

>> From WXXI News it's 1370 Connection. [Background music] I'm Bob Smith and you are about to meet a man whose work allows you to see things that physically can't be seen. I'll explain that right away. Drew Berry creates animated depictions of physical and biological processes on the molecular level that are so small, they are more tiny than the wavelength of light and they can't even be picked up by the best atomic microscopes on earth. A trained biologist himself, he makes it possible for his colleagues and the general public to see processes on a very most basic level of life and of chemistry. And he's been honored by a MacArthur Genius grant for his work and that would--clarifies the processes of life for both the researchers and the public. He's gonna be speaking tonight at 8 at RIT's web auditorium as part of the Caroline Werner Gannett Visionaries in Motion lecture series. He's joining us right now. Drew, thank you very much for being with us.

>> Oh, thank you for having me.

>> Okay, I wanna begin if I can with the kind of processes that your work takes on and how you came to do this which seems like an impossibility.

>> Okay, well, I'm a biologist by background and I specialized in different types of microscopes in examining our bodies, interiors or the landscapes of our bodies through microscopes. But certainly with the revolution of molecular biology over the last 50 years, a lot of the stories are--that are going on inside our bodies are the molecular scale which we can't directly see. But we have a pretty good idea what's going on down there. We can't see it or show it to you directly.

>> I'm going to sound a little stupid by asking this. But if we can't see it, are we basically just sort of imagining it in our mind's eye or sort of interpolating it from what we can see and making--I won't say an educated guess but a pretty good approximation of it without actually being able to see it concretely. How do we do this?

>> Well, there are a number of techniques we can use. We can probe the molecular world. We have a pretty good idea of what's going on down there but it what's--what it's--it is an alien world that it's very, very different to our normal sense of reality. So it does require interpretation to show it to a human audience.

>> Now because light, I mean it's got a wavelength to it, it's small, it's tight but it does have a wavelength to it and below that level, below the length of the lightwave is kind of where we're trying to see, isn't it?

>> That's right. So the molecules are smaller than visible light but we can use electron beams and x-rays to try and determine the shape and structure of things down there. And then from the structure we can work out what they're doing.

>> So, I mean we're not just trying to play on ultraviolet realms or anything like that, are we or are we?

>> No the--and so it's like a--so for example x-ray crystallography which has been the mainstay for at least 100 years but it's been 50 years determining the structure of DNA and so on. It's like if you had a chandelier in the next room,

you can't see the chandelier but you are--you can shine a light on it and then look at the reflections on the walls and from the reflections on the walls work out the shape of the chandelier, that's what they're doing.

>> So you can infer from things you can see into things that you can't.

>> Exactly.

>> And that's what basically you're doing at the start.

>> Yes.

>> You're building on that. Then you try to visualize from that what really happens on the level but we can't see your model nonetheless.

>> That's right. So--I gather many forms of data. There's--the problem with science and particularly biology is that the fancy language that scientists are using to describe what's going on down at the molecular scale. So if we strip away all the fancy language and just show people what the stuff is about, they get it and they're big stories it's--to--like diseases, medical discoveries like cancer or diabetes or malaria or various other diseases to show the discoveries in the frontier of our human understanding. But there isn't any other way to represent it or present it to people.

>> And you have to create it as three dimensional colored images in a way, and is that even totally appropriate in and of itself because I'm sure people will ask, well, what color is a proton Does it have one?

>> True. And so there are a number of artistic embellishments I used to help convey the story and in color where we--it's a very subtle but true art. It's very much a powerful way to communicate. So if things are green and yellow, there's a little bit disease. If they're pink and red, they're very healthy and alive and--or blue they're dead and cold. So these are sorts of good visual cues you can use to help tell a story. But certainly a lot of these things--a color is kind of meaningless set down to that scale. But there are molecules that have color like for example blood. Our hemoglobin, the molecule in our blood is red that's because of the iron inside it.

>> And that's why it's got the red color that we see?

>> That's right.

>> And so if you're seeing--if you're depicting a molecule or something and you depict it as bright red--

>> Yes.

>> it's alive and it's healthy.

>> It's just--it's more of a--it helps tell the story about what the place and what this thing is about. It's a subconscious sort of cue that people pick up on and using sounds as well, you can use sound design and like they do in Hollywood to help tell the--tell to create the atmosphere of what this stuff is about.

>> You can do things like animating everything from a cell division and cell growth to a cell death. For example, how do you visualize for example what happens when a particular cell dies?

>> Well, cell death is actually a very important part of how our bodies function when the--cells get diseased or defective because of chemicals or x-rays or whatever. So cells destroy themselves for the good of the whole body. So, that's a very important story particularly with cancer where it's just where cells go rogue and grow too much and they have switched off the ability to destroy themselves.

>> And under normal circumstances, you just expel them out of your body and anything from the normal digestive process to sweating them out or doing something of that nature.

>> Well, that they get consumed by the other cells, the healthy cells. They destroy themselves and package themselves up and then the other cells come and clear them away.

