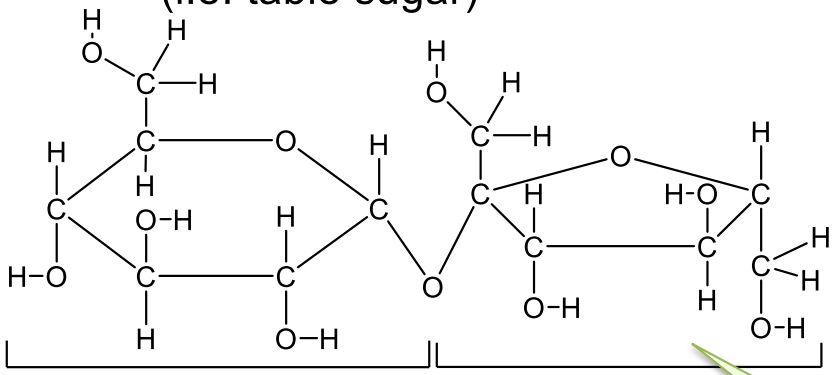
Crystallization

Sugars are sweet

A *dimer* molecule of Sucrose
(i.e. table sugar)



This half of sucrose is made of the *simple* sugar monomer **GLUCOSE**

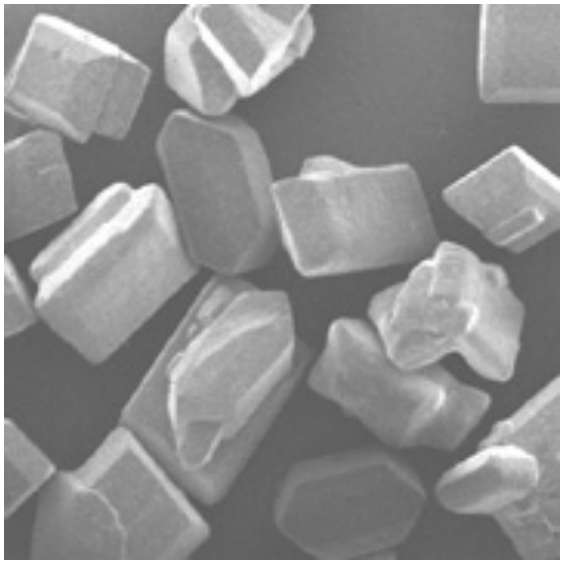
This half of sucrose is made of the *simple* sugar monomer **FRUCTOSE**

Because we perceive simple sugars (like glucose and fructose) *and* dimers like sucrose and lactose as *sweet* – all of these *monosaccharides* and *disaccharides* are commonly called *sugar*.

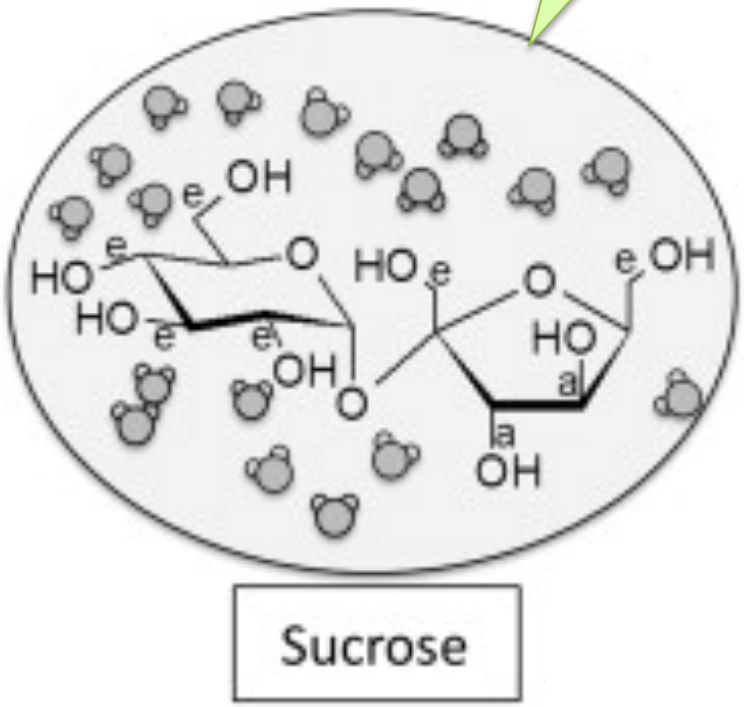
Sucrose is a disaccharide made of one molecule of glucose bound to one molecule of fructose.

