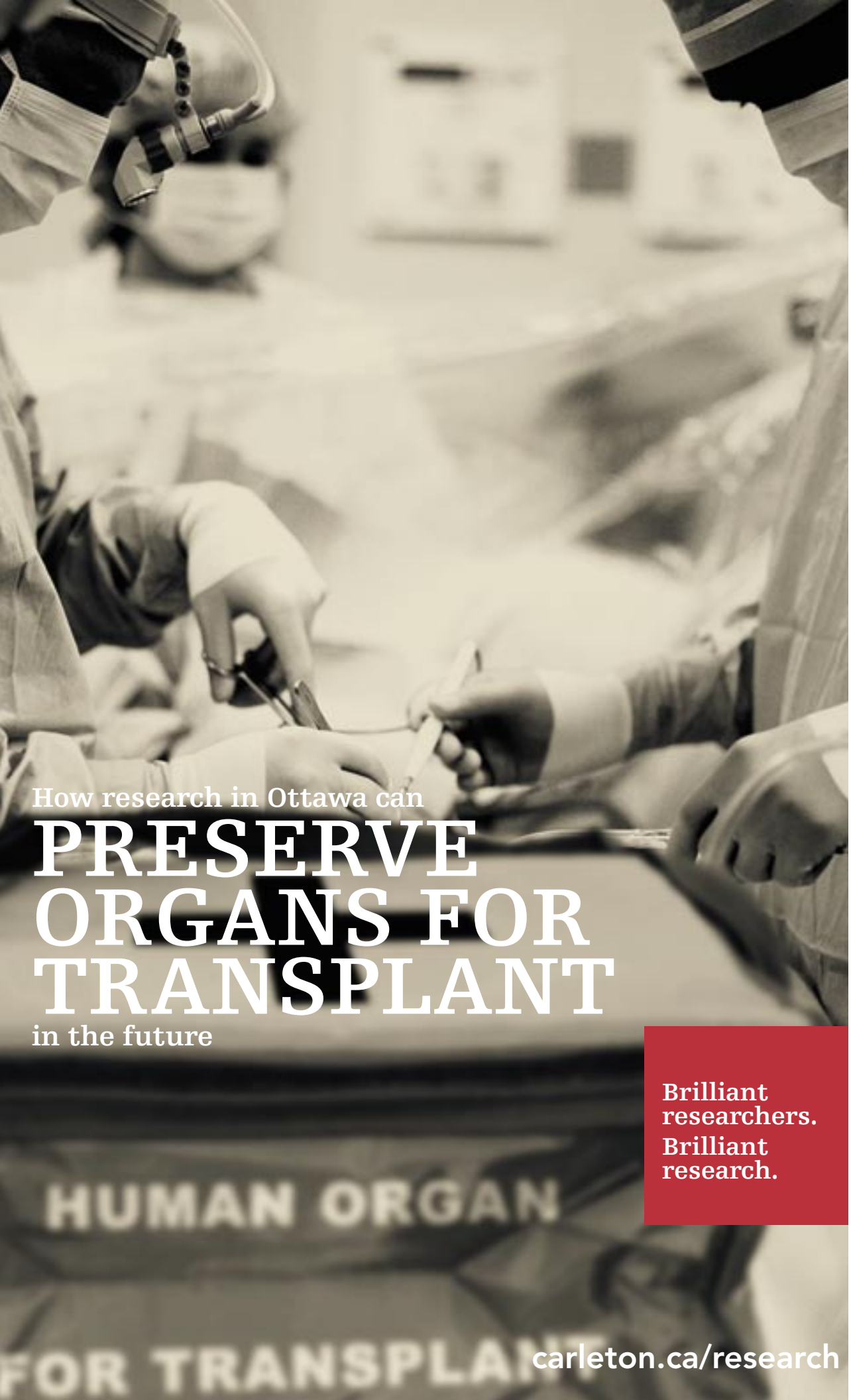


Carleton UNIVERSITY
Canada's Capital University

How research in Ottawa can

PRESERVE ORGANS FOR TRANSPLANT

in the future

Brilliant researchers. Brilliant research.

Ken Storey, PhD
Carleton University's
Canada Research Chair in
Molecular Physiology

carleton.ca/research

Brilliant researchers.
Brilliant research.

Research snapshot

Purpose
To understand how animals modify and adapt their biochemistries to identify the basic principles of how organisms endure and flourish in the face of harsh environmental conditions.

Scope
To study how amphibians, reptiles, and other animals survive freezing.

Thesis
That the ability to survive freezing is related to a number of factors including the production of ice-nucleating proteins that control ice formation in the bloodstream,and the activation of certain genes during freezing.

