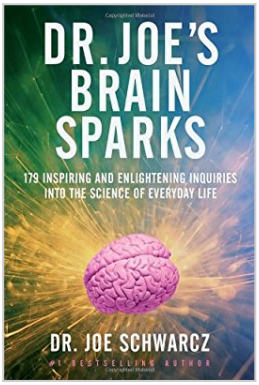

Dr. Joe's Brain Sparks: 179 Inspiring and Enlightening Inquiries into the Science of Everyday Life

By Joe Schwarcz

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Prepare to be amazed once again.

Did you know what when you shake a ketchup bottle you're practicing thixotropy? That the ancient Greeks made themselves look less ancient by inventing moisturizer? That the mysterious drug obecalp* is as effective as homeopathy and many herbal cures? From the bestselling author of **An Apple a Day**, **Brain Fuel**, and **Science, Sense and Nonsense** comes a fresh batch of inquiries into the science of everyday life. Dr. Joe, as he is affectionately known to millions of readers, listeners, viewers, and students, presents his third book in the Doubleday Canada series he launched with **Brain Fuel**.

Using a Q&A format, it explains the world through science, and science through our common experience. There are sections on diet and nutrition, new drugs, and the dubious claims made for alternative remedies and beauty potions. There is a profusion of inspiring, enlightening, sometime just downright bizarre information drawn from the laboratory, from history, from our medicine cabinets and the bottles under our sinks. Science is everywhere, and Dr. Joe is keeping track - and doing it in a marvelously warm, eminently readable style. Let the brain sparks fly!

*Try reading this word backwards.

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Review
Praise for *Brain Fuel:*
"Packed with scientific answers to questions you didn't even know you had."
— *Chatelaine*

About the Author
DR. JOE SCHWARCZ is director of McGill University's Office of Science and Society, where he teaches courses on nutrition and the applications of chemistry to everyday life. Among his many honours are the Royal Society of Canada's McNeil Award, and the American Chemistry Society's renowned Grady-Stack Award, of which he is the only non-American recipient. Schwarcz is the host of a weekly radio show on CFRB in Toronto and CJAD in Montreal, and writes a weekly column for the Montreal *Gazette*.

CHEMISTRY: THE BEST MEDICINE

A drug introduced in 1981, isolated from a soil fungus, revolutionized the transplantation of human organs. What drug was that?

Cyclosporin. Early transplants were plagued by organ rejection. The recipient’s immune system considered the organ a foreign intruder and mobilized its forces for battle. Doctors realized that if transplants were ever to be successful, the body’s immune system would have to be held in check.

By the time Dr. Christiaan Barnard performed the world’s first heart transplant in 1967, drugs that curbed immune activity were available, but they left a lot to be desired. The medications managed to keep the immune system from rejecting the organ, but the extent of immune suppression was such that it left the patient susceptible to all sorts of infections. In fact, Louis Washkansky, the first recipient of a transplanted heart, died of pneumonia he contracted because of suppressed immunity. But the problem of rejection was essentially solved when cyclosporin came onto the scene in 1981.

The discovery of the first truly effective anti-rejection drug was somewhat serendipitous, and dates back to the early 1970s. In those days, pharmaceutical companies searched high and low for novel antibiotics, investigating whatever fungus they could get their hands on. After all, antibiotics isolated from fungi, such as penicillin and streptomycin, had already proven their worth. Hoping to find some novel antibiotic-producing fungus, pharmaceutical companies routinely asked their employees to bring back soil samples from their travels. The Sandoz company lucked out. A soil sample collected in Norway yielded a strain of fungus that produced a compound composed of a ring of amino acids, eventually named cyclosporine. It looked like a good candidate for antibiotic activity. Unfortunately, it turned out not to have any such properties.

Eventually, though, disappointment turned to elation when cyclosporine was found to have a marked immunosuppressive effect! Administering the drug presented a problem, however, since it was almost completely insoluble in water. When taken orally, it never made it into the bloodstream. But researchers discovered that dissolving the drug in olive oil did the trick. In 1978, the first kidney and bone marrow

transplants in which cyclosporine successfully prevented rejection were performed in England. Today, hearts, kidneys, livers and bone marrow are routinely transplanted, thanks in large part to cyclosporine.

There is a footnote to the cyclosporine story, and a rather significant one. After a transplant, monitoring the use of all drugs taken by patients is critical because some medications can interfere with the action of cyclosporine. St. John's wort, for example, an herbal remedy available without a prescription, can negate the effect of cyclosporine and result in rejection. This interaction came to light when a heart transplant patient's body rejected the donated organ even though an appropriate amount of cyclosporine had been administered. Unknown to his physicians, he had been taking St. John's wort purchased at a health food store to ward off his depression. He almost warded off his new heart.

