NewScientist

THE #1 INTERNATIONAL BESTSELLER

DO POLAR BEARS GET LONELY?

AND ANSWERS TO 100 OTHER WEIRD AND WACKY QUESTIONS ABOUT HOW THE WORLD WORKS

From the Authors of the Bestsellers
Does Anything Eat Wasps? and *Why Don't Penguins' Feet Freeze?*

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Weird and Wacky Questions
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Edited by Mick O'Hare

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INTRODUCTION

It's a fair bet that you've never considered what compels you to choose random numbers in the Lotto draw. But now that we've told you that you do, you'll almost certainly want to know why. If you are truly perplexed, turn now. And has it ever struck you that if you go back forty generations your ancestors will total more than the number of people who have ever lived? How can that be? Find out the flaw in the logic. And what about eating bits of yourself in order to stay alive … you might not like what we suggest. Come to think of it, *we* don't like what we suggest.

For nearly fifteen years the readers of *New Scientist* magazine have been contributing their astounding knowledge to the "Last Word" column of science questions and answers. We now know why cheese goes stringy and what time it is (or isn't) at the North Pole. We know how to weigh our heads and we certainly know why penguins' feet don't freeze. We've also put to rest a couple of urban myths along the way—to find out if human hair and fingernails really do continue to grow after death. And we've also been happy to admit our own errors. To find out just how humiliated we were by a few broken drinking glasses.

But that's all part and parcel of scientific investigation. You propose a hypothesis, bash it about a bit, run a few experiments on it and then reject it or accept it while fine-tuning it along the way. And like all great scientists, that is exactly what the contributors to this book have done—deduced answers from the evidence available and then been supported or contradicted by their peers, which is what makes the "Last Word" column—and this book—such fascinating reading.

Both in the weekly magazine and online, *New Scientist's* community of "Last Word" readers continues to come up with the answers to the world's strangest questions. And more people are always welcome. You can pose your own questions or answer new ones (or even contradict those who have gone before) by buying the weekly magazine or visiting the website (http://www.newscientist.com/lastword). There you can join in the forum, read the blog, or simply offer your knowledge in answering some of life's astounding conundrums. You may even become the star of the next book!

In the meantime enjoy this one, in which we seem unduly concerned by thirst—you can find out in chapter 5 whether fish, sharks, or spiders get thirsty and, along the way, satisfy your own thirst for the world of scientific trivia.

MICK O'HARE

A big thank-you is due to Jeremy Webb, Lucy Middleton, Ivan Semeniuk, the production, subbing, art, Web, press, and marketing teams of *New Scientist*, James Kingsland, Frazer Hudson, and Paul Forty and Andrew Franklin among many people at Profile Books for their tireless efforts in the creation of this volume. I also thank Robin Dennis, my editor at Henry Holt and Company in New York, for bringing this project to the States. Thanks as well to the team at Holt, including Justin Golenbock, Emi Ikkanda, Tom Nau, Rita Quintas, and Kelly Too, for their hard work. Special thanks are also offered to Sally and Thomas for their patience while this book and its

predecessors were created. Finally, good luck to Ben Usher on his travels.

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FOOD AND DRINK

TWIN CHICKS

Upon cracking open my breakfast boiled egg, I found a whole new egg inside. It was not a double-yolked egg, it was a double-egged egg—a completely new egg with a shell and yolk inside another. Can anybody explain it?
Liam Spencer

An egg within an egg is a very unusual occurrence. Normally, the production of a bird's egg starts with the release of the ovum from the ovary. It then travels down the oviduct, being wrapped in yolk, then albumen, then membranes, before it is finally encased in the shell and laid.

Occasionally an egg travels back up the oviduct, meets another egg traveling down it, and then becomes encased inside the second egg during the shell-adding process, thus creating an egg within an egg. Nobody knows for sure what causes the first egg to turn back, although one theory is that a sudden shock could be responsible. Eggs within eggs have been reported in hens, guinea fowl, ducks, and even Coturnix quail.

