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On to vitamin B1!

Vitamin B1 is also called thiamin.

I call it the carb-burner.

It's the first of eight B vitamins that we will cover (the first of nine if you count choline!). And it's the first of seven B vitamins whose overwhelming role is to help you extract energy from the food you eat and put it toward good use. I call it the carb-burner because it's the B vitamin that specializes in burning carbs.

Carbs, or carbohydrates, are the type of energy you get from sweet or starchy foods, like fruit, potatoes, beans, and grains. 🍇🥔🍲

... or candy 🍭👁️

... or soda and other sugary drinks 🥤👁️

Don't get me wrong. You need thiamin to burn any kind of energy, including protein and fat. And you need all the other energy B's to burn carbs.

But here's the thing:

- You need TWICE as much thiamin to burn carbs as you need to burn fat.
- No other B vitamin has such a special role in burning carbs.

Thiamin and Glucose Intolerance

Eating carbs won't deplete your thiamin. But not getting enough thiamin *will* prevent you from burning carbs. What would happen if you eat carbs that you can't burn? The carbs will build up in our blood. Specifically, glucose, a type of sugar, is the main carbohydrate in our blood. If there is too much in our blood after we eat, we call it "glucose intolerance." Let glucose intolerance go on long enough, and we wind up with diabetes. 😬

Thiamin deficiency isn't the only factor in diabetes, but it's probably one of them. There aren't many studies testing whether thiamin helps prevent our blood glucose from rising too much after we eat, but there are some, and they are promising.

A lot of people feel better on low-carbohydrate diets. Are they deficient in thiamin? 🙋♂

Let's come back to that when we talk about how we become deficient.

If modest deficiencies of thiamin make us bad carb-burners, what do really bad deficiencies do?

Severe Thiamin Deficiency

Ok, severe deficiencies of thiamin:

- They make your hands and feet tingle, or become weak, numb, or painful.
- They cause the muscles around your eyes to become weak, paralyzed, or disordered. This can cause twitching or drooping.
- They can cause your heart rate to go up, or cause other heart trouble.
- They can make it harder to control your own body movements.
- They can make you feel weak.
- They can make you feel confused.
- They can make you feel apathetic.
- They can give you amnesia, and cause you to make up, distort, or misinterpret your own memories.

When severe thiamin deficiency only affects your hands, feet, and heart, it's called "beriberi." When it affects eye muscles or your control over the bigger movements you make in your day-to-day life,

it's called "Wernicke's encephalopathy." When it affects your mind, it's called "Korsakoff's psychosis."

In the absolute worst cases, severe, untreated thiamin deficiency leads to seizures, paralysis, and death. This is sad, because severe thiamin deficiency is often diagnosed *after* someone dies and they perform an autopsy. This is because many older medical textbooks insist on using the combination of eye problems, loss of control over body movements, and confusion for diagnosis. But a thiamin-deficient patient often just shows up feeling apathetic and moving more slowly, before things get rapidly worse... and become fatal.

Thiamin Deficiency Starves the Nervous System of Glucose

Notice how much these all center around your brain and nerves.

This is because your nervous system, far more than any other system in your body, requires glucose -- the major carbohydrate -- to function. Every day, your brain consumes 120 grams of glucose, the amount found in 3-4 large potatoes. This glucose doesn't just provide energy. It's also needed to make many of your neurotransmitters, the chemicals that your brain cells use to communicate with each other. These neurotransmitters are also what your nerves use to control your muscles.

You may have heard of the ketogenic diet. It's a low-carbohydrate, high-fat diet. When you spend a while on this diet, your nervous system readjusts how it uses its energy, and it starts consuming 75% less glucose than it usually does. And what are ketogenic diets most effective for? Epilepsy! That's what they were first invented for. So they help the brain. Many people report feeling calmer or sleeping better on them. More effects on the brain. Some people report brain fog that improves on a ketogenic diet. More effects on the brain.

Thiamin deficiency is overwhelmingly a problem of being a bad carb-burner, and having the nervous system starve as a result.

Are ketogenic diets just treating thiamin deficiency? Probably not "just." But thiamin may often be an important part of the picture.

Other Cool Things Thiamin Does

By the way, thiamin does some other cool things besides help us burn carbs:

- It helps protect us from oxidative stress. This is the wear and tear on our tissues that happens as we age. It gets worse with metabolic diseases like diabetes, or exposure to toxins like alcohol and cigarette smoke.
- It helps us recycle other vitamins, like vitamin K and folate (we'll get to those lessons soon enough!)
- We need it for detoxification.
- We use it to synthesize a lot of different things. For example, fats, cholesterol, and the building blocks of our DNA.

Getting Thiamin From Food

So how do we get thiamin from food?

The most certain way to do it is to eat three servings of anything from this list per day:

- 2 heaping teaspoons of nutritional yeast
- 3-4 ounces of legumes (lentils, peas, beans) measured before cooking
- 3-4 ounces of whole grains, measured before cooking

Enriched flour also has thiamin added to it, as a public health measure to prevent deficiency.

The thiamin content of meat is a confusing topic. Older databases say that red meat animals (beef, lamb, bison) have the most thiamin. They say pork is a mediocre source, and that poultry have very little. The newest databases say that pork is an awesome source, while red meat animals and poultry have very little.



I think I have an idea why there might be conflicting information about the thiamin content of animal products, and I'll explain it in just a bit. But for now, let's say meat is a "maybe."

You know what's a definite no?

FAT! That's right, fat has no thiamin to speak of. And this is the great irony. Although ketogenic diets spare thiamin better than any other diet, if they aren't designed carefully they can give you a thiamin deficiency. Even though you need twice as much thiamin to burn carbs as you need to burn fat, you still need thiamin to burn fat.