Around 1000 BC, a Chinese monk introduced the idea of blowing a substance up the nose of people to protect them from smallpox. What was this substance?

A powder made from the scabs of pustules on the skin of people who had survived smallpox. The eradication of this horrific disease, which is thought to have first appeared around 10,000 bc, is one of the greatest triumphs of medicine. The last recorded case of smallpox occurred in Somalia in 1977, more than thirty years ago. How did this triumph come about? Simple: vaccination! The name associated with the introduction of the smallpox vaccine is Dr. Edward Jenner, an English country physician who acted on the observation that milkmaids who had come down with a disease known as cowpox never contracted smallpox. Jenner injected young James Phipps with material taken from a milkmaid's cowpox pustule and then exposed him to smallpox. (Obviously, there were no ethics committees at the time to approve research.) The boy didn't get the disease, and the era of vaccination, the term deriving from the Latin for *cow*, was on its way. Although Jenner usually gets the credit for introducing the smallpox vaccine, it was twenty years earlier that Benjamin Jesty, a farmer, inoculated his wife with the cowpox virus and showed that it protected her from the disease. Unfortunately, he didn't have enough oomph to influence the medical community.

Even more amazing is that a technique known as variolation had been introduced by a Chinese monk almost two thousand years earlier. After the death of the son of a high-ranking Chinese official, the monk sought a way to cure the scourge of smallpox. He hit upon the idea of blowing the dust made from ground-up pustules taken from the skin of smallpox victims up the nose of healthy people. In all likelihood this was predicated on the observation that people who had survived smallpox became immune to the disease. Lady Wortley Montague learned of this technique when her husband had a political posting in Turkey. She brought it to the attention of the British royal family and suggested that variolation could be tested on condemned prisoners. Indeed, four such men were treated, and months later were exposed to smallpox. All four survived. This was enough to convince the royal family to undergo variolation. The French thought the English were crazy. In fact, Voltaire opined that "the English are fools, they give their children smallpox to prevent their catching it." They weren't fools. In smallpox survivors the virus becomes weakened and can offer protection to others, with only a small risk of causing the actual disease. The death rate from smallpox was usually somewhere between 20 per cent and 40 per cent, but the death rate from variolation was only about 1 per cent. It is interesting to note that this ancient technique saved many from contracting smallpox long before it was replaced by Jenner's more effective vaccination.

"It may be that the world's oldest medicine is the earth itself." To what does that statement refer?

The ingestion of clay to absorb toxic substances. Terra sigillata, which literally means “earth that has been stamped with a seal,” was originally dug up each year only on August 6, on the Greek island of Lemnos. It was mixed with the blood of a sacrificial goat, shaped into lozenges and dried. The famous Greek physician Galen recommended it as an antidote to poisons way back in the second century ad. Kings and popes commonly ate terra sigillata with their meals. Clays really do have the ability to bind various substances, and they even exhibit a property known as “cation exchange.” This means they can absorb positively charged ions such as those of mercury and lead, which are highly toxic. Indeed, terra sigillata used to be an antidote to poisoning by mercuric chloride. A story from the sixteenth century speaks of a condemned German criminal who, in a bid to avoid execution, proposed an experiment to the court. He would act as a human guinea pig and take a potentially lethal amount of mercuric chloride, followed by terra sigillata in wine. If he survived, he would be released. Although he went through a torturous experience, the man did survive and was indeed freed! Today, refined clays, as in Kaopectate, are used to treat diarrhea caused by bacterial toxins in the gut. The clay can absorb the toxins and relieve the condition.

Both George Bush Sr. and his wife, Barbara, were diagnosed with Graves’ disease. This initiated the testing of the water in the White House for what substance?

Iodine. Graves’ disease is a form of hyperthyroidism, a condition in which the thyroid gland produces too much thyroid hormone. As a result, metabolism speeds up, leading to weight loss, insomnia, muscle weakness, tremors, sweating, frequent loose stools, palpitations, bulging eyes and a feeling of edginess. Thyroid hormone contains iodine, and it’s conceivable that too high an intake of iodine can cause it to be overproduced. But the usual cause of Graves’ is an autoimmune reaction in which antibodies in the blood stimulate the overproduction of thyroid hormones. Since the odds of a husband and wife both developing this type of autoimmune reaction at roughly the same time are about three million to one, the White House water was tested for iodine. No excess was found, so it seems that George and Barbara were that unlucky couple in three million who simultaneously came down with Graves’ disease due to an autoimmune reaction. Other possibilities, such as a pituitary tumour, were ruled out. Autoimmune reactions can be triggered by a viral or bacterial infection, so the first couple may have shared some infectious agent.

