

Depletion of Q10 and/or L-carnitine leaves us feeling tired, and vulnerable to heart disease, infection and cancer

In clinical trials, high doses of Q10 and/or L-carnitine improved the condition of patients with heart failure, gum disease, infertility and certain cancers

These vitamin-like compounds improve athletes' performance, endurance and rates of recovery

Q10 – Ubiquinone

Q10 is technically a quinone. The molecule is structurally quite similar to Vitamin E and the carotenoids.

Q10 is found everywhere – hence its name *ubiquinone*. First extracted from the tobacco plant, and subsequently from beef heart, commercial production now starts from yeast.

Chapter 9

The Q Factor and Carnitine

Q10 and L-carnitine are quite different molecules, but they have a good deal in common. Both occur naturally in the body; both are widely sold as supplements with a range of claims

from increased energy and improved heart function to enhanced fertility and memory – and both have been largely dismissed by non-specialist doctors, in no small measure because of the wide variety of claimed benefits. They find it difficult to understand how any single nutrient can have so many benefits, and dismiss both as placebos.

Specialists, however, are more pragmatic. Dentists, for example, use Q10 to clear up gingivitis, the gum disease that causes more tooth loss than does dental decay. Heart specialists prescribe it for heart failure, angina, hypertension, and the cardio-toxicity caused by certain anti-cancer drugs. Infertility specialists use it to improve sperm motility, athletes to enhance performance.

L-carnitine has a similar array of specialised applications. Cardiologists use it to treat angina, heart arrhythmias, and heart failure. Infertility experts have shown that it improves sperm counts and motility – and neurologists prescribe carnitine compounds to enhance memory and mood in the elderly.

However, once you know how Q10 and L-carnitine work, and what they do at the cellular level, their wide and overlapping range of clinical applications makes absolute sense. It's harder to understand why it has taken so long for general practitioners to appreciate what these micro-nutrients could do for them – and their patients.

What are Q10 and L-carnitine?

Co-enzyme Q10 and L-carnitine are often referred to as vitamins, but although they are vital to life and occur in trace amounts in foods such as sardines and red meats respectively, they are not technically vitamins because we produce them in small amounts in the liver.

Unfortunately their production requires many other vitamins and minerals – and most people are depleted in most of these, and become more depleted as they get older. Heavy drinking and liver disease slow down production further; which is why levels of both Q10 and L-carnitine in our tissues decline with age^(42, 43, 46, 108).

This is a serious cause of declining health, because Q10 is a potent anti-oxidant^(23-28, 70); and both Q10^(4, 29-33, 65) and L-carnitine^(156-159, 180) are central to energy production.

Q10: the anti-oxidant

Q10 is a powerful anti-oxidant like Vitamin E. It protects the lipids in cell membranes^(110, 116) and LDL cholesterol ('bad cholesterol') in the blood^(34, 35) preventing them from going rancid. Rancid cholesterol is considered to be a major cause of heart disease, so Q10 protects against heart attacks.

A number of studies show that Q10 is better at protecting LDL cholesterol than Vitamin E^(21-23, 36, 77, 93-95), and a combination of Q10, Vitamins E and C, flavonoids, B vitamins and trace elements should make you more or less immune to heart disease (see Chapter 14, Heart disease).

Q10's ability to protect against free radicals should also reduce the risk of cancer. But that's only half the story ...

Q10 and L-carnitine: the Energisers

Q10, unlike any other anti-oxidant, is part of the process that gives us energy.

This process takes place inside the mitochondria. The mitochondria are tiny, bean-shaped structures which are the

L-carnitine

L-carnitine is an amino acid and Vitamin B-like substance. We obtain it from foods (the richest source is red meat), and make it in our liver and kidneys. This requires six other nutrients – which many of us are low in. Carnitine levels and synthesis decline with age, but can be boosted by betaine.

Q10 – discovered in the 1960s

Co-enzyme Q10 was discovered in Britain over 30 years ago⁽³⁾, and earned Professor Peter Mitchell the 1978 Nobel Prize for Chemistry.

His discovery was ignored by British industry, and developed by the Japanese company Eisai.

Super Oxide Dismutase (SOD)

Q10 may also stimulate the body to produce more SOD, a key anti-oxidant enzyme^(85, 86).

