Daniel Koshland, Jr. Retrospective Oral History Project:

Douglas Koshland

Interviews conducted by
Sally Smith Hughes
in 2012

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It is recommended that this oral history be cited as follows:

Douglas Koshland is Professor of Genetics, Genomics and Development in Berkeley’s Department of Molecular and Cell Biology, his father’s former department. He is able as a scientist and Dan’s younger son to discuss what Dr. Koshland considered his greatest scientific contribution, his research on induced fit, a theory, now generally accepted, of enzyme-substrate interaction. As a board member of the Marian E. Koshland Science Museum in Washington D.C., Doug speaks about the museum’s mission, accomplishments, and problems. He also mentions his father’s last scientific projects, on bacteria as a fuel source.
Dan Koshland’s idea of induced fit changed the understanding of protein — Nobel Prize winner Jacques Monod’s similar work — delay of Koshland’s induced fit paper may have cost him the Nobel Prize — positive and negative cooperativity — systems biology — Koshland’s use of math — chemotaxis — work with Julius Adler and Sandy Parkinson — Koshland’s work at Brookhaven National Laboratory may have contributed to lesser-known status than scientists from elite universities — receiving the Presidential National Medal of Science — focus on process and results rather than recognition — being a scientist in a family full of scientists — the Mariam Koshland Science Museum in Washington, D.C. — Dan Koshland and Bruce Albert conceptualizing the museum, working harmoniously with other advisors — firing and rehiring Patricia Legro as director — Dan’s attention to the health of an organization — decision to charge a small entrance fee — choosing a location for the museum — the problem of low attendance — applying concepts from the Exploratorium — the importance of interactive experiences on learning — assessment — designing a museum for adults rather than children — competition from the internet — distraction as the enemy of learning — Dan’s late life work on methane bacteria, applying expertise to new problems: climate change — philanthropy — the importance of being involved — family tradition of philanthropy — the importance of fun — philanthropic loyalty to University of California, Berkeley, and to Israel
Introduction by Sally Smith Hughes

The Daniel E. Koshland, Jr. Oral History Retrospective documents the scientific, philanthropic, and academic service activities of a scientist with deep and broad ties to the University of California, Berkeley and the wider scientific and philanthropic communities. The videotaped interviews with family members, scientific colleagues, and university personnel focus on the last years of his life, before his death in 2007. They provide perspectives on his diverse activities, his personality traits, and help to bring up-to-date the lengthy oral history with Dr. Koshland himself, which concluded in 1999.

This project, conceived and generously supported by his widow Yvonne Koshland, highlights the years 1999-2007 but also includes flashbacks to Dr. Koshland’s earlier activities. The Retrospective thus constitutes an amplification and extension of the earlier oral history but also stands as an unabashed tribute to a man whom the interviewees held in high esteem.

The Retrospective consists of interviews with seven individuals, amounting to roughly twenty hours of recordings, conducted in 2011-2012. Yvonne Koshland, in consultation with the interviewer, suggested the individuals to be interviewed, basing her choices on the unique perspectives on Dr. Koshland that each would present. All the interviews were videotaped, except for those with Mrs. Koshland, which, at her request, were only audiotaped.

Interviewees included:

Bruce Alberts  
Jenny Cutting  
Catherine Preston Koshland  
Douglas Koshland  
Yvonne Cyr Koshland  
Randy Schekman  
Robert Tjian

Project Staff included:

Project consultant: Yvonne Koshland  
Project director and interviewer: Sally Smith Hughes  
Videographers: Julie Allen, Travis Thompson  
Project Support: David Dunham

Sally Smith Hughes  
Berkeley, CA, 2014
It’s July 24, 2012, and we are in a Bancroft Library conference room talking to Doug Koshland. It’s part of a series of interviews on the last eight years of Dan Koshland’s life, Doug’s father. Doug, let’s start with your take on induced fit. Would you agree that it perhaps was Dan’s greatest scientific contribution?

