What is coenzyme Q10?

Coenzyme Q10 is a vitamin-like nutrient which is the only fat soluble antioxidant found naturally in the body. It is absorbed daily through the diet and can also be produced in small quantities by the body itself.

Almost every cell in our body contains coenzyme Q10, especially organs which need a lot of energy like the heart, liver and muscles. Coenzyme Q10 was previously considered to be an ineffective substance for athletes, as past studies with Q10 did not give consistent results. This may have been caused by the study design or by an insufficient dosage of Q10.

Functions of coenzyme Q10

Coenzyme Q10 fulfils two main functions in the body which are especially important for athletes:

- **Energy production (in mitochondria)**

  Q10 plays an essential role in the electron transport in oxidative phosphorylation and so in the mitochondrial production of ATP, the energy in each of our cells and all of our life processes. 96% of all aerobically produced energy is produced by Q10. Coenzyme Q10 acts as a catalyst which is never actually used, but a small amount of Q10 is always destroyed in this highly reactive, aggressive process. This is why there must be a constant intake of Q10 in food. Organs like the heart and muscles, which use a lot of energy, depend on a sufficient supply of Q10 and produce less energy and strength if they are a lack of Q10.

- **Antioxidants (in cell membranes)**

  Coenzyme Q10 is the most important fat soluble antioxidant in the body along with vitamin E. They are structurally linked to one another and are both part of the cell membranes which they protect from damage from radicals. It is Q10, which reacts first with radicals and is destroyed by them. Q10 protects vitamin E in this way and also helps to regenerate depleted vitamin E over and over again. Q10 should not be compared with the multitude of water soluble antioxidants, which move freely in the blood and have a rather non-specific effect. Along with vitamin E, Q10 has the special task of protecting the very sensitive cell membranes and this gives it a unique position amongst all antioxidants.

Advantages of coenzyme Q10

- Vitamin-like nutrient
- Only fat-soluble antioxidant found naturally in the body
- Safe nutrient without side effects
- Legally authorised, not doping
- Holistic effect on health, recovery and performance capacity
- Effectiveness depends on Q10 dosage + plasma level
- Enhanced performance for intermittent exercise
- Protects muscles and improves recovery

Coenzyme Q10 has been on the market for many years and is a well-known nutritional supplement. The permissible daily dose of coenzyme Q10 was restricted to 30 mg a day for a long time. But today higher doses of Q10 are allowed in the EU and new studies with higher doses up to 300 mg of Q10 give better results for athletes.

The time now seems to be perfect for the use of coenzyme Q10 in sports nutrition.
Q10 plasma level as a diagnostic tool

The human body has around 2g of Q10. The "normal" Q10 plasma level for a healthy person is between 0.67–0.99 mg/l. The Q10 plasma level is a good tool for diagnosing the general condition of the body. A Q10 deficiency is shown by a fall in the Q10 plasma level. So people who are exposed to high oxidative stress also have lower Q10 plasma levels than people in good health. With illnesses such as diabetes or heart disease the Q10 plasma level falls by 60–70% to 0.3–0.4 mg/l.

The Q10 plasma level is dependent on many factors and can vary greatly:

- Diet composition (low fat content reduces the Q10 intake)
- Nutritional behaviour (vegetarian etc. lower Q10 intake with food)
- Nutritional status (lack of selenium, B6, inhibits Q10 biosynthesis)
- High vitamin E supplement (inhibits Q10 intake)
- Statin therapy for hypercholesterinaemia (inhibits Q10 biosynthesis)
- Old age (lower Q10 biosynthesis)
- Illness (higher oxidative stress increases the use of Q10)
- Sustained physical endurance and training (increases the use of Q10)

So a lot of people, and athletes in particular, would benefit from having their Q10 plasma level measured to determine their personal Q10 level. Unfortunately, Q10 plasma level measurements are not covered by medical insurance, so have to be paid by the interested party or people concerned themselves. But a Q10 plasma level measurement, for example at Ganz-Immun in Mainz, Germany, only costs around €20 and so is quite affordable and often very useful.

