

## DeVane Lecture Discussion – 3/1/01

AK Good afternoon and welcome. I'm here this afternoon with Professor Joan Steitz, Sterling Professor of Molecular Biophysics and Biochemistry. Professor Steitz lectured to us on Tuesday and immediately after her lecture, got on a plane and flew to Paris, believe it or not, where she received the 2001 Award for North America from L'Oreal/Unesco for Women in Science. Following the dinner, she got back on a plane and flew back across the Atlantic so she could be with us here this afternoon. In addition to thanking her for her lecture on Tuesday, I would like to thank her for her heroic efforts to get back for our discussion.

Joan, I wanted to begin with a question which takes up the relationship between science and democracy at the opposite end from the one you approached. In your lecture, you focused on the various ways in which American democratic institutions or habits or traditions might be thought to foster scientific research and, in particular, biomedical research. That was your chief illustration or example. I'm curious as to what you think about the democratic management of science's product. That is to say, the discoveries, the inventions, the new techniques and powers that science puts in our hands, which flow out of our university laboratories and other centers of research. I think that many Americans—this is a crude way of putting it but it captures a feeling which is, today, I believe, widely shared—many Americans believe that science is such a complicated and arcane thing that it's impossible for ordinary men and women who are not scientifically trained themselves to judge the utility, the desirability, the morality of the avalanche of novelties which has come and continues to come our way. Do you share that concern as a scientist and a democrat? How do you feel about that? Are we moving toward a world in which public policy will increasingly, of necessity, be made by experts who really do understand the science, with *the people* being moved off to the side as spectators?

JS You're basically asking the moral and ethical questions that I said I wasn't going to consider. But, of course, I have considered them as I think we all have. And clearly, science is a realm of knowledge that happens to be moving forward very fast in this particular era. In other eras, it's been other forms of knowledge. And this is what humankind is about—acquiring knowledge. And what we do with the knowledge has to be more, in my opinion, a responsibility of the greater society than just those individuals that produce the knowledge. So the question is, how do we do this and do this effectively in this country? And one of the things that's very much on the mind of every scientist I know at this point is, how do we educate the public better to understand what's really going on? One of the institutions that I didn't mention at all in my lecture on Tuesday—I realize it wasn't directly in the line of what we were talking about, but is a very important force and is uniquely American—is the National Academy of Sciences. Now this is, in one sense, an honorific society. I think, currently, there are about 1,700 members who are elected and it's very prestigious to be elected to this body. But what this body does is, at the behest of government, to look into various issues and prepare reports. So the National Academy of Sciences was established by President Lincoln not quite 150 years ago because he wanted a panel of scientists to be able to look into scientific issues. And currently, there's a very large institution that's run by the National Academy of Sciences, called the National Research Council, that does things like make recommendations about how many vitamins you should be taking. It looks into air pollution, water pollution, do power lines really cause cancer, all of these questions. You'll often see in the newspaper that there's a new report from the National Academy of Sciences. It's really from the National Research Council that has been commissioned by some body of government to ask a body of qualified people to look into a particular question. And the reason that I brought up this background is, one thing that the current President of the National Academy of Sciences, Bruce Alberts, who used to be a professor at the University of California, San Francisco, is particularly interested in working on and has been doing some quite effective things with, is science education in K-12. He's gotten a wonderful committee to put together a report that basically talks about science standards—not a particular program of how students should learn science, but what students should understand at various levels. And this has served as the basis for a lot of very creative companies who are trying to write curricula—discovery-oriented curricula where the students, instead of learning facts, learn how the discovery process actually happens and get the facts out of that. I've just been asked to join a committee that's going to look at the teaching of

biology in the 21<sup>st</sup> century—again, a committee sponsored by the National Academy of Sciences and the National Research Council—to make recommendations about how we do that better. So this is something that's very much a concern, I think, to all scientists and the hope is that other people consider it important to try to understand science because we have to in this modern world. I've probably avoided your question.

AK No, no, this is very responsive. Viewed from one perspective, the individual citizen in this country is far removed from the locus of decision-making over matters of scientific importance. We vote for congresspersons and they vote to establish agencies and provide the agencies with a budget and the agencies hire scientists who provide expert reports and the decision gets made three or four steps down the line on the basis of information, theories, investigations, experiments and the like, which a citizen has no knowledge of and very little understanding of. That might lead one to be quite skeptical or anxious about our decreasing capacity to control the direction of the use of science. On the other hand, take as an example, global warming. This is an issue which has percolated up in the political and ethical awareness of the American people over the last decade or so to the point where it has become a campaign issue in a presidential election and, of course, there are underlying scientific controversies but many millions of Americans who, ten years ago, didn't have a clue about the physical processes involved in what we call global warming, at least today have some rough understanding of what it's about.

JS But that's partly because it appears in the press and we have good scientific reporting, we have these wonderful programs on public television and other television stations that are just tremendous resources in terms of learning about science. And I guess the question I would have for all of you is, how could we be doing it even better?

