TURNING POINT Genomicist navigates Spain's difficult funding climate **p.261**

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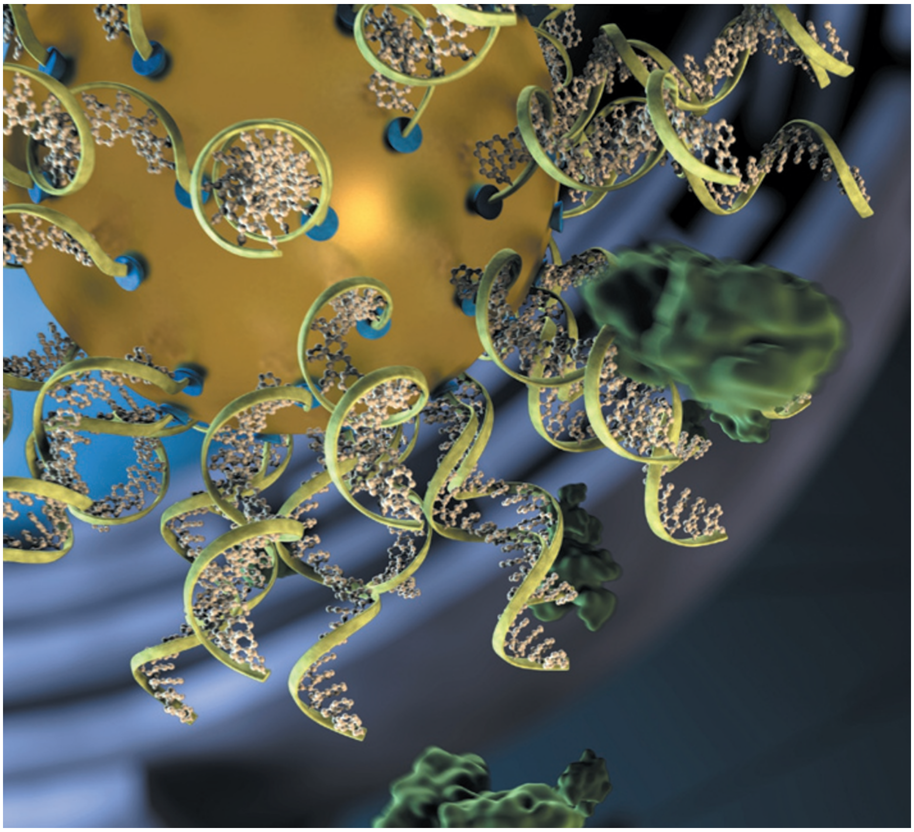


A computer animation illustrates the activity of particles called spherical nucleic acids.

COLUMN

Animated science

Understanding how visualizations can communicate research will help scientists to make the most of the technology, says **Quintin Anderson**.

As an animator, I help scientists to diffuse their ideas throughout the research community, raise awareness of their work and attract funding. But during my most recent project, I realized that many scientists could benefit from more information so that they can use animation to its full potential.

My client was Chad Mirkin, director of the International Institute for Nanotechnology at Northwestern University in Evanston, Illinois. He wanted an animation that whisked the viewer to the molecular level for a look at the properties of spherical nucleic acids (SNAs) — nanoparticles developed and researched at his lab. But it was his first time producing an animation. He wanted to know what his role would be. How would we keep the audience's attention? How would we communicate the science accurately and clearly?

Some basic tips will help to demystify science animation, and will let scientists take full advantage of this powerful tool.

The first step is to write a script describing the concepts and ideas that the researcher hopes to illustrate and communicate. The researcher can start by setting out a synopsis of the science, working alone or with the animator. Then he or she can break the synopsis down into scenes, and use it as a guide to write the narration. For example:

Scene 1 synopsis: SNAs are defined.
Narrator: Spherical nucleic acids, or SNAs, consist of densely packed, highly oriented nucleic acids, typically arranged on the surface of a nanoparticle.

