How Sweet It Is

Chemistry 1010

Review

Where do each of the following sweeteners come from?

sucrose isolated from sugar cane and sugar beets

HFCS made by treating cornstarch with enzymes

aspartame manufactured by combining two amino acids

Match the sweeteners above with their pictures.

HFCS

aspartame

sucrose

	HFCS	aspartame	sucrose
How do they compare in calories?	4 cal/g	4 cal/g	4 cal/g
How do they compare in sweetness?	1.0	1.0	180

Using the following symbols, represent the first two steps of sucrose digestion.

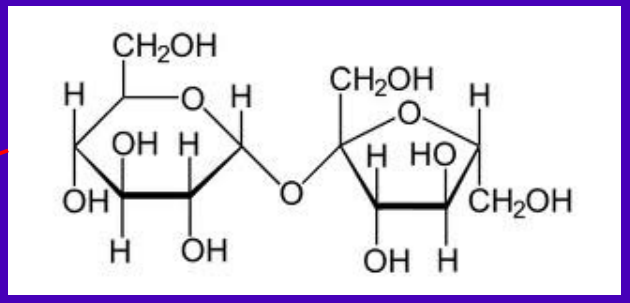
glucose = g

fructose = f

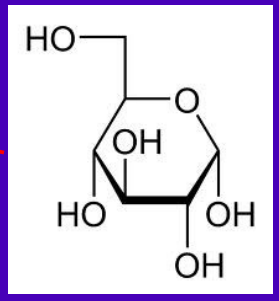
sucrose = g f

g f → g + f → g + g

Match the following compounds with where they occur in the picture.



sucrose (disaccharide)



glucose (monosaccharide)

Using the same symbols, represent the process of making HFCS from cornstarch.

cornstarch = g g g g g g g g g g ….

white powder

not sweet

corn syrup

g g g g g
g g g g g

syrup

not as sweet as sugar

HFCS

g f g f g
f f g g f

syrup

about as sweet as sugar

How does the appearance change during this process?

How does the sweetness change?

Other Sugar Products

How are each of the following related to sugar cane?

powdered sugar

molasses

brown sugar

natural brown sugar

rum

maple syrup

honey

agave nectar

powdered sugar

How is powdered sugar different from table sugar?

still sucrose, but finely ground

What else is it called?

confectioner's sugar, icing sugar

When is it used?

when it needs to dissolve quickly and form a smooth paste

What else is added?

cornstarch – to keep it from absorbing water

molasses

Where does molasses come from?

what is left over after sugar cane juice is boiled and the sugar crystals are removed – still contains some sucrose

What is it used for?

used in baking for its flavor

What is blackstrap molasses?

the 3rd time the syrup is boiled and sugar removed

Does molasses have any health benefits?

it contains vitamin B_6, Ca, Mg, K, Fe

brown sugar

How is brown sugar normally made?

add molasses to table sugar

What is the difference between dark and light brown sugar?

the amount of molasses added (3.5% vs 6.5%)

What is it used for?

used in baking for sweetness and flavor

What is natural brown sugar?

comes from evaporating cane juice

Is it really more healthy than regular sugar?

still mostly sugar, but retains minerals

rum

Where does rum come from?

fermented molasses
yeast and water added, sugar converted to ethanol (12%)
distilled to increase alcohol concentration
aged in wooden barrels

How is rum flavoring used?

cooking (like homemade egg nog)

How is rum used in Australia?

ethanol used as an alternative fuel

maple syrup

Where does maple syrup come from?

comes from the sap of maple trees in Canada and NE US

How is it made?

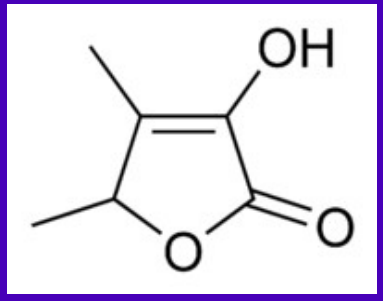
sap is collected, boiled
it takes about 40 gallons of sap to make 1 gallon of syrup
it must be 67% sugar to be called maple syrup

What kind of sugar is in it?

mostly sucrose

How does it compare to pancake syrup?

contains HFCS, corn syrup, flavoring



honey

Where does honey come from?

made by bees, gather nectar and make honey in hives
flavor can vary depending on the type of flower

What sugar does it contain?

38% fructose, 31% glucose, 17% water, 10% other sugars
not table sugar!

How does the sweetness of honey compare to table sugar?

about the same

What do you get if you ferment honey?

mead

agave nectar

Where does agave nectar come from?

produced from several species of agave plants grown in Mexico and Africa

What does it look like?

a thick liquid somewhat thinner than honey
can be light, amber, or dark depending on how much it is processed, with more carmel flavor as it gets darker

What sugars does it contain?

anywhere from 92-56% fructose, 20-8% glucose

How does its sweetness compare with sucrose?

