VISUALS UNLIMITED/NPL

Gene drives could be targeted at mosquitoes.

Esvelt says he also attended last month's JASON meeting in San Diego, California, where he outlined how would-be bioterrorists might weaponize gene drives. But he is much more concerned about the potential for accidental release of gene-drive organisms by scientists, he says. "Bio-error is what I'm worried about."

So, too, is the US military, says Renee Wegrzyn, the programme officer leading DARPA's 'Safe Genes' initiative, which supports research on restraining gene drives. The technology has been developed in recent years in fruit flies, mosquitoes and other organisms, using CRISPR gene editing. A UK-based team hopes to begin field tests of gene drives in *Anopheles gambiae* mosquitoes, the main carrier of malaria in Africa, as soon as 2024. "I've been very excited to watch the advances, but I've noted with increasing concern that the advances are outpacing biosecurity," Wegrzyn says.

The JASONs' gene-drive discussion involved around 20 scientists, according to Philipp Messer, a population geneticist at Cornell University in Ithaca, New York, who attended the meeting. "I'm not used to that kind of conference," says Messer, who says he told the group about his lab's efforts to study the evolution of resistance to CRISPR gene drives in fruit flies. "We just had open discussions about this technology and what we think the current state of the field was and what we think the problems are." Gerald Joyce, a biochemist at the Salk Institute for Biological Studies in La Jolla, California, and a JASON member who Messer says co-organized the meeting, declined to comment on the meeting, which is likely to lead to a classified report.

"Every powerful technology is a national security issue, but bio-error is what I'm worried about."

Under the DARPA programme, seven teams won four-year contracts. Esvelt plans to develop CRISPR gene drives in nematode worms — a fast-reproducing model organism — that are designed to spread a genetic modification in a local setting and then fizzle out. He and the other teams receiving military funding also plan to develop tools to counter rogue gene drives that spread out of control. Such methods include chemicals that block gene editing or 'anti-gene drives' that can reverse a genetic modification.

Other efforts are afoot to fund studies on the national-security implications of gene drives. This week, the Intelligence Advanced Research Projects Activity (IARPA), which is part of the Office of the US Director of National Intelligence, will hold a meeting about a planned funding programme for detecting genetically modified organisms that are potentially harmful, including ones that contain gene drives.

Todd Kuiken, who studies policy relating to synthetic biology at North Carolina State University in Raleigh, is glad to see gene-drive research receive more funding. But he has qualms about the US military's interest; with Safe Genes, DARPA has become the world's largest government funder of gene-drive research. Kuiken worries that this could sow suspicions about gene drives in parts of the world that view the US military in a less-than-favourable light, including countries that stand to benefit from the elimination of disease carriers such as mosquitoes.

Esvelt shares those concerns but sees military support as the only way, for the time being, to advance gene-drive technology, while making it safer for eventual deployment. Private funders such as the Bill & Melinda Gates Foundation, in Seattle, Washington, and the Tata Trusts, a charity based in Mumbai, India, have spent tens of millions on gene-drive research, but this funding has been directed to specific projects or institutions. "No one else is offering us large amounts of money," Esvelt says.

The DARPA programme explicitly prevents the release of gene-drive organisms and requires contract winners to work under stringent biosafety conditions and to disclose planned experiments to the public — measures that should reduce the risk of accidental release, Esvelt adds. "If what you're worried about is your cowboys running amok and causing trouble, then what you really want to do is employ the cowboys to make sure they stay out of trouble." ■

AGEING

Brain stem cells rejuvenate mice

Transplanted cells slow decline and increase lifespan.

BY SARA REARDON

Stem cells in the brain could be the key to extending life and slowing ageing. These cells — which are located in the hypothalamus, a region that produces hormones and other signalling molecules — can reinvigorate declining brain function and muscle strength in middle-aged mice, according to a study published this week in *Nature* (Y. Zhang *et al. Nature* http://dx.doi.org/10.1038/nature23282).

Previous studies have linked the hypothalamus to ageing. That makes sense, because the region is involved in many bodily functions, including inflammation and appetite, says Dongsheng Cai, a neuroendocrinologist at Albert Einstein College of Medicine in New York City.

Cai and his colleagues showed that stem cells in the hypothalamus disappear as mice grow older. When the researchers injected their mice with viruses that destroy these cells, the animals experienced declines in memory, muscle strength, endurance and coordination. They also died sooner than untreated mice of the same age.

Next, the team injected stem cells from the hypothalami of newborn mice into the brains of middle-aged mice. After four months, these animals had better cognitive and muscular function than untreated mice of the same age. They also lived about 10% longer, on average.

The researchers found that these stem cells release molecules called microRNAs, which help to regulate gene expression, into the cerebrospinal fluid. When the team injected these microRNAs into the brains of middle-aged mice, they found that the molecules slowed cognitive decline and muscle degeneration.

The findings represent a breakthrough in ageing research, says Shin-ichiro Imai, who studies ageing at Washington University in St. Louis, Missouri. The next steps would be to link these stem cells with other physiological mechanisms of ageing, he says. Imai would also like to know whether the microRNAs from the cells can pass into the bloodstream, which would carry them throughout the body.

Cai says his team is trying to identify which of the thousands of types of microRNA produced are involved in ageing. The researchers also hope to investigate whether similar mechanisms exist in non-human primates. ■