Sugars dissolve

Sugar dissolves readily in water



Sugar crystals



Sucrose

The hydrogen bonding capacity of sugars allows them to retain moisture in baked goods. It is this “wet sugar” that forms the sticky matrix that holds granola bars together, and gives glazes a glossy appearance

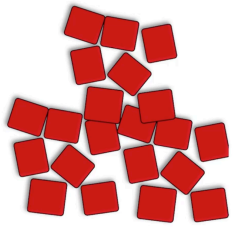
Crystallization

Most sugar is dissolved with small nuclei of crystals.

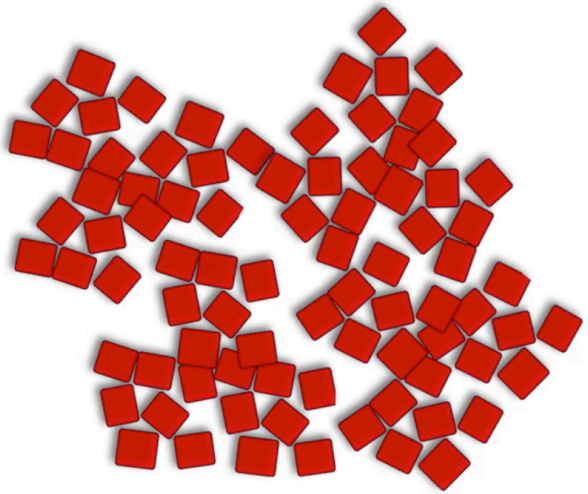
HIGH TEMPERATURE = FEWER CRYSTALS

Little crystals are needed to start crystallization.

- form nucleation sites



LOW TEMPERATURE = MORE CRYSTALS

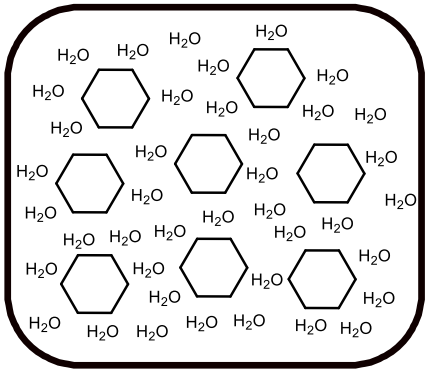


Crystal grows from nucleation sites.

