Static Magnetic Field bioeffects：from mechanism to biomedical applications

Xin Zhang

[1] *High Magnetic Field Laboratory, Chinese Academy of Sciences, Hefei, China*
xinzhang@hmfl.ac.cn

Nowadays, people are exposed to various types of magnetic fields, which include static magnetic field (SMF), whose magnetic flux density and distribution do not change over time, as well as time-varying magnetic field of different frequencies, which will not be discussed in my talk. On one hand, WHO (World Health Organization) and ICNIRP (International commission on non-ionizing radiation protection) have published some guidelines for the SMF exposure of human bodies to ensure that people are not overexposed. On the other hand, magnetic therapy, although not in the mainstream medicine, has been widely used by many people worldwide as alternative or supplementary treatments.

The goal of my presentation is to synthesize current scientific evidence on the biological effects of SMFs, covering a broad range of intensities from millitesla (mT) to 33 tesla (T). This will include observed phenomena and their underlying mechanistic bases. While the existing literature on magnetic field bioeffects contains numerous reports that lack reproducibility across independent laboratories, we now understand that this variability stems from a combination of factors: magnetic field parameters (e.g., flux density, direction, duration) and inherent biological sample heterogeneity. Crucially, the magnetic properties of biological systems themselves play a pivotal role in driving differential responses to SMFs. Recent advances demonstrate that disease-associated perturbations in redox homeostasis and iron metabolism can markedly alter the magnetic properties of tissues and cells, thereby modulating their sensitivity to SMFs. Importantly, identical SMF exposure conditions may yield divergent effects—not only across in vitro and in vivo models but also, as we hypothesize, in human applications.

[1] Xin Zhang*. Biological effects of static magnetic fields, 2nd edition. *Springer.* **2023**. ISBN: 978-981-19-8868-4.

[2] Shiyu Lu, Junjun Wang*, Xin Zhang*. Effects of Static Magnetic Fields on Metabolic Diseases. *Health and Metabolism*. **2025**,2(1):3.

[3] Chuanlin Feng, et al. Redox imbalance drives magnetic property and function changes in mice. *Redox Biology.* **2025**, 81: 103561.

[4] Ruowen Guo, et al. Endogenous iron biomineralization in the mouse spleen of metabolic diseases. *Fundamental Research*. **2024**, DOI:10.1016/j.fmre.2024.07.004.

[5] Chao Song et al. Magnetic Fields Affect Alcoholic Liver Disease by Liver Cell Oxidative Stress and Proliferation Regulation. *Research*. **2023**, 6: 0097.