Yes. To put it in a historical perspective, proteins facilitate chemical reactions. Before induced fit came along the simple idea was that a protein was just a very rigid structure that basically was a lock and key. The chemical it wanted to modify would fit into the keyhole and then that would somehow promote its change to be processed, however it was going to be processed. What my father really discovered was that proteins were flexible and that they changed their shape. So upon binding of a chemical to the protein it would change itself and fit like a glove and that change in its structure allowed it to do the chemical reactions much more efficiently than it could if it was just stuck in a rigid shape. That’s the idea of induced fit.

That concept that proteins change conformation is rampant throughout all biology as an important regulatory thing. Ten/fifteen years later [Jacques] Monod got the Nobel Prize for the idea that you could regulate the change in shape of proteins, to change when they were going to do their chemical reaction and when they weren’t going to do the chemical reaction. The classic example is oxygen binding to hemoglobin in your blood. And you couldn’t have made that model if you didn’t know proteins changed shape. The only way you can say that you can use change in shape to regulate something is to know that the change in shape happens. So that was really important. In fact, he actually submitted a paper at exactly the same time as Monod saying that you could regulate protein. The change in shape of protein is a way you could actually regulate how the protein functions. But his publication was delayed for a couple of years in the review process, and it’s not absolutely—

A couple of years?

About a year, which was much longer in part because he proposed a much more complicated mechanism. He basically proposed that the change in shape could not only work to make the protein bind the chemical better—what he called positive cooperativity—but sometimes you could have the change in shape make a chemical bind less well, and that was called negative cooperativity. And many people didn’t like that. In fact, there was no data for the negative cooperativity. There’s lots of evidence that you could change shape and make the protein bind better, but not the other one. I think that was
part of the reason his paper got delayed. But then twenty-five years later, as he pointed out, once we studied many more proteins it turns out that negative cooperativity is far more prevalent than positive cooperativity.

In the end my father’s theory, which came out at the same time as Monod’s, for which Monod won the Nobel Prize, was vindicated twenty-five years later as being really the more general one. So I think induced fit and protein changing, the idea of cooperativity, both positive and negative, that really was the body of literature for which he was most famous. But I think he actually made quite a few other contributions, some of them coming to light today.

I’ll give you one other example, which is current right now, something called systems biology. The way most of biology has been studied over the last hundred years is that you study the individual parts, and once you know the individual parts you can figure out how the process happens. So you understand each step in a manufacturing process, then by the end you can understand how a piece of clothing is made. But there are some cases where that doesn’t quite work, because when you put two things together you don’t get the obvious outcome; you get something which is more or larger or bigger or better. For example, consciousness. Neuron A fires, neuron B fires, somehow that doesn’t explain how I can visualize you and have this conversation. So that’s been a big thing. People are beginning to do math to try to understand how you can integrate multiple things and get something out different from the individual parts.

My father did this in—I don’t know—1970 or ‘75, studying how a cascade of enzymes that convert glucose to energy are regulated by their modification. He understood all the chemical reactions of the modifications from that and did the math on it and figured how the modification of the enzymes in the context of a cascade had a much bigger effect on their regulation than their modification when then were isolated from each other.

Hughes: Did he start out with the idea that he hoped to arrive at a more general proposition, namely the systems idea?

Koshland, D.: Well, he was a semi-pro mathematician, and so he really liked using mathematics. There was something he understood about the glucose pathway that was not linear, and he believed that the math could explain things you didn’t know. Many people now in systems biology have discovered this work and said, “Wow! This guy was really ahead of his time.” So that’s an example, I think, of a pretty profound contribution. If you ask people, “Who’s Dan Koshland?” they’ll say induced fit. [laughing] That always is what comes out in the end.

Hughes: What about Dan’s research on chemotaxis?
Yes, that was a huge deal. I think he made a tremendous contribution in chemotaxis. But he did have two or three colleagues who made contributions. Julius Adler was one, Sandy Parkinson; there’s a number of people who also contributed to the idea of what we understand about chemotaxis. The idea is how does a cell or an organism sense any kind of molecule and say, I know there’s something out there, and I’ve got to transmit this information to the inside of the cell to do something. Chemotaxis happens to be the way bacteria do that, to swim towards food. We do that when we smell something. They used bacteria because it was much simpler to understand how the bacteria could sense that there was food in the environment and transmit the information inside the cell and, say, change your flagella so you swim in a certain direction towards the food. I think he made very big contributions there, but probably because there was a group of contributors, that research doesn’t quite stand out as much as induced fit [where] he was all by himself. There was nobody else even thinking that way at the time.

