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Panel session:
Looking into the Future
FUTURE GENERATION DEVELOPMENTS: WHAT'S NEXT FOR THE GENOME?

JUNE 18, 2010 — 14:00-15:30, Pavilion 4, Conference Hall 4.3

St. Petersburg, Russia
2010

Description:

Since identifying the sequence of the human genome a decade ago, medical advances in the diagnosis and treatment of diseases, have long been promised. But moving from basic science to the doctor's office is not without difficulty and expense.

- 1) What are some of the major advances in medical technology that we can expect with the knowledge of the genome? When will these practices become widespread?
- 2) How are information technology and human genetics combining to create the next generation of medical devices and treatments?
- 3) How can the medical communities and governments better work together to bring these solutions to market in a timely fashion?

Moderator:

Geoffrey Carr, Science and Technology Editor, The Economist

Panelists:

Steven Burrill, CEO, Burrill & Company

Dr. Omid Farokhzad, Associate Professor of Anesthesia, Harvard Medical School

Konstantin Severinov, Professor, Molecular Biology and Biochemistry, Waksman Institute of Microbiology, Rutgers, the State University of New Jersey

Konstantin Skryabin, Director, Bioengineering Center, Academician of the Russian Academy of Sciences

Maxim Uvarov, General Director, Binnopharm CJSC

Vladimir Vidro, Vice President, GENOMETRICA Ltd

Evgeny Zaytsev, General Partner, Helix Ventures

Transcript:

G. Carr:

We are a small and select group, as I said. Anyone who wants to come and sit closer to the front is very welcome to do so. Gives the illusion of numbers.

Hello, and welcome to the panel session of “What is next for the genome?” My name is Geoffrey Carr. I am Science and Technology Editor for *The Economist* in London. And I have been interested in genomics for about two decades now. Originally, since the time that James Watson had the idea. I watched it grow. I watched it become a fierce race between the public and the private projects. I watched the announcement on the White House lawn, almost exactly 10 years ago, 10 years ago next week, that the thing had been done. I then discovered that it had not been, because this was a rather flaky draft. Eventually, it was done. I watched, with great expectation for all the medical advances that were going to come as the result, and I watched in vain.

So one question I would like to ask this panel is: what happened and why have the advances not turned up? But the other questions are about the future, and I only ask questions about the past so that it may elucidate the future. The other questions are what advances we can expect in the future and how we go about creating them, both from a scientific point of view and a business point of view? When might we realistically see these advances in the clinic? What, if any, is the role of government in the all of this? And possibly, we might ask what nonmedical benefits might come from Virginia. We have a very distinguished panel of experts here, from the commercial and academic world. And so I will introduce some of them and I apologize if I mispronounce anybody's name, because I speak Russian, well, not at all.

I have had one request please, gentlemen. From the lady there who is waving at me to slow down and speak slowly so that she can translate, is that okay? Yes, wonderful. So from my right to my left, from your left to your right. The first speaker will be Konstantin Skryabin, who is Director of the Russian Academy of Sciences' Bioengineering Center, who is responsible for the group that sequenced the first and so far only Russian genome. And he is now a part of a large collaboration to sequence about 200 cancer genomes, cancer of course being a genetic disease. The hope is that it will be the first to fall to the new genomic knowledge.

Then we have Konstantin Severinov, who is a Professor of Molecular Biology at Rutgers University in New Jersey, though he is Russian. He is interested in the regulation of gene transcription and the modification of proteins, which is a little technical for this meeting, but he is also a great skeptic about how useful genomics will be in medicine. Then we have two venture capitalists on my right, sorry on my left your right, Steven Burrill and Evgeny Zaytsev, sorry —

E. Zaytsev:

Evgeny Zaytsev

G. Carr:

Thank you, sorry about that. Mister Burrill is the CEO of his own company in San Francisco, Burrill & Company. And Mr. Zaytsev, thank you, is a Partner in Helix Venture in Palo Alto. Omid Farokhzad is Director of the Laboratory of Nanomedicine and Biomaterials at Brigham and Women's Hospital in Boston. He is an expert on the therapeutical use of nanoparticle technology. Maxim Uvarov is the General Director of Binnopharm which is a vaccine and generic drugs company. Vladimir Vidro is President of Genometrica, which is a throughput sequencing company. Gentlemen, you are all very welcome. The rules of this are: you have five minutes to talk about the subject. You can show slides if you wish. When you have all talked, I will ask a few questions and then we will take questions from the audience.

So, Doctor Skryabin, what did happen to stop the promised drugs in the past, and what advances can we expect in the future?

K. Skryabin:

Can you hear me? I think we will better speak English because the discussion will be more fluent. Do we need to do genomes? This is the question number one and there are two positions. And I hope that the discussion is finished because we realize that the making of the human genome, which is reading the genetic information, which is in all these guys, ladies and gentlemen who are sitting here. It is the rulebook which really controls behavior, diseases and so and so forth. That is why the first step was done in 2010, and it was a USD 4 billion effort. We just sequenced the human genome several months ago and the cost was around USD 40,000.00, USD 50,000.00. This just reflects the technical situation.

This is number one. I am sure that in two or three years, and we discussed it you know — you mentioned James Watson. We had dinner with him two days ago, and he claimed to know a lot of what has been going on at Cold Spring Harbor and at Harvard. The cost in three years will be USD 1,000.00 for one genome. It means that we do not need to get any more genetic data, which we are doing now. There are some mutations which influenced the diseases and so on and so forth, which can be predicted. We needed to do just a human genome percent. And I am sure that there will be a such a card, where the chip, which will have your genome and then you have a terminal in every doctor's office where you put this card, put your pin code and then you have all the information about your genome. But the question is, what does it give to you? Being a part of the International Cancer Genome Consortium, I want to tell you that in three years, we will know more than 20

thousand genomes of the different cancer patients. There is hope that this information gives us some information, what genetic differences in the normal tissue and in the cancer tissue reflect the appearance of the diseases. This is definitely not the end of the story, but this will be a very, very big straightforward attempt to understand the rules of the disease.

What are the main problems? If we know and we will do it, everybody sitting here will spend USD 1,000.00 to get their genome, if they are not afraid of the knowledge. But what will be the problem? Problem number one is the legal issues and I am sure we will be discussing it, because do other people need to know your genome or not? Because this is very personal data. Number two, how can you store all of this information, you need very big computer centers, which can analyze these types of information. You know, just for your reference, the books in the Library of Congress, which they wanted to digitalize, are equal to 10,000 or 15,000 human genomes. That is why all the books on earth are equal to several dozen thousands of this information, and we are billions.