AK It just occurs to me, as you talk, that when you mention the press and newspapers, the magazine, *Scientific American*, puts together, in a way, the two sides of your talk. Is there *The Scientific Frenchman*, or *The Scientific Italian*. Do these exist?

JS I don't actually know. That's a very good question. I don't know.

AK Let me come back briefly and then we'll open the discussion to the floor. Come back briefly to the main line of your talk on Tuesday. Many of the factors that you identified in your lecture as having contributed to the extraordinary growth of basic research in this country following the Second World War, many would characterize, I think, not so much as reflections of deep-seated patterns of democratic life and character in this country but rather as quite specific reactions to very particular historical challenges. I'm thinking of the rise of the Soviet Union and the Cold War competition, Sputnik and the arms race, and this, coupled with a growing appreciation that we need to make a long-term investment in basic research because, if we wait for 20 years or 30 years, it will pay off and there will be benefits of a tangible kind and we need to discipline ourselves to be more far-sighted in science investment strategy. But the question I was left with at the end of your lecture was, are these really distinctively American attitudes or... .

JS Or did we happen to be lucky in that we could afford to do it at that time? I don't know the answer to your question, And I don't know of anybody—at least I've not seen anything written on anybody -- who has analyzed whether it was simply that the right people came into control and they were able to talk to the Congress and Congress therefore gave the right appropriations and we set up this very powerful system of competitive merit review—the Peer Review System—that really got the best basic science funded. Or whether there is something about us that says, "Look, we've got to look at this in the long term and we've got to realize that, if we don't lay the foundation now, 20 years hence, when we want to use the knowledge, it just won't be there to be used." So I would love to know the answer to this question, but I don't. Does anybody here have an idea?

AK That's a wonderful invitation to the rest of you to join in. May I invite anyone who would like to come to the microphone to do so.

Q I know that you said that you weren't going to deal with any of the bioethical considerations, but I guess I have to ask this question. As an African American, should we be concerned about the possible misuse of biotechnology?

AK We should be concerned about the possible misuse of all knowledge. Of course we should.

Q But, in particular, biotechnology since it is one of the things . . . A friend of mind just said, "Well, we don't need any Doctor Mengeles around. I think the concern I have, mainly, is, being an old science fiction reader way back, that H.G. Welles warned us about these things. I mean, *The Island of Dr. Moro* comes up, and then, sometimes, people tampering too far with what people would say is God's work—not that I believe that. But is it a concern? Do you find, in your community, a concern for the bioethical considerations, particularly of biotech?

JS I think you're talking, even more specifically, about genetic engineering and what it might mean to the genetic lineage of the human race. Yes, I think there's always been quite considerable concern. One of the remarkable things that happened in the 1970s and early 1980s, after it became possible to clone genes, just technically, was that all the scientists who were involved in developing the technology said to each other, "Look, we'd better figure out whether this is dangerous before we move forward," and there were many meetings where the scientists got together and prescribed guidelines for doing experiments and for testing the things that had been made and, as time went on, in fact, what's happened is that those guidelines have loosened up. Because what we've learned—it's like, remember when we used to have television sets that had tubes in the back of them? You can imagine going into a television set and pulling one wire. Now, the probably consequence of that is not that you're going to turn your television set into a monster, but that you're going to inactivate it. It's not going to work anymore. And that's basically what we found out happens when a scientist (even though we know some things, we know a tiny little bit compared to what's really going on inside a cell) goes in and tinkers with something and usually what you do is you make it not work. It's only an extraordinary situation where you are able to make it do what you really want it to do. And so, in general, what turned out was that more and more experiments were done and more and more tests were done to ask, is this dangerous? It turned out it wasn't and the guidelines that are issued by the NIH for how carefully one needs to deal with all these newly genetically engineered bacteria and so on loosened up, as a matter of fact. And it was the scientists that raised that concern initially and there's a lot written about their deliberations at that time.

AK I think it's important to draw a distinction between two very different sorts of concerns that we have about genetic engineering—to stick with that as an example. One is that, on the basis of an incomplete understanding of the subject, we will do things which we will have cause to regret. For example, we will reduce our genetic diversity as a species and put too many eggs in one basket and put ourselves at risk as a result. The way of dealing with this danger is, of course, to expand the field of our knowledge and understanding and to constantly remember that what we know is partial and incomplete. But a very different concern which I think was implicit in something you said earlier, is that we oughtn't to be tampering with this at all, not because we may do ourselves some harm, acting prematurely on the basis of incomplete information, but because it's the fabric of the world. It's the tissue of God's creation and it isn't for us to intervene in its workings beyond a certain point. That is a moral anxiety that has its foundation in the expansion of human control itself and sees further control not as an antidote to partial control but as an extension of the problem.

Q I just hope that in this process of going into biotech deeper and deeper, that the biotechnicians don't have to say what the people at Los Alamos said about atomic fission, that they are sorry they ever tampered with it.

