

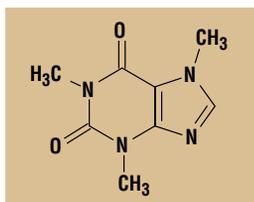
There is a word for you: “chocoholic,” when you *need* chocolate. Nothing else will do. Just thinking about hot fudge drizzling over ice cream raises your spirits. You crave a truffle, a Kit-Kat, a mug of velvety hot cocoa. Few, if any, other foods evoke such passion.

So what is unique about chocolate? Recent scientific findings are providing new evidence that chocolate may be healthier than is usually assumed.

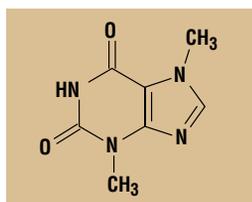
## So many good chemicals ...

One of the reasons chocolate is unique is the temperature at which it melts: between 94 °F and 97 °F. A morsel of chocolate slides across your tongue and liquefies into a perfect puddle of taste sensation. The human body, at 98.6 °F is just above the chocolate’s melting temperature. “Melts in your mouth”? Definitely true.

Chocolate contains more than 300 chemicals. Caffeine, a stimulant, is the most well known, but it is present only in small amounts. Another stimulant is theobromine, found in amounts slightly higher than caffeine. The two molecules are identical except for one methyl group (CH<sub>3</sub>), but it is not yet clear how they act together in chocolate.



Caffeine



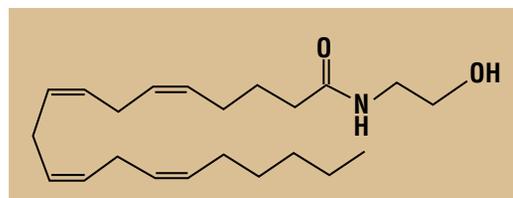
Theobromine

Another chemical known to make us happy when we eat chocolate is anandamide, so named because it means “bliss” in Sanskrit. Not only is it present in chocolate, but it is also produced by the brain and blocks out pain and depression.

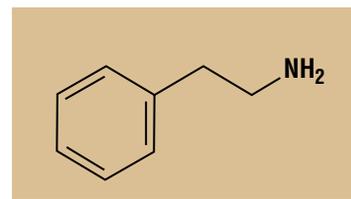
But when anandamide is produced by the brain, it is broken down quickly, so its effects don’t last. Emmanuelle diTomaso, an assistant biologist at Massachusetts General Hospital, Boston, Mass., and Daniele Piomelli, professor of pharmacology at the University of California-Irvine, have shown that chemicals in chocolate may inhibit this natural breakdown of anandamide. This means that when you eat chocolate, anandamide molecules from chocolate stay in the body longer.



MIKE CIESIELSKI



Anandamide



Phenylethylamine

ALL STRUCTURES: CESAR CAMINERO



By Gail Kay Haines



MIKE CIESIELSKI

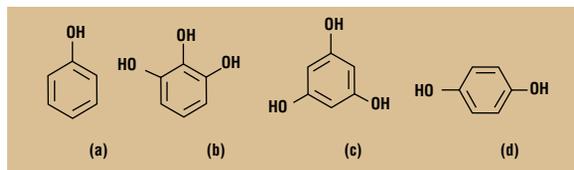
Then, there is phenylethylamine (PEA), a natural brain chemical which stimulates the parts of the brain that keep you alert and mimics the brain chemistry of a person in love.

## Is chocolate healthy?

Recent studies have explored chemicals in chocolate called polyphenols, which belong to a larger group of chemicals called antioxidants. These chemicals protect cells against damage from free radicals—atoms, molecules, or ions with unpaired electrons.

Inside cells, free radicals damage DNA and have been associated with Alzheimer's disease, heart disease, and cancer. Antioxidants prevent this damage from happening by blocking the action of free radicals and may therefore reduce the risk of being affected by these diseases.

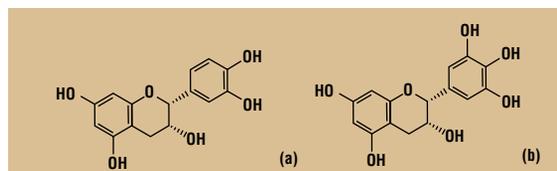
Antioxidants work by slowing or preventing a chemical reaction called oxidation, which can produce free radicals. Antioxidants terminate this reaction by preventing free radicals from being formed. Examples of antioxidants include thiols, which are organic compounds that contain a functional group composed of a sulfur atom and a hydrogen atom (-SH) and polyphenols, which are organic compounds that contain OH groups attached to six-membered benzene rings.



