NEWS

# Synthetic biologists face up to security issues

**WASHINGTON DC**

Concerns about safety and security in the young field of synthetic biology are developing almost as rapidly as the research itself.

With scientists now able to create complete genomes from scratch and to introduce new characteristics into viruses and bacteria, there are fears that accidental — or worse, intentional — release of such creatures could occur.

As a result, the US government, academics and the field's first private companies are now working together to address the potential problems before they become a reality.

Synthetic biology is one of the priorities for the newly formed US National Science Advisory Board for Biosecurity (NSABB), which met for the first time in June. A working group on the topic, set up by the board, will begin its discussions later this month. Its members have already consulted synthetic biologists who have set up their own governance project, funded by the Alfred P. Sloan Foundation in New York, which will have its first meeting in September.

And one of the first public discussions of the issue comes this week, at a synthetic-biology meeting in San Francisco on 19–20 August. As well as looking at the field's potential in areas such as drug development, cellular reprogramming and biological robotics, participants will tackle ethical and legal issues.

The discussion will echo an event in 1975, when pioneers of genetic engineering retreated to the Asilomar Conference Center in California to set safety and ethical principles to guide their field. The fear was that modified microorganisms might escape into the environment with unpredictable effects, perhaps causing disease or out-competing wild strains.

Now synthetic biologists have much more powerful techniques at their disposal. Improved DNA synthesis means, for example, that microbial genomes can be built from scratch, bypassing the need to get hold of the actual organism. A dramatic demonstration of the potential consequences came in July 2002, when researchers at the University of New York at Stony Brook reported that they had synthesized an infectious poliovirus using mail-order DNA (see *Nature* **418,** 265; 2005). Genome sequencer Craig Venter followed that by announcing plans to build a bacterium from lab synthesized DNA and by taking just three weeks to synthesize a virus that infects bacteria (H. O. Smith *et al. Proc. Natl Acad. Sci. USA* **100,** 15440–15445; 2003).

Others are using made-to-order components to re-engineer the genomes of bacteria or viruses — either to investigate how they work or to try to give them abilities that they would not have naturally, such as producing drug molecules or generating hydrogen for use as an energy source. In theory, these techniques could be used to create deadly organisms in the lab, such as Ebola or anthrax, or to make bacteria more dangerous by giving them antibiotic resistance, for example, or the ability to make additional toxins.

Does this increased sophistication mean that the field needs radically new rules? Drew Endy, a synthetic biologist at Massachusetts Institute of Technology and one of the leaders of the Sloan Foundation project, is not sure. "There hasn't been a clear conversation about whether *de novo* synthesis poses a different threat from genetic engineering," he says.

Wendell Lim at the University of California, San Francisco, who uses synthetic biology to study basic processes such as how cells grow and move, says that there is nothing special about the field that requires blanket restrictions and that each type of study should be judged on its own risks and merits. "To broadly raise alarms about all such approaches is akin to saying we should worry about all uses of semiconductors because one of their uses could be in launch systems for nuclear weapons," he says. "We need to distinguish the sub-areas of the field and specific biological components that truly pose a hazard, and figure out how to regulate them."

## Taking care

But there are some general precautions that most synthetic biologists support. Many think it would make sense to monitor products ordered from companies that generate synthetic genes on demand, such as Codon Devices in Cambridge, Massachusetts, and Blue Heron Biotechnology in Bothell, Washington.

George Church, who co-founded Codon Devices this spring, wants to go further, arguing that strict regulation is a key to heading off the public-relations problems that have plagued other areas of biotechnology. As well as monitoring orders for components such as synthetic genes, he says the government should screen certain raw materials that scientists could use to brew up their own DNA. "Basically you want a series of licences to cover almost every step where there's a reasonable bottleneck you can regulate," he says.

IMAGE UNAVAILABLE FOR COPYRIGHT REASONS

**The ability to build genomes in the lab has raised fears that the technology could be abused.**

But many argue that the openness of the field offers a built-in safety mechanism against unintentionally creating something harmful. For instance, Endy's lab hosts an online library of parts that can be built into genomes. The library is open source, meaning that all scientists in the field can test them. "There's an element of safety in using well characterized components," says Christopher Voigt, a synthetic biologist at the University of California, San Francisco.

Other synthetic biologists point out the success of initiatives to encourage young scientists to think about safety and ethical issues relating to their work. "It's important to talk about ways to minimize risk, and one of the most important ways to do that is to train responsible scientists and engineers," says Christina Smolke, a chemical engineer at the California Institute of Technology in Pasadena.


