Center for Strategic and International Studies

TRANSCRIPT

CSIS Event

"Synthetic Biology and National Security: Risks and Opportunities (PART 1 of 2)"

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FEATURING

Dr. Tara O'Toole,

Executive Vice President and Senior Fellow,
In-Q-Tel (IQT)

CSIS EXPERTS

Morgan Dwyer,

Fellow, International Security Program and Deputy Director for Policy Analysis,
Defense-Industrial Initiatives Group, CSIS

Andrew Philip Hunter,

Senior Fellow, International Security Program and Director, Defense-Industrial Initiatives Group,
CSIS

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ANDREW HUNTER: I am director of the Defense-Industrial Initiatives Group at CSIS. And I'm going to kick us off today before handing it over to my colleague.

And let me just introduce today's event by letting you know that this is part of a broader series that CSIS is doing on synthetic biology and implications for both economic and national security. And as I mentioned, this is the second event in that series. We had a first event looking at the potential for synthetic biology across both the economic and national security spaces. Today we're going to focus in closely and look at national security implications in detail.

And we do this at a time when biology, unfortunately, is at the top of everyone's mind because obviously we're dealing with a coronavirus pandemic which highlights the incredible impact that biology has on our lives. And synthetic biology has the opportunity to give us new tools to deal with this crisis. And it's become very clear that biology is absolutely a matter of national security that deserves focused national security attention and deserve to hear more on that – look forward to hearing more on that topic from Dr. O'Toole.

And then let me know that we do have on our event page for this event, which you may have visited, a button that says: Ask live questions here. If you press on that button you can submit a question. We hope to get to as many of those as we can today. If we don't, we still have an opportunity to revisit those in part two next week. So please do submit your questions online.

And I'm going to hand things off now to my colleague, Dr. Morgan Dwyer, who's the deputy director of the Defense Industrial Initiatives Group for policy analysis. Morgan, over to you.

MORGAN DWYER: Hi. Thanks, Andrew. So I am very excited to also be able to introduce our guest for today, Dr. Tara O'Toole. Dr. O'Toole is the executive vice president at In-Q-Tel. She's also had a long career in government, to include serving as the undersecretary for science and technology at the Department of Homeland Security. So what I've asked Dr. O'Toole to do today is start off with some opening remarks reminding us what synthetic biology is and then explaining what its implications for national security are.

So without further delay, I'm going to hand it over to Dr. O'Toole. And I will set up your slides right now. So give me one second.

TARA O'TOOLE, M.D.: OK.

MS. DWYER: All right.

DR. O'TOOLE: Thank you, Morgan. It's a pleasure to be here today. I am very grateful for the invitation to talk about this topic, which I think is critical to not

only national security but to our future and doesn't often come up in national security contexts. I think I have to begin by mentioning COVID-19. You know, as we start to emerge from this pandemic we're going to have to rethink what U.S. national security is all about. And in a broader and richer conceptualization of national security, I think we must include not only the need for a strong military and a robust economy, but we're going to have to rethink the institutions, and laws, and practices that we need to keep our people healthy and how to nourish basic democratic principles. So I will come back to that at the end. But right now I'm just going to talk about a few key points I'm going to try and persuade you of in the next half-hour. Next slide, please, Morgan.

So over the past 50 years or so we have greatly deepened our understanding of how living organisms work. And that understanding has been made possible and expanded by use of the technologies, the computer science, and everything else that comes with it to create what is justly called a bio-revolution. This is the next stage in a series of scientific revolutions that have marked key inflection points in civilization going back hundreds of years. Biotechnologies, including synthetic biology, are going to be foundational to the 21st century economy. And they're also going to be a critical arena for global competition in the geopolitical realm. China in particular is pursuing a very aggressive strategy to become the world leader in biotechnology. And it sees that very clearly as essential to its capacity to compete economically.

