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Microfluidics and nanofluidics research provide inexpensive ways to analyze blood and filter water (w/ Video)

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Rohit Karnik, an associate professor of mechanical engineering at MIT, addresses real-world challenges with his microfluidics and nanofluidics research. The studies that Karnik and his team have conducted on fluid flow at the molecular level have uncovered important data about fluid's unique behavior, and has led to the development of new technologies that can potentially solve some of the world's most pressing issues.

Blood analysis is critical to the diagnosis of malaria and a host of other diseases, and is particularly challenging in developing regions, where expensive diagnostic lab equipment is not readily available. Looking to develop an affordable point-of-care diagnostic device that can directly analyze a patient's blood, Karnik, who leads the Microfluidics and Nanofluidics Research Laboratory, and his team have developed a new microfluidic technique that can quickly separate specific cells from samples of whole blood. The process relies on the natural interaction of molecules on the cell with molecules on the surface of the device's channels, greatly reducing the number of steps required for analysis.

The Karnik research group has also tackled the challenge of providing safe drinking water, a global issue affecting roughly a billion people throughout the world. Karnik was the first to recognize the filtering potential of xylem, porous tissue in the vascular system of plants that conveys fluid. Xylem contains membranes small enough to pass water, but not bacteria. The team surveyed xylem structures of plants and built a water filter by simply breaking off the branch of a pine tree, peeling away the bark, and flowing contaminated water through the branch. The improvised filter was able to remove more than 99 percent of the bacteria from the water in a single filtration step. The peculiar structure of xylem enabled high water flow rates, pointing to the potential of constructing compact, low-cost, disposable water filters from plant xylem.

The group also focuses on controlling the nanostructure of materials such as graphene for improved water desalination and gas separations; microfluidic separation of cancer cells; and fluidic devices to improve the quality of nanoparticles for drug delivery.

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