

## Vitamin B, complex and complicated

Vitamin B is something of an umbrella of eight different vitamins and is the reason the vitamin alphabet skips from E to K! The intervening letters were reclassified as different B vitamins and other substances including omega 3 & 6 in the 1930s.

Supplements often contain all eight so are referred to as B complex. Plant sources include grains, pulses, leafy green veg and yeast, while animal sources are meat and fish. Most people will have heard of **B12** and will know that it comes only from animal sources and is therefore potentially deficient in vegans. But did you know that the liver stores 3–5 years of the vitamin, so a deficiency can be slow to manifest? And in over 60s omnivores, 1 in 50 are deficient in B12, needing injections every three months or daily supplements.

Without B12, DNA synthesis in the red blood cells is impaired so they cannot undergo mitosis (divide). As a result, they get bigger and don't function like healthy cells. This differs from classic iron deficiency anaemia – there the red cells are smaller than normal.

Vitamin B12 is used to treat **pernicious anaemia**, a condition that used to kill within two or three years (once liver reserves were depleted) prior to about 1920. It's caused by an autoimmune decrease in the number of parietal cells in the stomach lining. These produce something called intrinsic factor, a protein needed for the absorption of B12. Patients who have had their terminal ileum (last part of the small intestine) removed are also at risk of B12 deficiency and PA.

In the 1920s the surgeon George Whipple found that eating liver was an effective treatment for PA, but patients had to consume half a pound of it, raw, every day, to see any benefit. By 1928 an injectable concentrate had been devised, making the treatment much more tolerable. In 1948 chemists Folkers and Todd isolated the active ingredient, cobalamin, and named it B12. Now it's produced from bacteria. Before increasing your liver intake, do read the Vitamin A article – liver is a rich source of both vitamins, but unlike the water-soluble Bs, fat-soluble As accumulate and become toxic.

**Folic acid** is often mentioned alongside B complex and is also known as vitamin B9. Its name comes from the Latin *folium* or leaf, and leafy veg are the best source. It's important in cell division and growth (hence in pregnancy) and for production of red blood cells, so as with B12, deficiency can lead to anaemia. Rather confusingly, the presence of adequate amounts of folate can compensate for lack of B12 as folate is needed to recycle cobalamin.

## BB

Beriberi and pellagra are the diseases historically associated with vitamin B deficiency. Like scurvy, **beriberi** was first noticed as a sickness afflicting sailors on long voyages. Dry beriberi is a disorder of fat metabolism. Victims are emaciated and become paralysed due to peripheral nerve damage. Wet beriberi, or 'dropsy' as it was known, causes heart failure with fluid retention starting in the legs and gradually rising to the lungs, when it kills.

In the nineteenth century, ships' surgeons in the Far East began to notice that sailors on a ration of white rice were prone to developing beriberi. (The rice husk has a relatively higher oil content and was removed, giving the rice a longer shelf life.) Officers, with meat included in their rations, remained disease free – as did rural farmers on a humble diet of brown rice.

This prompted Dutch colony administrators to look to rice skins as a source of the vitamin, and military doctor Christiaan Eijkman confirmed this with his experiments on chickens fed on assorted rice diets. B1 was finally isolated in 1926 by Dutch chemists Jansen and Donath in Batavia (now Jakarta) but it took 300kg of rice polishings to produce just one-tenth of a gram of the crystallised vitamin. It was first synthesised in 1933 by Merck in New York and named *aneurin* (prevention of neuritis) but it was later named **thiamine** because *thio* in chemistry stands for sulphur. By the end of WWII thiamine was being added to Allied POW rations and is still added today to bread and fortified cereals.

Before the war, white bread was seen as fashionable, but it became the mission of British food scientist Jack Drummond to change this. As Chief Scientific Adviser to the Ministry of Food he lobbied white bread off the shelves in favour of the National Wheatmeal Loaf, with its higher vitamin B content. The jingle:

The Queen of Hearts  
Said 'No' to tarts  
There's Wheatmeal Bread for Tea.  
Each cream-gold slice  
Is oh, so nice  
And better far for me.

