Controlling Genetic Destiny with Synthetic Biology, Part 1 – Andrew Hessel – #913

Dave Asprey:

You're listening to The Human Upgrade with Dave Asprey. This is going to be a really fun show to record and just a fun interview, because I am a futurist. A big part of what I do very, very early Ecommerce and cloud computing, and so creating biohacking thing, I see a direction, I go there. So I self-identify as a futurist. I don't know what pronoun that makes me, it's a then is my pronoun. But what we're going to talk about today is the future of biotech and what that means in synthetic biology.

This is a double episode where the first part of the episode, we're going to talk about the science of it; and the second part of it, we're going to talk more about other aspects of it, about what does the future look like? But first, let's roll up our sleeves and for out, what is synthetic biology? What does it mean to us? Later, with a different expert coauthor of the same book, we're going to be able to go really, really deep on what's the world going to look like in five years in 10 years, in 20 years. These interviews are based on The Genesis Machine, which is a book about what's going on with synthetic biology. Our first guest here is Andrew Hessel. Andrew, welcome to the show.

Andrew Hessel:

Oh, thanks, Dave, and it's great to be here.

Dave:

I promised listeners that I would tell them what they're going to get from listening to a show so they can decide whether they want to invest an hour or so of their life in listening to you and listening to me and learning from us. What my promise is, and I'm sharing this with you so that you know and we can deliver on that promise is that we're going to teach them about synthetic biology and about how we can use computers to gain access to cells of something and maybe write better biological code, and that by the end of this episode, people will understand enough to at least think about the implications in their life, and maybe even to think about what they want to do next with their life; things like infertility, diabetes, depression, and to think about that hard question of, if you actually could upgrade the wiring in your body, the code in your cells, would you, and should you? Sound like something we can cover in an hour?

Andrew:

I think we can cover some of that, yeah.

Dave:

Some of it, yeah. You'd write a whole book on it if it takes more than hour.

Andrew:

It was written two hours, yeah.

Dave:

Right. Right. You must have used some AI for that because one of the great joys of being me is that I get to talk with you after you've spent your career doing synthetic biology, and then you spent thousands of hours writing a book about it, and you've distilled all that wisdom, and now we're going to get three drops of the most pure essence of all of that work, so it's highly effective. Let's get going, though. Okay.

You work on genomics bioinformatics and synthetic biology. Most people don't know what any of those are-

Andrew:

I can walk you into how I got started, because it's really not that complicated, because I started in the early days when things were pretty straightforward I think they're getting a lot more complicated fast, and that's part of the story. As I started in the early days when things were pretty straightforward, I think they're getting a lot more complicated fast, and that's part of the story. But when I was younger, I took a look at the world and thought, "What am I going to do in this world?" I realized I'm a minimal by nature and stuff doesn't matter to me.

So I wasn't really interested in most of the things that other people were interested in. It narrowed down to, I was just interested in life, like all life. I knew enough biology that all life is based on cells, so I thought, "Well, I have to go and learn about these cells." So I went to school and started learning cellular molecular and microbial biology. It's like starting at the ground floor in life and saying, "How does all this work?" My colleagues that were more interested in at the other end of the spectrum, humans, which are trillions of cells all organized into the most complex biology we know about, they went into medicine.

Dave:

Right.

Andrew:

I stayed working down in the trenches with cells and molecules and at the time, it was still pretty early. What was starting to happen was, people have always dissected animals and we may have done a frog in high school, we started to do molecular dissections, which was really interesting, really getting down into the guts of these systems. We started to do the first sequencing, which is, again, one of the molecules in the cell that everyone knows about, it's the most well-known molecule is the DNA molecule. It's like magnetic tape in the sense that it's the molecule that stores the program that runs this biological machine called the cell. We started to digitize it with sequencing technology, literally a machine that takes that molecule and starts to read the information that's encoded on it.

That information is digital in the sense that there's four chemical bits of information that can be ordered to produce the program ATGC, instead of zero in one, but apart from that, it's a lot like computers. I just started watching the world of computers and the world of biology start to intersect, and this was decades ago. I realized, "Wow," the more I was starting to use my computer more than any other biologist just processing this information, that's where the bioinformatics comes from. I was building databases and dropping information in, and I realized, "Wow, everything I'm learning about computers and networks seems to have a biological analog." So my brain just naturally loved this and-

Dave:

It totally does.

Andrew:

Yeah. so I just kept getting more and more interested in this, and what I started to realize well, all life is has basically the same machine and the cell doesn't matter whether it's a single-celled organ, like a bacterium or you and me, the core machinery is the same. The programming language of DNA is the same, and all of the diversity we get in the natural world around us is really just different software, and I was hooked. After that, all I wanted to focus on was genomics. So genomics, being reading the DNA code and getting it into a computer, software programs for analyzing that DNA code, because it just looks like a string of letters. How do you put meaning into that? Then, synthetic biology is where it gets interesting because now you actually start to want to program that code. You actually want to start writing programs, and that sounds a little weird, but once you've sequenced an organism and got that information into the computer, it's like using a word processor.

You can start to cut and paste and delete and duplicate, no problem in the computer. The fun part with synthetic biology is once you've finished any manipulations and analysis, we start to get a machine that printed out DNA. once you decide, "I want to write a program," whatever that program may be and, "I'm going to hit the print button and go and write that biological program and try and load it into a biological system." So that, in a nutshell is what synthetic biology is. It's a suite of tools and protocols that now allow us to read genetic programs, analyze genetic programs, and now start to write genetic programs to do something useful, hopefully, and-

Dave:

Well last time you were on the show in, it was about 2018, or maybe around episode 500, we talked about hacking cancer viruses and using a virus as a vector to rewrite your genome.

Andrew:

Yeah.

Dave:

A lot of people listening are like, "But we have to do things naturally," and like guys, viruses have been rewriting our genome naturally for the entire history of multi-cell life. That's how it works. We're just saying maybe we could do it purposefully instead of accidentally.

Andrew:

Yeah.

Dave:

Is that an accurate statement?

Andrew:

Well, again, if we started writing programs and the early days of writing programs were more like cooking. You've heard of recombinant DNA technology. Remember that DNA molecules like magnetic tape or film, and so we used to have to splice it. We used to literally have to cut the DNA molecule and put it together to get a new combination of letters, and that's how we wrote programs back then. It was really slow, but we did some useful things like make a few drugs. All of that has been moved, just like film and music into digital world. So now we can do this digital editing really fast, but we have a problem.

Once even we can manipulate that, but now we have to print out that DNA. We have to synthesize that DNA. That's the core of synthetic biology and it turns out our synthesizers aren't very good yet. 20 years ago we could only write a few hundred nucleotides of DNA, bases of DNA. Think of it as the letters and we had to string it together to make a longer program. The very first genome that we ever wrote using this technology, and I mean, by we, science was a virus in 2002. It was about 7,500 letters of DNA, and that's been [crosstalk 00:10:50]

Dave:

That's only 20 years ago, and if you say only 20 years, that's a tiny drop in the bucket of the amount of time we've been on the planet-

Andrew:

Right.