1.4 to 1.6 times sweeter

How can we show the relationship between all of these products?

sugar cane

natural brown sugar

molasses

table sugar

rum

brown sugar

maple syrup

maple trees

pancake syrup
HFCS

corn

honey

nectar from flowers

agave nectar

Agave plants

Notice that all of these products come from plants.

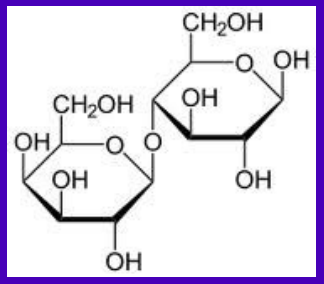




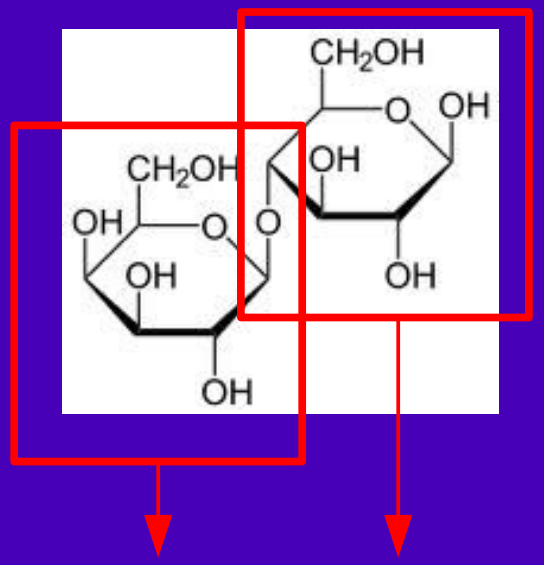

that's what plants do...

Are there any sugars made by animals?

lactose



What kind of sugar is lactose?



disaccharide

galactose glucose

How sweet is lactose?

not very sweet – 0.16

Who is milk intended for? babies

Why are some people unable to drink milk after infancy?

lose the enzyme which breaks down lactose
bacteria have it, digest it to produce gases
this is normal; lactase persistence is a mutation

Non-nutritive sweeteners

Products which do not contribute a significant amount of calories to the diet are called non-nutritive sweeteners.

What are some examples?

aspartame

sucralose

saccharin

stevia

sorbital

xylitol

Some of these are classified as high-intensity sweeteners, while others are bulk sweeteners.

high-intensity sweeteners:

aspartame

180

sucralose

600

saccharin

300-600

stevia

300

bulk sweeteners:

sorbital

0.6

xylitol

1

table sugar, honey, maple syrup, agave syrup, etc are also bulk sweeteners

Some of these compounds are found in nature, while others are produced chemically.

1) natural sweetener

stevia

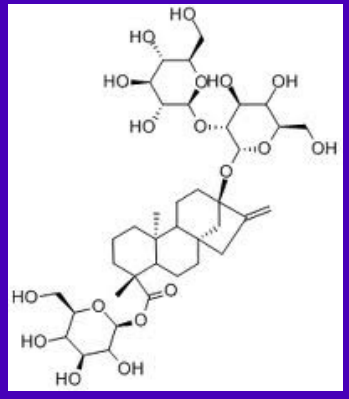
comes from

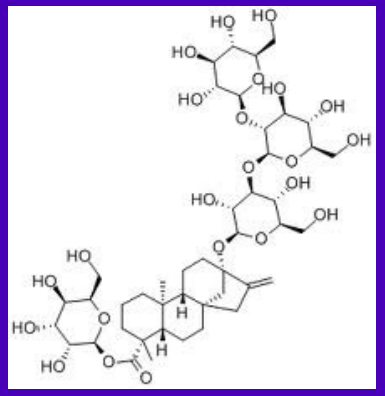
Stevia rebaudiana

contains two sweet compounds

stevioside

rebaudioside A





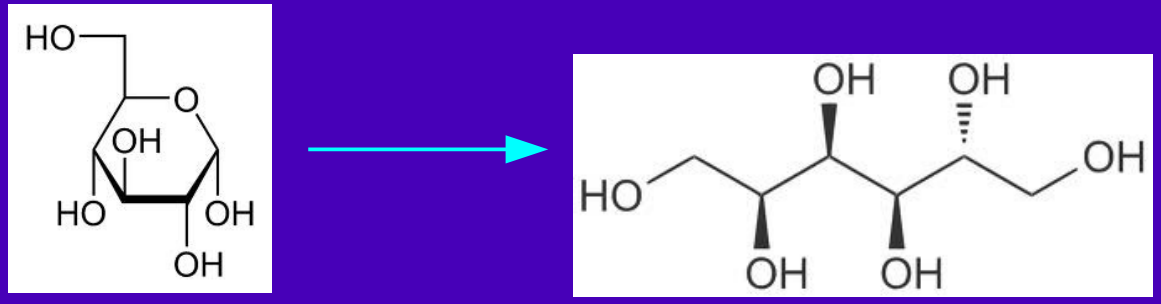
Stevia has been used extensively in Japan and South American, but is slowly catching on in the US.

