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Smart Magnetic Materials for Controlling Cell Fate[1]

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Toxicity of cancer chemotherapy, often resulting in failure of even healthy organs, represents one of the most vivid and still unavoidable outcomes of traditional medical approaches to treating a disease. The lack of specificity remains a fundamental obstacle in performing targeted treatment which should ideally affect only the particular cells in a human body. Nanotechnology has recently enabled the possibility to create materials comparable in sizes with cells and subcellular structures opening the opportunities for affecting intracellular processes on the level unattainable by macroscopic techniques. [1-2] Magnetic nanomaterials are especially promising for applications in life sciences due to their bi-functional behavior. On the one hand side, they are inherently stimuli-responsive and their properties can be controlled and modulated remotely. On the other hand, these materials themselves can be used for applying controlled stimulus to a cell thus changing its function and even inducing cell death [3]. For biological applications, such multifaceted functionality opens the unique opportunity to modulate cell behavior by interfacing it with magnetic material. Historically, chemically synthesized superparamagnetic iron oxide particles have been widely studied for biological applications such as magnetic separation, targeting, MRI contrast enhancement and magnetically induced heating [1,4]. At the same time, there is a growing interest to magnetic materials created by physical fabrication methods which allow for realization of very complex structures in terms of geometry and composition [5]. In this talk, both types of materials will be discussed. Thus, thermo-responsive magnetic micelles were used as nanocontainers for magnetically guided drug delivery and release triggered by heating in the RF frequency a.c. magnetic field. The microfabricated biofunctionalized microdisks targeted to the cancer cells were employed for mechanical stimulation of cell membrane due to oscillation of the disks in the low frequency (10-20 Hz) a.c. magnetic field, resulting in redistribution of free intracellular calcium and subsequent triggering of apoptosis - programmed cell suicide [3,5]. The details of mechanisms by which the cell responds to the stimulus applied by magnetic particles will be discussed.

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