Dave:

But it's changed a lot since then, right?

Andrew:

Well, the trend lines have, have changed, but that was the very first genome we ever wrote, and it was for a virus called poliovirus. But viruses are very small programs because they're not living organisms in and of themselves. They need a cell to be their computer. They're more like a USB stick. They load a program into that cellular computer, and that cell has to run that program. If it's a virus, usually the program is make more viruses. So I fell in love with that particular paper where that scientist had made that program. I realized are going to start working from the bottom up. Anything less than a genome is just a cellular component, like a protein, and that has a ton of value. Some proteins are medicines. Some proteins are structural. Some proteins are catalytic, they're enzymes that actually do a biochemical activity, but I was interested in writing genomes, so I just realized people are going to start to do this. Well, that was 2002. The first genome I ever wrote from scratch and booted up was 2014, so it took 12-

Dave:

Once you booted it up, you wrote it, you created the virus via synthetic tech and inserted it into a cell.

Andrew:

Well, here's the cool thing. It's the cell that makes the virus. All I have to do is write the string of DNA that encodes a virus, and that, of course, is already packaged up inside the virus. So-

Dave:

So what do you write the string on? So you write the string of DNA, you're creating the DNA with some 3D printer kind of thing?

Andrew:

There is basically a 3D printer for DNA. We call it a synthesizer and we don't have desktop synthesizers yet. There are companies that specialize in doing this type of synthesis and assembly work. Actually, there is a pretty good desktop synthesizer yet, but they don't synthesize the DNA in that machine. It's more of a desktop assembler of DNA but, that's exactly what it is. You take the program for a virus that you're working on, literally, on a computer. when you think, "Okay, I've adjusted it just right." You hit a button that's essentially like print, and a molecule of DNA is synthesized. So now, you have a molecule of DNA. What does it look like? It doesn't look like anything. It's a little pellet in a tube when you get it. It's literally freeze-dried DNA.

You add a little bit of liquid to it, a little bit of water, and you take that now with the DNA in solution and you have to get it into a cell. The cell is like the actual printer, so it's a factory. So if you get that DNA into the cell and there's some tricks to do that, it's not hard, then all of a sudden, that cell goes, "Oh, I have a viral genome inside of me." It's like adding an app to a phone and it just starts manufacturing virus, so the cell does all the work. The hard part for us is just writing the program. So I wrote my very first virus program in 2014 when I was working at Autodesk, and that was great, but it was just a virus that infected bacteria. It didn't have any real utility it's well studied.

It's how biologists learn about the mechanisms, but it didn't have a utility. So then I started to go, "Well, what do I want to write a virus for?" And there's an entire field to virology called oncolytics, which just means cancer breaking. These folks were making viruses or tuning viruses to recognize and kill cancer cells. I thought, "That's it. That's where I'm going to direct my energy." So I was very fortunate. I ended up starting a company in 2018 to focus on building cancer-fighting viruses, and it's still going strong in New York today. I'm just an advisor. I'm off to do other things, but there's a great team of people for that.

Dave:

So there's a crowd of people who say, "You should get all of your nutrition from mother nature, and we should all live in caves." I actually don't support that, because if you're going to get all of your nutrition from mother nature, you should get all of your toxins from mother nature. You should probably only be exposed to viruses from within 100 miles of where you're born and by bacteria as well. But that's not actually how the world we live in works.

So biohacking literally is changing the environment around you and inside of you so you have control of your own biology. Now, synthetic biology is the next level of control over your own biology, just straight up, right? I've said for years, "If I could rewrite my mitochondrial DNA to do what I wanted it to do, I would absolutely do that." There's probably some HLA DR Sequences in the rest of my biology I would love to modify so that I could look at toxic mold and just laugh in its face instead of collapsing in its face, as my biologies want to do. How soon will I be able to do those things, and can I be the first?

Andrew:

Well, let's just say we already have the technology to write a mitochondrial genome, because it's pretty small, actually. Let's just say we already have the technology to write a mitochondrial genome because it's pretty small, actually.

Dave:

Yes. [crosstalk 00:16:38] General mitochondria, they think they run us, "Well, I'll see you, Mr. Mitochondria." There we go.

Andrew:

So it's always a tricky question predicting in the future, as you know, especially with these exponential technologies, which have these dramatic S curves. They're doubling at the beginning, but going from two to four is not all that exciting, even eight [crosstalk 00:17:03] It's when really you hit the knee of the curve and it really starts to take off. We haven't hit the knee of the curve yet. We are absolutely in an exponential phase, and if you're tuned to what's happening in synthetic biology, it's magic. You just go, "Oh, my God. The breakthroughs are coming at this incredible pace," but we haven't even gotten started yet, because to give you a sense of where we're going, you have to look outside at nature and the incredible diversity of all the creatures out there, whether you're into plants, whether you're into insects, whether you're into pets, livestock, it doesn't matter.

All of that diversity is built on one chassis, the cell, with one core set of operating systems inside that cell all created using one programming language that we are reverse engineering faster and faster as a species where humans are hacking all live things and understanding how all that works. So when we hit that knee of the curve, we are going to start a cambrian explosion of engineered organisms. Now, that can be a small tweak adjustment, or it can be a complete rewrite of an organism, or it can be the creation of an organism that nature could never put together because nature has firewalls. Especially, with multicellular organisms, you go off on the tree of life over here, you cannot reconnect with an organism over here and make a new connection. We have firewalls in our genomes, but going back to biohacking yourself, and the hard part of genetically biohacking yourself is that you're essentially 50 trillion, little computers all working together.

Dave:

Yes.

Andrew:

Each of those cells have their own program, so how do you load a program into 50 trillion computers at once? It's not-

Dave:

Or, how do you load it into some, without it crashing the whole system?

Andrew:

Right, and making-

Dave:

It doesn't have to be simultaneous. By the way-

Andrew:

Yeah.

Dave:

... managing the internet is exactly what you're talking about. That was my whole career was how do you manage 50 million computers all from one console without state management being an issue? It's the same in biology [crosstalk 00:19:39] quorum sensing for mitochondria of half of them aren't the same as the other half, how does quorum sensing work? So are we going to be able to do this?

Andrew:

Yeah. So, the easy way to reprogram a 50 trillion cell organism is to load the program when we're just one cell. So I'm talking here the fertility clinics and the IVF. Now I have two IVF babies. We cover a little bit this in the book. I was not going to have kids. I had my taps turned off when I was 24, and in Canada that's that was tricky. I had to talk to a lot of doctors, but I never expected to have kids.

