



BIOLOGY | ENVIRONMENT

Fruits and Vegetables Are Trying to Kill You

Antioxidant vitamins don't stress us like plants do—and don't have their beneficial effect.

BY MOISES VELASQUEZ-MANOFF

ILLUSTRATION BY JOHN HENDRIX

JULY 17, 2014

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ou probably try to exercise regularly and eat right. Perhaps you steer toward “superfoods,” fruits, nuts, and vegetables advertised as “antioxidant,” which combat the nasty effects of oxidation in our bodies. Maybe you take vitamins to protect against “free radicals,” destructive molecules that arise normally as our cells burn fuel for energy, but which may damage DNA and contribute to cancer, dementia, and the gradual meltdown we call aging.

Warding off the diseases of aging is certainly a worthwhile pursuit. But evidence has mounted to suggest that antioxidant vitamin supplements, long assumed to improve health, are ineffectual. Fruits and vegetables are indeed healthful but not necessarily because they shield you from oxidative stress. In fact, they may improve health for quite the opposite reason: They stress you.

That stress comes courtesy of trace amounts of naturally occurring pesticides and anti-grazing compounds. You already know these substances as the hot flavors in spices, the mouth-puckering tannins in wines, or the stink of Brussels sprouts. They are the antibacterials, antifungals, and grazing deterrents of the plant world. In the right amount, these slightly noxious substances, which help plants survive, may leave you stronger.

Eating food from plants that have struggled to survive toughens us up as well.

Parallel studies, meanwhile, have undercut decades-old assumptions about the dangers of free radicals. Rather than killing us, these volatile molecules, in the right amount, may improve our health. Our quest to neutralize them with antioxidant supplements may be doing more harm than good.

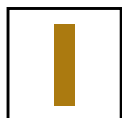
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By Andreas Weber

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The idea that pro-oxidant molecules are always destructive is “oversimplified to the point of probably being wrong,” says Toren Finkel, chief of the center for molecular medicine at the National Heart, Lung, and Blood Institute in Bethesda, Maryland. “Oxidants may be a primordial messenger of stress in our cells, and a little bit of stress, it turns out, may be good for us.”

Although far from settled, a wave of compelling science offers a remarkably holistic picture of health as a byproduct of interactions among people, plants, and the environment. Plants’ own struggle for survival— against pathogens and grazers, heat and drought—is conveyed to us, benefitting our health. This new understanding begins, in part, on a treadmill.



In the mid-20th century, as modern medicine seemed poised to vanquish the infectious diseases of yore, some scientists turned to the degenerative diseases associated with aging. Attention fell on a class of molecules called “reactive oxygen species,” or ROS. These volatile substances could damage DNA. Degenerative diseases, such as cancer and cardiovascular disease, often showed evidence of “oxidative stress,” suggesting that ROS spurred disease.

Oddly, our mitochondria, the energy factories of our cells, emitted ROS naturally. So degenerative disease seemed to stem in part from our own metabolic function: Your mitochondria “burned” fuel, emitted this toxic exhaust, and inadvertently set the limits on your existence. That was the working hypothesis, at any rate.

Experiments on rats and worms showed that reactive oxygen species, such as hydrogen peroxide, tear atoms from other molecules, destroying them in the process. That can be problematic when those molecules are DNA, our cellular instruction manual. We produce native antioxidants, such as the molecule glutathione, to counteract this pro-oxidant threat. They react with ROS, neutralizing the pro-oxidants before they can damage important cellular machinery.

When scientists blocked rodents’ ability to manufacture these protective molecules, lifespan declined. Observational studies, meanwhile, suggested that people who regularly ate vitamin-laden fruits and vegetables were healthier. So were people with higher levels of vitamins E and C in their blood.



Vitamins were strongly antioxidant in test tubes. So the ROS theory of aging and disease rose to prominence. You could slow aging, it followed, by neutralizing free radicals with antioxidant pills. A supplement industry now worth \$23 billion yearly in the U.S. took root.

But if those ROS were so harmful, some scientists asked—and the basic design of our (eukaryote) cells was over 1 billion years old—why hadn't evolution solved the ROS problem? At the same time, scientists began finding that exercise and calorie restriction increased lifespan in animals. Both elevated ROS. According to the ROS model of aging, animals that exercised and fasted should have died younger. But they lived longer.

