7 Emulsions, Suspensions and Other Dispersions

Emulsions and suspensions are disperse systems. While emulsions are sometimes formulated from oily drugs or nutrient oils, their main function is to provide vehicles for drug delivery in which the drug is dissolved in the oil or water phase. Suspensions, on the other hand, are usually prepared from water-insoluble drugs for delivery orally or by injection, usually intramuscular injection. An increasing number of modern delivery systems are suspensions of liposomes, or of polymer or protein microspheres or nanospheres, hence the need to understand the formulation and stabilisation of these systems. After a general introduction to colloidal systems (disperse systems below about 1 μm in diameter) this chapter will introduce the different types of emulsions, namely,

- oil-in-water (o/w)
- water-in-oil (w/o)
- multiple emulsions (w/o/w; o/w/o)
- microemulsions,

and give an appreciation of the factors leading to emulsion stability and physical instability, involving flocculation and coalescence. Approaches to formulation of emulsions to provide vehicles for drug delivery and parenteral nutrition (the main uses in pharmacy) should be understood. The chapter then deals with pharmaceutical suspensions and their formulation and forms of instability, which are principally sedimentation, flocculation and caking. Finally some newer colloidal systems used pharmaceutically will be discussed.

Pharmaceutical emulsions and suspensions are in the colloidal state, that is, their particles range from molecular size to visible (or coarse) dispersions. The word ‘colloid’ derives from the Greek *kolla* (glue) and was coined from the impression that colloidal substances were amorphous or glue-like rather than crystalline forms of matter. The colloidal state was recognised by Thomas Graham in 1861 and described by Wolfgang Ostwald some fifty years later as the ‘world of neglected dimensions’, a reference both to the fact that colloid science had somehow remained a Cinderella topic, and to the special world of systems in which the particles are extremely small.

Colloids can be broadly classified as those that are lyophobic (solvent-hating) and those that are lyophilic and hydrophilic. Surfactant molecules, because of their dual affinity for water and oil and their consequent tendency to associate into micelles, form hydrophilic colloidal dispersions in water. Proteins and gums also form lyophilic colloidal systems. Hydrophilic systems are dealt with in Chapters 8 and 11. Water-insoluble drugs or clays in fine dispersion, and oily phases will form lyophobic dispersions, the principal subject of this chapter. While lyophilic dispersions (such as phospholipid vesicles and micelles) are inherently stable, lyophobic colloidal dispersions have a tendency to coalesce because they are thermodynamically unstable as a result of their high surface energy.

Pharmaceutical colloids such as emulsions and suspensions (Figure 7.1) and aerosols are readily identified (Table 7.1): the *disperse phase* is the phase that is subdivided, and the *continuous phase* is the phase in which the disperse phase is distributed. Many natural systems such as suspensions of microorganisms, blood and isolated cells in...
Figure 7.1 Photomicrographs of emulsions and suspensions: (a) an oil-in-water emulsion (x 700), (b) a commercial suspension showing flocculated particles (x 140), (c) a suspension of spherical resin particles showing individual and aggregated particles (x 35); the emulsion particles in close contact show some flattening of the interface (see text)