How Your Brain and Body Makes Energy

Human cells are microscopic specks, no more than 10 micrometres across (one 100,000th of a metre), but each is an industrial estate packed with various units, all of which are vital for its survival. Some of these are familiar, such as the repository of genetic information that is held in the central nucleus, or the nearby protein-making factory (ribosome) that gets its manufacturing blueprints from our genes. Dotted around are thousands of power plants (mitochondria) that generate all of the energy we need to function.

Like all industrial units, each cell must have a reliable supply of fuel, ways of balancing internal demand with available supply, a dedicated system for transporting the fuel to the various units and a reliable back-up system to deal with any power cuts. It may function on a micro-scale, but the complexity of a cell's energy system is breathtaking. You might assume that we already have a good understanding of something as basic and essential as how the body and brain generate and use energy. But even as you read this, researchers are uncovering ever more of the ways in which the body converts what we eat into fuel and then routes it along the paths of least resistance.

Your muscles and organs, including your brain, can run quite happily on either glucose, derived from carbs or ketones, which are derived from fat. Both end up delivering ATP – the packets of energy on which all of the body's cells rely. In addition, the muscles (but not the brain) may derive energy from a type of fat known as triglyceride, which is shaped like a capital 'E', with a backbone of glycerol (a form of glucose) and three horizontal bars of fatty acids. The liver can also transform the amino acids in protein into glucose when the latter is in short supply. This usually involves breaking down some of the body's own muscles because these are the most readily available sources of protein, which is one reason why you will lose muscle mass if you fast for too long and why people on a ketogenic diet need to ensure that they eat a sufficient amount of protein.

All of these fuels are routed to the cells' mitochondrial power plants, where they are fed into a remarkably efficient 'electron transport system' that generates the vast majority of our ATP power. This system is totally dependent on a steady supply of oxygen, but we can also generate a limited amount of energy from stored glucose in the absence of oxygen in a process known as glycolysis (otherwise known as anaerobic – 'without oxygen' – metabolism). You rely on this when you sprint, because you can't breathe enough oxygen to meet your body's energy demands in the normal way.

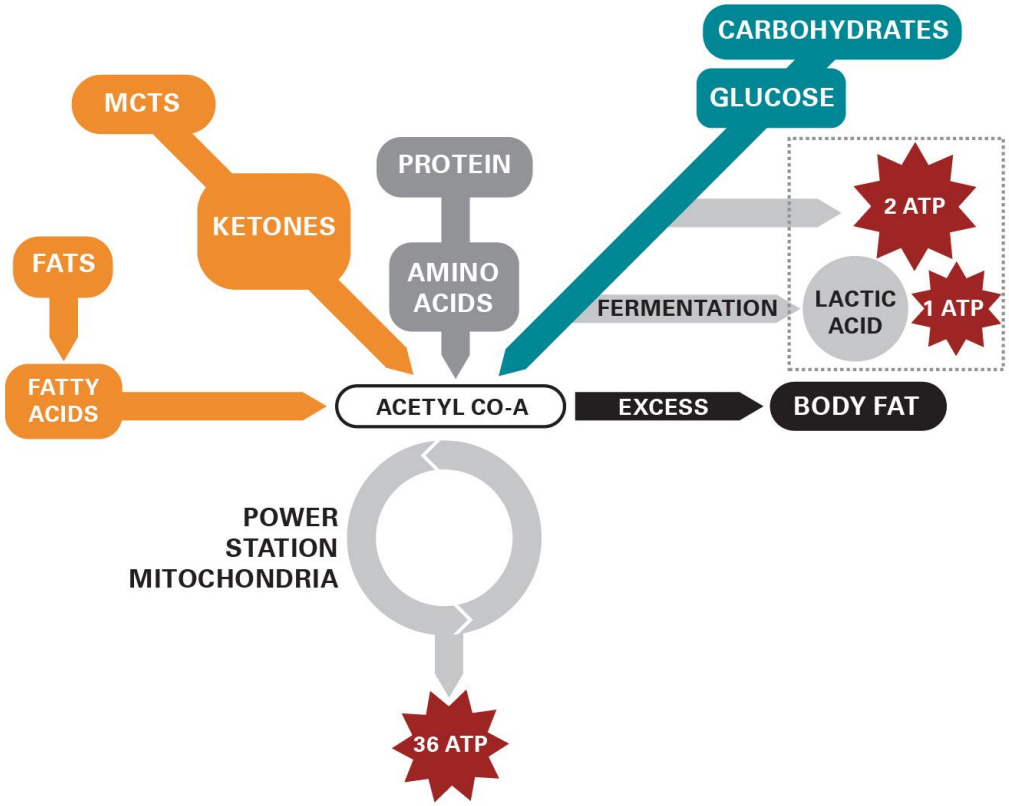

Figure 1 - How your body generates energy

Lactic acid, which is usually demonised as a 'toxic' waste product that makes your muscles tight, is produced during glycolysis. However, the human body is so efficient that it manages to squeeze another drop of energy out of this very poor fuel. Lactic acid is also created during fermentation, so you eat it whenever you have sauerkraut or natural yoghurt. Finally, a very hot topic right now is whether MCT oils (medium chain triglycerides found in coconut oil) – which the liver turns into ketones – might also power the brain via the so-called 'astrocyte–neuron lactate shuttle', using lactic acid as fuel.[i]