And finally, although the U.S. is arguably the innovation engine of the bio-revolution, we are the source of much of the basic science that is propelling us, but we have a very weak translational capacity, particularly in contrast to our translational capacity in the physical sciences. And this is going to pose significant national security threats if we don't attend to it. Next slide.

So the bio-revolution is really founded on several core technologies that I'm going to simplify greatly. But it is all about being able to read, write, and edit the code of life. One of the most important recognitions of the past century in science, at least, is that life is written in code. And as Jason Kelly of Ginkgo Bioworks has put it: Biology is essentially programmable. The code of life isn't written in bits or in ones and zeros. It's written in nucleic acids that are sequenced in code. And because of our capacity to sequence DNA, which we began to do in the 1970s and they're getting better and better at, we have gotten pretty good at reading the code of life.

Our ability to write it, to synthesize DNA, particularly in long strands, is less advanced. It's slower. It's more expensive. But again, we're getting better and better. And there are several entrepreneurial companies out there who have taken on DNA synthesis as their main project in business. And they are making great progress. I'm sure this audience has heard of

CRISPR, the gene editing tool that's known as the Swiss Army Knife, because it allows one to do many different things with DNA sequences. You can alter the sequence. You can add genes, you can remove genes, you can swap them around, and thereby modify the function that that gene is doing. It's become very popular. It's being used a lot, particularly in China, for many different purposes. And it's being used because it's very fast, cheap, and relatively easy to use.

Synthetic biology combines all of these basic technologies. And it uses these technologies to make stuff, basically. I'll come back to this, but it is using the parts and circuits, the bits and pieces, and the operating systems of living organisms to propel the living organisms to do what we want it to do. We may be trying to get yeast to produce opioids, or we might be trying to do something that has never been done before. And all of these technologies are being accelerated and improved by artificial intelligence methods. It is very important to understand this, all right? AI is going to fundamentally improve the accuracy and the speed and decrease the cost of all of these core biotechnology. It's already happening. It's being used to advance drug discovery. It's being used to create clinical triage methods, to diagnose X-rays, to advance personalized medicine, and of course it's being used in synthetic biology. Next slide.

So for several years I've been looking up the definition of synthetic biology in Wikipedia. And for several years it keeps saying: There is no accepted definition of synthetic biology. I think Chris Voigt's definition, that one uses it to access and direct bioprocesses to build things that do not yet exist, is a pretty good definition. And this one from Nature will also work. The essence of the project is that we are trying to manipulate complex multicell systems in organisms in a way that uses engineering principles and methods, including predictability, computer-assisted designs, and so forth, and also makes use of a developing catalogue of standardized parts that we can snap in and switch out, and have a pretty good idea, excuse me, of what these parts are going to do.

There's a lot of challenges associated with synthetic biology. It is absolutely a work in process. But it has come a long way, particularly in the last decade. Ron Weiss, who is a synthetic biologist, predicted in 2014 that an RNA-based delivery method that allowed you to use RNA as a kind of platform to deliver new bits and pieces inside the cell would be a game-changing inflection point in synthetic biology. And the COVID-19 pandemic is giving us a chance to test that out. You may know that one of the vaccines that is coming on very quickly is made by Moderna. And it is a messenger RNA-based vaccine. So if that works, Ron Weiss' prediction may come true. Next slide.

One of the reasons synthetic biology is so powerful and impactful is that it is going to have impacts across many industries. Already 20 percent of industrial chemicals are made using biological processes, which allows us to make these chemicals much more cheaply and consistently than the

usual chemical synthetic methods. Food is going to be, already is, a huge target for synthetic biology, because we have to figure out how to feed billions of people on less and less arable land under conditions of climate change, and scarce water, and so forth. So trying to produce food that is resistant to pests, that can withstand drought, et cetera, et cetera, is going to be a great objective of many companies.