Incidentally, it is especially unusual to encounter this phenomenon in a shop-bought egg, because these are routinely candled (a bright light is held up to them to examine the contents), and any irregularities are normally rejected.

Alex Williams

As the curator of the British Natural History Museum egg collection, I've come across quite a few examplesegg/b>

The Dominican friar and polymath Albertus Magnus mentioned an "egg with two shells" as far back as 1250 in his book *De animalibus*, and by the late seventeenth century pioneering anatomists like William Harvey, Claude Perrault, and Johann Sigismund Elsholtz had also given the phenomenon their attention.

Four general types occur—variations of yolkless and complete eggs—but this form in which a complete egg is found within a complete egg is relatively rare. Several theories have been proposed for the origin of these double eggs, but the most likely suggests that the normal rhythmic muscular action, or peristalsis, that moves a developing egg down the oviduct malfunctions in some way.

A series of abnormal contractions could force a complete or semi-complete egg back up the oviduct, and should this egg meet another developing egg traveling normally down the oviduct, the latter can engulf the former; more simply, another layer of albumen and shell can form around the original egg.

Often when no yolk is found within the "dwarf" or interior egg, a foreign object is found in its center. This object has served as a nucleus around which the albumen and shell were laid down, in a process not dissimilar to the creation of a pearl.

Anybody interested in learning more about this subject should try to find a copy of *The Avian Egg* by Alexis Romanoff and Anastasia Romanoff (New York: John Wiley & Sons, 1949) and read pages 286–95.

Douglas Russell
Curator, Bird Group, Department of Zoology
The Natural History Museum, Hertfordshire, United Kingdom

A ROUND FIGURE

Why do bottle caps on beer bottles—at least the few hundred thousand that I have drunk from—always have twenty-one sharp bits?
Volker Sommer

We have three explanations for this one. We're still waiting for a bottle-top aficionado (of which there seem to be many) to rule between them.—Ed.

The bottle cap on any bottle is regulated by the internationally accepted German standard DIN 6099, ensuring all bottle caps are the same. Along with specifying the diameter of the bottle neck, the form of the rim around which the cap is crimped, and the materials the cap may be constructed from, this document specifies the form of the crimp. One requirement is that the closure be sufficiently circular to maintain a tight seal all around the circumference, which implies a high number of crimps (and thus points). It must also be robust, however, which implies reducing the number of crimps to give each anaos=0 Dcrimp a larger bearing surface. Using twenty-one crimps is a good compromise between these requirements and is mandated in the standard. As to why it is twenty-one crimps rather than twenty or twenty-two, the best answer is simply "because it is."

S. Humphreys

Through trial and error, William Painter, the inventor of the crown cork, or bottle cap, discovered that the optimum number of teeth on a mold made of steel for securing carbonated drinks was twenty-four. He registered a patent for his design and for many years the twenty-four-tooth capping mold was standard. However, around 1930 the steel mold came under threat from a cheaper version made of tinplate. This newer mold could not win a patent if it also had twenty-four teeth, so it was changed to twenty-one to avoid infringing the original design. The new figure is the smallest number of teeth needed to prevent leaks and is now used across the world.

Chitran Duraisamy

The crown cap was patented by Painter on February 2, 1892 (U.S. patent 468,258). It originally had twenty-four teeth and a cork seal with a paper backing to stop drink and metal touching. The current version has twenty-one teeth.

The twenty-four-tooth caps were originally fitted to bottles one by one using a foot-operated press. When automatic machines were adopted, the crown caps were loaded into circular feed tubes and the twenty-four-tooth caps frequently jammed. With an uneven number of teeth this doesn't happen, and because the sealing quality of twenty-three teeth was no better than twenty-one, the smaller number was adopted.

The height of the crown cap was also reduced and specified in the German standard DIN 6099 in the 1960s. This also defined the "twist-off" bottle cap that is widely used in the United States.