JS Let me just raise one other thing here. All of you know that, within the last couple of years, there's been great concern about clinical trials of genetically modified foods and so on. And what's quite clear is that many of those things have not been handled properly. The patients weren't properly informed, the scientists, the doctors that were doing the actual test had not really acknowledged what the problems might be, and currently there are panels sitting and trying to draw up new guidelines that will

better cope with these particular issues. And it's tragic that in several very well publicized cases, people died.

Q I'm very happy to hear about science here at Yale but it seems to me there's only been one lecture about science and five about political science and economics. And then they don't know really that much about the history of economics and history. I'm glad to hear something about the positive effects of science. And I think a lot of scientists are going back across the ocean and not staying here in the United States. It was very interesting, what you said about *Scientific American*. I don't think the Europeans have the same sense that their technology is just one country's. That's because we're between two oceans and they are right next to each other—Germany, France, England. So I was glad that you talked about science.

AK Actually, David Galerntner, who will be lecturing immediately after spring break, will be talking about computers and democracy. Your observation raises an interesting question about the effect that science and technology have on the political apparatus of the modern state. States are territorial units that have borders. There's France, there's Italy, there's Spain, there's the United States. And you need a passport to go from one to the other. But electronic signals cross those borders at will and science—the ideas on which science is based -- are no respecters of the lines of political sovereignty. Increasingly, we live in a world in which everyone, everywhere, is connected by technologies that have their roots in science and their home in that technological universe is as relevant to them as their citizenship in the United States or wherever.

Q A couple of related questions, looking at the big picture of your lecture which tried to explain why the American system—if I can call it that—is really much more conducive to scientific research than other systems. I'd like to think you're right, but if I could be the devil's advocate in a couple of ways: first, you seem to mostly compare not democracies vs. non-democracies but one democracy, namely ours, with other democracies, namely Japan and the European countries.

JS Because that's where modern science is taking place.

Q I don't know if that really brings out what is unique about democracy when it comes to scientific research because scientific research has been going on for a very long time in all sorts of different political systems. One thing that occurred to me—again, if you look at the big picture—is that you're looking at the United States in really the last fifty but to a large extent the last twenty years. I wonder, when you consider the whole panorama of just western civilization, if that's really a good scientific sample, if this might not just be a blip on the screen that might, from the perspective of people 500 years from now, be connected with a lot of other things than democracy. The other observation which I think is related—and again, being sort of the devil's advocate—is that if memory serves, scientific advances have been made in non-democracies. For example, Sputnik and Yuri Gagarin were both launched by the Soviet Union which was not a democracy. And before my time, Nazi Germany launched rockets. Tom Lehrer had a great line about, "When the rockets go up, who cares where they come down? That's not my department, says Werner von Braun." That's a little reminder that great scientific progress can be made in political systems that are about as far from democracy as you can get. So if you could just put that in the big picture again, I'd appreciate it.

JS I guess my response to that would be that the particular instances that you chose to cite are really what I would call more technological achievements than scientific achievements. The basic science was done worldwide that supported those particular technological happenings. Now, it's certainly true that many other societies have contributed and, perhaps, I was a little unbalanced in talking about how important the U.S. has been. The U.S. has sort of been the leader. This isn't to say that there haven't been contributions and advances that have been very important ones, that have been made in European nations and in Japan, Australia, and so on. Whether this fifty years is going to turn out to be a blip in history, it could well be. We could blow ourselves off the face of the earth tomorrow, and then, of course, it would be a blip in history. There was one other thing. The John Dewey reading . . . Dean Kronman slipped a couple of additional readings into my packet that didn't derive from the last fifty years. He was looking at it from a much longer, more historical perspective and he put in a chapter by John Dewey that

was written, I think, about 1940 or in the '30s when he was, obviously, seeing the rise of Nazism. And he talks there about how important it is for people not just to enjoy and appreciate the products of science, which is what you highlighted, but to learn to think scientifically, which is what I was trying to talk about at the beginning in terms of science education, because that's a very important way that we can hold back these totalitarian systems. So that brings a different perspective to thinking about all of this, I think.

AK May I add a thought here? Yes, you're right, there have been remarkable technical, and I would say, in the deeper sense, scientific advances made in non-democratic settings—the most striking example that comes to mind for me is not Nazi Germany and the V2 rocket or the Soviet Union and Sputnik, but Renaissance Florence where Galileo and others flourished under the benign patronage of the Medicis who were not exactly a democratic clan. But, having noticed this important historical fact, I would say that science seems to thrive on an anti-authoritarian spirit which does seem to me to be associated in some fashion with democratic cultures and societies. There's something about the “well, I'll make up my own mind and form my own opinion, and judge things as I see them” attitude—the rough and tumble self confidence of the democratic citizen -- which at least lends itself to the spirit of the laboratory.

JS Exactly. And if you have a system that allows that to flourish when the ideas are good, and encourages it, then you have what we've seen in the last fifty years. I was really being very, very specific about this.

