

Slow gastric emptying can be detrimental to drugs inactivated by the gastric juices and can delay absorption of drugs more effectively absorbed from the intestine. In addition, since environmental pH can influence the ionization and lipid solubility of drugs, the pH change occurring along the gastrointestinal tract, from a pH as low as 1 in the stomach to approximately 7 or 8 in the large intestine, is important to both the degree and site of drug absorption. Since membranes are more permeable to unionized rather than ionized forms and since most drugs are weak acids or bases, it can be shown that weak acids, being largely unionized, are well absorbed from the stomach. In the small intestine (pH from around 4 to 6.5), with its extremely large absorbing surface, both weak acids and weak bases are well absorbed.

The most popular oral dosage forms are tablets, capsules, suspensions, solutions and emulsions. Tablets are prepared by compaction and contain drugs and formulation additives which are included for specific functions, such as disintegrants which promote tablet break-up into granules and powder particles in the gastrointestinal tract, facilitating drug dissolution and absorption. Tablets are often coated, either to provide a protective barrier to environmental factors for drug stability purposes or to mask unpleasant drug taste, as well as to protect drugs from the acid conditions of the stomach (enteric coating). Increasing use is being made of modified-release tablet products such as fast-dissolving systems and controlled, delayed or sustained-release formulations. Benefits of controlled-release tablet formulations, achieved for example by the use of polymeric-based tablet cores or coating membranes, include reduced frequency of drug-related side-effects and maintaining steady drug-plasma levels for extended periods; important when medications are delivered for chronic conditions or where constant levels are required to achieve optimal efficacy, as in treating angina and hypertension.

Capsules are solid dosage forms containing drug and, usually, appropriate filler(s), enclosed in a hard or soft shell composed primarily of gelatin or other suitable polymeric material. As with tablets, uniformity of dose can be readily achieved and various sizes, shapes and colours of shell are commercially available. The capsule shell readily ruptures and dissolves following oral administration and in most cases drugs are released from capsules faster than from tablets. Recently, increased interest has been

shown in filling semi-solid and microemulsion formulations into hard gelatin capsules to provide rapidly dispersing dosage forms for poorly soluble drugs.

Suspensions, which contain finely divided drugs suspended in a suitable vehicle, are a useful means of administering large amounts of drugs that would be inconvenient if taken in tablet or capsule form. They are also useful for patients who experience difficulty in swallowing tablets and capsules and for paediatric use. Whilst dissolution of drugs is required prior to absorption, the fine solid particles in a suspension have a large surface area to present to the gastrointestinal fluids and this facilitates drug dissolution thus aiding absorption and thereby the onset of drug action. Not all oral suspensions, however, are formulated for systemic effects and several are designed for local effects in the gastrointestinal tract. On the other hand, solutions, including formulations such as syrups and linctuses, are absorbed more rapidly than solid dosage forms or suspensions since drug dissolution is not required.

### Rectal route

Drugs given rectally in solution, suppository or emulsion form are generally administered for local rather than systemic effects. Suppositories are solid forms intended for introduction into body cavities (usually rectal but also vaginal and urethral) where they melt, releasing the drug. The choice of suppository base or drug carrier can greatly influence the degree and rate of drug release. This route of drug administration is also indicated for drugs inactivated by the gastrointestinal fluids when given orally or when the oral route is precluded, as for example when a patient is vomiting or unconscious. Drugs administered rectally enter the systemic circulation without passing through the liver, an advantage for drugs significantly inactivated by the liver following oral route absorption. Disadvantageously, the rectal route is inconvenient and drug absorption is often irregular and difficult to predict.

### Parenteral route

A drug administered parenterally is one injected via a hollow needle into the body at various sites and to varying depths. The three main parenteral routes are subcutaneous, intramuscular and intravenous. Other routes, such as intracardiac and intrathecal, are used less frequently. The parenteral route is preferred when rapid absorption is essential, as in emergency