>> And we can actually depict this going on.

>> It's actually it--well, it's actually one of the most difficult stories to tell to the public because it is very involved with chemical processes. So the idea is you visualize this and you can see the thing destroy--cells destroying itself for the good of the whole body.

>> 'Cause I'm imagining as well, can you depict for example a routine biological process like we'll just use one everyday thing that happens. People have their lunch. I had a ham sandwich. You could even depict at a cellular level the nutrients that I absorbed in my ham sandwich and how I'm metabolizing them and burning them to permit me to speak, to think, to listen to you right now.

>> Correct. And for example when you do digest your food, things like sugars get into your bloodstream and for particularly for diabetics that's an important issue and we can then investigate the role of pancreas in regulating the amount of sugar in your blood and how your muscles will respond to the chemicals that is release by the insulin or released by the pancreas.

>> You can do an animation of this to explain to let's say a medical student or somebody who's interested in understanding human biology, how this goes on and how the process operates at maybe even how you could use some kind of therapy to enhance it or cure it if it goes wrong.

>> Yes, a large number of people appears in the industry do medical ads on television. But my work tends to be more focused on museum exhibits for public education. So I guess we do the main focus is for university and high school education. But what I'm really pleased about is my work does get out into art galleries and public events too 'cause I wanna reach out to people who don't normally turn to science, who don't think science is for them, and to entertain them and to draw them in and give them some sense of how their bodies actually work down the molecular scale.

>> It seems like something that you would think the producers of a show like Noah would be knocking on your door all the time saying, can you help us, we wanna do a special on this process and illustrate it, can you help us out?

>> I do. I've worked on a lot of their programs in National Geographic, Discovery Channel and so on. That's a big part of my work is working on documentaries to show what they can otherwise show to help to fill in the gaps of their story.

>> So you could tune in to PBS almost any night of the week and we might see your work.

>> Yeah, it's possible. Yeah, I do have--yeah, I've done quite a few.

>> And so we'll get an understanding really of how our own bodies work and how our own processes work when they're working right.

>> That's--and wrong.

>> And wrong.

>> And--but we're--and there's the nature of being a living thing on earth and how all life on earth works down at the very small scale.

>> So you can also take a process that allows cell division and tissue development and growth and sort of animate and examine that on a low enough level that we can really get a hang on the mechanics of it then?

>> That's right and it's all quite extraordinary, quite beautiful and mind boggling how we do operate at very small scales, so it's a beautiful choreography.

>> And I'm imagining how it might be used for example to illustrate muscle development.

>> Yes.

>> I'm sure it's something that anybody from somebody who is an anatomical specialist to maybe even a professional athlete would wanna know that.

>> Sure. And it's quite we are fundamentally molecular machines down at the very small scale and there's I mean a number of wonderful visualizations of how muscles work and operate and the ratcheting along of the molecular machines, little protein motors that enable our muscles to function.

>> That's something I think most people don't realize. They just sort of instinctively figure, well, when I move in a certain way I just send a message from my brain through the nervous system and it makes the arm move, makes my hand move, makes me do a motion or deliver a curved ball toward the plate, whatever. A lot more complicated than that, but you can take me every step of the way with that idea.

>> There's a dozen stories, wonderful stories be told what happens in your brain, decisions you make, the chatter that goes on between your nerve cells, the decision and then the message going along your arm to telling the muscle what the job--all the muscle cells to do what they do. You're a big community of cells that are chattering to each other all the time.

>> All of which, even though the initial action might be voluntary really is going on in large measure and we're totally oblivious to it. We just don't, hey, I said throw a curve ball, I threw a curve ball. It either hit the strike zone or didn't. If it didn't, oh well, ball 1.

[Laughter]

>> Indeed, correct, yes, yeah.

>> Yeah. But you can take it every step of the way, all the way from the first idea in my mind until the umpires call it ball 1.

>> That's right. Well, the main issue is that just the stories to be told in science and my special being biology are enormous, impactful on all of our lives, our internal bodies but our whole existence. And there is just it's moving at such a pace, the very frontier of human understanding is moving at such a pace. Even as a specialist, following all the science and research, it's astonishing. And there's a huge need to communicate this to the public.

>> I'm thinking of another possible application of it and I'll ask about it in a moment since I remind everybody. You're listening to 1370 connection on WXXI, I'm Bob Smith. We're talking with Drew Berry, a biologist, a scientist who is also a man who creates animated depictions of physical and biological processes on the molecular level. That you can't see even with an electron microscope, but he can help you see through the animations that he makes. And he's gotten a MacArthur Genius Grant for it. We're finding out how it's used right now in advance of the lecture he'll deliver tonight at RIT's Web Auditorium as part of the Visionaries in Motion series. Looking at that kind of work on that level, can we use this for example to get some insight into what happens when, well, maybe an infection or some other disease strikes and see just what process goes when things go awry.