To counterbalance a Q10 deficiency, the Q10 plasma level has to be increased over a lengthy period to give the body organs enough time to slowly replenish the reserves of Q10. The Q10 plasma level necessary to do so was increased a number of times by the experts in the last 30 years, from 1.5 mg/l in the 1980s, to 2.5 mg/l in the 1990s to today's recommended value of >3.5 mg/l.

<table>
<thead>
<tr>
<th>Illness/Q10 deficiency:</th>
<th>0.1–0.5 mg/l</th>
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<tr>
<td>Normal value:</td>
<td>0.6–1.0 mg/l</td>
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<tr>
<td>Value for therapeutic use:</td>
<td>&gt;3.5 mg/l</td>
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The Q10 plasma level achievable depends on the bioavailability of the Q10 which is influenced in turn by a number of factors:

- Q10 dosage
- Q10 form (Q10 or QH)
- Timing of intake: before, with or after meal
- Type of food combination

Past studies have demonstrated a link between the effectiveness of Q10 and the Q10 plasma level. They also clearly demonstrated the difficulty in increasing the Q10 plasma level to the highest value possible. The use of QH (the reduced form of Q10) offers new possibilities for increasing the Q10 plasma level.
Q10 is a fat soluble antioxidant which has first of all to be emulsified in the watery medium of our intestine before being absorbed into the body. So its bioavailability depends on the Q10 formulation and the method of uptake. Fats, oils and emulsifying agents like lecithin increase the bioavailability of Q10. Whereas other nutrients which are absorbed in a similar way as Q10, vitamin E for example, inhibit the Q10 uptake.

It has been clearly demonstrated that there is an almost linear dependence between the Q10 plasma level and the dosage up to a quantity of around 200 – 300 mg a day (Kaikkonen 2002, Kon 2008) where it reaches a sort of plateau.

However, people appear to have a limited capacity to absorb Q10. In studies with people suffering from Parkinson's disease, it was only possible to achieve a plasma level of 6 mg/l with a 2,400–3,000 mg dose. Substances like piperine increase the bioavailability of Q10 by 30%.

Bioavailability of Q10

New: Q10 Gelpells® with higher bioavailability

So-called Gelpells® are a new way of administering coenzyme Q10 in which the Q10 is embedded in a gelatine matrix. Gelpells® increase the bioavailability of Q10 by 32%. Gelpells® are 100% natural, fully digestible and contain no added colours or preservatives.

The gelatine pellets consist of a natural polymer which dissolves in warm water. The substances in the pellets are stored in the cavities of the gelatine and are dispersed very finely into the water. This type of microemulsion increases the bioavailability of the nutrients.

Bioavailability of QH

Studies have shown that the reduced form of Q10 (QH) is 6–10 times more bioavailable than reduced Q10. Plasma levels of 6–8 mg/l can be achieved in humans with 300 mg QH (Hosoe 2007). With 450 – 600 mg QH, Q10 plasma levels of 8–10 mg/l can be achieved (Langsjoen 2008).

Studies are currently underway, also with trained top athletes in Germany, to see whether athletes in particular can benefit from such high Q10 plasma levels.
Q10 level in athletes

The optimal plasma level for athletes is not known to date. Do athletes need more Q10 due to their higher physical exertion?

Should athletes ever take Q10 supplements and what should their Q10 value be? Is a normal, "healthy" plasma level of 1mg/l enough or should athletes aim for the highest possible value of >3.5mg/l, for example?