- becomes solid
- has elastic modulus

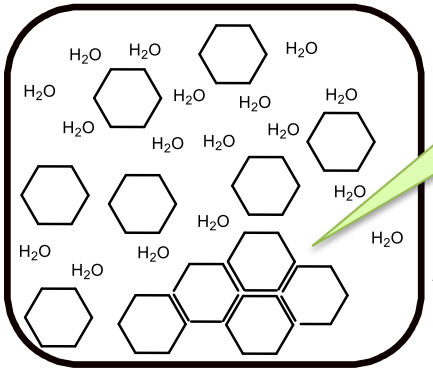
Pure sugar forms crystals

Sugar molecules dissolved and separated by water molecules

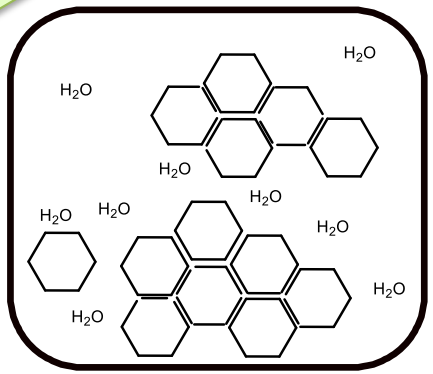


A *syrup*

syrup loses water by evaporation and cools down



more water lost by evaporation

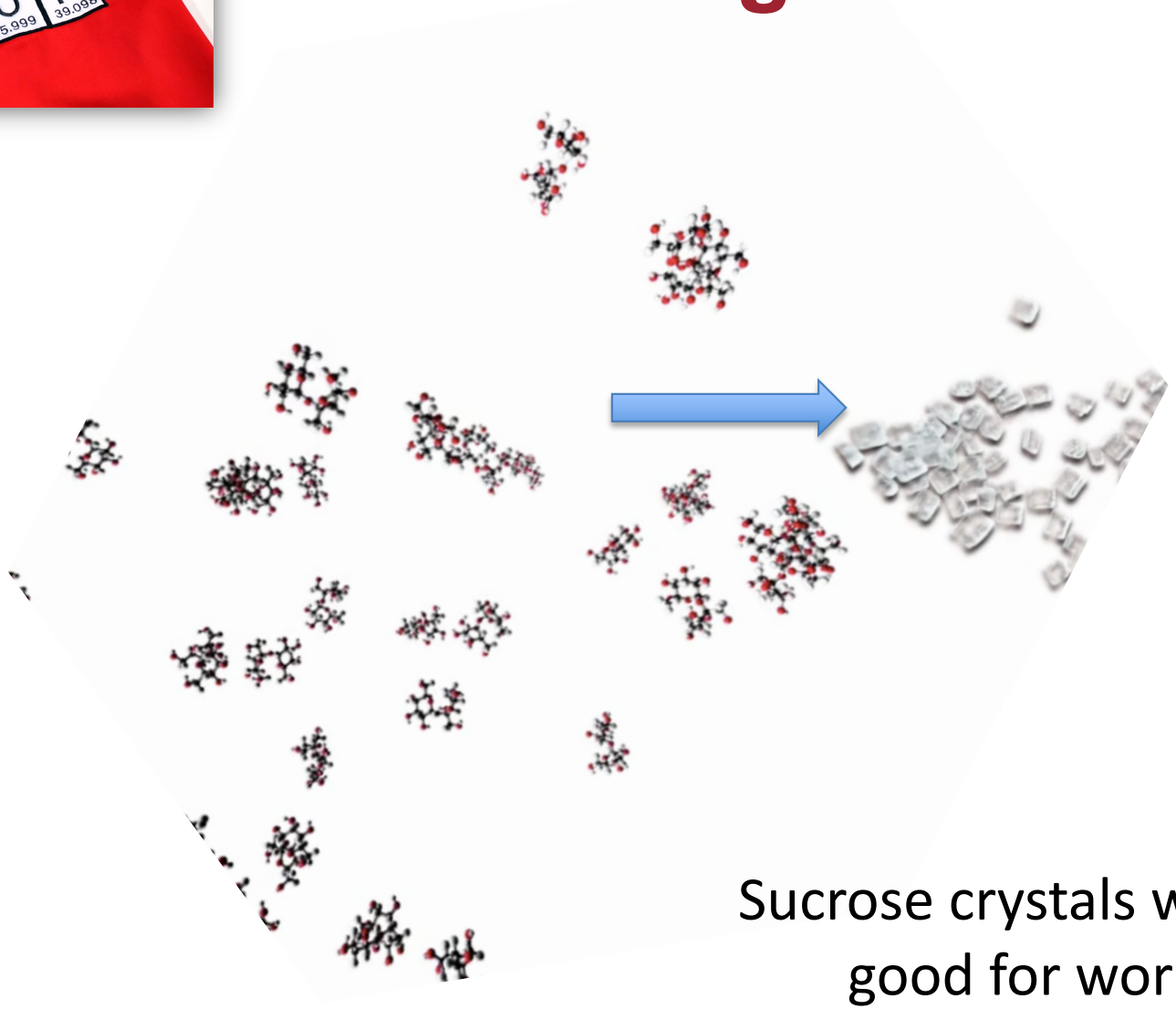


There is less water, so now some sugar molecules are hydrogen bonding to each other to form a crystal