The president and first lady received plenty of good-natured advice from the public about what to do, including eating broccoli, which is known to contain goitrogens, compounds that interfere with thyroid function. While this makes some theoretical sense, a grotesque amount of broccoli would have to be consumed for any effect on the thyroid to be noted. In any case, this was one bit of advice the president, having publicly expressed his distaste for the vegetable, was not likely to take. After those remarks, growers dumped truckloads of broccoli in front of the White House in protest, so he certainly would have had enough available had he chosen to indulge.

Graves’ disease can be treated with drugs that block the synthesis of thyroid hormone, with radioactive iodide to deactivate the thyroid gland, or with surgery to remove part of the gland. This can result in hypothyroidism, or insufficient production of thyroid hormone, characterized by weight gain, lethargy, fatigue, constipation, cold, clammy skin, diminished sweating, thickened nails as well as coarse and prematurely grey hair. There can also be memory loss and intellectual impairment that may be wrongly ascribed to senile dementia. Hypothyroidism can also be due to a chronic inflammation of the thyroid gland that causes it to become enlarged and impairs hormone production. This is known as Hashimoto’s disease.

Whatever the cause of an underactive thyroid, the condition can be treated by oral thyroid hormones, with Synthroid being the most common commercial example.

For some unknown reason, thyroid disorders are five times more common in women than in men. In the West, newborns are tested for thyroid problems, but in India some 250 million people are estimated to suffer from iodine deficiency, which is manifested in decreased motor skills, low IQ and poor energy levels. Low levels of thyroid hormones are also believed to cause some ninety thousand stillbirths a year, and nine million children to be born with some form of mental retardation, often referred to as “cretinism.”

In North America, salt is commonly iodized, meaning that it has potassium iodide added. But this does present a problem. Iodide is slowly converted to iodine in moist air. Since iodine is volatile, salt would slowly lose its power to protect against goiter. It is therefore common practice to add iodine stabilizers to iodized salt. These are substances that convert iodine back to iodide. Sodium thiosulphate used to be added, but it sounded too chemical and people became worried. So manufacturers switched to dextrose, which is as effective and sounds more innocuous. Sodium bicarbonate is also added because the oxidation of iodide occurs readily in an acid solution but not in a base. Disodium phosphate or sodium pyrophosphate are sometimes used to provide the alkaline conditions. These are also “sequestering agents,” which bind trace metals that catalyze the oxidation of iodide to iodine.

Unfortunately, this easy protection against goiter is not being carried out everywhere. In India, because of the humid air, salt is usually sold in large crystals that are resistant to humidity. These are sometimes sprayed with potassium iodate (yet another substance capable of supplying iodine for thyroid hormone production), but that makes the salt look dirty, so people wash the crystals before crushing them. The consequences are tragic.

Frankincense is a tree resin that has long been used in incense and perfume production. Recent research shows that it may also be useful in the treatment of what medical condition?

Osteoarthritis. The wearing away of shock-absorbing cartilage that protects the ends of bones can result in stiffness and pain as bone rubs on bone. It is not primarily an inflammatory condition, meaning that it is not normally accompanied by swelling, heat or redness. But osteoarthritis can have an inflammatory component as bits of cartilage break off and cause a swelling around the joint. Since extracts of the *Boswellia serrata* plant, commonly known as frankincense, have anti-inflammatory properties, it comes as no surprise that they should have some efficacy in treating osteoarthritis. Frankincense has long been used in Ayurvedic medicine, mostly for digestive problems, and notably has not been associated with adverse reactions. Its use, however, has generally not involved standardized products.

Now, Laila Impex, an Indian pharmaceutical company, has developed a drug known as 5-Loxin from boswellia resin with a reproducible, standardized composition. The major active ingredient is acetyl-11-keto-beta boswellic acid, which is known to interfere with the activity of 5-lipoxygenase, an enzyme that catalyzes the formation of leukotrienes, which are compounds that promote inflammation. Of course, osteoarthritis sufferers want more than theory. And now they may have it: a randomized, double-blind, placebo-controlled trial using varying doses of 5-Loxin has shown evidence of benefit. Seventy patients completed the ninety-day study, with those taking 250 milligrams of the drug every day showing a significant improvement in pain score and stiffness. Furthermore, when fluid was drawn from the subjects’ knees, in those taking the medication, there was a significant decrease in matrix metalloproteinase-3, an

enzyme that can break down cartilage. While one cannot make too much of a single study, there is room here for optimism, given that no side effects were noted. And frankincense may have yet another effect—at least in mice. Incensole acetate, a compound found in frankincense smoke, relieves anxiety and depression. I'm not sure how one diagnoses depression in a mouse, but that's another story. In any case, those wise men bearing gifts of frankincense may have been onto something.