Well, all by himself and relatively early in his career when he was still at Brookhaven [National Laboratory]. I wonder if, aside from the delay in publishing the paper, the fact that Dan was a relative unknown and was not from one of the prestigious institutions deterred recognition of his contribution.

Absolutely.

And he was competing with Monod, a huge name in science.

Absolutely, no, I think you’re 100 percent. My father always talked about it. He moved to Berkeley [1965], and one year after he got to Berkeley, he got into the National Academy! So the work he had done had been around for ten years, right? [laughing] But you come to Berkeley, you’re at a prestigious place, and all of a sudden you and your research get picked up, and it’s a big deal. His being an unknown from Brookhaven, which didn’t have the prestige of Harvard or Oxford or Cambridge, probably made a big difference in terms of recognition.

Did he have any regrets?

No, none, I think absolutely not. I was with him when he won the Presidential National Medal of Science. You go to the White House and the president gives you this thing. The family was all there, as well as about 150 people, all family members of the people who had discovered many important things. The guy [Wilson Greatbatch] who invented the pacemaker was there and all
these other people. Half [the awardees] were scientists, half were engineers. They had the president’s science advisor shake the scientists’ hands and the secretary of commerce read the actual prize descriptions. And somebody goofed. First of all, scientists have strange names. Koshland was probably one of the least strange. [laughter] And then they had words in the descriptions that are not in most people’s vocabulary. Nobody had coached this guy, and he mispronounced almost everybody’s name. For example, he had never seen the word ‘enzyme’ before, and so he said ‘exons’, which is sort of odd because it’s a biological word. He said, “And Dan Koshland for his pioneering work on exons.” He couldn’t read very well. My kids used to rip the book away from me because I couldn’t read very well, and you basically wanted to rip the guy’s script away, plus he paused at all the wrong places. It got so farcical that by the fifteenth award which was for somebody named Smith, and he said the name Smith right, the whole 150 people burst into applause! It’s like when an umpire gets it right at a baseball game and the crowd cheers because he got the call right.

We were walking out with my father and discussing, what is an award? I mean really, what does it mean? You’re getting this thing that seems to be very prestigious. The president of the United States is giving it to you, and he’s not giving it to very many people. My father just walked out and kind of laughed, he said, “You know, the great thing about these things is thinking back about all the wonderful people and the experiences and the process of getting to where you got.” That was what he focused on. He never focused on whether he got the accolades. In fact, Randy Schekman, a professor here at Berkeley, quotes him as saying—when my father did all his political manipulations here—if you don’t care about getting the credit, you can get a lot done. And I think he never really cared about the credit. It was the process that was a lot of fun.

Hughes: We’ll leave science in a minute, but I do want to hear how it was for you as a scientist, along with your twin sister [Gail Koshland], to be the son and daughter of these two eminent scientists. Was it intimidating or encouraging?

Koshland, D.: There are two things that made it not too intimidating. My sister may have had more issues than I did because I was a geneticist which is much closer to what he was doing. Certainly all the senior faculty at MIT where I was a graduate student knew exactly who he was. But his name didn’t come up in all the genetics papers we were reading. I wasn’t confronted with it on a daily basis, let’s put it that way. He was one of the truly exceptional people. My wife, Mary Porter, was reading Doris Kearns Goodwin’s book about FDR, both Eleanor and Franklin, and she just turned to me and she says, “Franklin Roosevelt is your father.” My father made decisions; he didn’t have regrets. He could say, “Well, I screwed up. I’m over it now. I’m going to move on right now.” He was just an amazing father, amazing scientist, amazing
husband. So why not hang around with somebody like that? I never felt like it was a negative. What’s the option? I could have a father who’s a criminal, you know, and not want to hang around with him, or I could hang around with this guy who was a pretty amazing, fun guy to be around! [laughing] Most people actually were pretty good about not confronting us about that.

