

INTERVIEWEE: Irwin Fridovich
INTERVIEWER: Jessica Roseberry
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PLACE: Dr. Fridovich's Office, Nanaline Duke Building

FRIDOVICH INTERVIEW NO.1

JESSICA ROSEBERRY: This is Jessica Roseberry. I'm here with Dr. Irwin Fridovich, and he is James B. Duke Professor Emeritus of Biochemistry. It's October 10, 2007, and we're here in his office in the Nanaline Duke Building. And I want to thank you, sir, for agreeing to be interviewed today.

FRIDOVICH: It's a pleasure to help.

ROSEBERRY: We'll be talking today about Dr. Mary Bernheim, or Molly, as she was known, and I appreciate that you're sharing your reminiscences of her with us. I wonder if you might just talk about—kind of when you first arrived, if she had a reputation in the department, or—?

FRIDOVICH: Yes, she did. And I arrived in 1952, and I guess she was known most for having discovered the amine oxidase. And in fact I remember there was a proceeding of a meeting—a symposium—on that subject, and the frontispiece had a full-face photograph of Molly. So that was what she was known for. She was also known for her good teaching. And the other thing that she was doing a lot of—there used to be *Chemical Abstracts* that published abstracts of papers from many, many journals in chemistry and biochemistry. And she was writing abstracts for publication in that. And I'd often see an abstract written by M.L.C. Bernheim. (*laughs*)

ROSEBERRY: Was that fairly unusual, or—?

FRIDOVICH: Yes, she was the only faculty member here who was doing that.

ROSEBERRY: Well, I wonder if we can go back to the first thing we discussed, the enzyme that she discovered. And I know that you've worked with enzymes as well, and I wonder if you could talk about—kind of the science of that, and explain—?

FRIDOVICH: Well, you know, some neurotransmitters are amines, and those enzymes are very important in metabolizing the neurotransmitters and in limiting their action. And now it's known that there are more than one amine oxidase—monoamine oxidase A and B—and there are diamine oxidases and polyamine oxidases, but the whole class developed from the discovery that she made, that there was an amine oxidase.

ROSEBERRY: So is this a pretty important discovery, it sounds like?

FRIDOVICH: At the time I think it was, yes. And it interested many people.

ROSEBERRY: Was she recognized, then, for that discovery?

FRIDOVICH: Yes, and for her excellent teaching. She was a wonderful colleague, always approachable, answer any questions you might have, and an interesting person, too. I don't know if you realize it, she was a pilot and she was also an instructor of flying. And she wrote a book about her flying. Do you know about that?

ROSEBERRY: I've heard about it, but please—

FRIDOVICH: It's called *A Sky of My Own*, by Molly Bernheim, and in it she describes how she came to fly. And the story was that after World War II, her husband, Frederick, who was in the Pharmacology Department, decided he was going to learn to fly. And she pretty quickly realized she was going to be effectively a widow, because he was always doing that and she wasn't involved. So she decided to learn to fly, also. And she did. And then there's a story in there—I have to tell you this. This is a funny one. At one

point, they decided that they would fly across the country and back, the two of them. And of course, they had to plan very carefully what airports they'd stop on, the routes, and so on. And she says that at one point, she was flying, and Frederick was sitting beside her. And she did something stupid, some mistake that almost got them killed, but she recovered, and it was okay. And through it all, Frederick just sat there and didn't say a word, stony-faced. But when she finally landed at the little airport that they were headed for, he took her by the arm, walked her out to the end of the longest runway, and then, she says, "We spoke of many things, including divorce." (*laughs*) You should read the book, you'll enjoy it.

ROSEBERRY: Sounds like it was well written.

FRIDOVICH: Yes, it was.

ROSEBERRY: So she had many interests?

FRIDOVICH: Yes. In addition, she was very interested in botany. And I have hobbies, also, and among them are hiking and canoeing. And on my hiking or canoeing trips, I might run into an interesting-looking plant. And I would bring back a berry or a leaf or something. And I'd show it to Molly, and she'd immediately tell me what it was and where it grew and everything about it. She was amazing.