With women working in the fields or factories after the war, Drummond campaigned for hot school meals and free school-milk, introduced in 1946 and 'snatched' by Thatcher in 1971. One biographer, James Fergusson, compares Drummond to a 1940s Jamie Oliver, both in his vision and energy of delivery. The subtitle of Fergusson's book *Who Killed Healthy Eating in Britain?* refers to the fatal shooting of Drummond, his wife and 10-year-old daughter while on holiday in France in 1952. Accident or conspiracy, British nutrition fell into the doldrums since, argues Fergusson in his fascinating book.

## BB

My fixation with thiamine began as a student nurse on placement in a local nursing home. A perfect job for a first-year student with zilch skills is to send them to keep an eye on the smokers outside! One of these, a former alcoholic in his mid 50s, was in the home due to alcohol-induced brain damage, **Korsakoff's psychosis (KP)**. The condition is caused by lack of thiamine. Sadly it cannot be reversed, but thiamine and other B vitamins are given to prevent progression.

The condition is named after Russian neurologist Sergei Korsakoff who in 1887 noted irreversible brain damage in alcoholics and other patients who were malnourished as a result of poisoning or pregnancy-induced vomiting. The patients appeared coherent (unlike in Alzheimer's), but were unable to form new memories and seemed anchored in the past.

Neurologist and writer Oliver Sacks describes a Korsakoff's patient 'Jimmie', amiable and lucid, but stuck in 1945. Sacks shows Jimmie a picture of the earth from space; he fails to identify it. When given a mirror, he fails to recognise by the grey-haired man looking back at him. He can win at draughts but loses at chess, because his memories disappear in less than a minute. At first, Sacks is disturbed by Jimmie's dislocated presence, "a moat or lacuna of forgetting all around him" and looks for ways to help him connect with his past and future. One idea is a diary, but Jimmie loses it. Games and puzzles work better, but soon lose their challenge.

Delving into his medical notes, Sacks reads that Jimmie's psychosis didn't start until a bout of heavy drinking in 1970. He wonders why his amnesia is backdated to 1945 and even has Jimmie hypnotised to see if 25 years of memories are repressed by trauma. They aren't, and Sacks later learns that flight into the past is a characteristic of Korsakoff's. To Sacks' relief, Jimmie gains a sense of peace and belonging when tending the home's garden and attending chapel.

I think thiamine was following me because, a year later, on the liver ward at the Royal Derby Hospital, I saw detoxing alcoholics being given vitamin treatment to prevent the onset of Korsakoff's and its precursor, **Wernicke's encephalopathy (WE)**. Alongside other drugs to help with the DTs (*delerians tremens*) they were given a yellow liquid covered by a black outer bag via an intravenous drip. Most of their calorie requirements would have been met by alcohol so reserves of thiamine were low – it's a water soluble vitamin so the body becomes depleted after just 18 days of reduced intake. The yellow liquid was a medicine called Pabrinex which contained thiamine, other B complex vitamins, glucose and vitamin C. It is covered by the black bag because riboflavin (vitamin B2) is destroyed by sunlight. So take note and buy milk in opaque cartons in future!

Thiamine and other B complex vitamins are required for glucose metabolism and without it WE and ultimately KP can develop. Warning signs – initially reversible with Pabrinex – are Wernicke's

triad of jerking eyes, confusion and unsteadiness walking (not to be confused with mere drunkenness!). Sergei Korsakoff died in 1900 from an undiagnosed heart condition aged 46 so never saw the isolation and application of thiamine to his eponymous psychosis.

A little bit more about jerking eyes. When drunk they twitch to the right but in a hangover they twitch to the left. Remember the three semicircular canals of the inner ear? Lined with little hairs that stand vertical in response to a change in posture in three planes? Connected to nerves transmitting this change to the brain? Good, but there's more! Alcohol diffuses into, and is lighter than, the canal fluid. When this happens, the tiny hairs start responding to Earth's gravity (so the brain thinks you are spinning) and the eyes twitch to the right. When you are hungover they twitch to the left because alcohol is eliminated from the blood and diffuses from the canal fluid, causing the hairs to spring back up. The jerking is called nystagmus and is one of the things the police look for when assessing drink drivers.

It's not just alcoholics who are given Pabrinex. Anyone at risk of malnutrition in hospital such as cancer patients, anorexics, pregnant women with extreme vomiting and more recently people with restricted dietary intake after obesity surgery will also receive the medicine.

