Headlines of the Future

A podcast by Bayer

Episode 1 – The Bio Revolution:

What are the features of a revolution? You know, they're disruptive. It's sudden. It's exciting also sometimes a little bit intimidating and hard to grasp and fully understand. And that's exactly what we're witnessing in science right now. This burst this acceleration of breakthrough and knowledge generation that we've never seen before.

Welcome to Headlines of the Future. Brought to you by Bayer.

Fascinating clues to help solve some of the most pressing global challenges from climate change to feeding a growing population to curing diseases can be found through science and innovation. I'm your host, Kate Hayes. In this podcast, we'll hear from visionary scientists, thought leaders, and entrepreneurs to learn more about how the science of today could positively impact our lives in the future.

I'm very happy you've joined today's episode and I can assure you, it's going to be revolutionary. We'll talk about the bio revolution - a revolution that could have the potential to transform many areas of our lives. But, what does the bio revolution actually mean? And how could it shape our future? I'm sure that our two experts who've joined me today have interesting answers and perspectives to share.

Dr.Michelle McMurry, Heath, president, and CEO of BIO, the biotechnology innovation organization. Welcome to the program. Thank you for joining. Thank you so much. It's a pleasure to be here.

And Dr. Juergen Eckhart, who is head of LEAPS by Bayer, the impact investment arm of Bayer. Thank you for being here. It's a great pleasure being here. I'm looking forward to the discussion. Wonderful.

Well, I'd like to start by asking each of you to tell us a bit about yourselves and your career backgrounds. I think it's interesting that you're both medical doctors by training, but now work in roles related to enabling breakthrough scientific innovations through investment and advocacy. So what led you to pursue a career in medical science and how does your path lead to where you are? Michelle, we'll start with you.

Well, I've always been interested in how science and medicine can help improve people's lives. I think people's health is one of their most important assets and one of the most important, features and foundations of being productive and reaching your goals. So science, I think can really unlock that potential for so many individuals and communities. And that's what really attracted me to biomedical research to begin with.

And what do you do as part of your world today?

So, today I lead the biotechnology innovation organization, which is the world's largest biotech science advocacy organization. So we represent over a thousand companies, academic institutions, and other organizations in over 30 countries. And we really just try to stand up for the potential that our scientists have to produce, you know, wonderful outcomes on the world around us.

So when you were in school, when you're getting your MD, did you ever see yourself doing what you're doing now? And I'm wondering, how did you get from point A to point B?

Not at all. I didn't even know what I'm doing now existed. I really started in medicine. Both of my parents were in the healthcare field. My mother was a public health nurse. My father was a psychologist who designed programs for communities that couldn't afford private, psychological care. And so I could see the importance of health and medicine on communities around me. And as I got to medical school, I loved not just the medicine, but also the science and the research aspects. And as I started learning a bit more about what research projects got pursued and which ones ended up on the cutting room floor, I got intrigued about the policy behind the science, the funding of the science, the political debates about which science was worthwhile and which wasn't, the forces that scientists and researchers felt from patients who were desperate for cures and solutions that didn't yet exist. And that really led me further and further upstream to asking the questions about what are the levers, what are the forces that determine whether or not a scientific breakthrough gets pursued or achieved?

That is so interesting. Well, Jurg, I know that's part of what you work on now, too. So tell us a little bit about your career and your journey to get where you are today.

Sure. So I also chose like Michelle to study medicine as a teenager. And I guess what originally drew me into this field is just, you know when you grow up and you see your parents' generation, or maybe your grandparents' generation, you see that many of them are really suffering from diseases. Chronic diseases for which there is no real good solution. When you grow up as a kid and you are sick, usually it's a matter of a few days, you know, it's an acute disease and you get back to full health again, and you realize that as people get older, you know, many of them are stressed, suffering from chronic disease. I think that's what ultimately drew me into medicine in the first place, because I felt well, we've got to do something about this. Right. And if I can, you know, contribute something with my sort of professional life to that sounded motivating to me. I think that's why I ultimately went into it. I didn't also realize later on, you know, being a medical doctor, working in hospitals that really, for many of these patients, we don't really have good solutions. You know, most of them are suffering from chronic diseases. While, you know, we have good therapies, many of those therapies are often just really symptomatic. They don't really reverse the disease. They don't cure the disease and we can't really fully restore health in many cases. And I think that then later on like me more into science and into new innovations and into venture capital and ultimately to what I'm doing today at LEAPS.

