

# Kitchen chemistry

FOCUS  
ON FOOD  
COOKING



Treating cooking as a science has enabled 'molecular gastronomists' to rustle up gems like snail porridge and bacon-and-egg ice cream. **Sanjida O'Connell** is ready to order



Molecular gastronomy utilises scientific techniques to produce uniquely delicious dishes

## NANOMODIFIED FOOD

### Nanoparticles could soon boost our nutrient intake

Science is infiltrating the world of food in a number of ways, ranging from GM to nanotechnology – the design and production of devices with components the size of a nanometre (one billionth of a metre). The main way that nanotechnology is being used in the UK is to examine the molecular interactions between foods and then work out how to achieve a better result. Many foods, from beer to bread, rely on the creation of a foam. This is where an unstable interface is created between air and water or oil and water. Instruments like the atomic force microscope can show scientists what is happening at the molecular level and thus how to create more stable foams – which could mean lighter bread without added chemicals. Nanotechnology is also being used to create nanoparticles that can be added to food to boost or insert nutrients. A company in Germany has created synthetic lycopene, an antioxidant found in tomatoes. Nanoparticles are already present within 40 cosmetic products.

Nanoparticles could boost nutrient intake

"IT IS A SAD REFLECTION THAT WE KNOW better the temperature inside the stars than inside a soufflé," wrote Professor Nicholas Kurti in 1969. Kurti, who was a low-temperature physicist at Oxford University until his death in 1998, had been frustrated at the lack of scientific exploration of the culinary arts. In 1988 he invented the term 'molecular gastronomy' with Parisian Dr Hervé This to describe the science of cooking and eating. Until the two met, both had been working independently on what was then little but a hobby. It has now grown to become a respectable branch of the sciences and has changed the course of cooking in some restaurants, such as El Bulli in Spain, and the Fat Duck in Bray, Berkshire. Indeed, one day we may all be using molecular gastronomic techniques.

The science of molecular gastronomy really began in the eighties when This, now working in a department for molecular gastronomy at the France College, Paris, set up a private laboratory where he was investigating the validity of French proverbs about cooking. By chance he heard of Kurti, who had already started to delve into the physics of cooking – including taking the temperature inside a soufflé. The two met for lunch in Paris. It is perhaps typical of This that even now he remembers what Kurti ordered: poulet au vin jaune du Jura, which This describes as, "braised chicken with a sauce

made from a special wine that's aged for six years in wood barrels – a veil of micro-organisms that decompose gives the wine its characteristic taste." According to This, their souls meshed and the science of molecular gastronomy was born.

### Pig proverb

Since then This has collected more than 25,000 old wives' tales and has tested about 1000. One of the first French proverbs he examined was originally described by Alexandre-Balthazar Grimod La Reynière in his 1803 book *L'Almanach des Gourmands*. Reynière wrote that roasted pigs should have their necks slit when they come out of the oven or the skin will soften. This seems like nonsense, since no fluid circulates between the skin and the rest of the head. But This's experiment on four suckling pigs of the same weight, from the same parents, reared together on the same farm, cooked outside on a large fire and taste tested by 143 people showed that the skin was indeed crispier when the heads were cut after cooking. The reason is because water is vaporised from the surface of the meat during cooking. Once the heat is removed, the outer layer of skin softens as this vapour seeps into it – making a cut in the head or neck region helps the vapour escape.

While the science of cooking might seem an unlikely place for

## DID YOU KNOW?

Crisp packets crackle so that we don't think the crisps inside are stale

Adding salt to water when cooking vegetables doesn't alter the flavour, the colour or increase the boiling point by a discernible amount

Frying meat in a hot pan does not 'seal in the juices'. Above 60°C muscle fibres contract and water is squeezed out of the meat. Frying creates new molecules that give off a 'meaty' aroma

Custard is a thick sauce because sugar molecules bind the proteins in the milk and eggs together

equations, This has invented formulae for describing dishes, as well as for testing the robustness of a recipe. This kind of experimentation can lead to new dishes. For instance, Chantilly cream is made by whipping cold cream, which creates an emulsion (a combination of oil and water). Chocolate chantilly is produced by substituting chocolate for cream. Melting water and chocolate creates an emulsion, which can then be whipped into a mousse-like texture, as long as the ratio of fat to water is the same as that in cream.