I’ll tell you a very funny story that just happened two weeks ago. My sister Phlyp is a sculptor, and she just installed a couple of pieces at the Howard Hughes Medical Institute headquarters. She also has a piece at Janelia Farm. I was arriving at Janelia Farm for a science meeting. I was registering, and somebody said to me, “Koshland, are you related to the sculptor?” [laughter] I laughed and I said, yes! I quickly told my sister this was the first time that had ever happened! I always get, “Are you related to Dan Koshland?”

So I then left that meeting and went right to a cancer meeting that was in Washington, DC. There’s a scientist, and he says, “Koshland.” [laughing] And then, of course, “Are you related to Dan Koshland.” I said, “Yes.” And he goes, “Your father hit my prize BMW in the UCSF parking lot.” [laughter] So most of the time it was about are you related to Dan Koshland, a great scientist, blah, blah, blah. But occasionally you have these fun twists on things.

Hughes: We could talk all day about his and your science, but we’ve got to move on. Let’s talk about the [Marian Koshland] Science Museum. Did you talk to Dan about the conceptual basis for the museum?

Koshland, D.: Yes. He got the idea to start the museum, I think, from Bruce Alberts. He wanted to do something for the National Academy, and he thought a museum would be a good idea. He and my mother [Marian E. Koshland] had already been doing a lot with the Exploratorium in San Francisco. So he decided to start the science museum, and they got together a board. I think they decided to have me be part of the board in case he died. So I was really the fly on the wall. The board consisted of prominent scientists who had had lots of experience both with education and science. Maxine Singer, who was president of the Carnegie Institution, was just the kind of people you had. Just fantastic people.

Hughes: These were people that Dan had pulled in?

Koshland, D.: Pulled in to help him. Most of them were probably members of the National Academy, but also other people he thought had expertise. So I was just kind of the fly on the wall that sat through these meetings when the museum was

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1 See Alberts’ oral history in this series.
actually being designed. I think just to have me be there and also in case something were to happen to this man who at that time was seventy-eight years old or something.

Of course I did talk to Dan about the museum, and it was fun to see it evolve. I think also it revealed some of his attributes and—maybe some people would argue—deficits. [laughing].

Hughes: What are you thinking about when you say attributes?

Koshland, D.: He and Bruce had an idea initially that they were going to tell how really basic observations in science subsequently transformed our lives in ways we never imagined. One example was understanding the fundamental principle that white light consisted of colored light of different wavelengths, and this is where he was a scholar and I wasn’t. I don’t remember the name of the scientist, but it was the guy that discovered you could take white light and shine it through a prism and break it up into all the colors. You could describe that mathematically with wavelength.

Hughes: Wasn’t that Isaac Newton?

Koshland, D.: It might have been. Anyway like the wavelength of light, Bruce and he thought the museum should rotate exhibits, highlighting scientists who had made basic discoveries that transformed our lives. I remember they came up with six names. I was at one of these meetings, and Maxine Singer raised her hand and said, “You know, Dan, you have six scientists. Not a single one is American. [laughter] But it just might be a good idea, if you open this museum in Washington D. C., to have one be an American.”

Then they hired a consulting firm to help them shape the idea of what the museum was going to be. I may be wrong, but it was my impression that the consultants were the ones who came in and said, “There are a lot of museums out there taking really basic research and showing how it changes our lives. But what makes the National Academy unique is that it is a live, current organization where the national government every year asks the Academy to look into, for example, do cell phones cause brain tumors? And they write reports on that. So why don’t you take advantage of these 450 reports a year on really current stuff and present the complicated issues of current science and how it deals with society in the museum?” One of the attributes of my father was he recognized it was a better idea right off the bat. I think everybody in the room went, wow, that’s a really good idea.