Barry Painter

CEREAL KILLER

Most healthy people I know eat cereal or fruit for breakfast. This gives complex carbohydrates for long-term energy. But I have a physical job as a gardener and I know if I rely on this intake I'll be ravenous by 10 A.M. On the other hand, if I have eggs, I'll be fine until midday. Clearly I need protein, but that shouldn't give me energy. What is going on, and is this common?

Steve Law

It may be that your hunter-gatherer ancestry is responsible for the favorable response to your morning serving of eggs. In the course of human evolution we have become physiologically adapted to the diet that prevailed for most of that time: that of a hunter-gatherer. This diet is assumed to have been dominated by lean meats, fruits, and vegetables. Cereal grains, on the other hand, are a relatively new addition to our diet, having found their place on the dinner table with the onset of the agricultural revolution only ten thousand years ago.

It has been suggested that our pre-agricultuan>os=0 Tral diet is the best way to support healthy physiological function, including improved energy production and appetite control. One of the characteristics of this diet is a low "glycemic load," which means glucose is released slowly into the blood as food is digested. Another is a higher level of lean protein than that eaten by modern humans. These characteristics are found in your eggs, whereas most breakfast cereals and fruit have higher glycemic loads and lower protein content.

The low glycemic load of your meal may help to stabilize your blood sugar level, sharp drops of which precede an increase in appetite. The protein in eggs is also a strong inducer of cholecystokinin, a gut-derived satiating hormone. And carbohydrate is not the only source of energy in our diets. The fat in your breakfast eggs provides approximately double the energy of carbohydrate, albeit in a slow-release form.

Benjamin Brown
Technical Research Officer
Health World, Queensland, Australia

SACRED DNA

Animals and plants share a common genetic ancestry, so perhaps vegetarians who refuse to eat meat on ethical grounds should avoid anything that has DNA at all. Is this feasible? Could anybody suggest a menu?
Richard Ward

I'm not aware of any living organisms that don't have DNA, so you'd have a hard time eating any tissues or cell cultures. You could try eating RNA viruses, but you'd need to produce them in a cell culture, which generally requires animal serum to keep the cells alive. Your food wouldn't contain DNA, but you would have used dead animals to produce it.

One cheat that springs to mind is red blood cells. In many species, including humans, the nucleus and mitochondria are removed from these cells during the maturation process. This is to make room for more hemoglobin, the iron-bound protein that carries oxygen. Because the nucleus and mitochondria contain all the cell's DNA, you could argue that provided you don't kill the animals, drinking their blood is the ultimate vegetarian diet. You'd need to filter out the white blood cells, which still have plenty of DNA, but the rest of the blood components would be fine. They'd provide you with protein, some sugars, and vitamins, but probably more iron than is healthy.

If that doesn't sound appealing, consider totally (bio) synthetic foods. Biologists routinely construct yeast and bacterial lines designed to churn out large quantities of a specific protein or other biological molecule. I assume it would be possible to scale this production up to produce sufficient quantities of purified proteins, sugars, and so on to act as a food source. Don't expect it to be tasty, though: the proteins and sugars produced would be purified from the culture as crystalline powders. I'm not sure whether it's possible to produce fats like this without killing the cells, but if you did the result would either be oil or a pretty nasty goo. Also, maintaining the cultures required to produce this stuff would rely on antibiotics to kill contaminant organisms, so going against the spirit of the idea.

~~Many, perhaps all, of the various vitamins and other nutrients we require could probably be synthesized in similar ways, given time and cash. The various mineral compounds we need—iron, copper, zinc, iodine, and so on—are probably available from a good synthetic chemist. And, of course, you could drink milk. It's a complex mixture of secreted proteins, fats, sugars, and pretty much everything else you need to stay alive. It may contain cells from the animal which produced it, but you could probably centrifuge these out.~~

Christopher Binny

All I can come up with is a dish of baked retrovirus served on a water biscuit made from purified starch, fried in a purified fat of choice, and seasoned with salt and vinegar. For the sweet course you might try a sorbet of snow sweetened with a purified sugar, honey, or syrup, a touch of citric acid for bite, and with added vitamins, trace elements, and essential oils to taste. It should be washed down with any spirit, or any wine or beer filtered to remove yeast traces.

