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REPORT

Three-Step Strategy to Reverse Mitochondrial Aging

By Michael Downey

Have you ever wondered how long you're going to live? The potential answer can be found in the energy-producing cellular powerhouses called **mitochondria**.

According to a growing number of cell biologists, the number and functionality of the mitochondria specifically determine an individual's life span.[1-3]

When we're young, we are relatively protected against mitochondrial deterioration. As we age, however, changes within our cells lead to the destruction of mitochondria—paving the way for aging and disease.[4-8]

In **2007** scientists made a remarkable **age-reversal** discovery:

> Damage to mitochondrial DNA becomes ***permanent*** a decade after ***mitochondrial dysfunction*** begins—and in the early stages, this damage remains **reversible.**[9]

In this article, you'll learn about a 3-step program aimed at **restoring** your body's vital mitochondrial health:

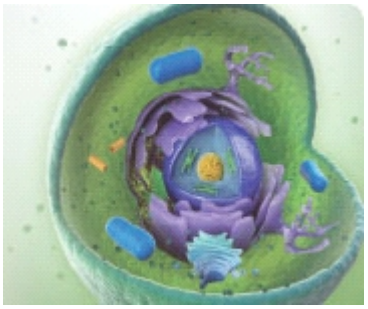
Step 1: *Boost* your body's natural mitochondrial DNA defenses with **CoQ10**.

Step 2: *Stimulate* the creation of *new* mitochondria with **PQQ**.

Step 3: *Support* your body's mitochondrial defense system with **shilajit**.

This strategy to reduce damage to **existing** mitochondrial DNA and **create new** mitochondria—is essential to inhibit a destructive cycle believed to be a ***root cause of aging***.

WHY WE NEED MITOCHONDRIA



Found inside the body's cells, mitochondria are responsible for producing our primary source of energy, ***adenosine triphosphate*** *(ATP).* ATP provides at least **95%** of the cellular energy that powers all living functions.

Unfortunately, a byproduct of this energy generation is the formation of a huge stream of **free radicals**.[4-7] Free radicals are molecules that possess a free electron—a property that makes them react with other molecules in volatile and highly destructive ways.[10-12]

Free radicals attack the structure of our cell membranes, creating metabolic waste products that disturb DNA and RNA production, interfere with the synthesis of protein, and destroy important cellular enzymes. Vital tissues and molecules **decay** under the assaults of free radicals.[10-14] In addition, free-radical disruption of cell mechanics creates **mutant** cells, which are linked to cancer and cellular aging.[15,16]

Mitochondria are the easiest targets of free-radical injury for two reasons:

1. They are located *exactly* where these free radicals are produced, and
2. They lack most of the antioxidant defenses found in other parts of the cell.[17,18]

Evidence strongly indicates that over time, accumulated damage to the DNA of the ***mitochondria*** in particular leads directly to metabolic disorders (such as diabetes) and degenerative disorders (such as Alzheimer's).[4-8,19-23]

Mitochondrial dysfunction is primarily seen in organs and tissues that have a high demand for **energy**—explaining why cardiovascular tissue and brain neurons are among the most susceptible.[24]

When we're young, we are largely protected against mitochondrial deterioration because our bodies produce substances to defend mitochondria from the onslaught of free radicals. However, as we age, that protection wanes, setting us up for a destructive cycle that accelerates aging and disease. As a result of this rapidly accelerating process, mitochondria in the cells of elderly people are mostly dysfunctional, whereas young individuals have virtually no mitochondrial damage.[8,25-27]

THE MITOCHONDRIAL THEORY OF AGING

Over time, there are **three** devastating changes within our cells that lead to the destruction of mitochondria—paving the way for aging and disease:[4-7]

- The rate of cellular production of two free radicals—***superoxide anions*** and ***hydrogen peroxide*** —significantly increases, attacking mitochondria the most.
- At the same time, intracellular levels of endogenous ***antioxidants*** that help prevent the harmful *effects* of free radicals decrease. There's also a reduction in activities of ***free radical-scavengers*** that neutralize free radicals *before* they can attach themselves to other molecules. These decreases diminish the mitochondria's normal defenses.
- The accumulated oxidative damage to the mitochondrial DNA and other mitochondrial components (as well as the cell as a whole) leads to decay of the mitochondria—and from that decay, the ***release of even more free radicals***!