THE DEFENCE BOOSTERS : Q10 and L-carnitine

L-carnitine for infants

Infants do not produce L-carnitine very effectively, which is why breast milk contains significant levels of the nutrient. L-carnitine is not present in soy or processed cow's milk; so baby-food companies routinely add L-carnitine to infant formula.

There is a strong case for supporting the elderly with carnitine too.

power-houses of each cell. The process transfers energy from the food we eat to ATP, which fuels the cells.

If cells lack Q10 and/or L-carnitine, they can't produce enough ATP. Nerve cells fire less efficiently, the tails of sperm beat less strongly^(109,160-163), muscle fibres tire more easily⁽¹⁶⁴⁻¹⁶⁸⁾ and perhaps, most notably, the heart beats less powerfully^(38, 57, 169-172).

Low levels of Q10 and L-carnitine in the body are considered by some specialists to be prime causes of heart failure: early signs of depletion of these two nutrients are feeling tired and drained of energy, and the end stage of depletion is, inevitably, death.

Q10 and L-carnitine's energy-producing roles make them important for the immune system too. This means that depletion in either nutrient is linked not only to low energy and heart disease, but also an increased risk of infections and cancer⁽⁹¹⁾. In short, the body begins to show all the key signs of ageing.



LOOK FOR

...

a Q10 supplement in oil form (in a gel) at a level of at least 30mg a day –

ENERGY FORMATION

Energy is transferred from the food we eat into ATP, the cells' basic energy storing molecules. This energy transfer is called oxidative phosphorylation, and takes place in the mitochondria.

The process requires both L-carnitine and Q10. L-carnitine transports fatty acids into the mitochondria, where they act as fuel in the Krebs Cycle. Q10 drives the Krebs Cycle faster, producing more ATP.



LOOK FOR

...

carnitine products that guarantee 100% L-carnitine, and no D-carnitine. The D-form of the amino acid is an

Q10/L-carnitine – antidotes to ageing?

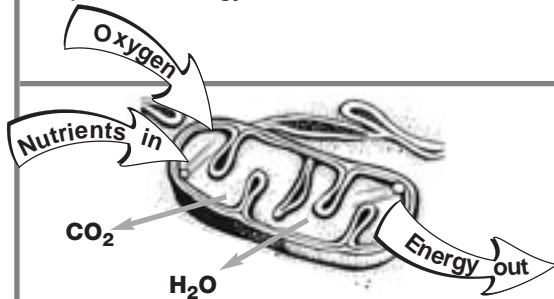
Some researchers believe that many aspects of ageing are indeed linked to the age-related decline in Q10 and L-carnitine synthesis⁽¹⁰⁵⁻¹⁰⁷⁾, and recommend supplements of both compounds as part of life-extension regimes.

If life extension sounds far-fetched, take a look at how Q10 and L-carnitine reduce the impact of ageing on our cells. It's called the Mitochondrial Theory of Ageing, and the evidence to support it is persuasive.

As mitochondria produce the energy their cells need, they also

The Mitochondrial Theory of Ageing

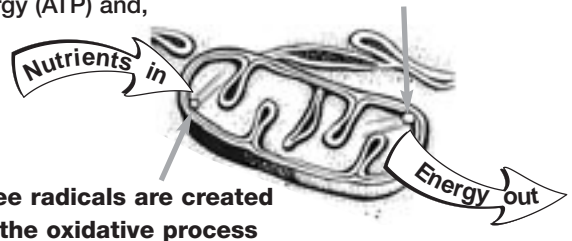
1 The mitochondria are the cells' energy factories, where the main components in foods are oxidised to produce energy.



2 Nutrients are 'burned' – with oxygen – to produce energy in the form of a substance called ATP. The byproducts are carbon dioxide (CO₂), water (H₂O), free radicals and heat. This heat creates body temperature.

3 Co-enzyme Q10 is needed for two important reasons.
 1) It promotes the efficient production of energy (ATP) and,
 2) It quenches the burst of free radicals that occurs when nutrients are oxidised, A healthy and young body will generate approximately 95% energy (ATP) and 5% free radicals within the mitochondria.

Q10 quenches and neutralises free radicals



Free radicals are created in the oxidative process



4 The amount of Co-enzyme Q10 a person produces is reduced as they get older. The proportion of energy generated by the mitochondria drops to 75% and the proportion of free radicals rises to 25%. So, not only is less energy available, but more free radical damage occurs. The body cells are becoming less efficient^(91,118).