Bryn Glover

I found the following information on the wall of the Johnson Space Center in Houston, Texas. One cubic meter of lunar soil contains enough of the right elements to make a cheeseburger, an order of fries, and a fizzy drink. That would contain no DNA, but might be a little expensive.

Graham Kerr

I considered this some years ago and put my conclusions in the form of a cookery book, available online at http://www.cs.st-and.ac.uk/~norman/Shorts/inorganic.html.

Norman Paterson

To whet your appetite, here's a recipe from Norman Paterson's book.—Ed.
For four malachite burgers you will need:

> Four slices of Welsh slate
> 1 kilogram of malachite
>
> Cut the slates in two. Break up the malachite with a sledgehammer. Divide the malachite equally among four slates and cover with the remaining four. Bake at 2200°F for twelve hours, by which time the malachite should be a beautiful bubbly green. Cool and eat. Excellent for picnics, as they can be prepared the century before. A dry, gritty flavor.

Most people who are vegetarian on ethical grounds oppose killing animals. They are rejecting the senseless deaths of the animals and the inhumane way the animals are treated, rather than worrying about similar DNA. Vegetarians have nothing against eating vegetable matter and fungi because these have no central nervous system and thus cannot experience pain.

Ceridwen Fitzpatrick

If all plants and animals have common DNA ancestry, then perhaps we are all vegetarian as vegetaris. Or if we are all also vegetables, maybe the world is awash with cannibalism.

Or perhaps vegetarians can eat their neighbors without feeling too much guilt. By the "common DNA" logic this is no more or less cannibalistic than eating a radish. The only solution to all these dilemmas would be for every creature to subsist purely on nonliving minerals and nutrients. Nonhuman animals, however, are unlikely to stop eating what they want.

Brian Falconer

STUFF THAT

I cooked some poultry stuffing and left it in a bowl in the fridge overnight, covered with aluminum foil. In the morning there were holes in the foil where it had touched the stuffing, which was stained black under each hole. Uncooked stuffing does not

produce this effect, and it makes no difference whether the stuffing is cooked inside the bird or separately. What is going on here, and are the black stains poisonous?
Andrew Stiller

Without its submicroscopic insoluble skin of oxide, aluminum cookware would catch fire easily. Fortunately, this is not usually a problem. Normally, breaks in the oxide skin of aluminum heal instantly when the exposed metal reacts with, say, air or water. But if, for example, mercury or certain alkalis or acids dissolve this skin, the exposed underlying metal reacts vigorously. So, while aluminum cookware and foil are safe and useful in the kitchen, it is important to keep them away from strong salt solutions or caustic soda, for example, and also from wet food when it is not actually cooking.

This is because wet, fatty materials, such as cooked lard, form fat-soluble detergents that penetrate microscopic chinks in the oxide layer, exclude air that otherwise would reseal the skin, and corrode pinholes into the metal. If floating fat has coated the metal, even cold chicken soup can eat through a thick aluminum pot overnight.

The black stain is mainly from small amounts of iron in the aluminum. It is not deadly, but it is better not to eat food contaminated with high levels of metals, which also spoil the taste. For wrapping cooked fatty or acidic food for more than short periods, plastic film is much better.

Jon Richfield

THE SPRING IS SPRUNG

The mineral water in my local shop has a label telling me it is from a three-thousand-year-old source, yet there is still a "best before end" date on it approximately two years in the future. If the water has been in its aquifer for three thousand years, why should it go bad in a sealed bottle?
Lewis Smith

Mineral water has passed through layers of rock that have different effects on the water.b>

The small pore size of the rocks that the water passes through acts as a filtration system, improving the purity of the water by removing larger molecules such as biological contaminants. As soon as the water emerges it is vulnerable to contamination again. The "best before" dates are based on the amount of time the bottler believes the water will remain without measurable levels of contamination due to the lack of completely sterile conditions in their bottling plants.