This came up with the idea that a demi-glace (a sauce obtained by simmering meat in water until it releases gelatin) could be made of vegetables or fruit by cooking carrot juice, for example, for a long time until its carrot taste undergoes a transformation and gelatine is then added artificially. This has worked closely with three-star Michelin chef Pierre Gagnaire. Gagnaire's menu now contains wonders such as Carob bouillon with ceps glace – little codling braised quickly in frothing butter with a grapefruit glace and Guinness-thickened chicory sauce, served with turnips and campari.

The same kind of relationship has recently been established here in the UK between physicist Professor Peter Barham, from Bristol University, and Heston Blumenthal, chef and proprietor of the Fat Duck. Barham

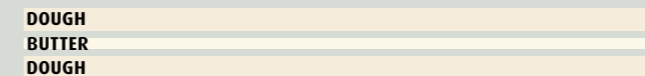
## COOKING BY NUMBERS

Food scientists have devised mathematics to represent recipes

Gastronomist Hervé This, of the Molecular Gastronomy Group INRA, France College, Paris, has come up with a way of describing diverse recipes using scientific formulae. The chemical phases involved in a recipe are gases, liquids and solids. G stands for gas. As the solids are numerous they are labelled S1 (solid 1), S2 (solid 2), and so on. Liquids are given letters, such as W for water and O for oil. These basic ingredients are then put through processes, denoted by, for example, '+',

which means 'mixed with' – when two ingredients are physically mixed together, or '/', which means 'dispersed into' – when one ingredient disperses into another. Repetitions of a process are given by a superscript. Puff pastry, for example, is made up of a layer of butter (B) in an envelope made of dough (D) folded into three (DBD)(DBD)(DBD), resulting in D(BD)<sup>3</sup> – since two layers of dough D join to make one layer. This is then stretched and refolded six times: D(BD)<sup>729</sup>. Here's how.

1. Layer of butter included in an envelope of dough:



The formula for this is

DBD

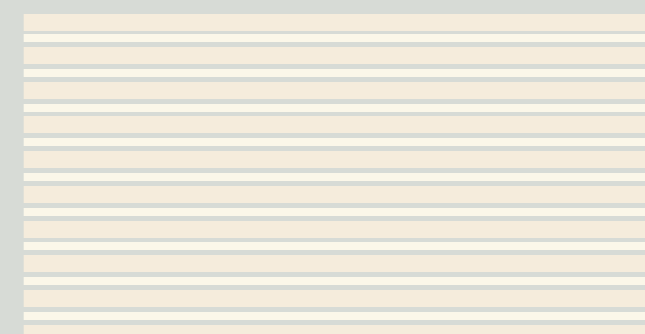
2. This is then folded three times:



Adjacent layers of dough blend into one so the formula is

DBDBDB or D(BD)<sup>3</sup>

3. This is then rolled out and folded into three again:



The formula is now

D(BD)<sup>9</sup>  
As the process is repeated another four times, the formula becomes D(BD)<sup>27</sup>, D(BD)<sup>81</sup>, D(BD)<sup>243</sup> and finally D(BD)<sup>729</sup>

The formula can then be rewritten because the dough contains several different ingredients. The final formula for puff pastry then becomes:

**STARCH**  
Given the notation S1 for solid 1. Starch is made up of two carbohydrates

**BUTTER**  
The formula for butter is (W/O)/S as it is a solid made up of water and oil mixed together

**GLUTEN**  
With the formula S2 for solid 2. Gluten is a protein normally made from wheat

$$(S1/S2) \left( \left( (W/O)/S \right) (S1/S2) \right)^{729}$$

# Food: Cooking

## ASK THE EXPERT

**Dr Hervé This**, Molecular Gastronomy Group INRA, France College, Paris

**What inspired you to become interested in the science of cooking?**

When I was at University in 1980 I had friends for dinner and I decided to make a Roquefort soufflé. The recipe was from *Elle* magazine and it said to “add the yolks two by two”. I reasoned that this belonged to folklore and had nothing to do with the success of the soufflé, so I put all the yolks in together. The soufflé wasn’t great. The next Sunday I had friends for dinner again and I made the same recipe, but this time I put the eggs in one by one. This soufflé was better. But the next day, I made a third soufflé putting the eggs in two by two and it was even better. So now I know it doesn’t matter how many yolks you put in a soufflé – I had merely become better at making soufflés. So from then on I decided to collect these proverbs and test them.