ROSEBERRY: Well, how would you characterize her if you were kind of to—?

FRIDOVICH: I'm not sure what you mean by that.

ROSEBERRY: Well, just—

FRIDOVICH: She was a lovely person, very friendly, very knowledgeable, and good hearted. During World War II, she and Frederick took into their home an English child. I don't know if you know that. London, of course, was being bombed heavily by the

Germans, and the English were trying to get the kids out of the city to safe places. And Frederick and Molly took an English child here for the duration of the war and kept in touch with that child after she returned to her own parents. So they effectively raised two kids—their own daughter and this English child. And Molly tells me that they were concerned about having enough fresh eggs for the children during the war, so they started raising chickens. (*laughs*)

ROSEBERRY: Was she a fairly private person, would you say, or—?

FRIDOVICH: Yes, but very approachable. If you had any reason to want to talk to her or ask her anything, she was available.

ROSEBERRY: Well, I know that she was on the original faculty.

FRIDOVICH: Yes, she was.

ROSEBERRY: And ended up, I think, being the last surviving member of that original faculty.

FRIDOVICH: I think that's true, too—certainly the last person who stayed here. Now, George Schwert was also a member of the original faculty. And he left here to become chairman of biochemistry in Lexington—University of Kentucky. And he died not long ago, so maybe he was the last surviving one. But he left, so he wasn't here—she was still here. And toward the end, unfortunately, she became bedridden and lost cognition, so that sometimes my wife and I would go to visit her, and I'm not sure that she knew who we were anymore. It was sort of a pity, to think of all that accumulated knowledge that was gone. That's how it goes, very often, anyway.

ROSEBERRY: I know that she was one of the few women on that original faculty, and, at times, was alone in the department, as a lone female.

FRIDOVICH: Yes.

ROSEBERRY: Was that something that was unusual, to be—?

FRIDOVICH: Well, there were very few women, either on the faculty or in the medical school classes. We would have medical school classes of about seventy-five students, and there might be one or two female students in the class. And that, of course, has changed to where more than half the class is women. But at the time it was unusual, but I don't think she felt any discrimination or odd about it. She seemed very comfortable to me.

ROSEBERRY: Well, tell me a little bit about Dr. Frederick Bernheim as well. I know that—

FRIDOVICH: He was in pharmacology, as I said. He was a much more formal type of person than she was, so not so easily approachable—but once you got to know him, he was a good fellow. (*laughs*) I liked him, too. And also he toward the end lost his memory and didn't know what was going on. Actually, he did some things that were very dangerous. They lived in a two-story house, and he would use a ladder to get up to the gutters even quite into advanced years—this huge ladder he'd climb up to clean out the gutters. And one time he had a fall there was a wound on his head, a depression in his skull where he'd fallen and actually compressed the skull itself and it never rebounded. It healed that way. Maybe that had something to do with his loss of cognition.

ROSEBERRY: Did that stop him from climbing up that ladder, or—?

FRIDOVICH: I think it did. Molly wouldn't allow it after that—probably stopped him from flying, too.

ROSEBERRY: I understand that he was also nominated for the Nobel Prize at one point, or was that—?

FRIDOVICH: I wouldn't know about that. You know, those are supposed to be secret, right? You're not supposed to know who's nominated, so I don't know.

ROSEBERRY: Okay. Did they have kind of a pretty— Was their scientific reputation—were they highly regarded scientifically?

FRIDOVICH: Yes, they both were. Frederick told me a funny story. He had wanted to do a post doc, I think it was Otto Warburg's laboratory, who was a world-renowned biochemist at that time. But he'd come from another lab, and Warburg had something against the mentor that was running the other lab. And when Frederick showed up and Warburg found out where he was coming from, he said, Get out of here.

ROSEBERRY: So he never ended up—?

FRIDOVICH: He may have, I don't know what the end of it was. But he did tell me that story. (*laughs*)

ROSEBERRY: Well, you mentioned her teaching as well. Was she—?

FRIDOVICH: Teaching graduate students and medical students, both sure. She had a normal teaching load in the department.

ROSEBERRY: So it was not unusual to have graduate students at that time, or—?