That is why this is a very, very big problem. Number two, first — the problem of the ethical issues, employees, insurance and so and so forth, and the second, who will take care of this information, where will information about my genome go, who will analyze it and who will use it? Up until now, the technology of the informatics of IT is not really up to the level that it could be. Just as an example, you know we did the sequence and we are working on 60 genomes now in Russia, and the work is being done in the Kurchatov Institute. We have the second-biggest supercomputer in Russia. When we do these genomes, we use 75% of the capacity of the supercomputer that is why the physical values were really in those. I think that is it, four points. And I am happy to continue if you are interested.

G. Carr:

No, that is perfect. Your five minutes will be precisely up then. Dr. Severinov, perhaps you would respond?

K. Severinov:

What I would like to do is kind of try to spoil the party of the genomics, but I have to say from the start that I do not necessarily subscribe to whatever I am going to say. But these are some things that you may want to think about. So since Geoff mentioned that some people think that ten years after the draft of the human genome has been determined we are not really where we want to be, I think the reason we are not there is simply because we had expectations which could not be met and, just to put this thing in perspective, of course the human genome was not the first genome to be determined and, in fact, the first genome ever to be determined was a genome of the virus called 4X174 and that was done in 1975, I think.

And then there were two more genomes of larger viruses called phage lambda and phage T7. So the latter two viruses contained only 40 genes, and 30 years after the time that their complete genome was determined, we still only know the functions of half of the genes that these organisms have in code. And of course one might say that this was simply because of the lack of interest in these particular viruses, but this actually appears not to be the case. And on the other hand, part of the reason we do not know enough about this very simple, you can think about them as very simple model organisms for which the genome had been determined so long ago, is that they are not standalone organisms, but rather they live within a cell, a bacterium, about which we also do not know enough. But, on the other hand with a human cell, if you happen to determine the complete genome of a cell, you add this level of complexity, which is the organism in which the cell lives, and there is no way we can really address that with genomics, or anything like that.

So in fact, there is a general question, I think. I think we are, in a sense, in the valley of death, because the only progress that we had during the last ten years was solely due to the development of technology. In terms of the scientific questions, I think there was relatively little. And of course, the promises that technology would ultimately come to be so cheap that interesting things can eventually be done on Mars, right? But again, we are not there yet so we are in a death valley because the amount of dollars available, either from industry or from governmental agencies, is limited and decisions have to be made what, as to what kind of research you are going to support, whether this is going to be a high throughput, data-mining, or fishing expeditions essentially, or genomics, transcriptomics, you name it, or hypothesis-driven research on particular interactions or particular targets which have been singled out.

And the problem is that if one decides to solely support or mostly support the high throughput research, even if the costs go down, you are always going to take the money from the other part, and it is really there where the drugs have been developed. After all, all of the advances in current clinical medical science that we have, they came from mostly at least from the hypothesis-driven research, or serendipity. I think this is pretty much what I wanted to put in, and I guess the last thing is that, mathematical analysis and data processing and everything will generate potentially new targets for drug development, for example when human cancers are analyzed. But again, the problem is that ultimately, each target will have to be studied individually in terms of finding out if this target is indeed drugable and that, in turn, requires an enormous amount of money, and people. And at least judging by the funding situation in the United States, by the time these targets are available to explore, there may not be enough people to do so, because many of them will disappear by attrition. Thank you.

G. Carr:

Thanks very much. Before we will go on to the question of money, could I just make an observation about high throughput in cancer, because it seems to me that cancer is an example of something where high throughput will be very useful, because since you are comparing the genomes of the cancers with the genomes of the healthy tissues of the same individuals, you are actually able through high throughput to identify the target successfully. So is that not an example? Obviously, you then have to do the biology and you have to identify the drug, what is drugable and what is not. But it is not simply a question of high throughput for throughput's sake. You have a hypothesis and the hypothesis is that the differences between the two genomes will tell you what is causing the cancer.

K. Severinov:

Well, yes and no, because if you are doing high throughput then really, you should be doing it both on healthy tissues in the population and the sick. And so, when the first genome was determined, that was the HAPLA genome, and it was compared — that is, when the two genomes that were first drafted were compared, people decided that there was relatively little variation in the human genome, less than 0.1%, which gave hope that actually some meaningful search of particular disease genes can be established, and of course it can be done. The problem is that once there were more genomes available, and once diploid genomes became available, the amount of variation in the normal genome, so to speak, went up at least an order of magnitude, or maybe more, which complicates the analysis.

G. Carr:

Can we bring the money in now? Mr. Burrill?

S. Burrill:

If I could have my slides please? I thought I would play both historian for a minute and then futurist for a minute. Thank you. And I think if you start at the top for just a second and you look at the major problems of the world today, and you just listed the four or five biggest problems in the world today, you would list global climate change and sustainability of the planet. You would talk about the need for clean water on a global basis. We would talk about energy security, energy self-sufficiency. We would talk about food security and food production and we would talk about healthcare. Those are the five big problems that the world has today. And what is interesting about all five of those problems is the topic that we have today is the answer to all of them. And so, we are very, very relevant in the context of solving these global problems.

Secondly, I think we have to recognize that we have been through an extraordinary economic crisis on a global basis and that changed everything from what we have done just a year or two ago. And so, our ability to adapt — I write books every year about this industry. My latest book just came out about that adapting. If any of you are interested, you can find it on our website or you can send me an email. And if any of you would like copies of my slides today, I would also be glad to provide them. But if you stood back and looked at what has happened in the world, we have gone through an extraordinary growth of global population.

Today, we have a planet with 6.2 billion people on it moving to 9 billion people relatively quickly. And yet in the last 200 years, we have had this massive growth of science that has changed the nature of everything that we do. It was just 50 years ago, 1953, that Watson & Crick got at the structure of DNA. Roughly 20 years later, in the early '70s, late '60s and early '70s, we actually started this industry around our knowledge of DNA and our early knowledge of how DNA might affect things, that we could convert into useful products and services. But it was just ten years ago at the turn of the century that we got to the sequencing of the genome which is the more present topic today. But if you stood back and looked at these things and said, "What is the great contribution that we are making to the world today," 500 years from now, a thousand years from now, when they write the cumulative history of the world, the contribution that we will have made is this great extension of life expectancy. If you look at that mathematically for a minute just in the last hundred years, we have doubled life expectancy on a global basis and the consequences of that is that we have an extraordinarily large and increasingly large population, on a global basis, of aged people.

If you look at a country like China with 1.2 billion people, 260 million of them are over 65 years old. That is one United States of old people, sitting in China, and the consequences of what we are doing in the innovation business is to create extraordinary value in dealing with these global problems. But if you looked at them realistically for a minute, we have to put them in the context in which we live and that is that healthcare costs all across the world are going up dramatically because most of the things that used to kill us do not kill us anymore.

