Carleton biochemistry professor Ken Storey is intent on learning how turtles survive freezing, so the knowledge can be used to freeze human organs for long periods for use in transplants.

Seeking life in the deep freeze

Why don't turtles, frogs, and bugs die when they're frozen? The medical world is watching Carleton prof Ken Storey for the answer, as **Pauline Tam** reports.

Let there be no doubt that Ken Storey likes turtles.

He uncovers a container to reveal a colony of young ones nestled in moss. "Awwww, aren't they cute?" he asks, contorting his elastic face.

In time, he will put the turtles in a freezer, and they will harden to lumps of ice. But the rigor mortis is deceiving. Despite the absence of a heartbeat, these turtles are very much alive.

Nature, it seems, has taught them how to chill.

They aren't the only ones who can survive deep freeze.

Elsewhere in Mr. Storey's lab, there are frozen bugs and frozen frogs. These animals hibernate in the winter by cooling themselves to the temperature of ice. During the spring, they thaw with the landscape, and come back to life.

Mr. Storey, a professor of biochemistry at Carleton University, has spent the better part of his career trying to understand this miracle.

By unlocking the secrets of how these animals survive freezing, he wants to one day freeze human organs without destroying them. The hope is to preserve hearts and livers for long periods so doctors don't have to race against time to perform transplants.

Medical scientists are interested in Mr. Storey's work, and not just for its potential to preserve organs; they view his research as an important window into how living cells work.

For that reason, Mr. Storey rarely has trouble attracting research funding. He is near the end of a five-year, $700,000 grant from the Natural Science and Engineering Research Council, just as another major award has come through. For the next five years, Mr. Storey will have more than $345,000 to spend as a Canada Research Chair, a federal endowment for the country's top scientists.

Recently, Mr. Storey was recognized by Carleton with an award for research excellence — a prize he has won three years previous. He also received $500,000 in federal and provincial grants to outfit his lab with the latest equipment to analyse genes and proteins.

Like so much of science, Mr. Storey's work boils down to asking the right questions, and having new technologies to push the boundaries of discovery.

"It's sort of a treadmill, where we set the treadmill very high, and we run along happily like rodents," he says, rubbing his hands with glee.

With his cartoonish gestures and fitful energy, there is a touch of the animals he studies in him. He is the first to admit it.

"You know how people say they look like their pets? I act like my animals. I'm a perfect match with my study organisms that live under a rock and go to sleep. We both have wild metabolic fluctuations."

He began freezing animals almost 20 years ago when, as a new professor at Carleton, he stumbled on an article about frogs. It described how a scientist accidentally left frogs in his car to freeze overnight, and discovered they could survive.

Inspired by what he read, Mr. Storey applied for a research grant. Very quickly, he discovered some frogs have a natural protectant made of simple blood sugar. As ice starts forming on their skins, the animals flood their bodies with the sugar, shielding each cell from being killed while frozen.

In the years that followed, Mr. Storey isolated a group of genes that acts as a master switch, shutting down a frog's metabolism, and filling its cells with protectant whenever the animal freezes.

The idea was to get the same genes to work in human organs.

He studied other animals, and found similar mechanisms in toads, bats, snails, turtles, and ground squirrels. Not all of them freeze solid like frogs do. Desert toads, for example, shrink and dry out in the sun, but can survive for months without oxygen.

In all cases, the animals' basic cell function is the same. First, they turn off most of their genes to conserve energy, halting the production of proteins in the process. At the same time, they stop burning fuels, whether they be fats, proteins, or carbohydrates.

"They turn off the use of energy and they turn off the production of energy," says Mr. Storey. "The cell just goes quiet."

This does not happen in humans. "Whereas our animals turn down their pilot light when times are tough, humans either keep the fuels burning, or increase them in a desperate attempt to generate enough energy."

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Ken Storey,
Biochemist

For that reason, Mr. Storey doesn't dabble in cryonics, which presumes to freeze a cadaver with the hope of reviving it in the future. But freezing an organ is entirely possible.

In 1997, Mr. Storey collaborated with a research group in California that tested the principles behind the procedure. They extracted a liver from a rat, cooled the organ, then flooded it with sugar and other molecules. The idea was to coax the liver cells into producing a protectant. The liver was then frozen, thawed, and eventually transplanted into another rat.

If the same mechanisms could be induced in human organs, prolonging their lifespan for more than just a few hours, doctors could avoid the mad scramble to transplant. They could even wait for a perfect match.

But that day is still a long way off. In the meantime, Mr. Storey plans to expand his study to include the fruit fly, the zebrafish, and the xenopus frog, whose genes and biochemical sequences have all been mapped.

The goal is to freeze them, then compare their genetic blueprints to those of the animals he has studied so far. "That's another step toward finally trying the technique on a human organ or human tissue," he says.

While Mr. Storey doesn't believe he will live to see the day his research becomes routine medical practice, he is certain his ideas will inspire other scientists to advance the field farther. "If I can show that this works, there will be a bandwagon with my name on it."

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