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Gene editing can drive science to openness

The fast-moving field of gene-drive research provides an opportunity to rewrite the rules of the science, says **Kevin Esvelt**.

The emergence of gene-drive systems — which spread engineered mutations quickly through populations — means that a single released organism could eventually alter most of its local population, and quite possibly all populations of the species throughout the world. Any accidental release, even if there was no ecological damage, would surely damage public trust and prompt harsh restrictions on research.

The US National Academy of Sciences released guidelines this week for the responsible conduct of gene-drive research. The report comes almost two years after the first published description of how the CRISPR–Cas9 genome-editing technology could enable gene drives in many different organisms. That's a fast turnaround for the academy, but an eternity for the field: in that time, scientists have demonstrated CRISPR-based gene-drive systems in four species.

The report makes some sensible suggestions, such as phased testing and ecological-risk assessments, but if we're going to develop proper safeguards for gene drives or other powerful technologies, we need to fix a greater problem: the closed-door nature of science.

No one would rationally design the current scientific enterprise. It is wasteful and inefficient. Researchers repeatedly run into the same problems and unknowingly duplicate efforts. It stunts collaboration: we never learn who has the other piece of a puzzle unless we run into them at a conference. It wastes time on endless grant-writing. It's terrible for researcher well-being: competitive pressure ruins playful discovery and creation.

And it's unsafe. Regulation will always be too slow. Science is too vast for researchers to reliably foresee the consequences of their work. The problem was neatly summarized by atom-bomb pioneer Robert Oppenheimer: "When you see something that is technically sweet, you go ahead and do it, and you argue about what to do about it only after you have had your technical success."

Some technical successes are not to be pursued. But others are desperately needed. How can we hope to tell the difference when science is done behind closed doors?

There are signs of progress. My colleagues and I publicly discussed the probable consequences of a CRISPR-based gene drive before doing any experiments. And many gene-drive researchers have already worked together to improve safety and call for transparency. But this has been done on an informal basis. For example, my group saw a gene-drive paper by another laboratory and was able to suggest changes — the need for extra safeguards to prevent an accidental release — but only because we received an in-press copy of the publication from a journalist.

Sadly, open and responsive science flies in the face of current incentives. Scientists who disclose their ideas are often 'rewarded' by being scooped by another lab, rather than by being recognized for their creativity. It is a prisoner's dilemma. The benefits come from cooperation by everyone. But by participating you risk being exploited by people who steal your idea, get it working before you do, and claim the credit.

Gene-drive research offers a way out. The field is new and small, and many of us have already worked together to publish a joint recommendation calling for future experiments to use multiple stringent confinement strategies. Several groups already disclose proposed and ongoing gene-drive research and invite feedback, and active discussions between researchers and funders seek ways to ensure that everyone will be similarly forthcoming.

My group and others will soon launch the Responsive Science Project to enable gene-drive scientists to share their plans and research with one another and with interested communities. We hope that it will become a central repository of ideas and information relevant to gene-drive research that will permit open assessment and critique before experiments begin.

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Journals could help by offering incentives to persuade scientists to share their proposals. When a paper is published by authors who didn't play by the new rules (to share what they're doing and collaborate with the people who first shared the key ideas), journals could check the repository to identify scientists who deserve a share of the credit and invite them to write an accompanying piece. Similarly, all funders should require immediate public disclosure of proposals involving gene drives, as well as regular public updates on the status of funded research.

If this attempt at open science works for one field, it could expand to encompass research on other shared-impact technologies and to fields beyond. That alone is reason enough to try the approach. But gene-drive technology is also unique in that its very nature demands a new approach.

Because the consequences of mistakes involving gene-drive organisms could affect communities outside the laboratory, scientists have an obligation to openly share their plans, invite suggestions and concerns, disclose experimental results as soon as possible, and redesign the technology as needed. Applied to gene drives, such an approach will also have a greater chance of earning popular support for applications that could save millions of human lives and rescue numerous species from extinction.

We should ensure that gene-drive research is open and responsive — then drive those changes through the scientific ecosystem. ■

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