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Research

Astronaut's eyes may become windows on the bloodstream

By Karl Leif Bates
News Service

Our eyes may become more than windows of the soul if a multidisciplinary team of U-M researchers succeeds with a clever combination of nanoparticles and ultrafast pulsed laser to see individual cells as they zip past in the bloodstream.

The team of physicians, scientists and engineers has $3 million from NASA to determine a way of detecting radiation exposure on the fly by looking for individual cells that have been harmed. Now, such cell counting is achieved only by drawing blood and using an expensive machine called a cytometer, operated by a skilled lab technician.

A certain amount of cell death is normal and expected, so there always would be some background fluorescence. What the researchers are looking for is a sudden increase in the population of dead white blood cells, which is one of the calling cards of radiation poisoning.

NASA is particularly concerned with radiation exposure as one of the leading health risks in long-term space travel. Radiation—sub-atomic particles moving at tremendous speeds—careens in all directions in space. It can kill cells and damage the DNA within them, causing long-term health problems, especially cancers.

Individual cells in the bloodstream are tagged with a nanoparticle called a dendrimer that is much smaller than a blood cell. It's a synthetic that is grown in layers of

branching molecules that resemble a tree. At the tips of these branches on the dendrimer, scientists can attach biomolecules that have specific affinity for the white blood cells. Other arms of the dendrimer carry a fluorescent material that will light up on cue if the white blood cell dies.

The idea of using dendrimers for real-time cell counting came from Dr. James R. Baker Jr., the Ruth Dow Doan Professor of Biologic Nanotechnology and director of the Center for Biologic Nanotechnology. His research group is also exploring the use of dendrimers for drug delivery and improved medical imaging.

To see cells as they flow, the researchers are using a pulsed laser developed by physicist Theodore Norris of the Center for Ultrafast Optical Science that can be focused down to a spot smaller than a cell. "Jim (Baker) was wondering about cytometry in vivo, and we came in with a photonic solution," Norris says.

The spot-focused laser allows researchers to watch a capillary blood vessel just a few blood cells in diameter and to count individual spots of fluorescence as they zip past. The focal area of the near-infrared laser is so tight that they can be sure that each flash of fluorescence represents just a single cell, says Norris, professor of electrical engineering and applied physics.

"This could be used for more than just radiation exposure," Baker says. "We should be able to continually monitor cell death from whatever cause."

On Earth, we are protected from most of this space radiation by the planet's magnetic field and by the thickness of the planet itself beneath our feet. But away from the Earth, astronauts will have only the vehicle around them and their clothing to shield them.

It is estimated that a 2$_{1/2}$-year mission to Mars could expose an astronaut to the lifetime dose of radiation allowed by NASA. An intense solar flare during the journey could even deliver a fatal dose of radiation in a single burst.

"NASA has told us that the trip to Mars could be one-way," Norris says. "Still, they've got people who are willing to do it."

U-M studies on living mice have shined the light through their semi-translucent ears to see the fluorescing dendrimers within capillaries. The proposal to NASA was for using the capillaries on the retina at the back of the eye, but human ears might work just as

well. "We just need to see a capillary," Norris says. "It doesn't have to be in the eye."

For more information, visit http://www.umnbei.umich.edu/.

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