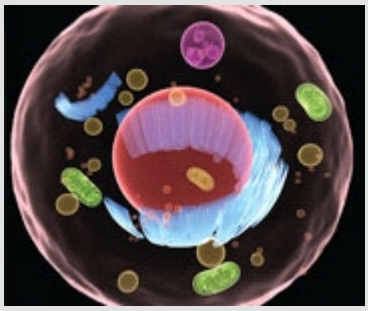
According to the mitochondrial theory of aging, this ever-increasing spiral is—in itself—an ***aging*** process.[4-8, 25,26] In fact, a growing number of cell biologists have suggested that the number and functionality of the mitochondria can specifically determine an individual's longevity.[1-3]

Based on this body of scientific evidence, scientists determined that a key to slowing—and even ***reversing***—a "natural" aging process would be a substance aimed at revitalizing youthful mitochondrial protection from free radicals.[27]

They discovered this mitochondrial solution in a substance that may already be in your nutrient regimen…***coenzyme Q10***.

WHAT YOU NEED TO KNOW

Block Mitochondrial Aging



- Daily damage to mitochondrial DNA appears to be a root mechanism of aging.
- If caught before it becomes permanent, early stage mitochondrial dysfunction can be ***reversed!***
- Levels of **CoQ10**—the body's natural mitochondrial defense—decline rapidly with age. But breakthrough research has found that supplemental CoQ10 blocks mitochondrial aging.
- **Shilajit** works synergistically with CoQ10 by replenishing its electron supply and increasing CoQ10 levels.
- **PQQ** powerfully supports the protection afforded by CoQ10 and shilajit by triggering the creation of ***new*** mitochondria.
- Taken together, CoQ10, PQQ, and shilajit offer a potent program to inhibit the intensely destructive cycle believed to be one of the ***root sources of aging!***

COENZYME Q10 PROTECTS MITOCHONDRIA

Scientists have established that **coenzyme Q10** (CoQ10**)** is an essential nutrient for normal mitochondrial function (namely, the production and transfer of **energy**).[28-30] When CoQ10 levels fall, mitochondrial ***dysfunction*** skyrockets.[28] Studies have found that boosting CoQ10 levels via supplementation increases mitochondrial *electron transport*—whether the cells are deficient in CoQ10 or not.[29,30]

CoQ10's ability to protect the vital mitochondria helps put an end to the vicious cycle that underscores a critical aspect of pathological aging. In fact, research with laboratory models has suggested that CoQ10 may be one of our most potent **anti-aging** nutrients. Studies have found that when cells or organisms are deficient in CoQ10, mitochondrial oxidative stress increases and aging is accelerated.[28,31] However, supplementation triggers a significant slowing down of the aging process and an extended life span.[32,33]

One study showed that rats supplemented with CoQ10 experience a **24%** increase in maximum life span and an **11.7%** increase in average life span.[34] In human terms, based on today's life expectancy of **78.5** years, this mean increase translates to a more than ***9-year increase in life span!***[35]

CoQ10 also seems to work via a multi-targeted set of ***epigenetic*** mechanisms that not only slow aging—but that also protect against a variety of mitochondria-related diseases.[36-38] Epigenetic mechanisms involve changes in ***gene function*** that do not relate to changes in ***gene structure***.[39] Studies have shown that CoQ10 protects against **neurodegenerative** diseases[40-42] and **mental health** disorders,[43] enhances **lung** function,[44,45] guards against the effects of elevated glucose in **diabetes** and **metabolic syndrome**,[46-48] and offers impressive defense against **cardiovascular** disease, one of the primary diseases of aging.[49-51]

Animal studies demonstrate that supplementation with CoQ10 reduces oxidative stress and reduces the buildup of ***amyloid-beta*** plaque (associated with Alzheimer's disease)[40-42,52,53] —resulting in a significant improvement in cognitive performance and memory.[53]

In human studies, 4 weeks to 6 months of CoQ10 supplementation at **60-300 milligrams a day** was shown to improve cardiac systolic function and ejection fraction.[49,50] One study showed that 8 weeks of CoQ10 supplementation at **300 milligrams a day** improved heart-muscle systolic function by enhancing both mitochondrial performance and endothelial function.[50] And in a 5-year, randomized, double-blind, placebo-controlled trial among elderly individuals, CoQ10 combined with selenium slashed the death rate from cardiovascular disease by more than **half!**[54] In fact, the authors of one study recognized CoQ10 as a "**scientific breakthrough** in the management of chronic heart failure."[55]

CoQ10 offers a powerful way to help slow—or even ***reverse***—a natural aging process by restoring youthful mitochondrial protection from free radicals.[27,56]

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COQ10: POTENTIAL THERAPY FOR INHERITED MITOCHONDRIAL DISORDER

Newly released research underscores the vital importance of **coenzyme Q10** (**CoQ10**) to mitochondrial health.

A study released ahead of print in **April 2013** by the journal *Mitochondrion* has found that patients with **mitochondrial DNA depletion syndrome** (MDS) have significantly deficient levels of CoQ10.[85] MDS is a hereditary condition characterized by grossly reduced cellular levels of mitochrondrial DNA in infancy. MDS involves various progressive disorders that are often ***fatal*** in childhood.[86]

Currently, there are no effective therapies available for MDS[86]—but this recent finding indicates that CoQ10 could represent a **candidate therapy** for this condition.