Most of the sugar molecules have crystallized

https://www.youtube.com/watch?v=qLaEdDNHGqc

Cooling sucrose alone

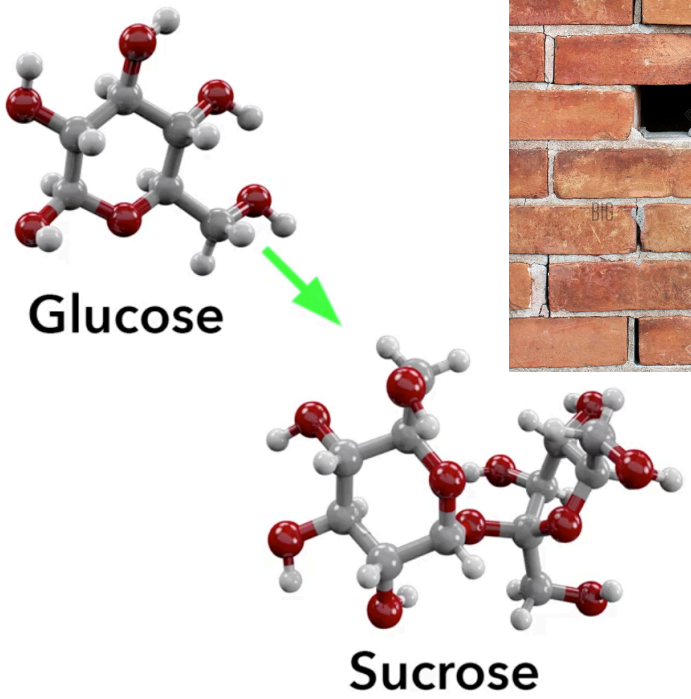


Sucrose crystals will reform…not good for working with sugar

How To Impede Crystallization

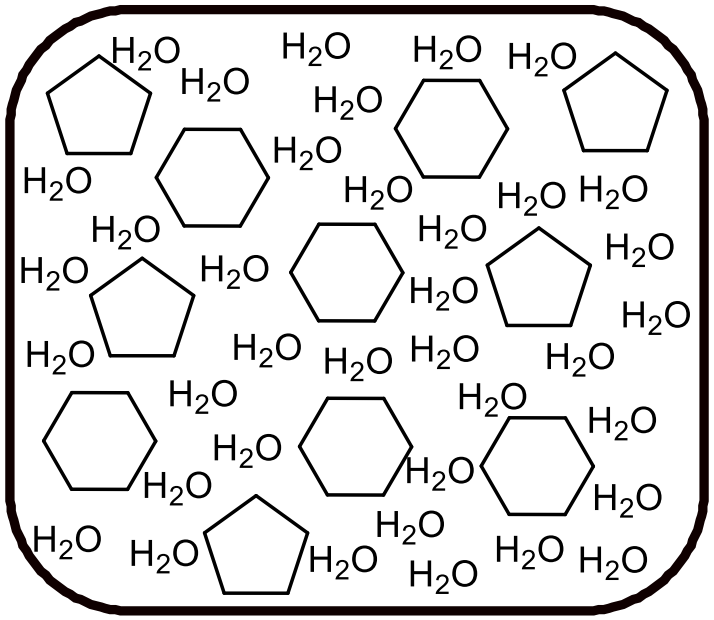
Not as strong a solid = more fluid

How? Add glucose

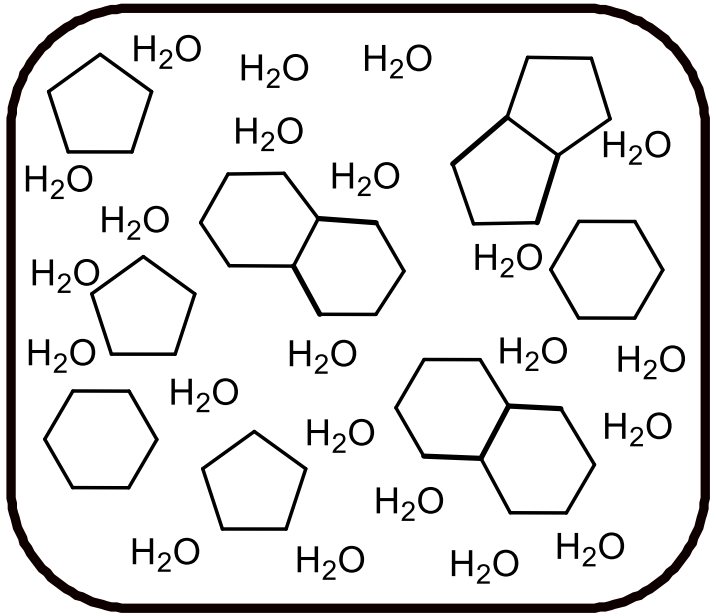


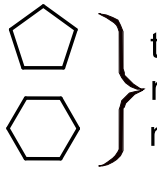
- Glucose is a part of sucrose and will form a solid with it.
- Solid will not be as ordered as sucrose lattice = less strong

Mixture or impure solutions do *not* form crystals



syrup loses water by evaporation or cools down



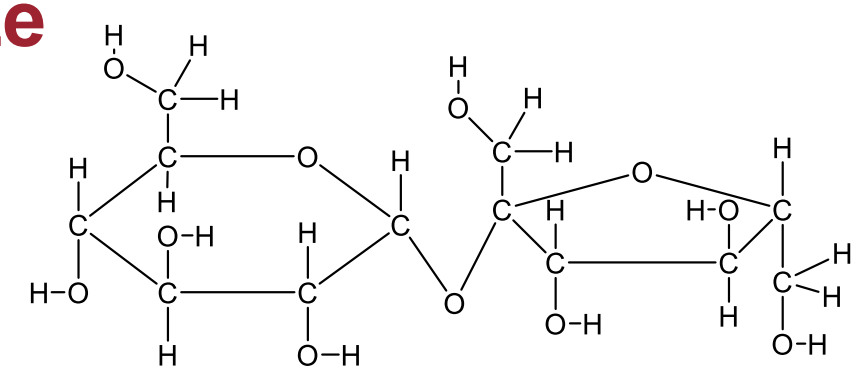