A study showed that a daily intake of two 500-milligram tablets of quercetin, a flavonoid found in apples, was effective in reducing the symptoms of chronic prostatitis. If an average apple contains 0.1 grams of quercetin, how many apples would have to be eaten every day to match the dose used in the trial?

Ten. Apples have a long-standing reputation of being a very healthy fruit. And this reputation is actually based on more than folklore. Epidemiological studies have linked apple consumption with a reduced risk of lung cancer, heart disease, asthma and diabetes. No, you don't have to eat truckloads of apples to reap these benefits—one or two a day can make a difference. Exactly which of the more than three hundred naturally occurring compounds in apples is responsible for the health benefits is unknown, but flavonoids, based on their antioxidant and anti-inflammatory properties, are strong candidates. Of these, quercetin has probably been the most thoroughly investigated. For example, in a placebo-controlled trial of men suffering from chronic prostatitis, 67 per cent of the patients taking quercetin had a significant alleviation of symptoms, while only 20 per cent of the men in the placebo group showed improvement.

When male cyclists were asked to train at maximum intensity for three hours a day for three days, those who received a daily supplement of one gram of quercetin suffered far fewer chest infections than cyclists who were given a placebo. It is well known that athletes who engage in extreme physical activity are more prone to chest infections, as are soldiers who are under great physical stress during missions. This is probably because their immune systems are weakened and unable to fend off microbes effectively. Researchers believe that quercetin helps ward off infection by binding to viruses and bacteria and preventing them from replicating.

Quercetin may even be helpful for the mind. Although Alzheimer's is a complex disease, it is thought to involve free-radical damage to brain cells. Since quercetin has free radical–neutralizing capabilities, researchers at Cornell University decided to study its potential as a preventative for Alzheimer's by soaking rat brain cells in quercetin before exposing them to hydrogen peroxide, a free-radical generator. Quercetin proved to be very beneficial in protecting the cells from damage. Of course, rat brain cells in a petri dish are a long way from a functioning human brain, but still, the result is interesting. Nobody knows how many apples need to be eaten to offer such protection against Alzheimer's, but for sure, there is no downside to eating apples. And if you want the full benefit of quercetin, eat the peel, where most of it is found.

What naturally occurring chemical in the body would someone try to boost by taking 5-hydroxytryptophan?

Serotonin. Serotonin is one of hundreds of chemicals used by nerve cells to communicate with each other. These neurotransmitters are released by one cell, traverse the tiny gap called the synapse that separates nerve cells, and go on to activate an adjacent cell by binding to specific proteins called receptors, much like a key fitting into a lock. One of the most widely studied of these neurotransmitters is serotonin, a compound that

plays a role in controlling our mental state. Antidepressants such as fluoxetine (marketed under the brand name Prozac) work by increasing the concentration of serotonin in the synapse. These drugs are called selective serotonin reuptake inhibitors (SSRIs) because they prevent the reuptake of serotonin by the cell that originally released it—which is sort of the body's way of recycling serotonin after it has done its job. Serotonin is produced in the body from the amino acid tryptophan, which is widely available in the diet. The metabolic pathway goes through an intermediate called 5-hydroxytryptophan, or 5-HTP, suggesting that, at least in theory, serotonin levels can be boosted either by ingesting tryptophan or 5-hydroxytryptophan.

Historically, there have been issues with tryptophan production, and a cloud was cast over this substance when a number of people died in 1989 from eosinophilia-myalgia syndrome, a condition that was traced to an impurity in a batch of tryptophan produced by one specific company. Because of this problem, focus shifted to boosting serotonin levels with 5-hydroxytryptophan, which can be extracted from seeds of the African *Griffonia simplicifolia* plant. A serotonin boost may do more than just elevate mood; it may serve as a sleep aid and migraine preventer. There is also some evidence that it can reduce cravings for carbohydrates and that it may alleviate the symptoms of fibromyalgia. The usual dosage of 5-HTP is in the range of one hundred to two hundred milligrams, one to three times a day. Evidence for efficacy is modest, but so are the risks. Cross-reactions with drugs are possible, particularly with those that also have an effect on serotonin levels, such as antidepressants, opiates and migraine medications. Needless to say, the use of 5-HTP should be discussed with a physician.

Why would a person's breath be tested for the presence of hydrogen gas?

