Subject Focus

Science

Spinning yarns of a superhero

Harry Witchel uncovers the reality behind the Hollywood science of Spiderman

Spiderman is an amazing superhero. He can climb up the side of skyscrapers, jump from rooftop to rooftop, and swing across New York City on huge web-like fibres that squirt out of his wrists. But can he motivate five to 18-year-olds to learn about science? The most vivid approach for helping young people to understand science, particularly genetics, molecular biology and biochemistry – where everything is too tiny to see – is to make it substantial, so the students can perceive it.

Most students have seen the recent hit movie *Spiderman*, and can be engaged with what they saw. To get them to think about and discuss science, one can add a *Hollywood Science* approach from the BBC television programme, in which one asks, "Can that really happen in real life?" What happens in the *Spiderman* movie gives students an opportunity to talk about many scientific concepts; tangible examples can be developed across the sciences, even in physics.

Discussion topics for primary

- The first change that the movie shows happening to Peter Parker during his transformation into Spiderman is that his vision is corrected overnight. Is this incredible change possible, and what would have to happen for it to occur?
- Spiderman climbs walls. In the film they actually show Spiderman growing little hairs (*setae*) from his fingers, and these give him the tackiness to stick to the side of bricks while climbing a building. Ignoring the fact that Spiderman did not take off his shoes when climbing the wall, would the connection of these hairs to the wall have been sufficient to support his weight?

Discussion topics for secondary

As students become older, they become more interested in DNA itself and what it does; the *Spiderman* movie provides plenty of scope for investigating that. They are all taught that genes are material things that parents pass to offspring during reproduction and through which they propagate their biological traits or characteristics, but what are genes really?

To make meaning of what something is, you have to know what it is not. Students have to know that in a cell there is not just DNA but also proteins; the older students will need to know that proteins are the building blocks of almost everything made by cells, from spider silk (*fibroin*) to spider toxins, and that these proteins are totally different from each other, but they are all chemically similar in their formulation. In short, the students can learn from Spiderman about the central dogma of molecular genetics, which is that DNA codes for RNA, which codes for the production of proteins. This concept gives a lot of scope for the *Hollywood Science* approach.

- Peter Parker is transformed into Spiderman after being bitten by a genetically modified super-spider. For this transformation to occur there must have been something in the spider bite. Based on science, what might this have been? Is it possible to transfer DNA into mammals by a spider bite? Unfortunately for Hollywood, most spider venoms are made of neurotoxins (for immobilising prey) and enzymes (for digesting), which are short proteins (*peptides*) and not genetic material or DNA. To add to this, students can discuss how DNA actually can be transferred, medically and naturally. What kinds of DNA transfer can lead to permanent changes? (DNA is only transferred from bites when the DNA is inside a bacterium, like the black plague.)
- The footage used in the movie to show the transformation of Peter Parker into Spiderman involves the flashing of a skull, the cells of the brain (neurones) signalling to each other, a spinning piece of a DNA double helix having a mutation inserted into the sequence, followed by zooming through a dark space surprisingly like the cinematic representation of a black hole. How in reality might these be related? In particular, how would a point mutation in the DNA sequence lead to changes throughout the body, and could this point mutation be the result of the DNA transfer from the spider bite? This could lead to important discussions about cloning and the differences between gene transfer in somatic cells versus germ cells.
- The DNA transfer from the super-spider allowed Spiderman to shoot silk webs out of his wrists. Could a mammal make spider silk? It sounds unlikely, but there is a company (Nexia) in the US that is working with the US Navy to make the protein of spider silk in goats. The goats secrete the web protein called fibroin into their milk, but because goats lack spinnerets, the web protein will ultimately have to be spun artificially.

Activities

The most exciting way to get beyond abstractions in describing DNA is to show that it is "stuff", that it is a chemical, and that all the beautiful Hollywood images of the double helix are very close up views of this chemical. The classic DNA activity for students is purifying DNA from a Kiwi fruit using ordinary household items. Complete instructions for doing this can be found online in *The Times Educational Supplement*, February 28, 2003, and online at **www.tes.co.uk**, in the article "Spiralling off the scale" by Kate Graham.

For a little bit more money, you can do the ultimate tangible DNA experiment with students (from 11 to adult). You can buy a kit from Bio-Rad that comes with everything that is needed to transfer DNA (plasmids) into bacteria. What makes these kits astonishing is that the process is so visible: after the DNA gets into the bacteria, the bacteria change colour under ultraviolet

Physics of Spiderman websites

www.Bio-Rad.com
Email: dominic_delaney@bio-rad.com

www.intuitor.com/moviephysics/spiderman.html

www.scifi.com/sfw/issue263/labnotes.html

About transformation:
http://profiles.nlm.nih.gov/CC/Views/Exhibit/narrative/research.html

STICKY BUSINESS: PETER PARKER'S TRANSFORMATION INTO SPIDERMAN RAISES ISSUES ABOUT HOW DNA CAN BE TRANSFERRED AND MANIPULATED

TRIBION

light, because the DNA in the plasmid includes the gene for Green Fluorescent Protein. It is amazing how simple molecular biology can be made, and this experiment really makes people smile when they see the little bacteria light up (see right).

Bio-Rad also has a kit for students (from eight to adult) in which each student purifies a bit of their own DNA (so there are no health and safety issues) from cheek cells. Then the students put the strands of their own DNA into a dashing, clear necklace to wear.

Harry Witchel is research fellow in the department of physiology, University of Bristol. He will be presenting two lectures at the Cheltenham Festival of Science (June 9-13, **www.cheltenhamfestivals.org.uk**) on "The Hollywood Science of Spiderman" and "Body Language and Beyond"