Outcome
The identification of unifying principles of biochemical adaptation and metabolic design which can be applied to medical science and, in particular, used to develop organ cryopreservation technologies that will help create banks of frozen human organs suitable for transplantation.

Selected publications
- Storey, K.B. "Reptile freeze tolerance: metabolism and gene expression." *Cryobiology.* 2006
- Storey, K.B. and C.J. Ramnanan. "Glucose-6-phospate dehydrogenase regulation during hypometabolism". *Biochem. Biophys. Res. Commun.* 2006

Grad student projects
Mamady Hapsatou,
fourth year, PhD in biology
Mammalian hibernation: regulation of torpor by the differential expression of genes
Christopher Dieni,
second year, PhD in chemistry
Regulation of enzymes of energy metabolism in freeze tolerant frogs

Honours
- 2004 ISI Highly Cited Researcher
- 1990 Fellow of the Royal Society of Canada International Association for Cryptographic Research (IACR)

Carleton UNIVERSITY
Canada's Capital University

Come in from the cold: how frogs can help us to preserve vital human organs

If you have ever been frostbitten, you will know that human tissue cannot survive exposure to the extreme cold without at least some damage. By comparison, the wood frog (Rana sylvatica) can bed down on the earth's surface under a thin blanket of leaves and snow, freeze solid for two to three months, and then thaw when spring arrives, its tissues and organs completely undamaged.

Biochemist Ken Storey believes that, despite the inability of our tissues and organs to protect themselves long-term at temperatures below 0° Celsius [C] (32° Farenheit [F]), what we can learn about how the wood frog adapts to its environment may be vital to human organ transplants.

"The biochemistries of different species are not the same and thus need unique solutions to the problem of how to survive freezing," he observes. "Nonetheless, wood frogs are similar enough to humans that if we can figure out how this amphibian literally lives with ice in its veins, we might be able to use this information to prolong the viability of human organs available for transplant."

Storey is the Tier I Canada Research Chair in Molecular Physiology at Carleton University. For nearly 30 years he has studied the cells and molecules of unusual animals for clues as to how some creatures can thrive under the harshest environmental stressors such as oxygen deprivation and subzero temperatures and is considered an expert in cryobiology (the study of the effects of low temperatures on living tissues, organs, or organisms).

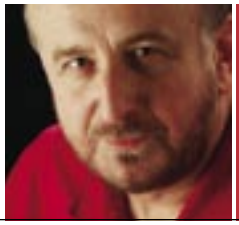
A NATURAL ANTIFREEZE

Although he initially studied freeze-resistant insects, he found out early on that the wood frog has specific traits that make it more for suitable for his research: it has the same vital organs as humans (e.g., liver, heart, and lungs) with a very similar basic biochemistry and yet a few key strategies that enable it to freeze solid each winter.

To understand these strategies, Storey puts male frogs in a freezer set at -2 to -3° C (28 to 26° F) at the start of winter and leaves them there for two to three weeks at a time. During this period he uses a variety of techniques such as magnetic resonance imaging, enzymology, and gene screening to monitor the animals closely. He has learned that the wood frog's ability to withstand subzero temperatures is partly due to a complex molecular interaction involving different genes, proteins, and regulatory mechanisms that releases glucose to help hold water in the animal's cells as it freezes. This slushy, sugary solution keeps the inside of cells liquid and prevents them from shrinking beyond repair. Other adaptations trigger and guide ice growth throughout the blood and body cavities so that ultimately about 65% of the frog's total body water is trapped in ice. The animal is effectively dead and yet, after melting, all its vital functions resume within minutes.

NEW MEDICAL BREAKTHROUGHS

What Storey has learned about the wood frog's biochemistry is helping other scientists to develop new technologies to preserve human tissue and organs for longer periods of time. "Thirty years ago it was impossible to keep vital tissues and organs cold enough for longer than 12-24 hours and impossible to freeze them. Now, that window of opportunity has more than doubled. In the future, who knows? With our insights into how frogs survive freezing may help us build a bank of organs that could be stored frozen for months and then thawed out and transplanted. Although this science will not allow us to freeze whole people and then bring them back to life, I do think that it could save many lives."



"Thirty years ago it was impossible to keep vital tissues and organs cold enough for longer than 12-24 hours..."

Canada Research Chairs
The Canada Research Chairs Program is designed to attract the best talent from Canada and around the world, helping universities achieve research excellence in natural sciences and engineering, health sciences, and social sciences and humanities.

Chairholders improve Canadians' depth of knowledge and quality of life, strengthen the country's international competitiveness, and help train the next generation of highly skilled people. When fully implemented, the program will support 2,000 research professorships across the country.

263-06 XXX 07 2006