To diagnose lactose intolerance. Lactose intolerance, the most common food intolerance in the world, is the inability to digest lactose, the sugar found in milk. Milk contains a fair bit of this sugar, roughly 5 per cent by weight. Lactose, the only carbohydrate of animal origin of any significance in the diet, is a disaccharide, meaning that it is composed of two smaller sugars, glucose and galactose. The breakdown of lactose in the digestive tract and the subsequent absorption of its components into the bloodstream require the presence of an enzyme called lactase. In the absence of this enzyme, lactose is not absorbed and its buildup draws fluid into the small intestine, causing diarrhea and often a very urgent need to visit the facilities. At the same time, the unabsorbed sugars serve as food for intestinal bacteria, which then produce gas as a byproduct. The buildup of gas can cause bloating, pain and flatulence. Indeed, the world record for gaseous emissions is held by a lactose-intolerant man who produced 141 outbursts in two hours after drinking two litres of milk. A great deal of this gas is hydrogen, some of which is absorbed into the bloodstream and is exhaled from the lungs. That is exactly why diagnosing lactose intolerance involves measuring the concentration of hydrogen in breath exhaled after a person drinks a standard dose of lactose.

Most cases of lactose intolerance are genetic. Populations that have not had milk as a mainstay of their diet have slowly lost the need to digest lactose. That's why about 90 per cent of Asians are affected, but only about 20 per cent of people of European origin suffer. But a lack of lactase can also be caused by intestinal diseases such as celiac or Crohn's disease. Some antibiotics—neomycin, for example—can also cause lactase deficiency. There are several approaches to dealing with lactose intolerance. Lactase can be added to milk to break down the lactose before it ever enters the body. Such milk will often be labelled as "lactose-free," "lactose-reduced" or "modified for easier digestion." This is a completely safe product.

Lactase drops, which can be added to milk, are also available, as are pills designed to be taken before indulging in milk products. In this case, the missing enzyme is replaced from an outside source. Avoidance

of dairy products is an obvious measure for lactose-intolerant people, although most can consume small amounts of dairy products, especially yogurt, in which the fermenting bacteria use up most of the lactose as a source of food. Unfortunately, some people are so intolerant that they will even react to tiny amounts of lactose found as a filler in some medications. Such sensitive people can still drink fresh milk, as long as it comes from a bear. For some strange reason, bear's milk contains very little lactose. Of course, acquiring the bear's milk does present problems of its own.

What might a dermatologist call "liquid gold?"

Liquid nitrogen. It is so useful in dealing with various skin lesions, including some skin cancers, that its value can be likened to that of gold. Liquid nitrogen boils at −196°C, drawing heat from its surroundings in a dramatic fashion as it converts from a liquid to a gas. Tissues with which it comes into contact freeze instantly, as ice crystals form inside cells. Then, as the cells thaw out, the crystals expand and damage the cell walls, causing the fluid inside to leak out, which kills the cells. A very similar effect can be seen when a frozen steak thaws out. The liquid that was previously locked up in cells now escapes and reveals itself as a red juice.

Liquid nitrogen can be used to cool a metal probe that is then applied to the skin, but more commonly it is applied directly to the skin as a spray or by means of a cotton-tipped swab. Warts, keratoses and some skin cancers can be readily treated in this fashion. And they have been treated like this for more than a hundred years, ever since the production of liquid nitrogen became possible. Air, which of course is a mixture of nitrogen and oxygen, can be liquefied when put under great pressure. When liquid air is allowed to warm up, nitrogen boils off first and can be collected.

The key to using liquid nitrogen therapeutically, though, was the development of the Dewar flask, or Thermos bottle as some call it, which allowed super-cold liquids such as liquid nitrogen to be temporarily stored in a doctor's office. Dewar flasks can be filled from a liquid nitrogen tank, which is a thick-walled metal container capable of withstanding high pressures. That, of course, is necessary because nitrogen can only be stored as a liquid under high pressures. The storage tanks have to be equipped with a safety valve, so that if the pressure inside becomes dangerously high, as may happen if the temperature is increased, nitrogen can be vented as a gas.

Should the safety valve not function, the results can be dramatic, as evidenced by a spectacular accident at Texas A&M University where a not-so-bright graduate student in chemistry tried to fix a faulty release valve by clamping a brass fitting over it. The result of this folly was the nitrogen tank taking off like a rocket, completely penetrating the floor above and finally lodging in the attic. Luckily, the spectacular launch occurred in the middle of the night and nobody was hurt. Of course, it is not the liquid nitrogen that should be blamed, but the faulty handling. Liquid nitrogen can be used safely. You can even make ice cream with it: just blend together the usual components—the milk, eggs, sugar, cream and flavouring—and then, instead of using an ice cream freezer, just stir in some liquid nitrogen. Presto, a fresh batch of ice cream is ready to eat!

When is blood-coloured urine not worrisome?