>> Yes, it's--it's still a hot area of research and it is a very involved area but we've done a number of visualizations of how your immune system deals with the invasion of bacterial or viral infections. And it is a--it's an important and wonderful story. So yes, that's a great story to tell.

>> Well now at the same time, when you do this, when you depict this process in a way, can we also get a good enough idea of how it happens, that we may be aided in our development on effective treatment.

>> Ah, yes. It's--there are people who are in related areas who do simulations, visualizations to test. There is a hypothesis about drug design and so on. My work is more just attempting to bridge the gap between where we are in medical research and in biological science and just--so the general public gets a sense of where we are, and what the sense of discovery and looking over the shoulder of scientists and just having a look at what the science is about.

>> But at the same time you can easily figure out, can't you? If you see this process, you might be able to say, well gee, if I have a molecule of potential therapeutic drug that's shaped like this and has these constituents, I wonder if I can get in and get in the way of that process I wanna stop. I wonder if this is how I can treat this. Can we actually get there from here?

>> Well that--that's a very good description of how much of drug discovery operates, and that's what the scientists at the [inaudible] bench are attempting to do. What I'm aiding them to do is to communicate what it is that they are discovering to the public and to students. So, that's my role.

>> Correct me if I'm wrong on this but doesn't it make a difference, you can put the same number of elements into a formula and create molecules that depending on how they're shaped and aligned, can have very different effects, some of them are useless, some of them could be great, right?

>> That's it. That's--it's a very subtle, very complicated, you can easily--thereby making very small changes, make big differences in effect. So that's the challenge of a lot of the medical research.

>> And so they may tweak a formula and turn something that's kind of useless or kind of pointless in a wonder drug?

>> They--well, it's more they have so many possibilities, different, different options so they--that's really where a medical research is at the moment, they can screen thousands--tens of thousands, millions of different options at once. But before it used to take a scientist a year to take one or several years to take--discover whether one particular drug works. Now they're doing tens of thousands and it takes minutes or days to determine whether it's gonna be work--to work or not, so it's moving in such a pace.

>> And we can kind of test this using the kind of imaging that you do and--and a lot of people are using that whole process right now to model it and sort of brainstorming.

>> Ah, yes. It can be used for scientists to communicate their ideas to their peers and that is a big important area. But I think for me it's much important to give the public a sense of what we are discovering on up to.

>> So you know what's going on and you base--basically this is a learning tool more than anything else.

>> It is, and a discovery tool for people to understand how their bodies function.

>> In a sense, is the biggest application of this kind of approach going to be not on the high school but maybe at the collegiate level in courses not just introductory courses but maybe even advanced ones.

>> Absolutely, yeah. And just we're under a big--we're doing a huge effort with E.O. Wilson, Ed Wilson out of Harvard--a biologist at Harvard University to revolutionize the way biology is taught and gonna prepare a set of school--high school level biology tools that I expect will be very popular at university level as well. So it's a big part, a big impart of what--where we care and where we're putting a lot of effort.

>> What occurs to me is you may end up making the hard copy biology or chemistry textbook if not obsolete than a very secondary tool of instruction after awhile because if I could take a CD with these animated images and presumably some explanatory text alongside and/or explanatory narration alongside it and I can watch this on my laptop or on an iPad or something similar, my tablet computer,

I've got it right there and that's going to be stronger than any textbook can give me.

>> Well, better than a 200 dollar text book that's been printed with lots of dead trees and shipped across the country. It's gonna be a free--in a minute you'll have it on your iPad and you'll be able to watch it for free.

>> Download it.

>> Now, but it's also not watching it, you play with it. They'll be interactive and you can get it--get a--you can get amongst it and really learn by playing and learn by listening to the great scientist and Nobel Laureates talking about it.

>> And if the software is rich enough, I might even be able to experiment and play with the chemical compound, throw something else in there, an extra bit of nitrogen or an extra bit of oxygen and watch it go in, in a whole different direction.

>> Yes. Yeah, definitely, and learn from that watching how things operate and playing with it.

>> So, I can have it as a laboratory I can carry along.

>> Great.

>> 263-WXXI and 263-9994, you're on 1370 Connection. I do believe we have Bill on the line. Hi, you're on the air.

>> Thanks Bob. As a layperson listening to this, I'm kind of struggling to keep up with what you're actually saying and it's kind of like listening to Star Trek episode which is exciting. But could you just go backwards for a minute and you talked about how in the past scientists would model the development of a drug and make it--do it take a little while to do it but now you said they can do combinations and look at the results of thousands in a very short period of time. Is that done with a computer? How is that done?

>> Yeah, that's--that's--really that's the scientist who I work with. That's not the work that I do but they are--that's the nature of--a lot of labs now are doing thousands of experiments on a tiny little microchip where it used to take a whole lab and lots of people time. So it is a very technical area of research but the point is that the pacer change and the pacer discovery is just in--revolutionized in the last particularly 10 years and it's moving at greater and greater speed, so it's very much the techniques they use in the labs and that the advances because of computers and other techniques it's--the game is changed and moving very quickly.