If your keto diet has several servings of meat per day, it has enough "maybe" food that it *might* keep you out of deficiency. But a heaping tablespoon of nutritional yeast, a thiamin supplement, or a multivitamin could go a long way if you aren't going to eat legumes or whole grains.

If you eat paleo, if you can tally these foods up to a total of 2 pounds measured before cooking, you can get plenty of thiamin:

Okra, Jerusalem artichoke; garlic; dandelion greens; acorn squash, and butternut squash; asparagus, kale, or Brussels sprouts; bamboo shoots; maitake, shiitake, oyster, or white mushrooms; taro root or leaves; white potatoes, sweet potatoes, and yams; beet greens; nori or spirulina; wasabi; mustard; thyme; caraway seeds; savory; nutmeg; anise; mace; marjoram; tarragon; curry.

And carnivore? Just go with pork and hope for the best? Or nutritional yeast.

In other words, yeast, legumes, and whole grains are our sure-fire tickets to Thiamin Land. If we don't eat them we rely on huge volumes of other foods, or supplements.

So how much sense does it make that low-carb or keto helps some people by sparing the need for thiamin, if these diets themselves are often low enough in thiamin to cause deficiency? 🙄

Well, to get a handle on this, we need to turn our attention to thiamin antagonists.

Thiamin Antagonists From Foods and Microbes

Here are a list of foods and microbes that contain things that actually hurt thiamin status:

- ✗ Raw fish and shellfish
- ✗ Ferns
- ✗ The larvae of the African silkworm *Anaphe venata*, a traditional food in many African countries

✗ Various bacteria found in human feces (there are no tests for them! 🙄)

✗ Several known fungi

✗ At least one amoeba that sometimes pollutes drinking water

✗ Sulfite

The antagonists in fish and shellfish are destroyed by heat. Their content in these foods varies widely for reasons that are largely unknown.

Sulfite is used as a food additive (🍷 !), is produced by gut bacteria that make your farts smell like rotten eggs, and is produced in our own body when we eat a diet high in animal protein and low in legumes.

The human gut is a black box. We know from research done decades ago that humans carry bacteria that destroy thiamin. We just have no way to test for them right now.

But this story gets even crazier. 🤪

Thiamin Antagonists In the Environment

Thiamin deficiency is being caused by something in the ENVIRONMENT. Thiamin deficiency bad enough to cause seizures and paralysis has been found in wild fish, birds, and reptiles from the US, Canada, Iceland, Sweden, and the UK. Outbreaks come in waves and affect the wildlife in large numbers. We DON'T KNOW what's causing it.

So could you wind up sparing thiamin by going low-carb, even if you cut out some of your best sources of thiamin in doing so?

Yes!

Or, at least, maybe!

As confusing as it is, this could make sense if we are suffering from exposure to unknown amounts of environmental thiamin antagonists.

Could this explain why older databases show different distributions of thiamin among meat products than newer databases do? Red meat animals like cows, buffalo, and sheep have a giant bacterial

mega-factory called the rumen. A healthy rumen may provide these animals with lots of thiamin. An unhealthy rumen (from grain-feeding?) may provide them with lots of thiamin antagonists. We don't currently know if the mysterious cause of thiamin deficiency in wildlife also affects farm animals, but it might.

Other Causes of Thiamin Deficiency

There are a few causes of thiamin deficiency that we *do* understand well:

- ✗ Gastrointestinal diseases hurt thiamin absorption.
- ✗ Persistent vomiting causes us to lose thiamin in the vomit.
- ✗ Liver diseases hurt thiamin storage.
- ✗ Alcohol abuse hurts its absorption, its storage in the liver, and its activation for use with our enzymes
- ✗ HIV/AIDS patients, anorexics, and hunger strikers are at high risk

Are Thiamin Supplements Safe?

Now, for some good news! Finally! Thiamin has no known toxicity! Zero! Zilch! This means that it's very safe to play around with thiamin supplements even if we don't know for a fact we have a deficiency and don't know for sure if they'd help.

There are a few different types. Thiamin hydrochloride or thiamin HCl is the cheapest and most common. Benfotiamine is more expensive. It's thought to be better at getting into the nervous system, but its superiority over the cheap stuff hasn't been clearly demonstrated. Thiamine pyrophosphate (TPP) is the activated form. In theory, it could be more effective for people who have energy problems (thyroid, low adrenals, diabetes). We know alcohol hurts our ability to activate thiamin, so maybe environmental antagonists do too. But none of this has been clearly studied. Worse, it's probably not absorbed intact.

Wrapping Up

So let's wrap this up with some take-home points.

- Get thiamin from nutritional yeast, legumes, or whole grains if you tolerate these well.
- Get it from huge volumes of the vegetables and spices I listed, if not.
- Fixing your gut might help, but we don't know exactly how.
- When all else fails, a carefully designed low-carbohydrate diet or thiamin supplements may help.
- When supplementing, using 100 milligrams multiple times a day is safe!
- We only get 1-2 milligrams from food, so expensive forms that provide, say, 10 milligrams may be perfectly effective.
- Try the cheap stuff first if you're concerned with money. Try the others to see if you get better results.
- You don't need to eat fat, or even food at all to absorb it.
- Still, you will retain and activate more if you take it with food and spread the dose across your meals.
- If you have signs of deficiency, or respond well to supplements, see if there are sources of antagonists you could clean up, like raw fish and shellfish, ferns, sulfites, or gut problems.

That concludes the thiamin lesson.

See you in class tomorrow for riboflavin!

Class dismissed,

Chris