5 Eventually this free radical damage means that the mitochondrial output of ATP energy is severely reduced. The cell switches to self-destruct and eventually dies. The body now begins to age rapidly. When enough cells self-destruct, organs fail and death results.

Anti-ageing strategies must include Co-enzyme Q10, beta carotene and L-carnitine. Q10 and beta carotene protect mitochondria from within, while carnitine compounds help to stabilise the outer mitochondrial membranes.



THE DEFENCE BOOSTERS : Q10 and L-carnitine

Beta carotene

Q10 should be combined with beta carotene. Beta carotene concentrates in the inner mitochondrial membranes, where the low oxygen levels enable it to play an anti-oxidant and damage-limiting role⁽¹⁵⁵⁾.

generate free radicals – which inflict accumulative damage on the mitochondrial structures. This is why elderly people have more damaged and less efficient mitochondria than younger people^(80, 82). This is one reason why older people's cells don't function as well – tissues are slower to heal, for instance.

Q10 is an unusually interesting potential antidote. This is because Q10 increases the amount of energy that elderly, damaged mitochondria can produce⁽⁴⁴⁾. And thanks to Q10's anti-oxidant qualities, it can cope with the additional free radicals this produces and protect mitochondria from further damage^(45, 47-49, 87, 104).

It will be some time before we have definitive evidence for the ability of Q10/beta carotene combinations to extend human life. In the meantime, there are short-term gains that you can experience for yourself with Q10 and/or L-carnitine supplements. The most obvious of these is the increase in energy which often appears at 30-100mg/day Q10, and/or 2-4g/day L-carnitine.

Q10, L-carnitine and heart disease

In 1993, at the 8th International Symposium on Q10, doctors from around the world reported using Q10 to treat angina, hypertension and heart failure.

In some cases heart failure patients improved from being bedridden to walking out of the hospital. A significant minority were able to stop taking all their medications^(6, 7, 50-53, 97-99).

These extraordinary results confirmed predictions made a quarter of a century before, by scientists who found low Q10 in the hearts of patients who died of heart failure and speculated that Q10 replacement therapy might be an answer⁽⁶⁶⁾.

Professor Svend Aage Mortensen, who heads the Danish heart transplant programme, talked about his terminally ill patients. These invalids, who were waiting either to die or for a new heart, responded so

well to Q10 that several were able to come off the surgery waiting list – a world first.

Professor Karl Folkers told me: "Q10 depletion is a critical factor in heart failure; the lower the Q10 content, the worse the heart performs. When you give Q10 to a patient with heart failure⁽⁷¹⁾, or to elderly subjects with healthy hearts⁽⁷²⁾, you get a clear-cut and positive response."

Karl was broadly correct, but L-carnitine is just as critical. In patients with heart failure, L-carnitine improves cardiac function⁽¹⁵⁶⁻¹⁵⁸⁾. In effort-induced angina, L-carnitine improves exercise tolerance and cardiac function⁽¹⁷³⁾ and reduces angina and arrhythmias⁽¹⁷⁴⁾.

Given their complementary mode of action, combined Q10/L-carnitine therapy is logical.

Fitness without exercise?

Could you improve your stamina, raise your energy levels and strengthen your heart without taking any exercise at all? It sounds unlikely, but, if levels of Q10 or L-carnitine in your tissues are low, supplements of either compound can make a noticeable difference, boosting mitochondrial function and providing the body's cells (including skeletal muscle and heart cells) with more energy.

Research shows that Q10 supplements boost mitochondrial function, providing body's cells (including muscle cells) with more energy.

Professor Vanfraechem is senior researcher at the Laboratoire de L'Effort at the Free University of Brussels. He knew that Co-enzyme Q10 can help in heart failure by strengthening the heart, and guessed it might have a similar effect in healthy people.

The guinea pigs were medical students who were healthy but unfit. Professor Vanfraechem gave them Co-enzyme Q10 for eight weeks. It improved their physical fitness and strengthened their heartbeat by up to 20 per cent – the sort of improvement normally only found after an intensive course of exercise⁽¹⁹¹⁾.

At Kobe University, Dr Hiroshi Yamabe and Dr Hisashi Fukuzaki carried out similar experiments with middle-aged women complaining of low energy and constant tiredness. After three months of 60mg Q10 a day, they improved their fitness by over 30 per cent. And, just as important, they felt much less tired⁽¹²⁾.

Q10, L-carnitine and heart patients

Q10's combination of anti-oxidant and bio-energetic properties reduces oxidation injury to the heart.

