poll conducted by *Good Housekeeping* magazine.
- 1932 National achievement award of the Chi Omega Sorority.
- 1933 Degree of Sc.D. from New York University.
Degree of Sc.D. from Wilson College.
- 1934 Publication of her biography of Dr. Mall, entitled *Franklin Paine Mall: The Story of a Mind*.
Degree of Sc.D. from Syracuse University.
- 1935 Degree of Sc.D. from Oglethorpe University.
Degree of Sc.D. from the University of Colorado.
Received the M. Carey Thomas Prize at the 50th Anniversary of Bryn Mawr College.
Named on Mrs. Carrie Chapman Catt's annual list of the country's ten outstanding women.
- 1937 Degree of Sc.D. from the University of Pennsylvania.
Degree of Sc.D. from Oberlin College.
- 1938 Degree of Sc.D. from Russell Sage College.
Retired from the Rockefeller Institute.
- 1939 Degree of Sc.D. from the University of Denver.
- 1939-47 Served on the Advisory Board of the John Simon Guggenheim Memorial Foundation.
- 1942-46 Served on the Board of Directors of the Children's Hospital, Denver, and as vice-president for three years.
- 1944 Chairman of the "Sabin Committee" of the Governor of Colorado's Post-War Planning Committee.
- 1944-47 Actively campaigning for the passage of six public health bills proposed by her.
- 1945 Received the Trudeau Medal of the National Tuberculosis Association.
- 1947 Received the Jane Addams Medal for distinguished service by an American woman.

- The Colorado Legislature passed four of the six bills for which she had been campaigning. These became popularly known as the "Sabin bills."
- Degree of Sc.D. from the Colorado State College of Education.
Medal for Achievement from the University of Colorado.
- 1947-51 Appointed Chairman of an Interim Board of Health and Hospitals of Denver, and later, Manager of the Denver Department of Health and Welfare.
- 1948 The American Woman's Association Medal for eminent achievement in the year 1947.
President of the Western Branch of the American Public Health Association.
- 1950 Degree of Sc.D. from the Woman's Medical College of Pennsylvania.
1951 Chairman of the reorganized Board of Health and Hospitals in Denver.
Received the Lasker award of the American Public Health Association, for outstanding achievements in the field of public health administration.
December 1, at an official celebration of her 80th birthday, the University of Colorado dedicated the Florence Rena Sabin Building for Research in Cellular Biology.
- 1952 The Sabin Award in Public Health established.
1953 Distinguished Service Award from the University of Colorado.
Died on October 3.
- Posthumously
A new school in Denver, the Sabin Public School, named for Florence Sabin and her sister Mary.
A bronze bas-relief of Dr. Sabin placed in the Denver General Hospital.
- 1957 Dr. Sabin depicted among seventeen women, "Pioneers of Progress," in a wooden sculptured panel by John Rood.
- 1959 Statue of Florence Rena Sabin, by Mrs. Joy Buba of New York, placed in National Statuary Hall at Washington, and formally presented by the State of Colorado to the United States of America on February 26, 1959. Replica of the statue to be placed in the new Colorado State Health Department Building in Denver.
A biography of Dr. Sabin, by Elinor Bluemel, published by the University of Colorado Press, Boulder, Colorado.

KEY TO ABBREVIATIONS

- Am. Assn. Adv. Sci.=Symposium Series of Publications of the American Association for the Advancement of Science
 Am. J. Anat.=American Journal of Anatomy
 Am. J. Med. Sci.=American Journal of Medical Sciences
 Am. J. Pub. Health=American Journal of Public Health
 Am. Rev. Tuberc.=American Review of Tuberculosis
 Anat. Anz.=Anatomischer Anzeiger
 Anat. Rec.=Anatomical Record
 Carnegie Inst. Contrib. Embryol.=Contributions to Embryology of the Carnegie Institution of Washington, Washington, D. C.
 Ergebn. Anat. u. Entwcklungsgesch.=Ergebnisse der Anatomie und Entwicklungsgeschichte
 J. Exp. Med.=Journal of Experimental Medicine
 Johns Hopkins Hosp. Bull.=Johns Hopkins Hospital Bulletin
 Johns Hopkins Hosp. Rep.=John Hopkins Hospital Report
 Nat. Acad. Sci., Biog. Mem.=National Academy of Sciences, Biographical Memoirs
 New York Med. J.=New York Medical Journal
 Physiol. Rev.=Physiological Review
 Proc. Assn. Am. Anat.=Proceedings of the Association of American Anatomists
 Proc. Nat. Acad. Sci.=Proceedings of the National Academy of Sciences
 Proc. Soc. Exp. Biol. and Med.=Proceedings of the Society for Experimental Biology and Medicine
 Tr. ——— Annual Meeting of the Nat. Tuberc. Assn.=Transactions of the ——— Annual Meeting of the National Tuberculosis Association.
 West. Med. Rev.=Western Medical Review
 Woman's Med. J.=Woman's Medical Journal

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