With so many energy-generating options available, you would think we'd all be leaping about, full of vigour. However, our modern Western diet is throwing a spanner into this highly efficient system, channelling excess, potentially energy-generating food into redundant body fat, and leaving us exhausted, both physically and mentally. This is happening because we eat too many carbs, and the wrong fats, as well as too much food overall.

So far, our journey into the body's metabolism has focused exclusively on macronutrients: that is, the foods that are transformed into either ketones or glucose for fuel. But how does this actually happen, and how can you support your metabolism to turn it into a mean, lean, energy-generating machine?

Every chemical step along the way requires enzymes, which are made within the body. These turn compounds into different compounds and ultimately enable the release of the pure energy that is stored in food. Something is wrong if you are storing that energy as fat, rather than feeling it as vitality.

All of these enzymes depend on keys – known as co-factors – to make them work. In the figure below we've added the micronutrients that lubricate the whole process. The doors of your metabolism won't open properly without these keys, so they are crucial for good health.

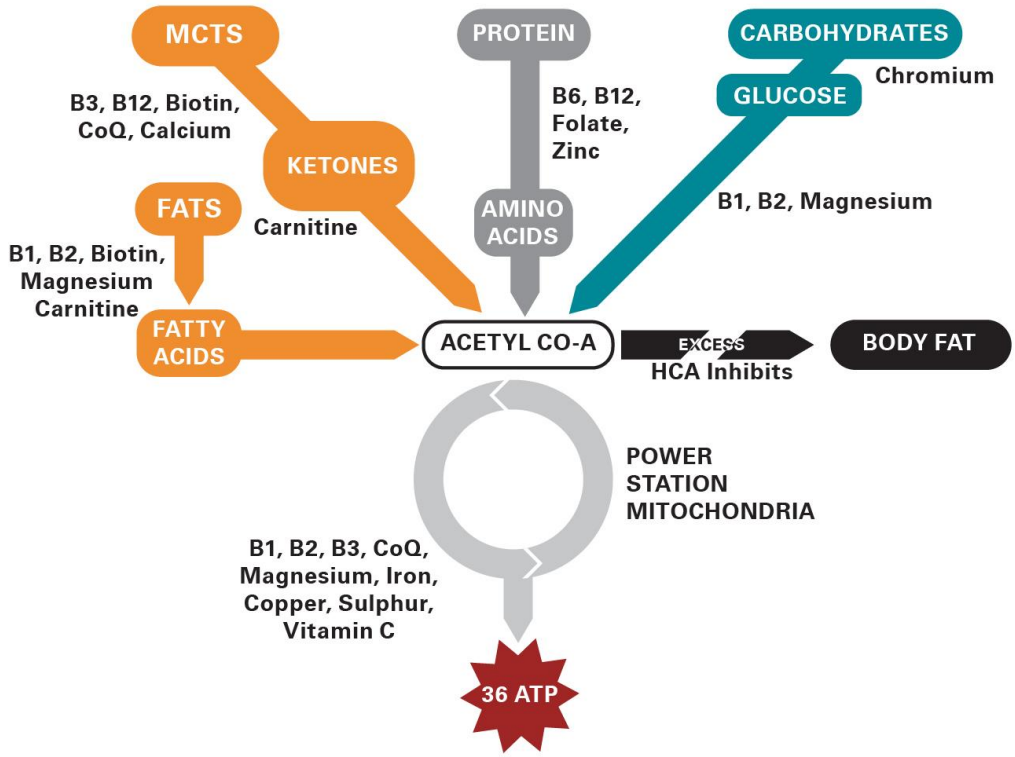

Figure 2 – Co-factor nutrients in energy production

Some people choose to add in these nutrients in supplements and report improvements in energy and concentration, as well as accelerated weight loss. The starting point is a good, high potency 'optimum nutrition' style multivitamin. The three 'hero' nutrients are the mineral chromium, the amino acid carnitine and HCA which comes from a type of tamarind called Garcinia cambogia. Some supplements provide these in combination.

REFERENCES

[i] L. Riske *et al*., 'Lactate in the brain: an update on its relevance to brain energy, neurons, glia and panic disorder', *Therapeutic Advances in Psychopharamacology* (2016), vol 7(2):85–89.