If you've been eating beets. Beetroot gets its colour thanks to a family of compounds known collectively as betacyanins. Ingestion of beets can result in a bright red discoloration of the urine, and quite a scare for the urinator, who may confuse it with blood. Blood in the urine is a frightening prospect and a possible sign of serious disease, while the presence of betacyanins is benign and possibly even healthy. Interestingly enough, not everyone produces red urine after eating beets, a fact that leads many researchers to believe that production is genetically determined. Experiments have, however, cast doubt on this explanation. When subjects are given a fixed amount of beetroot to eat, and their urine is chemically analyzed, they all show the presence of betacyanins, but in some cases in amounts too small to impart a visual effect. When the dose is increased, subjects who were visually "non-excretors" begin to produce red urine. Furthermore, when subjects ingest the same amount of beetroot on separate occasions, they produce urine of varying shades of red. Factors other than genetics are obviously involved.

Times of planting and harvesting greatly influence betacyanin content, so beets purchased at different times may have different effects. Betacyanin colour also is dependent on acidity, being more stable as acidity is reduced. At the normal pH of the stomach, about 2, rapid decomposition of beet pigment occurs. If the acidity is reduced, such as by taking drugs for excess stomach acid, the chance of excreting red urine is increased. In one reported case, a gentleman who had never previously experienced the red urine phenomenon was scared out of his wits by the brilliant red colour he produced after a course of ranitidine, a drug used to reduce stomach acidity.

The presence of iron, in the form of ferric ions in the stomach and intestines, can also prevent the beetroot colourants from being absorbed into the bloodstream. Since iron can be complexed by oxalic acid or by ascorbic acid (vitamin C), these compounds, which are widely distributed in foods, can also determine whether eating beets will produce red urine. There seems to be enough evidence here to suggest that the production of red urine after eating beets is not controlled by genetics, but rather is a function of stomach acidity and the presence or absence of other dietary components.

According to researchers at the University of Wisconsin, not only is beet-induced red urine not a matter of concern, it may actually be healthy. It seems beet extracts can stimulate the liver's production of "phase II enzymes," which help eliminate toxins, including carcinogens. This property has been shown in mouse liver cell assays, but such experiments are known to be good models for what happens in the human liver. Eating beets may therefore provide some protection against cancer. Incidentally, turning beet-red in the face is solely a matter of embarrassment and has nothing to do with eating beets.

What dietary supplement derives its name from the Latin word for flesh?

Carnitine. This compound was first isolated from meat in 1905 and named after *carnus*, the Latin for flesh. Carnitine is needed to transport fats from the bloodstream into cells, where they can be burned for energy. Although carnitine is essential for health, it does not have to be supplied by the diet since it can readily be made by the liver and kidneys from lysine and methionine, two common amino acids. Because carnitine plays a definite role in the burning of fats, there has been interest in studying its potential to increase endurance, to reduce weight as well as to lower levels of cholesterol and triglycerides. Theoretically, carnitine could be of use in these areas, but the human evidence accumulated has been disappointing. More than twenty years of research using two to six grams of carnitine a day for extended periods has shown no benefit in athletic performance or in weight loss.

More positive results have been seen in patients with heart disease. The heart, of course, is a muscle, and it derives the energy it needs to function partly from burning fats. When it is deprived of oxygen—as during periods of angina, or after a heart attack—fat breakdown and energy production are reduced. In such cases, carnitine has been shown to be of some help. When given to heart attack victims for four to eight weeks at a dose of two to three grams a day, carnitine can reduce damage to the heart muscle. Angina sufferers may also be able to increase their exercise tolerance with a dose of about two grams a day. In some studies of people who have leg pain because of poor circulation (intermittent claudication), two grams a day has resulted in a significant improvement in the distance they can walk pain-free.

There is also some evidence that suggests that cancer patients who commonly experience fatigue from poor nutrition, radiation or chemotherapy may experience enhanced energy and improved mood with carnitine supplementation. A few studies have shown a relief of nerve pain associated with type 2 diabetes. The clearest indication for carnitine supplements is for kidney patients who are known to experience impaired production of the compound and who are also known to excrete significant amounts of carnitine. Because carnitine has only been clearly shown to be beneficial in conditions that require a physician's attention, it is only available in Canada by prescription. U.S. laws are more lax, and since carnitine can be found to occur naturally in meat, it is regulated as a dietary supplement. Hence it is commonly advertised as an energy-inducing substance and a weight-loss aid, in spite of a lack of clinical evidence.

Ultraviolet light carries sufficient energy to break chemical bonds, as is evidenced by the link between exposure to UV light and skin cancer. What technology uses the bond-breaking ability of ultraviolet light to protect the general population from disease?