Narration should be concise. The overall length of animations can vary, but generally a video explaining a research idea or hypothesis will last for two to four minutes. A narrator will typically speak 125–130 words per minute, so a three-minute animation will contain no more than about 400 words of narration. Depending on the lag time between revisions, it can take two to four weeks to complete a script for a three-minute animation.

PROVIDE CONTEXT

Narration should mention the benefits or impact of the science so that the audience can relate to the content. Consider, for example, a hypothetical animation on insulin and the insulin receptor. A script simply describing the relationship between these molecules, without mentioning why their interaction is important, might read:

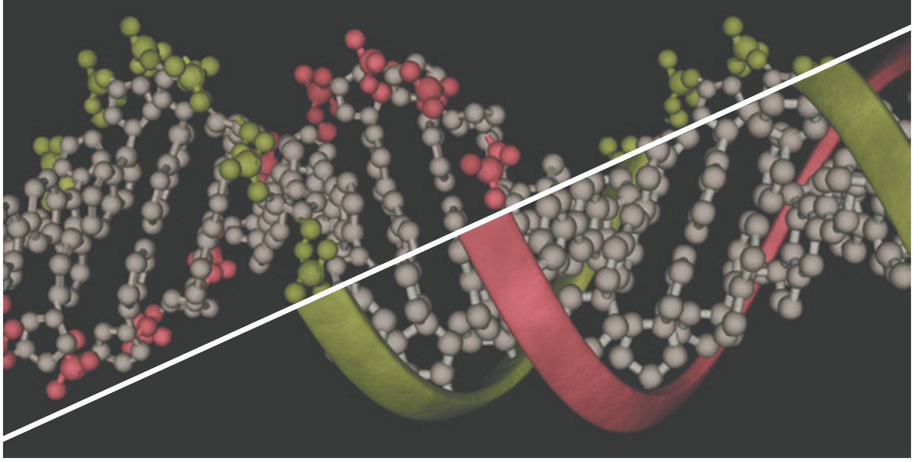
Scene 1 synopsis: The relationship between insulin and the insulin receptor is described.
Narrator: The binding of insulin to the insulin receptor leads to an intracellular signalling cascade that promotes the storage of glucose in cells. The failure of insulin to bind to the insulin receptor can prevent the cellular uptake of glucose.

To be more engaging, however, the narration could describe how the molecules' interactions affect health:

Scene 1 synopsis: The relationship between insulin and the insulin receptor is examined in the context of diabetes.
Narrator: The binding of insulin to the insulin receptor leads to an intracellular signalling cascade that promotes the storage of glucose in cells. If insulin fails to bind to the insulin receptor, the cells don't take up glucose, and blood sugar spikes, producing symptoms commonly associated with diabetes. ▶

VISUAL APPROACH

The ribbon model, used for the helix on the right, illustrates the shape and contour of the molecule. The ball-and-stick model, used for the helix on the left, emphasizes the molecule's atoms and the bonds between them. Which model is best depends on what the researcher wishes to highlight.



Q. ANDERSON

As with any communication about science, the audience's scientific background and level of education must be taken into account. Mirkin's animation was aimed at viewers with an undergraduate-level understanding of chemistry and biology. Mirkin, therefore, used biological language to describe how SNAs enter cells: "Their high density of nucleic acids leads to interactions with membrane-bound scavenger proteins. As a result they are taken up through endocytosis."

But in an interview with The Good Stuff (thegoodstuffshow.com), a website that develops informational videos on scientific phenomena for the layperson, Mirkin used nontechnical language: "You can feed them directly into cells, and the cells just soak them up." Pinpointing the target audience before writing the script is crucial.

MODEL BEHAVIOUR

After completing the script, the scientist works with the animator to turn his or her vision into reality. The chances of a productive interaction and collaboration are greatly increased if the researcher understands how aspects of animation such as models and colours can be used to communicate science effectively.

The animator builds models to visualize events. Different types of model help to evoke different aspects of the data or features of the players involved. Ribbon models, for example, are effective for illustrating the shape and contour of a large molecule. Ball-and-stick models emphasize the molecule's atoms and the bonds between them. Which model is most appropriate depends on what properties the researcher wishes to highlight (see 'Visual approach').

