dermatological preparations because they also have antimicrobial properties. Cetrimide (cetyltrimethyl ammonium bromide) is blended with cetostearyl alcohol to form cationic emulsifying wax which is the mixed emulsifier used in cetrimide cream.

Non-ionic surfactants

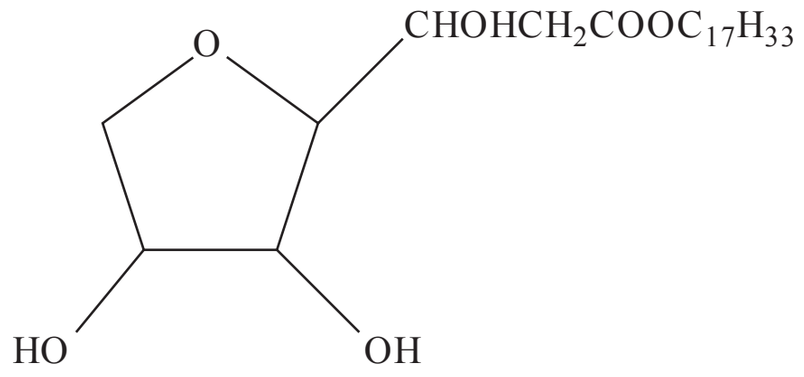
There are an enormous number of non-ionic surfactants available commercially with different oil and water solubility producing either o/w emulsions or w/o emulsions. Non-ionic surfactants are particularly useful as emulsifiers because they are less toxic and irritant than ionic surfactants, and therefore a limited number (e.g. polysorbate 80; Tween® 80) are used in parenteral and oral products. In addition, non-ionic surfactants do not ionize to any extent and thus are more resistant than ionic surfactants to changes in pH and the presence of electrolytes and polyvalent ions. Most non-ionic surfactants are based on:

- a hydrophobic moiety with 12-18 carbon atoms. The starting material may be a fatty acid or sorbitan.
- a hydrophilic moiety composed of an alcohol (–OH) and/or ethylene oxide groups linked together to form long polyoxyethylene chains.

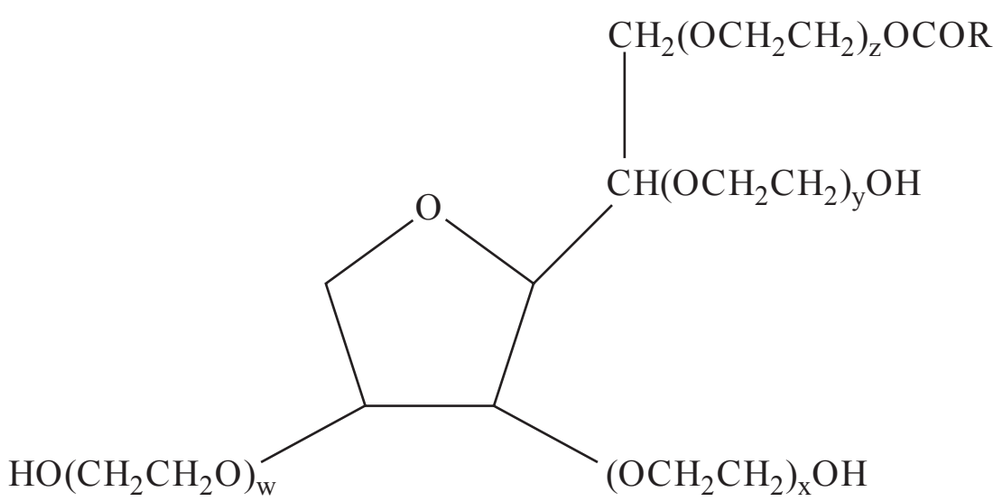
For each starting material, the polyoxyethylene chain can be modified and water solubility increased by the systematic addition of ethylene oxide.

Polyoxyethylene glycol ethers (macrogols). These are a series of non-ionic surfactant condensation products of fatty alcohols with hydrocarbon chain lengths from C_{12}-C_{18} and polyethylene glycol. They are used as both o/w and w/o emulsifiers as their oil and water solubility can be controlled by altering both the length of the hydrocarbon chain and the length of the polyoxyethylene (POE) chain. The most widely used emulsifier in this class is cetomacrogol 1000 (Table 27.2) which is used combined with cetostearyl alcohol to stabilize o/w lotions and creams, including the official Cetomacrogol Cream.

Sorbitan esters. The sorbitan esters are a series of surfactants, widely known as the Spans®, that are produced by the esterification of one or more of the hydroxyl groups of sorbitan with a fatty acid (hence the synonym *sorbitan fatty acid esters*). Various fatty acids are combined resulting in a range of commercial products, e.g. sorbitan monolaurate (Span 20), sorbitan monopalmitate (Span 40), sorbitan monostearate (Span 60), sorbitan monooleate (Span 80). The structure of sorbitan monooleate (Span 80) is shown below. The series of sorbitan esters are hydrophobic in nature and by themselves produce w/o emulsions.



Polyoxyethylene sorbitan esters (polysorbates). The polysorbates are more hydrophilic polyoxyethylene derivatives of the sorbitan esters above (full name – polyoxyethylene sorbitan fatty acid esters). The following grades are used in pharmacy: polyethylene 20 sorbitan monolaurate (polysorbate 20), polyethylene 20 sorbitan monopalmitate (polysorbate 40), polyethylene 20 sorbitan monostearate (polysorbate 60) and polyethylene 20 sorbitan monooleate (polysorbate 80). Commercially these are known as the Tweens®. The 20 in the name refers to the number of POE groups in the molecule. The formula for polyoxyethylene 20 sorbitan monooleate (Tween 80) is shown below. In this molecule, the subscripts w, x, y and z add up to 20. The group R is the fatty acid chain – in this case $–CH_2COOC_{17}H_{33}$.



An enormous range of polysorbate surfactants of differing oil and water solubility are available by controlling the fatty acid and the length of the polyethylene glycol chains in the molecule. Thus, the polysorbates are able to stabilize both w/o and o/w emulsions, depending on their HLB value (see 'Emulsifier selection' section below). Mixtures of sorbitan esters and their POE derivatives are used to form stable emulsions.

Fatty amphiphiles

Fatty alcohols and fatty acids. These are sometimes described in older texts as auxiliary emulsifiers. When used alone, they are weak w/o emulsifiers.