



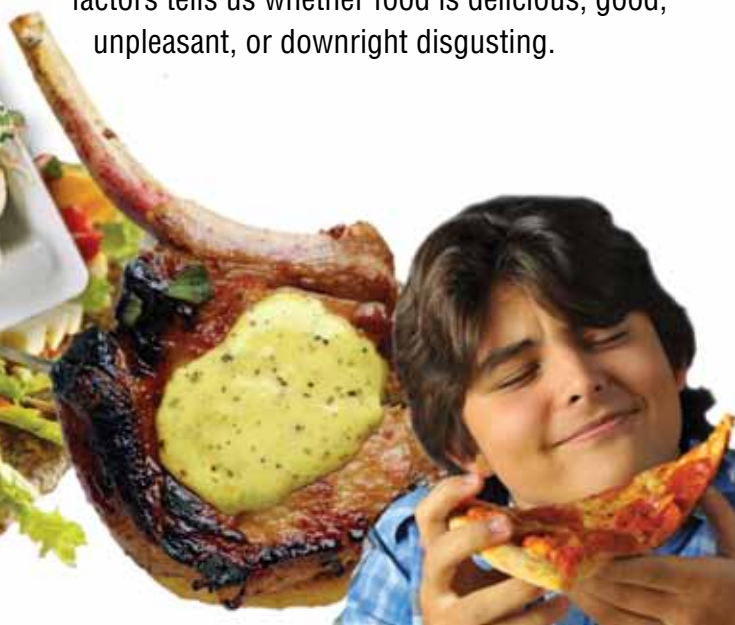
# Mmmm...

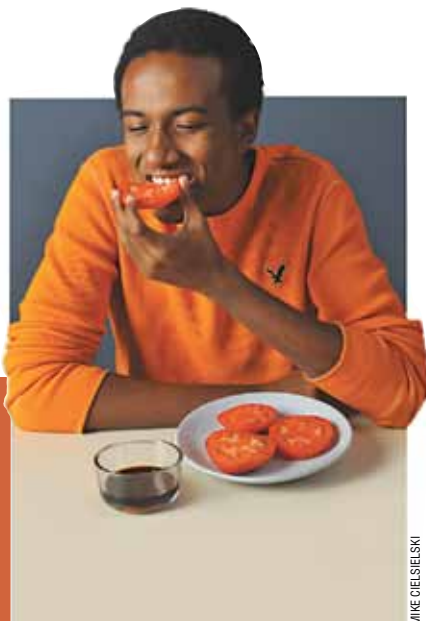
# Flavorful Food!

By Renée Heiss

**W**hy do people have different reactions to the same food? One person may love chocolate while another may find it too sweet. Some people love cheese while others find its taste and smell unappealing. And some people always want vanilla in their ice cream while others would rather avoid vanilla and choose another flavor instead.

The reason for these differences is due in large part to the taste of food, but there are other factors, too. The smell of food, its texture, its color, and its temperature also contribute to what is more generally known as the “flavor” of food. The combination of all of these factors tells us whether food is delicious, good, unpleasant, or downright disgusting.





## Why we enjoy food

The flavor of food is due mostly to how it tastes and smells. When you eat, the most immediate sensation is taste. But you actually smell food, too. If you hold your nose while you eat, you will notice that some foods will taste different.

There are five taste sensations: sweet, bitter, sour, salty, and umami. The umami taste was formally recognized in 1985 after scientists debated for a long time about whether umami was a basic taste. In 1985, they agreed that umami was the fifth basic taste. It is associated with savory foods, which include meat, tomatoes, and a food additive called monosodium glutamate.

Smell is as important if not more important than taste. For instance, when people who have a head cold try to taste salsa and chips, they feel the textural crunch of the chips and the tingle of the hot peppers on their tongues, but they cannot taste the flavor-rich salsa with its onions, tomatoes, and peppers because they cannot smell it.

When we chew, aromas are released that activate our sense of smell by way of a special channel that connects the back of the throat to the nose. If this channel is blocked, such as when our noses are stuffed up by a cold or flu, odors cannot reach



sensory cells in the nose that are stimulated by smell. So, we don't enjoy foods the same way. Without smell, foods tend to taste bland and have no flavor.

Smelling food is different from smelling roses. To smell a rose, you would bring the flower close to your nose and inhale the flowery scent. To smell food, the aromas either go directly through your nose or enter the back of your nose—as you chew and swallow food, in which case the aromas add to the flavor of food.

Taste and smell contribute only partially to the flavor of food—other factors include texture (crunchy or soft food) and temperature (hot or cold food). For instance, some people like to put fruit in the fridge and eat it cold while others prefer to eat fruit at room temperature. And some people would only eat cooked carrots while others like to eat them raw.

Also, the color of food can affect its flavor. Dark red beverages need less sugar to achieve an acceptable level of sweetness because people perceive dark beverages to be naturally sweeter. In this case, what you expect influences the taste of food.

In a classic experiment, French researchers colored a white wine red with an odorless dye and asked a panel of wine experts to describe its taste. The experts described the wine using typical red wine descriptors rather than terms they would use to evaluate white wine, suggesting that the color played a significant role in the way they perceived the drink.

The flavor of food also changes depending on how it is prepared or cooked. Take tomatoes, which have a soft texture and are bought in the store at room temperature. Add garlic,

oregano, salt, and pepper, cook them for a while, and you have spaghetti sauce. Dry the tomatoes, and you get crunchy sun-dried tomatoes. Refrigerate them, and you can chop them into a salad. The possibilities are endless, and the flavor is different each time.