If the water is stored in a plastic bottle the date might also relate to contamination from the constituents of the plastic, which may change the taste of the water.

John Thompson

The reason for the "best before" date on bottled spring water is not the contents but the container. Most mineral or spring water is packed in polyethylene terephthalate (PET) bottles. During the manufacture of the bottles, traces of catalyst or plasticizer, which may include antimony, remain in the plastic and are leached out into the water over time. To avoid this, glass bottles, which have stood the test of time, are preferable.

Rob Davids

"Pure" water does not decompose or suddenly go bad. However, manufacturers of foods and beverages have to give "best before" dates to cover their backs. If the bottle sat around for long enough the plastic might decompose or the seal might degrade, allowing bacteria to enter and contaminate it.

As for the water being three thousand years old, in fact most of the water we drink has probably been in existence as water molecules for millions of years. What is important is the purity of the water, not its age: three thousand years in an underground aquifer may have filtered out all the organic matter, but it may still contain harmful dissolved chemicals such as arsenic.

Simon Iveson

TASTEFUL MATTERS

Why do cooked foods taste different after they have cooled from the way they tasted when they were hot?

Alan Parson

Cooked, solid foods are not static substances. Chemically and physically they are complex dynamic systems, continuously changing without stopping to suit anybody, so there are penalties for eating them too early or when they are past their best.

Cooking or cooling changes various substances in foods, affecting composition and flavor. Yesterday's leftovers have undergone reactions, including oxidation and the evaporation of aromas and flavor components. Food also changes physically on cooling, by congealing, crisping, or crystallizing, for example. These changes may prevent some substances from reaching the nose or the tongue, or expel or redistribu **ve c sysincludinte fluids. Few such changes reverse precisely on reheating, just as one cannot uncook food by chilling it.**

Some changes are desirable, such as the setting of jelly or ice cream, but it is not for nothing that various foods are prepared at a particular temperature. Fresh hot food presents copious aromas in particular balances that reheating can never recapture.

Colin Collinson

Only a small amount of the taste of food is detected by the tongue, where taste buds recognize just five specifics: bitter, salt, sour, sweet, and umami (or savory). The majority of what we call "taste" is more specifically described as "flavor" and it comes from odor identified by nasal olfactory cells. That requires the flavor molecules to be wafted up from the mouth. This is more readily achieved when food is hot, creating convection currents and making odor molecules—as well as water molecules—volatile and mobile.

Water from food and saliva can dissolve flavor molecules so those more readily reach the taste buds while flavor vapors hit the nose. Having a cold that blocks the nose is even more effective in reducing flavor than eating food cold, and can make apples and onions indistinguishable.

Elisabeth Gemmell

FLAT REFUSAL

Why are fizzy drinks such as cola or champagne far more appealing than the same liquid once it has gone flat?
Olaf Lipinski

Most fizzy drinks are made so by injecting carbon dioxide into the liquid at high pressure. Carbon dioxide dissolves readily at atmospheric pressure, but the high pressure allows even more to be dissolved. It forms carbonic acid in the drink, and it is this which gives the drinks their appealing “fizzy” taste—not the bubbles, as many people believe. When the drink goes flat, most of the dissolved carbon dioxide has been released back into the atmosphere, so the amount of carbonic acid is also reduced.

The fizzy taste is more appealing than the flat one simply because the drink was meant to be fizzy. Cola and champagne are concocted with the fizz in mind, using the carbonic acid as an essential ingredient in the flavor, so they will naturally taste better when the drink is still fizzy. When they go flat, this means that one of the main flavors has disappeared, and the overall taste will change—usually for the worse.

Martin Roos

A good taste is a matter of blended, often contrasting, sensations and expectations. These include temperature—for hot and cold drinks, say—sound and texture for chips or creams, plus aroma, flavor, and stimuli on the tongue. Fizz is generally created from carbon dioxide, though pressurized air also lends some noncommercial spring waters a certain liveliness. A good fizz tickles the nose and splashes minute stimulating droplets around the mouth as you drink.