We've already produced really interesting materials and fabrics using such things as spider silk or sports fabrics, and more are absolutely coming. Nature has a surfeit of very interesting materials with singular properties that we can apply to all kinds of situations. This is going to be one of the areas that I suspect militaries are particularly interested in once they wake up and realize what synthetic biology has to offer. Fuels were originally a very popular objective. Have become less so because of economic realities. But they will come back, I would predict. And therapeutics are a very keenly focused area of synthetic biology. Synthetic biology is very much in the mix in searching for monoclonal antibodies, vaccines, and therapeutics that might be useful against this coronavirus.

Same thing goes for therapeutics. We've already begun clinical trials using gene therapy to cure hereditary disease, and to treat cancers. People are hard at work trying to create synthetic organs for transplant and are using synthetic organioids to do such things as to test for drug toxicity without killing lots and lots of guinea pigs. We will eventually, and faster than we think I would predict, start thinking about human augmentation. Not just how do we cure disease, but how do we enhance certain traits – like strength, and speed, and maybe even intelligence in humans over time. And as I said, agriculture and food is going to be a big focus going forward. Next slide.

I'm going to come back to this, but one of the key points I would like to get across is that biotechnology, and synthetic biology in particular, is going to be absolutely fundamental to the coming world economy. And we need to be competitive in this area. And that competitiveness, I think, is at risk as of this moment. I think the COVID-19 pandemic has proven that we cannot rely on stockpiles. We need to be able to make what we need when we need it, and basically make it to order. Synthetic biology holds out the promise of making this come true. And we're going to have to rethink how we create supply chains that can be stable and resilient against all kinds of threats, not just military threats but also natural disasters.

And I don't think I need to say anything about epidemic detection management and resolution, which is what I spent much of my career on. We cannot wait years for vaccines. We live in an age of epidemics. These epidemics are going to keep coming. We've already seen West Nile virus. We've seen SARS. We've seen MERS. We've seen Ebola. We've seen H1N1. We've seen Zika, and now COVID. It's not going to

stop. These epidemics are a consequence of the patterns of trade and travel that we have adopted. Things move fast all over the planet, as do people, very quickly. And intrusion, human intrusion into once remote ecosystems where we are coming in contact with animal microbes that we have no immunity to, that fundamental situation is going to ensure that more epidemics are coming our way. And we have to have a much more strategic response. We believe that the technologies are emerging that will allow us to very rapidly design and then manufacture at scale the vaccines that we need. Similarly, diagnostics, as we are now seeing and should have seen a decade ago, are critical to epidemic response. And these too are technologically feasible. And that feasibility depends on synthetic biology and, in particular, CRISPR. The technology, the rapid readout, point-of-care diagnostics exists. The reason we don't have them is a market failure, essentially.

Specific military applications include materials development, as I've discussed. I think distributed manufacturing is essential to the military and the world. That is emerging. And they too need rapid design and production of medical countermeasures, including diagnostics, as people are deployed around the world without necessarily having a huge medical backup at their beck and call. And as I said, I think human augmentation will inevitably become something that the world needs to think through and deal with. Next slide.

Now, the traditional elucidation of the national security implications of biotechnologies divide into deliberate bio-attacks using biological weapons and naturally occurring epidemics. The latter have often been dismissed as not a national security issue. I think that COVID has basically shown that we do not need to make much of an argument for that. Bioweapons are often misunderstood. When we had an offensive bioweapons program in the '60s we proved in all situations short of war that biological weapons are essentially the equivalent of nukes in terms of their ability to kill people and their large area of coverage. And remember, these tests were done using 1960s technology. And between then and now we have had a revolution in biology and biotech.

And engineered bioweapons are certainly feasible. And it is important to remember that you don't just have to go after infectious disease as a bioweapon. You could also target different parts of human functioning, including – (inaudible) – in the United States is also – (off mic) – weapon is dual use. These materials are very – (off mic) – these methods are automated. Next slide.

Gene banks and sequencing facilities. And they are doing this all over the country. And I said, they're partnering up their internet firms with their biotech firms and investing very heavily in personalized medicine, taking advantage of their sequencing power, which they developed for the last 20 years or so. We are in a war for talent with China. And they are successfully bringing back a lot of the Chinese students that we educated.