Q Professor Steitz, when I was listening to the lecture, I noticed that some of the main principles of democracy that we talked about throughout this lecture series so far have been freedom, equality and self reliance, and it seemed like all three of those are sort of involved here: that the scientists have the freedom to choose their own projects, they're all equal, it's not one boss telling everyone else what to do. They're self reliant, they have to come up with their own ideas, they can't just use other people's ideas. But then, I was also wondering—I know this is where you said you didn't want to go—that advances in science also can have the exact opposite effect, not in the scientific community but in the large community (which was sort of got at a little earlier). In terms of freedom issues, like people being very strongly encouraged to have pre-natal testing and then to abort fetuses that may have certain genetic abnormalities as deemed true by somebody, or equality in terms of the fact that clearly, already, we can see that people who have more money are much more able to benefit from a lot of these advances, and that may get more so if we get to any sort of human genetic alterations. Clearly people with more money will be much more likely to be able to benefit from those. And in terms of self reliance, I think, if you go to the doctors, you don't understand anything that they say anymore and you, basically, just have to rely on what your doctor tells you. So I wonder if that's the sort of discussion that occurs within the scientific community in terms not of how did democracy affect the advances in science, but how will these advances in science turn around and affect these democratic values?

JS Again, that's my question to you: How can we get everybody better educated in terms of the thinking that goes into science, so that these questions can become everybody's questions and not just the questions of the scientists? But what you said made me think of one other thing that I did want to bring up. As I'm sure lots of you here are aware, the whole question of genetically modified foods is a big issue in Europe -- interestingly, in Germany where it worries a lot of people a lot. It's also a big issue in Australia. And the counter side to that is that, if one thinks about the underdeveloped nations of the world—so you're talking about the people who can afford to do it and the people who can't afford to do it—we should be pushing hard on genetically modified crops that will, in fact, increase the productivity, increase the storability of food, increase its ability to be disbursed to all the people who need it. And we have two contrasting things going on in the world at the moment. So this is really a global problem. The people who are very worried about what this might be doing—which, personally, I'm not concerned about because understanding what has actually been done to the genetically modified food, I think it's very unlikely that it's a problem that's going to affect the long-term lineage of the plants, but it could solve some real social problems in the world at the moment. And so how do we consider this? How do we think about this? And, again, it's the developed, wealthy nations that are making a decision not to do this and the rest of the world is suffering.

AK Well, part of the problem—one aspect of it is that the questions that science presents are universal. They're not for Americans only, or for the French, or for Nigerians only. They're for everyone. But the questions they present, in many cases, must be decided within the framework of the old political institutions we have which are based upon the nation state system that divides the planet up into separate jurisdictions that have control over a little piece of the earth.

JS I know I haven't answered your question.

Q Just the particular part that interests me the most has to do with the effect that this has, maybe, on inequality—say, even in America, even if we ignore the rest of the world. Even in America, the fact that, clearly, people who have health insurance plans that pay for very expensive medications who can get very expensive tests are benefiting more from this than people who have less resources. But if, in the future, we start to do things where we actually add genes to people's genetic material in a way that is benefiting the wealthy more than the poor and creating, in some way, almost separate—it won't be separate species, but separate lines almost. And I wonder—that's very far off—but I wonder how much talk of that there is . . .

JS Perhaps, it's not so far off. I mean, I thought the human genome was decades off and here it is, upon us. I never would have imagined it would have happened this fast. These are things we have to start thinking about right now.

Q Is there talk of that among researchers? I've sort of felt at some times, and I've been involved in research here that, sometimes, the exact project at hand is sort of looked at as the main issue. And I wonder, because we don't have that centralized sort of organizing of our research projects in the same way as, say, a country like England, where it's much more top down, do we have a greater fear of problems sort of coming up from within the research that have greater social effects?

JS I wish I had an answer to your question. I really don't. It should be talked about even more than it is being talked about, by all sorts of people on all sorts of levels.

Q I think, early on in your talk, you described science as a search for truth and we've sort of looked today at how that truth might affect society. I'm kind of interested in the reverse of that. How does society affect the truth and not just which truth you go to see but how do the values of society, perhaps, affect the interpretation of data and how you want to describe the way the world is? Does it align with what our heart tells us or what our values of society are? Is that enough to go on?

JS What you're basically reminding us of is that scientists are people and people have preconceived notions, especially people who are very much engaged in a particular endeavor and are seeking to gain the favor of their colleagues and be thought of well by their colleagues will very often have preconceived notions about how an experiment should have turned out, or if it didn't turn out that way, can't you explain it in some other way? And some of the biggest jumps in science come when, all of a sudden, one lab or several different labs come up with a result that simply cannot be explained by the paradigm that everybody was thinking. And those are the big turning points. And what you're asking is, how does human nature, how does human character, how does human endeavor allow that to happen or allow that not to happen? And, in some senses, that's the difference between a good scientist and a not so good scientist. A good scientist will design the experiment, even to give results that were completely unexpected, and then will look at those results and try to ask, are they really taking us way beyond what we thought we knew; whereas other scientists will design much more mundane experiments that will only allow you to ask questions within certain boundaries.

AK Which you may not even notice.

