Iron oxide nanoparticles (IONPs) have emerged as a promising alternative to con- ventional contrast agents (CAs) for magnetic resonance imaging (MRI).Here, the fundamental principles of MRI contrast agents are discussed, and the current status of MRI contrast agents is reviewed with a focus on the advantages and limitations of current T1 contrast agents and the potential of IONPs to serve as safe and improved alternative to gadolinium-based chelates.This review addresses key aspects in the development of IONPs for MRI applications, namely, synthesis of the inorganic core, functionalization processes to make IONPs biocom- patible and also to target them to specific tissues or cells, and finally in vivo studies in animal models, with special emphasis on tumor models.Thus, IONPs functionalized with epithelial growth factor receptor antibodies, short peptides, like RGD, or aptamers, among others, have been proposed for the diagnosis of various types of cancer, including breast, stomach, colon, kidney, liver or brain cancer.Furthermore, the ease of functionalization of their surfaces with different types of ligands (antibodies, peptides, sugars, etc.) opens up the pos- sibility of carrying out molecular MRI.Studies in developing IONPs as T1 contrast agents have generated promising results, but the complex, interrelated parameters influencing contrast enhancement make the development difficult, and IONPs suitable for T1 contrast enhancement have yet to make their way to clinical use.The past advances and current challenges in developing IONPs as a T1 contrast agent from a materials science perspective are presented, and how each of the key material properties and environment variables affects the performance of IONPs is assessed.They have been extensively investigated as CAs due to their high biocompatibility and excel- lent magnetic properties.Gadolinium-based chelates are a mainstay of contrast agents for magnetic resonance imaging (MRI) in the clinic.However, their toxicity elicits severe side effects and the Food and Drug Administration has issued many warnings about their potential retention in patients' bodies, which causes safety concerns.Iron oxide nanoparticles (IONPs) are a potentially attractive alternative, because of their nontoxic and biodegradable nature.