



How AI could replace animal testing

Scientists across Europe are combining AI, human cells and mini-organs to predict chemical harm, reducing the need for testing on animals.

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Around 150 000 animals, mostly rats and mice, are used in the EU each year to test the safety of everyday chemicals, but that is starting to change. Animal welfare campaigners have long raised concerns about this practice, and questions remain over how well results from animals translate to humans.

Researchers have therefore set out to design more reliable, less invasive testing methods, building on the EU's earlier ban on animal testing for cosmetics.

"Companies must register and prove that their substances are safe in order to access the European market," said Professor John Colbourne, a biologist specialising in environmental genomics at the University of Birmingham, UK, where he also directs the Centre for Environmental Research and Justice.

That obligation comes from REACH, the EU regulation governing chemical safety, which also commits Europe to the so-called three Rs: replacing animal tests where possible, reducing the numbers of animals used for testing, and refining procedures to minimise animal suffering.

Colbourne led one of three closely linked research initiatives working since 2021 from different angles towards the same goal: replacing chemical safety testing on animals with non-animal approaches, including in vitro and AI-driven methods. The research was carried out as part of ASPIS, the EU's €60 million research cluster on next-generation chemical safety testing.

EU law states that animals should be used only as a last resort. But reducing animal testing is also about human safety, as well as animal welfare.

"Maybe 50 % of the animal tests we do are representative for humans," said Mathieu Vinken, a professor of toxicology at Vrije Universiteit Brussel in Belgium.

Vinken leads ONTOX, another initiative within ASPIS. Running until November 2026, it investigates how repeated chemical exposure harms the kidney, liver and brain.

Quicker, cheaper, better

Cost is another factor. “These animal tests are really expensive, especially chronic toxicity tests,” Vinken said, explaining that they can involve hundreds of animals. Chronic toxicity testing looks for harm caused by long-term repeated exposure.

In the 1940s to 1960s, when animal testing became established, no one anticipated the sheer number of chemicals that would eventually need to be assessed.

“It was not predicted that there would be thousands of new chemicals on the market every year,” said Colbourne. Nor could researchers foresee how difficult and costly testing them all would become.

“If it takes up to €15 million per substance and three to seven years, and we have thousands of substances to test, then we simply must do something differently,” he said.

Traditional animal tests can identify immediate toxic effects, but assessing the consequences of long-term exposure is much harder. Some diseases can develop after years of exposure to chemicals that cause subtle changes in cells, potentially increasing cancer risk or damaging reproductive health.

“The real challenge is to predict toxicity over the long term,” said Vinken. Rodents’ relatively short lifespans also make it difficult to reproduce effects that may take decades to emerge in humans.

Vinken’s team devised several tests using cells rather than animals, with AI helping researchers interpret what the results could mean for human organs. Some approaches use organ-on-a-chip technology – small devices containing human cells that mimic aspects of how a real organ responds to a chemical.

The research findings have attracted interest from international organisations, including the Organisation for Economic Co-operation and Development (OECD). “They found the information to be really valuable,” Vinken said.

This work builds on a longer shift already under way in Europe. Animal testing for cosmetics was progressively phased out over two decades, with a full EU marketing ban taking effect in 2013. That helped drive the development of non-animal methods, including reconstructed human skin models used for safety testing.

Learning from other species

PrecisionTox, the chemical safety research work led by Colbourne, compares the responses of five model organisms and human cells to around 200 chemicals before concluding in December 2026.

Researchers worked with fruit flies, roundworms and water fleas, as well as zebrafish and frog embryos at stages of development that fall outside regulated animal testing.

These species are widely used in biomedical research because, despite their obvious differences, they share many fundamental biological processes with humans. Evolution has conserved many of the basic mechanisms that keep organisms alive, reproducing and healthy across very different species.

“The processes required to stay healthy originated early in the tree of life,” said Colbourne. “There are huge differences between animals, but those differences aren’t related to what keeps us healthy and sustains life.”

By comparing results across distantly related species and human cells, the 14 laboratories involved in this research can identify how chemicals interfere with these shared biological mechanisms and potentially cause harm.

“We are trying to get at the rules of the game,” said Colbourne. “For instance, we are now better at treating cancer because we know how cancer works.”

Toxicology, he said, has previously focused on determining what concentration of a chemical harms an animal. “What PrecisionTox is trying to do is understand why.”

This work contributes to what scientists call “new approach methodologies”, or NAMs – a broad range of cell-based tests, computational tools and other methods designed to reduce or replace the use of animals protected under EU law.

These approaches could help protect wildlife and ecosystems as well as human health, since harmful chemicals can affect both.

Putting it all together

Understanding how a chemical can cause harm is only part of the picture. Researchers also need to know how much of it people are likely to encounter in real life.

This is where RISK-HUNT3R, the third initiative within the ASPIS cluster, comes in. It combines results from non-animal tests with real-world exposure data to assess whether a chemical poses a safety risk.

“We brought data together in case studies and integrated the information so that we could come to a decision [about the safety of a chemical],” said Bob van de Water, a biologist at Leiden University in the Netherlands, who coordinated the research.

The team tested the strategy on 60 chemicals – half toxic and half non-toxic – to see whether combining exposure information with non-animal test results could produce reliable safety assessments of the kind regulators such as the European Chemicals Agency could eventually use.

The aim is to rethink how chemical safety is assessed altogether, rather than simply replace each animal test with a laboratory alternative. This means combining human-relevant biology, exposure data and computational tools to make better predictions while reducing animal use.

Vinken said completely abandoning animal testing is not yet possible, but there is already considerable scope to refine procedures and reduce the number of animals used.

“AI will play a major role in strongly reducing animal testing in the future,” he said.

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