And what is it that you do at LEAPS? What is LEAPS all about?What's the mission? ,

The LEAPS mission really is to invest in early-stage potential breakthrough technology platforms. So really technologies that could change the way we do healthcare. Fundamentally, going from, from therapy to cure or even better to prevention on the healthcare side. We also think about the whole agricultural side of things. And in agriculture, we really looking also at breakthrough technologies that could change the way we do agriculture, make agriculture more sustainable, right? Not only focusing on feeding an ever-growing world population, but also trying to do so in a way that protects the planet, that is sustainable. So the LEAP's mission is really to go in very early in these technologies, help progress these technologies as much as we can. And then ultimately I guess, provide Bayer an opportunity, once these technologies are more advanced to

insource in-license or acquire these technologies. And as such, you know, we hope that we will be able to help renew Bayer's technology portfolio over time and stay at the forefront of innovation.

So the technologies that you're talking about are these what make up the bio revolution? I think this is a term that most people aren't yet familiar with. So I'm wondering if you can help us explain.

What are the features of a revolution? You know, they're disruptive. It's sudden. It's exciting also sometimes a little bit intimidating to people and hard to grasp and fully understand. And that's exactly what we're witnessing in science right now. We're witnessing this burst, this acceleration of breakthrough and knowledge generation that we've never seen before. It has the potential to impact almost every corner of our lives in a way that is completely resetting the table. And sometimes unsettling to people who are trying to understand and take in all the changes that are happening so quickly. But that being said, the bio revolution is also unlike other revolutions in that it is really helping us achieve our goals in a much more rapid way and get better health and better quality of life to each individual. And there are very few revolutions that are really targeted towards that outcome. And this one is, and it's doing it incredibly well. So while, you know, it does produce ripples in society. It does intimidate folks who are trying to understand exactly what it includes. It does have the ability to clean our environment, feed our populations and heal our illnesses. And those are incredible facets to watch.

Jurg, what are your thoughts on this?

Yeah, so the bio revolution, I think is basically happening because there is a confluence of developments and we're really thinking of three elements that are coming together. First of all, our knowledge about cell biology is just growing every year. It feels like it's growing exponentially. And when I compare what we know about how cells work today in health and in disease, I compare that to what I learned at medical school, right? There's just a whole, several new dimensions of understanding that were added over the years. And I think that new insight we are trying to see and to find cures or better therapies. So that's one, our insights in cell biology. The second time I mentioned that comes together, here is our ability to engineer cells. To go in and create a CAR-T cell. So modified a natural T cell such that it recognizes a cancer cell and basically kills the cancer cell. You know, our ability to engineer cells. Or, a very recent example, you know, taking an MRI and a right and instructing the ribosome to produce a virus particle, which then activates the immune system to basically cure or prevent a COVID. So all these engineering abilities are sort of the second element. And then the third, also a very important element is the whole data science machine learning, artificial intelligence. We are creating so many biological data and we need to be able to make sense of that data. And that's where the whole data science piece comes in. Right at helps us make sense of all of this. I think these are sort of the three forces at work. Which in my mind constitute the viral revolution and unleash possibilities, both in healthcare and in agriculture.

So healing illnesses, I think that's something that gets everyone's attention. Like how can we go from only being able to treat symptoms at best to actually curing diseases that have no cure right now. So tell us about some of the ways that you see this happening through the new technologies.

