human embryo research, but the work is not illegal if it is funded by private donors.

Mitalipov's team took several steps to improve the safety of the technique. The system requires an enzyme called Cas9, which cuts the genome at a site targeted by an RNA guide molecule. Instead of taking the typical approach of inserting DNA encoding CRISPR components into cells, Mitalipov's team injected the Cas9 protein itself, bound to its guide RNA, directly into the cells. Because the Cas9 protein degrades faster than the DNA that encodes it, the enzyme is left with less time to cut DNA, says genome engineer Jin-Soo Kim of the Institute for Basic Science in Daejeon, South Korea, and a co-author on the study. "There is little time for off-target mutations to accumulate."

But just because the team did not find off-target changes does not mean that the changes aren't there, cautions Keith Joung, who studies gene editing at the Massachusetts General Hospital in Boston.

MOSAICS MINIMIZED

The researchers also attempted to reduce the risk of mosaics by injecting the CRISPR–Cas9 components into the egg at the same time as they injected the sperm to fertilize it. This is earlier in development than previous human-embryo editing work had tried[2], and studies in mouse embryos have shown that the technique can eliminate mosaics when the father's genome is targeted[3].

In an experiment Mitalipov's group performed in 58 human embryos fertilized with sperm carrying the *MYBPC3* mutation, 42 were successfully edited to contain two normal copies of the *MYBPC3* gene. Only one was a mosaic. By comparison, the team found that 13 of 54 treated embryos were mosaics when the CRISPR–Cas9 machinery was injected 18 hours after fertilization.

The low rate of mosaics and the unusually high efficiency of gene editing make the study stand out, says stem-cell biologist Fredrik Lanner of the Karolinska Institute in Stockholm, who co-authored a commentary accompanying the article[4]. Additional testing is needed to show that the low rate of mosaics holds true for other gene-editing targets, but for now, he says, "it's a huge step in that direction".

The efficiency of gene editing in the study is exciting, adds stem-cell biologist George Daley of Boston Children's Hospital. "It puts a stake in the ground that this technology is likely to be operative," he says. "But it's still very premature." ■

1. Ma, H. *et al. Nature* http://dx.doi.org/10.1038/nature23305 (2017).
2. Tang, L. *et al. Mol. Genet. Genomics* **292,** 525–533 (2017).
3. Suzuki, T., Asami, M. & Perry, A. C. F. *Sci. Rep.* **4,** 7621 (2014).
4. Winblad, N. & Lanner, F. *Nature* http://dx.doi.org/10.1038/nature23533 (2017).

Princess Sumaya bint El Hassan is one of Jordan's leading science advocates.

MIDDLE EAST

Jordan stakes its future on science

The country wants to use a focus on research to solve its problems and build diplomatic ties in the Middle East.

BY AMY MAXMEN

When the World Science Forum kicks off on the shore of the Dead Sea in November, it will be the latest jewel in the crown for one of Jordan's biggest champions of science. Princess Sumaya bint El Hassan successfully lured the high-profile biennial conference to the Middle East for the first time — part of Jordan's ongoing push to transform itself into a regional research powerhouse. The country hopes to emphasize the power of science to transcend politics and war in the increasingly volatile Middle East.

It's a tall order, but there are signs that these efforts are beginning to pay off for Jordan, which created its first national science fund in 2005. In February, the country cemented plans for a reticular-chemistry foundry, the world's first. And in May, the Middle East's first synchrotron, SESAME, opened near Amman with the backing of seven nations and the Palestinian Authority.

Jordan's leaders see science, engineering and technology as an engine of economic growth for their 71-year-old country, which lacks the oil resources of many neighbouring states. The nation's political stability and central location have aided these ambitions. So has its diplomacy: Jordan is one of the only places in the Middle East where scientists from Israel and Arab countries can meet. "We are all in the region facing issues with energy, water and the environment," El Hassan says. "A bird with avian flu does not know whether there is a peace accord between Israel and Jordan, it just flies across the border."

The princess did not set out to be an architect of Jordan's science ambitions, however. In 1994, her father — the brother of King Hussein — asked the then-24-year-old art-school graduate to lead the board of trustees for an information technology college in Amman (now the Princess Sumaya University for Technology). El Hassan initially declined the job, but relented on the condition that she would first earn a computer-science diploma from the school.

Through that experience, El Hassan says, "I came to see science as a tool for human dignity. I began to see myself as a science enabler." In 2006, she became president of the Royal Scientific Society, an applied-science institution in Amman that also facilitates research collaborations across Jordan.