FRIDOVICH: No. The department was small at the time. I doubt that there were more than five faculty all together, plus the chairman. The chairman at that time when I came was Philip Handler. The founding chairman was named Perlzweig, and he had died perhaps from hypertension, because Molly told me that she'd watch him as they were eating lunch together and Perlzweig would salt his food until there was a crust of salt on

the food. With that much salt intake, he must have had hypertension. (*laughs*) Anyway, he passed away and then the next chairman was Phil Handler. So when I came, Phil Handler was the chairman and was a most impressive person. He left here to become president of the National Academy of Sciences. That's a post that's supposed to last six years but has a possibility of renomination or reelection for another six years, and he did serve two six-year terms. At the end of that time, we were all hoping he'd come back to Duke, an office was prepared for him. He was planning on it, but he came down with lymphoma, and in fact died before he could get back here—died in the Deaconess Hospital in Boston, as I remember.

ROSEBERRY: Was Mary Bernheim also teaching nutrition courses, or was that—?

FRIDOVICH: I think she was, and she was also teaching nursing students. That was fairly unusual, because I think she was the only biochemistry department member who was doing that.

ROSEBERRY: Were there other women who came through the department during the time—?

FRIDOVICH: As graduate students, yes. I remember one named Flodie Cobey, who was a graduate student when I got here. I think Flodie went to Tennessee, became a faculty member there. But I lost track—I don't know what she's doing now.

ROSEBERRY: So there weren't maybe as many faculty members who were female in the department?

FRIDOVICH: Well, at that time, she was the only one. But since that time we have others, of course.

ROSEBERRY: So during your time there were other women—?

FRIDOVICH: Well, my time stretches over a long period of time. And so there are now female faculty members—several—and graduate students, also. So at that time, I guess Flodie was the only female graduate student, but that's no longer the case, there's at least half the class.

ROSEBERRY: Well, you mentioned that, you know, Dr. Bernheim's discovery of this enzyme was fairly important for that time. Did the importance of that discovery fade as new things were learned about that field, or does it still influence science today?

FRIDOVICH: Well, amine oxidases are important enzymes, but once you finish discovering something and purifying it and characterizing and so on, then you move on to something else. So I wouldn't say it's a hot topic of investigation anymore, but it was important that it be found, and she did it. Do you have any other questions?

ROSEBERRY: I'm sure I do. Let me check my notes to make sure. I didn't know—I had read that she also was involved in some contributions of land for the Eno River, and I didn't know if that was common knowledge as well.

FRIDOVICH: Yes, that's true. She and Frederick had a large property along the river. In fact, she took me there one time. Since I like to hike, she took me there, and we walked around it. And then, finally, I think they donated it to the nature conservancy.

ROSEBERRY: So they owned this land originally?

FRIDOVICH: Yes, they did.

ROSEBERRY: Okay.

FRIDOVICH: But I don't know anything else about it.

ROSEBERRY: Yeah.

FRIDOVICH: I'm not sure I even remember where it was anymore. She drove, took me there, and we hiked around it, and—.

ROSEBERRY: Yeah. I bet there were a lot of unusual plants that she could study there.

FRIDOVICH: Oh yes. Maybe that's why they bought it.

ROSEBERRY: Well, what was the—when you arrived, what was the physical space of the department? What did it look like at the time?

FRIDOVICH: Oh, the department at that time was based in the Davison Building, that is, the medical school building in Duke [Hospital] South. And we were on the second floor in space now occupied by Pathology. And the space was kind of constricted. There was a large lab, because at that time the medical students took a laboratory course in biochemistry. It was part of the biochemistry course. And so there was a large lab to accommodate the medical students. Of course, that aspect of biochemical teaching disappeared when they went to the new curriculum. So when we outgrew that space, we moved to what is now the Bell Building. And the Bell Building, at that time, was much smaller than it is now. They added wings on to it, wings on wings, and then finally even that wasn't big enough and we moved to this Nanaline Duke Building, where we still are—and, as you noticed when you came in, there are all sorts of renovations going on, because it's no longer a new building. (*laughs*) And, in fact, when it was built, certain things were not required that are now required, like a sprinkler system, for example. So that all these things are now being installed, you know, modern standards are being applied. And, as you see, it's very nice.