And so, healthcare costs with an aged population are now about 20% of the GDP in the United States and in the OECD countries it's moving at the same rate. So the challenge then, is we have essentially unlimited healthcare and unlimited demand for healthcare and that is causing substantial challenges to us. And if you look at the healthcare equation for a minute, we have an equation today that by and large focuses on late stage detection where we have low reversibility. That is to say we wait for people to get sick, and when they get sick, we try and do something. And we have all kinds of problems in healthcare systems around the world, because we are not yet in the business of wellness. We are in the business of sickness, that is, taking care of sick people, yet

we have the technologies today that are going to enable us to move to predictability, that is to say what is likely to happen to each of us, and the ability to preempt or to prevent disease. And that is the change that this technology is bringing to us.

And if you stay on the left side of this chart for a minute, the existing systems are basically one-size-fits-all drugs, and where we are moving relatively quickly is to the right side of this chart, where we are actually using what we know about how we work biologically and have validated evidence that tells us what really works. We understand the mechanism of action which means we understand why it works. We are moving to this world of personalized medicine, so we will be able to treat Geoffrey differently than we treat Steve. We will know what works in a comparative way, so we will know what things will work better than others and we will actually end up with some guidelines that enable us to improve the healthcare systems around the world using all these new tools that are coming out of this.

Now, the driver of that change is the topic of this panel because we have driven the cost of sequencing down faster than we drove the capacity down in integrated circuits. If you look at where we were as a computer world 20, 30, 40 years ago, we had rooms, we had buildings, rooms the size of this building with computers that today we have a 'Berry in our pocket, little devices that we use. And as the cost of getting information onto a chip went down, this world resulted. If you put that in our context, the cost of sequencing is going down at a substantially faster rate. So we have to say as cost per bit of biological information, it goes down at a substantially fast rate, what are the consequences of that and society over the next 20 years? And so, you have to think creatively for a minute about the lower cost of sequencing and what that does to us.

And in fact, not to dispute the earlier comments but we are essentially already at the level that we can sequence your genome for roughly a thousand dollars. Some might say, it is USD 5000, some might say it is USD 10,000, but we have companies today that can do it for a thousand dollars. If you assume for a minute that just in the next year or two, we get it down to a hundred dollars per individual, we could sequence everybody in the world and have an enormous database of information that could be very helpful to us and that is where we are going as this cost of sequencing comes down. And the results of that today is a whole new world of diagnostic tests all across the spectrum, from risk assessment at one end of the spectrum, to patient monitoring and patient selection at the other, that are providing those tools to get at ultimately this world of both genetic diseases, that is to say those things that we inherit through our DNA and those diseases that we acquire, largely because of our behavior, laying the groundwork then for an entirely different practice of medicine which will be transformative to the world.

That is what this panel is all about. That is what this discussion is all about and that is where the lower cost of sequencing is moving us very, very rapidly. We will then see a world of targeted

therapy. We already have that in most of the cancer areas today, where we have identified a host of cancers and we can target them by mutation specific. It will lead us relatively quickly to individualized medicine where we can actually differentiate each one of us on the panel and take care of each one of us individually and ultimately to the world of personalized care, which is the world of wellness.

Concurrent with that, we have developments that you are going to hear about in a minute in nanotechnology, and others, where we are going to live in a world that we are able to spit on to our cell phones or our Blackberries or our iPhones or we will have a little micro fluid chip in there that will go up to the magic computer in the sky the same way the GPS does and come down and tell people not only what is going on in me, but do the comparison to everybody else, and it will change the nature of healthcare because of that.

Now, there are 6.2 billion people in the world today and there are four billion people that have cell phones. So more people have cell phones than access to electricity or clean water. And so, if you would just assume for a minute that we are moving to a consumer digital health-centric world built around all this technology, we are going to be transforming healthcare. The only other thing I need to say before I pass this on is that the same technology that we are using on the healthcare side is the same technology that is redefining these other global problems and leading to an industry of clean tech, or green tech, in which we are able to take biomass and throw bugs and enzymes and catalysts into those biomasses and create energy to change the nature of both agriculture, where we have to grow twice as much food on half the land and half the water, using genomics to get at designer crops and other things. You can see the growth of that on a global basis.

And secondly, you can see the tremendous change in the bioenergy area where we are able to take biomass, that is to say garbage or waste material or other things, throw the same bugs and enzymes, catalysts in them and generate fuel at lower costs than we are doing today, and so we see a use of this not only on the healthcare side as I indicated but in clean energy and in the food area.

And so finally, I would just say that when Darwin wrote his *On the Origin of Species* 150 years ago, he said, "It is not the strongest of the species that survive, nor the most intelligent, but the most responsive to change". Our challenge in this panel and our challenge in this industry is to recognize the massive change in the world today and if we adapt relatively quickly to that world, we will be very successful in seeing the benefits of all of these technology. Thank you.

K. Skryabin:

I want to make one comment when you speak about prices. Three billion letters in the human genome, only one mistake can make the disease. That is why the accuracy of reading is very

important — the price depends very much on the accuracy of reading. That is why we need to define what we mean when we say human genome. If it is one time around, when it is a hundred times around and so on and so forth. That is why when you say USD 100 for a genome, it is a business idea, okay? But nevertheless, if you have USD 1000 from the population of Russia, it is something like a USD 100 billion business.

G. Carr:

Mr. Zaytsev.

E. Zaytsev:

Thank you, Geoff. My name is Evgeny Zaytsev. Can you believe I live with this name in Palo Alto? Thank you. I am a physician by training; I have my PhD. in physiology. I was in research before my venture capital career, which is about 10 years. I want to look at the developments in science from a slightly different perspective, the way we look at it as investors, because I believe what drives innovation in this field is very much the market utility of what the scientists are developing and that is by the way — this comment is very important in this regard, really what are we getting for the science we are developing. What is the sequencing, what are the new drugs or any other development and how these advances in science and technology provide clinical benefits to the patient maybe in several steps (and there could be some value creation chain), but there should be some clinical benefit to the patient in the very end. And I believe that we as researchers and business people have a lot to do yet, because we have not cured human diseases yet. People, if you look at the mortality structure, people still die from the same causes that they died from 30 years ago. It is still heart disease, cancer and stroke, and even though we have made a lot of progress in making people live longer, we created new problems, as Steve mentioned in his presentation. People live longer and we have the disease of aging which also creates an opportunity for business.

