Polyethyleneimine as a versatile coating/reducing cationic polymer for metallic nanoparticle-based cancer theranosis

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Polyethyleneimine has been long known for its efficient DNA/RNA molecule delivery intracellularly due to the so-called ´sponge effect´. However, the potential of PEI as coating and reducing agent in nanoparticle synthesis/stabilization and its implication in nanomedicine in terms of intrinsic biological activities has only been addressed in the last years. Within this scenario, we have thoroughly characterized the chemical, physical, and biological contributions of PEI when coating iron oxide and gold nanoparticles. First, we studied the biological implications of the polymer as coating layer of superparamagnetic iron oxide nanoparticles (SPIONs) by assessing the effect that PEI-coated SPIONs have on mononuclear cells (macrophages), tumor cells, and endothelial cells [1-2]. PEI-coated SPIONs activated macrophages (pro-inflammatory cytokine secretion, pro-inflammatory gene expression, cytoskeleton modulation) mediated by TLR-4 engagement and ROS production, as pro-inflammatory response was inhibited when macrophages were pre-treated with TLR-4 inhibitor and ROS scavengers. In addition, PEI-coated SPIONs skewed endothelial cells gene expression profile toward an activated status. Surprisingly, PEI-coated SPIONs also exhibited anti-migratory effect on pancreatic tumor cells by modulating invadosome dynamics and, thereby, extracellular degradation ability, altogether suggesting an anti-metastatic potential [3]. Likewise, PEI-coated SPIONs impaired endothelial cell migration and invasion by affecting cytoskeleton dynamics, both *in vitro* and *in vivo*, suggesting their use as anti-angiogenic agent in cancer therapy. We then characterized the potential of the cationic polymer as a template for Au^{3+} reduction into gold nanoparticles (AuNPs) with a promising theranostic potential for colon carcinoma treatment [4]. PEI did also proved efficient in reducing and further stabilizing colloidal gold nanoparticles (AuPEI) into quasi-fractal nano-assemblies. These quasi-fractals showed a good plasmon-coupling facilitating NIR photothermal therapy and photo-acoustic imaging of colorectal carcinoma. In summary, PEI proved to be a versatile and promising tool in cancer therapy endowing metallic nanoparticles with intrinsic properties, *e.g.*, anti-migratory/invasion, pro-inflammatory, and anti-angiogenic features.

References

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Figure

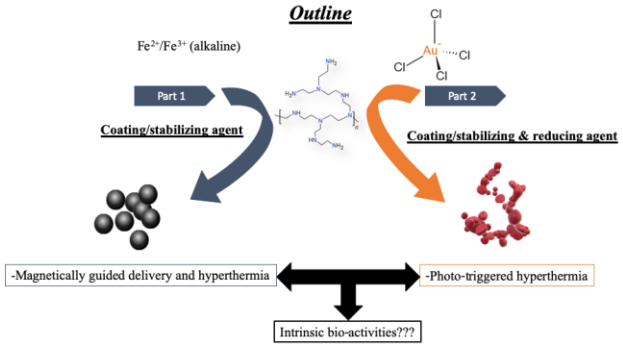

Figure 1. Synthesis routes for polyethyleneimine-based iron oxide and -gold nanoparticles and their exploitation in cancer theranosis