

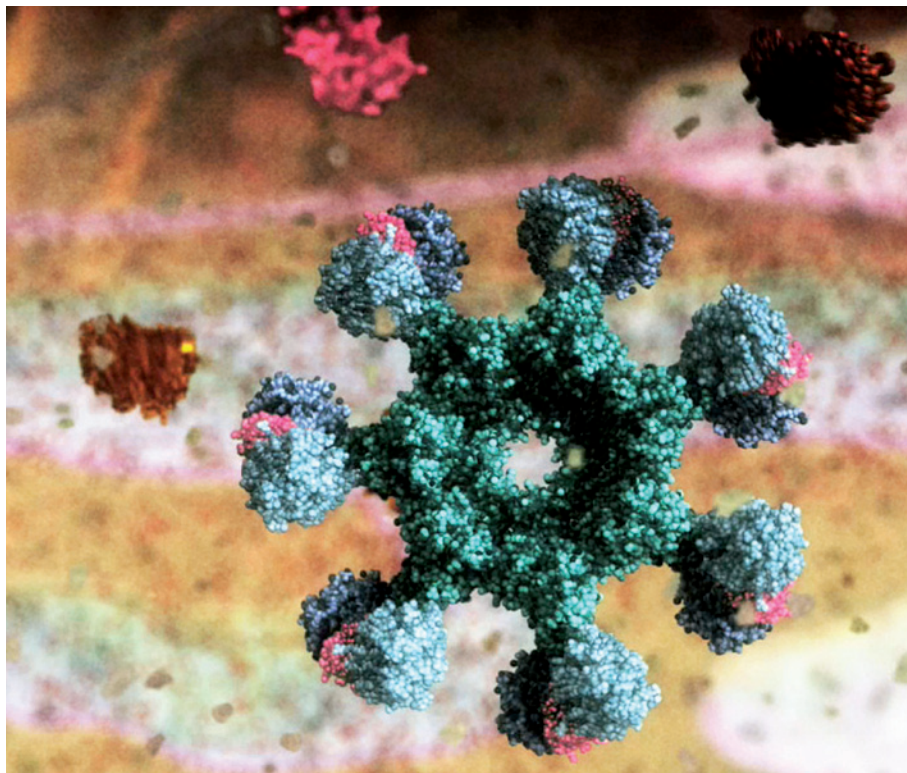
CAREERS

TURNING POINT Postdoc's efforts bring explorer award and policy post **p.361**

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D. BERRY/WALTER AND ELIZA HALL INST.



The protein structure known as the apoptosome, from the animation *Apoptosis* by Drew Berry.

BIOMEDICAL ILLUSTRATION

From monsters to molecules

Scientific animators are borrowing tools from Hollywood to breathe life into cells and molecules on screen.

BY CORIE LOK

Janet Iwasa listened as Samara Reck-Peterson struggled with a presentation. Reck-Peterson, a cell biologist, was trying to describe how dynein — a protein complex that acts as a molecular motor to transport cargo along the cell's cytoskeleton — moves. The complex is at the heart of Reck-Peterson's research, but she had only a styrofoam ball and pipe cleaners to demonstrate its complex actions at the faculty meeting. Iwasa, a

scientific animator and a lecturer in the same department as Reck-Peterson at Harvard Medical School in Boston, Massachusetts, recalls thinking: "We can do better than that."

So began a collaboration between the biologist and the animator. Over the past two years, the partnership has resulted in eye-catching images and animations of dynein that grace Reck-Peterson's presentation slides and her lab's website. Iwasa is now working on dynein animations that the researchers themselves can tinker with by manipulating the

motor's 'joints'. Reck-Peterson hopes that the animations will help her lab to design its next experiments, providing insight into exactly how this motor works. "The animations have made it easier to talk concretely about our ideas, both within the lab and with others in the field," says Reck-Peterson.

Iwasa is in the vanguard of scientific animators working in academia. Harvard's cell-biology department hired her three years ago to facilitate communication among faculty members and other scientists. Since then, she has worked with about a dozen researchers to visualize the molecules, pathways and cellular processes that they study, such as cell death. She also has a growing freelance business, 'onem micron illustration', creating animations, illustrations and websites for researchers at Harvard and other institutions.