>> See, like Bob was saying with such a small incremental change you can get really tremendous difference in results and for my simple mind, that's--that's a hard thing to fathom how a microchip should accomplish that.

>> Sure. And by what was Bob was describing, it's like your key they use to open your lock and your door and with a very small change, your key no longer works and molecules very much work that way. Their shape determines their function.

Very much like a key, its shape determines whether it's gonna work or not and that's why little changes make a big difference.

>> So they can write a computer program to capture those small changes, is that my understanding?

>> Yes. It's more--you have thousands of possibilities of shapes of key and you don't know which one may or may not open the lock, so what you do is you create thousands of keys and you see which one will open it. And before that used to be hugely slow process that a lab would have--it take years to do and now they're able to do it on a very small scale on a computer chip thousands of--in running your time, so that's the difference.

>> And then you can run a reaction to actually replicate it in real time using real chemicals and real circumstances and conditions and you got your drug in a day or two?

>> Yeah, well--

>> And then you can find out whether or not it's gonna do the job.

>> That's right or--and then also whether it has sides effects. That's always an issue.

[Simultaneous Talking]

>> Those may take longer to test.

>> Yup.

>> That's unbelievable, really.

>> Yeah.

>> Tremendous.

>> It's a very exciting time for biology.

>> Hey, thanks very much for calling. And now you're not gonna get designer drugs in a day but you will get the compounds quickly and begin the process and you can start the actual testing an awful lot sooner than the trial and error to create the compound on the first place. It used to take which was years in and of itself. You can telescope the process quite a bit, can't you?

>> The discovery of compounds that will have an effect, yes, but it's still the long process of trials that they do to make sure it doesn't have any other bad effects on the patient, so it--there is still that process.

>> That's the time they have to take to try it out with us.

>> That's right.

>> If assuming that we're willing to give it a shot to--in the hopes of getting better.

>> That's right. So from the point of discovery when you hear about in the news, there's often 5, 10, 20 years before they finally have a product on the shelf and that's why you have to be very careful too to make sure you fully understand what this drug will do.

>> Time for one more call before the break and that's coming from Ed on the line at 263-WXXI.

>> Hello Ed, you're on the air.

>> Hi, how are you doing?

>> Doing great.

>> Oh yeah, I'm just wondering if have you been able to image or computerize or animate what's happening with the telomeres at the end of the DNA [inaudible]?

>> That's a good one. It's a topic that's actually coming out. I have seen other people try and tackle it. It's a very rapidly changing area. They're making great strides to understand how that the telomeres work and their importance in a number of--number of different diseases and function. So, it's not one that I have done but it is one that I will be doing in the next year or two, and yeah--so yeah, no, it's a great topic.

[Simultaneous Talking]

>> [Inaudible] able to determine how to stop the telomeres from--

>> Shrinking?

>> shortening?

>> Kinda wearing out.

>> They--they--that is actually a healthy process. It's part of the account. It's like we're talking about apoptosis, the cell death. It's actually healthy for cells to have a timeframe and then to move on and to pass away or to destroy themselves or to keep your body renewing itself and healthy, so that's one aspect of it. So it's actually a healthy process but--

>> Yeah, but I thought they're thinking about extending longevity too because it sounds only what, what we reproduce, tell you what, 23 times or something that--

>> That's right.

>> before they die, so if they can solve that problem, is that going to help with the longevity? You know, that's great.

>> Great, great point. That's--that there are a number of things that touches on for longevity of our human bodies but there are a process that's already in our cells for repairing and elongating the telomeres. So that's--that they're already [inaudible]. But we have to be very careful because if you will relate to--if you are one--one possible outcome, this is not can say this is the only outcome but one possible outcome is if you do extend and repair the telomeres, cancers can become more prevalent because if there are cells that are self

renewing and grow too much, that's--that's essentially what a cancer becomes. So it's--you have to be careful, but it is an area of intense research and that's--that's the path of science.

[Simultaneous Talking]

>> Ed, we thank you very much, Ed, for calling in. I remember a conversation I had with the science writer and editor Ben Bova not too many years ago in which he said that that was the frontier of research to determine ultimately our longevity, maybe even to the point of guaranteeing us if not necessarily immortality, then at least indefinite lifespan. Now, if we can get to that, now that sounds like a very exciting kind of thing to zero in on and depict a model, an image and maybe even animate. Could it lead us to an understanding of how to extend our lives well beyond that ceiling, 100 to 110 year wall that we almost never get through?

>> I hope they--but before we get to that point, I hope they solved a lot of other issues to maintain quality of life and health and so on. I mean that if you will live that long, you'd really wanna have a fully functioning brain and you wanna have a healthy body to enable you get out and enjoy the sunshine, so--

>> Alright, yeah, a hundred good years could be argued to be better than 120 or 150 not so hot years.

>> Exactly, yeah.

>> So we gotta figure out all of those things at once, which means the research is going to be very intensive, and a lot of friends for a lot of years. We're never gonna run out of things to talk about at a research and probe, are we?

