Reimagining your Rx

VCU researchers are redesigning medicines. In the future, some prescriptions might be manufactured in a factory the size of a refrigerator – or even be produced by your body itself.

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Say “prescription medication,” and most people envision a one-size-fits-all white pill made in a huge factory far away.

While that picture of pharmaceutical production may be largely accurate for now, researchers at VCU are redesigning medicines. What will your future prescriptions look like? Some of them might be manufactured in a small portable factory – or even be produced by your body itself.

Dr. Thomas Roper, director of pharmaceutical engineering in VCU's Department of Chemical & Life Science Engineering (Photo by Hillary Kuhn)

'By taking processes from the macro scale to the micro scale, we are able to bring science and engineering closer to the patient,' Roper says.

According to Dr. Thomas Roper, director of pharmaceutical engineering in VCU's Department of Chemical & Life Science Engineering, tomorrow's medications are moving toward manufacturing processes that shrink the environmental and industrial footprint as they expand global access to drugs. And those meds are likely to be more customized to the patient and easier to take.

"I would say that the theme of my lab is miniaturization for the purpose of personalized medicine," Roper said. "By taking processes from the macro scale to the micro scale, we are able to bring science and engineering closer to the patient."

Pharmacy on Demand, a project that Roper is working on with collaborators from the Massachusetts Institute of Technology, is an object lesson in these themes. In this case, the object is a pharmaceutical factory merely the size of a refrigerator.

Patients in hard-to-access places often have to wait for medicine – or go without it altogether. Pharmacy on Demand is working on an alternative approach based on small, configurable pharmaceutical manufacturing platforms that can ultimately be shipped to different locations to supply patients with locally produced, high-quality meds.

Such a strategy would expand access to pharmaceuticals worldwide, reduce environmental impact and make the manufacturing process safer by avoiding the burden of the construction of manufacturing sites.

"In my opinion, the biggest advantage of these miniature manufacturing facilities is footprint," Roper said. "Take hydrogen, for example,

which is highly flammable and explosive. If you have a big reactor with hydrogen under high pressure, there are huge safety parameters that must be accounted for, but a facility this size is intrinsically safer because there is much less hydrogen available to react at any one time."

Roper hopes to initiate work in the area of biological catalysis that will streamline the pharmaceutical manufacturing process further.

"Another potential way to manufacture medicines is biologically," Roper said. "An area I am interested in is biological catalysis of reactions, so eventually you are creating medicines in a biological host such as E. coli or ultimately even in a human cell."

In this paradigm, the medicine is not a tablet from an amber-colored bottle, but a chemical process that transfers the manufacturing of the medicine to the patient's body.

"In other words, if you string together chemical transformations that can be done by enzymes in a cell, you can effectively eliminate the external manufacturing footprint," Roper said.

He sees other trends away from the production of medicines that patients take regularly and toward the creation of processes that play out in a patient's body over time. These include commercial gene therapies like Strimvelis, GlaxoSmithKline's recently approved treatment for severe combined immunodeficiency or "bubble boy disease."

Roper also points to the development of long-acting medicines that patients take only once every 60 to 90 days. When perfected, they may offer major advantages, including freedom from the stigma of disease and greater assurance that patients will actually take their prescriptions.

Creating ways to increase patient compliance with treatment regimens is an important aspect of pharmaceutical research.

“Patient compliance in pharmaceuticals is terrible, which reduces the effect of the medical treatment. Even in cancer treatment, patients will not always take their medicine when they are supposed to,” Roper said. Creating ways to increase patient compliance with treatment regimens is an important aspect of pharmaceutical research.

He noted an additional advantage to many of the next-generation drugs – one harder to quantify.

“There is a general improvement in patient quality of life,” Roper said. “These treatments come closer to being cures, so people have to spend less time feeling like a patient.” •