Biomedical animators in the United States, Canada and elsewhere are seeing rising demand for their work from sectors including academic research, publishing, biotechnology and the drug industry. Animation studios have proliferated in the past five years, and medical-illustration master's-degree programmes have expanded their class sizes, with graduates generally able to find jobs with animation firms and research institutions. More and more scientists are seeking out animators, and a few, hoping to tinker with animation to aid their research rather than build a fully fledged career in it, are learning to use the tools themselves.

Driving this interest is an expansion in digital media connected with devices such as the iPad, and a burgeoning appreciation from publishers, scientists, educators, museum staff and others of the power of three-dimensional (3D) visualizations to communicate complex concepts. "The job is now getting the recognition and respect it deserves," says Drew Berry, a biomedical animator at the Walter and Eliza Hall Institute of Medical Research in Melbourne, Australia, who won a 'genius' grant from the MacArthur Foundation in Chicago, Illinois, last year.

TO ACADEMIA AND BEYOND

Scientific animators work with software similar to that used to create special effects and animated films in Hollywood, including a program called Autodesk Maya. But instead of creating monsters and explosions, they pull in data from a variety of sources, including review and research papers, to bring molecules and cells to life on screen. Dozens of papers can be necessary to inform a single animation. Animators also tap into scientific databases, ►

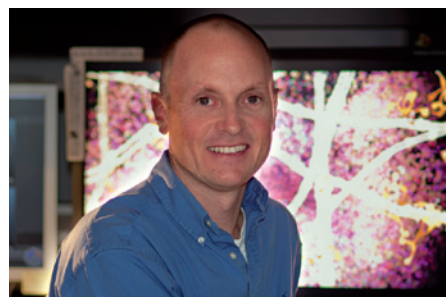
► such as the Protein Data Bank (www.pdb.org), to extract molecular structures, images, microscopy data and other key information. Some animators also spend a lot of time in close discussions with scientists to nail down details of how a molecule or cell moves or interacts with others. It is an iterative process, and a project can take months. “Diving into the latest data and making sense of it is challenging, but rewarding,” says Berry.

In academia, animators also develop courses and adapt animation tools for use in science. Eventually, they hope, visualizations could become a research tool used to develop, test and refine biomedical hypotheses, not just a method of communication. “As we get more data, we need better ways to synthesize the data into models,” says Iwasa.

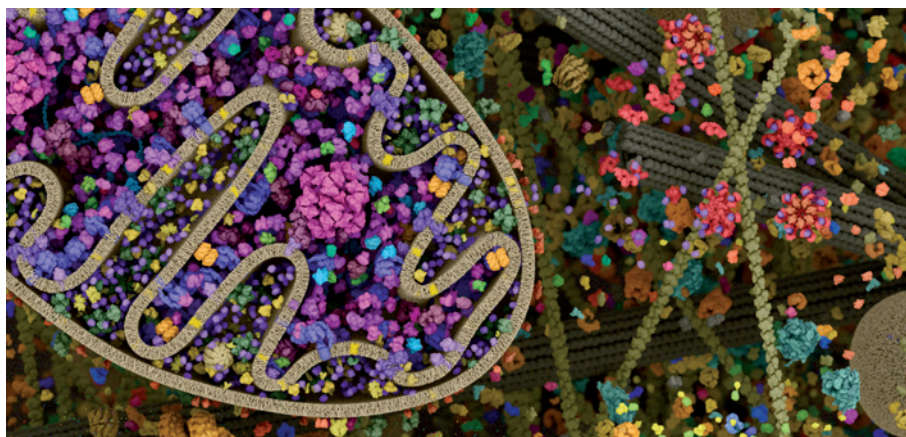
Academia is only a small part of the market for scientific visualizations. Scientific animators can also be found at a growing number of commercial animation and design studios that specialize in biomedical work. These firms have been hiring increasing numbers of people over the past five to ten years, to serve an expanding client base. InViVo Communications in Toronto, Canada, started with three employees in 1998 and has since expanded to 46, including animators, programmers and sales people. XVIVO, a studio in Rocky Hill, Connecticut, has almost doubled its full-time staff to 15 employees over the past three years.

Such studios work mainly for the drug industry, but also for publishers, medical schools and teaching hospitals, and even for lawyers involved in malpractice lawsuits that require visuals as legal evidence. Medical-device, biotech and pharmaceutical companies use animations about their latest products in sales, marketing and educational materials. Visualizations also end up in museum exhibitions, classroom teaching tools, digital textbooks and documentaries, and on journal covers and websites.