>> No, that's right.

>> Which means you're gonna be busy for a long time. We'll talk about other things that you're going to be doing in just a moment. Got to take a short break, but we will be back in a conversation with Drew Berry. He has been honored with the MacArthur Genius Grant for his work in creating animated depictions of all the physical and biological processes at the molecular level that we can't even see directly with the sharpest electrode microscope there is. But he gives us an entree into that world and we're talking about how he does it during this hour here on 1370 Connection. I'm Bob Smith back in a minute in WXXI.

[Music]

>> 1370 Connection continues on WXXI. I'm Bob Smith. We are talking with Drew Berry, a man who creates animated depictions of physical and biological processes on the molecular level that even microscopes can't pick up. But he's using his knowledge as a trained biologist and his skill as an animator and artist to give us an understanding of things we can't directly see but we can see in our mind's eye as a result of his work. He's got a MacArthur Genius Grant for it and he's going to be speaking about his work tonight at 8 at RIT's Web Auditorium as part of the Caroline Werner Gannett Visionaries in Motion lecture series. He's here with us right now. You can join us as well at 263-WXXI, 263-9994. Wanna talk about DNA for a moment. We have this image of that sort of twisted ladder that they call the double helix. First of all, based on an actual

modeling of it, the molecular level, how accurate is our mind's eye depiction of it that we got from our biology textbooks?

>> Well, that was really one of the most pivotal moments in all of science was the discovery of the double helix, because that twisting shape told us how by its shape where the information is encoded in us and how it's shared from generation to generation. And that was really that the model that Watson and Crick built based on the x-ray crystallography, the x-ray images, the x-ray data from Rosalind Franklin that that model they built out of wire and cardboard is very much the tradition of what I'm doing. So what I'm doing is nothing new, it's creating pictures of what we're thinking about, what we're seeing through microscopes. So, that double helix that you see in your textbook is an accurate model but it's a representation in a sense that humans can grapple with this. That's sort of a--it's usually shown with the shiny balls stuck together, the atom stuck together. There's many ways of representing it, but it's at the molecular scale so it's sort of a--it's a little bit weirder than that, but that gives you a sense of it.

>> But where did--in what way, how do you prefer to depict it whenever you're looking at a biological process of say cell division or replication or whatever, whatever you want to try to depict, how do you look at it, and what do you see in your minds [inaudible] and translate to an animated image on screen?

>> Well, it's more the wonderful stuff of biology and what's happening inside our bodies comes when you bring lots of those sorts of types of data together, lots of different ways of investigating how we work at the molecular scale, and really what our bodies when you look at it and bring it all together you realize that we are little molecular machines, they are little molecular clockwork that march along and manipulate other molecules and it's staggering when you do see it, the little molecular machines that are--the way we operate.

>> And imagine, we have seen in microscopic depictions zeroing in on cells and we've seen pairs of chromosomes and we kind of know what a human cell looks like.

>> Right.

>> Or what at least it's supposed to look like. And we have that sense, but what are we missing by not being able to see even further down in, by not being able to zero in and take a really [inaudible] close look.

>> That it's really just the beginning. It's the cover of the book. It's the beginning of the story when you see cells and chromosomes. Chromosomes are actually gigantic molecular structures. They're about the biggest we know of, and they're very elaborately organized. It's like seeing a giant bundle of rope from a very far distance. Simple when you really get down to it, it's far more rich and wonderful than that. And that's really just the tip of the ice--very much tip of the iceberg of all the molecular structures inside of us.

>> So that's about the biggest molecule you'll ever see?

>> Well. Yeah, DNA is like an extremely long thin thread, so it's about--its 2 nanometers, so it's extremely thin thread but it's 40--30 to 40 million nanometers long, so it's extremely long very thin rope. And to keep it organized and to control the access of the genetic code that it contains, it's bundled up

and packaged up in lots of different--different ways by other molecules and so and so.

>> And so at the same time though, I'm trying to imagine how you would depict how a particular gene expresses itself, fires and says to everything around it, okay, this organism is going to grow up with this characteristic. This is how it gets blue eyes, this how it gets light color hair. This is how it gets a particular body shape, or even a particular tone of voice. I mean I'm trying to imagine how all of those things interplay together.

>> Yup.

>> Can you depict that?

>> Well, as a--there's a number of steps between the genetic code that's written in your DNA--written with four different letters, G, A, C, and T, and--and the expression of--of a character, a trait like--like your color of your eyes. So, but the--the point is if you--there is a trait like let's say you have brown eyes, the--the pigment, that that is a molecule so it's a pigment of a certain shape that causes the color that--to come about. So, that trait will be written as a gene or several genes inside your genetic code. So, the--the steps between the code through to the actual outcome, the product, the color--change of color of eye is--there's a number of steps there. It's like making a car and then--and you have the blueprints at one end and you have the car at the other. There's just a wonderful factory in between that does a number of steps to build your car.