For Michael Ristow, a researcher of energy and metabolism at the Swiss Federal Institute of Technology in Zurich, the inconsistencies became impossible to overlook. In worms, he found that neutralizing those allegedly toxic ROS reduced lifespan, so

he designed a similar experiment in humans.

He had 39 male volunteers exercise regularly over several weeks; half took vitamin supplements before working out. The results, published in 2009, continue to reverberate throughout the field of exercise physiology, and beyond. Volunteers who took large doses of vitamins C and E before training failed to benefit from the workout. Their muscles didn't become stronger; insulin sensitivity, a measure of metabolic health, didn't improve; and increases in native antioxidants, such as glutathione, didn't occur.

Exercise accelerates the burning of fuel by your cells. If you peer into muscles after a jog, you'll see a relative excess of those supposedly dangerous ROS—exhaust spewed from our cellular furnaces, the mitochondria. If you examine the same muscle some time after a run, however, you'll find those ROS gone. In their place you'll see an abundance of native antioxidants. That's because, post-exercise, the muscle cells respond to the oxidative stress by boosting production of native antioxidants. Those antioxidants, amped up to protect against the oxidant threat of yesterday's exercise, now also protect against other ambient oxidant dangers.

Contrary to the ROS dogma, Ristow realized, the signal of stress conveyed by the ROS during exercise was essential to this call-and-response between mitochondria and the cells that housed them. To improve health, he figured, perhaps we shouldn't neutralize ROS so much as increase them in a way that mimicked what happened in exercise. That would boost native antioxidants, improve insulin sensitivity, and increase overall resilience.

Ristow called this idea “mitohormesis.” The term “hormesis” came from toxicology (“mito” was for mitochondrion). It describes the observation that some exposures generally considered toxic can, in minute amounts, paradoxically improve health. For instance, minuscule quantities of X-ray radiation, a known carcinogen, increases the lifespan of various insects.

Hormesis may be most easily grasped when considering exercise. Lift too much weight or run too long, and you'll likely tear muscle and damage tendons. But lift the right amount and run a few times a week, and your bones and muscles strengthen. The intermittent torque and strain increases bone mineralization and density. Stronger bones may better tolerate future shocks that might otherwise cause fractures.

In his experiment, Ristow saw that vitamin supplements interrupted this sequence of stress followed by fortification, probably because they neutralized the ROS signal before it could be “heard” elsewhere in the cell. By interfering in the adaptive response, vitamins prevented the strengthening that would have otherwise followed the stress of physical exertion. Antioxidant supplementation paradoxically left you weaker.

Vitamins are necessary for health. And supplements can help those who are deficient in vitamins. Insufficient vitamin C, for instance, causes scurvy, which results from defective collagen, a protein in connective tissue. Among other functions, vitamin C aids collagen synthesis.

But the primary role of vitamins in our body, according to Ristow and others, may not be antioxidant. And the antioxidant content of fruits and veggies does not, he thinks, explain their benefits to our health. So what does?



ark Mattson, Chief of the Laboratory of Neurosciences at the National Institute on Aging, has studied how plant chemicals, or phytochemicals, affect our cells (in test tubes) for years. The assumption in the field has long been that,

like vitamins, phytochemicals are directly antioxidant. But Mattson and others think they work indirectly. Much like exercise, he's found, phytochemicals stress our bodies in a way that leaves us stronger.

Plants, Mattson explains, live a stationary life. They cannot respond to pathogens, parasites, and grazers as we might—by moving. To manage the many threats posed by mobile life, as well as heat, drought, and other environmental stresses, they've evolved a remarkable number of defensive chemicals.

Health doesn't result solely from the instructions your genome contains, but your relationship with the world.

We're familiar with many components of their arsenal. The nicotine that we so prize in tobacco slows grazing insects. Beans contain lectins, which defend against insects. Garlic's umami-like flavor comes from allicin, a powerful antifungal. These "antifeedants" have evolved in part to dissuade would-be grazers, like us.