And also, people in developing countries live wealthier and that creates diseases of affluence, and this is another opportunity for the biopharmaceutical industry. We are also speaking about business. We also need to remember that the whole industry is in the middle of a very big change now and there are very strong megatrends that are driving this change. I think this revolution in the biomedical industry creates a lot of opportunity for innovation and investing in innovation. First of all, we all know about it. In the coming two or three years, about USD 20 billion in revenues are at risk of losing their exclusivity.

And we all know that big companies are not generating enough new drugs. They are really not capable of innovating and many R&D dollars of big pharma companies are going into acquisition of

smaller biotech companies, which is certainly a very good trend for us for biotech investors because this creates a market for acquisitions of our portfolio companies. The other thing that is very important is the healthcare costs and healthcare reform in the United States. Actually, it is coupled with the recession of recent years and you probably noticed that people here in Russia speak about the recession in the past tense but we all know that we are still in the middle of the crisis, and there is still very limited access to capital on the global markets, especially for innovative small companies and for big pharma as well.

But the healthcare reform in the United States means a lot for the whole global biomedical market because what it does is it creates a very strong pressure on costs. And I think it is going to generate a lot of demand for innovation because only new innovative products can generate cost-effective technologies and only very strong pharma-economic rationale can provide new business models and new products that will be cost-effective.

The other thing is the regulatory environment. It is certainly global and we all know that it is driven by everyday rules. But it is becoming increasingly complex and small companies have much more flexibility to adapt to those changes and they can do that in a cost-effective manner.

So I am saying that, basically, to make the case that innovation in this industry is a very good place to be in. I think all these changes favor a certain sort of biomedical business. And I think it is a very good time to invest in these types of businesses. And also on the background of this sort of economic crisis, I think — just remember, all the biggest hits in biopharmaceutical industry were in the 1980s when there was another recession also, very strong, and now these are huge multibillion dollar businesses.

For example, Amgen was created in 1980 and Pitch Johnson, the founder of Asset Management, my first company, was one of the first investors. He made new advances in science and technology and generated a lot of wealth. And we just need to think about it from the market perspective and it is very important that actually people in this country think about it from the market perspective because you probably know that the government announced that biotech is one of the state priorities, but there is very limited number of people in this country who actually know what biotech is. Thank you.

G. Carr:

Thank you very much. Do you think there are enough people in Russia who know about venture capital to support your model working in Russia?

E. Zaytsev:

Who know venture capital?

G. Carr:

Yes. Are there Russian venture capitalists to support it?

E. Zaytsev:

Yes. That is a very good question. There are quite a lot of venture capital funds today in Russia. There are seven funds created by the Russian venture company, a fund of funds created by the Russian government. There are eight funds created by RUSNANO that is the Russian Corporation of Nanotechnologies, and a couple of dozen what they called regional venture capital funds. Many of them — well, there are only two of them that are focused on life sciences and I see some people here who represent that small group of enthusiasts.

The problem is that venture capital really requires experience, long-term experience and not all venture funds are created equal. Even in the United States, you probably know the statistics. Most of the funds do not even return capital to their limited partners because venture capital performance really depends on experience and professionalism. And the Russian venture capital industry is still in the early stages of its development. There are very good people in the funds but they still need to sort of grow and gain that experience. By the way, I think it is very important for the Russian biotech industry to be integrated into the global innovation process and also create partnerships with professional global venture capital firms. I think it is very important to get access to the global high value technologies as well as to global expertise in this field.

G. Carr:

Thank you so much for that explanation. We now have three people who are involved in these degrees to — in the companies that we have been discussing in general here. First Doctor Farokhzad who is involved with a couple of venture start-ups in nanoparticle technology, could you give us a bit of your experience?

Dr. O. Farokhzad:

Thank you Geoff. So I am a physician by training, and I have done more science than medicine. I did my science training at two different centers at Harvard Medical School and then at the National Cancer Institute. And then following there you know, I was, by that time, trained as a molecular biologist, then I went to MIT to a chemical engineering lab and I knew very little about engineering altogether. And I morphed into a person interested in nanotechnology and when I joined the Harvard faculty about six or seven years ago, I established a laboratory of nanomedicine and

biomaterial, which essentially capitalizes on a convergence of a variety of disciplines to develop really enormously powerful medicines of the future.

You know with nanotechnology and its application to medicine, you can do a variety of things that you know just 10 or 15 years ago, would sound you know almost like a story. You can develop, for example targeted therapeutics that you would give to a patient and this device would almost act like a robot and would go around your body and find a disease tissue and deliver a drug very precisely to the site of interest. But then spares the other parts of the body where the diseases tend not to go.

You can develop technologies that at the very early stages of a disease can do detection, and this is important because intervention early is likely to be much more effective than late intervention. And so, imaging technologies that are being developed with the application of nanotechnology are likely going to fundamentally change the landscape of diagnostics in the next five to say fifteen years, and then technologies are being developed that actually combine these things. You can have therapeutics that you would administer to a patient and you actually get real-time feedback as far as what the effect of that is in the disease tissue. And if you can imagine the implication of getting almost a real-time read on how a cell responds to therapy, that you could have markers that can shorten a clinical trial duration because you can actually be reasonably predictive of outcome.

So the bottom line is that — and these are, you know, from the application of medicine, but then there is a scientific application, the use of nanotechnology as research enablers. You know folks have been talking about DNA sequencing and DNA nanopore technology can, you can actually get the genome sequences the way we heard, you know down to some thousand dollar price and USD 100 actually is not out of range. So what will it do, though? So this is what we can do bench side. What is reality and what is the impact that we are going to see in nanotechnology and when?

Well first of all, nanotech is nothing new and this application to medicine is nothing new. There are dozens of drugs today clinically approved that are considered nanotechnology products. The majority of them, however, aren't the types that I spoke of just a few minutes ago. These are just simpler forms of nanotech drugs. And they have actually been in practice, something like Doxil, has been in practice since the mid 90s. But what is going to happen is a lot of what I just said is on the verge of clinical translation or in some cases interclinical evaluations.

And so much of these targeted therapies and these theranostics that can image and treat and these targeted molecular imaging technologies are going to become a reality in the next let us say five to 10 years. And what does that mean for the pharma business? I think the landscape of the pharmaceutical industry is about to change in a way that it has never changed in the past. Biologics

have had an enormous impact on the bottom line of just about every pharma company. But I think the impact of nanotechnology on the bottom line of pharma would actually be much larger than the impact that the biologics have had on the bottom line of the pharmaceutical business.