My parents would never talk science when we were at home at dinner. Never. We talked about baseball, we talked about football, anything but science. I
never actually saw my mom lecture, and I think I saw my dad give one lecture six years before he died. I just never went to his scientific lectures. So I really hadn’t seen him in a professional setting. So he’s in this room with, I don’t know, forty-five other people, a big conference room, running this think tank about what the museum was going to be. He was really sweet, which was something that was a little striking to me. “Maxine, that’s such a good idea,” and blah, blah, blah. “Yes, we’ll have to think about that. Yes, John, this is a really good idea.” Our family Talmudic discussions about the Vietnamese War were much more animated and a little less friendly. So I thought oh, this is all very interesting. Somebody had told me that he ran things with an iron fist in a velvet glove. So this was the velvet glove going on. He clearly was very acknowledging of people’s ideas, and didn’t embarrass anybody in public, and cagily would move the conversation back to the topic.

My father was also a doer. So the board liked the concept of building exhibits based upon the Academy’s reports, and the consultant was supposed to design and build a few exhibits based on a few reports. After about four months, my father fired the consultant. He said the guy was just burning through money, rather than actually taking the idea and creating an exhibit. The consultant was an ideas guy and not a doer. There was a big stink because Bruce Alberts and Patrice Legro did not really think it was quite warranted; maybe they should give the consultant some more time. My dad was just saying, “No, we gave this guy a lot of time. I can’t see what he’s doing with all this money. We’ll fire him.” And in the process they fired Patrice also. And then about four months later they decided, well, maybe that was a mistake. The consultant had to go, but they made a big mistake firing Patrice. And so she came back on, and she’s been the director ever since. Patrice is one person from whom you might get a slightly different view of my father. [laughter] But I think the episode reflects: one, my father recognized an idea was better than his; two, he was a doer; and three, he had the courage to fire someone. Everybody has this awful pit in the stomach when you have to tell somebody, “I’m sorry, I think this is not going to work out.” But he had the courage to do it, right?

01-00:25:08 Hughes: When he became chief editor of Science he got rid of some people.

01-00:25:14 Koshland, D.: Yes.

01-00:25:18 Hughes: In the end you’ve got to consider the organization.

01-00:25:21 Koshland, D.: Yes, you do, and the long term. I’ve discovered in my own science there’s a morale issue. If you have a bunch of people you want to be working very hard, and you get that kind of team spirit, and there’s somebody who’s not carrying their weight, the other people notice. I’ve had my students, postdocs, come to me and say, “Why are you letting this person stay?” A lot of times
people need somebody to tell them to move on in their life. I think my father understood that too, that sometimes it’s good to say, “You’re not very good at this. Find something else.”

My father strongly believed that the museum should charge some minimal entrance fee rather than being free. He said that if somebody comes to something for free, somehow you’re not expecting very much, and you think, well, that’s a free museum, it can’t have really good stuff. Should you pay a little bit of money, then people tend to respect and like it a little more. Somehow it makes them feel like they’re getting something.

01-00:27:24
Hughes: Did he win that debate?

01-00:27:26
Koshland, D.: He did, as I remember, yes. It costs a little bit of money to get in there, at least that’s my memory. I’ve been there a couple of times and it’s not very much.

Initially the museum was going to be part of the National Academy building which is on the mall. That turned out to be a big problem because doing anything on the mall has to be approved architecturally by a bigger Washington, DC committee. The issue was, where could you get the largest attendance?

Right outside the National Academy building on the mall is the Einstein statue. One of the most popular things to do on the mall is to come and sit on Einstein’s lap. People put their child on Einstein’s lap, and they take pictures. All the tourist buses come in huge numbers, and they first come to the Einstein statue, and then they go over to Lincoln Memorial which is across the street. So the idea was that if you had the museum there it would be a good place. People could walk by it and see it, right? But it was going to take forever to get the architectural go-ahead, and whether you’d even get it was not even clear. So when the National Academy bought a second building on Fifth or Sixth Street, wherever it is, they decided that the museum would be better there.

What all small museums are facing in the United States is getting people to come. Many of the concepts that are in museums can be done through an Internet-based system, a virtual experience, rather than having to actually be in the museum. It would be interesting to know what my father would think today. I think he was still a believer that people like real experience versus virtual experience. But the museum just isn’t getting enough people coming through it to probably survive long-term that way.