Mattson and his colleagues say these plant "biopesticides" work on us like hormetic stressors. Our bodies recognize them as slightly toxic, and we respond with an ancient detoxification process aimed at breaking them down and flushing them out.

Consider fresh broccoli sprouts. Like other cruciferous vegetables, they contain an antifeedant called sulforaphane. Because sulforaphane is a mild oxidant, we should, according to old ideas about the dangers of oxidants, avoid its consumption. Yet studies have shown that eating vegetables with sulforaphane reduces oxidative stress.

When sulforaphane enters your blood stream, it triggers release in your cells of a protein called Nrf2. This protein, called by some the "master regulator" of aging, then activates over 200 genes. They include genes that produce antioxidants, enzymes to metabolize toxins, proteins to flush out heavy metals, and factors that enhance tumor suppression, among other important health-promoting functions.

In theory, after encountering this humble antifeedant in your dinner, your body ends up better prepared for encounters with toxins, pro-oxidants from both outside and within your body, immune insults, and other challenges that might otherwise cause harm. By "massaging" your genome just so, sulforaphane may increase your resistance to disease.

In a study on Type 2 diabetics, broccoli-sprout powder lowered triglyceride levels. High triglycerides, a lipid, are associated with an increased risk of heart disease and stroke. Lowering abnormally elevated triglycerides may lessen the risk of these disorders. In another intervention, consuming broccoli sprout powder reduced oxidative stress in volunteers' upper airways, likely by increasing production of native antioxidants. In theory, that might ameliorate asthmatics' symptoms.

Elevated free radicals and oxidative stress are routinely observed in diseases like cancer and dementia. And in these instances, they probably contribute to degeneration. But they may not be the root cause of disease. According to Mattson, the primary dysfunction may have occurred earlier with, say, a creeping inability to produce native antioxidants when needed, and a lack of cellular conditioning generally.

Mattson calls this the "couch potato" problem. Absent regular hormetic stresses, including exercise and stimulation by plant antifeedants, "cells become complacent," he says. "Their intrinsic defenses are down-regulated." Metabolism works less efficiently.

Insulin resistance sets in. We become less able to manage pro-oxidant threats. Nothing works as well as it could. And this mounting dysfunction increases the risk for a degenerative disease.

Implicit in the research is a new indictment of the Western diet. Not only do highly refined foods present tremendous caloric excess, they lack these salutary signals from the plant world—"signals that challenge," Mattson says. Those signals might otherwise condition our cells in a way that prevents disease.

Another variant of the hormetic idea holds that our ability to receive signals from plants isn't reactive and defensive but, in fact, proactive. We're not protecting ourselves from biopesticides so much as sensing plants' stress levels in our food.

Harvard scientist David Sinclair and his colleague Konrad Howitz call this xenohormesis: benefitting from the stress of others. Many phytonutrients trigger the same few cellular responses linked to longevity in eukaryotic organisms, from yeasts to humans. Years of research on Nrf2 in rodents suggest that activating this protein increases expression of hundreds of health-promoting genes, including those involved in detoxification, antioxidant production, control of inflammation, and tumor suppression.

In the dance between animals and plants, there's true mutualism. "We're in this together, the plants and us."

Sinclair studies another class of native proteins, called sirtuins, associated with health. They're triggered by exercise and also, Sinclair contends, a molecule called resveratrol, found in grape skins and other plants. "It's too coincidental that time and time again these molecules come out of nature that have the surprising multifactorial benefit of tweaking the body just the right way," Sinclair says.

They're not all antifeedants, he argues. Plants churn these substances out when stressed, prompting further adaptations to the particular threat, be it drought, infestation by grazing insects, or excessive ultraviolet radiation from the sun.

For grazers, these stress compounds in plants may convey important information about environmental conditions. So grazers' ability to "perceive" these signals, Sinclair argues, likely proved advantageous over evolutionary time. It allowed them to prepare for adversity. A grape vine stressed by fungi churns out resveratrol to fight off the infection. You drink wine made from those grapes, "sense" the harsh environmental conditions in the elevated tannins and other stress compounds, gird your own defenses, and, in theory, become more resistant to degenerative disease.