And this comes not just in the context of making better drugs that work, but from a regulatory perspective, a lot of these nanotechnology products are reasonably complex. If you make something that you administer to a patient, it goes and finds disease, it treats it, it images it, it reports back when it is done. As you can imagine, making an equivalent of that or a bioequivalent of that from a generic company perspective, is very difficult, almost impossible. How do you show bioequivalence of such a complex therapy when an innovator company actually develops it?

And so what that means is that the pharma model could actually fundamentally change. Meaning you do not have the patent cliff anymore, where a very important blockbuster drug comes out and all the generics are behind it competing for the same product. That is a hypothesis, something as simple as Doxil which is just liposomal formulation of Doxorubicin, clinically approved in 1995, off patent for six years. The sales of Doxil have continued to increase, even coming off patent with not a single Doxil generic under path to approvals today. And why is that? Because demonstration of bioequivalency is virtually impossible. And so for a generic company to make the same drug, they would have to completely redo the clinical development strategy. So then the key, I guess for my venture capital colleagues here, is what did you not invest and to what do you invest in because I just said, biologics have had a humongous impact on the bottom line of the pharma business, but a lot of dead bodies were found in the streets of people who invested in the biologics in the early days.

And so, are we in the early days of nanotech so that the guys next to me are going to lose a lot of money or are they going to see a lot of ROI because nanotech is actually coming to maturity? And I would say, because I am founder of two nanotech companies, two companies that were in the latter group. Our work is mainly on developing nanoparticle technologies that are used for therapeutic applications. And actually a technology that we developed that can deliver a chemotherapy drug in a targeted way when it is systemically administered for treatment of cancer, that technology is entering clinical trials October of this year in the US. And to the best of my knowledge, it is actually the first example of a targeted polymeric nanoparticle; a sort that can give you controlled release in targeting that would enter a clinic.

And my other company is developing nanotechnology-enabled vaccines. In fact, our lead program is a vaccine for a smoking sensation. And having a walk around Saint Petersburg, I would say we could use a lot of that here. And those technologies are all within months to a year or two of clinical translation. So the way I see it today is we are in a verge of a very exciting time in medicine, because of nanotechnology. Thank you.

M. Uvarov:

My name is Maxim Uvarov. I'm the CEO of Binnofarm. I've decided to change my speech a little bit. As you can see this is a global market and we are here in Russia and I would like to talk about the problems which we face here in Russia. I will do my best to speak in Russian.

The first problem that we have encountered is that we do not all speak the same language. A translation today serves as an example — it seems that words such as "innovations" and "biotechnologies" are understood by everyone, but a rather commonplace English expression like "venture capital" was translated as "risky capital"... These problems exist everywhere, and we encountered them when we presented several projects to President Medvedev, at a meeting of the Modernization Committee. One of these projects is restorative medicine, the growing of human organs from human cells. This project is being carried out in conjunction with the Moscow State University, working with a relatively large number of research institutes; however, the most pressing issue is the need for governmental support to get this enormous project up and running. This involves relatively large and risky investments, and not everybody can make this kind of commitment. It is necessary to create a certain playing field to enable these investments in our country. We need to implement or apply international experience in Russia. For example, why is patenting something here so problematic? Simply put, we lack a legal structure for normal patent protection. In this case, this is essential. However, apart from this issue, we need support from the government to get this process moving. For example, there is an interesting discussion going on in the next room about creating a city of innovations, and what that requires. However, support from the government is also needed to stop all of this in time. I will explain. I was playing with some kids this weekend, and asked one of them — how old are you? He said he was 10. Then I asked him, "What do you know about genomes?" He poked around the Internet, read a bit, and said, "Well, I know a lot about the genome." I said, "So what will happen if we change the genome?" He thought for a long time, and answered, "Hairy fish?" Essentially, this wasn't far off the mark. Given this sort of situation, we need to be able to stop this whole process in time. Movies about the X-Men or Spiderman depict our near future, but not everyone is willing to see that. Therefore, I think I would like to finish my speech saying that this is an incredibly interesting market, and it will be incredibly interesting to see what comes after the genome. However, are we ready to face this future? Thank you.

K. Skryabin:

Let me make a little comment. If you play with a ten-year old boy, it would be nice if this boy had gone to the DNA school in Cold Spring Harbor, where he got all the education, and learned, What

is DNA? How are hereditary things organized?, and so on and so forth. Then, when you ask the question, then this ten-year old boy will give you a very good lecture, then you will get enough knowledge, after which you will never speak about Spiderman.

G. Carr:

Thank you. I'm sure we would all benefit from a visit to Cold Harbor occasionally... Finally, Dr Vidro, please.

V. Vidro

I am representing Genometrica, which is an equipment engineering company, and because of this, and the fact that I am a physicist and engineer by trade, I would like to approach this issue from a different direction. I believe that the last 10 years of genomics development failed to live up to our expectations because of two inherent problems. The first has to do with the fact that most of the research is carried out in large genome centers, equipped with large, highly efficient computers. These centers are batch manufacturers, which significantly limits the ability of smaller companies and individual researchers in carrying out more experimental projects. They are forced to wait in a queue and adapt to the equipment at a given genome centre. As a result, they end up closely resembling each other. The second reason is that new equipment, developed by different companies, new equipment for sequencing, for example, is so strictly limited by the fact that there is only one type of technology, there is only one software package, and one set of chemicals, so that the ability to make useful comparisons of data produced by different researchers is greatly inhibited. Since genomics and equipment development are developing in this direction, they have lost the opportunity for research diversity. It is obvious that active and effective development is practically impossible without diversity, since diversity adds a necessary element of flexibility. The situation closely resembles that time in IT development when the only available equipment were mainframes, large scale computers. When somebody wanted to make a calculation, they had to wait in the queue. This problem was resolved by the development of desktop computers, widely available application platforms, which could then be used by individual researchers or even home users. It is obvious to anyone that this was precisely the moment when IT technologies began rapidly evolving, when any person, any researcher was able to make any calculations, carry out their own experiments, and exchange applications. We believe that the equipment used for genomics research needs to take the same path, and this will make research development faster and more effective. In fact, this is precisely what the Genometrica project, which I mentioned before, is about. We develop equipment intended to solve this issue. This equipment is designed

