Hold the ice: Research reveals behavior of antifreeze molecules

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Chemists at New York University have discovered a family of anti-freeze molecules that prevent ice formation when water temperatures drop below 32 degrees Fahrenheit. Their findings, which are reported in the latest issue of the *Proceedings of the National Academy of Sciences* (*PNAS*), may lead to new methods for improving food storage and industrial products.

"The growth and presence of ice can be damaging to everything from our vehicles to food to human tissue, so learning how to control this process would be remarkably beneficial," says co-author Kent Kirshenbaum, an associate professor in NYU's Department of Chemistry. "Our findings reveal how molecules ward off the freezing process and give new insights into how we might apply these principles elsewhere."

A common misperception is that water necessarily freezes when temperatures reach 32 degrees Fahrenheit or zero degrees Celsius. Not so, scientists point out.

"Nature has its own anti-freeze molecules," explains co-author Michael Ward, chair of NYU's Department of Chemistry. "We simply don't have the details on how they work."

To explore this topic, the researchers created artificial, simplified versions of protein molecules that, in nature, inhibit or delay freezing. These molecules were placed in microscopic droplets of water, and ice formation was monitored by video microscopy and X-ray analysis. The experiments allowed the researchers to determine which critical chemical features were required to stymie ice crystallization.

The experimental results showed that there are two ways the molecules adopt anti-freeze behavior. One, they work to reduce the temperature at which ice begins to form, and, two, once ice does begin to form, they interact in ways that slow down its accumulation.

The researchers then investigated the molecules' structural features that might explain these capabilities. Their observations showed molecules act as "ice crystallization regulators." Ice has a crystal structure, and the anti-freeze molecules may associate with these crystal surfaces in ways that inhibit the growth of these crystals, thus delaying or halting the freezing process.

Provided by New York University