Then, life changes. I meet an incredible woman. Suddenly, she hacked my biology. I wanted to have kids with her. So I end up in the IVF clinic because my taps had been turned off for so long, let's just say my little swimmers weren't swimming so great. But it's a candy store for me. This is some of the most incredible cell biology we do on the planet where we can literally harvest eggs and essentially, fertilize them to make a single cell that now becomes a human being. I was a kid in a candy store. Now, if I wanted to change a program, that's the point where you do it, and you don't have to rewrite the whole human genome to do that. You-

Dave:

I'm laughing right now because even though I'm an anti-aging guy, my first book was on fertility and preconception.

Andrew:

Yeah.

Dave:

It just connects to that. That is the easiest time to get stuff right. But okay, everyone listening to this is already past being a single cell, right? So if you're looking to have kids, you can do things to reduce their chances of diseases. It's still not legal to do that in much of the world, that hasn't stopped people from doing it. it'll almost certainly have negatives consequences we didn't think of and positive ones we didn't think of because that's how evolution works. So what do we do? Okay. I'm a walking bag of meat with too many cells right now. How do I upgrade them?

Andrew:

Well, that's tricky right now, because again, it's the problem of loading the programs into the right thing. Now, you can reprogram some of your cells now and there's different ways to do this. But let's just say these technologies are still in development. Everyone parses it through humans, but you have to start working in animal systems before you go to humans. It's just the ethical thing, unless you're a biohacker. by the way, there was a whole chapter in the book that we didn't put in, but I'm happy to talk to you about it. It's the rise of the biohackers, because-

Dave:

How did you not put that in there? I made us rise for a reason.

Andrew:

I don't know. I'll have to talk with Amy about it.

Dave:

You're actually talking about there's two kinds of biohackers. There's the bio-curious people, hacking your cats to glow in the dark. That actually started in 1993, the use of the word for hacking other biology, and then I used it for hacking our own biology. So you were probably talking about the former definition, right?

Andrew:

Well, put it this way. I look at some of the biggest medical advances have been done by self-experimentation.

Dave:

Yeah.

Andrew:

I think you agree with this, we're all experimenting on ourselves in our lives. We have a lifelong experiment in trying to achieve whatever it is we want to achieve. Some people climb Maslow's pyramid to the top of self-actualization, others are just happy just at a certain level, friends and family. But we're all hacking our lives to optimize whatever it is we're trying to do or we're giving up and just sliding to the bottom and hopefully, someone will feed us.

Dave:

Yeah.

Andrew:

But the biggest challenge in doing medical research or biological research on humans is informed consent. It's really hard to people when things are getting more and more complicated and often guided by AI-

Dave:

You just mandate it and then it's no problem. Don't even worry.

Andrew:

True. That's a whole different [crosstalk 00:24:20]

Dave:

You weren't supposed to laugh. Come on, now.

Andrew:

But it's self-experimentation. You have to be able to have some freedom to play with things, but you don't want to be the earliest adopter of these brand new technologies. So biohacking and freedom to operate is really important, particularly as these technologies become more accessible and you want to try doing certain things. Occasionally you see the biohackers inject something into their eye or into their skin and you get a program into cells, even if it's in your arm, theoretically, you've loaded that program. You're now some of the cells in your arm can behave differently, produce a drug, for example.

Dave:

It looks like from what we've learned is that when you inject, and one of the synthetic biotechnologies that I'm really excited about is mRNA vaccines for anti-aging and living a long time. The fact that we use one now for a certain medical condition, we'll see what the results of that are, but it's one experiment of a technology platform. But what they found is they injected it into the arm, but it looks like it doesn't stay in the arm, and it looks like most injections move around. So keeping it local, like lots of studies that showed, "Oh, other cells in the body were making the protein that the mRNA was supposed to make," but what's an example of completely not turning on the immune system, what could you do with mRNA, as a synthetic biologist saying, "Oh, I can do an mRNA vaccine," what could you do?

Andrew:

So I want to be really clear. I think the mRNA vaccines, the fact that we took mRNA and got it into the world, into literally a billion injections, I think that's such a game changer for this technology. So for people that don't know, mRNA is essentially the working instructions to produce a protein and that's all it is.

Dave:

That's all it is. It's not evil. It's a shovel.

Andrew:

It is-

Dave:

You can take a hold with that or whack someone with it, right?

Andrew:

It's easy to program, so it opens the door to programmable medicines and programmable vaccines. So it is really, I hate using this word, but it's the killer app of synthetic biology. It's what pushed synthetic biology into humanity on a broad scale. No other synthetic biology product to date has been so far-reaching. Food is catching up, by the way.

Dave:

Mm-hmm (affirmative).

Andrew:

So food is the first medicine, but mRNA is so powerful, but the mRNA vaccines that they used were stupid. Number one, it's the first time we've written these programs. So I want to be clear, and the first time you do anything, it might work-

Dave:

Are you saying they deployed beta code on a large number of computing modes?

Andrew:

Well, it's the first time we've done it. I'm just saying there's room for improvement. It worked-

Dave:

There is-

Andrew:

... but there's room for improvement. The second thing is it was just wrapped in what they call a lipid layer. So it's a lipid nanoparticle that protects that RNA because RNA tends to degrade very quickly. Just keeping it stable was a biochemical feat, but putting it in a lipid nanoparticle, essentially is very non-specific. When you inject, it will fuse to different cells. It has no targeting ability. It will fuse to cells. It will drop the program in, and it'll run the program, which in this case make the spike proteins for coronavirus, which stimulates an immune response. So a great application, whether you support vaccines or not, this is probably the technology that will be used for all vaccines in the future.

Dave:

It's one of those things, whether you support breathing or not, I really don't support breathing carbon monoxide, but I support other types of breathing. So I don't think at this point, unless you know exactly what you're talking about. I also don't support eating protein, if it happens to be a protein that will kill you.

Andrew:

Yeah.

Dave:

I support eating protein, as long as it's good for you. So [crosstalk 00:28:44]

Andrew:

Yeah.

Dave:

You clearly know this, but just for listeners, if you say you're anti-vax, you're dumb, because there might be one that's good for you. There might be 10. If you say you're pro-vax always, I promise you there's some vaccine out there that some crazy scientist is probably thinking of that might not be good for you. So that's why we have informed consent. It's not a big deal, but for all of the synthetic bio our informed consent frameworks and our regulatory frameworks are broken. I think Amy's going to talk more about that, right?

Andrew:

She speaks eloquently about it, and I think, look, the world needs an upgrade in a lot of the regulatory structures, and that's because things are happening faster. They're more powerful. Individuals in small groups today can do what used to take nations days. So the rules have to change, and biotech is probably the most accessible technology and one of the most powerful. It's often compared to nuclear in its potential for causing good and bad. But let's face it, if the kid down the street working in their backyard could produce a nuclear weapon, we would have a problem. The challenge that we have with biology is the kid down the street using some of these tools could potentially build, not an atomic weapon, but an atomic scale weapon.

Dave:

Well, they could build smallpox pretty easily-

Andrew:

They could-

Dave:

They probably even get funding from people who are looking to learn more about it or something.