with a whole range of specific characteristics, aimed at solving this issue. First, this equipment is intended for use in small laboratories. We are talking about equipment intended for analysis based on laser-induced fluorescence, and in practice, this is basically the only analysis that we need. The equipment is modular, which allows for installation specifically in small laboratories. Moreover, its architecture closely resembles computer architecture. Here are some slides, illustrating this equipment — here is an example of some interchangeable lasers, which work in various ranges. Here is a sample analyzer and a spectrophotometer, exceptionally sensitive, broadband, with a wide dynamic range. This gives you a good idea of the equipment we have to offer. Because it is modular, researchers are able to use different combinations and thus, set-up their experiments however they wish. The most important characteristic of our equipment is scalability. Starting on one end there is the need for equipment to be made from affordable parts to even make it usable in the classroom, so that students can learn on systems based on the same principles as the equipment that they will be using in their future research. On the other end of the spectrum, in the near future, in the next two to three years, we plan to offer equipment based on these same principles that will have the ability to demonstrate advanced sequencing processes. Our equipment's second set of characteristics is related to its ability to function online and the applications it offers. All of our equipment is based on open-source technologies, so any researcher is able to set up their experiments or install their own applications. It has a built-in database, and everything can be controlled via Ethernet or Internet. Therefore, this equipment can be used as a foundation for relatively large research networks, especially considering that every researcher will be able to carry out their own experiments. Equipment that is both modular and built on open source principles is apparently quite universal. This means that the same equipment can be used for all kinds of different analysis, including sequencing, PCR, and hybridization. It's exceptionally low cost, uses a minimal amount of reagents, is simple to maintain, and as I have already mentioned, allows for great freedom in experimentation.

G. Carr:

I think I am going to have to cut in here. We are trying to keep to the time. We got a half an hour left for questions.

O. Farokhzad:

You know, there is a problem of strategy. I know there are something like five different machines which cost up to USD 50,000 and can do up to 5 million nucleotides per run, and this is the type of strategy. Do we need it to bring these machines to the hospitals? I mean into the schools. Or do we need to have the big centers that do the big genomes very fast and very cheap, and then go to

some computer centers where you do the checking of the information? That is what is coming next year or the year after. I am not saying that this is not a good machine. Maybe it is fantastic but you know, it is a problem of strategy which the countries will choose for the healthcare.

G. Carr:

Yes. I have just been around the world, looking at these institutions in this field. And I went to one in China, the Beijing or BGIs or what used to be known as the Beijing Genome Institute. They claim to have more sequencing capacity than the whole of North America. They are going for the big industrial end, do you think that is a sensible idea?

O. Farokhzad:

I was in Hong Kong in Shenzhen last week. And so, the center, it will be 250 machines. Our European consortium has 35 machines, but the problem is that machine is not everything. As the COO of the BGI said, "We are your muscles; you are our brains." That is why sometimes, you need to make the distinction between the muscles & brains. So I am not sure that the cost up to now, we asked about three sequencing genomes from the Chinese guys and the price was just the same as in Europe or in States. That is why we will see what happens.

G. Carr:

I will open questions to the floor in a moment, but I would like to take the chairman's privilege to kick off. I am quite persuaded by the idea that there will be improvements in the diagnosis of disease and that will be a medical advance. But nothing I have heard really persuades me that genome technology is going to help for the treatment of disease that would generate new drugs. Could the panel address this point for me? Who would like to be first?

S. Burrill:

So let me just start for a minute. I think part of the reality is that we have a very archaic definition of disease. And so where new technology is taking us is to understand disease at a molecular level, not at a symptom level. And the result of that is that we have taken things like cancer and to define that as literally hundreds of different diseases today. And our ability then to interact with the mutation-specific medicine is where we are going.

So I think the technology is enabling us at both ends, one to get to a different definition of disease and therefore, a different treatment paradigm largely on the diagnosis side originally. And so, by understanding the genetic mutation, we would understand the snip, or whatever is causing the problem, redefining disease and then beginning to develop therapeutics which can interact with that

or prevent that. And so, we have done that fairly well in cancer already. We have done at least as well in cardiovascular disease and other areas. And so, you have seen maybe as many as a dozen new cancer drugs that are very much targeted at mutations.

G. Carr:

I think that was not quite my point. My point is that they — you know the tools of genomics — are quite well adapted to diagnosis. You look at the genome. You look at the phenotype, the disease. You do the correlation. If you have a big enough population, you can work out the correlation between a particular snip or a particular inversion or whatever and a particular disease type.

So, it is adapted to diagnoses, the process of genomics. But to go from that to actually producing medical treatments, particularly drugs, is the only thing about the process of genomics itself which informs that or you're simply back to the drug treadmill of having found out what the disease mechanism was and going on the very, very long process of turning that into a treatment, which we sort of know how to do, but I was hoping the genomics might help that as well.

K. Skryabin:

It is the general question of molecular biology, if you know the target, if you look through the sequencing, that this catalytic unit, this enzyme, this protein has a wrong structure, here then you can develop the drug which will compensate these mutations. And this is a simplified explanation, but you know, a more serious thing is that if the car doesn't work, first you needed to diagnose this. What is not working, okay? And then, you need to add a different method, which is a stem cell, which is a lot of the new molecular biology and cell biology approaches, which can help you to improve this type of imitation. It is not a simple thing that if you know that this letter is wrong —

G. Carr:

The point I was trying to make was exactly that. But we are here. We are talking about genomics and also about nanotechnology. It is a very narrow way of looking at the problem or is this a narrow way of looking at the problem? Is it that actually the fundamental way of looking at the problem or is it restricting our thinking rather than enhancing it?

K. Skryabin:

Can I make an analogy? Okay, the situation is that human beings now, over the last five years, started to know how to read books. In two or three years, we will have a lot of educated people who will know how to read books. And then, as you said to me, okay, if you know how to read books, what is the reason for this? So from the knowledge gained from reading books, your idea started.

You know the phrases, then you know the verbs, then you know the poems, then you can forget Tolstoy and *War and Peace*, and then you have a different approach to the whole problem, to your whole understanding.

S. Burrill:

So I would just say that it is this understanding the molecular basis of life that is leading us to ultimately molecular treatment. So we have to get to the definition and the disease first. And then, once you have been able to diagnose that, you can then develop the therapy that can interact.

So the big changes are removing from a one-size-fits-all symptomatic treatment today, to actually why we are moving to the world of genetic or molecular medicine.

K. Severinov:

But if that were the case then — I mean, someone mentioned the U.S. healthcare system, and that has been becoming progressively more and more expensive over the years. So I believe people live longer there, but also they live longer — well, not in Russia, but in China and other places, right?

So, personalizing the thing actually can, in fact, increase the burden. I mean, this would be the burden on individuals because you have to imagine just the scope of this thing. And the reality is that this may not be really that necessary and that simple things may be available. For example, when you were talking, you mentioned this analogy. You produced a cell phone. And you said, you know, cell phones were rare before, and now you can do something like this. The problem is that cell phones fulfill a clear need, people's need to communicate, right? However, the genomic data may not — at least at our current level of understanding — may not fulfill a specific need because knowing your or my genome may produce certain data and certain frequencies, the probabilities of us dying of this or that. But in fact, we are not even prepared at this moment to understand what these frequencies actually mean for our individual lives.

