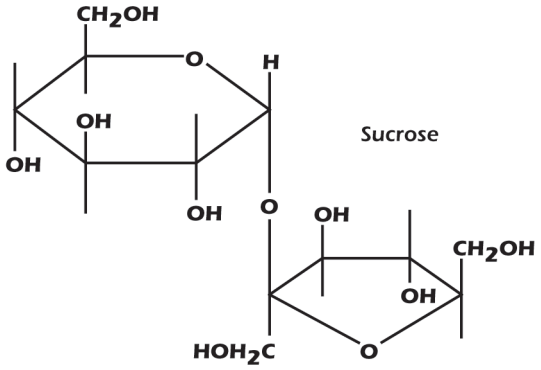
Chapter 2
Web Text Box 3

Super-sweet Chemicals

A disparate collection of chemicals including chloroform, lead diacetate, glycerol, the protein thaumatin, the artificial sweetener aspartame and a whole range of chemicals from plants share the ability to interact with our sweetness taste receptors and are therefore perceived as sweet. The most familiar sweet chemical is sucrose, the most common storage sugar found in plants and the compound we mean when we say “sugar” in everyday life. It is a *disaccharide* of glucose and fructose.



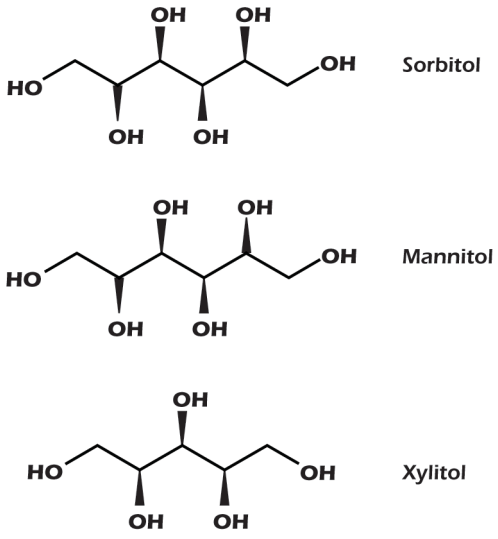
The Sucrose Molecule

Sucrose is used as the standard when we consider sweetness and is given a value of 1 or 100%. Taste is very subjective and nonlinear so sweetness comparisons are always approximations. Usually the comparison is on a weight basis but sometimes it is done on the basis of possible dietary value compared with that of sucrose.

Not all monosaccharides and disaccharides have the same sweetness: fructose (book figure 2.8 on page 24) tastes sweeter than sucrose; its relative sweetness is 1.8. Glucose (book figure 2.7 on page 24) is slightly less sweet than sucrose with a relative sweetness of 0.8. The disaccharide lactose (book figure 2.9 on page 25) is much less sweet (0.16) and (to the writer anyway) tastes gritty rather than sweet.

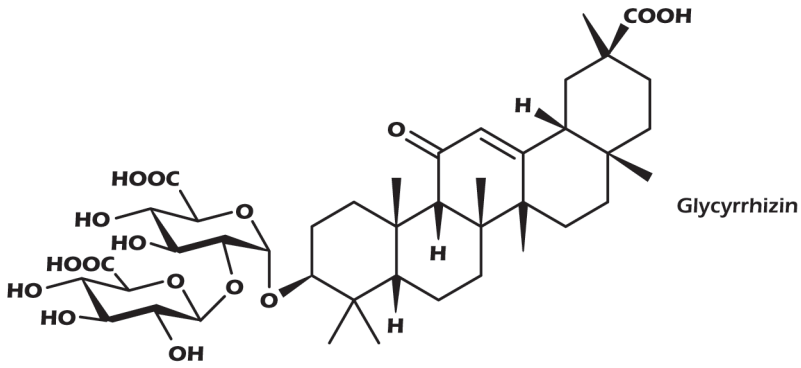
People who for various reasons (such as being diabetic or wishing to lose weight) wish to restrict their sugar intake find other sweet chemicals enormously useful while other sweeteners are used a great deal in the food industry. The toxicity of lead diacetate makes it unpopular now but once it was used to sweeten foods and particularly drink – one of its names is “sugar of lead”. Chloroform too is now known to be toxic but was once used to sweeten medicines and toothpastes.

