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Ask a Scientist: What does the word “chemical” mean?

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Courtesy of The University of Tennessee, Knoxville.

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I once had a plumber tell me to never use Drain-O because it was “just a bunch of chemicals made by scientists in a lab.” As if being a chemical made in a lab was condemning enough to not require any further explanation. This is a sentiment a lot of people share: chemicals are bad. But what, exactly, is a chemical?

If you google “definition of chemical,” you’ll be nicely greeted with a definition from Google’s dictionary. But, if you want more than one source (which you always should!), click on some of the links provided and you’ll see than the definition of chemical is not quite as clear-cut as Google would

have you believe. I mean, Google is great, but it's not God.

So, what's the definition of chemical? Well, basically, it comes down to two options. The first, from the Oxford American College Dictionary, states that a chemical is, "a compound or substance that has been purified or prepared, especially artificially." The second, from the Cambridge Dictionary, defines a chemical as, "any basic substance that is used in or produced by a reaction involving changes to atoms or molecules." These two definitions perfectly illustrate the debate about chemicals: are chemicals unnatural, harmful substances, or are they simply the building blocks of everything around us?

Most people, at least in the U.S., use the first definition of chemical – something artificially made that does not occur in nature and which is also, for some reason, "bad." Those of us that have strong educational backgrounds in science, however, tend to use the second definition. *Everything* is a chemical, because everything is made up of atoms or molecules.

Now, the question is, why is there such a split between these two groups, and what are the consequences of that split? Well, one hint could come from Google's Ngram Viewer, which plots the frequency a word appears in books in a certain year. Take a look at the Ngram for "chemical". There's a sharp increase in the 1940s. Now, let's add "organic" to the Ngram. Notice how the shape of the graphs are really similar? The rises and falls appear in the same years. This is because the history of the definition of chemical is tied tightly to the organic food industry.

But wait – the Baby Boomers didn't worry about organic food, so how can the organic food industry be old enough to influence the idea of 'chemical'? You might be surprised to learn that the organic farming movement started in the 1940s, with the publication of books like *Look to the Land*, *The Living Soil*, and *Farming and Gardening for Health or Disease*. These were in response to the beginning of industrial agriculture. Food was no longer being grown in small, local farms; food was being produced on massive scales and shipped all over the country. This change in farming was accompanied by the introduction of synthetic fertilizers and pesticides – the first "bad chemicals."

It wasn't until the 1970's that people really started paying attention to the organic movement. Books like *Silent Spring* led to investigation of industrial farming practices, which revealed that synthetic fertilizers and pesticides were drastically altering our entire natural landscape. Large populations of birds, fish and insects were disappearing. People began to worry – if these chemicals were so harmful to other animals, couldn't they be harmful to us?

The organic food industry began with mom-and-pop shops opening up all around the country, but once people realized that organic food was an untapped market, large corporations started to take over. In 1988, the Whole Foods Co. was founded. Throughout the 1990s, Whole Foods opened up shops all around the country, usually acquiring the local organic food stores along the way. The organic food industry was officially big – growing by about 10-20% each year until 2012, at which point almost all organic food was being sold by multinational corporations.

What does all of this have to do with the definition of ‘chemical’? The success of the organic food industry *depends entirely* on people distrusting chemicals. The more people fear chemicals, the more people are convinced that “organic” is better. Organic became equivalent “not artificial”, which is why we no longer just have organic food, but also organic lotion, organic make-up, organic shampoo, organic soap, organic toothpaste... pretty much anything you put on or in your body can be marketed as “organic” and sold at an increased price. That’s not to mention all of the marketed “natural” products, which are not at all defined or regulated.

Where does this leave the definition of chemical? Well, we believe that the definition of chemicals as anything involving atoms or molecules is correct. However, if you choose to define chemical as “artificial” and “bad,” just realize you’re part of a much larger issue. Distrusting chemicals leads to distrusting science and medicine, and when people choose to disbelieve things that have been rigorously tested and proved, we face a much larger problem: the “post-truth” era that we seem to live in today.

We’re not saying that all chemicals are good. Some chemicals, like fertilizers and pesticides, cause a lot of damage and definitely need to be removed from our agricultural system. Organic food *does* prohibit synthetic fertilizers and pesticides, and is therefore not a bad investment. However, organic food has not been shown to have any other large benefits. It’s not healthier, doesn’t have a better flavor, and it doesn’t have more vitamins or nutrients. Things that never involved fertilizers or pesticides to produce in the first place, like soap and toothpaste, gain absolutely nothing from being “organic.”

So, when deciding on the definition of chemical, look past the marketing ploy of organic, anti-artificial and “natural” messages. Remember that a world without chemicals would be a world without water, alcohol, salt, sugar, ibuprofen and lots of other things we all know and love!

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