

The NIH Nanomedicine Vision

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Thank you Richard. And both Richard and I want to thank Mark, Karen, Milan, Sam for spending a sunny afternoon here in Ft Lauderdale to join us and talk to us tell us something about their vision of nanobiotechnology. There are a number of words that you can throw at this, nanotechnology, nanobiotechnology. The one that the NIH is putting at this is called nanomedicine. Let me tell you just a little bit about that one. But first I want to preface this by saying I found this quite fascinating as evidently most of you have because the room is still full. We've heard ideas of nanotechnology, material science, synthetic chemistry, regenerative medicine, functional molecular biology, membrane physiology, and touched on some medical, clinical applications. I think one can immediately conclude a few things. First, nanomedicine, nanobiotechnology is not an entity; it's a collection of ideas that have to fit together due to the skills and insights of a number of disciplines. Second, it's clear that we are on the, we are on the edge of developing something new. And that is in fact why NIH has taken an interest in this. The context started about two years ago, 2004, but when the NIH director, Elias Zerhouni engendered what he called the NIH roadmap. There are three main entities, three main topics; a clinical enterprise, research teams of the future and new pathways to discovery, and in new pathways to discovery, you can immediately see molecular libraries in imaging, building blocks, structural biology, bioinformatics, and at the bottom nanomedicine. Of all of these, nanomedicine is probably the least predictable. It's a long shot, but NIH is willing to put some money on the table, to bet that this is going to go somewhere. In fact the commitment over the next five years is for a total of eighty million dollars. All of these are trans NIH initiatives. Those in the room here, most of you, most of us, who are vision and vision related scientists, but will, I hope be pleased to know that NEI, the National Eye Institute, is the lead institute, the home, for nanomedicine. And Richard Fisher is doing a tremendous job in that. His day job as you know is being the program director for Cornea, but in addition he has taken on the tremendous effort to put together, with a capable team of other program directors from across NIH, the effort on nanomedicine. What is nanomedicine? These technological innovations, referred to as nanomedicine by the NIH have the potential to turn molecular discoveries arising from genomics and proteomics into wide spread benefit for patients. We hope so. That's gonna take a while won't it? But I think it's worth the gamble. In fact the gamble some people think is soon to come around the corner. But as Mark mentioned right up front, some of the predicted benefits our height. This is in the context of expanding the market for drugs so were talking commercialization and hence, when you are buying your nano stocks, read the fine print carefully, before you invest. Elias Zerhouni said, "Let's get into nanobiotechnology and let's do it in some way which is unique for NIH." What can NIH bring uniquely to this topic? Well what we in the room, funded by NIH do, is biology toward the application to medicine and medical need. One can envision nanomedicine from the NIH

perspective as having several components. We're gonna go back and start the basics and we're gonna first ask what is in a cell? Sounds like cell biology to me. In this case it's very quantitative. Let's characterize the physical and chemical properties of molecules and assemblies of molecules in the nano machinery of cells. Mitochondria are nano machines in cells. Rather complicated aren't they? Second, let's translate this or let's begin to think of this in engineering principals. If you are going to rectify something, you'd like to know the principles by which they operate so that you can get in and alter those principles. And ultimately, we would like to gain enough understanding to get in and repair tissue and have an impact on disease. The way this is going to play out, now here's your tax money, you just paid your taxes a couple of weeks ago and so we're gonna spend eighty million dollars of them. Over the next five years, there will be six to seven centers operating. In fact three of those centers will be funded by the end of 2005 fiscal year meaning September end of September this year. And another three to four centers the year following. Each of those will be funded for a total cost of about two million dollars. They are envisioned as multidisciplinary, and as you've heard today the ideas of nanobiotechnology are not localized to a single department plaque on the door in a medical school or a basic department, but instead it crosses boundaries through medicine to biology, physics, chemistry, engineering, and computational mathematical modeling. In order to make this an NIH effort, one would like to see someone who, or a group, that is working on a biologically focused area. We would envision these as being broad, with a number of technological approaches but perhaps not totally encompassing comprehensive. The tools that are developed, and we've heard some very interesting tools, but Mark, excuse me, Milan told us about some interesting nano tools as did Chris just now, those tools should have some applicability beyond the specific system that's being worked on. And obviously as that was already mentioned, the toxicity, toxicology, biocompatibility; those are different sides of the same question; ultimately these devices need to coexist with biology and in bodies. And coexist with cells and perhaps in cells, so the toxicity, toxicology; biocompatibility issues need to be looked at. Well how do we get to these centers? At the moment the money is on the street already since September of 2004. Twenty nanomedicine development awards were funded. We didn't know what we were looking at so we asked the extramural community, you, science broadly, to come up with ideas and here are twenty ideas that were funded. These were funded at fifty thousand dollars each to spend in six months and go and think and put together a concept paper that would potentially form the basis for a nanomedicine center later on. The end of this year, two million dollar total. And one can see membranes, RNA synthesis, DNA repair, biocompatibility, protein folding, immunomodulation. Other ideas, membrane signaling, biomimetic nanoconductors. One that we in the room might find particularly interesting, compatible, would be the supermolecular cellular compartments, because that is a group at the University of Pennsylvania who is targeting, a group which is targeting, the photoreceptors. The inner segments and outer segments are biologically extraordinarily active in making membrane, shipping them through the cilium, or at least the components, assembling them in

the outer segment, in functional supramolecular compartments. So the vision community in fact is already represented at the table in these conceptual development awards. But also as you heard from Chris, David, and Mark, NEI is already supporting a number of efforts that relate to nanobiotechnology and nanomedicine in cornea, in drug delivery, in tear film at the front of the eye, and this list is not inclusive because we also today heard from Mark Grinstaff and David Pepperberg and on Monday the symposium on the ARVO was symposium Monday morning there will be others speaking including people such as Mark Humayun who are working on these ideas. So the NEI is already receptive to coming in with ideas of nanobiotechnology. And here is the last slide. Where does this go? Well what I've shown you here are some words that are really macroscale targets. Ultimately one would like to get to cornea repair, or lens replacement, or to have a neuroprosthesis that would substitute for input to the retina when photoreceptors are dead. Or to have diagnostics, or imaging, or immunomodulation going on. But these are large scaled topics. And as I have said, the rationale for the NIH nano concept is to start at the basics, understand the cellular systems, and take this to the level of controlling and repairing the biology of the eye and visual system. That's all pretty grand and the only way that we are going to get there is as a big vast enterprising science community across many different areas of medicine and science in this country. This may take five years, ten years, I don't think it will take until 2081 as I think that was mentioned, but it's not gonna be tomorrow, but the opportunity is out there. So again, let me thank the speakers who have come. I found it fascinating and now I think Richard will have a little time for some questions.