Summary

This work deals with a preparation of superparamagnetic nano- and microparticles with hydrophilic surfaces for bioapplications. The work is divided into three parts in consonance with experimentally solved problem. First part describes a choice and an optimalization of synthesis of iron oxides nanoparticles with appropriate toxicological, morphological and physico-chemical properties, which surface can be post synthetically modified. Maghemite – γ-Fe₂O₃ particles were prepared by consequent oxidation of magnetite – Fe₃O₄ as an initial substance for a preparation of materials for diagnostics and separations. A conventional alkaline coprecipitation method of magnetite preparation was modified to produce nanoparticles with narrowed size distribution without use of surfactants during their synthesis. Prepared maghemite nanoparticles were ca. 6 nm in diameter and their saturation magnetization was $M_s \sim 70 \text{ A} \cdot \text{m}^2\cdot\text{kg}^{-1}$. Such observed value is far higher in comparison with the state of the art and argues thus a proposition the $M_s$ depends not on the preparation method, but only on the nanoparticles size. Maghemite nanoparticles morphology was evaluated by picture analysis of SEM and TEM micrographs, hydrodynamic size and zetapotential was measured with DLS. The structure of the maghemite was confirmed with powder XRD and saturation magnetization was measured with SQUID magnetometer.

Second part describes methods of maghemite nanoparticles surface modifications with D-mannose, poly(L-lysine) a poly(N,N-dimethylacrylamide) with the aim of stem cells labeling for their post implantation tracking with MRI. High efectivity of the cell labeling was achieved with such modified nanoparticles and the nanoparticles reduced the viability of cell cultures minimally. Contrast enhancement of the stem cells on MRI scan was proved as on gelatine models, so on cell cultures in vitro before implantation and in vivo after the implantation. The surface modifications were analyzed with TEM, DLS, elemental analysis, ATR-FTIR and SEC.

Third part deals with a preparation of hydrophilic microparticles based on poly(N,N-dimethylacrylamide) filled with maghemite nanoparticles. Initially, the preparation of plain poly(N,N-dimethylacrylamide) microparticles was described. From three employed methods, suspension, dispersion and inverse emulsion polymerization, the last one was chosen as a suitable method for the preparation of magnetic composite microparticles. Prepared composite microparticles contained high amount of magnetic nanofillers (up to 70 wt. %) randomly distributed in polymer matrix. Effects of maghemite colloid volume and concentration added into polymerization feed on microparticles morphology and yield were described. Morphology was investigated with SEM, TEM and VIS micrographs analysis. Microparticles composition was measured with elemental analysis and analysis of Fe content.