Glycerol (book figure 2.19 on page 34) is a bit less sweet than sucrose (0.6) but is often used as a sweetener in foods. Other polyalcohols derived from sugars taste sweet: sorbitol (from glucose), mannitol (from mannose), and xylitol (from the 5 carbon sugar xylose) all occur naturally. All are synthesized in chemical plants for use as sweeteners.



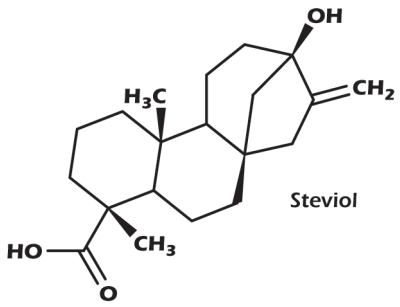
Polyalcohol Molecules

Plants make other chemicals that taste sweet. Many such compounds are glycosides consisting of a sugar joined to another group by a glycosidic bond. Licorice root is the source of glycyrrhizin which is 30 to 50 times sweeter than sucrose. The taste of licorice comes from other compounds in the root but glycyrrhizin gives traditional licorice its sweetness.



Glycyrrhizin Molecule

Stevia (relative sweetness ~300) is used as a sweetener commercially. It comes from shrubs found in the Americas. It is around 300X as sweet as sucrose. It is a glucose glycoside of steviol.



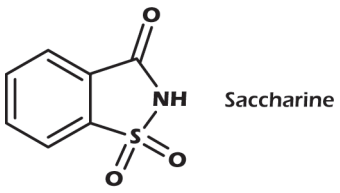
Steviol Molecule

Some fruits contain sweet tasting proteins. These are often many thousand times sweeter than sucrose. Monellin is 2000 times sweeter than sucrose and thaumatin I is 100,000 times sweeter. Protein sweeteners have the disadvantage that they denature and lose their sweetness if cooked (or at pH extremes), nevertheless thaumatin is approved as a sweetener in foods. Sweet proteins behave differently in the mouth from other sweeteners. The sensation builds slowly and lingers for some time.

Interestingly there is a protein called miraculin that does not have a taste itself, but if taken makes sour (acid) things taste sweet. The effect lasts an hour.

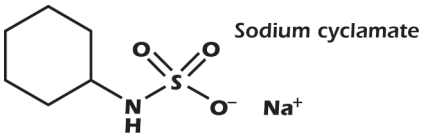
The most familiar nonsugar sweeteners are those made in the laboratory. The early ones were discovered by chemists prone to finger-licking. Later ones have been specifically designed.

Saccharin was discovered in 1878 and is 300X sweeter than sucrose. It is used as the soluble sodium salt (the hydrogen on the nitrogen dissociates easily). It has an unpleasant aftertaste said to be bitter or metallic.



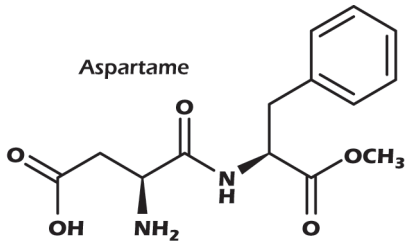
Saccharine Molecule

Sodium cyclamate is another early sweetener, discovered in 1937. It is less sweet than saccharine (30 to 50 times sweeter than sucrose) and it too has an unpleasant aftertaste. Somehow saccharine cancels the aftertaste of cyclamate and cyclamate cancels that of saccharine so they are often used together!



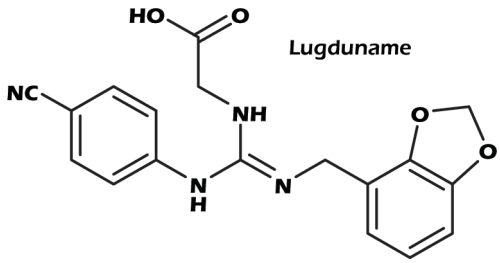
Sodium Cyclamate Molecule

Many amino acids taste very slightly sweet. The methyl ester of the dipeptide aspartylphenylalanine (both as the regular L isomers, see In Depth 9.2 on book page 147) is known as aspartame and is 200 times sweeter than sucrose. It was discovered in 1965 and has become a very popular sweetener in foods and particularly in low-sugar soft drinks.



Aspartame Molecule

Chemists at the University of Lyon set out to make very sweet chemicals and came up with lugduname which probably holds the record as it is 225,000 times sweeter than sucrose. Its odd name derives from the Latin name for Lyon. Should it find a role in foodstuffs it will probably be given a more appealing name.



Lugduname Molecule