



**W**alk into any clinical research lab and you will undoubtedly find one or more microscopes. The problem with conventional microscopes, however, is they can only show images of thin slices of dead tissue or cells in a dish. It takes a special kind of instrument to produce images from inside the living body, which is exactly the kind that Elizabeth Hillman is building.

“It is a significant technical challenge to build imaging systems capable of studying cellular or molecular processes in living organisms,” said Hillman. “You need devices that can image very fast and in 3-D and that show you lots of different things at once. It’s a complex problem, one that forces you to think about physiology and physics at the same time.”

One such optical imaging technique is microscopy to investigate the brain, particularly the relationship between blood flow and neuronal activity. Functional magnetic resonance imaging (fMRI), one of the most ubiquitous tools used to investigate neuronal activity, relies on detecting subtle changes in blood flow in the brain.

“The problem is, we really don’t understand why these changes in blood flow occur,” said Hillman. “Even the best neuroscience textbooks only devote a page or so to blood flow in the brain.”

Hillman’s work is beginning to tease out this complex process, improving our fundamental understanding of how the brain functions, and also raising the possibility that fMRIs will one day prove even more useful and revealing. In another project, she is developing a technique that permits her to create images of the organs in live lab mice, which she hopes will allow pharmaceutical companies and researchers to study diseases and treatments without sacrificing large numbers of animals. She has also developed techniques to make images of living human skin and is using optical imaging to investigate how the electrical activity in cardiac tissue changes during a heart attack.

Because all of these measure different wavelengths of light, none require the heavy shielding or careful dose monitoring necessary in radiologic imaging. Hillman hopes that ultimately many of her imaging tools will prove useful in the clinic and as laboratory research tools. She is quick to point out, however, that she does not expect her techniques to entirely replace MRIs.

“Optical imaging isn’t going to be the next MRI,” she said. “MRIs do some things well, but they can’t tell you things like how bad the burn on your arm is or whether you have good blood flow in the back of your eye. Our systems can.”

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## *Unlocking the Brain’s Secrets*

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