The suggestion that CoQ10 may constitute a therapeutic hope for treating this serious mitochondrial-deficiency disorder demonstrates just how powerfully CoQ10 protects mitochondria.

This also underscores CoQ10's vital importance in slowing or reversing the "natural" aging process in ***healthy*** individuals.

PQQ CREATES NEW MITOCHONDRIA

While **coenzyme Q10** optimizes mitochondrial function and protects them from free radical damage, scientists have found another coenzyme that triggers the creation of new mitochondria altogether.

A huge research advance in **2012** showed that the coenzyme ***pyrroloquinoline quinone*** (or **PQQ**) activates genes that induce **mitochondrial biogenesis**—*the spontaneous formation of new mitochondria in aging cells!*[57]

This represents a major breakthrough in battling the mitochondrial destruction that underlies aging.

PQQ deficiency has a profound effect on your genes—especially those involved in cellular stress, cell signaling, transport of metabolites, and of course, the creation of new mitochondria.[57] Specifically, PQQ deficiency negatively affects the expression pattern of **438 genes**—but research has found that this effect is ***reversed*** after supplementation with PQQ.[57]

Prior to this breakthrough, some of the only scientifically validated ways to reliably stimulate the creation of new mitochondria were sustained ***calorie restriction*** or ***strenuous physical activity***—both of which are too rigorous and impractical for most aging people.[58,59] PQQ now provides the most practical means of ***reversing*** the deadly decline in functional mitochondria that is the underlying cause of premature aging and degenerative disease.

Earlier findings repeatedly indicated PQQ's central role as a potent growth factor.[60,61] In preclinical trials, when animals were deprived of dietary PQQ, they exhibited stunted growth, impaired conception rates, and most importantly, fewer **mitochondria**.[62-64] However, re-introducing PQQ into the diet ***reversed*** these effects—while simultaneously increasing mitochondrial number and energetic efficiency.[62,63]

Like CoQ10, PQQ also actively supports the energy transfer within the mitochondria that supplies the body with most of its bioenergy. Its exceptional stability allows it to carry out thousands of these transfers without undergoing molecular breakdown. PQQ has been proven especially effective in neutralizing two of the most potent free radicals, the superoxide and hydroxyl radicals.[65]

5,000 TIMES MORE EFFECTIVE THAN VITAMIN C!

Research demonstrates that PQQ is **30** to **5,000** times more efficient at reducing oxidation than other common antioxidants such as vitamin C.[60]

In a revealing **2010** study, scientists reported that similar protection of mitochondrial function that is seen with some other compounds (such as quercetin, hydroxytyrosol, and resveratrol) at high dietary concentrations measured in **millimoles** occurs with PQQ at dietary concentrations measured in **nanomoles**.[66] In other words, it takes **a million times** more of these other

compounds to have a mitochondria-protective effect equivalent to PQQ!

The revelation of its ability to favorably affect system-wide cell development, metabolism, and mitochondrial biogenesis helps explain the wealth of data on PQQ's **neuroprotective** and **cardioprotective** benefits.

PQQ has now been shown to block the development of abnormal proteins linked with neurodegenerative diseases. For example, it prevents cellular damage and demise due to accumulation of ***amyloid beta*** protein associated with **Alzheimer's** disease,[67,68] and of the ***alpha-synuclein*** protein that is associated with **Parkinson's** disease.[57,69]

In humans, supplementation with **20 milligrams a day** of PQQ significantly improved cognitive function in middle-aged and elderly people. These results were amplified when the subjects also took **300 milligrams per day** of CoQ10.[70]

In animal studies, researchers investigating its impact on **cardiovascular disease** have demonstrated that PQQ reduces the size of the heart area damaged by acute heart attack and favorably decreases lipid peroxidation.[71] PQQ also helps heart muscle cells resist acute oxidative stress—*specifically by preserving and enhancing mitochondrial function*.[72]

Neither humans nor the bacteria that colonize the human digestive tract have demonstrated the ability to synthesize PQQ,[73] which has led researchers to classify it as an **essential micronutrient.** This means that the body can't make enough of it for good health—and that supplementation is essential.[74]

SHILAJIT REVITALIZES COQ10

Shilajit

We've already learned that CoQ10 protects mitochondria from free radical damage. It does this by "depleting" itself—by donating its own electrons to (and thus neutralizing) the flood of free radicals generated during cellular energy production. Of course, this results in depleted stores of active CoQ10.