JS Which you may not even notice! And that's the whole point—that scientists are people and, of course, we have our blinders on because we think we know a lot but there's so much we don't know that could be completely unanticipated. That's one of the excitements of doing science because you do run into these things and then it's terribly exciting.

AK I'm reminded of Mahzarin Banaji's lecture a few weeks back in which she talked about, and then demonstrated very vividly . . .

JS That we pay attention to what we . . .

AK Yes, and the operation of our pre-conscious assumptions, beliefs, preconceptions, prejudices, and these shape our experience of the world. And, of course, the same has to be true in the laboratory. You don't cease being a pre-judgmental human being when you walk through the door into the laboratory. But one might say, just as real greatness in moral and political life begins with attention to the unnoticed things, so, too, in science. The real greatness comes with the observation of what has simply gone without saying or noticing because it's so deeply embedded in experience.

Q I have two questions and I hesitate to ask both, but I'm equally excited about them so I will. And they're for both of you. The first is, how good or bad is the growth of science, in terms of funding and prestige and success, for other fields of knowledge and, in particular, the humanities? I've sometimes felt—I'm a humanities student myself, so I'm probably oversensitive to it—I've sometimes felt like we've gotten to a point where money and prestige accrue to scientific knowledge, artistic achievement, political endeavors, but to this whole realm of knowledge which is of another sort—the humanities—they just get more and more neglected. So that's question #1—science and the humanities or other fields of knowledge.

AK This is a great and fascinating question. I'm very interested to hear what my esteemed colleague has to say.

Q Well, you're clearly at Yale, which is one of the places that, I think, is doing ever so much better and trying so much harder to hold on to the value of humanities, which I applaud in one sense, and sometimes I find very frustrating as a scientist.

AK I think it's not so much the funding that makes the difference. At least it's not just that the sciences are very well supported in material terms and the humanities less so. It's that, today, in our culture, in our civilization, so much intellectual prestige flows to the sciences on account of the indubitability of their discoveries and of the progress in discovery which characterizes work in the various scientific disciplines. By comparison, the humanities seem to be not only unprogressive—I don't mean retrograde. I mean not moving forward in a clear and discernable way, but filled with undecidable controversies and a muddle and a tumble and full of doubts, frankly, about their own intellectual respectability. The study of literature today, the study of history is profoundly compromised at its core by doubts which the practitioners of these disciplines have about the objectivity and intelligibility of the results of their own work. And the scientists stride by, aglow with confidence, and we humanists look with envy. Of course, we mock and speak with contempt and disdain of mere science, but we're filled with jealousy, not because they're well heeled and we're not, but because they're actually making progress in the way of discovering *the* truth, and we're not.

JS And I think, partly, what you're saying is that scientists are sort of united and together in moving forward. And this is a wonderful feeling—to be part of the community where you feel that you're making very interesting discoveries. But one point I did try to make in my lecture, and I do want to bring it up again, is this fundamental business of how science operates in our large research universities today. It's not the Yale endowment that's going to science. The science is basically funded entirely from the outside and the Yale monies are going to the humanities and these other areas that make our life, both academically and otherwise, very, very rich. And part of the reason that somebody like me is at Yale instead of at Cal Tech or MIT, which have all sorts of virtues in terms of doing science, is that there one doesn't have the breadth and the intellectual richness that one has at a place like Yale. I'm very pleased that where Yale is putting its money is, in fact, into these other disciplines and sort of tolerating the science on the side. It's nice to be tolerated and let those other funds come in. And it's wonderful to be a part of this community.

Q I think I didn't ask my question quite as pointedly as I should have though. What I really meant was just does science growing help humanities do better? Or does it make humanities do worse? And here's a reason to think that it helps humanities do better—Oxford in the early 20<sup>th</sup> century. In the early 20<sup>th</sup> century, except for, maybe, the University of Berlin, Oxford was the world's greatest university, maybe except for the one in Beijing whose name I forget. I can't pronounce it anyway. But Oxford was, in the English speaking world, probably the world's greatest university. They made a conscious decision not to fund science, to invest in ivory tower, humanistic intellectualism, and nobody would rate them at the top anymore. They have fallen, and probably because they didn't fund enough science. They didn't have the general amount of money and thought flowing through their campus. They weren't cutting edge anymore. On the other hand, a reason to think that science being very well supported hurts the humanities is probably Stanford now, which is cutting humanities and humanities are not getting any attention, or very little attention from students because so much prestige—well, mostly, in that case—although, I think you're generally right, Dean Kronman—in that case, it's mostly money to the sciences. So this is what I mean. If you're a university president and you want the humanities to do well, do you throw a lot of support behind the sciences, as Levin has just done? Or do you do otherwise?

AK I think you support the sciences emphatically and, by that, I mean financially and otherwise while simultaneously pointing out the absolutely essential role that the humanities play in helping us frame and address questions that the sciences raise but are themselves incapable of answering. I don't know if that's a fair response. But the question of the end to which your knowledge should be put is not a question that knowledge itself can finally answer. I believe there is no discipline that provides us with the tools to answer that question definitively. Does English Literature? Does History? Classics? Law? No. But these other disciplines equip us, I believe, with the habits of mind and of character, they put us in a posture to be able to entertain thoughtfully and responsibly that range of questions. So I'm reminded of a phrase that Thomas Cech used in his piece, which you included in the readings.