There are so many, The field of cell and gene therapy is just incredible. Jurgen touched on what we're beginning to be able to see and utilize in MRNA technologies, which, you know, has sccelerated our ability to produce a vaccine for an illness like COVID from, you know, the previous record of four years down to one year. That sort of acceleration of our ability to identify a biological problem and address it is part of what we're seeing. The ability to have regenerative medicine to grow tissues in labs or in Petri dishes so that we can replace failing tissues in patients. The ability to use CRISPR, that Nobel prize-winning technology to go in and surgically with incredible precision alter a miswrite in a gene to cure disease and cure an illness. These are just some of the technologies that we're seeing coming online, but there's, there's many, many more. And all of this is incredibly exciting to patients and to scientists.

So CRISPR is something that I think a lot of people hear about, but don't necessarily understand what it is. What does that mean? So how are you explaining that to people simply?

You know, it's interesting. We were talking about this in the agricultural space, not so long ago. And we were talking about how people have - we've gone from Mendel and knowing 150 years ago, Mendel was breeding certain crops by crossing different types of plants to get the genes that he thought were more preferable expressed in a plant that he was trying to evolve. That was a very luck-based, a brute-force way of changing how genes are expressed in a plant. Then we moved on to what was sometimes the controversial field of GMOs, where we used also a sort of brute-force methodology of putting a gene that we had an interest in into plants that so we kind of just shot it into a plant genome and made sure that we had it somewhere expressed, maybe one copy or several copies until we got the type of plant we were looking for. But all of those are like using a sledgehammer compared to CRISPR. CRISPR allows you to go in and at the gene level at the individual based per level, decide exactly where you want to put a new sequence or code of DNA. And it opens up the possibilities in terms of what types of changes we can make in the genome. For example, we have a member company Benson Hill that is really seeking to engineer small crops so that they have more protein expression. They are more colorful, more flavorful, and more able to grow in hydroponic settings that are low light, low soil settings that are more environmentally sensitive. All of this will allow us to produce safer, more nutritious, more delicious foods in a way that is cheaper and more sustainable. These are the types of changes that are not just nice to have, but that we need to have given the challenges we face and the changes in climate that we're witnessing.

So Jurgen, do you think that most people are aware of the challenges the world is facing? I mean, we hear a lot about climate change in the news, but I'm not sure that it's trickling down to most people in society in terms of, we, you have to make some drastic changes because the world is coming to a serious crossroads. What are you thinking?

I think it's changing quickly, Kate. I think it becomes more and more front page, you know, news and newspapers about climate change, but also about chronic disease. You know, most people probably have family relatives with chronic diseases. They know that part of the problem, but also climate change I think, is becoming more and more at the forefront of themes. So I think it's changing quickly. Right. And, I think with that, people are also then quickly looking for solutions.

Do you invest in technologies like CRISPR within LEAPS by Bayer? Do you invest in companies that are working on gene editing and for what kind of applications?

Yes, absolutely. We do that, both in the healthcare side, but also in the plant side. So in healthcare, of course, Michelle has very well described how CRISPR works and what it can do. You can basically very precise edit h genome. So if somebody has a genetic disease, right, you can hopefully be able to repair that. But we also need editing not only for genetic disease we also need it for other, other diseases. When we prepare, you know, cancer, cancer cells, or CAR-T cells and all the things. We want to be able to edit cells, to make sure they have the properties that they need to do the job that we want them to do. That's part of this cell engineering that I was talking about. And similarly, in plants, you want to make sure plants have the right properties so that they can, for example, withstand climate change, thunderstorms, whatever have you - rain, flooding, drought you know, you can make plans more resistant with giving them the right kind of traits that they need to survive in those environments.

So earlier, I think you both have mentioned, you know, the application of MRNA in terms of creating this COVID vaccine so quickly. And it has obviously been essential for helping to climb out of the pandemic. But what implications does it have for future vaccines? Is it going to change things, Michelle, in terms of how quickly we will be able to develop vaccines for other diseases?

Almost certainly. Most certainly. We will never be able to unsee what we've seen in the last 18 months on so many different levels, you know, as a culture on, you know, in individual families,

but definitely, scientifically. I don't think we'll have the cultural patients for science unfolding at its previous rates, because we now know what's possible. And there's a lot of good in that. That means that we now see that some of the barriers to cures that we're looking for, or hunger that we're trying to fill are more political and will barriers than they are scientific barriers. And that is a huge advance because a scientific barrier is not always predictable when you'll be able to surmount it. But, you know, barriers of will and barriers of politics are things that if we put the right concerted effort behind, we can get ahead of, and that's amazingly good news.