two different kinds of sugar molecules make a *mixture* not a pure substance

With more than one kind of molecule, it is harder for the molecules of one kind to find each other and crystallize. The crystals are smaller, or don't form at all. The different sugars *interfere* with each other's crystallization

Mixtures of sugars don't crystallize easily

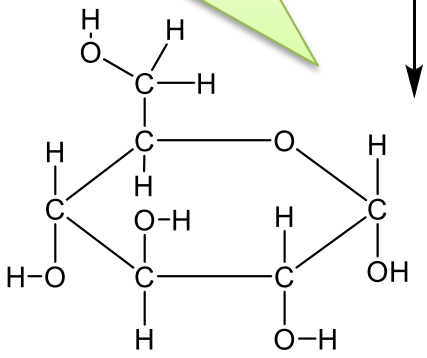
A *dimer* molecule of Sucrose
(i.e. table sugar)



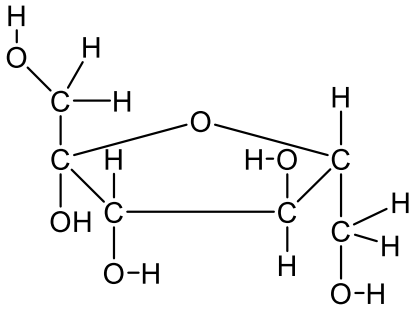
Add a small amount of acid (e.g. lemon juice) to 1 cup of sucrose dissolved in water will break some of the sucrose apart into glucose and fructose – essentially creating *invert sugar syrup* on the spot.

