Groundbreaking technique helping to pave the way for advances in personalized medicine

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Maikel Rheinstadter (right), along with PhD student Rick Alsop, analyse how drug molecules interact with human-like tissues created in Rheinstadter Lab. It's part of a process that helps identify how and why drugs work differently in different people and could help improve existing drugs, accelerate drug innovation, and lead to significant advances in personalized medicine. Credit: McMaster University

Imagine, one day in the future, you go into the pharmacy with a prescription from your doctor, you swipe your health card and a robot in the back provides you with the exact drug composition that will work for your body. No more trial and error with multiple drugs. No more experimenting with drug dosages.

It sounds like something out of a sci-fi movie, but a groundbreaking process developed by Maikel Rheinstadter, biophysicist and associate professor in McMaster's Department of Physics and Astronomy, is bringing researchers one step closer to making this kind of personalized medicine a reality.

The process uses synthetic human-like tissue created in a petri dish to help identify how and why drugs work differently in different people, an innovation that could help improve existing drugs, accelerate drug innovation, and pave the way for significant advances in personalized medicine.

"If you go to your favourite clothes store to buy a t-shirt, you have 16 different sizes to choose from, but if you get a prescription for a drug from your doctor, there are no variations," says Rheinstadter. "For adults, everyone takes the same drug, but we all have slightly different body compositions. Even drugs like aspirin and ibuprofen work differently depending on your body composition. It's a question of finding the right drug composition that works with your body."

Rheinstadter says his goal is to understand how drugs, and the active ingredients that could potentially be used to create drugs, such as hormones, enzymes, vitamins– even sugar or caffeine– interact with different body compositions at the molecular level.

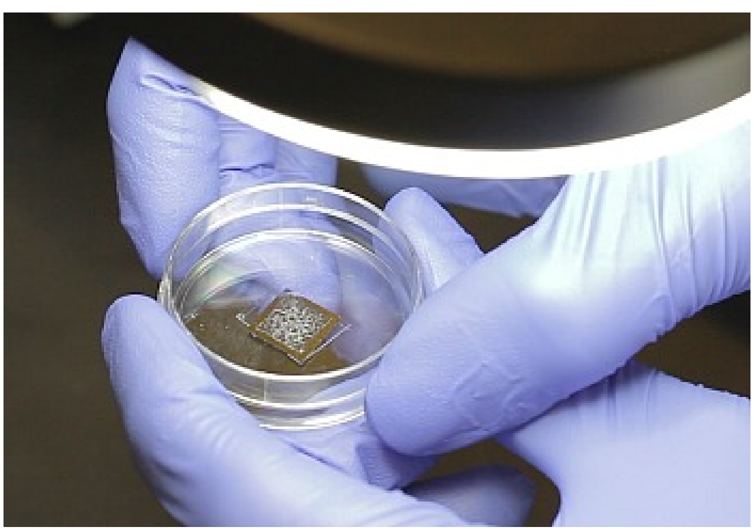
Researchers in the Rheinstadter Lab begin by creating synthetic, human-like tissues that can simulate a variety of body compositions. It's a technique that was developed by Rheinstadter along with PhD student Rick Alsop.

"We create these tissues from the bottom up," says Rheinstadter. "We can mimic a person who is healthy, someone with high cholesterol, someone with arthritis, someone who is older. We can even make things like synthetic Alzheimer's tissue. The key is creating these tissues."

Drug molecules are then added to the tissue, which is placed on a silicone chip and left to grow in a petri dish.

Once created, the tissue is put in an x-ray diffractometer, a molecular microscope with a specialized chamber designed to simulate the inside of the human body. While in the chamber, the microscope uses x-rays to generate images of how the drug molecules are interacting with the tissue.

Rheinstadter then uses a cutting-edge computational microscope to analyze the image and calculate the motion of the molecules to see how the tissue is responding to the drugs.



The Rheinstadter Lab creates synthetic, human-like tissues that can simulate a variety of body compositions and can be used to test drugs in the petri dish. Credit: McMaster University

"This process allows us to get very detailed information about how drugs work in various types of tissue and get the results very quickly," he says, adding that his lab is one of the few labs in the world capable of this kind of analysis. "Five years ago it would have taken months on a super-computer to study a drug but with this process, we can now study a drug overnight."

Rheinstadter says this technique has wide-ranging applications. For example, it could accelerate the pace of drug discovery and reduce the need for drug testing in humans and animals. It could become an important step in the clinical trial process– quickly identifying drugs that have the potential to be effective, or weeding out drugs that could be harmful to certain groups of people. It could also help improve existing drugs.

"Take antimicrobial resistance for example," he says. "We can make tissues that mimic the ones in which the antibiotics are working and tissues where the antibiotics aren't working to understand how the interaction is different. Once we understand the mechanism and why it does or doesn't work, we might be able to tweak existing antibiotics to make them effective again."

Researchers in the Rheinstadter Lab are currently testing a number of drug and molecular interactions in the petri dish and, through this technique, have recently succeeded in providing evidence that curkumen– the active ingredient in turmeric– is an effective molecule in combatting the formation of Alzheimer's senile plaques.

Rheinstadter says he is pursing potential partnerships with the pharmaceutical industry, and has also begun working with other research groups on campus. "We have so many research collaborations here–that's what McMaster is good at," he says.

Provided by McMaster University

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