One implication is that modern agriculture, which often prevents plant stress with pesticides and ample watering, produces fruits and vegetables with weak xenohormetic signals. "I buy stressed plants," Sinclair says. "Organic is a good start. I choose plants with lots of color because they are producing these molecules." Some argue that xenohormesis may explain, at least in part, why the Mediterranean diet is apparently so healthful. It contains plants such as olives, olive oil, and various nuts that come from hot, dry, stressful environments. Eating food from plants that have struggled to survive toughens us up as well.

Philip Hooper, an endocrinologist at the University of Colorado Anschutz Medical Campus, points out that plant-animal relationships are often symbiotic, and communication goes both ways. One example of direct plant-to-animal, biochemical manipulation comes from the coffee bush. Flowering plants compete with one another for the attention of pollinators, such as bees. Coffee bushes seem to gain advantage in this "marketplace" by using caffeine. The drug excites pollinators' neurons, etching the memory of the plant's

location more deeply in their brains. Some think that biochemical tweaking increases the probability that the pollinator, which faces a panoply of flower choices, will return to that particular coffee bush.

In the dance between animals and plants, says Hooper, “I think there’s true mutualism. We’re in this together, the plants and us.”



While xenohormesis is a compelling idea, it remains unproven. Barry Halliwell, a biochemist at the National University of Singapore, and an expert on antioxidants, has seen the dietary fads, from vitamins to fiber, come and go. He says the hormetic and xenohormetic ideas are plausible, but not certain. Various studies suggest that people who consume a lot of fruits and vegetables have healthier lifestyles generally. Those people probably go easy on the junk food, which alone may improve health.

Even within the hormetic idea, Halliwell sees the attempts to bore down on the individual chemicals as problematic. “That’s worked very well in pharmacology, but it hasn’t worked at all well in nutrition,” he says. He doesn’t think any single phytonutrient will explain the apparent health-promoting benefits of fruits and veggies. “Variety seems to be good,” he says. That critique speaks to a larger problem: It’s often unclear how lab research on simple organisms or cell cultures will translate, if at all, into recommendations or therapies for genetically complex, free-living humans.

What works in genetically uniform organisms, or cells, living in highly controlled environments, does not necessarily work in people. Human studies on resveratrol in particular have yielded contradictory results. Proper dosage may be one problem, and interaction between the isolates used and particular gene variants in test subjects another. Interventions usually test one molecule, but fresh fruits and vegetables present numerous compounds at once. We may benefit most from these simultaneous exposures.

The science on the intestinal microbiota promises to further complicate the picture; our native microbes ferment phytonutrients, perhaps supplying some of the benefit of their consumption. All of which highlights the truism that Nature is hard to get in a pill.

These caveats aside, research into xenohormesis reminds us that we are not at the complete mercy of our genetic inheritance. Genes matter, but health depends in large part on having the right genes expressed at the right time—and in the right amount. If our genome is a piano, and our genes are the keys, health is the song we play on the piano. The science on hormesis, the stresses that may keep us strong, provides hints about what kind of song we should play. Keep the body conditioned with regular exercise. Keep your cells’ stress-response pathways intermittently engaged with minimally processed, plant-based food.

These recommendations end up sounding rather grandmotherly—if your grandmother was a spartan, no-nonsense peasant who lived off the land. But the underlying thrust contradicts assumptions about the need to protect oneself from hardship. Certain kinds of difficulty, it turns out, may be required for health. That’s because health doesn’t result solely from the instructions your genome contains, but from your relationship with the wider world. Resilience isn’t completely inherent to your body; it’s cultivated by outside stimuli. And some of those stimuli just happen to be mildly noxious, slightly stressful chemicals in plants.

Moises Velasquez-Manoff is a science writer and author of An Epidemic of Absence: A New Way of Understanding Allergies and Autoimmune Diseases. He lives in California.

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OR SIGN UP WITH DISQUS **George Gantz** • 7 years ago

Moises - Thank you for the brilliant essay and the work you are doing to bring the intricate complexities of human biology into the light! We are intimately connected to and communicating with all of nature at a fundamental molecular level in ways that we are only beginning to appreciate and may never fully understand. Most of what we think we know is actually wrong - and it turns out the nascent science of nutrition and its commercial partners (supplements and industrial agriculture) have been promoting the modern equivalent of snake oil for a century.