JS "Liberal Arts Colleges"

AK "Liberal Arts Colleges and Cross Training," the metaphor of intellectual cross training, that there is some collaborative benefit to be had here from the interaction of these very different disciplines. And how to describe that, how to conceive that—it's difficult. It's not so clear. But that they need each other, that seems to me to be a foundational premise.

JS But I think even financially, I think the point has been made by many people that the government investment in basic research doesn't really just fund the sciences. It also helps the universities in much more subtle ways, with their infrastructure and, in that sense, it feeds into the other academic endeavors that are so important for the sort of cross training that's needed. And I really think that that is true. Every time that we see tuition that comes in on a government grant going to Yale and we know that tuition isn't coming in from students in humanities, we know that that money is going, basically, to fund graduate programs in other fields. And we sort of writhe about a little bit. But on the other hand, that's the sort of thing that should be happening in this day and age when, as you say, science seems to be such a big thing. I think it should be happening.

Q Does America have an obligation to share the fruits of her basic research with the rest of the world? Specifically, could you comment on the situation that Yale holds a patent on an AIDS drug which [world organizations] have asked be relaxed for generic production in several countries.

JS Are you talking about the . . . from Chang's lab and pharmacology specifically?

Q I'm not really sure. It was in the *New York Times Magazine* a couple weeks ago—about generic production of drugs in Brazil—how they were ignoring international patent law in order to produce drugs more cheaply so they could save lives.

JS And Yale was getting into the act?

Q Well, no, Yale has a patent on an AIDS drug which they sold to Bristol Squibb—I'm not sure what the name of the company is.

JS Which actually rescued the Medical School from bankruptcy in the last several years, with all the money from this particular AIDS drug that's come in. So your question is, basically, should the patent rights be relaxed so that it could be produced generically?

Q Or just more in general, could you comment on, does America have an obligation . . . You mentioned the fact that we've invested in basic research a great deal. Do we have an obligation to share that with the rest of the world?

JS So what your question is actually asking about is the licensing and the patenting of the products of science. Let me go back and explain a little bit. In 1980, the Bayh-Dole Act gave the rights to the intellectual property that came from government funded research to universities and said that the universities, then, could negotiate and own the patent, could license scientific knowledge. And so, instead of that money going back to the government, it's up to the universities to engage in that sort of interface with something actually going into production as a result of what was discovered at the university but funded by government funds. And this is what we're getting into—what should actually happen there. This is a very, very complex area—the whole biotech industry is dependent on license agreements, patents that have come from universities because most of the discoveries on which they are based were made in universities. My personal feeling is, yes, of course, Yale needs the money that comes from this drug in civilized countries, but yes, it should be made generically and used by people that can't afford to use it elsewhere. That's my personal feeling.

AK Without reaching a bottom line judgment, let me try to clarify what's at issue here. Let's suppose that a discovery is made in a laboratory at Yale, whose research is paid for by a government grant, but under the Bayh-Dole Act, the ownership—the legal ownership, the patentable rights to that discovery, belong to the university and not to the government which has paid for the research. Now, let's suppose that this patentable discovery, that the patent on it could be sold to a commercial manufacturer for \$100 million. Alternatively, Yale could agree to let the drug—if it's a drug that's been discovered—be manufactured by anyone, anywhere, without obtaining permission from the holder of the patent. That decision—the decision to follow the later course—would cost Yale \$100 million because the alternative is to sell the patent to a commercial producer who will require licensees to obtain its permission for a fee, and so on and so forth. So Yale will lose \$100 million. If it follows the first course and gets the \$100 million, what will that be spent on? Well, I can assure you, not on BMWs for the faculty and fancy vacation homes and the like. It will be spent, in this case, most of it, on refurbishment and expansion of the research facilities, hiring new faculty to join the laboratory . . .

JS Probably not just for the science departments either. It will go into the underpinnings . . .

AK . . . for graduate students in French History and so on and so forth. Now, the question, then, that all of this raises is, should Yale spend the money on that or should it spend it—which is really what it is doing in a not too indirect way—on aid to those who would be benefited by the less costly availability of the drug in question. And that question can be generalized in the following way: Yale has many resources. It has an endowment of \$9-10 billion, it's got 300 buildings on its campus. Yale is a wealthy institution. It could disband overnight, distribute its wealth and improve the welfare of millions—maybe hundreds of millions of people around the world. Should it do it? That question is just a larger version of the question you've raised and making it larger, actually, I think, dramatizes what's at stake.

Q [Inaudible]

AK But it would amount to that. It would be foregoing a very substantial sum of money that might be . . . And I've put these alternatives in the extreme. They are actually the poles of a continuum of possibilities and there must be some appropriate and morally and institutionally attractive solution in between.