**What proportion of these proverbs are correct?**

Even educated French people sometimes believe the proverb: a woman should never make mayonnaise when she has her period. Some proverbs like this one seem wrong and are wrong. But some seem wrong and are right,



some seem right and are right – and some I have no idea about.

**Will people soon be able to do molecular gastronomy when they cook at home?**

This isn’t possible since molecular gastronomy is a science – it’s about looking for mechanisms, understanding them and producing knowledge. But molecular gastronomy techniques could be applied to cooking. By sharing the knowledge with people, applications of molecular gastronomy have become very popular, particularly in France.

**Do you think that some dishes could be thought of as frivolous, such as sardines-on-toast sorbet?**

Knowledge is knowledge. Recently I found that the 400 sauces made in France can be described formally and divided into 23 categories. A chef can use this information to produce more sauces. It’s not a question of going to expensive restaurants. I am working for the millions of people in France and abroad, not three-star chefs.”

## TODAY’S SPECIALS

A few tasty treats from Heston Blumenthal’s menu

### SNAIL PORRIDGE

Chopped up snails are sautéed in butter with garlic, oats and jubago ham. Parsley and shavings of raw fennel finish the dish, which ends up like a risotto in texture. Diners have rated this Fat Duck classic ten out of ten



### RAW OYSTER WITH PASSION FRUIT GEL

This dish is served with a sprig of lavender. The oyster will taste of lavender, proving that we mainly taste using our sense of smell. One diner claimed it was so good he thought he was having an oral orgasm!



### GREEN TEA AND LIME MOUSSE

Lime gets the saliva going and the tannin in the tea dries the mouth. The two are mixed with vodka, egg white and sugar. A spoonful is poached at the table in liquid nitrogen, which freezes it instantly. Like eating a hollow snowball, although one diner said it tasted like a lime-flavoured cloud



► says that one area of molecular gastronomy which fascinates him is how all the senses play a role in our appreciation of food. For instance, eat a little ice cream. Now take another mouthful, but keep your eyes shut and fondle a piece of velvet. The ice cream should taste even creamier. But if you run your hand over fine sandpaper while eating, the ice cream will start to seem gritty.

Barham’s research has already led to changes in Blumenthal’s kitchen – such as cooking meat at low temperatures. The ideal temperature is around 55-58°C, but when the centre of a joint gets this hot, the outside will have become even hotter and therefore tougher. At the Fat Duck, meat is vacuum sealed in a plastic bag (to prevent surplus chemical reactions occurring on the meat surface and to avoid any contact with the water) before being placed in a temperature controlled water bath at, say 58°C for lamb, for several hours. The meat ends up uniformly cooked, pink and tender. Indeed, Barham says other bizarre

methods could soon be a reality: “Further developments include using ultrasound to mix novel emulsions, such as vodka mayonnaise.”

It was the Frenchman Jean Anthelme Brillat-Savarin who defined the word gastronomy by saying that it meant ‘everything about food’, and who inspired This to refer to his new branch of science as gastronomy. It is perhaps apt for the Barhams and Blumenthals of today that Brillat-Savarin also said, “The discovery of a new dish does more for the happiness of mankind than the discovery of a new star.”

*Dr Sanjida O’Connell is an author and documentary filmmaker*

### » FIND OUT MORE

[www.fatduck.co.uk](http://www.fatduck.co.uk)  
Heston Blumenthal’s restaurant

*Chemistry and Physics in the Kitchen* by Nicholas Kurti and Hervé This (*Scientific American* April 1994, downloadable from [www.scientificamerican.com](http://www.scientificamerican.com))  
Good background information on the birth of molecular gastronomy