14 ^ | ▾ • Reply • Share ▸

**oroboros** • 7 years ago

I have been doing some reading on the topic of Reactive Oxygen Species (ROS) this week, and arrived at a preliminary figure of mutations they cause that's utterly astounding.

Your body contains on the order of 10.9 trillion cells containing human DNA (that's excluding red blood cells and your microbiome--just 10% of your total cell count contains human DNA).

It is estimated that each of those cells experiences 20,000 mutations to its DNA each day from ROS produced through normal cellular metabolism.

That means that in the last 24 hours, if you have an average body, you suffered and repaired 218 quadrillion mutations to your DNA.

References available here:

<http://everything-causes-ca...>

6 ^ | ▾ • Reply • Share ▸

**Mac** • 7 years ago

fascinating, thank you for this.

6 ^ | ▾ • Reply • Share ▸

**Bett** • 7 years ago • edited

When I see your articles (or videos), I know I will be both challenged and enlightened. You're one of my favorite thinkers, and I am grateful for your research.

4 ^ | ▾ • Reply • Share ▸

**013090** • 7 years ago • edited

From the article: 'One implication is that modern agriculture, which often prevents plant stress with pesticides and ample watering, produces fruits and vegetables with weak xenohormetic signals. "I buy stressed plants," Sinclair says. "Organic is a good start. I choose plants with lots of color because they are producing these molecules." '

You can tell he doesn't know much about organic farming. Organic farming uses plenty of pesticides and also provides ample watering just as much as non-organic. So even if the theory is true, it wouldn't favor organic food much. This also matches the science, since a multitude of studies have been done to compare the health affects of organic vs. non-organic, and they are all pretty unanimous. Local and organic may be nice if you want to support your local economy, but in terms of health and nutrition there is no difference.

and organic may be nice if you want to support your local economy, but in terms of health and nutrition there is no difference.

6 ^ | v 2 · Reply · Share ›



sb → 013090 · 7 years ago

Perhaps you and I are reading different journals, because most of the science I see indicates the opposite. In an effort not to cherry-pick, I did a single search and selected only the very first article. It happened to be a review article by Brandt et al 2011 proving you incorrect:

<http://www.tandfonline.com/...>

In case you don't have access where you are, these folks assembled the data from 100 published articles into this single summary to find a significant 16% increase of defense-related compounds and a 12% increase in secondary metabolites in organically grown produce. There's plenty of other interesting tidbits in there but I will let you find them on your own.

9 ^ | v 1 · Reply · Share ›



imfarkas → sb · 7 years ago

You can easily find studies which conclude the opposite of what you are trying to prove here. According to a meta-review of 240 studies "the published literature lacks strong evidence that organic foods are significantly more nutritious than conventional foods": <http://www.sciencebasedmedi...>

It would be better to avoid hasty generalization on a such a controversial topic.

7 ^ | v · Reply · Share ›



Hannibal Smith → imfarkas · 7 years ago

Who cares if organic food isn't "significantly more nutritious" than non-organic? Neither are significant sources of nutrition to begin with, so all the "ideological controversy" is like two fleas arguing with each other about the ultimate size of a Pink Elephant. The defining criteria should be taste. Organic food simply tastes better and that may reflect more holistic harvesting, processing and storage methods that go along with the organic philosophy. Biodynamic is probably the best tasting of all.

4 ^ | v · Reply · Share ›



Peter Olins → Hannibal Smith · 7 years ago

@Hannibal—Strictly-speaking, it's the "organic" label itself may be the thing that makes food taste better: <http://www.theatlantic.com/...>

This is surely a testament to the power of marketing. Perhaps the extra satisfaction that you derive from the perceived difference is worth the extra cost, especially if you have plenty of money. I agree, that for many of us, the aesthetic qualities of food are at least as important as the nutritional ones.

Another study found that people were not able to correctly distinguish organic versus conventional produce. In fact, they got it wrong:

<http://www.telegraph.co.uk/...>

BTW I'm not clear what holistic harvesting is, or how it affect taste.

5 ^ | v · Reply · Share ›



Ormond Otvos → Peter Olins · 7 years ago

You say "Namaste!" to every plant you take food from...