Although Q10 cannot actually be used but is regenerated, it appears to be lost during sustained exertion, such as sports training. Trained athletes often have lower Q10 plasma levels than untrained people (Wyss 1990). This may be caused by a number of things. Athletes appear to have a greater requirement for Q10 and high Q10 consumption which is not covered by normal food intake and biosynthesis in the body. Highly trained athletes can therefore have lower Q10 levels in tissue and blood, and this can limit their performance. So it is especially important for athletes to monitor their Q10 plasma level and to supplement their Q10 as necessary. There is, as yet, no recommended Q10 plasma level for athletes. But the latest studies show a link between the Q10 plasma level and performance capacity: the higher the Q10 plasma level, the higher the performance capacity.

Q10 dosage for athletes

Normal Q10 values in plasma can be achieved by the targeted dosage of even small doses of Q10 (30 –100 mg a day). Higher dosages of 200 – 300 mg Q10 a day can increase muscle Q10 content.

It seems to be confirmed that a dosage of 100 mg Q10 a day for athletes is too little to bring about a performance enhancing effect. It should also be pointed out that a few earlier studies were unsuccessful because the Q10 plasma level could not be increased sufficiently despite the 100 mg/day. In an earlier Italian study, a dosage of 100 mg Q10 per day only increased the plasma level to a value of 1.34 mg/l (Zuliani 1989), which is too low to achieve any effects for athletes.

In a later Italian study, it was possible to raise the Q10 plasma level to 2.23 mg/l using a better Q10 formulation with the same dosage of 100 mg per day (but in a different formulation). After 2 months of Q10 supplements, muscles only became exhausted with greater exertion and overall performance improved.

In a dose finding study, a dose of 100 mg Q10 showed no effects, but a 300 mg dosage of Q10 and a Q10 plasma level of 3.29 mg/l significantly increased endurance and exhaustion improved in a maximum speed test on the ergometer (Kon 2008).

Today, we must conclude that the Q10 dosages in earlier studies were generally too small to achieve any significant positive results for athletes. Clinical studies with athletes are increasingly proving positive effects for a dosage of 300 mg Q10 or Q10 plasma levels >3.3 mg/l. With a dosage of the reduced form of Q10 (QH), even higher Q10 plasma levels can be achieved with smaller dosages.

Possible coenzyme Q10 deficiency in athletes

triggered by:

- Increased consumption and increased requirement for Q10 due to sustained, heavy physical exertion
- Reduced Q10 uptake due to vegetarian diet
- Limited Q10 biosynthesis due to deficiencies of nutrients like selenium, vitamin B6, magnesium etc.
- Intake of high doses of vitamin E inhibits Q10 uptake from food and lowers the Q10 plasma level
- Statin therapies limit Q10 biosynthesis and lower the Q10 plasma level
Measuring sporting performance

Measuring human physical performance is one of the most difficult study parameters that exists. To measure an increase in performance, it is important to establish the measurement parameters and also the test configuration and range of test groups. Performance can be measured in 5 different stages:

1. Increased performance in animals (rats)
2. Increase in true performance parameters of untrained or older athletes
3. Increased endurance (time to exhaustion) and reduced clinical parameters
4. Enhanced performance and recovery with intermittent exertion for athletes
5. Enhanced true performance parameters for trained athletes

**Re 1:** First indications of whether a substance can have performance enhancing effect with cell cultures or animals (usually rats), but studies with humans are always absolutely essential.

**Re 2:** The enhanced performance of untrained people or older people is a further indication of a substance's potential. But training often has a great influence here and the effect of the substance must be clearly differentiated from the effect of training.

**Re 3:** Measuring endurance/time to exhaustion (stage 4) is easy to measure and often provides double figure increases (10–30%). But the time to exhaustion is not a true performance parameter and values are higher than true performance parameters by a factor of around 10. But time to exhaustion is an indication of a substance's potential and whether there is any chance of enhanced performance.

**Re 4:** Enhanced performance for intermittent exertion is a true parameter of enhanced performance, which is based on protecting the muscles and improving regeneration.

**Re 5:** It is very difficult to measure enhanced performance for trained top athletes (stage 5), as changes are in the order of 1–3%.