Q I have been intrigued by what I consider to be a fascinating little experiment in democracy in our scientific realm. And I want to get your reaction to it as a possible model that could be extended. I don't know if you have seen the film "Lorenzo's Oil." It tells a sad story of a family whose child had a rare disease and I'm not going to replay the whole thing.

JS I know of the movie, but I haven't seen it.

Q The intriguing thing in the film is that it tells the story of a family who solved a fundamental question about the nature of a deadly illness afflicting their son themselves. In the course of it, they persuaded a group of highly respected scientists to stop doing business in the way it is usually done and to do it differently, in this particular fashion. They persuaded people who were pursuing independent lines of research on a neurological question to stop pursuing it quite so separately and, instead, to share what they were turning up in a highly collaborative way on an ongoing basis. They also persuaded these scientists to meet a couple of times a year and, when they met, to always have people afflicted by the relevant illness, or family members, present for their meeting so that questions could be raised. In turn, the scientists who participate in this thing benefit from extremely aggressive fund raising that is done by, particularly, the people who created this thing. And there is at least one research scientist here at Yale who participates in this project—a very respected neurologist. It appears that the ability to access funds that are generated in this fashion may have somewhat expedited the course of research on this problem. I guess I found the notion that scientists were being pushed to be more collaborative and to have, in some way, consumer input, an intriguing example, perhaps, of democracy. And I wonder if you think that that is likely to prove to be a sort of short term aberration or if you think that there is something in the elements I've mentioned that offers, perhaps, an intriguing model for the future that might be worth looking at for wider application?

JS I think it's a wonderful example. I think it's probably not the only one. I think more communication among scientists and with people who are recipients of the particular science that they're doing is always extremely helpful. My research has been a little bit involved with people who have lupus and it's been a wonderful experience to meet some of these people, to talk to them, to try to give sort of lay lectures about what we're doing and just to get the connection that way. This is a very human aspect of doing science. And the more involvement that there could be, either from the public in general or from people who are focused on a particular problem—this is why I gave the example of the American Cancer Society, which is the biggest and, perhaps, the most impersonal. But there's a society for every single disease and most of them do have specific connections with particular scientists who are working in that area. This sounds like a particularly effective interaction.

Q I think that in that type of organization, lay people have a very narrow and specific role and it doesn't ever involve challenging scientists in their professional arena. That, I think, is what's unique about this particular thing. And I think that, if there is any value in it, even if there is, it's not likely to continue unless those who wield the power of the dollar do something with it. It's about structures and the way they work.

AK One interesting analog, though, I think, can be found in the rule making, the formal rule making procedures which many of our federal agencies follow—for example, the certification of a new drug or a new technology. They require, typically, what are called "notice and comment" hearings before permission can be granted to market the drug, and in those hearings, comments are invited from all interested individuals and groups. Typically, individuals don't appear before the agency to either exhort or protest. But they are often represented by consumer groups which are concerned with the welfare of those who will be the end-use consumers of the drug or the technology in question. And frequently, in that setting, the judgment of the scientists who have played a significant role in the provisional judgment of the agency to follow a certain course of action will be challenged and not infrequently reversed by the agency itself. So there are many different points in our administrative state at which lay people, speaking through, often, their collective representatives, the consumer groups who speak on their behalf, do have some dramatic and effective input into the process.

Q And I think people involved in AIDS have really been a very notable recent example of the power of that.

AK Again, I don't know if that's as prevalent in other countries as it is in this country—that citizens come together and sort of band together to try to do something about a particular disease that then engages the scientists that are involved as well. I just don't know.

Q The lady's speech was mostly about the history of research science in the United States recently and I'd like to ask a question about the future of American faith in science and that leading to a better life. It seems fairly clear that science and technologies do lead to a better life in the sense of improved medical facilities and techniques and so forth and so on. But it seems to me in some ways, this century has been a culmination of the modernist project and this great faith in human achievement in the sciences leading to, in some ways, this utopia of another sort—not necessarily a political utopia but . . . [hiatus in tape]

JS . . . the rest of society proclaims them as such and I don't see any reason why it should.

AK Well, here we come, though to an interesting point that Tocqueville makes in that excerpt that I snuck into your packet. Tocqueville, at several points in his Essay on Democracy in America, says that Americans—democrats in general, Americans in particular—are concerned with the body, with matters pertaining to the body, with comfort above all else. The American democratic instinct is to be as comfortable as you can. Americans are not concerned with the life of the mind, with the refined discipline of the soul, with the exploration of paradox and mystery. Those are aristocratic preoccupations, as Tocqueville characterized. We like to be comfortable in our jammies. That's the American way. And science—the great glory of basic science—for most Americans is that, after a 10 or 20 or 30 year wait, it produces things that make us wonderfully more comfortable and there is no end to it. We're getting more comfortable all the time—at least some of us are getting more comfortable all the time and will we ever come to a point where we say, "Enough. We're comfortable enough. We don't need more creature comforts. We'd like more time and space for free reflection, for introspection, for thought, for prayer, for spiritual activity of one kind or another," and there is a certain momentum in America today that, I think, will be difficult to resist. And I don't see where the end of our comfort culture lies. And the further we go down that road, the more we ordinary non-scientists will be inclined to put scientists on a pedestal because you're the ones who are making us so darned comfortable.

