New Scientist

Will We Ever Speak Dolphin?

and 130 more science questions answered

More questions and answers from the popular 'Last Word' column

edited by Mick O'Hare

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Introduction

Ian Fleming, the author of the James Bond spy novels, really didn't know what he had started when he decided the fictional spy should order his vodka martinis shaken, not stirred. First it became one of the most famous catch-phrases in movie history. Now it's become the subject of an entire chapter in this latest edition of science questions and answers from *New Scientist*. Just why did Bond want that martini stirred? The debates have raged long and hard down the years but now we think we've cracked it. Turn to page 88 for the full lowdown on the science of Bond's iconic tipple. We think there's very little more to learn now, but conceit is the downfall of any scientist, so if anybody out there knows better our contact details are below.

And not only did James Bond enjoy his martinis, he also had – according to the screenplay of *Thunderball* – a double first in Oriental Languages from Oxford University. So if he hadn't been a fictional character, he'd have been just the person to answer the title question of this book (see p. 85). As an accomplished linguist, if Dolphin could be learned, he'd have learned it – not least because it would have come in handy in *The Spy Who Loved Me*. It's surely not improbable that undersea megalomaniac and archetypal Bond villain Karl Sigmund Stromberg had been learning Dolphin as part of his evil plan to relocate the human species underwater, so Bond too would surely have swotted up to ensure he could foil yet another madman. Unlikely, you say? Well, it's perhaps not as improbable as the fact that in more than twenty movies

Bond has been shot at more times than any other fictional hero, yet never taken that final, fatal bullet. Check out just how improbable on p. 102.

Of course, there's more to this book than a fictional spy and his foibles. Do you know why we become hoarse when we shout, whether it's better for the planet if we all become vegetarians, or why we want to urinate more in cold weather? Well we didn't either until somebody bothered to get in touch and ask us and then somebody else gave us the answer. The Last Word column in *New Scientist* magazine – which gave birth to this book and its bestselling predecessors including *Does Anything Eat Wasps?* and *Why Don't Penguins' Feet Freeze?* – has been answering everyday science questions from the general public since 1994. You can ask one yourself or, even better, answer one by buying the weekly magazine or visiting us online at www.newscientist.com/lastword.

This volume, of course, contains all new material save for a small number of the answers at the start of Chapter 4 which provide background science to the vodka martini story. Now grab your vodka, your vermouth and your olive jar and read on. And after you've shaken or stirred do let us know if you disagree with our cocktail of conclusions. There may still be another chapter waiting to be written on Bond's favourite drink.

Mick O'Hare

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1 Food and drink

Squeaky cheese

Why does halloumi cheese squeak against your teeth as you eat it?

Nikos Skouris
Nicosia, Cyprus

This is an example of the stick-slip phenomenon. The cheese is rubbery and as your teeth begin to squeeze it, the halloumi deforms with increasing resistance until it loses its grip and snaps back to something like its original shape. At the point where the slipping stops it regains its grip and the process repeats, commonly at a frequency near 1000 hertz, give or take an octave or two. The vibration produces a squeal of corresponding frequencies that may vary with the circumstances, such as whether the cheese has oil on it.

Squeaky halloumi is enough to make some people's toes curl, like fingernails dragged down a blackboard. This is because such sounds often warn of injury – a broken bone grating – or an unpleasant sensation, such as sand in your teeth, or stone abrading fingernails.

Probably long before our ancestors evolved into apes, they developed an inherited distaste for such noises and the associated sensations. It was likely an evolutionary adaptation to their way of life; those who did not respond to the signals tended to have shorter and less productive lifespans.

Jon Richfield
Somerset West, South Africa

Cereal cement

My two favourite breakfast cereals are Shreddies and Weetabix. When I've finished, the remnants in the bowl look similar, but I can always tell which was which: a Shreddies bowl can be washed up quite easily, while Weetabix clings like cement. Why the difference?

Frank Johnson
Birmingham, UK

As a lifelong consumer of Weetabix, I feel qualified to answer this question. Both Shreddies and Weetabix contain a high proportion of starch, which can form an adhesive paste with water. This phenomenon is well known to bookbinders because it is used to make paper.

Starch consists of a mixture of amylose and amylopectin, polymers that can absorb water to form a gel. As the gel dries, the water is expelled and bonds between the molecular chains reform, creating a semi-crystalline 'cement' which will adhere to any adjacent surface.

