UNIVERSITY of HOUSTON | ENGINEERING

Department of Biomedical Engineering

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Publications | Contact

Date	Friday, November 1, 2024
Time	12:00 to 1:00 PM
Location	SEC 201

The Effects of Magnetic Fields and Field Gradients on Living Cells

Diagnostic medicine widely uses magnetic resonance imaging (MRI). MRI uses a static magnetic field to polarize nuclei's spins, fast-switching magnetic field gradients to create time and space resolution, and radiofrequency (RF) electromagnetic waves to control spin orientation. These magnetic, static, and electromagnetic RF fields interact with human tissue and cells. However, reports on the effects of the MRI technique on the cells and human body are often inconsistent or contradictory. Recent progress in improving sensitivity and resolution is associated with MRI magnets' increased magnetic field strength in both research and clinical MRI. MRI also uses contrast agents, like gadolinium-based Dotarem or ferromagnetic nanoparticles, to increase the image's contrast. Their effects on cells and organs are still debated and not fully understood.

This talk focuses on the influence of a static magnetic field gradient with and without a gadolinium-based MRI contrast agent (Dotarem) on macrophages. Macrophages are crucial in homeostasis, regeneration, and innate and adaptive immune responses. Functionally, different macrophages have different shapes and show different molecular phenotypes that depend on the actin cytoskeleton, which the small GTPase RhoA regulates. Recently, we reported that magnetic field gradients caused extreme macrophage elongation and prevented macrophage migration. Similar effects were observed in rodent models, where genetic or pharmacologic interference with the RhoA pathway deregulated the macrophage actin cytoskeleton. We will also discuss the potential cause of MRI contrast agent Dotarem toxicity: the gadolinium retention effect on macrophages. Although Dotarem is the least toxic among MRI contrasts used, we will show that gadolinium in Dotarem accumulates in various organs and tissues, exerting toxic effects.

Dr. Jarek Wosik is an electrical and computer engineering research professor at the University of Houston and the TcSUH principal investigator of the HTS RF devices, high-frequency materials characterization, and bioengineering laboratory. He earned his M.S. in Solid State Physics from the University of Warsaw and Ph.D. from the Institute of Physics, Polish Academy of Sciences, in Warsaw, Poland. His project mission is to make scientific and engineering contributions to using microwave- and radio-frequency electromagnetic waves for biomedical applications and to develop tools for high-frequency characterization of superconducting, dielectric, magnetic, and biological materials. His recent research highlights include experimental demonstrations of enhanced RF heating of non-magnetic nanoparticles (NPs) due to the adsorption of proteins and interface loss-governed RF EM interactions with NPs. He has also obtained very high resolution (3D isotropic 34 µm resolution demonstrated) magnetic resonance images (MRI) when cryo-probes built for 7 Tesla imaging of small animals were used. In addition, his work on the exposure of macrophages to a magnetic field showed actin cytoskeleton changes, which are strikingly like changes induced by RhoA pathway interference (local application of a magnetic field/gradient to the transplanted organs could prevent macrophage movement and inhibit the development of chronic rejection). He co-founded a technological startup to translate his research into commercial products.