ROSEBERRY: When did the department begin to grow in size?

FRIDOVICH: Well, in the 1950s, the NIH [National Institutes of Health] was created and grants were possible, and that money made it possible for the medical schools—not just Duke—to hire faculty, in anticipation of the fact that they would get grants and there'd be overhead from the grants coming to the school and some of the salary of those faculty could be paid from the grants, that sort of thing. So that led to quite an increase in the size of all departments in all medical schools in the U.S.

ROSEBERRY: So was the NIH fairly—were they giving out many grants during that time?

FRIDOVICH: I don't know about the total numbers, but I was on a study section about thirty years ago, and I know that the percentage of the applicants who were funded was about at least three times what it is now. Now it's something like 10 percent, then it was 35 percent. I recall that very clearly. So it's tough now, (*laughs*) yes.

ROSEBERRY: Tougher than it was then, it sounds like. So was Dr. Bernheim, Mary Bernheim, continuing to work on the enzymes throughout her career, do you know?

FRIDOVICH: I think by the time I got here in '52, she wasn't that actively engaged in research anymore; most of her time was given to teaching, to abstracting for *Chem Abstract*, that sort of thing.

ROSEBERRY: Tell me a little bit more about that. I know you mentioned that when we first began our—

FRIDOVICH: You mean *Chem Abstracts*? Oh, well, now, of course, you can get all this online, so it's no longer necessary, but this was a service that published abstracts, very short paragraphs, presenting the nuggets—the key findings of thousands of papers that were being published in many dozens of journals. And they needed knowledgeable

people to read the papers and then write those abstracts, which were then published in what was called *Chem Abstracts*. And *Chem Abstracts* got thicker and thicker until (*laughs*) it got to the point where if you dropped a volume on your foot, you'd break your foot. (*laughs*) And she was doing that abstracting.

ROSEBERRY: So that sounds like it could be a pretty time-intensive job.

FRIDOVICH: Oh, yes. And I guess she liked to do it. I guess it gave her a reason to be reading many papers that she otherwise might not read so carefully, right? It's like, if you have to teach something, you have to really know it. And if you're going to write an abstract, you have to really read carefully and understand what you read. So maybe that's why she did it.

ROSEBERRY: Are there any memories of her that maybe stand out to you that, you know, if someone wanted to write a biography about her, or if someone wanted to just, for historical purposes think about Mary Bernheim, is there anything that stands out to you that might be important to share?

FRIDOVICH: Well, there were so many facets to her, as I mentioned: the flying, the botany, the teaching, the research. I wouldn't latch on to any one of them. They were all a part of Mary—Molly, actually. I don't know why the name Molly was always used. I never heard her called Mary. I didn't even know (*laughs*) her first name was Mary. I always thought it was Molly.

ROSEBERRY: That's interesting.

FRIDOVICH: I don't know when that started.

ROSEBERRY: So, Mary—you didn't know it was Mary until—?

FRIDOVICH: Until I saw it in the book, (*laughs*) *A Sky of My Own*.

ROSEBERRY: Oh, how interesting. How interesting. Okay.

FRIDOVICH: And, of course, as soon as I found out about the book, I had to get it, because here's a colleague, wrote a book about flying and I didn't know about it, so I got it and read it, enjoyed it very much.

ROSEBERRY: Did you know that she was an aviator?

FRIDOVICH: Yes, I knew that. In fact, she took me up. There was a small airfield near Chapel Hill where she kept her airplane, and one day she asked me if I'd like to try going up with her. I said sure. So we went up and we flew around, (*laughs*) and she let me take the controls for a while and then told me that the whole time I'd had the controls, I'd been climbing, (*laughs*) gradually.

ROSEBERRY: Going up into the sky—

FRIDOVICH: I thought I was flying level, but she said most beginners are so afraid of crashing—going down—that they're going up all the time. (*laughs*) That's what I did.

ROSEBERRY: So it sounds like she was pretty willing to share her hobbies with others.