01-00:29:35
Hughes: Oh, you think so?
Koshland, D.: Yes. They’re drawing a large audience of students, high school students and those kinds of folks, but the problem of Washington is there are so many other museums.

Hughes: Yes, there’s a huge competition, isn’t there?

Koshland, D.: Huge competition.

Hughes: I remember Dan saying that he really wanted the exhibits to be interactive. That immediately says to me “Exploratorium”. Do you think that he superimposed some of his experience with the Exploratorium on his own museum?

Koshland, D.: Yes, sure, I agree. Absolutely. Certainly, he really liked the interactiveness of the Exploratorium. There’s this issue still today of conveying facts of science rather than conveying the process. And the excitement comes for us scientists from the process not the facts.

So many advanced science programs in middle schools start with the idea of let people experiment, let them be interactive. And then they end up with teaching them here are Newton’s Laws, this is this, if you do this, blah, blah, blah. I think the problem is, it seems inefficient when you’re teaching science by just letting people discover and explore. But in the end, I think that a didactic approach is a big mistake, and I think he thought so too, because it just makes learning science so dry and boring.

In the DNA component of the exhibit in the Koshland Museum, there was a list of a thousand sequences from viruses that affect humans. There are a thousand different isolates of HIV, and one of them had had a mutation in it that changed it to be a much more virulent virus that would hurt you much worse. You could scan through these sequences. You could roll them through, like on a computer screen, one after another. Part of the exhibit was just to see that there were all these sequences. But there was a student there, I think she was even a minority student, who was just determined that she was going to find the change in the DNA sequence. She was scrolling through all the thousands of them, one by one, looking at them. And the point was in part that the computer could do that very quickly. It could scan and find the difference. She knew that, but she wanted to look at all these sequences and explore and look for the difference. I think that was exactly the kind of engagement my father wanted to see. Whether you can capture that virtually or not, I don’t know.

Hughes: Are there processes for assessing how exhibits are working?
Koshland, D.: Yes. I don’t remember now to be honest; it’s been six or seven years since I’ve been in the museum. There were little ways of checking off how well you did stuff and assessing how well you did relative to everybody else, just for your amusement. If you took the test, they wanted to show that you then became a sample in a larger population study, and then would show you how you became part of that population study and whether it meant something or not. Were you an outlier or were you in the major curve? So there was that component. There was also, I think, a component in which the person could see how much they had learned having gone through the whole thing. The museum itself wanted to know how well people were learning, to discern whether the exhibits were good or not.

One of the decisions they initially made—which was a little different from the Exploratorium—was they wanted to attract upper teenager to thirties and fifties age groups. The museum was not meant for little kids, so it’s going to be a more sophisticated content. If you’re talking about eighteen- to fifty-year-olds, what’s the baseline for what you look for? The depressing and/or maybe interesting fact is that most people have a science education at about eighth grade. Even if they had science in high school, that knowledge has been lost. So when you’re going to design a museum for eighteen- to twenty-five-year-olds, you’re actually designing it for thirteen-year-olds, because that’s basically what their science knowledge is.

I think had the museum been done sixty years ago it would be a tremendous success. It’s just faced now with the Internet world and the changes in how people view museums, what they do in them, and their time and everything else.

Hughes: You’re a professor at a major university. How do you feel about so many things being virtual? What is gained, what is lost?

Koshland, D.: Let’s take lectures as a really good example. If you have one great teacher each semester, that’s great. Great teachers are like great artists. Lots of people are good or reasonably good at teaching organic chemistry. But there are occasionally some people that are just spectacular. I had a professor at Haverford, he was just hilarious! It’s hard to believe that somebody could be funny, incredibly rigorous, incredibly hard, and he taught organic chemistry. My father, I understand, was really good at teaching the introduction to biochemistry. So you could videotape that, like we’re doing here, and you could put it on the Internet, and people in China and everywhere else could hear Dan Koshland teaching biochemistry. Whole schools of people are taking advantage of the great classes at MIT. So that’s a plus side to it all.