Dissolved carbon dioxide has a distinct taste of its own, which is slightly sharp. Flat beverages have lost this bite. Going flat upsets the balance of the flavors and other stimuli, and without them such a drink is likely to taste insipid or too sweet, and … well … flat.

Jon Richfield

A side effect of taking the drug acetazolamide is that all carbonated drinks taste flat. Acetazolamide is used to help prevent altitude sickness by pre-adjusting the acidity of the blood to acclimatized levels. This also counteracts the acidity caused by carbonic acid in fizzy drinks, making them taste as if they were flat. I experienced this odd phenomenon firsthand last summer while drinking a soda before climbing Tanzania’s Mount Kilimanjaro.

David Clough
University of Cambridge, United Kingdom

NO WRINKLES

How do they get the smooth, round chocolate coating on confectionery like Whoppers?
BBC Radio 5 Live listener

I spent six months making Smarties, a similar type of confectionery, in 1977. The chocolate centers were tumbled in a device resembling a cement mixer that gave them repeated coatings that alternated between sweet starchy liquid and powdered sugar, blow-dried after each coat. It took a week or two to learn the knack of ensuring an even coating: we had to remove clumped material, get the right combination of wet and dry, and keep the layers thin. Trainees' lumpy sweets were sold off cheap.

I handled about a ton of chocolate centers a day, putting on the white inner coat. More experienced workers did the outer candy coating, in similar "cement mixers," and the finished product was polished by tumbling the sweets in powdered beeswax, except for the black ones, for which petroleum jelly was used, apparently to avoid a whitish bloom.

Significantly, this was not a conveyor-belt manufacturing process. Each worker controlled their own rate, taking anything from an hour to an hour and a half per batch, depending on experience.

Peter Verney

MINIMUM DAILY REQUIREMENTS

I have heard that a family of four can be kept fed 365 days a year using only about 9.5 square yards of land. Is this really possible anywhere in the world? Could it really take only two hours a week as was suggested, and what would be on the menu?
Jan Horton

Opinions differ. There may be no def="0 ve >

Energy flow is a key issue. The sun's intensity at the Earth's surface depends on latitude and season. The average value over a twenty-four-hour period across the whole of the Earth's surface is about three hundred watts per square yard. Therefore each day, a 1-yard-square plot receives an average of about twenty-six megajoules of energy—more close to the equator. The recommended dietary intake is about two thousand kilocalories a day. So, in theory, an average 1-yard-square plot receives enough solar energy to support three people. However, photosynthesis has an efficiency of only 10 percent so you would need more than 3.5 square yards per person. The figure of 2 square yards per person might just be achievable near the equator, although this seems optimistic.

There are also difficulties in getting the required nutrients and minerals, and in seasonal reductions in output.

Simon Iveson

I don't weigh my garden produce, but this year I did grow enough to fill a freezer, plus the produce my family ate fresh. All of this was grown on two small patches of land totaling about eight square yards. I believe I could have grown the minimum daily requirements for two, or possibly even four, if that had been my intention.

The produce—interspersed and rotated—included runner beans, sugar snap peas, onions, parsnips, raspberries, strawberries, spinach, broccoli, cauliflower, and blackberries. I grew carrots, tomatoes, cucumbers, peppers, zucchini, and herbs in pots on a one-square-yard shelf in my greenhouse.

I grow more intensively than advised by seed packets, and I start most of the outside crops in a heated greenhouse in winter. Some crops, such as beans, take up very little ground space, and crop rotation makes good use of space. In addition we eat wild fare, such as rabbits, and we could have supplemented our diet in various other ways had we not preferred to encourage the wildlife rather than eat it. Two hours a week on a plot this size is plenty of time.

But could it work anywhere? The soil in my garden has been cultivated for generations. I recently started a vegetable patch in an uncultivated part of the garden and the result was poor. And I'm not sure I could have grown enough to feed us out of season without a greenhouse or freezer.

