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How do white blood cells move so fast?

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If you fall and scrape a knee, it's the job of white blood cells called neutrophils to rush to the site of infection and chase down invading bacteria.

In order to race after bacteria at speeds up to a thousand times that of most human cells, neutrophils must move in a special way.

Lillian Fritz-Laylin, PhD, a postdoctoral scholar in UC San Francisco's Department of Cellular and Molecular Pharmacology, and Megan Riel-Mehan, PhD, a postdoctoral scholar in the Department of Bioengineering, want to know how that works.

"Our immune system relies on fast cells like neutrophils getting to where they need to be," said Fritz-Laylin. "But we know surprisingly little about how these fast cells move."

Fritz-Laylin is a cell biologist. Riel-Mehan is a visualization scientist who develops tools to process and display complex data.

Fritz-Laylin used a fast, high-resolution lattice light sheet microscope to record 3-D images of neutrophils migrating through a fibrous matrix. But the recorded data were enormous and complex. "I couldn't open even a single frame of one movie on my laptop without a software crash," Fritz-Laylin said.

That's where Riel-Mehan came in. She processed and rendered the images, drawing on her animation background and developing new

software tools to shade crevasses and allow a human viewer to visually understand the 3-D data.

The rendered videos revealed that neutrophils create two types of protruding "feet" to help them move: planar sheets and multi-petaled rosettes. Previously, scientists thought planar sheets could only form when cells were grown in flat dishes, but the new videos show that planar sheets form even in a 3-D matrix that resembles the cells' natural environment.

This was the first time that researchers were able to watch up close as neutrophils moved in three dimensions.

Now, Fritz-Laylin is investigating how these protrusions are built and how they mechanically propel neutrophils forward, allowing them to race through our bodies and chase down invading microbes.

Fritz-Laylin and Riel-Mehan worked with a team of biologists, microscopy specialists, and data scientists to produce this video: Dyche Mullins, PhD, and Graham Johnson, PhD, of UCSF; Bi-Chang Chen and Eric Betzig of Janelia Research Campus; and Tom Goddard of UCSF Chimera.

"This project exemplifies the wonderful interplay that can exist between experimental science and visualization science," Riel-Mehan said. "It makes the case that visualization should be part of the research process, not just something you do at the very end for an article cover."

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