Andrew:

Let's just say he or she would probably have difficulty making smallpox because there's so many red flags around that sequence, no one will sympathize-

Dave:

It in terms of maybe it's built into the 3D printers to stop it, like you can't make a photocopy of a $20 bill. It comes out with little stripes on it for a reason. I hope there are. That would be cool.

Andrew:

So there is no universal digital layer of protection, and this is with synthetic biology today. There is an industry organization that self-polices the groups that do the synthesis. Look, one of the big protection areas is when you may have a design on your computer, but until you hit print, it just stays on your computer, it's not going to hurt anything. You hit print, now it becomes a biological program that could be a problem. So the industry is focused on that compilation layer, essentially, that translation layer. That's good enough for today, but it's not going to be good enough for tomorrow, because the synthesizers that I talked about, which limit the complexity or the program you can write.

Today, those synthesizers are services, but when they become desktop devices capable of printing out viral genomes and bacterial genomes or yeast genomes or human genomes, because eventually, writing a giga base billion based genome like a plant or an animal is going to be within reach of a desktop device. We know that. The trend line is clear because the cells in your body are able to, every time they divide, write a human genome, and that's in a few hundred microns. So there will be biochips in the future that do things today that require large automated laboratories, like write DNA.

Dave:

One of the things that I believe, and I haven't really talked about this, but you're probably the right guy to talk about it with. I think humans are a failed species. We need some core hardware rewriting in order to continue growing and flourishing, because we have core behavioral things that allow us once there's enough of us to just do a lot of really dumb shit as a collective organism. It's relatively simple prioritization of simple things and probably mitochondria, but maybe we'll do it, maybe we won't.

But I think I should be able to upgrade myself, even if other people don't, but I don't think I should be able to make other people upgrade themselves. So let's assume that I'm a script kitty, and I'm going to go out there and write my own code and do all this stuff, and let's say, I succeed radically. Is there a way to share? How do people know that their stuff worked? If you did something crazy in your lab and like, Oh my God, this could change the world," how do you get it out there?

Andrew:

Well, so let's unpack this a little bit. I actually think that we're moving in that direction. So the closest technology we have to synthetic biology is the technology it stands on, which is digital computing. Today, you can create all sorts of digital material and send it around the world instantly. You can keep it private. You can share it with a small group of friends, or you can publish it openly. Today, with blockchain type technologies, you can publish it and it can never be deleted. There's-

Dave:

Although we can't have censorship proof things for synthetic biology could, oh wait, actually we could. That's why the blockchain apart from crypto is amazing for this.

Andrew:

Yeah.

Dave:

So you could share it and the world wouldn't know it.

Andrew:

So you could send a biological program anywhere using digital technologies, and if you had a printer on the other side, it's just like downloading a file to print out on your printer. Of course, people are doing this with 3D printers as well. There's a site called Thingiverse that maker bot made ages ago where you could just drag and drop 3D objects to print. So I'm getting a little bit of feedback, Dave. I'm not sure why.

Dave:

Oh, sorry, let me turn that down.

Andrew:

But we're starting to see that same architecture come into place with Symbio. It's still early, and so I don't want to get people over excited about this, but any program that someone makes genetically, and let's just, for example, use it really, really simple. They write an mRNA program and package it in a lipid particle and they put it on their skin and it just makes it glow. It's like a temporary tattoo in the skin. It just glows, and it'll glow for as long as the cell expresses a fluorescent protein, the mRNA will degrade and it'll go away. It's absolutely temporary, doesn't seem to cause an immune reaction, right?

Dave:

Cool. I want that.

Andrew:

Yeah. It's the hello world in biology is making a cell glow. So-

Dave:

Wow. There's a great reference. So if you're a computer science person, the first program you probably wrote said, "Hello, world," and printed it over and over. So glow in the dark, I got to make myself glow in the dark is what you're saying?

Andrew:

Yeah, and you don't have to go and rewrite every cell in your genome. You just basically have to make a glow in the dark skin lotion and wherever you put it on, it's a neat idea. Anyway-

Dave:

[crosstalk 00:36:53] I'm up for it. I think my kids would love it. They make themselves glow quite a bit, probably.

Andrew:

So let's just say some biohacker writes that program, does it, puts out a YouTube video and basically says, "Here's the program. Here's what I made, feel free to go and duplicate it." That's out in the world. Now, that's a very simple example, harmless and could very well happen with today's technology and the number of people getting access to that technology. But let's take it one step further. Let's say, you've just been diagnosed with an untreatable brain cancer, and you have access to these tools and technologies as well. The doctors, they've done a biopsy and you've literally got the genetic information now available for that brain cancer. There is the possibility you could design a brain-specific virus. There's a number of viruses that get into the human brain, and you write a program from the literature to kill those cancer cells. You're never going to use it on anyone else, you just want to try and save your own life because you know that it's untreatable. That-

Dave:

You have a fundamental right to do that. Anyone who tries to stop you from exercising that right is a murderer, and you have a right to self-defense against someone like that.

Andrew:

This is where we have to think about all this stuff differently, because well maybe you don't have all the tools to do it to yourself. Maybe you're the person with cancer, but your son or daughter is the one that is taking the synthetic biology training, and they decide that they're going to go and help you. Now we're on the cusp of that, because there are so many smart people going into this field. We spent the last few decades programming computers, now the kids that are really looking to the future are thinking, "I'm not going to program computers. That's relatively easy. I did that in grade school. I want to go program life and I want to write programs that are going to be valuable," which may be to fight a cancer.

It may be to cure a disease like diabetes, because that's just missing a protein, insulin. It might be because you want to make a new food that doesn't involve animal suffering. You just want to grow large amounts of chicken- like protein, or beef like-protein, whatever it is, people are going to start using this technology more and more for things that they think are important. As the cost drops, it gets faster, better, cheaper, and more powerful because now there's a growing community of programmers and tools. We're going to see the creativity get ratcheted up to 100. This is what I think is so fascinating.

Dave:

If I wanted to go on the offensive and use synthetic biology to control the brains of politicians, whatever brains they have, what would I do, because that's what they would be trying to do to me? So this is what hackers do. We look at what they're going to do, and then we figure out counter measures to protect ourselves. So how does that work?

Andrew:

So programming brains, brains are the most complex meat in the known universe, right? So-

Dave:

They are.

Andrew:

So it's not easy to program a brain. We tend to use tried-and-true tools like education and advertising-

Dave:

Propaganda-

Andrew:

... propaganda, another manipulation. What you hear and see and how you process it, which can be guided by education and propaganda, et cetera, is how we program brains today. Now, is it possible to write genetic programs that could program a brain? My sense is, absolutely-

Dave:

Just change dopamine receptors and things like that [crosstalk 00:41:08]

Andrew:

Well, there's turning the big knobs. So right now there's a growing investment in psychedelics. But as a class, these are just neuromodulators. I'll back up a step. I've always imagined the brain as like a music studio, the big mixing boards with 300 sliders, and you've got a band in the studio, I call the band reality. Depending on how the mix is, reality comes across very differently. Everyone has their own music studio in their head. Everyone's got the sliders set a certain way and that's just how they perceive reality, and-

Dave:

It's true that there's a lens we all have and it's different.