Phenol (a) and three examples of phenol derivatives: pyrogallol (b), phloroglucinol (c), and hydroquinone (d). These molecules are components of large molecules called polyphenols.

The health benefits of some polyphenols—such as quercetin, which is found in citrus fruit, buckwheat, and onions—are well established, while other polyphenols' health effects are still being investigated. The largest and best studied group of polyphenols are the flavonoids, a group of several thousand compounds present in various fruits, vegetables, and chocolate.

Joe Vinson, professor of chemistry at the University of Scranton, Pa., and his research students have found that polyphenols in chocolate have



Examples of flavanols: epicatechin (a) and epigallocatechin (b).

beneficial effects against heart disease. The scientists showed that cocoa polyphenols acted as antioxidants in the body, compared with coconut butter and sugar alone. Also, the scientists discovered that in hamsters, cocoa powder at a dose equivalent to two dark chocolate bars per day significantly inhibited atherosclerosis, a type of heart disease in which fat clogs up arteries, and raised the levels of good cholesterol.

Cocoa is especially rich in chemicals called flavanols, which are flavonoids also found in tea, wine, and nuts. Ian McDonald, professor of metabolic physiology at The University of Nottingham, and colleagues have shown that people who consumed a flavanol-rich cocoa beverage had increased blood flow in their brains. This result suggests that cocoa flavanols could be used to prevent vascular impairments in the brain resulting from, say, a stroke.

Norman Hollenberg, professor of medicine at the Harvard Medical School and Brigham and Women's Hospital, and colleagues have observed that the consumption of a flavanol-rich cocoa beverage also increases the amount of nitric oxide in the blood vessels, allowing them to dilate and stay pliable. This result suggests that cocoa flavanols could also be used to improve heart health.

Also, Juan Carlos Espin de Gea, a senior research scientist at the Spanish Research Council in Murcia, Spain, and colleagues are working on processing the cocoa beans differently to include the flavonoids usually lost in the processing of the beans. They asked six volunteers to consume a milk beverage made with flavonoid-enriched cocoa and later to drink chocolate milk made from traditional cocoa. When they drank the flavonoid-enriched cocoa, these volunteers had eight times more of

antioxidants epicatechin and procyanidin B2 than when they drank regular chocolate milk.

Another piece of good news: You might think that chocolate causes acne, decays teeth, and makes you fat. Not so. No current research connects specific foods to skin problems. Chocolate husks contain chemicals that prevent tooth decay (although they don't offset the added sugar), and too much food causes weight gain.

But how about all this saturated fat, usually blamed for the ills of chocolate? Let's look at how chocolate is made to understand why chocolate is not *totally* healthy.

## How chocolate is made

The cacao beans used to make chocolate come from a tree called *Theobroma cacao* (food of the Gods) that is cultivated in the tropics. Tiny flies called midges pollinate the



trees, and each pod contains 20 to 60 seeds in a sweet pulp. The pods are removed from the tree, split with a machete, and the pulp and beans are removed and fermented under banana leaves in the sun.

Then, the sugary pulp breaks down, heating the beans. Many chemical changes take place, affecting flavor, aroma, and color. The rich cocoa aromas develop, and the beans change from purple to chocolate brown. After fermentation, the beans are dried on bamboo mats or wooden floors.

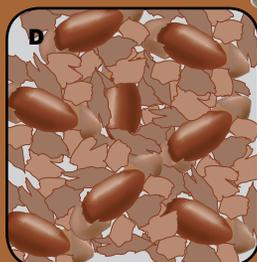
These dried beans are shipped to the manufacturing plants, where they are cleaned, sorted, and roasted. This roasting loosens the bean shells so they can be easily removed. What is left are dark chips called nibs, which are crushed