Studies have detailed how **shilajit**, a phyto-mineral pitch substance found in the Himalayas,[75-77] stabilizes, revitalizes, and preserves CoQ10 in its active (***ubiquinol***) form, boosting the levels of CoQ10 available to protect against mitochondrial aging. [78-81]

Cutting-edge scientific evidence has demonstrated that components of **shilajit** serve as **electron reservoirs**, replenishing electrons lost by CoQ10 and allowing this vital coenzyme to remain active longer.[78-80]

Shilajit's potent support of CoQ10's mitochondrial protection against aging was validated when laboratory mice were subjected to strenuous and stressful physical exercise. The combination of shilajit and CoQ10 resulted in **27%** greater ATP energy production in muscle cells—and in **40%** greater energy production in brain cells—than the energy increase measured in these tissues with CoQ10 alone.[80]

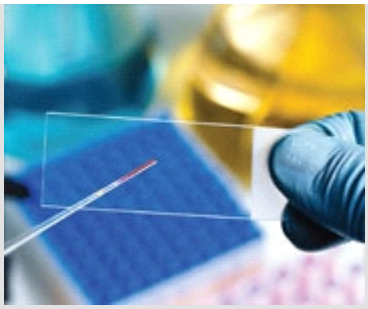
In other research, mice were initially supplemented with oral CoQ10 alone. As expected, CoQ10 levels rose in heart, liver, and kidney tissue. Remarkably, when components from shilajit were added to the supplement, CoQ10 levels rose ***even further***—as much as **29%** in liver tissue.[81]

Another element of shilajit—***fulvic acid***—has been shown to further support this process by channeling other electron-rich shilajit components into the mitochondria to support CoQ10 and electron transfer.[82] Fulvic acid also works independently to stimulate mitochondrial energy metabolism and protect mitochondrial membranes from oxidative damage.[82,83]

In an unpublished study, people who took **200 milligrams** of shilajit **once daily** for 15 days registered an increase in ATP levels in the blood after exercise. [84]

Ultimately, the synergistic effects of **shilajit** plus **CoQ10**—combined with the capacity of **PQQ** to create new mitochondria—offer an unparalleled option to protect mitochondrial DNA and ***combat aging!***

UBIQUINOL PROVIDES SUPERIOR BIOAVAILABILITY



Called a “coenzyme” because of its unique ability to participate in chemical reactions but remain at steady-state levels in the cell, coenzyme Q10 plays a central role in energy metabolism.[28-30]

CoQ10’s ability to cycle back and forth between ubiquinone and ubiquinol accounts for many of its unique properties. Ubiquinol, with its ability to scavenge free radicals, is an electron donor, while ubiquinone is an electron acceptor. This remarkable ability to cyclically accept and donate electrons, as well as to effect complementary chemical reactions in the mitochondria, accounts for CoQ10’s unparalleled value to almost all life forms.

The chemical difference between ubiquinone and ubiquinol is that the ubiquinol compound contains two hydroxyl groups. These two hydroxyl groups enable ubiquinol to be more easily dissolved into water than ubiquinone, thus making it easier to assimilate, which helps explain why it is so much more bioavailable than ubiquinone.

In a side-by-side single-dose human study, ubiquinol absorption was compared directly to conventional CoQ10 (ubiquinone) using the same delivery system. Subjects were given either **100 mg** of ubiquinol or **100 mg** of ubiquinone. The findings showed that in aged test subjects, ubiquinol absorption was **60%** greater in this single-dose side-by-side comparison.[87]

A review of published studies on human subjects reveals that it requires very high doses of ubiquinone CoQ10 to achieve the same levels attainable with modest amounts of ubiquinol CoQ10.[88-92] Clinical studies using **1,200** and **2,400 mg** per day of ubiquinone achieved CoQ10 blood levels similar to **150** and **300 mg** per day respectively of ubiquinol.[88-91]

SUMMARY

According to the mitochondrial theory of aging, damage to mitochondrial DNA from the massive free-radical assault of cellular energy production is a root mechanism of aging. The body produces **CoQ10** to protect mitochondrial DNA, but levels decline rapidly with age.

Scientists have discovered that it can take almost a decade for this aging damage to become permanent. The good news is that early stage mitochondrial dysfunction can be ***reversed!***

Breakthrough research found that two coenzymes (**CoQ10** and **PQQ**) can work together to protect mitochondria against free radical assaults—and to create new mitochondria in the process.

Supplemental **coenzyme Q10** blocks mitochondrial aging, while **PQQ** triggers the creation of ***new*** mitochondria. In addition, **shilajit** works synergistically with **CoQ10**, replenishing its electrons and prolonging its antioxidative effectiveness.

Taken together, **CoQ10** and **PQQ** and **shilajit** offer a potent program to inhibit—and ***reverse***—the intensely destructive cycle that is believed to be a ***root source of aging!***

If you have any questions on the scientific content of this article, please call a **Life Extension**® Health Advisor at 1-866-864-3027.

By Michael Downey

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