Chemists make tiny molecular rings with big potential

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Ohio State University chemists have devised a new way to create tiny molecular rings that could one day function as drug delivery devices or antibiotics.

The rings are made from polymers -- large molecules that are made up of many smaller molecules -- and the chemical reaction that creates them is similar to others that create polymer chains. But this new reaction solely makes rings, ones tailored to perform specific functions.

In a recent issue of the *Proceedings of the National Academy of Sciences*, the chemists report constructing polymer rings of a specific size and binding them to charged sodium atoms -- a first step in a long road that could lead to applications in medicine.

Polymer chains are already often used in drug delivery, pointed out Malcolm Chisholm, Distinguished Professor of Mathematical and Physical Sciences and professor of chemistry at Ohio State. Polymer rings could have similar uses. "These rings could encapsulate certain molecules, transport them somewhere, and release them at a specific time," he said.

The technique may eventually be used in drug design. The kind of ring molecules grown in this study, known as depsipeptides, are similar to some natural compounds produced by microorganisms that are employed as antibiotics, such as valinomycin. Scientists are also studying depsipeptides as possible anti-cancer agents.

Chisholm hit upon the idea for the new process when he decided to capitalize on what some chemists would call a "bad" reaction.

"A bad chemical reaction is a competing reaction," he said. "So if I'm trying to grow polymer chains, and for some reason a side reaction occurs that chops up my chains, or grows some rings instead, that's a bad reaction. And I thought, if we could control the bad reaction to be selective, to do just one thing for us, then we'd actually have a new kind of process, something that would be completely different from everybody else's."

Chisholm doesn't want to oversell the technology.

"This project is really just beginning, and so there won't be any immediate applications. But there could be potential for future applications in medicine, because these molecules can be varied to perform specific functions," he said.

He described how the ring-making technique works. A catalyst -- an added chemical substance that enables the reaction -- reacts with a single ring-shaped molecule, and multiplies it many times over, spawning rings of many different sizes. He likened the process to a child blowing a cascade of bubbles.

The rings form, break apart, and reform, until the chemists introduce a compound that specifically binds with one size ring in particular, and removes it from the mix. Then all the other rings assume the size and shape of the ring that was removed.

"It's as if all the bubbles in the end collapse to that one particular bubble you were looking for," he said.

While there are other methods for making polymer rings and chains, this

is the only one that solely makes rings. It's also the only one for which the catalyst is reusable indefinitely, which Chisholm counts as a significant advantage.

Next, the chemists would like to bind their rings to other charged atoms, such as ions of potassium and lithium.

Source: Ohio State University