This effect is much more noticeable with Weetabix than Shreddies simply because Weetabix is made of fine flakes of cereal compressed together, while Shreddies are made from longer strands. That means Weetabix has a greater surface area of adhesive in contact with the bowl, making it more difficult to clean.

Chris Sugden
London, UK

I have no experience of Shreddies, but am familiar with the Weetabix problem. So while I don't know the difference between the properties of the two cereals, I can give this advice to your correspondent. Soak the used Weetabix bowl for a few minutes, rather than a few seconds, before cleaning – it makes it much easier.

David Purchase
Bristol, UK

A spoonful of sugar...

If I leave my jar of brown sugar standing overnight, the surface crystals will bind together and I will need a spoon to scrape and loosen them so I can pour the sugar out. What property of brown sugar causes the surface to bind together so quickly?

Peter Franks
Sydney, Australia

This question was really nostalgic for me. Many years ago I collaborated with David Bagster, a chemical engineer at the University of Sydney, whose research career was dedicated to the wayward properties of unrefined sugar and how to overcome them to allow it to be handled in bulk.

Raw or brown sugar crystals have a permanent liquid layer on their surface. Normally this is apparent only as an obvious stickiness but if it can evaporate, as in your correspondent's sugar jar, the sugar in the surface layer will crystallise and cement the grains together. In cold weather the sugar can crystallise throughout the whole mass, turning it solid.

Bagster told me of a spectacular case of this, in which a bulk transport ship took on a load of raw sugar in the tropics destined for a cold-water Russian port. On arrival the sugar had set like rock and was immovable. The last I heard, the situation hadn't been resolved and the ship was still clinging on to its load.

Guy Cox
Australian Centre for Microscopy and Microanalysis
University of Sydney
New South Wales, Australia

If the humidity around brown sugar is low then it will dry and clump into hard pieces, making it difficult to pour. This happens to my brown sugar even in a jar with a lid.

To prevent this, during the winter months I put a piece of bread or apple peel into the container. The sugar then stays moist and free from clumping.

Gina Kirby
New Maryland, New Brunswick, Canada

Those garlic blues

I made a salad dressing with olive oil, apple cider vinegar, garlic cloves chopped into halves, fresh ginger, mixed herbs and mustard powder. When the dressing was finished I put a lidded jar of it in the fridge, and two days later topped it up again with fresh ingredients. The following day the garlic from the original batch had turned bright blue. Why?

Ellice Bourke
Katherine, Northern Territory, Australia

The discolouration is the result of some complicated chemistry involving the garlic's flavour compounds. The phenomenon is confusingly called 'greening', and the food industry has encountered enough accidentally coloured batches of processed garlic for it to have generated some interest.

In the traditional Chinese pickle of garlic cloves in vinegar known as Laba garlic, the colouration is intentional. Chemists have speculated on its cause since at least the 1940s, and in the last few years Chinese and Japanese researchers have worked out what is going on.

The flavour of garlic is generated when an enzyme called alliinase acts on stable, odourless precursors. These are normally in separate compartments in the cell but can combine if there is damage, including that caused by vinegar. The major flavour precursor in garlic is alliin (S-2-propenyl cysteine sulphoxide) while a minor one is isoalliin ((E)-S-1-propenyl cysteine sulphoxide).

Key to the colour change is a product of these reactions called di-1-propenyl thiosulphinate. It can react at slightly acid pH with amino acids from the ruptured cells to form pyrrole compounds, which are then linked together by di-2-propenyl thiosulphinates to form dipyrroles. These are reddish purple, but as the cross-linking continues, molecules with deeper and bluer hues are formed. Among these are compounds called phycocyanins, which are related to chlorophylls and are found in some algae that are used as blue colouring by the food industry.

Keeping garlic somewhere cool increases the amount of isoalliin present, which is why the best Laba garlic is produced several months after harvest. It probably also explains the blue garlic halves in your questioner's salad dressing taken from the fridge.

Isoalliin is also the major flavour precursor in onions. They smell different from garlic because they lack alliin and have a second enzyme that intercepts the product of the alliinase reaction to form onions' characteristic tear-producing molecules. Onions do not turn blue because this second reaction leaves less thiosulphinate to be converted to coloured compounds. This explains why onions undergo 'pinking' instead.

