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Challenges of our own making

The successful transplantation of a synthesized genome highlights unresolved ethical and security issues posed by synthetic biology.

Who gets to imagine the future where science and technology are concerned? If we are creating new objects, who is responsible for the proliferation of good consequences and the prevention of bad ones? These perennial conundrums were aptly posed last July by the social scientist Sheila Jasanoff of Harvard University at a high-level conference on synthetic biology (see go.nature.com/HTQ7JS).

Events last week illustrated their continuing relevance. Scientists led by Craig Venter published the first successful transplantation of a synthesized genome into a recipient cell (D. G. Gibson *et al. Science* doi:10.1126/science.1190719; 2010). The feat was a technical tour de force, requiring the accurate synthesis of a slightly modified genome of the bacterium *Mycoplasma mycoides* — all 1.08 million base pairs of it — followed by its successful insertion into a related species, *Mycoplasma capricolum*, and then the demonstration of replication of descendant cells exhibiting the characteristics of *M. mycoides* (see pages 406 and 422).

As many biologists were quick to point out, this was not the synthesis of life, nor indeed of a cell. But it was the first time that an organism had been put together with DNA constructed from specifications in a computer database, albeit derived from an existing organism rather than conceived from scratch. The long-anticipated development is a landmark in synthetic biology — a field that is burgeoning not only in its science and engineering but also in the discussions that surround it.

Credit is due both to the pioneers of the field for fostering open deliberations about the research-community, societal and ethical issues surrounding synthetic biology, and to the Alfred P. Sloan Foundation of New York for its long-standing support of these efforts. Unfortunately, such discussions repeatedly point to key concerns without resolving them. The achievements reported last week underline the need to do better.

A prime example is the lack of international governance for synthetic biology, not least in relation to security issues. The European Union, the Organisation for Economic Co-operation and Development as well as national governments such as those of the United States and, to a lesser extent, China are engaged. But none seems willing to take the lead in establishing an international framework of governance and standards.

Another chronic security issue is the growth of do-it-yourself synthetic biology. The construction and transplantation of whole genomes remains beyond the capacity of most labs, although both may be routine within five years. But the ability to undertake hazardous biology in the garage is already with us. With trust being so important in science, universities and individual investigators are almost certainly not attentive enough to security risks. Nor are governments: the very possibility of malign synthetic biology, whether by states or eventually by 'biohackers', only reinforces the need for a much more extensive worldwide network of centres able to detect emerging infections.

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Meanwhile, the anticipated power of synthetic biology leads back to the larger, as-yet-unresolved questions that Jasanoff posed. US President Barack Obama took a belated step in the right direction last week when he asked his bioethics council to consider the wider significance of synthetic biology and to report back in six months. But other organizations — ethical, environmental, medical and commercial — also need to join the discussion.

If its visions can be fulfilled, the power of synthetic biology is profound. The extensive discussions that have already taken place have revealed no significant new moral or societal constraints on its full realization. Accordingly, where there are concerns, they now need to be developed beyond the knee-jerk soundbite. Those inclined to worry about synthetic biology should take only small comfort from the fact that the complexity of organisms makes it so difficult to deliver. ■

All at sea

US agencies have moved too slowly in gathering key data on the oil spill in the Gulf of Mexico.

When disaster strikes, the priority for governments and individuals alike is to limit the damage and help the people affected. But also critical is the rapid, coordinated collection of data to document the disaster. Getting a full picture of exactly what happened can be a huge help in planning recovery efforts, minimizing losses in future disasters and, if need be, in holding guilty parties accountable.

In the case of the ongoing oil spill in the Gulf of Mexico, researchers have been hampered in their desire to collect more data and have been left feeling ill-informed about what has been done so far.

In theory, the necessary mechanisms for arranging data collection exist. The US Incident Command System, which coordinates federal agencies and first responders during a crisis, has a mandate to collect 'ephemeral' or 'perishable' data. That is also part of the job of the Office of Response and Restoration, run by the National Oceanic and Atmospheric Administration (NOAA), and of the Environmental Protection Agency (EPA).

In addition, academic scientists can apply for up to US$200,000 in quick funding from the National Science Foundation (NSF) to study a disaster's aftermath, through its aptly named RAPID programme.

The process is easy — proposals can be as brief as two pages — and decisions are fast: it took the NSF just five days to award the first three RAPID grants after the Chilean earthquake in February 2010. The NSF also works with agencies such as NOAA and the EPA to avoid duplication of effort, to team up research groups that might work well together and, for marine disasters, to ensure available ship time.

