

Rapid advances in biotechnology and AI are creating new opportunities and uncertainties. Dr Susan Chapple FIIRSM, founder of JB Safe and IIRSM Ambassador, explores what this means for risk and safety professionals

The rapid pace of innovation across the biological sciences is creating exciting new technologies and opportunities, with the ability to positively transform the way in which we live and work.

At the same time, this is introducing uncertainty and new types of risk. As technological applications expand outside the laboratory, they become increasingly relevant to the wider community of risk and safety professionals. Expertise in understanding how these risks are identified, assessed and safely managed remains an important part of the job.

One question I ask myself is: as technologies evolve and their adoption becomes more widespread, do we as risk and safety professionals need to evolve too?

To illustrate just how quickly things have changed, let me take you back to the beginning of my career. In the early 2000s, I worked at the Wellcome Sanger Institute in Cambridge on a project linked to the human genome project, the global effort to produce the first human genome sequence and make it freely available to researchers around the world.

The project took 13 years to complete and cost in the region of US\$3 billion. Fast forward to today and scientists can sequence a human genome of equal or better quality in just a day or two for only a few hundred dollars. The pace of change has been extraordinary and in my view it is only accelerating.

Sequencing was not the only area of biology that was rapidly changing. Molecular biology and genetic engineering techniques that I used to alter the DNA of viruses and bacteria, one gene at a time, were beginning to be combined with other new technologies and engineering approaches, giving rise to what we now know as synthetic biology. By the mid-2000s, synthetic biology was emerging as a recognised field which has grown rapidly.

In addition to this rapid pace, we are seeing technology become more accessible, cheaper and easier to scale and adding artificial intelligence (AI) into the mix has helped to accelerate what is now possible.

Technological progress is inevitable and supporting the responsible development and application of innovation is increasingly important. Responsible innovation asks who benefits from a new technology, who might bear its consequences, and how its benefits can be realised while protecting people and the environment.

These questions are not unique to the biological sciences but could apply to any area of work where

KEEPING PACE WITH INNOVATION

the use of technology and its evolving capabilities are seen. We should be mindful not only of the potential benefits of innovation but also what might happen if used, either deliberately or accidentally, in ways that could cause harm, a concept known as dual use.

This is not a new concept. In 2005, researchers reconstructed the influenza virus responsible for the 1918 flu pandemic. The benefits of understanding why this virus had been so damaging and what lessons could be learnt to help prepare for future pandemics were acknowledged, but the research was controversial. Concerns were raised about the potential harm of recreating a dangerous virus. Technology and capabilities have moved on further within biological sciences and wider accessibility together with the convergence with AI means that the potential benefits are considerable but so too are the risks of harm.

But let's consider again the opportunities at our fingertips that have the potential to help address some of the current global challenges, one example being antimicrobial resistance (AMR).

Bacterial AMR, according to the World Health Organization (WHO), was estimated to be associated with more than 4.7 million deaths globally in 2021 and one in six laboratory confirmed bacterial infections worldwide resistant to antibiotics in 2023.

A beautiful and recent example of technological progress is the landmark publication by researchers from Stanford University and the Arc Institute that describes the first example of entire viral genomes being designed by AI and successfully going on to generate functional viruses. These viruses are known as bacteriophage.

Bacteriophages (or 'phage' for short) are small, relatively simple viruses that can only infect bacteria and have the potential to be used as AMR treatments either on their own or in combination with antibiotics. Sometimes bacteria can also become resistant to phage.

The researchers used large genome language models. In the same way large language models such as ChatGPT learn patterns from example texts, the large genome models learn patterns from the DNA sequences of phage genomes. The result was AI models capable of predicting completely new genome sequences with the intention of creating functioning viruses.

The researchers used the AI generated genome sequence information to make viable, functioning phages with the ability to infect bacteria in the lab. Promisingly, they also showed that a cocktail of these AI-designed phages were able to kill bacteria



resistant to the original phage that the AI had been trained on.

It's easy to get excited about the opportunities when the technology we have available now, in the lab, has the promise to help develop new therapeutic AMR medicines. However, the same technological capabilities also raise questions about how to proceed with future work in a safe and responsible way.

For example, what are the implications of this technological approach being applied to viruses that infect humans, economically or ecologically important animals and plants? What would the consequences be on human health, crops, environment, etc?

While the researchers took a proactive approach to their work and introduced biosafety and biosecurity measures to reduce the risks from AI-generated genome design, these measures were mainly voluntary rather than required. The AI models were not trained on viruses that could infect animals or plants and the phage genome chosen for the work was a well-understood standard lab strain providing a well-characterised experimental system. As required for this type of work, it was carried out under laboratory containment. The authors also highlighted the importance of involving biosafety and biosecurity experts throughout the process in future genome design projects.

These are important safeguards for individual projects within the laboratory, but responsible innovation extends beyond this controlled environment.

The importance of responsible innovation was captured nicely in an accompanying article in the *Science* journal. "The question is no longer whether

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DR SUSAN CHAPPLE FMRB

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generative viral genome design will exist. It is whether society can build oversight that allows its benefits to unfold while preventing it from enabling serious harm.”

REFLECTING ADVANCES

What we can do now with technology and working practices also highlights the challenge of existing governance. Technical guidance, for example, can struggle to keep pace.