NEIL BRANDVOLD FOR *NATURE*

The country has focused its science efforts on areas that could improve daily life for its citizens, such as energy development. "The country was dependent on oil in Iraq, and then natural gas from Egypt," says Khaled Toukan, chairman of the Jordan Atomic Energy Commission. "The problem with these sole sources is that we were subjected to political changes, like the US invasion of Iraq and the overthrow of the Egyptian government." Now, he says, Jordan is looking to exploit its uranium resources to include nuclear power, and it is exploring the potential of solar and wind energy.

The Jordanian government is also looking for ways to cope with one of the lowest levels of water availability in the world — a problem that has intensified with the recent influx of an estimated 1.3 million Syrian refugees. Some help could come from a partnership that the Royal Scientific Society announced in February with the University of California, Berkeley, to build a reticular-chemistry foundry. Reticular chemistry involves making porous crystals. It was pioneered by Jordanian chemist Omar Yaghi, who heads the Berkeley Global Science Institute and has developed materials that can harvest water from the atmosphere.

Still, Jordan faces a long climb to fulfil its scientific ambitions. The country spent just over 0.4% of its gross domestic product (GDP) on research and development in 2011, the latest year for which figures are available. That beats its wealthy neighbour Saudi Arabia (0.07% of GDP), but Jordan lags behind some nearby countries, such as Turkey. And although Jordan nearly doubled its yearly output of scientific publications between 2005 and 2014, from 641 to 1,093, the overall number remains small.

To help build research capacity, the government set up the Jordanian Scientific Research Support Fund in 2005. The fund was initially supported by a law that required all companies in Jordan to pay 1% of their profits into the fund. By 2012, when that statute was overturned, the fund had acquired US$85 million. It is now kept afloat by Jordan's universities, which must spend 3% of their annual budgets on research or contributions to the fund. Between 2008 and 2016, the foundation gave a total of $35 million to 325 projects, mainly in the medical, pharmaceutical and agricultural sciences.

Abeer Al Bawab, a chemist who in March became minister of higher education and director of the fund, is thinking deeply about how to monitor its success. "The oldest university in the country is only 55 years old, and the support fund has just been around for ten years," she notes. Because Jordan is still building its culture of science, Al Bawab says that metrics such as the rate of scientific publications are not by themselves the best indicators of progress. She hopes to quantify the intersections between academic research, science policy and the private sector.

In the meantime, El Hassan hopes that the World Science Forum will help to raise the profile of science in the eyes of the Jordanian public. "A generation of analytical thinkers and risk takers," she says, "is something I'd like to see." ■

POLICY

Fears rise over US climate report

EPA officials are consulting global-warming sceptics as they weigh up a technical review.

BY JEFF TOLLEFSON

A sweeping US government report on the state of climate-change science is nearing the finish line, but researchers who wrote it aren't ready to relax just yet. Federal scientists have twice reviewed the roughly 600-page document — which examines everything from shifting weather patterns to rising sea levels — as have the US National Academies of Sciences, Engineering, and Medicine. Just one hurdle remains, but it may be the highest: final sign-off by top officials in President Donald Trump's administration, many of whom are sceptical of climate science.

Although there have not yet been any signs of trouble, researchers are keeping a close eye on how the White House and federal agencies handle the science report — a technical prelude to the fourth National Climate Assessment, a legally mandated analysis of the causes and impacts of global warming that is due in 2018.

Many climate scientists are particularly uneasy about the potential for interference by the US Environmental Protection Agency (EPA), one of 13 agencies that must approve the science report before its expected release in November. EPA administrator Scott Pruitt, who rejects well-established climate science, has raised the possibility of organizing an adversarial 'red team–blue team' review of such research.

RALPH FRESO/GETTY

As temperatures soar, researchers worry that science could be "held hostage" by a sceptical White House.

And he has help from the Heartland Institute, a think tank in Chicago, Illinois, that promotes scepticism about climate change.

"We can't allow science to be held hostage," says Donald Wuebbles, a climate scientist at the University of Illinois at Urbana-Champaign and co-chair of the report. "I'm hopeful it won't get to that, because it would look really bad for the administration to fight this."

It wouldn't be the first time that a Republican president had sought to stymie the United States' national climate-assessment process. The administration of George W. Bush came under fire for ignoring the first National Climate Assessment, which was released by then-President Bill Clinton in 2000. After ▶