JS I don't know where it's heading. I hope it's not heading in the wrong directions.

Q On to the second question.

AK Let the record show, he waited his turn and he went to the back of the line.

Q This question is apropos of what you were just saying because it concerns Tocqueville. I was struck by that wonderful moment in your lecture, Professor Steitz, where you said, "If there's one thing I hope I've impressed on you, it's that what Tocqueville said may have been true in the 1830s, but it is not true now, and America invests more in basic science than any other country." That was great because it's so rare, in interpreting authors and deciding whether they're right and so on—all this humanistic activity – that we ever get anything really clear. But this is a clear moment. You read through [Tocqueville] and he's so right so often that you become numb to any moment where he might be wrong. But here's a moment where he's glaringly wrong. It's a bigger point than just about science and America's interest in basic science. It's about all learnedness. He says, "Americans have no one who is learned and, equally, no one who is ignorant," that there is a sort of leveling down. We have in this country now immense numbers of learned people, an investment in knowledge and prestige accruing to it, and for that matter, he said that we don't have any artistic interest or artistic production. And yet, we have a whole lot.

JS I was struck by exactly what you were struck by. But isn't it just that we're 150 years later, and things have changed? The way we think about our society has clearly changed. What Tony said is right.

We're after the creature comforts and we're so busy getting there, but clearly, some of us have decided that you have to take some time for thought and thinking about the basics and that that is very valuable—those ideas are necessary.

Q I don't think that constitutes much of an answer. I admit that things have changed in the last 170 years, but that doesn't explain why they've changed. And to say that they've changed because people now care about other things is true, but it doesn't explain why people care about learnedness and so on now. In other words, I'm saying that our America is not Tocqueville's. It's changed in important ways and I'm just trying to . . .

AK I wonder about that, though. Tocqueville very frequently contradicts himself and says two things which can't be fit together, both of which are true. It's one of the things that explains Tocqueville's great longevity as a storehouse of wisdom about American culture. He says here, for example, in chapter 9, I think it is—chapter 9 of the materials that have been assigned. He says, "I am convinced that if the Americans had been alone in the world, with the freedom and knowledge inherited from their forefathers, and with the passionate desires which are their own" (those are mainly the passionate desires to be comfortable and sit around the fire of an evening) "they would not have been slow to discover that progress cannot long be made in the application of the sciences without studying the theory of them. They would have said that one skill leads to improvements in another and however absorbed they might have been in the pursuit of the principal object of their desires" (which is sitting around the fire) "they would soon have realized that it is necessary to turn aside from it occasionally in order the better to attain it in the end." That's a Tocquevillian way of describing the National Institutes of Health—that we turn aside from culture, we fund 20, 30, 50 year projects in basic research because we've learned to be a little patient. But what we're really after, in the end—what we were after in 1830, what we're after in 2001—is comfort, comfort, comfort. There was one other questioner.

Q The question concerns something that made a big brouhaha in the political campaign but seems to have taken a back burner, and that is prescription drugs. And you mentioned in your lecture, talked about the American system and how it made this culture of people and universities that were able to create amazing biological research. And the result is that patents get licensed. Pfizer, for example, buys a \$100 million patent license from the university, makes a drug, and to cover its costs and make a profit, sells it for \$50 on the American market. Pfizer goes to Canada and says, "We've got this drug." And Canada says, "Well, that's great but our law says you can only charge \$11 for it." Canada charges \$11 for it. They go to France and France says this is great, but you can only charge 20 francs for it and Pfizer is faced with selling no drug or selling 20 francs worth of drugs—and sells 20 francs worth of drugs. And the net result is that the U.S. is subsidizing drugs throughout the world and the U.S. consumer and people who can't afford it are faced with paying enormous prices, essentially to subsidize drugs in foreign countries. And I'm wondering if there's a way out of it, if there's a way to enable people in this country who need prescription drugs to get them at a reasonable cost while also not killing what you described as the unique American way of developing by medical research. This is obviously not an easy question.

JS So you're not just really talking about the research that's behind the prescription drug. You're talking about all research because all research can be exploited or brought to benefit people everywhere in the world so, in a sense, the fact that the U.S. government is putting this money into researchers at U.S. universities is basically giving it away to the entire world, because even if it isn't that specific, it basically has the potential for doing the same thing. And is this something that we shouldn't be doing as the wealthiest nation on the face of the earth? I think it's something we should be doing. On the other hand, I think it's appalling that we haven't figured out how all of our own citizens can benefit. I'm horrified. But that's not my area.

AK Thank you for flying all the way across the Atlantic twice to be back with us this afternoon. [Applause] Before we disperse, let me remind you that we will gather again on Tuesday, March 20<sup>th</sup>, to hear David Galerntner of the Computer Science Department. See you then.