Do you think that the public will become more accepting of vaccines in general, as a result of what has happened with the COVID vaccine?

Well, that's something that's difficult to predict. It was interesting. I don't know if you guys seen the article recently in the Washington Post, where they were looking back historically at the polio vaccine and the launch of the polio vaccine in the early part of the 1900s actually led to similar types of protests and concerns that we're seeing with the COVID vaccine today. So I think there'll always be concerns around scientific progress and it's our role as scientists and clinicians to do everything we can to clearly and soberly discuss the benefits as well as the risks so people can feel a part of the progress. We have to do more to educate the upcoming generation. You know, we need better science education in schools so that kids can feel equipped to judge for themselves as new scientific advances come along and not feel at the whim of politicians or commentators to interpret the science for them. So we need to equip the next generation. We need to do everything we can to speak clearly amd often with people around the science that we're doing and we need to continue to show the benefits. I think the benefits of the COVID vaccines are clear. For vaccines in general, it's been one of the most effective medical breakthroughs of the last 100 years. And there's no reason to think it won't continue to be.

So in your advocacy work, do you spend more time talking about health care advances, or do you find more people have concerns about the bio revolution applications for agriculture? ,

You know, that's a hard question. I think there's a range of questions and concerns, but there's also a range of excitement and anticipation. So we spend a lot of time on all the fronts. We see it really is, you know, the climate change aspects. There's a lot of people worried about climate change can things like biofuels and more sustainable forms of agriculture really help us address our concerns and fears about the changing climate. We have a company, for example, LanzaTech who creates a bio-based version of jet fuel. You know, there's a lot of concerns right now about how jet travel is contributing to global warming. Imagine if you can use biotechnology to completely change that impact, that's very exciting. And we often use that appealing picture of how they're, here's a problem and here's how science is addressing it to kind of open the dialogue on other issues. Agriculture has huge potential as well as we've already touched upon them then of course, in medicine and healthcare. So I think all of those areas face their detractors and face people who are concerned about the progress in the future, but the advances in the potential, or are just as undeniable.

Yes. Jurgen, what are some of the ways that LEAPS by Bayer is investing in companies that are hoping to make a difference in the fight against climate change?

Maybe, let me start with an example of nitrogen fertilizer. Nitrogen fertilizers is a big invention, about a hundred years old. You know, it really enabled modern agriculture, right? Plants need nitrogen to grow. But today we realized there are many problems. Sustainability problems with nitrogen, fertilizers. The production of that is, is very energy-intensive. And I think is responsible for a lot of greenhouse gas emissions on this world. So we could find new ways to provide the plants with nitrogen, which they need to grow. And replace our nitrogen fertilizers that we are using today, then we could have a big impact on this world. We actually have made a number of investments in companies in that space. Joyn Bio, Sound Agriculture and Andes, they all work on different ways, how you could fixate nitrogen from the soil. Some through bacteria, you know, that live in a symbiotic relationship with the plants.

They can fix a nitrogen from the soil or from the air in the air. We actually have an abundance of nitrogen, more nitrogen and oxygen in the air that we breathe. So we could find ways how we could make that nitrogen. Available to the plants or that a plant can grow without adding additional nitrogen fertilizer, we could have a huge sustainability impact. So that is one way, for example, where we invest in this field.

That is so interesting. And so cool. So in the work that you do, how do you approach possible ethical boundaries? Whether it's having to do with agriculture or healthcare innovations? I know that everyone wants to approach this the right way so that there aren't problems down the road. So how do you think about possible ethical concerns within the technologies you're investing in?