>> Now of course when we see it on a factory macro level, we're seeing a very big process that's easy to capture with a lot of people involved in it at different stages. When you're trying to depict a process like that at the microbiological level that triggers gray eyes, blue eyes, whatever, I'm imagining--I'm trying to think how you would depict it just by a molecule sort of firing and lighting up on a certain way or another. I don't know, or moving in a certain way and clicking something throwing a switch.

>> Well, it's--it's much more like a factory than you think because the molecules are the different parts of the--there are the wrenches and the hammers and--and the robots inside a factory and the people inside the factory and--and there's a conveyor belt or a process of steps that will have to happen one after another in--in the correct order to produce your car at the end. So, that's what I'm depicting, and that is actually more of like what your body works. It's not just these--a soup of molecules just randomly running around. There are a number of machines that get together that get built by these--molecules and they assemble your body, a circuit throwing a certain way. You know, it almost has--has a feel of a computer chip in a way and issuing a command that says blue eyes, blonde hair, whatever. And that's how it goes.

>> Yes, yes. And, well, it's more of rather than just a circuit, it's--it's a whole spectacular connection. It's--it's a whole network of circuits and thousands of circuits that throw a loom that creates the fabric of your body.

>> And everything happening all at once.

>> Yeah. And--and talking to each other. They're not doing an--an isolation. They're constantly crisscross chatter all between the different systems of

molecules but all between all the cells. A constant chatter and communication and correction and making sure they're all on track.

>> You could create a whole motion picture on that starting from the lowest level of the single DNA strand all the way up to the--to the final product, I suppose.

>> Yeah. It's a popular one in film. I mean we got Fantastic Voyage and many other films and then certainly CSI and other programs on television, you see, they often go into lab and they zoom in and do these wonderful special effects that those are people--related work to and mine.

>> Yeah. And they're of course--they're of course zooming in on something else. They're--they're looking in from the entry wound into the center and going toward the bullet trajectory.

>> Yes.

>> And seeing how somebody got blown away.

>> Sure, yes. But it's the same idea. You're--you're trying to show what you can't see any other way.

>> And--and what you're doing then is--is animating a process that in a way, we need something like that just to be able to imagine it on our mind's eye.

>> Yes, that's right.

>> 'Cause you can't see it.

>> That's right. That's right. And but once you see it, you do get it.

>> And once you've done that, of course, is your hope in the end--how--how do you want this to be used? Because there's a lot of knowledge here being conveyed and--and maybe even knowledge being expanded because as you see something, you seek probably connections, don't you, between processes that might not necessarily--the relationship might not necessarily been clear before you depicted it but there it is now. Once you do all that, how do you want that to be used by people who see it?

>> Well, the first step is just to give everybody a sense of what biology is about and what we're discovering and how their bodies function. The next--the main thing also is with--with rich visualizations is to draw people in and to engage them and get them asking good questions about how their bodies work and what the drugs do and so on. So that's--that's really the initial step. But what I'm finding is particularly of YouTube and--and other online possibilities is kids now are doing 'cause they--they have to learn this stuff in high school and they're getting excited by visualizations 'cause of what they get with computer games and so on. Is--is they're doing raps, they're on using and uploading on to YouTube their own--their own interpretation of how to tell a story of how DNA functions and so on.

>> So you would see it set to music, set to a beat?

>> Absolutely. And then to rap and to lyrics and to tell a story.

>> Well, they used to talk about the music of the spheres when they were talking about the way the universe was operated. What's the music of a human body like? Does it matter and could it be anything?

>> Ah, it's--it's what? It's--it's actually one area we spend greater time on is--is reconstructing the gurgles and noises of inside the body, but actually--and I've just--just early this year, the Icelandic singer Bjork, I did a music video for her which was a voyage through her body at the microscopic scale, but she wrote a song which is about her DNA and her ancestry and her thread to the 30,000 years of her ancestors through her chain of mothers. So that was her musical interpretation of DNA, what it means to her.

>> That's right. Chain of mothers because I guess Icelandic civilization is matrilineal, isn't it?

>> Yes. I think it goes both ways.

>> Yeah. So--so, I mean it--it's a little bit different culture so, nevertheless though, how did she managed to sort of trace down 30,000 years of her ancestry all the way back to the beginning where, I don't know, maybe they were just populating the--populating Iceland for the first time.

>> I don't know. She--she goes back and then she goes across to Europe and then she has many connections all across Europe through her genes. But that was--that was, of course, came about because the National Geographic are doing--were investigating and using her as the--as the test subject.

>> What did she find out, other than the genetic source of her unusual sense of fashion which became well known at the Grammy's a few years ago?

>> Indeed. And so she--she's--she just found that she has many connections all across Europe and, you know, we were all cross-fertilized from many different directions and in quite surprising ways.

>> And at the same time, what did you hope--what did she hope that people would take away from that, other than sort of a feeling of shared kinship?

