Capturing Circulating Tumor Cells (CTC's) Using Nanotechnology

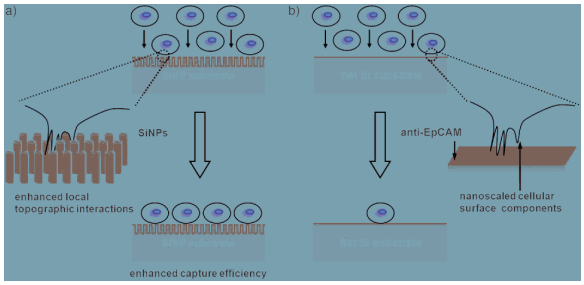
Kyle Rafferty, Biomedical Engineering, University of Rhode Island

Nanotechnology is an advancing field in today's scientific world and refers to engineering on an extremely small scale, usually 100 nanometers or less. Because of this small size, many devices that are currently being developed can give rise to important medical advancements dealing with disease control and treatment. One of those disease treatments now being improved upon with nanotechnology is Cancer. Cancer, according to WHO (World Health Organization) will overtake heart disease as the top worldwide killer sometime this year and not look back, escalating in occurrences and deaths over the next couple decades (4). With this in mind, it only makes sense to put more effort into the development of treatments for cancer in the upcoming future.

Cancer, if gone unnoticed or untreated, will inevitably metastasize. Metastasis occurs when cancer cells break away from the primary tumor and travel to another organ in the body by either blood stream or through the lymphatic system (metastasis is also most common cause of cancer related deaths)(3). Theses traveling cancerous cells are called just that, circulating tumor cells or CTC's. "…quantification of CTC's in patient blood provides new and valuable information about managing cancer. Over the past decade, CTC counting has been used for examining cancer metastasis, predicting patient prognosis, and monitoring the therapeutic outcomes of cancer" (1). This means that knowing the amount of CTC's in a patient's blood stream is vitally important to know for several reasons ranging from how advanced the cancer is, to treatments, and to how effective the treatments are. The problem is that, due to the low abundance of CTC's in the bloodstream (especially in early stages of cancer), it is very difficult to isolate the CTC's and to get an accurate count.

Previous methods used to capture tumor cells ranged from immunomagnetic beads to a flat silicon substrate coated with an epithelial-cell adhesion-molecule antibody, or an anti-EpCAM. However, both of these methods had inherent problems that managed to only capture around 4-14% of the CTC's traveling in the blood stream. However, a recent improvement on these methods is being developed and tested currently at the David Geffen School of Medicine at UCLA and the California NanoSystems Institute at UCLA (2).

This improved method builds off of the flat silicon substrate discussed earlier. With new advancements in nanotechnology in machinery, researchers have now developed a new cell-capture platform based on 3-D nanostructured substrates. This new silicon chip consists of many densely packed nanopillars which add surface area to grab more CTC's as they pass. The small graph below is a diagram showing the difference between the silicon nanopillar substrate (SiNP on the left) and the flat Si substrate on the right.



Early trials using this new nanopillar technology has shown that this increases the capture percentage up to 65%. Researchers believe that this percentage can be improved upon to yield results as high as 84-91% in the future (2).

Sources:

(1)Wang, Shutao. "Three-Dimensional Nanostructured Substrates toward Efficient Capture of Circulating Tumor Cells." Angewandte Chemie International Edition 48 (2009): 8970-8973. 26 Jan. 2010. http://www3.interscience.wiley.com/cgi-bin/fulltext/122658940/PDFSTART (impact factor: 10.879)

(2) Berger, Michael. "Nanotechnology trap captures cancer cells in blood." Nanowerk, Nov. 30 2009. 26 Jan. 2010. http://www.nanowerk.com/spotlight/spotid=13743.php

(3) Wikipedia contributors. "Metastasis." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 23 Jan. 2010. Web. 26 Jan. 2010.

(4) Stobbe, Mike. "Cancer top killer in world by 2010." The Seattle Times, 10 Dec. 2008. 26 Jan. 2010. http://seattletimes.nwsource.com/html/health/2008489006_cancer10.html