According to 2009 data from a survey by the Association of Medical Illustrators in Lexington, Kentucky, illustrators and animators employed full-time earn a median salary of US\$52,000 at the start of their careers, \$65,000 in mid-career and up to \$150,000 as seasoned veterans. Many animators also work on a



Medical animator Drew Berry has won a MacArthur grant, a sign of the field's increasing recognition.



Animations such as these images of mitochondria and proteins help researchers model cellular processes.

freelance basis, in which case their incomes can vary greatly; the median is \$79,000 a year, but incomes can reach up to \$250,000.

ARTFUL SCIENCE

Many scientific animators enjoy combining their passions for science, art and computers. Gaël McGill, director of molecular visualization at Harvard Medical School and president and chief executive of the studio Digizyme in Brookline, Massachusetts, spent his summers as a teenager with an aunt who was an art teacher, but he also loved science. He studied biology, art history and music as an undergraduate, then earned a PhD in cancer biology and completed a postdoc. Along the way, he discovered an interest in communicating science and started teaching himself how to use Maya at night, as a way to put his artistic skills to work.

Having a background in art or an eye for design and visual storytelling is crucial for scientific animators. An innate sense of aesthetics or some basic training in lighting, colour and composition to enable visual expression through drawing or other media is key to success, says Graham Johnson, an animator who will soon be starting a position at the University of California, San Francisco. He will be continuing his work developing software that, for example, integrates molecular modelling tools with animation programs to better connect raw scientific data with animation capabilities. “People with just a science bachelor's and no formal art or illustration background will probably struggle,” he says.

Employers can quickly tell whether a budding animator has artistic talent by looking at their portfolio, or ‘demo reel’, which should showcase about a minute's worth of animations, says Andrea Bielecki, president of InViVo. An animator's personal website is also very telling — it should be easy to navigate, slick and quick to load demos.

A love of software and tinkering at the computer is essential. Computer-programming skills aren't required, but they are in hot demand: interactive biomedical applications

for the web, or for the iPad and other devices, are the fastest-growing part of InViVo's business, and skilled people are needed to write them, says Bielecki.

Although an artistic and production track record is paramount, having a scientific background can help with career advancement. Some design studios don't require it, but McGill hires only people with scientific master's degrees, PhDs or MDs to work at Digizyme. At the very least, those interested in scientific animation should have the ability to read and understand the relevant literature and to talk to scientists about their work.

A DEGREE OF ILLUSTRATION

Some in the field, such as McGill, are self-taught. Others learnt their skills through informal or part-time courses. Iwasa, for example, started her career as a graduate student in cell biology at the University of California, San Francisco. Already skilled in using programs such as Adobe Photoshop, Illustrator and Flash, she found that she enjoyed creating the figures that accompany manuscripts. With the support of her mentor, she took a basic animation course every Friday afternoon at another local university, and began making animations with her lab mates. After earning her PhD, she enrolled in a 12-week intensive course on how to use Maya.

Others attend accredited master's programmes in medical illustration. There are only a handful of such courses in North America; one of these is the University of Toronto's MSc in Biomedical Communications. The programme has a strong animation component and takes in 16 students each year, up from 8 in 2004 — a response to a rising number of applications and inquiries, and a growing job market. During the two-year professional programme, students take classes in biology and medicine, and learn about design concepts, software and the animation process. They also work closely with scientists on visualization projects. Many land jobs at animation studios, research institutions and elsewhere within a few months of graduation.

However, some graduates from the master's programmes, especially from courses that

don't emphasize animation as much as that at Toronto, are not quite ready to work as production-level animators in a studio, says David Bolinsky, medical director of XVIVO. He recommends taking another year or so to attend a dedicated animation programme.

Many students entering the Toronto programme have bachelor of science degrees; an increasing number have advanced degrees, including PhDs, says Nicholas Woolridge, director of the course. Most are "passionate amateurs" in art, he adds. Applicants must submit a portfolio of work. "It doesn't have to be polished, but it needs to show that they can think visually and are visual problem-solvers," says Woolridge.

McGill, who teaches a one-year animation course for researchers at Harvard, is developing a new graduate programme, focusing on computer 'biovisualization'. Applicants would need to meet the same entrance requirements as for Harvard's other biology graduate courses, take the same first-year courses in cell and molecular biology and possibly even do lab rotations. McGill foresees his first set of students being existing PhD candidates who stay on for an extra year to earn an additional master's degree in visualization. McGill hopes to launch the master's programme in 2012, and eventually create a PhD programme. He sees his field shifting towards more research and software development, rather than just making animations.