>> Well, it was on her own personal exploration of what it meant to her to have this chain of connection to her past and where she comes from and what her person, her body is--is an expression of. So, that that was her own personal exploration of that.

>> What she like to work with, by the way?

>> She was--she was fabulous actually. She was a lot of fun, very creative. She knew what she wants and she knew what she didn't want. And she brought together a whole team, a team of a--there were some instrument makers from MIT's media labs. They built some instruments. There's computer hackers, game programmers. She brought a pretty eclectic team together for her new album. And it was a lot of fun, a very creative time. Now, [inaudible] for me to sort of as she says, "Go Jimi Hendrix," on the side, so yeah.

>> She has a rap of being somewhat quirky, even excentric. Is that a fair reflection of her or she's just somebody who's kinda pushing the envelope a little.

>> She--I agree with all that. I think she is one--someone who likes to be at the frontier and to be challenged than to try out very different things. So we had no--she definitely--it was a very interesting person.

>> I guess so. Are there others who were kind of interested in making use of this visual art form and this visual art form and putting it together with either other art forms or cinema or anything else? Are we getting fillers from elsewhere in the artistic world?

>> It's actually out there quite a bit and, yeah, I have--I did for example in Hollywood I worked on [inaudible] so still I had 3 and a half seconds of fame where I did Keanu Reeves' DNA and his DNA was part human, part alien and so on, so I got a chance to visualize that. But there's a--there are actually lots of demand for this kind of visuals to explore our bodies all sorts of art forms. And then there are people who are exploring cultures of cells and what that may represent. And so, it's a pretty interesting area of biology. And then I'm glad that artists are embracing it because there are a lot of questions to be told that beyond get it out of the labs and get away from scientists just to fully understand what it is that we are discovering about ourselves.

>> Now that we've decoded the genome, are you able to even play with a little bit more different kinds of building blocks and construction pieces in a new way?

>> Yes. Yeah, I know that's--that's a very interesting area there. They're actually creating from scratch life, because now they understand the genetic code and they know now the most fundamental basic things that are required for creating life and they've done that in the lab. And they're also doing things like writing, writing things in the genetic code. And then there're people who are using DNA as a structural--as just because of the nature of how rigid it is and how its twistability in using those physical attributes to build things nanoscopic machines to do jobs that they're hoping to replace computers with.

>> And using DNA as circuit switches?

>> As circuit switches but as little--as little torsion machines, as mechanical machines, as physical devices, vessels to hold things at a very small scale. I mean I don't know because it's just very new area and it's also a gallery of tremendous change and possibility and is--but it's actually working out there. It's amazing what they're doing.

>> I wonder something else too, as we're developing images of how process has come together and how molecules are constructed, are we gonna use them more to test whether or not some of our traditional closely held ideas actually make sense or maybe we've got to step back and say, hey, maybe it doesn't work that way or maybe it can't work that way. Let's look at it as--in a different way and let's try something new.

>> Yeah, that's pretty much that the process largely of science, so that that's--that's what we're going through and--

>> So we can speculate then about on and the possibilities and see if they fit together by using it as, well, there I say it is similar to the way kids put together Lego structures to see if they'll stand up.

>> Absolutely. Yeah, and actually there's programs for kids, school kids to build these molecular machines themselves. And it's one--a big program running out of New York. This is just the beginning. It's a lot of change coming and a lot of possible--very exciting times and I think overwhelmingly positive and an advancement of the human race.

>> 263-WXXI, 263-9994. It's a place where art, where imaging, where science, where research, where theory as well as practice all come together in one place. That's the work of Drew Berry. He creates animated depictions of physical and biological processes we can't see. And he's got the MacArthur Genius Grant for that work because it clarifies the processes of life for researchers, for the public, for everybody who wants to know. And we're finding out about it this hour. He's gonna be speaking tonight at RIT's Web auditorium as part of the Caroline Werner Gannett Visionaries in Motion series. He's here with us now in 1370 Connection and if you're curious, dial in, 263-WXXI, 263-9994 and your questions will be answered right here in 1370 Connection. I'm Bob Smith. Getting a grant like that and the notoriety that undoubtedly comes with it, how did it feel when you got the word?

>> I--when I got that call, the faithful call just comes out of the blue and you don't know it's--it's coming, I'd actually--I wish I knew was coming because I had spent several days not believing it. I do. It was too bizarre and too incredible, but it's a wonderful opportunity for me particularly to take risks and just to try things that may fail but just that are out of my comfort zone and out of my usual career progression. And the Bjork project for example was--was that was definitely because of it I--she was--she was wanting an interactive drum machine based on DNA structures and that we did that but I have also decided to do the--the music video as well. So that was a risk, and it was also stepping well out of my comfort zone to pure art and even though it was all reconstructed accurately but it was still very arty piece, so that's what I hope and intend to use this--this money for.

>> I guess it's art coming together with science.

>> Yes, yes, and why not. They do it all the time, so bring that on.

>> And at the same time though, does it enable you to do a lot of things that ordinarily you wouldn't be asked to do in the normal course of your work, either academic or maybe commercial?