Yeah, that's a very good question. We need to take all these concerns seriously and we need to use these new technologies in a responsible and transparent way. And I think the best way to handle this is to be very transparent in what we do. So what we have for example started an open platform where we are fostering a dialogue around these technologies about investing and ethics around these technologies. This is a independent editor who is managing this site. It's a non-for-profit activity where we're just trying to, first of all, educate what's happening, what the scientific news and breakthroughs are and how we could potentially leverage them for the benefit of mankind. And I think by being open and engaging in dialogue, that's really the first step to hopefully make people accept and realize the potential in this and be supportive of these developments. I think for many of these man-made problems that we're having today, greenhouse gas, sustainability, etc. there are man-made solutions available or becoming available soon and we should seize these opportunities.

Is it going to be possible, you think at some point to cure cancer? Like what kinds of diseases are we looking at right now that it's not possible to cure at the moment? Are there solutions that are being developed or that could be developed in the future?

Absolutely. Yes. Cancer is probably about 300 or even more different diseases. For many of those kinds there actually already are therapies today, which are kind of cures and people who have survived those cancers have a normal lifespan ahead of them. So for some of those cancers, we do have cures over. From many, we don't yet. And that's why we can’t stop working on it. But even besides cancer, you know, if you look at neurodegenerative disease, if you look at cardiovascular disease, many of these diseases are really characterized by permanent tissue function loss, right? So if you, if someone you know has had a myocardial infarct, he has scar tissue in his heart. And that scar tissue of course, is not working like a beating heart muscle cell. If we have ways to replace this scar tissue with healthy beating heart cells, then we really have a cure similar for Parkinson's patients, right, who have lost their dopaminergic neurons. We don't really have anything that is curative. We have some symptomatic therapy for them, but if we would have a way to basically replace that lost tissue function by urging neurons that would stick in the brain and do the job then we could speak of cures. And we have investments in our LEAPS portfolio that are working on those things, and that hopefully will become a reality in the not too distant future. That would be so amazing.

Well, now we've come to the part of the interview that we take our podcast title from. Michelle, imagine we're looking at a headline about some impact of the bio revolution in a news article 20 or 30 years from now. What headline would you like to see?

Well, I'm an immunologist by training. And so to me, it's breathtaking how much we've learned about the immune systems since I was studying it almost 30 years ago in graduate school. And we've been able to unlock it as, you know, as a key tool to fight cancer. We've been able to gain a greater understanding of auto-immune diseases and break many of those diseases into sub-illnesses that we now better understand, and we've been able to see its power in helping us protect ourselves from infectious diseases like COVID. So I really think this combination of our understanding of DNA and our unlocking the immune system has great potential and power, but

there are so many exciting areas of science. It's almost like asking someone to choose between their children because there's so much great potential out there.

I think one thing I would like to ask a little bit more about from both of you, you know, in the beginning, Jurg, you mentioned these elements of the bio revolution and one thing we haven't talked a lot about is the role of data science in all of this.

These biological advances are now coming quickly, but I think it's really that convergence of the biological advances and the digital and data advances.

So what role has that played in, in making all of this possible? What are your thoughts on that?

It's an important role and I give you two examples. One is we now talk about in silico drug discovery, right? So in the past drug discovery happened in vitro right in our lab. And today more and more of these activities that used to happen in a lab are happening really in computers. We have great models with which can simulate cells and in which we can test certain things and do the first steps of product discovery. So that's one way how this is changing, that it's going from the lab into sort of the computer office and other machines are changing, the way we do healthcare. I want to briefly mention a company we have invested in that is called ADA. What they basically have developed is artificial intelligence that will ask you about your symptoms and ask the right follow-up questions as a doctor would do when he sees a patient to basically narrow down the possibilities on what this person could be suffering from based on the symptoms he is mentioning, or she is mentioning, and based on the four answers to the follow on questions that are being asked, and all of this is being done with artificial intelligence today. Basically, ADA is an app so that you have the doctor in your pocket. You plug in your symptoms, it asks you follow on questions and at the end it delivers you a certain diagnosis, maybe two or three options that could be of interest and that we should do further examination. What I like about this so much is maybe an aspect we haven't really talked about. I think the bio revolution will also allow us to bring health care to remote regions in developing countries, right? Where not everybody has access to a healthcare practitioner around the corner. And that's maybe another aspect of this viral evolution that I think is really important that it excites me. It's hopefully going to help us bring health care to many, many more people in this world who today don't really have good access.