FRIDOVICH: Oh, yes. Anyway, you want to find out about Molly, read the *Sky of My Own*.

ROSEBERRY: Read the book, mm-hmm. Well, are there—let me also ask—the department, it sounds like, was fairly small, even—and when you first arrived it was—?

FRIDOVICH: Yes, it was a few faculty and small number of graduate students. That was the situation.

ROSEBERRY: I've heard that there—that—you know, some people that I talk to say during that time there was almost this kind of family feeling.

FRIDOVICH: Yes. Of course, the space that we occupied wasn't air conditioned, so that was another thing. So we suffered together, and in the summertime you can imagine what it was like, because not only was it hot outside and humid and hot inside, but we were using things that generated heat—Bunsen burners, autoclaves. I mean, it was incredible. *(laughs)*

ROSEBERRY: That sounds pretty grueling, in the South, especially.

FRIDOVICH: Well, that's the way it was, you know. So you got used to it. You didn't like it, but you got used to it.

ROSEBERRY: Was anyone sharing laboratory space or office space?

FRIDOVICH: Well, there was an office that was the chairman's office, but it had a rather large side office. And in it were several secretaries who provided secretarial help, not only to the chairman, but also provided bookkeeping and secretarial help to all the members of the department. Nobody had their own secretary. So if you needed some typing—a manuscript—you wrote it out longhand, and you could turn it into one of those secretaries to be typed. And if you had a grant and someone had to keep track of expenditures and balances and so on, there was a bookkeeper in that office who did it for everybody in the department. So in that sense, we were all dependent upon the same resources, and in a sense competing for the same resources.

ROSEBERRY: But the space was not necessarily—?

FRIDOVICH: Each faculty member had their own space. So I recall, for example, the chairman, Phil Handler, had a rather large lab, and there were several post docs and graduate students—sharing that lab. But it was big enough that each person had their own bench. There was equipment that was shared. For example, I remember that there

was only one reasonably modern spectrophotometer—ultraviolet visible spectrophotometer—Beckman DU, and we all shared it. But that's the way it was. You know, if you didn't have money to buy one, you had to use what was available. And, of course, the humidity presented the big problem in those days, because the DU had a resistor in it. It was, I think, 10-megohm, high resistance, so that a thin film of moisture over the surface would conduct more than it was rated, right? And that, (*laughs*) of course, spoiled everything. So it had a drawer that you could pull out with Dryerite in it, a drying agent to keep the inside of this box at low humidity. Trouble was, you had to turn it over to get to it, because it was on the bottom. And when you turned it over, you had to be very careful not to set it down on the knobs, or you would (*laughs*) destroy it. So you'd carefully place big rubber stoppers, then turn this heavy thing over and set it down on the rubber stoppers. In the height of the summer when it was really humid, the Dryerite that would last about two days, and it would start acting erratically again, and you had to replace it again. (*laughs*)

ROSEBERRY: A lot of preparation.

FRIDOVICH: Yes.

ROSEBERRY: Do you have any sense of what those kinds of conditions might have been like during the time when Dr. Bernheim first arrived, maybe, you know, in the decade or so before you arrived, or—?

FRIDOVICH: Oh, I'm sure they didn't even have the Beckman DU—that was a new spectrophotometer. They had Colemans, Kletts, comparators—visual comparators—much simpler instruments. But you know, they didn't allow you to select a wavelength, for example, by turning a dial. You'd put in a filter, a different color filter—if you wanted

to isolate some part of the spectrum. Whereas the modern instruments, if you want 340 nanometers, you turn the dial to 340, and that's what you got, pretty much.

ROSEBERRY: So you had to specifically filter for that particular—?

FRIDOVICH: Yes. I mean, there'd be a light source—a bulb, an incandescent bulb—and it's putting out all wavelengths, right. And between that and your sample, there was a slot to drop in a glass filter: green, blue, red, whatever. And you'd use the appropriate filter, depending upon what assay you were doing.

ROSEBERRY: So that's maybe what she would have done when she—?

