Researcher studies ice worms to help extend organ life for transplants

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Ice worms can live in cold temperatures because of their elevated energy levels.

The cold weather keeping much of the country in a deep freeze this winter can quite literally be a real drain on a person's health. A Rutgers University–Camden researcher is looking for a way to keep energy levels up, even when the temperature drops.

"If you want to live in the cold, you have to make lots of energy," says

Daniel Shain, a professor of biology. "That means your cells would have to produce more ATP (Adenosine triphosphate), the currency of energy for all life on Earth. When we get cold, our ATP levels plummet."

Maintaining high energy levels in human cells could lead to improvements in organ transplantation. Donated organs must be transplanted into recipients during a very small timeframe – usually 24 hours or less - but that window could be extended by increasing the ATP levels while the organ is on ice.

To find the mechanism for maintaining high ATP, Shain has dedicated his research to studying ice worms, the only annelid worms known to spend their entire lives in glacial ice.

"Most single-cell organisms that can live on ice – organisms that have been around for hundreds of millions of years – have these elevated ATP levels," says Shain, who notes that ice worms have are multi-cellular and complex, like humans. "We have tried to manipulate human cells to have these elevated ATP levels to mimic ice worm physiology. The idea is to try and keep these organs alive from days to weeks instead of hours."

Shain says it's a very simple idea, but actually doing it is a challenge because human cells are so much more complex than single-cell organisms like bacteria, algae, and fungi.

"The easiest way to think about it is that we have a thermostat in our body that regulates energy," he says. "It keeps energy levels from getting too high. In ice worms, that thermostat is broken. They have all this extra ATP. This is what makes ice worms somewhat extraordinary in the animal world. They're one of very few animals that have figured it out."

Ice worms, however, aren't immune to freezing temperatures. Shain says they survive on coastal glaciers where the temperature remains constant, which is why they aren't found on inland glaciers, where it is much colder. If the temperature were to drop a couple of degrees below zero, the ice worms would die.

"They are paradoxically very sensitive to freezing," Shain says. "They're able to live right at the freezing point thanks to their elevated ATP levels.

Shain, who spent last summer searching for ice worms in Tibet, says he and students in his lab have tried using different drugs to act on enzymes within human cell to change strictly regulated ATP levels without much success.

"What needs to happen is we need to get rid of a particular enzyme, but that's counterintuitive Trying to break that thermostat in human cells is experimentally difficult," he says. "We now feel like we partially understand the mechanism for making this change and we've only just scratched the surface of applying it to human cells. We've learned it's not so easy, but it's not impossible, either."

Provided by Rutgers University