Andrew:

Yeah.

Dave:

You and I don't have the same lens, even though we have common language.

Andrew:

Right.

Dave:

If everyone understood that, most people aren't assholes or crazy, they just have a different lens.

Andrew:

Right.

Right?

Dave:

But there's a lot of molecules you take and it changes the sliders and it can be amazing. It can open up completely new experiences, most of them tail off in eight or 12 hours. You go back to your old slider positions, or sometimes the slider stays a little different.

Could we possibly use an mRNA vaccine that turns on production of MDMA inside cells? So it just pumps it out constantly for politicians.

Andrew:

MDMA is a small molecule that I think is chemically synthesized, not biochemical, but there's no reason why-

Dave:

Something, or Silicide or LSD-

Andrew:

Yeah. Yeah.

Dave:

I'm asking this a little bit, tongue-in-cheek, obviously, but you could do some pretty weird stuff with synthetic biology.

Andrew:

Well, you can basically make anything biology can make, and because again, I mentioned at the top of the show, we don't have the species barrier. We can actually go beyond what biology can make, because now we can mix and match from very different points on the tree of life, like taking a jellyfish gene and putting it in a cow. But we're also going into this new area that I think is super fascinating, and it's protein engineering. Did you see last year that Google DeepMind essentially solved the protein folding problem with their AI algorithms?

Dave:

That's a huge thing, because we never could figure out how proteins are going to fold, and they finally got it right.

Andrew:

Well, to determine the 3D structure of a protein requires some super heavy duty equipment that just is not commonly available, nuclear magnetic resonance machines, et cetera, et cetera, et cetera. Sometimes, we have to crystallize the protein just to get a structure, so this is a whole field. Today, all you need is the there's 20 letters that signify the amino acids in our body. There's only 20 amino acids. Now you can take that string of letters, it doesn't matter the size, run it through Google's algorithms, DeepMind's algorithms and get the three dimensional structure of the resulting protein that is atomically accurate. Now, that's like just as a display of the power of this technology, Google published the complete protein, solved protein repertoires of 21 different organisms, including human. Essentially, any protein sequence we have we can get a structure that's pretty much as good as anything we'd get off of our actual physical measurement devices, or sometimes is better. Now, that's wild, but here's where it gets more interesting.

That's reverse engineering protein folding. The next step is using AI tools to actually design and build new proteins. This is an example I've used, but it crystallizes the idea. Say carbon is one of the most plentiful elements in the universe, obviously. What if you want to polymerize carbon into nanotubes, or what if you wanted to polymerize carbon into diamond? This is not something that nature has done, but using tools like Google DeepMind algorithms, the AlphaFold it's called and AI and a DNA synthesizer to make protein so that you can actually test the resulting protein in the real world, in a cellular system. Now, you've got a system that could potentially hyper evolve and make that enzyme, and that to me is fascinating, and someone will probably do something like that very soon. Right now, there's a professor by the name of John McGeehan in Scotland, who for years has been working with an enzyme that was found in a bacterium growing on plastic waste in garbage dumps, that-

Dave:

Oh, I heard about this guy, right.

Andrew:

Yeah. So they found a natural enzyme that the bacteria had evolved or amplified that could chew on the plastic and degrade it. It wasn't working very quickly, but that's wild. So then they started doing protein engineering to improve the activity, and most recently it's been working with Google DeepMind to amplify the activity. It just keeps getting better and better, and already, they can digest a plastic bottle down to monomers in a day, which is incredible. So now this opens the door to enzymes that can really start to chew up some of the toxic waste that we thought were going to be around for a 1,000 years, which is pretty cool. It also opens the door to new medicines. It also opens the door to just redesigning metabolism for completely unique organisms.

Dave:

Wow.

Andrew:

Yeah.

Dave:

We're on the cusp of a complete rewrite of the potentials of biology.

I dare someone to use Google DeepMind to create and patent a protein that has exactly the shape of the Monsanto logo.

Andrew:

There is already DNA origami where people use computational tools and CAD programs to make just about any shape using the DNA molecule. But it'll definitely go to proteins.

Dave:

Yeah.

Andrew:

It'll go to proteins.

Dave:

That would be funny because one of the problems here is that the way the language is written right now, Monsantos put tens of thousands of farmers out of business by saying, "Oh, some of our transgenic corn ended up in your field, even though you didn't want it, so therefore you're growing our corn, and therefore you owe us," the idea that I might either intentionally or unintentionally get some synthetic bio that's patented by someone into my system, and therefore, someone claims ownership of my biology, well, those are fighting words, at least where I'm from in New Mexico. So we got to fix that right away, where ownership is there. I know Amy and I are going to get into that, but when you and I talk about that, that's a very evil idea I just had about Monsanto that would throw the legal system and the patent and IP and trademark systems into all sorts of tizzies that would probably take a billion dollars in attorneys, and I love that. Attorneys need to eat too.

Andrew:

I've, in general, championed opensource biology. It's because I think the entire architecture around IP and biology has to change, because like today, if you're programming anything, there are great resources to do it. But there's also just a lot of code that people have written that you can use for free. When you start programming, you don't have to write every bit of code from scratch anymore, and this allows us to write more and more sophisticated programs that are pretty bulletproof right out of the gate, because the hard part, whether it's a sword algorithm or payments, or this is how you go and collect and address, a lot of these modules have been pre-written.

Now, the genome is organized in much the same way. A gene is just a module for a particular protein. There are other modules that are switches to turn that protein on and off, given different conditions and how all of this comes together to produce a living cell is still magical, but it's spaghetti code. So it's taking a while to reverse engineer. But the current IP architecture doesn't allow us to remix easily. It's not tracking ownership. It's not tracking the evolution of code like we get with computer programs where you have all the versioning systems, and-

Dave:

We just need creative commons, a Linux license and GitHub for biology and we're pretty much done. All these are solved problems, right?

Andrew:

Yeah, exactly. So people have written about this, they published a lot of papers on it. What we haven't seen yet is the complete execution of it where it's just taken for granted. The thing that I think is really important to incentivize this and grow it is that I believe it has to look a little like the music industry in the sense that the creator owns the content. It's easy to remix and share or play, but you get a royalty. So if you write a really great piece of genetic code, you could retire off of your genetic code collection.

Dave:

It's an NFT problem, actually-

Andrew:

Yeah, very similar.

Dave:

If you made a by law that all biological stuff like that has to be NFT-ed, that's interesting.

Andrew:

Yeah, and we started to see some people playing around with it. The geneticist George Church was looking to NFT as genome. I think that may have stalled along the way for some, all the NFT stuff is opening up. But I think it's really fascinating that the intersection of AI and computing where it is today, but also just the new architectures around blockchains and just open books really, it's open books, which is, I find so fascinating. It could be an open book or textbook or instruction, anything that we put on a blockchain is essentially really hard to go and just delete, and everyone has access to it. That's really a remarkable technology, and I think it's fascinating that it's coming together at this time where we really need to have open standards and transparency for trust, particularly with something that's universal to us, like life.