2) found in nature but obtained by manufacturing

sorbitol

found in fruits such as apples, peaches, pears, and prunes

manufactured from glucose

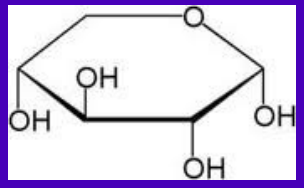


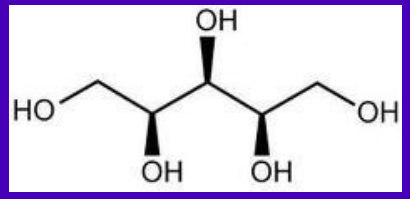
Sorbitol is used in products like mouthwash, toothpaste, mints, and sugar-free chewing gum.

xylitol

found in birch bark, berries, corn husks, oats, and mushrooms

made from xylose (another monosaccharide)





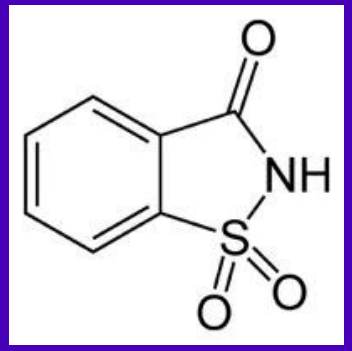
xylose

xylitol

Xylitol is used in toothpaste, mouthwash, and can also be used in baking. It is commonly sold as Xylosweet.

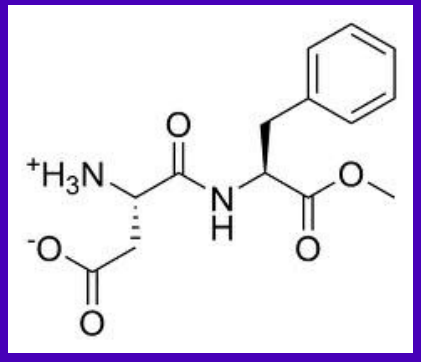
3) artificial sweeteners

saccharin



Saccharin was the first artificial sweetener, discovered in 1879. From 1970-2001 there were warning labels about it causing cancer, but these were lifted when it was found to only affect rats.

aspartame



Aspartame was first synthesized in 1965 and approved for use by the FDA in 1974. The patent expired in 1992.

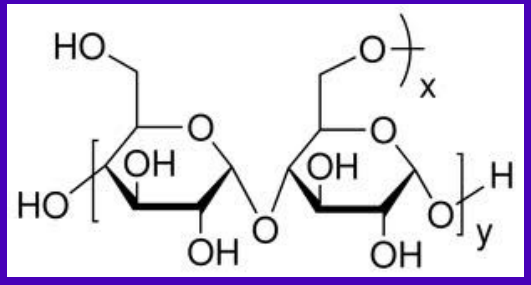
sucralose

Sucralose was discovered in 1976. It is made from sugar, but it isn't digested, and doesn't contribute to calories. It has 3 Cl atoms in place of the OH's in sucrose.

If high-intensity sweeteners are so sweet, how can they be packaged in the same size packets as sugar?

they are mixed with a filler – most commonly maltodextrin

maltodextrin is made from starch, and consists of short chains of glucose (3-19) which are mildly sweet or tasteless



Are any of the non-nutritive sweeteners actually good for you?

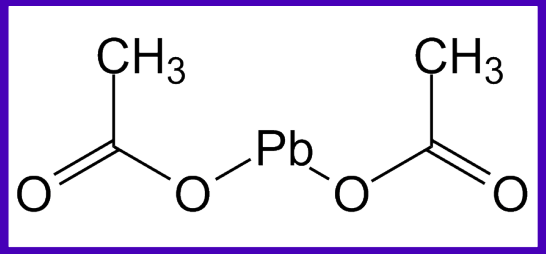
Xylitol can actually prevent tooth decay – which is why it is used in gum, toothpaste, and mouthwash. Chewing xylitol gum has also been found to help prevent ear and upper respiratory infections.

Stevia has been found to improve insulin sensitivity and decrease insulin resistance, and is recommended for those with diabetes. It has been used medicinally in a variety of cultures in South America to treat heartburn and other ailments.

Are there any other sweet compounds that are not used as sweeteners?

yes, hundreds of known compounds
they are either known to be harmful or not yet proven safe

lead acetate $Pb(CH_3COO)_2$ was used by the Romans, contributing to lead poisoning by those who consumed it



ethylene glycol $C_2H_6O_2$ is used as an antifreeze, and is dangerous to children and pets because it is sweet