In a recent trial, patients given Q10 before heart bypass grafts had less oxidative damage and fewer ventricular arrhythmia – irregular heart beats after surgery⁽⁸¹⁾.

In studies with recent heart attack patients, both Q10⁽¹⁴¹⁾ and L-carnitine^(170, 174) improved their symptoms and outcome very significantly.

ATHLETIC FANS

Q10 has gained a host of athletic converts. Sam Wright plays for the UK women's hockey team that won a bronze medal at the 1992 Olympics.

"Last year I went down with a virus, and I was totally fatigued. I changed my diet and exercise programme, and I started taking Q10. Since then I've been really well, the fittest I've been for a long time.

"About half the squad are taking it, and we all want to go on with it as part of our training. There isn't too much difference between the top teams in the world, but if we get a bit extra from the Q10, that could make the difference between bronze and gold."

Jonathan Edwards, former World and Olympic Triple Jump Champion, also took Q10 as part of his nutritional programme.

ME Patients

There are anecdotal reports of ME patients responding positively to high dose Q10, often given with an Omega 3 oil preparation. Co-prescribing L-carnitine should also be considered.

Legal

Q10 and L-carnitine levels often fall in athletes. Taking Q10 and L-carnitine supplements merely returns them to normal ^(60-64, 175-176).

You can get effective doses of Q10 and L-carnitine by eating 3lbs of sardines and 1lb of steak every day – which is why these substances are legal – but for most people supplements are a more realistic option.

On a cholesterol-lowering drug?

Anyone taking a statin (a cholesterol-lowering drug) should take a Q10 supplement. These drugs block the enzyme that makes cholesterol – but the same enzyme also makes Q10.

Patients taking these drugs tend to have very low Q10 levels⁽⁶⁶⁾, with all the risks that this implies. Q10 supplements repair the deficit⁽⁶⁹⁾, and are strongly recommended in these cases.

Athletic use

If Q10 can improve physical performance by a third in untrained subjects, what might it do for athletes? At the University of Bologna, Dr Pier Fiorella took a group of top runners and gave half of them Q10 for 40 days prior to endurance trials, in which the Q10 group out-performed the control group by 13%⁽¹³⁾.

In top level athletics this is a considerable gain – enough to put an also-ran onto the winning rostrum. The Q10 athletes also showed less sign of the muscle damage that usually follows endurance events⁽¹⁴⁾, indicating they would be able to train harder and recover more quickly between races.

Other sports scientists have shown that Q10 supplements increase Q10 levels in the muscles, and boost exercise capacity ^(58, 59), although there have also been negative findings⁽⁹²⁾.

L-carnitine has generated similar benefits. In separate trials it increased peak speed in marathon runners⁽¹⁷⁷⁾; strength and VO₂ max in elite rowers⁽¹⁶⁵⁾; and raised VO₂ max by 5% and more in long-distance walkers⁽¹⁶⁴⁾ and untrained cyclists⁽¹⁷⁸⁾. (A 5% increase in VO₂ max is sufficient to transform an average performance to highly competitive.)

The build-up of lactic acid in muscle is a major cause of fatigue. Due to its ability to boost mitochondrial activity, L-carnitine reduces lactic acid build-up during exercise^(167, 168). Its ability to reduce post-exercise pain and stiffness helps athletes train harder, and is particularly helpful in weekend players who cannot maintain a regular training schedule⁽¹⁷⁹⁾.

Because of their serial modes of action, Q10/L-carnitine combinations must be more effective than either compound on its own. In professional and weekend athletes, this combination should enhance performance and aid recovery. And it is not doping: topping up the levels of Q10 and L-carnitine which fall in the body during training is like replacing lost fluids – and just as safe.

Oral health

Q10 for gum disease

The oral cavity is teeming with bacteria, many of which are potential causes of disease. It is only our immune systems, and oral hygiene, that keep them at bay.

But in many of us the bacteria are winning. Forty to 80 per cent of adults have some degree of gum disease – and gum disease is the biggest cause of tooth loss.

Good brushing and flossing techniques are important, but there is evidence that if you're deficient in Q10, brushing and flossing make little difference⁽⁶⁷⁾.

This is why the trials of Q10 in the treatment of gum disease are so interesting, because in the battle between the bacteria and the immune system, Q10 can tip the balance in our favour.