The negative side I find is that the human brain hasn’t changed. It has taken us hundreds of thousands of years to be where we are today, and we’re not going
to change in two years or five years to have a new brain. We’ve learned that if you really want to learn something, you have to get away from distraction. You can’t multitask and learn something relatively deep. Many of the students here think well, I’ll miss the lecture, and I’ll just listen to a recording of it in my dorm room. But there’s something about being forty-five minutes in a room where you can’t get to your computer, you can’t get to your cell phone, you can’t do anything else, and you’re forced to concentrate. If you’re daydreaming in a lecture room and you’re stuck there, within a minute or five seconds you’re back on target. You can’t go off target very long because there’s nothing else there, right?

My children who did very well in college learned that if you’re really going to study for a test, you bury yourself in the bottom of the stacks and you just get away from distractions, right? I think that’s the disadvantage of the virtual world. Some people listen to the lectures, and they’ve got the radio going, and they think they’re learning, but it’s not the same as being in a quiet space. And the other problem of listening to a lecture in your room is missing the learning that comes from talking to other people.

There are some interesting new models where you listen to the lecture in your dorm room, and then you come to the lecture hall for the discussion where you meet with the professor. That might be a valuable scenario in which you’re getting some concentrated time where you’re thinking hard about something with a bunch of other people. I think it’s going to be a big challenge in terms of moving forward and what the real educational format is going to be. It’s tough.

01-00:40:21
Hughes: Towards the end of Dan’s life, he worked on methane bacteria and got one patent and submitted a second patent application. I gather that the second never became a patent per se.

01-00:40:53
Koshland, D.: Yes. I think he was a man who used his basic logic and instinct to think he could solve every problem which was interesting. [Laughing] He always felt, for example, that curbing the auto industry to get better miles per gallon was a stopgap, at best, small band-aid, because he’d do the calculation. If you change the mileage from twenty miles per gallon to thirty miles per gallon, as soon as the population goes up by 50 percent you’ve lost all the savings from increasing the gas mileage]. In other words, if there are 50 percent more people driving cars that make thirty miles per gallon, you have just as much energy usage and pollution as when cars only got twenty miles per gallon. Since the population was going to grow, improving gas mileage was never going to solve the problem of the energy crisis, both in terms of pollution and in terms of energy source, right? Because you’re not replacing oil, which is complex and takes millions of years to form.
His simple idea was to use bacteria to make methane for gas. He was an enzymologist, and he had worked on these things early in his career, not because he was interested in the environment at the time, just because he was interested in understanding how an enzyme can convert a simple carbon compound to another carbon compound, and how does it do that? He was a protein chemist and he was a mathematician early on. Enzymology was not very exciting to my generation—it’s something that had been worked out. But now when you apply it in the context of trying to solve environmental issues it becomes exciting again. So I think his studies on energy were good for him, because in some ways he wasn’t learning something totally new; he was applying something he had known all his life to a new problem.

I don’t remember what that patent said; I just need to jog my memory here for a second. [reading patent]. What he basically was going to do here was to use bacteria to convert carbon dioxide to methane. When the methane is burned it makes CO₂. But because you’re using CO₂ as a starting material and at the end of the process you’re generating CO₂, you’re not generating any new CO₂, right? You’re starting with ten molecules of carbon dioxide, you convert that to ten molecules of methane. You put the methane in your car, it gets burned, and it makes ten molecules of carbon dioxide. You haven’t actually made any new carbon dioxide.

So how do you do that? Well, a particular type of bacteria use the energy from the sun to convert the carbon dioxide to methanol. And then you use a second bacterium to convert the methanol to methane, and then the methane you can burn in your car. There were problems with that because the process is expensive. The bacteria which are using light to convert the carbon dioxide to methanol, for example, aren’t very good at it: they’re not very efficient. Then you’re not going to get enough methane out in the end to be able to support the cars that everybody needs, right? So one of the things he was working on was you have an enzyme that’s involved in converting the carbon dioxide to methanol. [He tried] to make that enzyme be better at what it does, to alter its structure so that it was more efficient at using light and CO₂ to make methanol. As I remember the story, and I may have it wrong, he knew there were tricks you might be able to do by putting together different groups of enzymes to actually do the chemical conversion by pulling them from different organisms and putting them together. And that was the way that he was going to try and help the system become more efficient. So the question was could you make it efficient enough that you could use this process as a real way to generate enough methane to feed all the cars in the United States?

