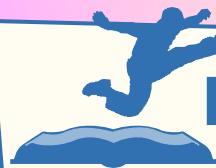


Be an Engineer!

Design your own recipe for lemonade using lemons, sugar, and water. On the basis of what you learned, decide how many lemons and how much water and sugar to use. Make your lemonade and then taste it. Is it too sweet? Too sour? Ask friends to taste your drink. Chart their responses.

Now, revise your recipe. Try to balance the tastes of sweet and sour. Sample the new batch and then ask your friends to taste it. How is it different? Chart their responses. Does everyone perceive sweet and sour the same?

Make your recipe one more time, but this time add a secret ingredient (as long as it's approved by an adult). Can your friends tell what you added? Do they think it improved the taste?



Beyond the Book

Research the pros and cons of using sucralose, an artificial sugar replacement, instead of real sugar.

FOCUS Book

The Science of Lemonade





The Science of Lemonade



FOCUS Question

How does the balance of chemicals
in lemonade affect how it tastes?

Scale, Proportion, and Quantity

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Tasty Chemistry

Gulp, gulp, gulp . . . aaah! You just drank an ice-cold glass of lemonade. Alone, lemons are sour enough to make your face pucker. But lemonade is just the right mixture of tangy and sweet. What makes this lemony liquid so yummy?

That delicious taste comes from the chemicals in the basic ingredients of fresh lemonade: water, lemons, and sugar. You might drink premixed lemonade from a carton or mix water with a powder or frozen concentrate. Those types of lemonade may taste a little different because of other added ingredients. But the final product is still a combination of chemicals that gives your tongue a treat.

The chemicals in these ingredients create a tangy yet sweet drink.





Read-Think-Write

Write your answers on separate paper. Use details from the text as evidence.

- 1 Is lemonade a heterogeneous solution?
Why or why not?
- 2 According to the text, why do the ingredients in lemonade stay mixed together?
- 3 How do citric acid and sucrose react to form a sweeter solution than sucrose alone? Use details from what you read.
- 4 How do we recognize the different tastes in a glass of lemonade? Include details from the diagram on page 7.
- 5 How are fresh lemonade and lemonade mix the same? How are they different? Use examples from the text.



FOCUS Question

How does the balance of chemicals in lemonade affect how it tastes? Imagine you made lemonade and put in too much sugar. How would this affect the taste, and why? How could you balance the flavors?

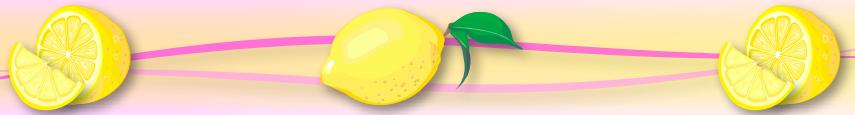


That glass of lemonade tasted so good, you make another one. Following your recipe, you measure the right amounts of water, lemon juice, and sugar. You then combine the liquids and solids in a glass. You stir a few times and take a drink. Wait! That's not lemonade! The sugar has not dissolved and has mostly settled to the bottom. You have made a heterogeneous (HEH-tur-o-JEE-nee-us) mixture, which means the parts are still separate.

Stir until the sugar dissolves and the clear water turns yellow. Now you have stirred up a lemony, sweet solution. All the ingredients mixed together evenly to make a homogeneous (HO-muh-GEE-nee-us) mixture. Your last sip will taste the same as your first. Also, it would be difficult to separate the ingredients. This is lemonade!



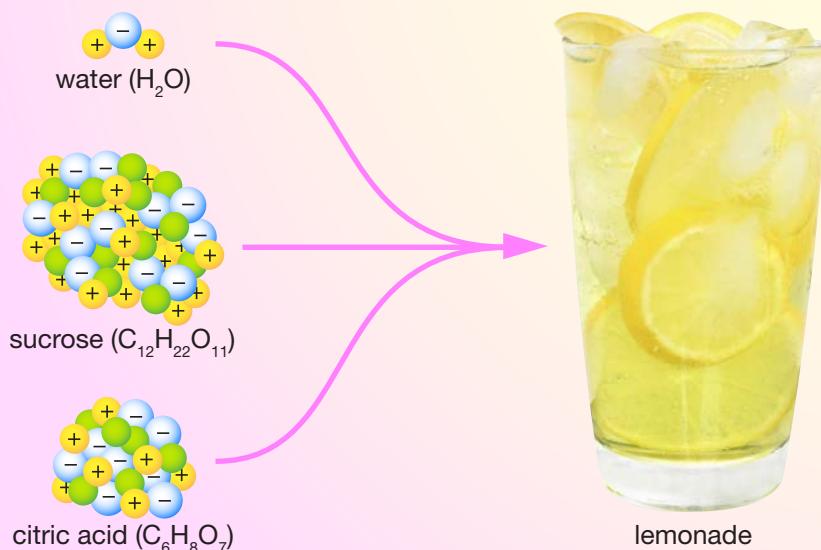
To make tasty lemonade, mix the ingredients until you have a homogeneous mixture.



What's Happening in the Glass?

Your three ingredients form a well-mixed solution because of the attraction between their atoms. Atoms that have negative charges connect, or bond, with atoms that have positive charges.

A water molecule has two hydrogen atoms (slight positive charge) and one oxygen atom (slight negative charge). Sugar, or sucrose, also has hydrogen and oxygen atoms with slightly positive and negative charges. When you add sugar to water, the atoms in the two substances are attracted to each other. The natural citric acid from the lemon juice has atoms with positive charges that are attracted to the negative charges in the water molecules. All these bonded atoms form a sweet-tasting solution.