Dave:

Very well said, and I'm hopeful we get there so far. The chemical medical industry, their track record isn't very good there, but we have a chance to rewrite that now. I've gone straight for upgrading humanity, because that's actually the mission statement for my portfolio of companies, but there's other stuff we're upgrading. You talked about fermentation, but what else is going to happen that's maybe a little bit outside of humans that synthetic biology is going to improve or maybe harm?

Andrew:

Well, the one that we're on the cusp of that I think is really going to be significant is the scientists that I've worked with over the years that are developing the synthetic yeast. Now yeast, just to give you the briefest overview is about a billion years more evolved than a bacterium like E coli. A yeast cell is closer to you and me than it is to the bacterium. It's got a true nucleus, which is like the hard drive of the cell. It's bacteria, it's just mixed in. It's like a bag of biochemicals, but the yeast cell is organized very much like our cells, and of course, yeast is the foundation of bread and beer.

So we know how to grow a lot of yeast and we know how to have it make things that many of us consume. When you have the ability to reprogram yeast to make molecules, whether it's a drug, whether it's a new flavor, whether it reprograms your mind, because you can certainly put any bit of biology that makes a psychedelic substance, has a genetic code that describes how to make that psychedelic substance, you could put that in a yeast. So I think we are going to get a tremendous amount of yeast engineering opening up and that it's going to completely open up a whole new beverage and food industry, so which is fortified medicinal foods or foods that just change your mental state.

Programming the simple organisms is where synthetic biology is today, and we've got so much room to play with there. It is going to keep us busy, but all of that knowledge can be transferred to us. I think we'll start to reprogram us, I mean humans, sooner than most people think. I'm not going to say we're going to do this tomorrow. The first gene edited humans was done in China. There were all sorts of problems with that work that researcher is actually still in jail for the work that he did and the methods that he used. But now that seal's been cracked, more responsible researchers working with parents to solve a real problem, doing genetic surgery will happen, so genetic surgery will come.

Biohacking ourselves will have to come as this technology gets more accessible and really the highest bar, ethically and morally is when we're comfortable enough to use this technology to enhance a child; a child that would be born no problems, no deficiencies, because of course, genetic surgery will be used to correct children that have serious genetic errors, that'll happen. We've always used our technologies to fix people that are sick or suffering, but enhancement where it's more guided by our desires is a whole new area that it has the highest bar, but we're going to start to play, I believe, with other animals closer to us, like dogs.

Dave:

In my world, is unethical not to enhance your children.

Andrew:

Well we-

Dave:

We have-

Andrew:

Yeah, just to go back to the point of vaccines for a minute, vaccines are an enhancement of our children. We are loading programs into them so they don't have to have the serious diseases that kids had to literally suffer through like polio decades before.

Dave:

As long as I would say, it depends on which vaccine, and it depends on which child, depending on their genetics and whatnot, so I'll say absolutely. Giving your children long- lasting immunity against common threats is an absolute thing you want to do, and there's a whole bunch of technology that we could probably roll out that could do that. You could modulate their cytokine receptors so that they're less susceptible to cytokine storms.

You could do all sorts of cool stuff if you just have this palette of things out there, and I'm with you. If there was a thing I could do at conception or a little while after conception that would give my kids robust immunity to all the common things they were going to get without some unforeseen downside, I think all parents would do that. By the way, would you double your kid's IQ? I probably would, but that might make a very odd kid who could never get a date. You have to think about stuff like that. Right? Andrew, you and I know what we're talking about. I finally went on a date, got married, but it took me a while.

Andrew:

No, the problem is we just don't have any experience programming humans, but we will get a lot more experience programming cells and we will start working our way up to humans fairly quickly because the rate limiting step in biology versus computers is really different. With computers, we had to invent everything. So we also had to build the factories that made the chips and we had to have the applications that could use the chips, and there's a whole economic break on that whole system that keeps the doubling time or own every 18 to 24 months, or as fast as you can upgrade an iPhone. Anyway, so-

Dave:

Not to cut you off though, just The Selfish Gene idea from Richard Dawkins, humans are wired in our biology to be selfish. It's part of our code. So, of course, we're going to upgrade ourselves because we're wired to do that. They'll say that's okay, but I want to call out in your book, you talk about the Genesis

Engine. Look, we have a next generation of scientists who are listening to the show and thinking about, "What do I want to do with my life?" With this pile of synthetic biology, you can literally through and repair all of the bad shit that we have done to the environment over the last 1,000 years, in particular, over the last 50 years. If you don't do that, your children won't survive. So you better fix our soil. Okay. You better fix our oceans, and it's not going to happen naturally in your lifespan, but it will happen with synthetic bio in your lifespan if you choose to do it. It's a survival thing, but probably not for my generation, just for you.

Andrew:

Well, I want to close that just on the last point, Moore's Law limited by hardware. Our Synbio will be limited by our ability to write programs because tells can run any program, so it's going to happen-

Dave:

And they scale quickly-

Andrew:

And they scale quickly, but everyone's writing the same programming language. It's not like, "Oh, I know C++," "Well, I use Java," and it doesn't matter. Every single cell runs the same basic operating system in the same operating ... so we're going to start programming faster and faster. Already, there's a number of applications that are creating billion-dollar companies, and soon we'll have trillion-dollar companies in the space, and they'll be doing something simple that we all need, whether it's Synbio toothpaste or what, I don't know, but that's definitely going to happen, but I agree. We're going to start to think about engineering ourselves in the future, and the upgrading kids well, it'll only come when we're really confident we're not going to cause our kids harm, but that will come and it'll come after we've gained more experience engineering other creatures.

For certainly anyone that's truly sick, anyone that is really suffering or will die, those folks are going to like really be driving this technology and more and more people will be coming online to help them and come up with solutions and the solutions can be today personalized to an individual. The old pharmaceutical model that, "We can't make a drug, unless we can sell a billion dollars' worth of it a year, it's just not worth it otherwise and it's going to take us 10 years to make this drug," that model goes out the window with Synbio because now a small group of people could make, for example, a virus to kill your cancer specifically for a few thousand bucks.

Dave:

That's coming pretty quickly, wouldn't you say?

Andrew:

I would say it's pretty much here. What's not here-

Dave:

Naveen three to five years of away. Naveen Jain has been on the show as a friend.

Andrew:

Yeah, and there have been cases already where custom engineered genetically based programmable drugs have been made for kids with life-threatening diseases. It's taken a year or two to develop the drug, but under $2 million. So already we've seen parents come together to organize and fundraise and pull together a team to make a customized drug to treat a child with a metabolic disease, for example, and that is remarkable. So people say, "Oh, these technologies are only going to be accessible to the wealthy," I always push back on that because these technologies, when they start to run free are going to be, and I don't mean lack of standard, I just mean that faster, better, cheaper, takes over.