Okay. So Michelle, how would you characterize what data science has done to help with the bio revolution?

It's definitely an accelerant. It has helped us now. I used to think about the difference between biology and engineering. As you know, in life sciences, we were trained to observe and maybe to look for an answer or a solution. Well, engineers think that they can create an answer, a solution. They can engineer a process to fix any problem that's before them with the convergence of information science and biology. You're now seeing people take that same can do, I'm going to fix it attitude. It's within my abilities to problem solve approaches to the issues of illness, disease, and the life sciences. And that's, what's so exciting. You add to that, the ability to analyze huge volumes of data and in a small amount of time. And it's a powerful combination. I remember when I was in graduate school the sequence of a gene would take us - even to sequence a small section of DNA - would take us days. And you would pour these various large, very fragile gels and you'd run it through. And half of the time after you ran through the sequence, you couldn't even fully decipher the picture that appeared on the get. Now, all of that is done in minutes and machines that can give you an entire genetic sequence. That type of accelerant is so incredible to watch and to see. And maybe we can even talk about like how that capability, how the ability to sequence genomes so quickly and also, you know, upload them to open-source platforms where they're accessible to all researchers helped in even identifying and making the COVID vaccine possible.

I mean, how did that all come together to make that work? It played a very large role.

Yes. One of the untold stories of our COVID response has been the amazing international collaboration between scientists, not just scientists and academia, but between scientists and companies and across countries and all of that has been amazing.

COVID virus sequence was quickly shared around the globe through websites and through data sharing technologies just transformed the way we were able to then put that into a vaccine paradigm that worked. So yeah, it was incredibly important.

Yes. So Jurgen, what is a headline that you would like to see in 20 or 30 years about the impact of the bio revolution?

I, of course, listened to what Michelle was saying to this question. I was fully subscribed to what she said, but maybe just to add something. I would not talk about healthcare but I would talk about agriculture and carbon. I think 30 years is really right around 2050. Right? And if by then we could see a headline that says, you know, the world is carbon neutral. That will be fantastic. I think we should really strive towards achieving that by 2030. That's probably the most important thing that we should achieve as mankind.

So, you know, educating the next generation is also probably extremely important, because they're the ones that are going to carry that torch. We have to make these climate goals and they are really going to have to drive them through the finish line. So I guess in closing, I would like to ask both of you, what would be your best advice? Or how do you get young people more excited about science and wanting to go into one of the fields that could make a difference in the future?

You know, it's interesting. I think over the last 10 or 20 years, a lot of our scientifically inclined bright, young minds have been attracted to information technology or, you know, some of the other areas, but I really foresee us looking back on this period as having the same sort of impact on driving people into science that we saw with the Apollo project. People see the potential of science in the midst of COVID and also how fundamental science is to anything else we want to accomplish or achieve with our lives. We'll see even more and more young people drawn to learning about science and we have to uphold our part of the bargain and make sure that they have the education and the opportunities to take advantage of that interest. It's been more than a hundred years since we have had a pandemic in this world. So two generations had really forgotten about what that really means right now. We all learned the hard way, what that really means. And I think, or my prediction is that many young people will be inspired by biology, right? It will probably realize, well, biology, you know, diseases can be a real problem for this world. And with the success of the COVID vaccines, you know, they will be drawn into hopefully considering a career in science. And hopefully there will be a lot of interest to learn more about biology, science and potential solutions to diseases that were suffering from. And even if they don't go into those fields, they'll at least be very open, we hope, to the innovations that will come and understand why they're so important for meeting the world's challenges.

Well, thank you both so much. It was so interesting to hear your perspectives and thank you for listening to Headlines of the Future. We hope you found our excursion into the world of the bio revolution as exciting as we do. If you want to learn more about science and innovations that will help address some of our most pressing global challenges, you can visit Bayer.com.

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