2 ^ | v · Reply · Share ›



Hannibal Smith → Peter Olins · 7 years ago · edited

Expectations can play a huge role in taste outcomes, but I really meant here within the context of fresh fruits, not processed food where "organic" is used largely for marketing fiction. Organic processed food is still processed junk food. Slapping lipstick on a pig doesn't make it prettier. I'll allow that perhaps a non-vine ripened organic tomato (fruit) is still not going to taste very good, thus indicting other issues than is it organic or not?

We do have to keep in mind that the whole supply chain of "organic" has been corrupted by crony capitalism over time so it no longer means what it originally meant back when it was just a small grass-roots movement before the early 90's and the advent of GMOs. Hence the burgeoning "biodynamic" to distinguish from the corporate corruption of "organic".

Anyway, it's easy enough for anyone to do a personal blind taste test with fresh fruits. Fructose content and aftertastes should be easier to detect with a cleansed palate of refined sugars, artificial flavorings, chemicals, etc. than, say, the amount of bitter-tasting sinolates in cruciferous vegetables. It also seems to be overlooked that "organic" is supposed to be less about just nutrition or taste than environmentally-sustainable farming practices, i.e. a holistic viewpoint.

^ | v · Reply · Share ›

**oroboros** → 013090 • 7 years ago

The pesticides used in organic farming may not be as effective as synthetics are at actually protecting the plants, thereby leaving them a little more stressed.

I'm familiar with Bt, neem oil, diatomaceous earth, copper sulfate, rotenone (now phased out inside the US except as piscicide). They all have their limits. Topical Bt, for example, won't persist long after a rain, unlike the Bt-producing crops that are engineered to express the Cry proteins inside their cells.

3 ^ | v • Reply • Share ›

**013090** → oroboros • 7 years ago

All excellent points. I stand corrected; thank you for your response.

3 ^ | v • Reply • Share ›

**Psylic** → 013090 • 7 years ago

"Organic farming uses plenty of pesticides..." Are you classifying helper plants, hot peppers, and screening with organophosphates?

1 ^ | v • Reply • Share ›

**Hochy** • 7 years ago

I'm going to go have a salad.

2 ^ | v • Reply • Share ›

**Amy Jansen** • 5 years ago

Would have appreciated footnotes.

1 ^ | v • Reply • Share ›

**George** • 6 years ago

Great writing and a nice introduction to this research.

There is evidence to support the idea that antioxidant vitamins and minerals, if consumed together in the amounts found in a good diet, do protect against one effect of a bad diet, increased cancer risk. In the recent result from the SU.VI.Max study, persons with a high inflammatory diet score (an approximate test of diet quality) over an 8-year period had a cancer and all-cause mortality death rate equal to people eating a high quality diet only when taking a mixed antioxidant supplement (Not just high-dose C and E, but low dose C, E, carotene, zinc, and selenium). People eating a good diet got no extra advantage from the supplement.

<http://intl-ajcn.nutrition...>

1 ^ | v • Reply • Share ›

**Luzmin Fernandez** • 7 years ago

This is so interesting. I've always been weary of supplementation when there are no known deficiencies. Nothing beats real food. Thank you for a wonderful article.

1 ^ | v • Reply • Share ›

**SailingSouth** → Luzmin Fernandez • 2 years ago

Unfortunately there is no easy way to know if you have deficiencies in most vitamins and minerals. While you rely on the food you eat to obtain the minerals you need, if those minerals are lacking in the soil, then they will not be present in the "real" food. For example, consider the mineral boron, an essential mineral that is key in avoiding arthritis. In countries like Jamaica, where there is little boron in the soil, nearly everyone develops arthritis. In countries that have plenty of boron in the soil, like Israel, no one develops arthritis. Most agricultural areas of the U.S. have little boron in the soil, and arthritis in its various forms is widespread. In situations like this, the only way to avoid the eventual development of arthritis is to take a boron supplement.

This has nothing to do with conventional versus organic growing methods. And this problem is not limited to fruits and vegetables. For those who eat meat, if the animal has grazed on pasture where boron is lacking in the soil, the meat will not contain it either. Or if the animal has been penned, then unless boron has been added to the feed, the animal will also be lacking. All of this is true for all the minerals, as they must be obtained from the soil (they cannot be manufactured by the body).