glucose and fructose *isomers*

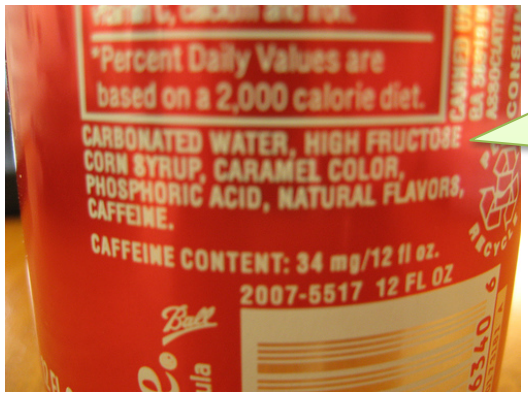
Acid
or
The enzyme *Invertase*



GLUCOSE



FRUCTOSE



Cold beverages are often sweetened with fructose containing syrups to prevent sugar crystals

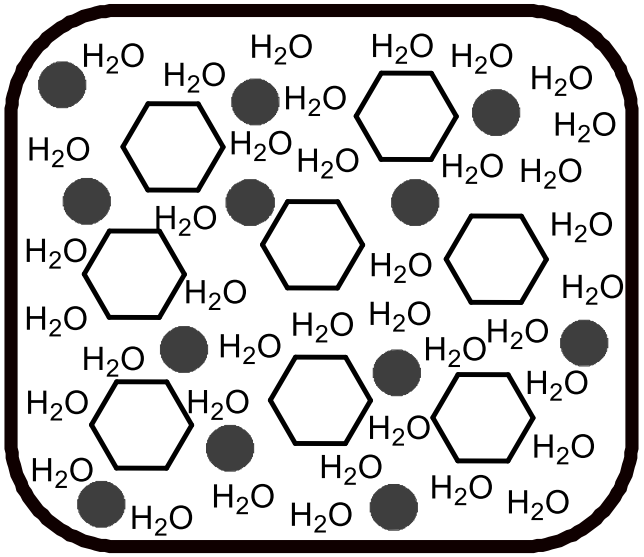
This trick of adding lemon juice to sucrose is a strategy for preventing crystallization of sucrose as in the making of caramel candies.

Fructose is *very* soluble, and the more fructose there is, the harder it is for anything to crystallize.

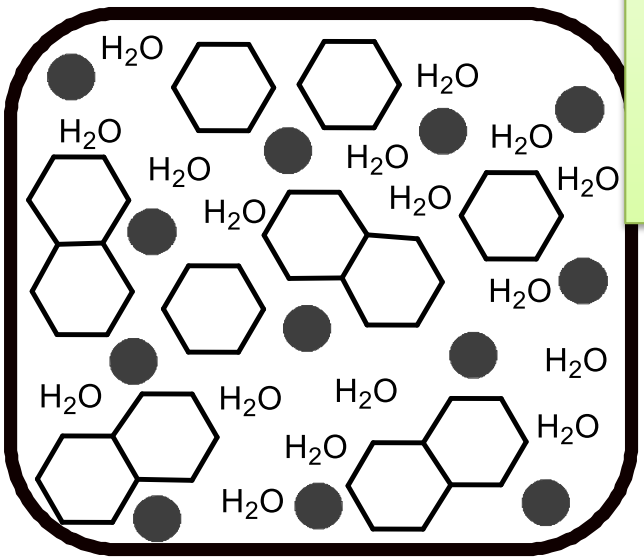
Lots of sugar… but no crystals

Other molecules (like fat, etc) can prevent sugar crystallization by interfering with large crystal formation

Agitating, stirring or beating the sugar solution also interferes with crystal formation



syrup loses water by evaporation or cools down



Sugar molecules dissolved and separated by water molecules and *interfering* molecules like fats or proteins

There is less water, so now some some sugar molecules are hydrogen bonding to each other but the *interfering molecules* get in the way and interfere with large crystal formation

Blown and Pulled Sugar Candy

What characteristics does the sugar need to have to have in order to able to be molded into shapes?

malleable