Y. Krestinsky:

Ladies and gentlemen, colleagues, my name is Yuri Krestinsky and I represent Moscow's Institute of Public Health in the Russian Federation. My approach to the issue takes a step away from the scientific methodological aspects of this topic. This is an economics forum and, accordingly, my approach touches on the economic aspects of this particular topic. At present, it's self-evident that genetic technology will contribute to the restructuring of the entire healthcare system. Healthcare, including the pharmaceutical industry's biotechnologies, represents a significant segment in many countries' economies. It is obvious that a shift to personalized medicine will lead to a convergence

of various industries. I'm talking about the convergence of medical technologies, pharmaceuticals, and biotechnologies. Therefore, I pose a practical question — what effect will this have on healthcare economics and how will this change the markets? I expect that Mr. Burrill is probably the most qualified person here to answer this question.

S. Burrill:

So first of all, 55% of the drugs used in the United States do not work for the patients they are prescribed to. So the cost to society today for things that do not work, societies around the world, is absolutely extraordinary. And the benefit of all of this technology is going to reduce the enormous amount of waste in the system around the world for things that basically do not work and begin to reallocate those things to things that do work. We are never really going to get to a personalized medicine that is so customized that virtually every drug has to be customized for every individual, but we have enough commonality among the genome and enough of the diseases that we can get to a much more personalized medical world than we are in today. So the economic argument is the savings of a system that by and large does not work because we are treating symptoms of diseases rather than diseases and we are treating them very poorly. We will provide the economic reward that you are looking for.

K. Severinov:

Can I just comment on this briefly? I think there is a methodological, so to speak, problem with this whole concept of personalized medicine. Because as someone mentioned, the big companies do not have enough drugs in the pipelines, right? It is not that we have an enormous amount of drugs from which we can choose, mix and match, and sort of find something that is used by this guy or that guy. The problem is that we have too little, right? And so, the whole potential of personalized medicine can only be realized if there was a pool to draw the drugs from, and there is none.

Dr. O. Farokhzad:

But I would actually add that you know, if you look at an average drug, it takes some ten plus years to make, USD 1.4 billion to develop, that we are looking at this at a very narrow window of time and judging it. Let us not forget that the Genetic Information Nondiscrimination Act of the United States was only passed in 2008. Until that time, I for one would have been scared if you guys sequenced my genome because I would worry about the implication for health insurance, the implication from an employment perspective.

So today you know, in mid-2010, we can say the clock starts ticking and let us judge it in the next decade and say, "How has the genome impacted human health?" And my prediction is that over

the next one or two or three decades, we are going to see a reduction in cost. We are going to see more effective drugs. Today, one out of every 10 drugs that goes into clinical development fails. And of the ones that become approved, only two out of 10 has a positive ROI. And why is that? It is exactly what you said, which is a lot of these drugs are being used inappropriately on the wrong patients. So I actually think knowing who to use the drug for, having the information on the patient information is going to help us develop better drugs and economically, we will see that saving.

K. Skryabin:

I want to make just one example: a patient goes for surgery, heart surgery, and then after the surgery he gets Warfarin, the anti-clotting drug. For ten dollars, we can do the diagnostics of one mutation and we can say to the guy whether this drug will work or not. And it can save his life, ten dollars, and this is pure genomics. I'm sure that in one or two years we'll have several hundred such examples, which will have come from the genome sequences, obviously.

M. Uvarov

I would like to answer this question in the following way — I believe that, after a certain period of time, the doctors will become sort of conduits, since treatment itself will be personalized. More to the point, the medication itself will be personalized. I do not know when this will happen, but this will significantly change the economics. Therefore, in a way the manufacturing companies themselves, by adapting directly to particular clients, will play a greater role than the doctor himself. In particular, I would like to draw my colleagues' attention to a particular detail— look at the size of our audience, at the number of people in this room, and compare it to other audiences. I think we need to be more attentive to this situation, and to explain more clearly what a genome is. I believe that this is an incredibly interesting topic, and that there is a lot to talk about here but, unfortunately, not everyone sees things this way. Still, I think that we need to continue talking about this, and to try explain it to people. This is not up to us; it needs to be done at the state level, especially since it was the government who organized this gathering. These are very interesting issues, and need to be worked on and explained to people, including 10-year-old children.

From the audience:

This is all great, and what Mr. Skryabin said is excellent. However, as we are still in Russia, I would like to point out to everyone here, especially the Russians, that this problem in particular is partly due to the fact that those who are carrying out all the research mentioned before are working here in this country. Our problem lies in the fact that we do not have the financing for significant

development; we are financing projects from our own pockets and often have many difficulties. Quite often, we only find out about how our research is being used from our American and European colleagues, which is very sad, quite deplorable. How can this be fixed? I have been here for some time, but I have not heard anyone mention this issue. It is wonderful for us to talk about global economics, but gentlemen, please do not forget about Russia. Thank you.

K. Skryabin

Please let me answer this. You are absolutely correct in what you say, for many reasons. Here is the main issue — the greatest developments will, of course, take place in cancer research. This is beyond doubt, and many have mentioned this before. There is a worldwide cancer study group, called the International Cancer Genome Consortium. Russia is a full-fledged member of this organization. I spoke about this earlier — research into kidney cancer, carried out in Russia in cooperation with the largest research centre in France, the largest centre in southern Europe, and this is our only opportunity. Our only chance is in collaboration. If you are talking about basic science, about particular implementations - this is the first aspect. The second aspect is if you are talking about creation of companies who focus on diagnostics or other issues related to genomics — this is already taking place, but a lot hinges on this. We have spoken with Watson, and he said, let's do it this way — let's take every student entering a biology department or university, specializing in biology, and let's test them, analyze their genomes. This is something for the university to deal with. It creates a market and will immediately help those small diagnostic companies to grow and gain practical experience. Otherwise, you are absolutely right — we will continue sending our DNA to Switzerland, just as we do now, and they will analyze our genomes and then send them back to us. We know that there are seven large centers in the world — there are the Chinese, there is the Brown Institute in the USA, in California, and then there are four centers in Europe and one in Russia. These are the central players currently carrying out human genome research.