If a substance has shown positive effects in the initial test stages, this is a good indication that enhanced performance might also be possible for trained top athletes. But if a substance does not show any effects in the initial test stages, it can also be concluded that this substance is really not effective.

Higher performance with Q10

Q10 supplements were able to increase sporting performance parameters in a few studies.

4. Enhanced performance of athletes for intermittent exertion

But Q10 can act, above all, as an indirect means of enhancing performance. As Q10 reduces damage to cell membranes induced by exertion, recovery time is shorter and higher exertion/performance can be achieved during further exertion.
Antioxidants in sport

Opinions still differ as to the value of using antioxidants in sport. Antioxidant supplements reduce the creation of radicals during sports activity.

Free radical damage cell membranes and can cause muscle damage. Many experts still believe that this muscle damage is necessary to trigger bodily induced defenses to free radicals.

But that is not correct and all athletes who train in this way are taking a big risk, as muscle can become so badly damaged that scars form in the muscles and muscle performance is permanently reduced.

Physical exercise already sends enough signals to the body for it to adapt to exercise. So it is not necessary to create muscle damage which is actually counterproductive. Any damage in muscle cells must first be repaired before the muscle can grow. So muscle damage makes regeneration longer and inhibits muscle growth.

Antioxidants for athletes may:

- Reduce exercise–induced muscle damage
- Increase endurance
- Reduce regeneration
- Achieve performance improvements for repetitive exertion

So antioxidants can be useful for athletes, but do require special care with regard to their form and dosage. A mixture of different antioxidants is probably the best way to supplement.

- Water soluble antioxidants like vitamin C have a pro-oxidative effect in high dosage and create more rather than less radicals
- High dosages of vitamin E inhibit the Q10 uptake in the intestine and in cell membranes and so should be taken separately from Q10.

Vitamin E and Q10 in sport

Athletes have been taking vitamin E for a long time. Many athletes take high doses of vitamin E (up to 1,000 mg and more a day) to fight radicals and to prevent or treat muscle damage and inflamed joints. Q10 and vitamin E have similar and synergistic properties. Both are part of the cell membranes and work hand in hand in the fight against free radicals and reactive oxygen compounds.

- Vitamin E is regenerated by Q10
- Q10 protects vitamin E, as it oxidises before vitamin E
- Q10 has as many anti-inflammatory properties as vitamin E

But there are also risks in taking high doses of vitamin E. High dosages of vitamin E can be toxic for the liver, as vitamin E can concentrate excessively in fat tissue and the liver. High doses of vitamin E also inhibit the uptake of Q10 and reduce the Q10 plasma level by around 20%.

So it may make more sense for athletes to reduce their high dosage of vitamin E (< 400 mg/day) and replace it with 300 mg of Q10. But both substances should be taken at different times of the day, for example, vitamin E in the morning and Q10 in the evening.

The dosage combination could be, for example, 400 mg vitamin E and 300 mg Q10 or 90–150 mg QH.
## Overview of studies: CoQ10 in Sport