FRIDOVICH: Oh, certainly, yes. Surely, because that was the only thing available in—the decade before I arrived, that was what was available. There was even an instrument called a comparator, which (*laughs*)—it was really clever, but very simple. There were two quartz rods. And they could be moved. And when you looked through the eyepiece, you saw a split field. One half of this field was the light coming through one quartz rod. The other half of the field was the light coming through the other quartz rod. (*unknown man enters and speaks*) Okay. (*unknown man leaves*) And one quartz rod was in the standard solution. And the other one was in the unknown. And you'd move it until the line between them disappeared. You matched them perfectly. And then from the height of the liquid (*laughs*) that they were in, you could calculate the concentration of the unknown from that of the standard. That's what was available, that's what we used. I remember using that, too, because it was still around, you know. For some things it was okay.

ROSEBERRY: I know she was first beginning her investigative work maybe in—I think in the twenties or something like that. That must have been—

FRIDOVICH: Way before my time—

ROSEBERRY: —been very primitive, I'm sure.

FRIDOVICH: Yes.

ROSEBERRY: Yeah. Well—

FRIDOVICH: Before I was born. (*laughs*)

ROSEBERRY: I think it was—I don't have it written down, but I think she discovered that enzyme in '24, I think, and then came to Duke, obviously, in the thirties. Different times, obviously, yeah. Well, are there any other women, as you kind of look at—you know, women that might need to be mentioned for historical purposes—of that early time, that you think about, that—?

FRIDOVICH: Not in this department. In the Department of Medicine, there surely were—I'm blocking on her name. There's a woman physician who's still around; I see her sometimes in the hall. And she specialized in genetic diseases of children—chronic granulomatous disease, that was a specialty of hers. And why I'm blocking on her name is because I'm getting old. I know her very well, and her husband, too, but I can't remember her name now. Her kids went to school with my kids. I should, you know. Anyway, possibly if you showed me pictures of the faculty of the medical school, I could pick her out in an instant. Her name now comes to mind—it is Rebecca Buckley.

ROSEBERRY: So that's someone to—?

FRIDOVICH: Anyway, she did a lot of good work in that field, this chronic granulomatous disease. It's an inborn disease, a genetic disease—fortunately, not very common. Because it causes an inability to fight infection. So in the days before antibiotics, people that had this would suffer one massive infection after another by

common organisms that you and I encounter a thousand times a day and have no problem with, and it would finally kill these kids. And what it was due to was that the phagocytic cells—leukocytes—that normally gobble up infectious organisms were not able to kill the infectious organisms—so that they could grow. You were a rich medium for them to grow in, and you had no defense.

ROSEBERRY: Are there any others that come to mind?

FRIDOVICH: She's the only one that comes to mind, because I knew her very well.

ROSEBERRY: Okay.

FRIDOVICH: I'm sure there are others, but I don't know.

ROSEBERRY: Sure, of course. I wanted to go back—when we were talking about Dr. Bernheim and she was—when you first arrived, and she was being recognized for the work that she had done originally.

FRIDOVICH: Yes. Because other people then got interested and worked on it. There were symposia. She was invited as a speaker and honored as, you know, the person who discovered the area, and her photograph was on the frontispiece of the proceeding volume that was published.

ROSEBERRY: So was she—how did she respond to that attention?

FRIDOVICH: I would say she was extremely modest. You'd never hear any of that from her. And if you didn't find it out from someone else, you wouldn't know.

ROSEBERRY: So was that national attention?

FRIDOVICH: Yes, at the time, sure.

ROSEBERRY: So maybe that would be the fifties and sixties, maybe, when that—?

FRIDOVICH: Forties, fifties, yes, right. Not much beyond that.

ROSEBERRY: Well, is there anything that I have not asked you today that I should have asked?

FRIDOVICH: I'm sure, but I can't (*laughs*) think of it. And if you need to come back, you feel free to call and make an appointment.

ROSEBERRY: Okay.

FRIDOVICH: Okay?

ROSEBERRY: Thank you so much. I appreciate it.

FRIDOVICH: My pleasure.

ROSEBERRY: I've enjoyed talking with you today.

(end of interview)