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Research Perspectives

Our post-human future

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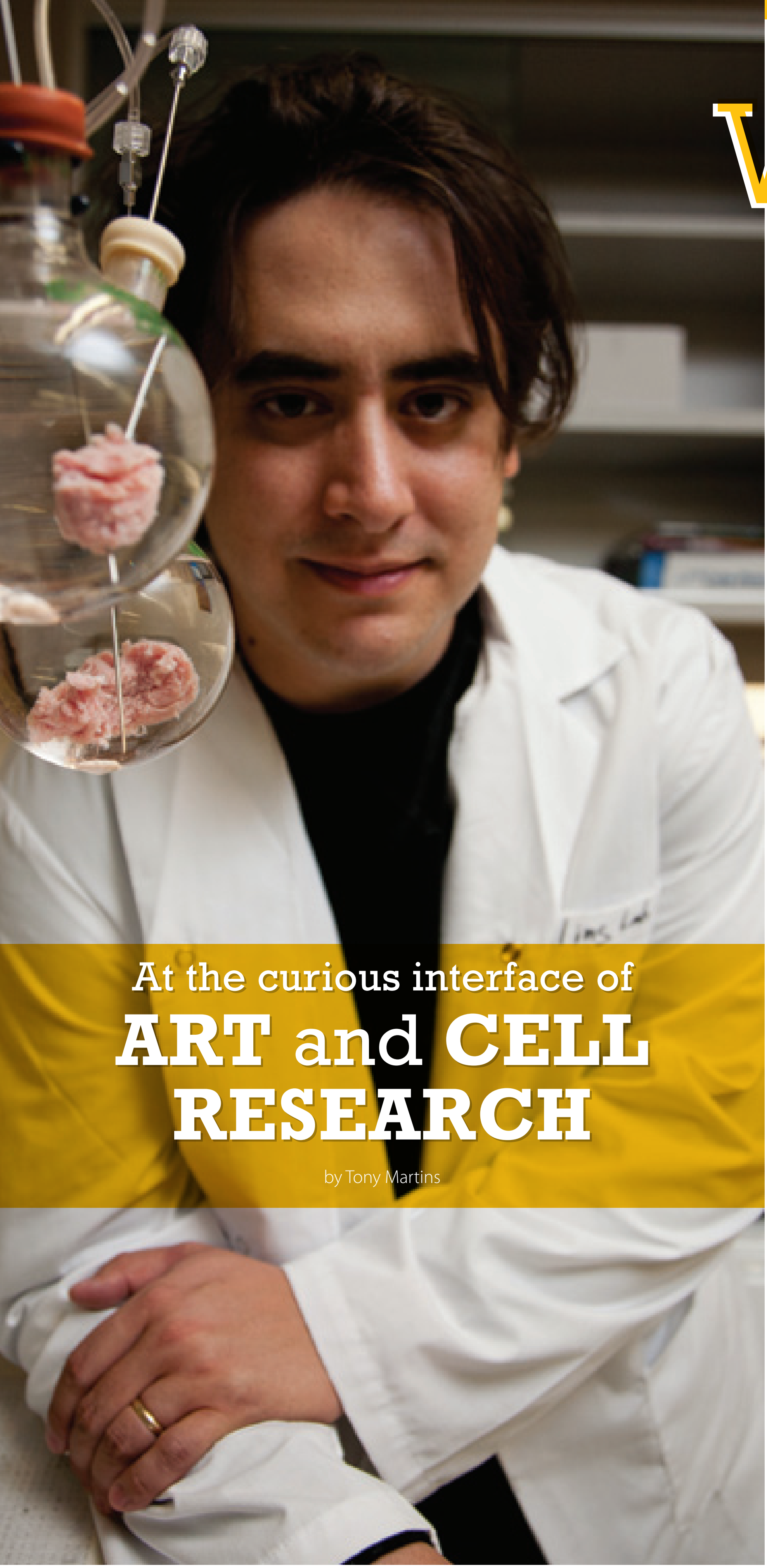

At the curious interface of ART and CELL RESEARCH

by Tony Martins

What predicts the function and fate of a living cell? **Andrew Pelling** and his team work and play at the interface of art and biophysics to examine rarely explored factors in cell function equations—the mechanical factors.