^ | v • Reply • Share ›

**Hannibal Smith** • 7 years ago • edited

I was under the impression that the "antioxidants" in plants were in fact hormetic stressors, not ORP-style antioxidants per se. There's still an argument to be made that protecting the mitochondria (which has no protection) from ROS makes sense and it seems to be demonstrated in a few animal studies looking at mitochondrial-specific antioxidants and extended lifespan. And there's bound to be a gap between the initiation of ROS and the body's positive hormetic response to it and within that gap lays mutational damage. No thanks!

Obviously, what makes really talking about here at the end of the day is the experience. Everything is subjective. We simply don't yet know

Obviously, what we're really talking about here at the end of the day is the epigenome. Everything is software. We simply don't yet know all of the multitude of positive or negative outcomes of all the software that we ingest and from the environment, including the hundreds of thousands of unregulated synthetic chemicals. Just due to random chance, some of those synthetic chemicals are bound to promote positive epigenetic control, but that's not liable to be a license for apologism except to short-term profiteers such as Monsanto, et al..

1 ^ | v · Reply · Share ›



Rasmus Lasthein · 7 years ago

Extremely interesting and very inspiring, thank you.

It just shows that in both nature, science, art, society etc. sometimes (often) $1+1=3$ and very "fuzzy".

1 ^ | v · Reply · Share ›



Richard Friebe · 2 years ago

This is an article from 2014. And now, five years later, hormesis is still not a term widely known, although it is one of the most important mechanisms, or family of mechanisms, of life as such, and it can help us make sense of why a lot of things in biology and in ourselves happen at all, help us make the right choices in life, too, help us be less afraid of all the "bad stuff" out there, because a lot of it is actually good for us if we do not get too much of it. Understanding hormesis, which would include doing a lot more research into it, could help us solve - or better address at least - many, many pressing problems from antibiotic resistance via feeding the world sustainably to cancer, and many more.

I myself wrote a book about it:

<https://www.amazon.de/Horme...>

It was published by a big German publisher and licensed to a couple of countries and for a couple of languages, it got very good reviews in the press, sold ok, but it made no big splash, and certainly did not change anything in terms of public perception, and never was there any interest from any British or American publisher. Maybe somehow we just do not want to know...

^ | v · Reply · Share ›



Paul Melzer · 2 years ago

Why is it we've witnessed a steep rise in chronic illness, cardiovascular disease, diabetes, etc., over the same recent decades as we've increased our consumption of fruits and vegetables? Like the cherry-picked studies that Ansel Keys used to set us off on the disastrous path we've followed, the nutritional epidemiology studies that the author points to as having suggested those that eat plenty of fruits and veggies have higher amounts of antioxidants in their blood failed to take into account healthy user bias (that they were less likely to be smokers, for example).

^ | v · Reply · Share ›



Walter Stuart → **Paul Melzer** · 2 years ago

Or consume fewer doughnuts and such.

^ | v · Reply · Share ›



idster · 3 years ago

Moises, it's one of the rare occasions on which it feels natural to thank the author of an article. Thank you.

^ | v · Reply · Share ›



Amy Jansen · 5 years ago

Eating fruits and vegetables preferable organic seems to be omitted as well as the tremendous damage caused by pollution and not addressed in the USA but rather shift to China when the USA is competing for the most polluted country in the world. I am unsure that vitamins generated from fruits and vegetables are as detrimental as those 100% made of chemicals.

^ | v · Reply · Share ›



Katy Rogers · 6 years ago

I love this! This ties together so much I have been studying. Fantastic job. I'll add the link to my blog Friday. People should understand this. Thank you.

^ | v · Reply · Share ›



Ormond Otvos · 7 years ago

Very well written. A pleasant change from the vitamin crowd.

^ | v · Reply · Share ›



knutrition · 7 years ago

Great thinking. Before we call supplements useless, we do know that specific supplements up or down regulate metabolic pathways. For

instance, if we have a defective gene for producing methyl B12, we can take the methyl form. Another point is that as we age, we may be less efficient at revving up our antioxidant and anti inflammatory defenses. Loved the sentence that ended with animals and plants are in this together.

