

template formation by affecting the optimum condition for addition of  $\text{NH}_4\text{OH}$  under stirring condition and TEOS under static condition.

#### 19.4 FUNCTIONALIZATION OF MSNs

Till date cocondensation approach and covalent attachment of biologically active molecules with functional groups have been considered most successful techniques for attaching functional groups onto MSNs. Cocondensation technique enables functionalization of the pore walls of MSNs during the synthesis process, which minimizes the need of drying, particle separation, and re-dispersion. When MSNs are synthesized for targeted delivery application, additional functional group, which act as targeting group, need to be attached on the outer surface of particle. Also, introduction of capping agents or surface layers over the pore in the form of ultrasmall nanoparticles or mechanically interlocked molecules (MIMs) fulfills gate keeping properties by keeping the pores closed, thereby preventing release of guest molecules and opening when an external stimulus in the form of temperature change or magnetic field is applied.

Brinker et al. have reported encapsulation of MSNs as cores into liposomal bilayer shell, as shown in Fig. 19.5. Nanostructures thus formed have low toxicity and immunogenicity because of liposome, whereas silica core provides stability to the protocell and the mesoporous core helps in controlling drug loading and release.

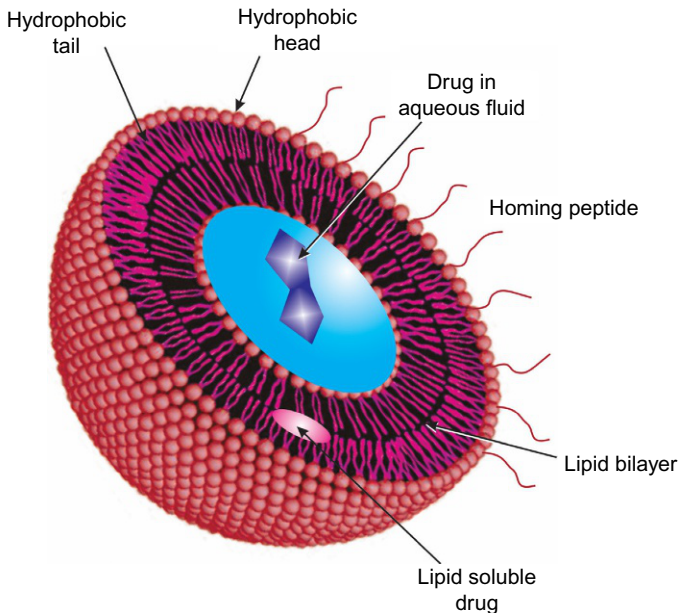


FIG. 19.5 Liposomal bilayer shell.