As a Canada Research Chair cross-appointed to the physics and biology departments at uOttawa, Andrew Pelling heads up a busy lab on the cutting edge of multidisciplinary cell research. Pelling also makes time to pursue related interests in bioart—that strange conjoining of imagination and hard science.

Pelling often collaborates with German media artist Anne Niemetz and was a visiting professor this spring at SymbioticA, an artistic laboratory of life sciences at the University of Western Australia.

"Admittedly, the boundaries between all these projects and disciplines become blurry," says the inquisitive researcher. "Often my students are helping out on the bioart stuff as well," Pelling says. "It's fun for everybody."

Although the outcomes of his research may hold serious benefits for human health and longevity, the words "fun" and "play" are important in Pelling's vocabulary.

"I love exploratory, curiosity-driven research, and I think I'm good at working that way," he explains. "The world needs specialists, but there is still a lot of room for play—especially in a lab… I think this only creates more interesting ideas and innovations."

One way that Pelling and colleagues seek to innovate is through an exploration of how the mechanical forces at work in the movement of muscles, organs and blood affect cells. They examine such questions as the impact of the stretching and contracting of lung tissue during breathing and of high blood pressure on the aorta.

"It's been shown, for example, that stem cells respond to the stiffness of their microenvironment," Pelling explains. "We can cause them to follow different fates just by changing how soft or stiff their microenvironment is. No drugs, no chemicals, no gene transfer. Just mechanics regulating stem cell fate."

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"Some require physical stretch—not a biochemically induced conformational change—to expose a binding site in order to do their job," Pelling says. "The shape of many cellular structures, for example the flagella, have evolved the way they have because any other shape would not have worked. This is due directly to the physics of the environment."

Among the obvious applications for Pelling's research are the detection of and treatments for diseases that stem from inhibited mechanical properties, genetic mutations or biochemical cues. The less obvious applications, however, are what really pique this scientist's curiosity.

"What is most interesting to me is the use of mechanical, topological and physical stimuli to dictate or control cell fate, differentiation and morphogenesis," Pelling states. "The end game is designer organs or hybrid bio-silicon-electronic devices, not necessarily for transplanting into humans but as tools."

To indulge these curiosities, Pelling's lab applies a range of cellular manipulation techniques, such as gene insertion to tag proteins, as well as the use of scanning probes, optical microscopes and a range of custom-built "stretchers."

Pelling is quick to point out that mechanical forces affecting cells are not necessarily a bad thing. In fact, the opposite is usually true. Our bodies require these mechanical dynamics to function normally.

"Where things get problematic," adds Pelling, "is when a cell loses its ability to respond properly to these mechanical forces and cues or loses sensitivity to the properties of the mechanical microenvironment."

In addition, when forces within the body become unbalanced (as happens with high blood pressure), cells can respond adversely.

"The effects of higher blood pressure are numerous," Pelling explains, "but one is that the pressure weakens the structure and mechanical properties of the aorta—often resulting in aneurysm."

Pelling's mechanical investigations are somewhat unusual because science has traditionally focused on biochemical factors, such as the genome, when studying cell behaviour.

"Although a tremendous amount of information has come from these efforts, the picture is extremely one-sided, and we are missing a wealth of mechanical information," Pelling contends.

"We now know, for instance, that many proteins have evolved to be activated by a physical force," says Pelling.

"It's amazing how poking, pulling and stretching these things has so many effects, all of which are extremely complicated," says Pelling. "They are really naive, even simplistic, experiments that have immensely complicated outcomes. That's what's so fun about this stuff."

"I say this all the time," concludes Pelling. "I wish I had more people in the lab because we are always stumbling across interesting phenomena and don't have enough people to pursue all the possible leads. It seems like every week there is an interesting result from my group that blows my mind."

What kind of a post-human world might Pelling envision? He says, "I mean, why just stop at a perfect copy of a human heart? Not that making such a thing is trivial, to begin with, but what about creating a new organ we don't currently possess? Maybe an organ with four small lungs, an IP address and a Twitter account. I know this sounds completely mad, but why stop where human evolution did?" RP