In the Gulf, however, these coordination mechanisms don't seem to be working well enough (see page 404). Basic information about the chemical composition of the leaking oil has been slow in getting out to researchers. And, delayed by initial hopes that the spill would be capped quickly, the NSF's first RAPID grants are only now being awarded, a month after the crisis began. NOAA has been slow to respond to public concerns about its ability to track the spill. It was only last week that it announced a task force to assess the spill's actual size — a key and much-debated piece of information. There are many proposals for how it might do this (see page 421 for one example). But researchers still seem to be unclear over exactly what data NOAA is collecting.

Disasters are, by their nature, bound to be followed by disorganization and confusion. It is unrealistic to expect a 'perfect' response. And in fairness, the Gulf oil spill has been particularly difficult in this regard. Unlike earthquakes, hurricanes and most other disasters, which strike suddenly and unambiguously, the oil spill has unfolded slowly. Many days went by before it became clear just how bad the leakage was, and how big a response would be needed.

Nonetheless, aspects of the US approach could be improved. For example, the Office of Response and Restoration currently experiences a boom-and-bust funding cycle from one oil spill to the next. As the 1989 *Exxon Valdez* spill in Alaska's Prince William Sound has faded into memory, the office has lost around one-third of its staff, leaving the remainder stretched. One solution would be to rebuild the office and keep it at adequate staffing levels by supplementing its annual budget with money from the federal Oil Spill Liability Trust Fund, which is supported in large part by a tax on the petroleum industry and is intended to pay for the government's response to oil emergencies. This would allow for basic research into the best response efforts, along with ongoing monitoring. Another useful step would be the establishment of a cross-agency data-sharing plan for disasters, so that information would be open and publicly available, and gaps in the data would be obvious.

Meanwhile, BP, the energy company that owns the well, took a positive step of its own on 24 May when it announced that it would make up to $500 million available over the next ten years for independent research on the spill's long-term environmental impact.

Disasters should not be viewed cold-heartedly as a chance to do some unique research, but neither should they be lost opportunities. Volcanic eruptions, hurricanes, earthquakes and oil spills push the environment to extremes, and can identify the limits of scientific knowledge. Science must not be allowed to miss out. ■

In the public eye

Society deserves to see a return on its investment in science, but researchers need help to make their case.

The US National Science Foundation (NSF) is unique among the world's science-funding agencies in its insistence that every proposal, large or small, must include an activity to demonstrate the research's 'broader impacts' on science or society. This might involve the researchers giving talks at a local museum, developing new curricula or perhaps forming a start-up company.

The requirement's goal is commendable. It aims to enlist the scientific community to help show a return on society's investment in research and to bolster the public's trust in science — the latter being particularly important given the well-organized movements currently attacking concepts such as evolution and climate change.

Unfortunately, the very breadth of the requirement can leave researchers struggling (see page 416). Few of them have training in the activities involved — especially when it comes to education and outreach — and the NSF has not done enough to provide a support infrastructure to help.

Such an infrastructure does exist in embryonic form. For example, a few research institutions, including Stanford University in Palo Alto, California, and the University of Wisconsin–Madison, already have centres that aim to connect scientists with experts in teaching, education and public outreach, to equip them with the necessary skills and to disseminate best practices. And a few places, such as the University of New Mexico in Albuquerque, have developed workshops in which graduate students, postdocs and junior faculty members get professional training on how to interact with the public, media and government. Such efforts need to be expanded and institutionalized throughout the country.

Broader-impacts efforts also need to be better evaluated and rewarded. For example, the NSF should consider offering cash awards for the best broader-impact activities, the money from which could help to continue or expand the activities. This would motivate investigators to put greater effort into these endeavours, and would spread the word to other scientists about the sorts of activities that have proved successful.

Such initiatives would motivate what is really needed: a fundamental change in the culture of science to value not just achievement in the laboratory, but also work that makes science a part of people's lives.

The US Congress can help. The America COMPETES Reauthorization Act, which would extend an earlier boost given to the budgets of the NSF and two other science agencies, requires grant applicants to show that they have received support from their institutions in meeting the broader-impacts requirement. It also calls on the NSF to clarify the requirement's goals and to improve evaluation of the outreach activities. The act is being held up by political manoeuvring, despite strong bipartisan support. Congress should pass it without delay.

It is a truism to say that science and society are intertwined. But no relationship should be taken for granted. The NSF needs to help scientists show the world that their work is valuable. ■