In the UK, the Genetically Modified Organisms (Contained Use) Regulations 2014 and the accompanying HSE guidance were updated to reflect advances in science and technology, including synthetic biology. More detailed technical guidance is provided through SACGM Compendium of Guidance. Nevertheless, HSE recognises that parts of the 2007 compendium require updating to reflect the current regulatory framework, evolving laboratory practices and rapid technological developments.

Current UK legislation provides a robust framework but governance and oversight must continually evolve and adapt alongside scientific advances and accelerating development cycles to help support responsible innovation and remain relevant.

A four-part framework already exists for understanding and supporting efforts aimed at responsible innovation:

- **Anticipate:** consider possible impacts, intended and unintended
- **Reflect:** question the goals of innovation. What problems are we solving and for whom?
- **Engage:** involve diverse voices to help shape the direction of innovation
- **Act/Adapt:** keep innovation flexible, able to pause, change, or redirect when challenges emerge.

Responsible innovation is not confined to individual organisations or countries. There is a need for a coordinated international effort.

In May 2026, the Organisation for Economic Co-operation and Development (OECD) published a paper highlighting the need for a global approach to

COLLABORATION IN PRACTICE

IIRSM's partnership with the Institute of Safety in Technology and Research (ISTR) brings together complementary expertise in safety, risk, research and emerging technologies. The organisations signed a Memorandum of Understanding at the IIRSM President's Reception in 2025.

IIRSM Co-President Rosie Russell says it “strengthens both organisations by bringing the strategic risk thinking of IIRSM together with ISTR's understanding of research, development and emerging risks”.

“ISTR has a long-established specialist community working at the interface between safety and scientific and technical research,” says ISTR Chair Adam Stevenson. “IIRSM brings a broader perspective on safety and risk management, organisational resilience and strategic decision-making.”

The partnership is particularly valuable as technical and organisational risks increasingly overlap in areas such as biotechnology, AI and automation. “Collaboration helps connect the two and, importantly, prevents specialist communities from becoming siloed,” Adam says.

The relationship is already supporting knowledge-sharing, with Rosie leading workshops for ISTR members on effective safety practice, human factors, mental health and wellbeing. Looking ahead, Adam would like the partnership to develop through joint workshops, training, publications and working groups, with both organisations turning to each other when risks cross the boundaries between specialist technical and wider organisational issues.

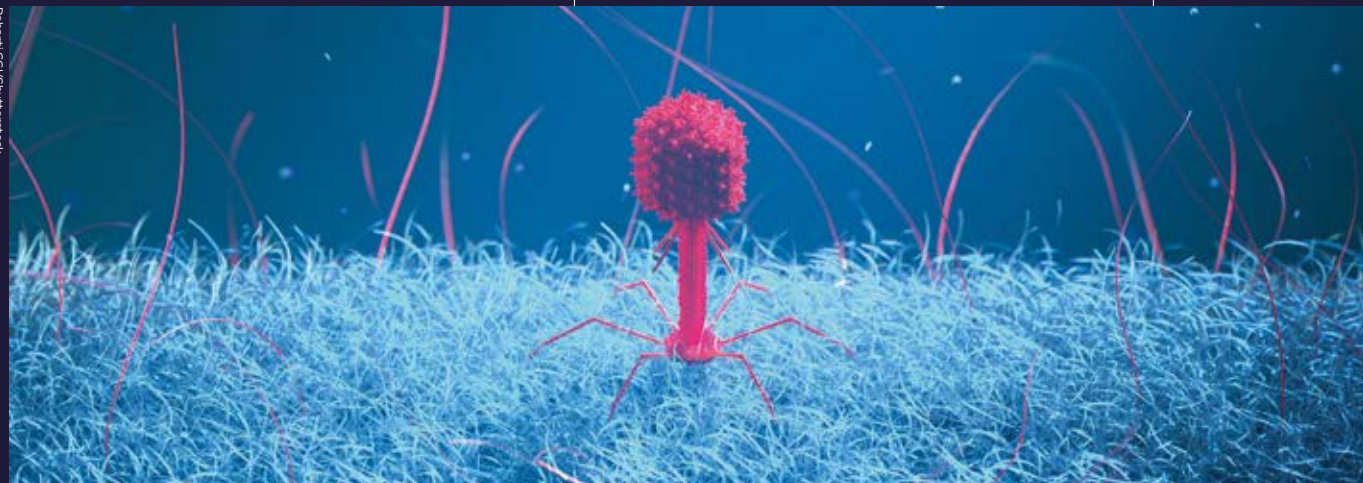
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anticipatory governance for fast-paced biotechnology developments, specifically mentioning synthetic biology. The paper points out that “the role of policy shifts from managing isolated risks to shaping the trajectory of the innovation ecosystem”.

So, what does this mean for risk and safety professionals? Should we evolve alongside the technologies that we are helping organisations develop and adopt? I think we should.

Our fundamental skills in managing risk open up the opportunity for us to contribute to the innovation process. Perhaps by developing a greater awareness of areas such as ethical dilemmas, societal impacts, anticipatory and adaptive governance and frameworks such as AREA, which may already seem familiar to many, we can evolve and broaden our professional perspective. Giving us the chance to become more effective enablers of responsible innovation. ♥

BELOW: A 3D rendering of a bacteriophage



Dabarti CG/Shutterstock