And they're also luring back top senior scientists from America, offering them lots of money to do high-risk research of their choice.

So China's ambitions need to be understood, both in the context of what they are trying to do in the realm of medicine, but they also need to be understood in terms of economic competition and what that will mean for geopolitical standing going forward. Next slide. If we want to maintain competitiveness in biotech and in synthetic biology the first thing we have to do is recognize the national security implications of this and build an effective translational infrastructure. We have to measure and track the bio economy. We have to create a strategy that would improve our response to pandemics.

We also need to bring a lot more people with a background in the life sciences and biotech into public service. And we need to be very careful that we don't kill the goose that's laying the golden eggs with CFIUS reviews. WE need CFIUS reviews. We need to get tough on China's investing. But we don't want to crash the ambulance.

Finally, I just want to end with a couple of thoughts. National security has to be everyone's business. We cannot take our technological leadership for granted. It is…we are at a moment when the fundamental technologies that move the world are shifting. They are shifting to biology. And yet, very few in the national security community recognize this or understand the underlying science or are in a position to take advantage of the technologies that will come out of it.

I would suggest, as we reimagine and reinvigorate the U.S. government and national security upon emergence from the COVID-19 pandemic we have to resist being cynical and despairing. We have to take our responsibilities for leadership and citizenship seriously. And we have to be careful that we don't suffer again, in this national crisis, from a failure of imagination. Synthetic biology, biotechnologies are the future. We have to imagine it carefully and in detail. Thank you.

MS. DWYER: Wonderful. Well, thank you so much, Dr. O'Toole. What we'll do for the rest of the session, I'll stop sharing this. What we'll do for the rest of the session is do a couple of moderated questions. We've gotten some great questions from the audience. I think you covered a lot of them in your remarks, which is excellent. We'll try to get to some of those at the end. But what I was hoping to do with our remaining time is unpack a little bit of what – about what you talked about. And I want to start off with where we are today as a national security community which, as you point out, hasn't fully sort of understood or embraced the importance of the biological sciences and biotechnology. But I think it's fair to say that that's changing.

So where we are today as a national security community is in 2018 the U.S. released a biodefense strategy. So could you talk to us a little bit

about what's in that biodefense strategy, how has that prepared us for pandemics like COVID-19, and how should we rethink that, particularly in light of emerging technologies, like synthetic biology, going forward?

DR. O'TOOLE: Well, the 2018 biodefense strategy was many years in the making. It was a very thoughtful piece of work. I would say it was more aspirational than it was a strategy. And most particularly, it did not really include an action plan with resources, et cetera, et cetera. So as a strategy, it was largely unimplemented. And where it was implemented, it was not given sufficient resources to actually be effective.

MS. DWYER: So from the resources – resource capability, each one of those – (audio break) – where should – (audio break) – in – (inaudible) – that can apply to many different industries and towards many different capabilities. What are the next steps in terms of those R&D investments? How do we prioritize?

DR. O'TOOLE: Well, right now we have to invest in diagnostics. From what I can tell, we do not have the manufacturing capacity to create the diagnostics that we need to open up the economy again. And it is not a matter of these big commercial diagnostic companies catching up with the demand. I don't think they can catch up with the demand. I think we need to think about what diagnostics we need and how we are going to make them. There are technologies out there that could give us rapid point-of-care diagnostics.

Some could even read out like a pregnancy test. You could do it in your home. Those would be very useful because people, as they emerge into society again, are going to need to be tested and retested, right? This isn't going to be over in one fell swoop. So I would like us to – I would like us to put together a roadmap for getting those diagnostics. There's different kinds of diagnostics. And some are better for some purposes than others. And then a major push to manufacture them and get them out into use. That's the first thing.