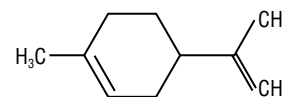
## Natural and artificial flavors

Lots of chemical compounds contribute to the flavor of food. Chocolate, for instance, is a mixture of some 300 flavor compounds; vanilla comes from about 300 chemicals mixed together; and coffee beans contain more than 800 chemicals. Identifying these chemicals can help create a variety of artificial flavors that are used in nearly every food product available in a grocery store, including potato chips, ice cream, chewing gum, and soft drinks.

Chemists create artificial flavors from the chemical compounds present in plants and animals. They use them in their natural state, or they process them to make new flavors.

They also create concentrates by extracting the juice of fruits, such as oranges and lemons. They remove the water from the juice, and the concentrated orange or lemon juice goes into cans. You can later add water to reconstitute the juice.

What's interesting is that we don't need all the flavor compounds in a given food to re-create its flavor. For



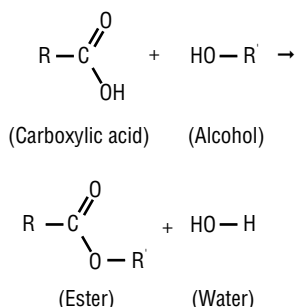
Limonene

instance, an orange contains 250 flavor chemicals, which all combine to create an orange flavor. But artificially flavored Tang, a powdered drink mix, contains only six aromatic chemicals, yet it has an orange-like taste. So, we can re-create a good orange flavor by combining only a handful of the most abundant or most strongly flavored compounds present in an orange.

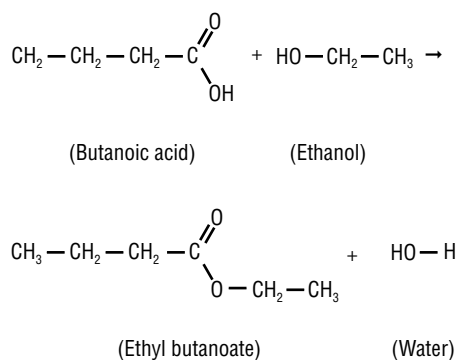
Also, the same flavor may not work in different types of food and beverages. For instance, the lemon-lime flavor that works in

candy might not work in a soft drink. A lemon-lime candy might contain lemon and lime oils, which are extracted from the skin of lemon and lime. These substances are 90% limonene. But limonene cannot be used to make lemon-lime soda, because it is not soluble in water. So, lemon-lime soda contains a mix of different flavor chemicals that also give it a lemon-lime flavor.

Artificial flavors get their characteristic odor from various compounds, particularly esters—chemical compounds formed by the chemical reaction of an alcohol with a carboxylic acid. An alcohol is an organic compound with the general formula R–OH, in which R is a hydrocarbon group and –OH is a hydroxyl group. A carboxylic acid is a compound with the general formula R–COOH. The formation of an ester molecule occurs through the following reaction:



For example, the formation of ethyl butanoate, one of the compounds that give pineapple its flavor, is produced through the reaction of butanoic acid with ethanol, as follows:



If you use different alcohols and different acids, you can obtain different flavors. You can compare that to combining two colors of paint. When you combine red with yellow, you get orange. Similarly, when you combine pentanol with acetic acid, you get pentyl acetate, an ester that smells like a banana. Table 1 lists some of the many acids and alcohols that

are present in a fruit salad that contains pineapples, oranges, grapes, and pears.

But wait. Isn't ethanol the type of alcohol found in alcoholic beverages? It sure is, but when it combines with the acid, it loses the characteristics of drinking alcohol. Likewise, acetic acid is the main component in vinegar. Yet, when it reacts with an alcohol, the flavor changes dramatically. When two compounds react to form a new compound, the properties of the new compound are not a simple combination of those in the original one. They are completely different.

Flavor chemists combine many chemicals to achieve a desired scent. Day after day, they test different combinations before settling on the one that will achieve the desired result. To achieve what they perceive to be the smell of pineapple, chemists combine different acids and alcohols.

But don't expect to take a tour of a flavor and fragrances factory. Those companies

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## Where else do you find esters?

Esters are not only responsible for the flavor of food but also for the smell of everyday products. At home, you may have washed your hands with pomegranate-scented soap. Maybe you chewed peach-flavored gum on your way to school. Perhaps the carpets at school were vacuumed with melon-scented powder. And then maybe one of your female classmates wore perfume that day that smelled like apple. These are all examples of esters in action!

So, as you go through your day, take some time to smell the soap, the hand cream, and the fruits and vegetables at lunch. These flavors are actually an important part of our daily lives, even if we don't realize it! *CM*



Check out the video podcasts on flavorful food at: [www.acs.org/chemmatters](http://www.acs.org/chemmatters)

Alcohol	Acid	Ester	Odor
Ethanol	Butanoic acid	Ethyl butanoate	Pineapple
Octanol	Acetic acid	Octyl acetate	Orange
Ethanol	Heptanoic acid	Ethyl heptanoate	Grape
Pentanol	Butanoic acid	Pentyl butanoate	Pear

Table 1. Flavor compounds present in a fruit salad.

carefully guard their secret ingredients unless you do the following. First, you will need a degree in organic chemistry and a successful job application. Then, you train for 5 years to learn how to synthesize flavor chemicals, but still without learning the secret flavor ingredients. At the end of those 5 years, you must pass a test to become a junior flavor chemist for 2 years. When you complete your apprenticeship, you take another test, and when you successfully pass that test, you finally become a senior flavorist. At that point, you will finally learn the secrets of the company that hired you 7 years earlier.

### SELECTED REFERENCES

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