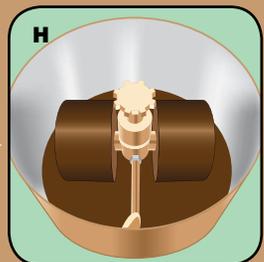
MIKE DIEBELSKI



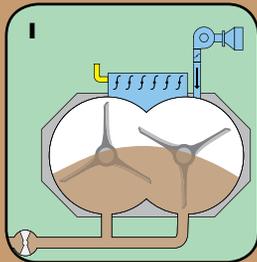
Cocoa beans are cleaned and roasted



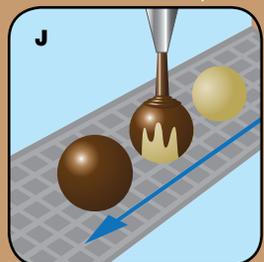
The beans' shells are removed



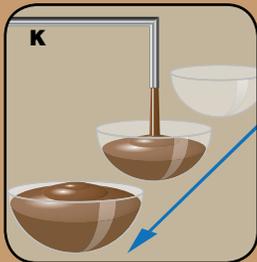
Chocolate liquor is mixed with sugar and cocoa butter (and milk for milk chocolate)



The mixture is stirred in a tank with more cocoa butter



Enrobing process \*\*



Molding process \*\*\*

to form a liquid paste called chocolate liquor.

To make dark, semisweet, and bittersweet chocolates, nibs and sugar (and sometimes additional cocoa butter) are mixed together for up to 72 hours to further smooth and blend all particles, creating creamy chocolate.

So here's the bad news: Cocoa butter is essentially all fat. There are three major kinds: a "bad-for-you" saturated fat called palmitic acid; oleic acid, a heart-healthy monounsaturated fat; and stearic acid, part of which later converts to oleic acid in the liver. Overall, one-third of chocolate's fat is known to be unhealthy. All three kinds of fats produce high amounts of calories in the body, although they do not cause an increase in blood cholesterol when consumed in chocolate.

Here's the good news: Chocolate straight from the tree has more beneficial chemicals than possibly any other food, including blueberries, red wine, or green tea. They are not only antioxidant, but anti-inflammatory, anti-allergic, anti-cancerous, and anti-viral.

So why is chocolate often rated junk? It's all in the processing. Processing determines whether chocolate is a healthy food or a high-calorie indulgence. Roasting and fermenting tends to decrease the amount of antioxidants. Food stores sell mainly milk chocolate, with sugar, milk, and extra cocoa butter added because they taste good, but the more noncocoa items are added to cocoa, the more dilute the healthy chemicals become.

## Making healthier versions of chocolate

W. Jeffrey Hurst, principal scientist at Hershey Co., Hershey, Penn., and colleagues have compared the amount of antioxidants in cocoa-containing products. The products they considered were natural cocoa, unsweetened baking chocolate, dark chocolate, semisweet baking chips, milk

chocolate, and chocolate syrup. They discovered that natural cocoa contains the most antioxidants, followed by baking chocolates, dark chocolates, baking chips, and finally milk chocolate and syrups, when compared on an equal weight basis. So if you want to consume a lot of chocolate, you may be better off choosing natural cocoa or dark chocolate rather than milk chocolate or chocolate syrup.

Over the past two decades, various candy makers—including The Hershey Co. and Mars, Inc.—have been trying to use this scientific knowledge by making chocolate-based candies that are high in antioxidants and flavanols. The most recent trend is "premium" chocolate, often made of top-quality beans with high cacao content, no milk, and fewer additives.

Scientists may even be able to modify the genes of the cocoa tree in the future. Last June, Mars, Inc., partnered with IBM and the U.S. Department of Agriculture to launch a five-year project to unravel the genome of the cocoa bean. The team of scientists from these three institutions may find ways to make the cocoa tree more resistant to pests and disease and provide healthier, more nutritious, and better-tasting chocolate.

Want the most for your calories? And your dollars? Check out the nutrition information on the labels. The fewer additives, the better. Meanwhile, dark chocolate or chocolate nibs are a healthy alternative to milk chocolate or chocolate syrup.

So, is chocolate a healthy food, a luxury item, or junk? It can be all three, just not all at the same time. The choice is yours. Go easy! Go dark! Go chocolate! ▲



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### SELECTED REFERENCES

- Beckett, S. P. *The Science of Chocolate*, 2nd ed; The Royal Society of Chemistry: Cambridge, UK, 2008.
- American Chemical Society: The Elements of Chocolate [http://acselementsofchocolate.typepad.com/elements\\_of\\_chocolate/](http://acselementsofchocolate.typepad.com/elements_of_chocolate/) [February 2009].
- The Exploratorium, Science Museum in San Francisco: The Sweet Lure of Chocolate [http://www.exploratorium.edu/exploring/exploring\\_chocolate/](http://www.exploratorium.edu/exploring/exploring_chocolate/) [February 2009].

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