In terms of the broader picture of the use of synthetic biology in defense, I would favor taking – choosing one or two big goals, big missions, and trying to achieve it. I think that is actually – the moonshot or the Manhattan Project approach is actually a very effective way, history shows, of bringing together multidisciplinary teams and putting together something that's bigger than the sum of the parts. So I would pick a couple of bit projects and create public-private partnerships around achieving them. Both to show what synthetic biology can do and what it can't do, and as a way of acquainting the leadership and the country with the promise of this new technology.

MS. DWYER: And from your perspective, particularly at In-Q-Tel, I was wondering if you could talk a little bit about in those sort of public-private partnerships what barriers you might see with all of the companies that make up the bioeconomy, their ability to work with the government. How can the

government change the way it operates or make it easier for some of those companies to invest in innovative new technologies?

DR. O'TOOLE: Well, of course, In-Q-Tel was created to make it easier for small, innovative companies to deal with our enormous, slow-moving, highly bureaucratic government. And I think it's worked very well. I think it's a fascinating model in its own right. It's all of the reasons that you would imagine. Small entrepreneurial companies have to work at the speed of business. They are burning cash while they put together the company and get their products out the door. So speed is money. Time is money. And government moves very slowly. The typical government contract takes months, if not years, to put together and execute. Small start-up companies can't live on that timeline.

It's also very difficult for government to effectively survey the whole landscape of innovative companies out there and make decisions about both business worthiness and innovation, because government is busy doing other stuff. And I think small companies are not very enamored of working with government for all those reasons, and also because it's very difficult for – (audio break) –

MS. DWYER: (In progress following audio break) – you talked about.

DR. O'TOOLE: I think that would be very difficult. I think they are fundamentally different intellectual platforms, different engineering platforms. And I think it's more a question of one age of technology being supplanted by the next. We don't use steam engines anymore. We did not adapt steam engines into electric trains or jet fighters. And I think – I think this translation to a – what I'll call a bio economy, but a bioscience based industrial base, is going to be like that. I think it's a genuine inflection point. It is not a gradual evolution. It's something very different.

MS. DWYER: That makes sense. So we've got time for about one more question. And so I want to wrap it up by asking you to build a little bit on your remarks about technological competition with China. So I think a lot of the national security community has been looking at the COVID-19 pandemic also as an inflection point for relations between the U.S. and China, and sort of China's role in the world. So I was wondering if you could talk about that from the context of this biological revolution that we've been talking about. What role is biotechnology and synthetic biology going to play in the post-COVID-19 relationship between the U.S. and China?

DR. O'TOOLE: Well, I want to make clear that although I think competition with China is very real, and very important, and we need to understand what they are about – particularly in the realm of biotechnology and their bio economy and how they see that – there's no question that this is a geopolitical competition, in my mind. On the other hand, the entire world of biomedicine is based upon international collaboration, on the open

sharing of scientific ideas, particularly basic science. And if we're going to get a vaccine, we need a vaccine for the world. And it's going to take that kind of international collaboration.

So I think we have to find a way, difficult as it might be, to maintain this scientific openness and collaboration around these goals shared by all humanity – feeding the world, dealing with disease, et cetera – while at the same time being realistic and steely-eyed about the difference in their notion of government and ours, and their notion of power and what they're going to do with it, and ours. But hopefully going forward, synthetic biology's going to help us find vaccines and therapeutics and diagnostics to rid the world of COVID-19.

MS. DWYER: Well, wonderful. So I want to thank you, Dr. O'Toole, for joining us remotely today for our synthetic biology series at CSIS. For those of you who submitted questions online that we didn't get to, we're doing a follow-up panel discussion next week on Tuesday at the same time, 1:00 p.m. eastern time. So please join us for a follow-on discussion of synthetic biology's implications for national security. And thank you, again, for joining us today, Dr. O'Toole.

DR. O'TOOLE: It was a pleasure. Thank you for having me.

MR. HUNTER: And, Morgan, if I could add one last note? This is Andrew again. I wanted to make sure to thank Gingko Bioworks, who provided the support that made this event today, and also this series, possible. So thank you to them.

(END)