compared to nonporous silica, which results in lower toxicity for MSNs relative to nonporous silica particles.

19.7.3 Effect of Particle Size on Toxicity

Behavior of particle in biological system depends mainly on its size and surface chemistry. Targeted drug delivery phenomenon is critically dependent on these two parameters. These also influence important interactions like particle aggregation, protein adsorption to particles, intracellular particle movement, and reactions at the nano-bio interface, all necessary factors controlling biological behavior and cellular toxicity. There are reports in literature that mention that particles with size <50 nm caused increased necrotic cell death in contrast to particles having size above 100 nm, which show limited toxicity. Another very important factor influencing particle cytotoxicity in cellular arrays is surface charge. Bare SNPs exhibit higher cytotoxicity compared to silica particles, which are cationically modified. Under in vitro conditions, toxicity of MSNs is reduced if positively charged amine group is attached with MSNs. Pasqua et al. mentioned that mesoporous silica in unmodified form was more cytotoxic compared to amino or thiol functionalized MSNs. Considering intravenous injection of nanoparticles, PEGylation of MSNs is very crucial as it reduces the hemolysis of human red blood cells in contrast to pure silica MSNs. Still there is a need to study in detail as to how biochemical distribution is affected by physiochemical parameters of MSNs. This in turn will help in preventing unwanted activation of immune response, build up in healthy organs, and obstruction of biological membranes.

19.8 FUTURE SCOPE

The literature has many reports that mention lower levels of cytotoxicity in cellular system with mesoporous silica particles. Still there is need for analysis of more cytotoxic parameters. The biological systems are more complex and have more variability compared to cell lines grown in harsh environment; it will be more beneficial if the in vitro tests include different tissues and primary cells in the arrays. In the coming future, it will be more beneficial to focus on in vivo studies of MSN biocompatibility. Some of the studies in which mesoporous silica materials were injected confirmed that no toxicity originated from the degradation products. Hence it becomes very necessary to choose components for nanostructure synthesis that are strictly biocompatible. Animal in vivo studies conducted with MSNs have shown no signs of toxicity, which support the fact that surface functionalized form of MSNs exhibit adequate biocompatibility to qualify for in vivo biomedical applications. It can be concluded that MSNs are now emerging as important therapeutic tools. They can deeply impact the integrity of biological membranes by affecting circulation times, their interactions with nontargeted cells and biodistribution. Thus in vivo toxicity and particle