^ | v · Reply · Share ›



Sum Mundus · 7 years ago

Thank you for the article Moises!

^ | v · Reply · Share ›



Janna Shapero · 7 years ago

Moises, Brilliant article! I want to read your book. I am a herbalist of many years and this premise is the norm in the plant medicine world. A great example is Rhodiola rosea which grows under stressful conditions in northern mountainous regions. It is considered an 'adaptogen' a plant which helps people adapt to stress. It was traditionally used in Siberia and other northern countries like Scandinavia and Tibet to increase stamina, energy and resistance to disease, especially during the harshness of winter. If you pursue this topic further, look into David Winston's writing on adaptogens. Also noteworthy is ginger which has a high level of irritating volatile oils provoking detoxification and digestive function. Thanks for the great read!

^ | v · Reply · Share ›



Peter Olins · 7 years ago

Since many agricultural pesticides activate the same protective systems as plant-derived ones, surely a logical extension is that low level exposure to some of these materials might be beneficial?

Moises, I'm a great fan of your extensive science writing, but sometimes I think that you give similar weight to established and speculative ideas. This juxtaposition may make for a seductive narrative, but I wonder if you sometimes do your readers a disservice by doing this. There's a fine line between entertaining and informing.

^ | v · Reply · Share ›



Janna Shapero → **Peter Olins** · 7 years ago

Wow Peter have you been eating your veggies? This article is very future forward. Speculation and challenging established science is how we break free from stupidity. Its more than a seductive narrative, it represents an extremely important argument that questions the benefits of isolated active ingredients in nutraceuticals. Fruits, vegetables and plant medicines have broad chemical profiles for a reason. We think we are smart by reducing nature down to individual components tinkering away in laboratories but in reality we are just naive. It is about patenting and profit more than health benefit.

1 ^ | v · Reply · Share ›



Ormond Otvos → **Janna Shapero** · 7 years ago

Poi.

^ | v · Reply · Share ›



Rodrigo · 7 years ago

Great article!!

^ | v · Reply · Share ›



dogfood411 · 7 years ago

"Evolution turns the unavoidable into the necessary" is a great quote that leads right into the heart of this impressive write-up. <https://www.youtube.com/wat...>

^ | v · Reply · Share ›



freefood89 · 7 years ago

Does this mean that if I were to take vitamins for non-antioxidant purposes, then I should take them 12 hours away from exercise? I would like to read the cited papers.

^ | v · Reply · Share ›



Dan → **freefood89** · 7 years ago

Here you go: <http://www.pnas.org/content...>

^ | v · Reply · Share ›



freefood89 → **Dan** · 7 years ago

thanks!

1 ^ | v · Reply · Share ›



I know · 7 years ago

Ya, we are in deep doo doo, the food and all of it is killing us softly. No doubt. forget all the research and testing just look around at the

kids with food allergies and sick. I recall the taste of milk, potatoes and even cheese's - in 1986, clean. Alive.

^ | v • Reply • Share ›



Maya Stickers • 7 years ago

would that mean consuming tobacco might be helpful in toughening our system in some ways?

^ | v • Reply • Share ›



Martin Hackberry → Maya Stickers • 7 years ago

There are indications that smoking helped doctors survive the plague; and the tobacco plant as well as smoking it is integral to Amazonian shamanic practices of healing, so maybe.... See <http://180degreehealth.com/...> and <http://www.livescience.com/...> for more info.....

1 ^ | v • Reply • Share ›



Lloyd Miller → Maya Stickers • 7 years ago

Probably best to chew it moderately! Burning it and putting it into you lungs, probably not good!

1 ^ | v • Reply • Share ›



Ormond Otvos → Lloyd Miller • 7 years ago

Why can't a little smoke toughen us up?

^ | v • Reply • Share ›

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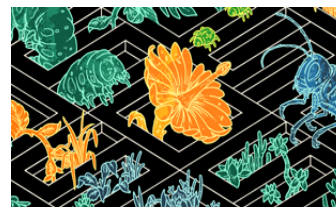
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