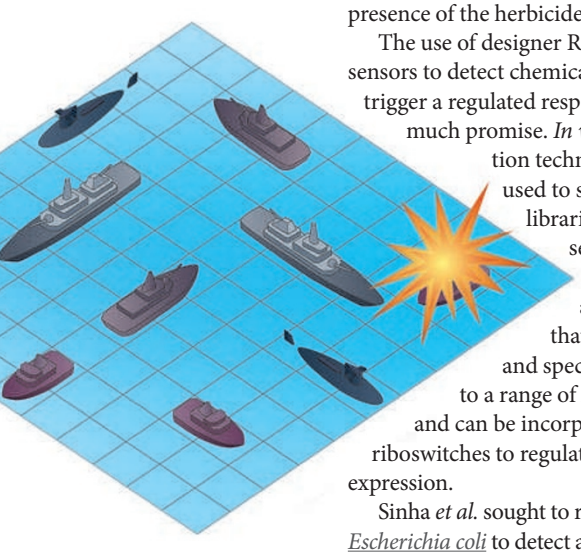
BIOREMEDIATION

Seek and destroy

The use of synthetic microorganisms to detect and degrade environmental pollutants has the potential to revolutionize the field of bioremediation. Sinha *et al.* have now identified a herbicide-responsive riboswitch that can be used to control motility, allowing bacteria to migrate in the presence of the herbicide atrazine.



The use of designer RNA-based sensors to detect chemicals and trigger a regulated response holds much promise. *In vitro* selection techniques can be used to screen large libraries for RNA sequences (known as aptamers) that can tightly and specifically bind to a range of ligands and can be incorporated into riboswitches to regulate gene expression.

Sinha *et al.* sought to reprogramme *Escherichia coli* to detect atrazine, a heavily used herbicide that has become a persistent pollutant in agricultural soils in the United States. The authors began by screening a library of RNA sequences for their ability to bind to an atrazine derivative bound to a solid support matrix. After multiple rounds of binding and elution with free atrazine, a pool of potential atrazine-binding aptamers was recovered. One limitation of such a selection procedure is that not all of the atrazine-binding aptamers will function in the context of a riboswitch, which also requires that the RNA can undergo a conformational change. Therefore, the authors cloned the pool of atrazine-binding aptamers into the 5′ untranslated region of *cheZ*, a gene that is important for regulating cellular motility in *E. coli*. They introduced these constructs into an *E. coli* strain lacking endogenous *cheZ* and then selected those cells that were motionless in the absence of atrazine but became motile on plates that had been supplemented with the herbicide. The putative riboswitches identified by these selection procedures were assayed for their ability to regulate the expression of a β-galactosidase reporter gene, and a single riboswitch was observed to trigger a fourfold increase in reporter activity following the addition of atrazine. The authors found that the riboswitch regulates expression at the translational level. In response to atrazine a pseudoknot in the RNA sequence is disrupted, revealing a purine-rich RNA sequence that may serve as a ribosome-binding site. Importantly, by expressing the *Pseudomonas* spp. ADP chlorohydrolase gene *atzA* (which converts atrazine to hydroxyatrazine, a compound that is not thought to be a threat to human health) in the riboswitch–*cheZ E. coli* strain, the cells could be further reprogrammed so that instead of just migrating in the presence of atrazine, they could also degrade the herbicide.

The system designed in this study will need to be further refined — to allow the bacteria to exhibit chemotaxis towards the herbicide — before any potential application in bioremediation can be realized. Nonetheless, these observations suggest that such approaches hold a great deal of promise.

Andrew Jermy

“cells could be further reprogrammed so that instead of just migrating in the presence of atrazine, they could also degrade the herbicide.”

ORIGINAL RESEARCH PAPER Sinha, J., Reyes, S. J. & Gallivan, J. P. Reprogramming bacteria to seek and destroy an herbicide. *Nature Chem. Biol.* **6**, 464–470 (2010)