Those interested in animation as a side activity or add-on skill to enhance their research can dabble at a basic level on their own. Many software packages, including Maya, can be downloaded at low cost, or even for free, as educational versions. "Just start playing and have fun," says Berry. Only then will people see whether they really enjoy the arduous and sometimes frustrating process of animation. Online tutorials, workshops and user forums can help amateur animators to learn on their own; see, for example, listings on www.molecularmovies.com. Most sites are geared towards film animation, but the concepts are the same.

McGill says that early-career scientists who master some skills in 3D animation can advance their careers by giving better seminars, using visual models of data to garner and inspire ideas and insights, and developing new research tools. In one case, a student of McGill's used his visualization skills to devise new DNA folding software that allows researchers to design their own molecules in three dimensions. "When you're going through the process of making a visualization," says McGill, "you come up with new questions and open up new ways of thinking." ■

Corie Lok is the editor of *Nature's Research Highlights*.

TURNING POINT

Jennifer Burney

Jennifer Burney, a physicist-turned-environmental-scientist at Scripps Institution of Oceanography at the University of California, San Diego, tells Nature about her upcoming tenure-track position in public policy and the unexpected honour of being named an Emerging Explorer by the National Geographic Society in Washington DC.

How did you end up pursuing both physics and international development?

I graduated with a bachelor's degree in history and science; I have always wanted to discover how science happens in a social context. But I enjoyed scientific research, which prompted me to pursue a physics PhD at Stanford University in California. I deferred graduate school for a year to volunteer with rebuilding efforts in Nicaragua following 1998's Hurricane Mitch. It was exciting to be in the field devising creative solutions. I eventually returned for my PhD, working to develop a superconducting camera that will help to capture images of cosmic bodies such as pulsars or exoplanets. But I continued to work for a non-profit group in Merced, California, called Engineers for a Sustainable World, which works with communities in the developing world.

You worked in the non-profit sector for a time, instead of going straight to a postdoc. Why?

As my PhD ended, I chose to try a non-academic route. My adviser said he would support me in whatever I decided. I knew that I wanted to investigate energy and climate issues in the developing world. So I cold-called a non-governmental organization (NGO), the Solar Electric Light Fund in Washington DC, which is involved in rural electrification around the world. One project was solar-powered drip irrigation in West Africa. They needed somebody to figure out how to evaluate the technology. That required assessing the design and how to make it cost-effective and sustainable.

How did this work influence your postdoc?

I continued working with the fund, and got interested in how energy and climate affect food security, water availability and agriculture. In 2008, I took a postdoc at Stanford's Program on Food Security and the Environment. Last October, I started a second postdoc at Scripps, where I began working on mitigating the climate impact of burning biomass for cooking and space heating. Now I'm involved in a project to replace cooking stoves with cleaner technologies over 100 square kilometres in northern India — and then



SCRIPPS INSTITUTION OF OCEANOGRAPHY

measuring the climate, health, hydrological and agricultural impacts over space and time.

Were you surprised to get a policy-based tenure-track position?

Yes. An advertisement for someone interested in science, technology, engineering and policy came up at the University of California, San Diego, and I thought, 'why not?' It was an exciting opportunity, not necessarily to straddle the worlds of NGOs and academia, but to have a job, starting next year, in which I would be teaching policy to scientists and science to policy-makers, while continuing my research.

How will the National Geographic Emerging Explorer distinction affect your career?

I'm still figuring it out. For the next year, *National Geographic* will track my scientific endeavours online. I just returned from the orientation meeting, where I met this year's class and previous explorers — and I have found a lot of common ground for collaboration. For example, one fellow works on ecological sanitation, and started a network of composting latrines in Haiti. We are planning some joint projects in West Africa, a region that needs new ways to generate fertilizer.

How have you benefited from stepping outside academia?

Leaving academia can invigorate your science. I'd encourage scientists to explore non-academic interactions — from giving public lectures to collaborating with NGOs. Being around non-scientists who channel their passion and understanding of science into real-life projects can shed light on how to make the most of your own expertise. ■

INTERVIEW BY VIRGINIA GEWIN