Table 24.2 Examples of non-aqueous solvents used in pharmaceutical solutions

Solvent	Use
Alcohols, including polyhydric ones (i.e. those containing more than one hydroxyl group per molecule)	Ethanol is the most common organic solvent used in pharmaceutical solutions. It is often used as a co-solvent in oral, topical and parenteral solutions. Propylene glycol ($CH_3CH(OH)CH_2OH$) contains 2 hydroxyl groups per molecule. It is often used as a co-solvent in oral, topical, parenteral and otic solutions. Glycerol contains 3 hydroxyl groups per molecule. It is widely used as a solvent or co-solvent with water, in oral and parenteral solutions. Low molecular weight polyethylene glycols (PEGs) with the general formula $HOCH_2(CH_2CH_2O)_nCH_2OH$. These are used as solvents or co-solvents with water or ethanol. Used in parenteral solutions.
Fixed vegetable oils	Fixed oils are expressed from the seeds, fruit or pit/stone/kernel of various plants. They are non-volatile oils and are mainly triglycerides of fatty acids. Examples include olive oil, corn oil, sesame oil, arachis oil, almond oil, poppyseed oil, soya oil, cottonseed oil, castor oil. Historically, they have been used for intramuscular administration. They are used to a lesser extent now due to their irritancy and the possibility of allergic reactions to certain oils. They are being replaced by synthetic alternatives such as ethyl oleate.
Esters, such as ethyl oleate, benzyl benzoate, ethyl ethanoate	These are used as a vehicle in certain intramuscular injections.
Dimethyl sulfoxide	Used as a carrier for idoxuridine for topical application to the skin.
Glycofurol	Used as a co-solvent in parenteral solutions for intramuscular or intravenous injection.
Ethyl ether	Used as a co-solvent with ethanol in collodions.

solutions – are used for a number of reasons, such as to enhance product stability, bioavailability or patient acceptability, aid product manufacture and/or identification. Each excipient has a clear role in the product, thus, the nature of an excipient used depends on the requirements of the pharmaceutical product. The excipient must be non-toxic, nonsensitizing, nonirritating, as well as compatible with all the other components of the formulation. The route of administration is important; many excipients are acceptable by certain, but not all, routes. For example, the preservative benzalkonium chloride is used in oral, but not nebulizer, solutions, as it causes bronchoconstriction. Like the drug, excipients could be small (e.g. sucrose) or large (e.g. hydroxypropyl methylcellulose) molecules.

Pharmaceutical solutions

Solutions are one of the oldest pharmaceutical formulations. They are administered by many different routes; they are often therefore classified by the intended route (e.g. oral, otic (ear), parenteral). Solutions are also classified by the nature of the formulation, or by the traditional name which relates to the solvent system used, such as syrups, elixirs, spirits and tinctures. The latter terms are described in Table 24.3. While all pharmaceutical solutions must be stable, and acceptable to patients, other requirements of solutions administered by the different routes vary. For example, parenteral and ocular solutions must be sterile, oral solutions must be palatable, solutions which come into contact with body fluids must be isotonic and at physiological pH, especially if large volumes are used. Multidose products often contain preservatives to ensure that the growth of any microorganisms that are accidentally introduced during product use is inhibited. The requirements of the different types of pharmaceutical solutions are detailed in Table 24.4. These requirements are achieved by the inclusion of a number of excipients, as detailed in Table 24.5.