GOVERNMENT

Canadian leader names science ministers

New prime minister gives research a higher profile.

BY NICOLA JONES

Canada's new prime minister, Justin Trudeau, took office on 4 November — and as one of his first acts, created the post of Minister of Science.

Kirsty Duncan, a medical geographer at the University of Toronto in Canada, will be the first to hold the job. Duncan, who contributed to the 2001 report of the Intergovernmental Panel on Climate Change, has also written a book about the 1918 Spanish flu epidemic.

Her appointment marks a change from the government of former prime minister Stephen Harper. His administration placed oversight of science in the hands of a junior minister of state in the Industry Canada department.

"Harper collapsed the purview of science into the purview of industry," says Carol Linnitt, an environmental-policy analyst at the Vancouver-based non-profit environmental group DeSmog Canada.

Scientists and science groups say that they are excited by Duncan's appointment but want to know more about the Minister of Science's responsibilities. "A real minister! And someone with a PhD!" says Marc Saner, former director of the Institute for Science, Society and Policy at the University of Ottawa. "From the point of view of image, it's great. How this works in practice, I don't know."

Trudeau has also appointed Navdeep Bains, a financial analyst, as Minister of Innovation, Science and Economic Development.

"If we take it at face value, we now have two ministers responsible for science," says Rees Kassen, a biologist at the University of Ottawa and chair of the Partnership Group for Science and Engineering, an Ottawa-based association of science and engineering organizations. He suspects that Duncan will work to ensure that the government conducts research in areas that universities and businesses are not exploring, whereas Bains will seek to encourage technological innovation in the private sector.

Trudeau, who is expected to appoint a chief science adviser, has also picked an environment minister — renaming the post as Minister of Environment and Climate Change. The new minister, Catherine McKenna, is a lawyer whose work has focused on international trade, investment and constitutional issues. ■

SHARON LEES/GREAT ORMOND STREET HOSPITAL

Layla Richards is in remission from leukaemia after getting cells treated with DNA-cutting enzymes.

GENETIC MODIFICATION

Gene-editing wave hits clinic

Companies prepare to test range of therapies in people.

BY SARA REARDON

Layla Richards, a one-year-old girl with leukaemia, is in remission thanks to gene-editing technology that allowed her to receive modified immune cells from another person.

Her case is the second use of gene-editing as a treatment in humans — the first was last year in people with HIV. Similar trials are planned, and companies are also preparing to test therapies that inject DNA encoding gene-editing enzymes directly into the human body.

The team that treated Richards, led by immunologist Waseem Qasim of the Great Ormond Street Hospital for Children NHS Trust in London, had planned to start a safety trial of the gene-editing technology in 10–12 people next year. But when the researchers came across the baby, in whom all other treatments had failed, they obtained special permission to treat her. Several months on, Qasim says that she is doing well. They will present her case in December at an American Society of Hematology meeting in Orlando, Florida.

To administer the therapy, the researchers extract immune cells called T cells from a healthy donor and expose them to DNA-cutting enzymes known as TALENs. The system, developed by researchers from Cellectis, a company headquartered in Paris, is designed to deactivate immune genes that would otherwise cause the donor cells to attack when injected into another person. The system also modifies genes to protect the cells from anti-cancer drugs. The individual then undergoes therapy to destroy his or her own immune system, which is replaced with the modified cells. The treatment is not a permanent solution for leukaemia, says Qasim, but rather a 'bridge' to keep someone alive until a matched T-cell donor can be found.

HIV SUCCESS

The first ever use of gene-editing in people employed a similar *ex vivo* approach. Last year, Sangamo BioSciences in Richmond, California, published results from a clinical trial in which it used gene-edited cells to treat 12 people with HIV (P. Tebas *et al. N. Engl. J. Med.* **370,** 901–910; 2014). Instead of TALENs, the researchers used a DNA-cutting enzyme called a zinc-finger nuclease (ZFN).

When added to blood extracted from patients, the ZFNs cut out the gene for a protein on T cells targeted by HIV, and the team then pumped the cells back into the patients. The results were positive — at the time of the announcement, half of the participants had been cleared to stop taking their antiretroviral

drugs. Sangamo tells *Nature* that it has now treated more than 70 people with the therapy.

For some diseases, however, it makes more sense to edit the genome *in vivo* — for example, if the target cells are in an organ or tissue type that is harder to remove than blood.

In a study presented in October at a meeting of the US National Academies of Sciences, Engineering and Medicine in Washington DC, Sangamo senior scientist Fyodor Urnov reported that his group had injected 15 monkeys with viruses that carried genes encoding a ZFN and normal versions of factor IX — a blood-clotting protein produced in the liver that is mutated in people with haemophilia B.

The ZFN cut the genome at a section that encodes a protein called albumin, which is made in large quantities in the liver, and inserted a healthy version of the factor-IX gene. The monkeys began producing much more factor IX: levels in the blood increased by 10%. Urnov says that the albumin site could be a good place to insert other genes, likening it to "a USB port in the human genome" (R. Sharma *et al. Blood* **126,** 1777–1784; 2015).

A committee at the US National Institutes of Health, which approves all clinical trials involving modified DNA, gave the green light to human trials of the factor-IX therapy in September, according to Urnov, but Sangamo must still get permission from the US Food and Drug Administration (FDA). Urnov says that the company will apply by the end of the year, and that trials could begin in early 2016. Sangamo plans to apply for permission to do several other trials of gene-editing *in vivo*, including of therapies for the blood diseases haemoglobinopathy and β-thalassaemia.

Others also plan to start testing the approach in people. On 3 November, biotechnology start-up Editas Medicine in Cambridge, Massachusetts, announced that, by 2017, it hopes to start trials of *in vivo* gene-editing. The researchers would inject DNA encoding the CRISPR/Cas9 enzyme system into the eyes of people with a rare retinal disorder called Leber congenital amaurosis to correct a mutated gene.

The treatment is a 'bridge' to keep someone alive until a matched T-cell donor can be found.

Therapies both *ex vivo* and *in vivo* risk causing cuts and mutations elsewhere in the genome, but the *in vivo* scenario introduces another concern because the DNA-delivering vector can remain active in the body for years after injection. This could have unforeseen effects, such as inducing an immune reaction to the DNA-cutting enzyme, worries biologist Valder Arruda of the University of Pennsylvania in Philadelphia, who is exploring treatments for haemophilia that involve conventional gene therapy. Sangamo, however, says that it has not seen evidence of such effects in its animal studies. Other challenges of editing *in vivo*, says Qasim, include ensuring that enough of the target cells actually get edited and that the vector delivers its payload to the right part of the body.

The list of disorders that editing *in vivo* might help to treat is growing. At a synthetic-biology meeting in April, biomedical engineer Charles Gersbach at Duke University in Durham, North Carolina, reported a study done in mice with the mutation responsible for muscular dystrophy, a muscle-wasting disease. When the team injected a viral vector encoding a DNA-cutting enzyme into the mice's muscles, the injections corrected the gene in about 20% of muscle cells — enough to improve tone and strength substantially. "I think [*in vivo*] is the next wave of gene editing," says Gersbach. ■

CLARIFICATION

In the World View 'Forensic DNA evidence is not infallible' (*Nature* **526,** 611; 2015), it may not have been clear that the current investigation in Texas is reportedly focusing on statistics and not the specific problem of secondary contamination in touch-DNA samples.