Sadly, the trials that suggest that Q10 supplements may help^(10, 11, 15-20, 67, 69) are small and poorly designed – so they cannot be regarded as conclusive.

One problem is that the doses of Q10 used were too small. To achieve high and sustained levels of Q10 in the intracrevicular fluids (in the pockets around the roots of the teeth) requires at least 90mg Q10/day. At this dose Q10 kills the disease-causing anaerobic bacteria by oxidising them – in the same way as the antibiotic metronidazole.

Toothpaste containing 1% Q10 achieves very high levels of Q10 at the roots of the teeth, but only very briefly. A combination, however, of 90mg Q10/day PLUS Q10 toothpaste daily or twice daily should be highly effective at treating gum disease and holding it in check.

Xylitol for tooth decay

The most widely eaten functional food in the UK is Wrigleys Extra chewing gum. This valuable product contains xylitol, a sugar derived from birch bark. Not only does it taste pleasant, it also 'starves' the bacteria which cause dental decay, so that they die off and are replaced by less damaging bacteria.

Xylitol has also been shown to bind to calcium present in the saliva, forming xylitol-calcium complexes which are believed to increase the uptake of calcium into the tooth.

The end result is a very significant reduction in dental decay⁽¹⁴²⁻¹⁴⁵⁾. The changed bacterial populations in the mouth and throat also confer protection against middle ear infections⁽¹⁴⁶⁾.

Tea for teeth

Regular tea drinkers have lower levels of dental decay⁽¹⁸¹⁻¹⁸³⁾. Not only does tea provide fluoride, it also contains flavonoids and related substances that prevent the growth of cariogenic bacteria⁽¹⁸⁴⁻¹⁸⁷⁾ and dislodge them from dental plaque⁽¹⁸⁸⁻¹⁸⁹⁾.

Green tea is now a major component in functional chewing gums in Japan. How long before it appears in your toothpaste?

Cranberries

Cranberries help, too. New work⁽¹⁹⁰⁾ suggests that the flavonoids in cranberries prevent disease-causing bacteria sticking to the teeth and gums – just as they do for urinary tract infections.

Q10 and the cancer connection

Because Q10 is essential for cell energetics, a lack of Q10 leads to impaired cellular function – including the immune cells which form a crucial line of defence against cancer. Conversely, Q10 supplements improve immune function in animals, particularly in elderly animals where Q10 levels are reduced; and give significant protection against cancer⁽¹⁴⁷⁻¹⁴⁹⁾. Could this have clinical implications?

Professor Karl Folkers, one of the pioneers of Q10 research, found that Q10 levels in blood of cancer patients in Sweden and the USA were uniformly lower than in the controls^(75, 150, 151). He then started an open study, giving high dose Q10 and multi-nutrient support to a small number – 32 – of high risk breast cancer patients. This study does not meet the standards of current oncology trials, and the results are not scientifically safe. Nevertheless, they make fascinating reading⁽¹⁵²⁻¹⁵⁴⁾.

All patients were given routine chemotherapy, radiotherapy and surgery. By now, according to the statistics, about nine of them should have died. There have been three deaths, for non-cancer-related reasons. The other 29 women report significant improvements in their condition. They use fewer painkillers, there have been no cases of cancer spread, and six cases of partial or complete cancer remission.

Cancer specialist Dr Knud Lockwood has treated over 200 cases of breast cancer every year for the last 35 years. "I have never before seen spontaneous regression of the type of breast cancers we treated in this trial," he said. "I call this a breakthrough. The fact that the patients feel so well on this treatment is a major bonus, and a huge improvement over conventional therapy."

If Q10 does have an anti-cancer effect, improved immune function may well be involved, but there are other possible modes of action. Cytokines (cellular 'messengers') are essential for some tumours' survival, and may be made by the cancer cells themselves. In one group of myeloma patients, high dose Q10 reduced levels of the cytokine TNF alpha to below detectable levels⁽²⁾. This implies that high dose Q10 may be effective in treating other diseases where TNF alpha is involved, including rheumatoid arthritis, asthma and ulcerative colitis.

Although similar results have been reported in the USA⁽⁹⁰⁾, leading cancer specialists are taking a cautious line. The finding that levels of Q10 are low in cancer patients is intriguing, but that doesn't necessarily mean that supplementing with Q10 will treat an established cancer. More work is needed.

Sven Moesgaard, the nutritionist who designed the programme, says, "We analysed the entire world literature on the anti-cancer effects of all the vitamins and minerals, and assembled a broad-based nutritional package based on that search.