It's like cell phones, everyone's going to have a cell phone. It's just some cell phones will have more features. You say that humanities a fail piece, I don't think so. I think we're on the cusp of going from human to superhuman in some ways. But I think there is a real big filter that we have to get through during that phase shift. I also think we have to become supernatural. I think we have to really, really defend the natural world from-

Dave:

Yes, we do.

Andrew:

... because otherwise we've already been herding it. But I think we become-

Dave:

Quite a lot.

Andrew:

But I think the idea of protecting the natural world, because wow, what a giant library of code that does amazing things. If we become superhuman where we literally start to re-engineer ourselves to remove the susceptibilities to cancer, to age more gracefully, to increase our intelligence or balance our intelligence, because sometimes we just get mentally imbalanced, go into depressions or manic states, et cetera.

Dave:

Yeah.

Andrew:

I think this is what happened this century.

Dave:

We must be stewards of our own biology and of the environment around us, and we've been that to a certain extent. We just sucked at doing it because we didn't have the right tools or the right knowledge or the right understanding and now, we're cracking the code to really understand it. What we haven't figured out and what Google even hasn't done, even with DeepMind, is understand the behavior of complex systems, emergent behaviors that you don't predict, which is most of what's going wrong in the environment. You introduced the species here and you didn't figure out that it would make this other species do that, but that's like herding sheep. You can't model herding sheep either very well, but you can do it if you're there, and you can, "Oh, that one's going sideways, let's fix it," because you have monitoring, alerting systems and tools to correct problems, and that's just how you manage anything.

Andrew:

Yeah.

Dave:

So I'm feeling pretty hopeful that what you're saying there is true. I'll tell you without that step of human evolution, and without that step being open source and available to everyone, we will fail a species and we're right on the cusp. If there's six elite people saying, "I'll just reprogram humanity from my own ends," it won't end well, it just won't. So I'm feeling relatively hopeful, but I got to know. Have you done any of these to yourself? Not even one little one?

Andrew:

No, I haven't done any hacks to myself. Again, I feel my kids are on the cutting edge of these technologies in the sense that they wouldn't have been born without the IVF, the fertility technologies that we developed over the last 40 years. Even the difference between my daughter who's seven and my son who's four was a dramatic shift in the technology. My daughter, who is seven, we were not offered any genetic testing as parents. We did some just because they were available, but we weren't offered any. There was no genetic counseling. There was no pre-implantation screening of the embryos. Basically, the doctor said, "I want to put in four embryos."

I said, "You're nuts. You're nuts. No, two max, four ..." but it was just using cell biology, but hitting with a hammer. My son, just three years later, different spot, different clinic. It's like, no, full profiling the parents, appear full counseling. The embryos were made. They were all tested genetically before implantation. We knew exactly boy, girl, but that they'd all passed all the check marks. In fact, we only had one embryo that cleared all the hurdles put in one embryo, a son, so that's amazing. But now, just imagine two new technologies that we write about in the book that are coming online, well, a couple of them.

One is, we're moving to where we can start to make eggs in the lab, eggs and sperm in the lab. It's called in-vitro gametogenesis. That's a game changer, because now most of the work in IVF is just getting a few eggs; sperm, not often the problem. But getting a few eggs that can be 15, $20,000 worth of work. With IVG making the eggs in the lab, you can do it from a blood sample. So now that opens the potential to have, let's just say a thousand eggs. Let's keep it small. Now you could fertilize every one of those thousand eggs, genetically screen each of those thousand eggs. Now, you can basically say, "Which of those thousand eggs are we going to turn into our baby?" That's not even genetic engineering, that's just selection-

Dave:

That's just selection, and-

Andrew:

But let's just say that there's some inborn error of metabolism with those parents and everyone, let's just say, that they're just doing standard IVF. They've got 10 eggs. They're precious, but every single one of them didn't pass the genetic testing. Now we're getting to the point with our gene editing technologies that they can say, "Look, we're going to take this one and we're going to correct the errors." That's amazing, and now that child will be born that wouldn't otherwise be born. That's where we're at today, and people are asking for that. Ever since the first CRISPR edited baby was produced. Now people are saying, "Great, can you do genetic surgery to fix the problem that is preventing my child from being born?"

Dave:

I know a very wealthy person who I believe, I'm not going to disclose who it is, who said that he already did that, that he and his wife corrected two genetic things that were in their embryos.

Andrew:

I'm not surprised. First of all, the fertility industry is not highly regulated. So after the fact, we'll probably get these stories coming out of things that have been done that worked, but we're getting to the point, in general, we are very accepting of technologies that allow a child to be born that wouldn't otherwise be born. There is tremendous demand from parents for that. When I put on my future hat and think technologically, where in the future does this go? I see the addition of chromosome 24 to basically every kid that comes out of a fertility clinic, and chromosome 24 being basically another chromosome goes into every cell, it is copied along with every cell division. But it's basically a set of genetic programs that can be activated on demand. I love that idea, and it's super cheap. It's just adding one extra chromosome standard to every embryo. The reason why this resonates with me, because I remember the early days of computing when you bought a computer, but there was no internet to download programs.

Dave:

I remember.

Andrew:

So they pre-loaded every program that you might want onto that computer, and all you had to do to turn it on was by an activation code. I see the potential for that with synthetic biology and humanity in the future. But really, we're in this phase shift where we could very well leave this century, it's starting to become superhuman.

Dave:

We'll be a diff species if we do in this century. It's pretty much written in the cards as I read it.

Andrew:

Man, a lot changed between 1900 and 2000. It's hard to imagine what changes between 2000 and 2100.

Dave:

It is very hard to imagine, and some upgrades are just required, and some of it is really superhuman level. I'm very hopeful that we have the freedom to explore which superpowers you want. There's the reason we have the X-Men and they're not all the same. You want to be Wolverine, good for you, man. Whoever that blue chick that's all flexible, and can change, I want to be her. I think she's just got more interesting-ness.

Andrew:

Well, this is why I think-

Dave:

What's her name? Come on, Upgrade Collective. Our live audience knows. What's her name? [crosstalk 01:11:22] The shape-shifting blue one?

Andrew:

Mystique.

Dave:

What? Mystique. Thank you. I'm choosing Mystique over Wolverine, even though he is my favorite. So there you go.

Andrew:

No, it's interesting because this is probably the most exciting time to be human, and it's going to challenge us. Just like with computers, there are risks associated with it that we have to learn how to, essentially, just turn the volume down on those. We have to conquer it and we don't have to conquer it fully in the sense that I think cybersecurity is a pretty good indicator here. There are real risks with our current computing architecture, but it works good enough most of the time, not for everybody. Sometimes, there's horrible things happening, but it's good enough that we run the world on it. We need to harden it going forward, but I think we have to take some of the lessons there just for thinking about our biological future.