In Mirkin's animation, for example, the design of short strands of DNA and RNA — oligonucleotides — required both ribbon and ball-and-stick models. To make the oligonucleotides easy to identify, Mirkin wanted their backbones to look like a helix — a shape commonly associated with nucleic acids. For that, we used a ribbon model.

However, the ribbon model was not appropriate for representing the bases connected to the backbone. It simplified each to a flat plank, making cytosine, for instance, indistinguishable from adenine. To differentiate the bases, we represented their atoms as balls, and the bonds between these atoms as sticks.

In other cases, where the emphasis is not on the chemical bonds and atoms, but on the space that the atoms occupy, I represent the atoms using 'space-filling' models, in which each atom is shown as a sphere that butts up against the next. This depicts the molecule as a solid object with an uneven surface.

KEEP IT SIMPLE

I urge my clients to remember that models simplify the underlying data. If the model does not capture the science adequately, the researcher should brainstorm with the animator to make it more suitable.

> *"Animation can be not only fun, but also incredibly effective."*

Although the shape and contour possibilities are many, they are not endless. Software can create a variety of models, but each one takes up computer resources, so scenes with thousands of objects are difficult to show, especially if those models are very detailed. Lipid bilayers, for example, are notoriously hard to craft because they contain hundreds of thousands of lipid molecules.

Scientific accuracy sometimes has to be compromised. For example, the space inside cells is crowded with proteins. If this were shown, depicting a single event in the cell would be difficult. Therefore, this space is commonly left empty in animations, to demonstrate more clearly and cleanly the biochemical events that are the focus of the narrative. Brownian motion — the random movement of particles caused by molecular collisions — may have to be omitted or reduced if it impedes the view of the science. Simplified representations might not be completely accurate, but they help to communicate the science clearly in a short time.

ARTISTIC IMPRESSION

Colour and sound can reinforce the scientific details. For example, adopting a meaningful colour scheme can help the viewer to make sense of a complex scene. In a cross-section of the bacterium *Escherichia coli*, David Goodsell, a molecular-illustration pioneer at the Scripps Research Institute in La Jolla, California, colour-coded molecules to identify the different functional compartments of the cell. But proceed with caution to avoid confusion. If, for example, the cytoplasmic proteins in the *E. coli* cross-section had been given the same colour as the membrane-bound proteins, then these compartments would have been hard to tell apart.

Adding music can make an animation more engaging. BioVisions, a multimedia lab at Harvard University in Cambridge, Massachusetts, accompanied an animation called *The Inner Life of the Cell* with an evocative piano piece. In my view, the music was not just for entertainment. The repetitive melody mirrored the rhythmic cycles of cellular processes, enriching the feeling that these processes were both understandable and eternal. The crescendos enhanced the beauty of these basic scientific processes. The music, which won the 2006 Telly Award for Best Music Composition for a Non-Broadcast Film or Video, helped the viewer to become immersed in the intracellular world, and helped to create a lasting impression.

But sometimes music detracts from the aim of the animation. Again, knowing one's audience is key. BioVisions made a version of *The Inner Life of the Cell* in which a narrator describes the intracellular processes illustrated. It had no music, and for good reason: a score could have become distracting for, say, a student using the animation to prepare for a cell-biology exam. Scientist and animator should determine the objectives and audience of the animation to work out whether music helps or hinders.

Animation can be not only fun, but also incredibly effective. By crafting an engaging, audience-appropriate script, and providing proper feedback to the animator, scientists can turn their research into something more than facts, figures and acronyms. They can craft it into a compelling visual story. ■

Quintin Anderson *is the creative director of the Seagull Company in Midland, Texas.*

CORRECTION

The Careers Feature 'Financial Burden' (*Nature* **501,** 579–581; 2013) wrongly stated that TIAA-CREF is based in Charlotte, North Carolina. It is based in New York City.