Water treatment. Most people take water treatment for granted. Open a tap or turn on a shower and you expect clean water to emerge. Of course, in this context, the meaning of "clean" is somewhat elusive, since the increasing sophistication of chemical detection techniques means that what may have been considered clean just a few years ago can now be found to be tainted by chemicals. Whether the presence of contaminants at the parts-per-trillion level is significant is debatable, but there are some nasties, such as NDMA (N-nitrosodimethylamine), which may present a risk of cancer even at such trace levels. This substance is a byproduct of many industrial processes, but it also forms in water that has been disinfected with chloramines. Interestingly enough, municipal water treatment facilities have been moving to replace chlorine treatment with chloramine treatment because of the byproducts of chlorination. Compounds such as chloroform, formed during chlorination, are potentially carcinogenic. When chloramine is used instead of chlorine, these do not form. But we may be going from the frying pan into the fire, because chloramine treatment leads to NDMA formation, which may be a bigger problem than chloroform.

But there is a solution. Water can be passed through a reactor equipped with ultraviolet lights. The wavelength of UV used, in the 200-to-290-nanometre range, readily breaks bonds in NDMA and causes the molecule to self-destruct. And NDMA is not the only substance susceptible to the destructive effects of UV light. Waterborne bacteria such as E. coli and protozoa such as cryptosporidium and giardia can also be destroyed by ultraviolet light, and when the use of hydrogen peroxide is combined with UV treatment, pesticide residues, pharmaceutical products and endocrine disruptors found in personal-care products are also broken down. Furthermore, UV can also be used to treat waste water from sewage treatment to cut down on contaminants entering the environment. This then places less of a burden on municipal water treatment facilities. Another bonus is that ultraviolet treatment, unlike chlorination, leaves no worrisome residue in the water. It is not the end-all in water treatment, but it is an extremely useful technology to cut down on trace

contaminants in our water supply.

Circe was the sorceress in Greek mythology who drugged Odysseus' crew to make them forget their homeland, then proceeded to turn the men into swine. When Odysseus set out to rescue his crew, he protected himself with an antidote derived from the snowdrop flower. This same antidote is used today in the treatment of what disease?

Alzheimer's. Myths often have some basis in fact. The ancient Greeks knew that an extract of the *Datura stramonium* plant, known today as thorn apple or jimsonweed, had the ability to rob people of their memories and cast them into a hallucinatory state sometimes accompanied by delusions of being turned into animals. The active ingredient in datura is atropine, which has the effect of blocking the action of an important neurotransmitter known as acetylcholine. Neurotransmitters are molecules that transmit information from one nerve cell to another and are responsible for effects ranging from controlling the heartbeat to the retention of memory. Alzheimer's disease is characterized by a deficiency of acetylcholine, and progress of the disease can potentially be slowed by drugs that increase the levels of acetycholine in the brain. One way to do this is by blocking the action of an enzyme known as acetylcholinesterase, which breaks down acetylcholine. As it turns out, the snowdrop, *Galanthus nivalis*, contains a natural acetylcholinesterase inhibitor known as galantamine.

This is what Hermes, the messenger of the gods, advised Odysseus to use to protect himself from Circe's drug-enhanced sorcery. And this is what peasants in the Balkan countries have used for centuries to treat themselves for various "nerve" problems. In the 1950s, a Bulgarian pharmacologist became interested in this folklore and alerted the medical community. Eventually, galantamine was isolated and tested in Alzheimer's patients. The results were not miraculous, but there was a definite slowing of decline and in some cases even improvement in cognition. Isolation from snowdrops proved to be difficult and the yield was low. Researchers, however, discovered that the common daffodil provided an excellent source of galantamine, and chemists also found a way to synthesize the compound in the lab. This, then, allowed galantamine to be extensively tested and paved the way for its appearance as Reminyl in the prescription marketplace. The name was eventually changed to Razadyne, following the deaths of two people who had been mistakenly given a diabetes medication, Amaryl (glimepiride), instead of Reminyl.

When Hermes introduced Odysseus to the snowdrop, he referred to the plant as the "moly," which just may be where our expression "holy moly" comes from.

In 1929, Philip Hensch at the Mayo Clinic observed that patients with rheumatoid arthritis improved greatly if they developed jaundice or if they became pregnant. This observation led to the discovery of what drug?