But I see us coming out of this century with much more respect for natural systems, a completely new architecture for making medicines, lot more creativity or medicines and other things biological, not just medicines, but a completely new architecture for programming biology and more and more examples of really cool, amazing stuff that happens. But I've also written that I think we have to have a bigger firewall between the natural world and the stuff that we're playing with. I'm not quite sure how to do that today, but I think some of our explorations into space where basically you're living in a bioreactor, a closed system is going to help us generate not only better sustainability technologies, but also learn how to really keep a hard firewall between natural and synthetic, because I am fully down with protecting the natural world.

Dave:

One of the things I appreciate about your Genesis Engine book, because you talk about nine risks. I think what you're talking about there is risk number eight, super mice and monkey human hybrids. Super mice or super rats, more to the point, would be incredibly destructive of humans. Rats are already a major problem for us, imagine rats 10 times smarter, we'd be screwed.

Andrew:

Imagine cats-

Dave:

Just straight up.

Andrew:

Imagine cats 10 times smarter, we'd be screwed.

Dave:

Anyway, we'd have to have dogs 10 times smarter. They could chase the cats. It's going to be a total mad house, right?

Andrew:

Yeah.

Dave:

But this is the kind of thinking it takes. If you're good going to say, "I'm going to upgrade my pet mouse," don't put it in the germ line, okay? Seriously, we got to be concerned about this.

Andrew:

Yeah. I think we will see people hacking themselves, but I think there's going to have to be an age of consent. Again, I think if you're the first person to try a new genetic program on yourself, you're taking a very big risk. But this is why I think that there's an opportunity for biohackers, self-experimenters, to professionalize and share code in their communities the same way software developers do. I don't know. This potential excites me. I'm sure it scares many people, but I don't see it stopping. We are hard-wired to explore, as you say, and self-experiment and hack. So I think part of it is I used to say in my presentations at SU, it's going to get faster, cheaper, weirder and-

Dave:

It is, yes. I love that, faster, cheaper, weirder. It's so smart. So a lot of the Upgrade Collective, our live audience are saying, "When can I get this done? I have a heart issue that I really want to work on," or, "I'm concerned about Alzheimer's," and things like that, is this a three-year thing? Is this a five-year thing?

Andrew:

For humans, it's a longer course because again, we're so conservative when it comes to humans. There's so many regulatory agencies to bring anything biological online that it's really tough. So for anything with humans, you're going to have a long timeline. But again, that's assuming some other group or company is doing this to eventually sell it to you as a product or service, because all the rules there are meant to protect you as a consumer. If you have a serious health issue and are a technologist and you would be willing to go and learn computing to go and solve a technology problem in computing, now the window is opening for you to go and enter this field, use this technology to essentially treat yourself, and because again, no one can really stop you from doing something to yourself, or they can, but it gets harder and harder as these technologies are become more available.

Dave:

It does.

Andrew:

But, again, products and services are different because we just have such high regulatory bars for that. Now, that being said, this is one of the reasons why I ended up thinking dogs will lead the way with a lot of this stuff, because dogs are our four-legged family members and we don't want them to suffer, and yet, their lives go fast motion compared to ours, seven years per year. So the stuff around longevity around heart disease and other illnesses, I think our pets are going to be the recipients of a lot of these technologies before we get them. But what we learn from working with our pets will come back and help us.

Dave:

It's true dogs, and then race horses, that's where all the good biohacking stuff comes. Almost every laser and electrical device I have was not licensed for humans when I first got it, but it works great.

Andrew:

I like to say, I believe in dog. Yeah.

Dave:

Yeah. Very well said. Andrew, thanks for writing a fascinating book along with Amy. For listeners, this is the first part of a two-part interview, so in a couple days we'll release the interview with Amy so I'm getting both sides. We got our deep tech dive here and we're going to get our futurist dive in the next one. Is there a webpage or a place where people should go to learn about your work?

Andrew:

No, I've taken down most of my web profiles, just because there was starting to get stale through COVID and writing.

Dave:

Yep.

Andrew:

This is what I do for most of the time, I just make a list of keywords for Google alerts, synthetic biology, whatever you're interested in and I just get pretty much every major news article pointing to a paper or et cetera, just from those alerts, that if you Google synthetic biology, you'll find amazing things. If you're young and a student you're wanting to learn about this, check out the iGem program, International Genetically Engineered Machines. It is based on the robot competitions, US First, it is an amazing community. It's the entry point for many young people to get into the community of synthetic biology. If you're an entrepreneur, the money flowing into Synbiois nuts. More money was invested in 2021 than in the previous 11 years. So it's a really good time to start thinking, "If I want to solve a problem with biology," to go and build a business.

Dave:

Well, the time is right, and I'm working right now on putting together some AI newsletters for my Dave Asprey page. I may end up doing a synthetic biology one because Google feeds are relatively limited in what they can do, so I'll hope we'll be able to announce those so we can get some really good stuff around biohacking and all. So guys, if you just go to daveasprey.com center for my list as soon as I get the AI add-ons there, you'll be able to say, "I want curated news," not just stuff that I write, but very, very focused on just the stuff that I pay attention to based on my lens of reality, instead of yours. We talked about lenses of reality earlier, I always like getting a chance to see your reality through your books and anything else that you end up writing. Are you active on Twitter? I see you've got an account there [crosstalk 01:20:08]

Andrew:

I shut everything down to actually write the book, and I've just started to post a few things. I should say, by the way, if you're really interested in this stuff buy the book, it's a great entry point.

Dave:

Yeah, and the book is-

Andrew:

It's a book about science, but it's not written for scientists. It's really meant-

Dave:

It's readable, yeah.

Andrew:

... to be successful. It's about some amazing people and stories and we've got some fun scenarios that help you think about where some of this stuff is going. But really, this is a technology that we're all building day-by-day. I think the voice of the biohacker communities in general are you need to be part of the discussion. You need to be communicating to others that might have more of the technology skills what it is that you want or need, because for too long, the folks that were responding to your needs were just really picking and choosing the things they could make the most money with.

Dave:

Well, I wish you fantastic luck and good fortune in all of the things you're working on. We need the tools for synthetic biology now. We need the right frameworks and the right freedom to talk about them and deploy them, because we got to fix a lot of problems in the world and in ourselves right now. This is probably the only thing we can do. I don't think space lasers are going to do it this time. That's a little bit too 1980s for me. So thanks, Andrew.

Andrew:

Oh, you're welcome, Dave. I'll leave one last note. One of the easiest things to do is just back yourself up biologically. I have this strong philosophy that as long as you have cells in a tube somewhere, you're never really quite gone. I'll close on that note that there's always the opportunity in the future to do upgrades.

Dave:

Yep. We're going to build super humans one way or another. Upgrade Collective live studio audience, thank you for helping me crowdsource the questions that we got to ask Andrew, and you're listening to this. It was The Genesis Machine by Andrew Hessel and Amy Webb, a book really worth reading. You think that knowing about crypto makes you cool? No, that just makes you average. Knowing about synthetic biology makes you cool. I'll see you for the second half of this interview.