Meriel G. Jones
School of Biological Sciences
University of Liverpool, UK

Odour water

If I keep a plastic mineral-water bottle topped up with tap water and regularly drink directly from it, the neck smells vile after a couple of weeks. Why is this and why is it always exactly the same smell?

Ann Gilmour
Belfast, UK

Our mouths are home to around 700 types of bacteria. As well as harmful organisms, which can cause tooth decay, gum disease and permanent bad breath, there are 'good' bacteria, which promote oral health by stopping the harmful ones proliferating.

When you drink directly from a bottle, you leave some of your oral bacteria and saliva on its neck. The saliva contains food debris and dead cells on which oral bacteria can thrive. If you don't wash the neck after you have drunk from the bottle, the bacteria left on the plastic will break down nutrients in the debris and release the unpleasant stale smell your correspondent noticed. The smell is always the same because your bacterial flora stays the same.

This is similar to the situation that causes 'morning breath'. During the night, your saliva flow slows and is less effective at washing out food particles and delivering oxygen to the bacterial flora. This stimulates the growth of anaerobic microbes, which are particularly smelly – hence bad breath in the morning.

Bad breath is likely to be more pronounced if you have been breathing through your mouth, as this will dry out the saliva, further cutting the chances of a good wash-out. One reason for drinking is to wash out a dry mouth, making it particularly likely that material left on the bottle's neck contains problem-causing bacteria and debris.

Joanna Jastrzebska
Auckland, New Zealand

Pooling resources

When I open a new jar of marmalade the contents are a nice, semi-solid, homogeneous mass with a smooth surface, however old the jar is. Yet when I make a spoonful-sized hole in the flat surface to remove some marmalade, the next time I open the jar a couple of days later, the hole has started to fill with a syrupy liquid. What is it about breaking the surface of the marmalade that sets this process in motion? It continues until the jar is empty.

Kenneth Crowther
Derby, UK

A proper marmalade contains plenty of pectin, which is fluid while the product is still hot from cooking but forms a gel as it cools. The gel is a sponge of chain-like pectin molecules in a liquid syrup. The sponge neatly fills the jar as you open it and the syrup neatly fills the sponge, simply because the sponge formed from molecules dispersed evenly throughout the syrup. If you were to skim your marmalade from the top instead of digging great, vulgar holes in it, the marmalade would remain intact.

But if you tear gaps into the delicate structure, quarrying it, then the fluid syrup from the higher levels of sponge will seep down into the hollows.

You might feel guilty though when you remember how forgivingly, selflessly, marmalade turns the other cheek, melting obligingly on hot buttered toast. But don't trust its treacherous meekness. Lumps bide their time to topple onto your best shirt, smearing elbow, table and floor. And in hotels it will humiliate you in the eyes of guests, hosts, clients or colleagues. Can't find that report? What is that sticking to the seat of your trousers?

Jon Richfield
Somerset West, South Africa

Pick-me-up

If you drop a piece of food on the floor, it is supposedly safe to eat it as long as you pick it up before 10 seconds have elapsed, because it takes that amount of time before it can be colonised by microbial life. Is there any truth in this whatsoever?

Lorna Milton
BBC Three Counties Radio
Luton, Bedfordshire, UK

Individual microbes are too small to go crumb-hopping. They travel with whatever medium they are living in or on, in this case whatever dust or dirt is on the floor. When you drop food, two things are likely to happen: traces of the food stick to the floor, and traces of the floor (or what's on the floor) stick to the food. So unless the floor is surgically clean, the food will have acquired a new cargo of bugs however quickly you pick it up.

Chris Newton
Nailsworth, Gloucestershire, UK

This is a polite fiction – everyone knows it is an urban myth but plays along. Jillian Clarke is the youngest recipient of the Ig Nobel prize, won in 2004 for her study while still in high school of the 5-second rule. The time chosen for the 'rule' varies, but she traced its origins to at least as far back as Genghis Khan, when it was the 12-hour rule.

Clarke discovered that the quicker food is scooped off the floor, the fewer bacteria are transferred. Even so, while you would have to be unlucky to get ill, 5 seconds is long enough for food to be contaminated with a lethal dose of *E. coli*.

The number of bacteria that reaches the food depends on various factors: the population density of bacteria on the floor, the contact area between food and floor, and the presence of