How Sweet It Is!

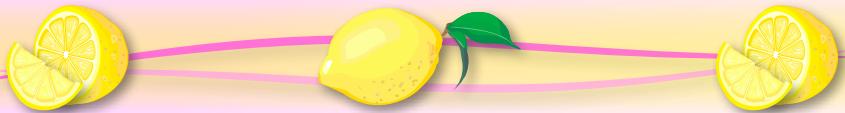
Some people stop using sugar to avoid extra calories and prevent tooth decay. Others may become sick if they eat sugar. Many different sugar replacements can make lemonade sweet. Stevia is a natural sweetener that is three hundred times sweeter than sugar. Sucratose is an artificial sweetener that is six hundred times sweeter than sugar.

Taste buds detect the atoms of artificial sweeteners just as they do with sugar. The brain recognizes them as sweet. But sucrose also triggers the parts of the brain that say, “I’m satisfied.” No matter how sweet they are, artificial sweeteners don’t get that reaction. This can possibly lead to drinking too much lemonade. Maybe you really can get too much of a good thing!



Artificial sweeteners are used in many types of food and drinks, such as sodas, gum, and ice cream.

Natural sweeteners, like stevia, are made from plants.



It's Still Lemonade . . . or Is It?

Fresh lemonade is great if you have the time. For a quick lemony fix, many people use a lemonade mix. Just add water and stir. These powders include sucrose, just like fresh lemonade. They also contain citric acid, but only a tiny amount compared to fresh lemonade. Instead of using lemons, there may be natural and artificial lemon flavorings. Mixes also have chemicals to prevent clumping and to stay fresh. Many drink mixes also use food coloring to make the drink look yellow or pink.



Lemonade mixes can also come in different flavors, such as strawberry or raspberry lemonade.



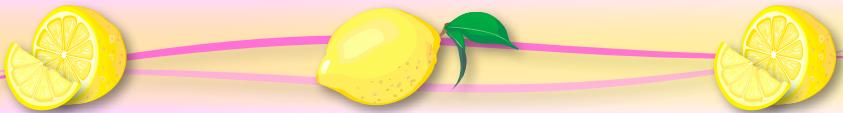
Sweet over Sour

The tangy, sweet taste of lemonade is due to the citric acid and the sucrose at work. In water, sucrose (sugar) begins to break down into two different molecules, glucose and fructose. Citric acid molecules from the lemon juice speed up this process. The newly released fructose is sweeter than sucrose, so now the lemonade tastes sweeter.

Sometimes it takes a few tries to get the right balance of sweet and sour when you're making lemonade. Sucrose is a good flavor suppressor. It overpowers other flavors, especially the sourness of citric acid. Sucrose also resists being overpowered by other flavors. It is a good idea to follow a recipe closely so you don't make lemonade that's too sweet.



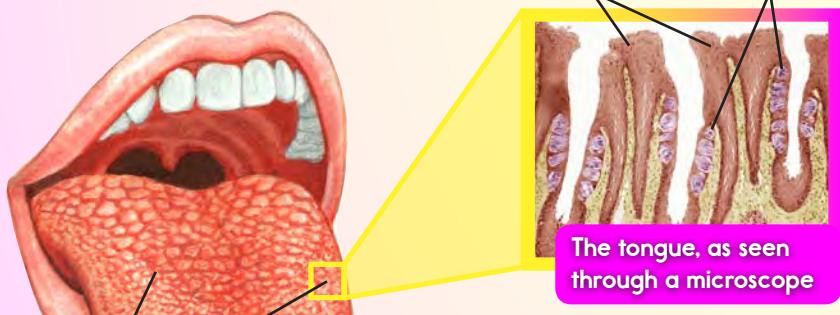
The sour citric acid in lemons is what makes your face pucker.



Taste, the Tongue, and the Brain

Remember that first sip of lemonade? You tasted it with your tongue, but your brain told you what flavor you were sensing. Inside your mouth are about five to ten thousand taste buds that detect chemicals. The more taste buds you have, the more sensitive you are to tastes, especially bitter tastes.

Most of your taste buds are located on the bumps, or *papillae* (puh-PIL-ee), that cover your tongue. Each taste bud has special detectors for five different types of tastes: sweet, sour, salty, bitter, and *umami*. (*Umami* is the taste that is found in foods such as meat, tomatoes, and soy sauce.)



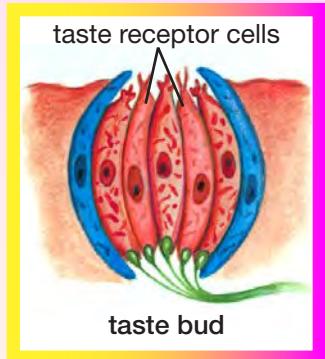
Fact or Fiction?

Taste buds can also be found at the back of the mouth and elsewhere in your throat.

People once believed that the tongue had specific areas for each taste. But in fact, all parts of the tongue can sense many different tastes.



Tiny hairlike parts at the edges of each taste bud detect sugar and citric acid molecules in the lemonade. A single taste bud has fifty to one hundred taste receptor cells that each detect different chemicals. This is how you can tell so many tastes apart.



A taste receptor cell detects hydrogen atoms in citric acid and sends a chemical message to the brain. Your brain tells you, “This is sour.”

Meanwhile, a sugar molecule attaches to a different taste receptor cell. This cell sends a different chemical signal to the brain. Your brain tells you, “This is sweet.”

All these signals and messages happen instantly the moment the lemonade touches your tongue.

Do You Know?

Our ability to detect bitter taste may have developed to help protect us from eating poisonous plants, which often taste bitter.

THE SENSE OF TASTE

