The Chinese University of Hong Kong
Department of Biomedical Engineering

Detection of Circulating Tumor Cells via Electrically-Charged Superparamagnetic Nanoprobes

Professor SHI Donglu
University of Cincinnati

Date : 10 December 2024 (Tuesday)
Time : 10:00am
Venue : Room 1122, William M W Mong Engineering Building, CUHK

Abstract

Circulating tumor cells (CTCs), which detach from primary tumors and enter the bloodstream, are considered pivotal agents in cancer metastasis. We present a novel approach for the sensitive detection of CTCs using electrically charged magnetic nanoprobes. Cancer cells are known to exhibit the "Warburg Effect," a metabolic hallmark in which they generate energy primarily through anaerobic glycolysis, leading to elevated glucose uptake and lactic acid secretion. Our findings reveal that the increased negative surface charge on cancer cells is a direct biophysical consequence of this heightened glycolytic activity. This surface charge serves as a reliable indicator of cancer cell metabolism, governed by the rate of glycolysis. We have established a robust correlation between lactic acid secretion and the net negative electrical charge on cancer cell surfaces. This negative charge is attributed to the cross-membrane movement of mobile ions, balanced by ion pumps to maintain cellular charge neutrality. Superparamagnetic nanoparticles functionalized with positive charges demonstrate strong and selective binding to cancer cells. In studies involving twenty-two cancer cell lines, we observed a close relationship between lactic acid secretion and the net negative charge on the cell surface, reflecting a direct link to the glycolytic capacity modulated by glucose uptake. This charge-based targeting presents a promising method for capturing and sensitively detecting CTCs in whole blood. Direct CTC detection on blood samples showed highly encouraging results, highlighting the potential of this approach for clinical applications.

Biography

Dr. Donglu Shi is a professor of Materials Science and Engineering at the University of Cincinnati. His research focuses on nanoscience-based precision medicine, cancer diagnosis and therapeutics, and biomaterials, which involve designs of unique nanostructures that not only interface with biological systems but also offer new bio-chemical-physical properties for fundamental studies. Dr. Shi has conducted research across diverse fields such as nanoscience, energy materials, biomedical engineering, precision medicine, and condensed matter physics. His efforts have led to over 300 peer-reviewed journal publications, with some of his works appearing in leading journals like Nature, Physical Review Letters, Advanced Materials, and ACS Nano.

***** ALL ARE WELCOME *****

For enquiries, please contact Ms. Joyce Chan, Department of Biomedical Engineering at 3943 8278