Tony Holkham

My family has decided that it would be possible to feed a family of four from 9.5 square yards of ground for a year if we were only producing vegetables.

You can grow climbing beans up poles along the rear of the plot and freeze the surplus. You can also grow trailing plants, such as pumpkins or cucumbers, within the plot, but let them trail outside it. Silver beet can be cropped continuously and potatoes can be grown in a stack of old car tires. Similarly, tomatoes and Brussels sprouts grow upward and you can bottle or freeze surplus tomatoes.

Herbs can be grown in pots with multiple openings, as can strawberries. Carrots, parsnspaple ips, rutabaga, and turnips can be grown between the tall plants. You need to stagger the plantings a little and freeze any surplus. Radishes are fast growing, so they need little space at any time, while celery is a "narrow" plant and the surplus can be frozen.

Keep seeds each year and store or barter the surplus seeds or grown vegetables for goods to preserve.

My garden is a little bigger than 9.5 square yards, but I haven't had to buy green vegetables (or eggs) for a family of three for longer than I can remember. In our case we also have chickens, which fertilize the soil and enter the equation themselves because they provide food (but take up space).

The vital part of this equation, however, is growing vegetables that can be stored or preserved.

Sandra Craigie

The difficulties inherent in calculating the food output of land are shown by the fact that our first correspondent above, Simon Iveson, later revised his calculations:

Since answering this question, I have thought of two important additional points.

First, the human body is not able to metabolize 100 percent of the energy stored in the plant material that it eats, so this would increase the land area needed to feed a person. Presumably the exact percentage we can metabolize depends on food type.

Second, cloud cover would reduce the amount of direct solar radiation that reaches the Earth's surface, further increasing the land area needed per person.

Two square yards is starting to look unfeasible.

Simon Iveson

AS TIME GOES BY

Why does red wine become lighter in color as it ages, but white wine become darker?
Volker Stuck

Color maturation in wines is just one small aspect of a very complicated chemical process. When red wines age they gradually turn from a deep purple color to a light brick red. Red wines are kept in contact with the grape skins throughout fermentation. During this process, blue/red-colored phenolic compounds called anthocyanins leach from the skins into the wine. As the wine ages, small amounts of oxygen react with anthocyanins and other, mostly colorless, phenolic compounds, causing them to polymerize and form pigmented tannins. Over time, these produce the brick-red color. Often tannin complexes grow as they react with other wine constituents, such as proteins, and many become too large to stay in solution and precipitate out, leading to the sediment you may find in aged wines.

White wines start out in bottles with a greenish tinge (young wines in Portugal are called *vinho verde*) and end up with a browner hue. White wines are not fermentht Ted with the grape skins, so they contain vastly lower levels of phenols, and therefore tannins. Also, white grapes do not contain anthocyanins—otherwise they would not be white. Consequently those few tannins found in whites are nonpigmented. It is presumed that white wines become browner with age because of the slow oxidation of what few phenols are present. A similar process can be observed in the discoloration of a half-eaten apple.

One interesting side note is that anthocyanins are only found in the skins, so it is possible to make white wine from red grapes if the skins are removed. White zinfandel, common in the United States, is an example of this.

Oliver Simpson

It was stated in a previous answer that "young wines in Portugal are called *vinho verde*." This is in fact incorrect. *Vinho verde* is a wine made with certain types of grapes in a certain region of Portugal, and there are white and red *vinhos verde*.

Although *vinho verde* should indeed be drunk while young (with the possible exception of *alvarinho* styles), the name itself does not imply youth.

Antonio Brito

QUESTION OF TASTE

Why does garlic make your breath smell in a way that, say, lettuce or potatoes do not?
Chris Goulding

Garlic produces a potent antifungal and antibacterial compound called allicin when the clove is cut or crushed. This is created by the enzyme alliinase acting on a compound called alliin. Allicin is responsible for the burning sensation you experience if you eat garlic raw.