"According to our patients, and the trial results, which I must emphasise are preliminary results, we think it works. But it's true that we need more data. The pilot trial raises a lot of questions, and we want to follow this up with a much larger study."

The Copenhagen patients have no doubts about the outcome. "When I was asked to join the trial I was hesitant," says Patient C, a 70-year old widow. "But I feel so well on the supplements, better than I've felt for years; whereas other cancer patients I know who just get the ordinary treatments have a terrible time.

"All women with breast cancer should have this treatment. Now the doctors tell me that my cancer has completely disappeared. I call it a miracle."

The future for Q10

There have been, and still are, Q10 sceptics. Their first argument was that Q10 could not be absorbed. Well-designed studies have disproved this: Q10 is absorbed^(37-39, 88), if it is given in the optimal formulation.

(It should be pre-dissolved in soy oil in a soft gel capsule, which must be impervious to light as Q10 degrades in sunlight. Q10 is insoluble in water; so Q10 in tablet or powder form is less well absorbed.)

The next concern was that taking Q10 supplements might suppress the body's own Q10 production. However, after stopping a 12-month course of high dose Q10 supplements, volunteers' blood levels of Q10 fell back to pre-treatment levels – but no further⁽⁷⁸⁾.

The third objection was that Q10 supplements wouldn't get to the mitochondria and other sites where it is needed. This too has been refuted⁽⁶⁸⁾. People suffering from certain rare diseases, where mitochondrial function is very poor, have been successfully treated with Q10 supplements which boosted mitochondrial function^(40, 41, 100-103).

This is no surprise – Q10 is made in the liver, and transported in the blood (in LDL cholesterol) to every tissue in the body. It is concentrated inside the mitochondria, so every cell must have a mechanism for absorbing Q10 from the blood. Q10 supplements presumably pass through the liver, enter the bloodstream and are taken up by the body's cells as required.

Additional clinical research is slow. Eisai in Tokyo has the world monopoly on production and, although it has a massive re-investment programme, it sees no need to fund clinical trials to achieve a product licence for Q10, as they are selling everything they can produce.

Most Q10 research is done by independent clinicians who have given it to their patients, seen it work, and then written up the results in minor scientific journals. Nevertheless there have been positive results in trial after trial, in country after country.

Not a cheap option

Q10 is not cheap. For that reason many Q10 products on sale in health food shops and chemists contain too little Q10 to have any effect.

The dose generally used by scientists and athletes is 60-100mg a day, but Q10 is so safe that you can experiment with higher doses.

Heart patients have been maintained for years on doses of over 300 mg/day without side effects^(54-56, 68).

I recommend a minimum dose of 30mg a day, rising to 300mg to treat specific conditions. At the entry (30mg) level it costs about 20p a day or £6 a month.

SUMMARY

Guidelines

- Look for Q10 which is pre-dissolved in soy oil in dark gel capsules. Take it with food.
- Athletes commonly take 100-300mg of Q10 a day – heart patients take up to 300mg. A good start point for athletes would be 90-100mg a day.
- For maximally improved physical performance, combine Q10 with L-carnitine (2-4 g/day) with optional creatine and carbohydrates⁽⁸³⁻¹²¹⁾.
- Q10 can become pro-oxidant after intensive exercise⁽¹³⁸⁾. To prevent this, athletes should combine Q10 with Vitamins C and E and flavonoids.
- If you are on a cholesterol-lowering drug, take Q10 – as many of these drugs slow the body's own Q10 production.
- For mitochondrial protection, combine Q10 (min. 30mg a day) with beta carotene (at around 10mg a day)⁽⁸⁴⁾ and L-carnitine (500-1000mg a day).
- In athletes, the elderly and in cases of liver disease, micro-nutrient programmes which include L-carnitine, Q10 and beta carotene should improve energy levels.
- Eat more broccoli, cabbage and Brussels sprouts – they up-regulate anti-oxidant enzymes which stabilise Q10^(74, 115).
- A supplement containing mixed carotenoids, copper, zinc and manganese will also help make the most of extra Q10 in the body^(119,120).
- To treat gum disease, a dose of at least 90mg is recommended, together with a Q10 toothpaste if you can find one.
- Skin creams containing Q10 are ineffective. Skin rejuvenation requires a more complex strategy! (See Chapter 18. Skin).

