Optical Tweezers Give Insight into Malaria-Infected Red Blood Cells

by Kevin TAN and Chwee Teck LIM

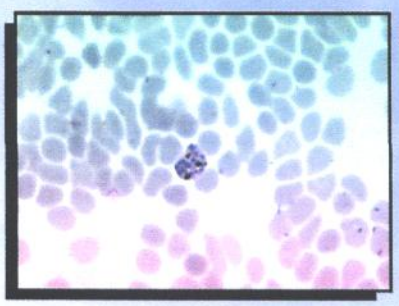

Figure 1: A red blood cell infected with the schizont stage of Plasmodium falciparum.

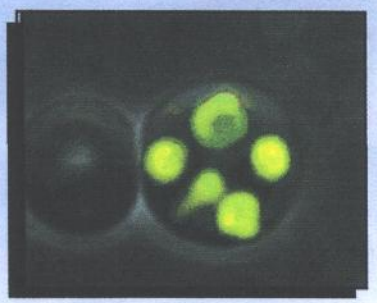

Figure 2: Fluorescence microscopy of acridine orange-stained malaria culture sample. Nuclei of individual P. falciparum *cells are revealed in green.*

Red blood cells (RBCs), also called erythrocytes, are biconcave-disc-shaped structures that transport our body's oxygen. Robust yet highly deformable, they can bend, stretch, and fold their way inside blood vessels less than half their diameters. Unfortunately, these cells, so vital to our survival, are coveted by the *Plasmodium* species, a single-cell parasite that causes malaria.

The RBC is rich in haemoglobin, an important food source for *Plasmodium*. As part of its complex life cycle, the parasite invades a RBC, reproduces within it, and releases its progeny. Once inside, the parasite causes the RBC to undergo extensive cellular remodelling.

Molecular and structural changes cause a decrease in the elasticity of the parasite-infected RBC membrane, which results in cell rigidity. In the case of *Plasmodium falciparum* infection, the RBCs may become sticky and clog the microvasculatures of organs such as the brain. Impairment of blood flow in the human host may lead to stroke and death.

To date, little information has been available on the physical changes the parasite-infected RBC undergoes, partly due to a lack of appropriate technology. A better understanding of the parasite-engineered structural alterations of RBCs may offer ways to interfere with these changes and perhaps reduce the parasite's virulence.

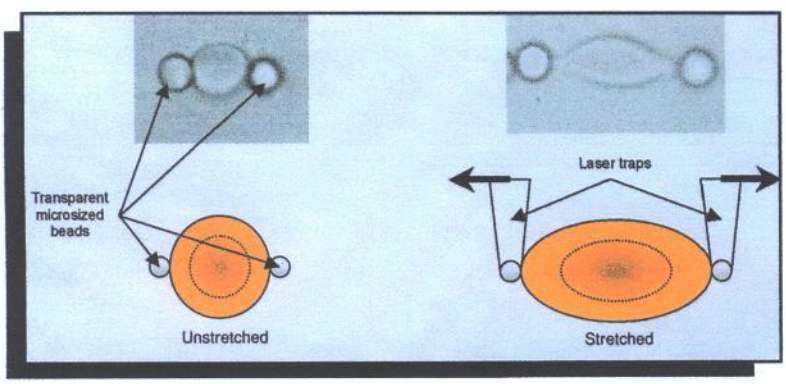

Figure 3: Stretching of red cell using optical tweezers.

Researchers at the National University of Singapore's Division of Bioengineering, led by Chwee Teck Lim, are working with Kevin Tan's team at the Department of Microbiology to do just that. Lim's specialty lies in the use of optical tweezers to extract information on the physical properties of human RBCs at the cellular and molecular levels. Though working with a relatively new technology, Lim has already put in place an optical-tweezers set-up that can stretch RBCs with forces beyond — by nearly an order of magnitude — those obtained by other investigators. Such large-deformation studies provide realistic information on the elastic properties of the RBCs.

Lim and Tan intend to use this set-up to study and quantify the physical alterations and interactions of *P. falciparum*-infected RBCs not only at the cellular but also at the molecular level. They will, for the first time, provide an in-depth understanding of elasticity changes which the RBC undergoes as the parasite matures within its host. Using parasite mutants deficient in certain postulated RBC-altering proteins, the group will attempt to find out which one plays a predominant role in affecting RBC deformability. Such a protein may be a potential drug target.

Subra Suresh and his research team at the Massachusetts Institute of Technology will also participate in this project.

For more information contact Chwee Teck Lim at bielimct@nus.edu.sg or Kevin Tan at mictank@nus.edu.sg