19.4.1 Effect of Functionalization on Targeting

The functional groups are present in the surface layer and these groups can be linked to additional functions as the targeting components, for example, simple molecules such as folic acid or antibodies, and peptides.

It also becomes important to prevent extensive protein adsorption onto the particle surface under physiological conditions as this would decrease the target ability of the particle and increase recognition of particles as foreign by the defense mechanism of body, leading to their rapid removal from blood circulation.

In order to provide a cover to nanoparticles for reducing protein adsorption some groups have reported use of polyethylene glycol (PEG), which creates a hydrophilic "molecular cushion" around nanoparticles that shields them from proteins in the blood serum. Mou et al. synthesized PEG functionalized MSNs for targeting breast cancer cells. The targeting antibody was first linked to PEG and then covalently attached to third functionalized MSNs, this considerably reduced protein uptake by particles. Minimum protein adsorption or stealth properties depend on surface concentration of PEG as well as PEG molecular weight. According to results of various studies it has been concluded that surface densities of ~1–2 chains/nm^2 and molecular weights ranging from 2000 to 5000 for PEG are optimum for reducing protein adsorption on nonporous nanoparticles.

19.5 MSN DRUG LOADING

High specific areas and pore volume of MSNs make them suitable carriers for loading large quantities of drug through adsorption to the pore walls into the porous matrix, as shown in Fig. 19.6. Delivery of drugs becomes tedious when it is hydrophobic in nature. MSNs have efficiently addressed this challenge; they maintain their structural integrity in organic solvents, because of ceramic matrix. The loading of drug into MSNs can be carried out in nonaqueous media, and the major issue of forces of repulsion between the drug and carrier material under aqueous conditions due to pH dependency and electrostatic interactions (charges) can be neglected. Depending on drug solubility, the optimal solvent can be chosen for facilitating the interactions of drug with the pore wall compared to solvent-drug interactions. Generally, an organic solvent is chosen as medium for drug adsorption and predominantly a monolayer adsorption is observed, which can be modeled using Langmuir adsorption isotherm. Proteins from aqueous solution get adsorbed to pore walls in the form of monolayer. This helps in formulating a rational basis for the loading process and to fine tune the amount of drug loading required for any specific application. For drugs that are more hydrophilic in nature, their "pH matching" can be done with a suitable aqueous solvent to increase drug-loading capacity, which will not be possible in organic media. Many studies have suggested that controlling specific interactions between functional groups present on the pore wall and the drug can lead to desired drug-release process. One other method for drug incorporation into