Enter the Nanoman

How do you explain a topic like cancer nanotechnology to non-experts? Nicole Steinmetz illustrates an approach combining science and the performing arts.

In an era dominated by ‘fake news’ and ‘alternative facts’ it can be difficult to ensure the public receives accurate and accessible information. Communication with the public becomes even more challenging when it comes to reporting scientific advances. The media tends to sensationalize scientific discoveries and the misreporting of scientific data is rife. This can lead to general fatigue, as when readers are told one day that their coffee causes cancer and the next that it protects them from cancer. But in some cases, misleading reporting can have serious implications, such as the MMR vaccine scandal. It is also difficult to convey the true nature of scientific discovery when the media, and to some extent even the scientific journals themselves, focus on breakthrough research rather than the daily grind of real experiments with all the inevitable setbacks and failures. The gulf between the reality of the laboratory and the version of research reported in the media has never been wider than for newer disciplines such as nanotechnology, which have gripped the imagination of the public and have been featured in numerous movies and novels. For all the promise nanotechnology offers, including my personal area of research (cancer nanotechnology), progress still faces the same hurdles found in every other research field: dead ends, experimental failures and the need to repeat experiments over and over to learn from mistakes. What can we do to make the public more aware of the reality of scientific research? If only there were a superhero we could rely on...

Luckily we can rely on our own superhero: the Nanoman. More precisely, to make cancer nanotechnology accessible and to highlight the advances and challenges, we have taken an interdisciplinary approach that mixes STEM with the performing arts. This is a collaborative effort between Knight & Brinegar (www.knightandbrinegar.com), a retro-forward musical-writing team, and me (www.steinmetzlab.com). The Nanoman project bridges the fields of nanotechnology, gaming, graphic design and theatre to capture the concepts of drug delivery and cancer nanotechnology. Across various media platforms, the Nanoman is on an important mission to deliver chemotherapeutic drugs to tumour

tissue, while avoiding healthy cells. We use storytelling, music and interactivity to explain the challenges of current cancer treatments as well as the engineering principles that can be applied to enhance cancer therapy, with the ultimate goal of improving patient survival.

For example, in an interactive musical performance, our laboratory scientist Dr X is on a mission to find a cure for cancer. She invents a nanotechnology-based approach in which a plant virus (tobacco mosaic virus) is used as a nanoscale carrier for targeted drug delivery. The Nanoman is born. But when injected into the patient’s blood stream, he is quickly recognized as an intruder by the immune system. The immune system is on alert, and phagocytes such as macrophages attack and remove the Nanoman from circulation before our tiny superhero can reach his target, the tumour. The result of the first experiment: GAME OVER.

However, this is what science is about. Facing failures, we are continuously challenged to solve puzzles, to reflect on the findings, to develop alternative strategies, and eventually to succeed. In video gaming, the player gets a new life and a new mission begins. In the laboratory, we revise the strategy, learn from our experience, and improve the design, resulting in the Nanoman v2.0. This is captured in our song ‘The Scientific Method’ (www.thenanoman.org). Dr X, her students and the Nanoman discuss the findings of this first experiment: “This is the scientific method. Fail. Fail again. Fail better,” advises Dr X. The students and Dr X sing: “And the next time we will try to do better. We’re learning what works. We’re learning what won’t. We’re learning what it’s about. Because knowing is much stronger than doubt. Don’t worry, things will work out. That’s how you get equipped!” And this is how the Nanoman is equipped with additional superpowers to overcome the biological barriers he encounters during his mission to fight cancer.

Clearance by the immune system is indeed a major hurdle to successful drug delivery using nanocarriers. The mononuclear phagocyte system is programmed to remove foreign objects from circulation. New surface chemistries have been developed to overcome this ‘biological barrier’, and thus

in the second experiment the Nanoman is equipped with a polymer overcoat that acts as an invisibility cloak to avoid phagocytes. Of course, then there are further barriers and challenges to overcome, such as how to find the target cells and how to get inside!

Our interactive musical theatre entitled *The Nanoman — A Nerdcore Musical Festival* integrates all the components of the Nanoman outreach programme: video complements live acting, and the audience members are taught songs while one member controls the Nanoman on his journey through the body via video gaming activity. The objective is to unite STEM disciplines with the visual and performing arts. By combining cutting-edge research with innovative theatre, we want to create a live experience that is more interactive, engaging and entertaining than a typical lecture, and more informative and educational than a typical play — something that would be at home but still groundbreaking in a TED Talk or a downtown New York theatre space. At the same time, we like to highlight the fact that science and engineering require patience and puzzle-solving skills. Researchers must develop a thick skin and must demonstrate persistence to achieve steps forward in the fight against cancer, and indeed in any scientific challenge. I learned this during my career as a high-level athlete on the German figure skating team: to learn a new jump, one takes many falls, but this is part of the process; the key is always to stand up and try again, until one succeeds. □

NICOLE STEINMETZ is the George J. Picha Designated Professor in Biomaterials, Case Western Reserve University School of Medicine, Cleveland, Ohio 44106, USA. e-mail: nicole.steinmetz@case.edu