>> I guess so, it's more--I just wanna take personal risks. There are a lot of projects out there that primarily ended education and public education and hopefully this will be [inaudible] augmented with something else that, you know, may or may not work. It's just an opportunity to try something else new.

>> What would you like to do that you haven't done yet? What kind of process or project would you like to depict, to illustrate and set in motion but you haven't gone around to it yet and maybe wondered whether you could but boy, you'd like to give it a shot?

>> That's a great question. You know, I'm gonna give you I guess a bit of a frustrating answer. It's just that there are so--when you get to the frontier of science and understand where humans are at, at our level of understanding of how our bodies are functioning, there are so many stories to be told and each one of them are completely mind boggling. Each page of a textbook, when you really understand what it is they're trying to tell you through simple diagrams, what that actually means when you'd really get on to it, it completely blows your mind. And so, I really am perfectly happy keeping going, just turning those pages of those text--textbooks.

>> Which leads me to something, a question that I've often wondered about. Can we depict, can we model just to use one for instance the path of a thought through the human brain? And if so, how would we do it? How would you choose to do it if you took that on?

>> Well, they're, they're just developing and they now have the ability to see you thinking about things. They now have devices that can actually see your thoughts forming and actually without you telling them see and enable that--to see what these sort of choices you're making. So that it's an interesting time and build it [inaudible] too those sort of capabilities but fortunately at this point it still requires you to labs with equipment but--

>> Excuse me, you mean--you just scared me a little bit.

>> Good, yeah.

>> Because you just I think implicitly raised the possibility of somebody outside you being able to read your mind, read your thoughts in some way, maybe including some thoughts that I'd rather keep to myself.

>> Sure.

>> Yeah.

>> As we all wanna keep to our selves and--and but fortunately that's sort of an extreme technical challenge and--but 50 years or 100 years from now, who knows. Then maybe these are devices well being our equivalence of iPads then. But I don't know the--it's--that's one interesting area but it's--they actually have good visualizations of how our brains function and the pathways of information through our brains and that in itself--like for example music, there are parts of our brain, modules of our brain that have to do with rhythm, very different areas to do with tonality and melody and so on. So, there--all these little modules of the brain, they're really starting to get a handle on how we function.

>> So, we're not that far away from being able to depict let's say the process of somebody sitting down and writing a melody for a song?

>> More of them ruminating with the melody in their heads rather than--your mechanical action of creating that song is still very, very complicated. It's all the steps that your body has to go through.

>> Sitting down at the guitar--

>> Oh yeah.

>> and running all of the melody progressions and riffs.

>> It's an impressive feed in itself.

>> That's an impressive feed.

>> Yeah.

>> But beforehand, they might be able to figure out a way to depict that melody going through your head and you're figuring, I'm gonna put an A chord here, a G-7 here, et cetera, et cetera.

>> That they may well but I'd much rather hear them play it, quite frankly.

>> Oh yeah.

>> Yeah.

>> Absolutely, because if there's so much lost in the translation but--

>> That's right.

>> But they're only able to go at least that far and how much you want to create an animation of that if you could or if you even thought it was an appropriate thing to do.

>> Absolutely. Now I do--beautiful thing to see someone singing a song, what it looks like in their minds as I sing a song. The different parts, the bits it would light up, the cross communication. It'd be a--it's like when you see those time lapse, nighttime shots of a city with all the cars driving around and the beautiful patterns and the ordered structure of cars going down roads. It's very much like that. I think it would be very beautiful thing to see.

>> 'Cause I know a lot of artists have tried to do it, filmmakers too. I mean Walt Disney tried to do it with Fantasia, set its whole army of animators to work and we got what we got out of that certainly. But not necess--it would not necessarily look like Mickey Mouse battling with walking brooms with buckets of water then.

>> No, no, indeed. And in part that that's why you have to tie in the stories with the actual human--human experience and what the person is that that's doing. And so just the abstract places you go to when you--the very, very weird worlds you go inside our bodies, it all ties back to our own human experience, on this macro world that we live in and the people we associate with and so on. That's where the connections between those two worlds I think are very interesting.

>> And that's really maybe your--is that your next step perhaps?

>> Yeah, it is because that's always where my animations are grounded is the human story. It's not just about the facts, it's about the whole context in the story, what this means for us as human beings.

>> Can't wait to see it. Can't wait to see what's next. Thank you for sharing this process with us and this journey that you've taken us all along.

>> Oh, thank you. Thank you very much.

>> Our thanks to Dew Berry who is going to be speaking tonight at 8 o'clock at RIT's Web Auditorium. It's part of the Caroline Werner Gannett lecture series Visionaries In Motion. He shared his work with us, work that's gotten him a [background music] MacArthur Genius Grant, on this hour of 1370 Connection here at WXXI AM and FM HD2 Rochester. For Dave Campo, our technical director, I'm Bob Smith. It's been a pleasure.

[Music]