How Animations Can Help Scientists Test a Hypothesis

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Take a look at this drawing. Can you tell what it is? I'm a molecular biologist by training, and I've seen a lot of these kinds of drawings. They're usually referred to as a model figure, a drawing that shows how we think a cellular or molecular process occurs. This particular drawing is of a process called clathrin-mediated endocytosis. It's a process by which a molecule can get from the outside of the cell to the inside by getting captured in a bubble or a vesicle that then gets internalized by the cell. There's a problem with this drawing, though, and it's mainly in what it doesn't show. From lots of experiments, from lots of different scientists, we know a lot about what these molecules look like, how they move around in the cell, and that this is all taking place in an incredibly dynamic environment.

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So in collaboration with a clathrin expert Tomas Kirchhausen, we decided to create a new kind of model figure that showed all of that. So we start outside of the cell. Now we're looking inside. Clathrin are these three-legged molecules that can self-assemble into soccer-ball-like shapes. Through connections with a membrane, clathrin is able to deform the membrane and form this sort of a cup that forms this sort of a bubble, or a vesicle, that's now capturing some of the proteins that were outside of the cell. Proteins are coming in now that basically pinch off this vesicle, making it separate from the rest of the membrane, and now clathrin is basically done with its job, and so proteins are coming in now — we've covered them yellow and orange — that are responsible for taking apart this clathrin cage. And so all of these proteins can get basically recycled and used all over again.

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These processes are too small to be seen directly, even with the best microscopes, so animations like this provide a really powerful way of visualizing a hypothesis.

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Here's another illustration, and this is a drawing of how a researcher might think that the HIV virus gets into and out of cells. And again, this is a vast oversimplification and doesn't begin to show what we actually know about these processes.

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You might be surprised to know that these simple drawings are the only way that most biologists visualize their molecular hypotheses. Why? Because creating movies of processes as we think they actually occur is really hard. I spent months in Hollywood learning 3D animation software, and I spend months on each animation, and that's just time that most researchers can't afford. The payoffs can be huge, though. Molecular animations are unparalleled in their ability to convey a great deal of information to broad audiences with extreme accuracy. And I'm working on a new project now called "The Science of HIV" where I'll be animating the entire life cycle of the HIV virus as accurately as possible and all in molecular detail. The animation will feature data from thousands of researchers collected over decades, data on what this virus looks like, how it's able to infect cells in our body, and how therapeutics are helping to combat infection.

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Over the years, I found that animations aren't just useful for communicating an idea, but they're also really useful for exploring a hypothesis. Biologists for the most part are still using a paper and pencil to visualize the processes they study, and with the data we have now, that's just not good enough anymore. The process of creating an animation can act as a catalyst that allows researchers to crystalize and refine their own ideas. One researcher I worked with who works on the molecular mechanisms of neurodegenerative diseases came up with experiments that were related directly to the animation that she and I worked on together, and in this way, animation can feed back into the research process.

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I believe that animation can change biology. It can change the way that we communicate with one another, how we explore our data and how we teach our students. But for that change to happen, we need more researchers creating animations, and toward that end, I brought together a team of biologists, animators and programmers to create a new, free, open-source software — we call it Molecular Flipbook — that's created just for biologists just to create molecular animations. From our testing, we've found that it only takes 15 minutes for a biologist who has never touched animation software before to create her first molecular animation of her own hypothesis. We're also building an online database where anyone can view, download and contribute their own animations. We're really excited to announce that the beta version of the molecular animation software toolkit will be available for download today. We are really excited to see what biologists will create with it and what new insights they're able to gain from finally being able to animate their own model figures.

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Thank you.

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(Applause)