However, allicin is not stable and generates numerous smelly sulfur-containing compounds, hence its pungent smell. After ingestion, allicin and its breakdown products enter the bloodstream through the digestive system and are free to leave again in exhaled air or through perspiration. This is the first effect of garlic.

In addition, the chemicals in garlic change the metabolism of the body and trigger degradation of fatty acids and cholesterol in the blood: this generates allyl methyl sulfide, dimethyl sulfide, and acetone. These are all volatile and can be exhaled from the lungs, giving you garlic breath the morning after a meal. It is not necessary to eat garlic to have garlic breath because allicin can be absorbed through the skin. Just rubbing garlic on the surface of the body can be enough to generate smelly breath because it exits the body via the lungs.

The only real solution to smelly breath from garlic is for us all to eat it.

Peter Scott
School of Life Sciences
University of Sussex, United Kingdom

Garlic owes its pungency and subsequent halitosis-producing qualities to a variety of sulfur-containing compounds that are produced after cutting the cloves, some more transient than others and with a variety of health-giving properties. Sulfur is responsible for some of the smelliest substances known, from the brimstone stench beloved of vulcanologists and the rotten-egg smell of hydrogen sulfide to the potent secretions of the skunk.

Geoffrey Chaucer made a comment on alchemists of the fourteenth century in his own inimitable way:

> Evermore where that ever they gone
> Men may hem ken by smell of brimstone;
> For al the world they stinken as a gote …

Paul Board

CHEESE SCRUB

Mold has always been a menace on my blocks of Gouda and Edam cheese, which I store under a cheese cover. Recently my wife told me to put a lump of sugar under the

cover with the cheese, and I have not seen mold since. The sugar gets moist and slowly dissolves, but nothing else seems to happen to it. My wife learned this from her mother, and so it must be an old and possibly widespread remedy. Why and how does it work?
Georg Thommesen

This habit is also common in northern Germany, where the explanation given is quite simple. The sugar lump takes up moisture from the air trapped under the cheese cover, slowly dissolving as it does so. The relatively dry air reduces the suitability of the environment for cheese molds.

David Fleet

The sugar cube absorbs water, lowering the relative humidity, so that mold can no longer grow on the surface of the cheese. Salt would work just as well, as would saturated solutions of sugar or salt—saturated solutions are those that still contain some undissolved sugar or salt.

This forms the basis of humidity control in museum display cabinets. If the humidity is too high, undesirable molds grow, but if it is too low, wood and leather might crack. Saturated solutions of different salts can peg the relative humidity anywhere from 10 percent to 90 percent. For example, a saturated solution of lithium chloride will maintain a relative humidity of 11 percent, while a saturated solution of common salt keeps the relative humidity at around 70 percent.

John Hobson

The sugar will draw liquid from the air by its intrinsic hygroscopicity—its tendency to absorb moisture. This is the reason sugar cakes in the damp, and in the process it will suppress the growth of mold or bacteria.

The mechanism is related to the one that protects honey from microbial growth. Honey is so effective at this that it was once spread on wounds to prevent infection. Honey suppresses mold and bactuti are terial growth thanks to its high concentration of sugar. By drawing water away from its surroundings, the sugar desiccates any fungal and bacterial cells and spores in the honey. Cells must feed to reproduce and so they absorb food in contact with their cell membranes or which their excreted enzymes have released. Sugar in the honey will draw water out of the cell, which will either kill it or encourage it to live on in the spore phase and eschew reproduction until it encounters a more benevolent environment. This is the spore's job, and so it sits and waits and ceases to be active in the honey.

Bill Jackson

SHAPING THE MOLD

I discovered a pear that had started to go bad in my fruit basket. The first evening it had a perfect bull's-eye pattern of mold. Sixty hours later it had grown more (partial) rings of mold. Another forty-eight hours later it had grown still more partial rings, always separated by the same gap and all still roughly concentric. At that point it was getting pretty rotten, so I threw it away. But what causes the mold to grow in rings?