Wernicke-Korsakoff syndrome was the subject of my degree dissertation in 2009 so thiamine and the other Bs were a ready-made first article when I revisited the vitamins for *Newstrack* in 2014.

## BB

**Pellagra** is the other classical B deficiency syndrome, and is caused by lack of B3 or niacin. It is characterised by a rash in areas of skin exposed to sunlight and comes from the Italian *pelle* 'skin' and *agra* 'sour'. It is rarer than beriberi, and affects people on diets based mainly on corn. Characterised by the 3Ds – dermatitis, dementia, diarrhoea – it can be fatal so a 4<sup>th</sup> D is death. It's caused by a lack of niacin (vitamin B3) and its precursor the amino acid tryptophan. Caisimir Funk isolated niacin – also from rice polishings – in 1912 when he was actually trying to identify anti-beriberi factor. Get weaving your tabard, it's brown rice all round!

Pellagra was endemic in California during the Great Depression. In *The Grapes of Wrath*, Steinbeck laments the abundance of fresh food going to waste while farm labourers are dying of malnutrition. Waste oranges are sprayed with kerosene; surplus potatoes are thrown in the river; unsold piglets are buried alive in quicklime – “in the eyes of the hungry there is a growing wrath. In the souls of the people the grapes of wrath are filling and growing heavy, growing heavy for the vintage.” I cheated here because I came across that quote in the *Oxford Handbook of Clinical Medicine*, but it's interesting that these authors comment that the food supply paradox is now added to by self-starvation “in pursuit of the body beautiful” and, I would add, the rapidly increasing incidence of food allergies and intolerances.

If gastroenterologists had one wish, it might not be the ending of all their diseases, but that humankind stand in a right relationship with Steinbeck's fertile earth, his straight trees, his sturdy trunks, and his ripe fruit.

Away from the library and back to the kitchen ... it's worth emphasising that B vitamins are lost in boiling so other cooking methods such as steaming, microwaving, baking or stir-frying will conserve more of the vitamin. These magical substances are effective in such tiny quantities that even a moderately diverse diet, if not boiled to a pulp, should keep us healthy ... and the soak-up-a-hangover fry-up could have a sound medical rationale in topping up thiamine levels.

	<i>Helps with...</i>	<i>Found in...</i>	<i>Deficiency...</i>
B1 Thiamin	Glucose metabolism, maintenance of nervous system	Wholegrain cereal, brown rice, quinoa, buckwheat, bread, meat, fish, yeast, nuts, pulses, green & yellow veg, oats, potatoes	Beriberi, wet & dry, Wernicke's encephalopathy, Korsakoff's psychosis
B2	Energy production, healthy	Dairy, fish, leafy green	Insomnia, poor conc-

Riboflavin	nails, hair & skin	veg (LGV)	entration, chapped lips
B3 (E375) Niacin	Sex, thyroid & digestive hormones, general nervous system function	Wholegrains, LGV, egg yolk, dairy, yeast & meat	Pellagra. Fatigue, blood sugar imbalance, ↓ libido
B5 Pantothenic acid	Adrenal glands, digestion, nervous & immune systems	Wholegrains, nuts, egg yolks, liver, LGV	Low BP, insomnia, fatigue, teeth grinding
B6 Pyridoxine	Concentration & motivation, growth & repair (with zinc)	Dairy, wholewheat, eggs, meat, oily fish, LGV	Depression, eczema, asthma & diabetes
B7 Biotin	Metabolism of protein, fats and carbs	Yeast, liver, kidney, pulses, nuts	Impaired growth in children
B9 Folic acid	Needed for cell division and production of red blood cells	Dark green veg, liver, kidney, eggs. Synthesised in the colon	Birth defects if mother deficient during pregnancy, macrocytic anaemia
B12 Cobalamin	Red blood cell production, recovery from injury & concentration	Red meat, fish, eggs, dairy. Sprulina is a good source for vegans	Anaemia, fatigue, memory loss. Older people commonly have 3-monthly injections.

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A drug company website but interesting on the history of PA

<http://www.active-b12.com/content/b12-history-pernicious-anaemia-and-nobel-prize>