S. Burrill:

Let me answer your question directly. But first let me give you an example for a minute. In the last year, in the United States alone, we raised USD 55 billion in the private sector for companies — USD 55 billion in the United States alone, in the worst year in the history of this industry. So it is the private capital market that is going to spawn this industry and build this industry, not public funding, not government funding. On the other hand, we have to recognize that we have 15,000 biotech companies in the world today, not five or 10 or 20. And there is actually plenty of capital in the world for all the companies that deserve it. The problem is that we think that every science project

deserves a company, and that is not a valid assumption. And so, what we need to do is to get more efficient, more experience as others have said, people in the system that can appropriately allocate not only financial capital, but their network capital and their experience capital to enable all of this to happen.

My firm among them is trying to do that here in Russia. But there certainly are experienced people. I have been doing this for 40 years. There certainly are experienced people in the world who can find companies, can find capital and build companies of scale. And it will be the private sector, not the public sector. Yes, we have very, very substantial R&D spending all over the world today. China, Korea, India, Russia, other countries, other than the United States and Europe are spending massively. But it is the private sector that is basically financing this industry. And we started the industry in the late 60's and 70's in the United States. I wrote the business plan for Genentech. I know what it is like to build an industry. We did it off the backs of entrepreneurs. We did off the backs of private companies. And we will do that here in Russia as well although there are some institutional barriers that make that difficult.

O. Farokhzad:

And I just want to add actually, I do not think that to build great companies is an issue of capital or it is not an issue of capital alone, let me say. And the reason I say that is because I wonder what is it about Silicon Valley that makes so many great companies come out? What is it about Boston or Cambridge that so many Biotech companies come out of there? And why does it not happen in, say Chicago, or some other great cities that have equally good education? You know, I think, if you can answer that question and fundamentally import the answer to Russia, then I think, you can create the same types of very rapid innovative economy that still exists in Silicon Valley or in Cambridge, and I do not think it is just capital alone.

S. Burrill:

So let me quickly answer that question: it is the stigma of failure. In Silicon Valley, if I start a company and fail, I will dust myself off and people will say, "I bet Steve is going to come back even smarter the next time."

In most other parts of the world, if I start a company and fail, people will say, "You better stay away from Steve. That last company failed". And so as cultures around the world can accept the risk and reward and understand that as scientists, we fail and we fail and we fail and we fail, and then, we discover something. The same is true with business. It is okay to fail. And we have to have a system that tolerates that failure if we're ever going to change the system. If you are only given one chance to succeed with your company, it will be very difficult. And so, what we have learned in the

United States is lots of things failed, but that gives us the base on which to build successful companies. And so this entrepreneurial drive that tolerates failure is what separates the Silicon Valley from the rest of the world.

G. Carr:

How would you go about changing that in other parts of the world?

S. Burrill:

So that is a big challenge and it was indicated earlier this morning, mostly by Craig Barrett, we need education, a very strong education base, and we need a lot of research, and we need to reward our entrepreneurs. Now, we can reward them with monetary reward, which we have done. And we can reward them with publicity, which we have done. But there needs to be both economic and non-economic reward in order to change a culture, so that we build a culture of entrepreneurship. Now, they cover a culture that kind of top down government. You have to remember the Biotech industry grew out of world class academic science. It did not grow out of the pharmaceutical industry.

G. Carr:

And your specific point, because it is interesting, what about toleration of failure — presumably and ultimately, the people who have to tolerate the failures are the people with the money? The people like yourself, in the context of America, people like you. The financial institutions are the ones who have tolerate failure. How do you change their attitudes?

S. Burrill:

Well, we have already done that. So if you look at us as venture capitalist, we fail all the time. We just hope that our winners are more than our failures. So the answer is that we are portfolio investors.

G. Carr:

Well, Yes. I can see that is sort of objectively. But as a cultural shift, how would you come to Britain, I mean we're in Russia, but I don't know a lot about Russia. I know a bit about Britain, are we sort of half way between the two? We have some venture capital, but we still have this stigma of bankruptcy. Then, someone who has failed in business in Britain is not often going to get a second chance. They still do sometimes. How would you change the culture in Britain?

S. Burrill:

Well, that is why they all moved to the United States.

G. Carr:

Exactly.

E. Zaytsev:

Well, there are a couple of other things also that need to change in the mindset here in Russia. First, people, when they start their projects — actually, you know, the other interesting thing is people call their projects “projects”. We do not call our companies “projects”. So here, people start projects, not companies and that is another thing. They do not think about their scientific projects as businesses and that is very important because their research and development efforts are not marketing driven, because the first thing the technology entrepreneur, in this case biotech entrepreneur, has to ask himself, is basically, who cares? Who needs this project that I am developing, this product or service that I am developing? And in Silicon Valley, that is the first question entrepreneurs ask. That is the first question a venture capitalist asks when he sees your company. The other part of the problem is that people need to understand from the very beginning that biotech is a global business and they need to build their companies as global businesses. That means intellectual property protection on all the markets where the company is going to operate. That means they have to think about it globally because if the company is not global, it is not going to be attractive for venture capitalists. There are many good projects, as you call them here in Russia, that are oriented or focused on the domestic market, and that is great. These could be very good businesses. But to be able to attract venture capital, especially professional venture capital, it needs to be a global company. So that is a part of it.

G. Carr:

All right, time for one last question. I promised the organizers we would end at 3:30.

From the audience:

It's very nice to talk about organizing biotechnological companies in Russia; however, gentlemen, the question is not whether our economy will continue to be resource-based, or whether we will be able to make money from biotechnologies. This was not my question, I was actually talking about the fact that the government spends quite a lot of money. If you have a look at how many grants are being awarded, and at the numbers that have been bandied about — I think you know about this better than I do. And what are the benefits of all this? There pretty much aren't any. I am simply

talking about the fact, about the inequality of access to these funds, to this money, do you see what I mean? There is money and it is being spent, but there are no results, and as a result there is an impression that nothing is happening. That is what I want to talk about, and what a pity that there is no time. Thank you.

G. Carr:

You needed to make genomes of the decision makers who distribute the money. I finally understand why you don't give the money to the right persons.

G. Mikhailik

Good afternoon. Director General of AVA-PETER, Gleb Mikhailik, I represent practical healthcare. We are the largest high-tech human reproductive centre in Russia. We actually carry out more treatment procedures than all of the research institutes in the Russian Academy of Medical Sciences, and we have relatively strong ability to attract new technology and funding. However, the main thing that Russia lacks...

G. Carr:

Sorry to interrupt. We have to come to question because we have to close very quickly.

G. Mikhailik

The main issue, changing healthcare and the purchasing system in Russia, is no more complex than decoding and applying the genome. I will repeat that, unfortunately, until certain conditions for the purchasing of equipment are met, this issue cannot be resolved. I speak from my own 15 years of experience in the field.

G. Carr:

Well, thank you very much. My thanks to the audience, to all the panelists. I don't think we achieved much of a consensus.