Cortisone. At the time, researchers had already determined that the adrenal glands, which sit on top of the kidneys, were involved in the body's response to stress. Back in the nineteenth century, Thomas Addison had noted a relationship between shrivelled adrenals and increased susceptibility to infection and had hypothesized that the adrenals must produce some substance that helps the body deal with stress. Hensch, aware of this theory, now suggested that jaundice or pregnancy stress the body, which in turn responds by increasing the activity of the adrenals. Tadeusz Reichstein in Switzerland and Edward Kendall at the Mayo

Clinic eventually isolated a number of steroids from adrenal glands, one of which they identified in 1935 as cortisone.

It took another decade before chemists at the Merck pharmaceutical company were able to synthesize cortisone in sufficient amounts to experiment with therapeutic applications. They showed that in normal doses the compound was important in maintaining the activity of the immune system, but that in higher doses it *suppressed* immune activity, including inflammation. Finally, in 1948, Drs. Charles Slocomb and Howard Polley at the Mayo Clinic injected a rheumatoid arthritis patient, who had insisted on being a guinea pig for whatever experimental treatment was available, with one hundred milligrams of cortisone. The pain relief was almost miraculous. They then tried cortisone in a number of other patients, including one who had been totally bedridden. Upon treatment he got out of bed and attempted to dance! Another patient took seven baths in one day to compensate for the ones she had missed while suffering from arthritis. Unfortunately, there wasn't enough cortisone available to continue treatment, and the patients relapsed. But it was clear that a breakthrough had been achieved.

Today, cortisone and its chemical relatives, referred to as glucocorticoids, constitute an important class of drugs for the treatment of a variety of diseases. As the term implies, these drugs increase blood levels of glucose, the substance the body uses as a source of energy for tasks such as fighting off infections. Higher doses of glucocorticoids, however, have the opposite effect and *suppress* the immune system. Since inflammation is characteristic of increased immune activity, cortisone can serve as an anti-inflammatory agent. That's why it is useful in the treatment of inflammatory conditions such as arthritis, eczema, asthma and Crohn's disease. As always, there is a cost to be paid for the treatment. The increased level of glucose in the blood can lead to diabetes, and depression of the immune system can impair the response to attacks by viruses and bacteria. Weakening of bones, possibly leading to osteoporosis, is another possible side effect, as is the buildup of fatty tissues, causing a "moon face." But there is no doubt that glucocorticoids have had a major positive impact on the practice of medicine, and that Philip Hensch, Edward Kendall and Tadeusz Reichstein were well deserving of the Nobel Prize for Medicine that they shared in 1950.

Why has it become safer in recent years for people with compromised immune systems to walk through Trafalgar Square in London?

Because until recently, Trafalgar Square was carpeted with pigeons. The square is of course a great tourist attraction, and the feeding of pigeons used to be a popular activity for Londoners and tourists alike. But there was a problem: the birds' droppings were unsightly and corrosive to the neighbouring buildings, and the flock, which at its peak was estimated at thirty-five thousand, was regarded by many as a health hazard. And with good reason: a number of infectious diseases are associated with pigeons—or, more specifically, their droppings. The most common one, although still rare, is histoplasmosis, a fungal infection. It is also known as Darling's disease, although there is nothing endearing about it.

Histoplasma capsulatum is a fungus found in bird and bat droppings as well as in soil. When bird droppings are moved about, as when maintenance workers try to clean it up, the fungi can become airborne and can be inhaled. Most people who come in contact with the fungus don't ever realize they have been infected because their immune system deals with it effectively. But immune-compromised individuals—such as those infected with the HIV virus, or patients undergoing chemotherapy—are more susceptible to the ill effects of the disease. Symptoms usually occur three to seventeen days after being infected, with an average of twelve to fourteen days. While symptoms may vary from person to person, the fungus mainly attacks the lungs,

causing respiratory symptoms that are flu-like.

Chronic histoplasmosis can resemble tuberculosis, so it is not easily picked up by a physician. As a matter of fact, 40 per cent to 70 per cent of chest x-rays of those who are infected show up normal. If the disease becomes disseminated, it can lead to multiple organ failure and death if left untreated. Even the eyes can be affected. Ocular histoplasmosis damages the retina and can cause loss of vision that is not unlike macular degeneration. It therefore comes as good news for the immune-compromised that the pigeon population of Trafalgar Square has been reduced. In 2000, the sale of bird seed was terminated, albeit not without controversy. Other measures were also introduced to discourage the pigeons, including trained falcons. Bird supporters and tourists kept feeding the birds, however, which prompted Ken Livingstone, the mayor of London at the time, to enact bylaws in 2003 to ban pigeon feeding within the square. On September 10, 2007, the bylaws were tightened, sealing an outright ban on feeding birds in the area of the square. Now there are relatively few birds in Trafalgar Square, which is used for festivals and hired out to film companies—activities that were not feasible in the 1990s. And, of course, the statue of Lord Nelson that dominates the square is grateful.

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