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<tr>
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<td>Male professional basketball players</td>
<td>Maximum oxygen uptake ↑&lt;br&gt;Blood CoQ10 conc. ↑&lt;br/Cardiac performance parameters ↑</td>
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<tr>
<td>Cerioli (1991)</td>
<td>Blood free fatty acid concentration ↓&lt;br&gt;Fat metabolism (conclusion) ↑&lt;br/Aerobic exercise capacity (concl.) ↑</td>
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<tr>
<td>Cooke (2008)</td>
<td>22 trained and untrained athletes 200 mg / day 14 days</td>
<td>Muscle CoQ10 concentration ⇑&lt;br&gt;Serum SOD oxidative stress ⇑&lt;br/Plasma CoQ10 concentrations ⇑&lt;br/Time to exhaustion (tendency) ⇑</td>
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<tr>
<td>Faff (1997)</td>
<td>Rats, 10 mins treadmill, twice a week for 4 weeks</td>
<td>Time to exhaustion ↑&lt;br/Exercise-induced lipid peroxidation ↓</td>
</tr>
<tr>
<td>Fiorella 1991</td>
<td>Highly trained runners Running test</td>
<td>Longer distance (+12.9%) ↑&lt;br/Time to exhaustion (+7.9%) ↑</td>
</tr>
<tr>
<td>Gökbel (2010)</td>
<td>15 healthy sedentary men 100 mg / day 8 weeks</td>
<td>Mean power output ⇑&lt;br/Fatigue index ⇑</td>
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<td>Kon (2008)</td>
<td>300 mg / day</td>
<td>Plasma creatine phosphokinase release ↓&lt;br/Plasma myoglobin release ↓&lt;br/CoQ10 may prevent muscle damage during sustained exercise</td>
</tr>
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<td>Mizuno 2008</td>
<td>17 healthy volunteers a double-blinded, placebo-controlled, three crossover design 100 mg / day 300 mg / day 8 days</td>
<td>Maximum velocity (300 mg) ⇑&lt;br/Subjective fatigue sensation (300 mg) ↩</td>
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<tr>
<td>Shimomura (1991)</td>
<td>Rats, 90 minute downhill treadmill running exercise</td>
<td>Lactate dehydrogenase release ↓&lt;br/Plasma creatine phosphokinase ↓</td>
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<tr>
<td>Vanfraechem (1981)</td>
<td>6 inactive young men</td>
<td>Exercise performance ⇑</td>
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<tr>
<td>Wyss 1990</td>
<td>Subjects with decreased work ability absent from disease Middle aged housekeepers with sedentary lives 90 mg Q10 / day</td>
<td>Total oxygen uptake after maximum intensity exercise ↑&lt;br/Oxygen equivalence of lactic acid ↑&lt;br/Total oxygen metabolism ↑&lt;br/Maximum oxygen uptake ↑&lt;br/Maximum work capacity ↑&lt;br/Total work volume ↑</td>
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<tr>
<td>Yamabe 1991</td>
<td>Exhaustive cycling exercise</td>
<td>Physical ability ↑&lt;br/Exercise aerobic function ↑&lt;br/Increase in exercise time ↑&lt;br/Peak VO2 ↑&lt;br/Aerobic threshold ↑&lt;br/Severity of symptoms of physical inability ↓</td>
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<tr>
<td>Ylikoski 1997</td>
<td>25 Finnish top-level cross-country skiers double-blind cross-over study</td>
<td>Parameters of physical performance (AET, ANT and VO2Max) ↑&lt;br/Improved performance and recovery time in 94% Q10 period vs 33% in placebo period</td>
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<tr>
<td>Zeppili 1991</td>
<td>Volleyball athletes and inactive adults 100 mg 10 / day</td>
<td>Total work capacity ↑&lt;br/Maximum oxygen uptake ↑&lt;br/Plasma Q10 concentration ↑</td>
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<tr>
<td>Zuliani (1989)</td>
<td>12 healthy untrained subjects Exhaustive cycling exercise 100mg / day 4 weeks</td>
<td>Free fatty acid levels ↓</td>
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Literature


Kaneka: A global player with pharma standards

Kaneka is a global Japanese chemical company with 7400 employees and a turnover of around $5 billion. Around 800 employees are engaged solely in research and development and Kaneka invests $150 million a year in research. Kaneka is the largest producer in the world of Q10 and QH.

The Kaneka company and all its products must comply with the safety and quality requirements for foodstuffs and pharmaceuticals in Japan which are the highest in the world.

The Kaneka company and all its products are subject to constant quality control. Kaneka applies the highest safety and quality standards to all its products to ensure the best possible quality for customers. The Kaneka seals of quality KanekaQ10® and KanekaQH® are the customer’s guarantee of this.

Kaneka has been manufacturing and selling pharmaceuticals and foodstuffs such as Q10 for over 30 years without problem.