**MARS SOCIETY**
Follow the action from the meeting of Mars enthusiasts in Boulder, Colorado.
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So far, observers are giving synthetic biologists credit for tackling such issues. But some, such as Paul Rabinow, an anthropologist at the University of California, Berkeley, think that the field needs to take a broader view than it has so far. He is speaking at the San Francisco meeting this week and says he will tell attendees to pay more attention to the danger that synthetic biology could be abused for biowarfare or bioterrorism, something that is harder to control than the risk of accidents.

"The field has been attempting to turn this into a safety issue, but we're living today in a security regime," he told *Nature*. "Dealing with safety is good, but they're fooling themselves if they think that's going to be the end of this question."

Venter agrees, arguing that rather than regulating labs and companies, governments need to use synthetic biology to develop ways to defeat bioterrorist attacks, such as producing drugs and vaccines, or sensors to detect altered organisms in the environment. "If we're not concentrating 100% of our defensive effort on countermeasures, I think we're missing the big picture," he told the NSABB in June. ■

**Erika Check**

# NASA draws up blueprint for craft to reach Moon and Mars

**BOULDER, COLORADO**

NASA last week revealed its plans for the next generation of space vehicles, designed to get humans back to the Moon and, eventually, to Mars.

On 13 August, Christopher Shank, special assistant to NASA administrator Michael Griffin, described the agency's future exploration machinery, which is proposed to replace the shuttle in 2010.

His talk, given at the Mars Society Conference in Boulder, Colorado, precedes a full report scheduled for release this month, called the Exploration Systems Architecture Study. This will lay out how NASA intends to meet President George W. Bush's goal of sending humans back to the Moon by 2020 in preparation for a Mars mission.

"It will be a 'go as you can afford to pay' approach," Shank told the 300 members of the Mars Society, a private group whose mission is to promote human exploration and colonization of the red planet. "Let the long, hard slog begin."

That, he said, means deferring other programmes, such as future research on the International Space Station (ISS) and lunar-base development, until the new space vehicles come online. The first vehicle will be a 25-tonne Crew Exploration Vehicle (CEV), which will ride into space on a modified shuttle booster rocket; this will initially supply and return ISS crews. After 2010, work will begin on a 100-tonne Heavy Lift Vehicle (HLV) that can carry heavier payloads. The HLV will also use a rocket modified from the shuttle's boosters and external fuel tank.

Lockheed Martin and a team at Northrop Grumman–Boeing have contracts to develop the three- to six-person CEVs. Potential designs include a large Apollo-like capsule or a smaller, slimmer shuttle. NASA will pick the winning design in 2006.

Mars Society members were thrilled to hear about the vehicle plans and they support Griffin in getting started. But they object to the proposed timeline, and the size of the CEV. They want to see a 7-tonne vehicle being used as this could take humans directly to the Moon and back, and so accelerate lunar-base construction. NASA's 25-tonne CEV could carry six people as well as ISS supplies and parts. But to reach the Moon it would need to rendezvous with another, as yet undeveloped, vehicle in lunar orbit before returning to Earth.

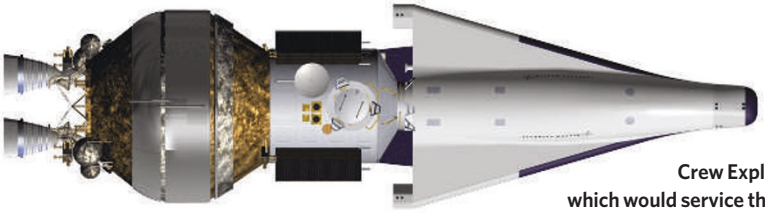
> "It will be a 'go as you can afford to pay' approach. Let the long, hard slog begin."

"It's a choice between having a Cadillac ISS programme or a lunar base," says Robert Zubrin, society president. He argues that continuing to focus on the ISS does little to further the goal of getting to Mars. Shank counters that NASA does not separate the ISS from Moon and Mars missions, as the same components are integral to both.

Zubrin and his fellow enthusiasts applauded the plans for an HLV, which is critical for a martian journey. But some, such as David Schuman, a lawyer at NASA's Goddard Space Flight Center in Greenbelt, Maryland, criticized the decision to delay HLV development until after 2010.

Without solutions to the shuttle's current safety issues, he notes, "we could be left without any heavy-lift capability". That would delay ISS completion, pushing Moon and Mars timelines back another decade. As it is 36 years since the first lunar landing, Zubrin and fellow exploration proponents say that delay is not only unbelievable — it is unacceptable. ■

**Kendall Powell**



One of the designs for the Crew Exploration Vehicle, which would service the space station.

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