Hughes: What about the technology licensing office here at UC? How helpful were they?

Koshland, D.: I really don’t know the details of that, so I can’t speak to that.
Hughes: Do you have time to talk about philanthropy?

Koshland, D.: Sure.

Hughes: Then we can call it a day.

Koshland, D.: Okay.

I don’t practice philanthropy as well as he did. Another testament to him is, if you give to something, you shouldn’t just give the money. You have to be involved before, during, and after—the whole process. What makes it meaningful is to have an input.

And I think that was a very important component to how he gave. He just was involved and cared about the process. Philanthropy’s a long tradition in my family; it came from his father, his father’s father. I think the idea was, we’re all pretty lucky and didn’t deserve what we [inherited]. We just got the stuff dumped in our lap, and so you have an obligation to help other people out. His [attitude was] philanthropy’s not only good, it’s also fun. Fun I think was an important object.

My grandfather [Daniel E. Koshland, Sr.] was interviewed one time and was [told] that it was great that he was such a philanthropist and sacrificed so much. My grandfather says no, not at all; he says when you do philanthropy, you meet the nicest people. I think it’s true. It’s sort of selective for people who wanted to give. It’s not about them; it’s about somebody else. If you hang around in nonprofit organizations, generally it’s a bunch of nice people you get to hang around with. So those were the life lessons.

I think he had a lot of causes he felt very strongly about. Probably the strongest was Berkeley, which is not surprising. But it transformed his life, and it was a place he always wanted to be, and so I think he felt very strongly about giving to the university. He felt very strongly, though, you need to make sure your money’s doing something.

Hughes: Were you aware that his philanthropic interests shifted over time?

Koshland, D.: I guess I was a little bit. That was a little bit like the science parents [who didn’t talk about science at the family dinner table]. He really didn’t talk too much about philanthropy. It was a thing you were expected to do at some point in your life. The idea for him, really, was that most people don’t take it on seriously until their death is looming. [laughter] You’re not necessarily thinking about philanthropy when you’re thirty or twenty-five, so we didn’t
really talk very much about it. I think my parents cared more about not broadcasting our wealth. They were more concerned about that than broadcasting that you were a son of a scientist. As a result, they kept a lot of [their philanthropy] behind the scenes and not in our media.

I think he was proud of what his father did; he was proud of what he did. He was sure the children would do well as well. I think part of it was he wanted that legacy to continue, or continue as long as the money continues—shirtsleeves to shirtsleeves in three generations. I know Israel came up [in his philanthropy], and I think he really liked the spirit of the country and the fact that they were sort of entrepreneurial, particularly in the environmental areas. Berkeley was always a big deal.

1-00:57:36
Hughes: I knew he had been a longtime supporter of the Weizmann [Institute of Science]. But that was logical; there’s the science again. But I didn’t know he considered Israel an entrepreneurial country.

1-00:57:49
Koshland, D.: Well, I think he got interested in supporting their climate change. They’re doing some really interesting stuff with solar energy. They were being forced to because of their environment. They didn’t have much water; they don’t have a lot of energy; they had to deal with issues that were on the edge of what would be helpful to other people.

1-00:58:14
Hughes: Well, Doug, do you want to say anything more?

1-00:58:20
Koshland, D.: It’s just another example of the many flavors of a really remarkable person who I think enjoyed life as much as [he could]. When he died, it was a sad day, but I think he had no regrets, and we have no regrets. He barely had a bad day. There are clearly some things he would have done. He had some tragedy in his life, but overall, he was just a great guy to be around.

1-00:59:03
Hughes: Thank you.

[End of Interview]