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UBIQUINOL®
Foundational Science:
Examining Ubiquinol's Role
in Mitochondrial Function
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Rethinking the Powerhouse: Mitochondria at the Center of Cellular Health

As new information about mitochondrial function has become a focus of scientific research, it has led to a greater understanding of the role of ubiquinol in several processes foundational to cellular and overall wellness.

Beyond their role in producing adenosine triphosphate (ATP)—the energy molecule of the cell—mitochondria are now recognized for their contribution to the following broader cellular processes that together help maintain cellular homeostasis, a critical pillar for wellness:

Mitochondrial biogenesis

Increasing mitochondrial size and number to meet rising energy demands or prepare for cell division[1]

Mitochondrial fission and fusion

Splitting and rejoining mitochondria to repair damage, recycle components, and adapt to stress[1,2]

Signaling pathways

Coordinating stress and immune responses and repair mechanisms to maintain balance[3]

Programmed cell death (apoptosis) and mitophagy

Safely removing damaged cells or mitochondria to protect overall function[4,5]

Cell senescence

Permanently halting the division of damaged cells to protect surrounding cells[4,7]

These roles position mitochondria as central to cellular resilience, maintenance, and performance. They also have an integral and wide-ranging effect on physiological processes associated with aging.[8,9]

Mitochondria are now being described as the CEO ("Chief Executive Organelle") of the cell, responsible for regulating complex metabolic networks, signaling, innate immunity, cell division, cell fate, and ultimately, the fate of the organism.[3,10]

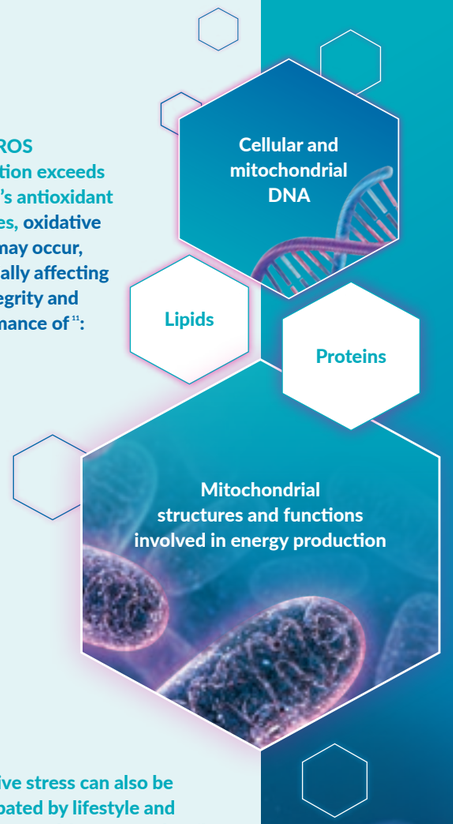
Oxidative Stress and Its Effect on Mitochondrial and Cellular Resilience

Reactive oxygen species (ROS) are natural byproducts of mitochondrial energy generation and are neutralized by antioxidants.[11]

Oxidative stress may influence energy production and cellular repair, with age-related changes in antioxidant defenses further affecting mitochondrial function and mitochondrial DNA (mtDNA).[6] The **oxidative stress theory of aging** states that long-term imbalances between ROS and antioxidant defenses can influence mitochondrial activity and cellular health with age.[12]

Oxidative Stress

When ROS production exceeds the cell's antioxidant defenses, oxidative stress may occur, potentially affecting the integrity and performance of[11]**:**



Oxidative stress can also be exacerbated by lifestyle and environmental factors, such as[13]**:**

- Poor nutritional intake
- Physical inactivity
- Tobacco and alcohol use
- Exposure to UV radiation, pollution, and other environmental toxins

The ratio of ubiquinol to ubiquinone, commonly referred to as CoQ10 balance, is one measure used in research as an indicator of oxidative stress. When the percentage of ubiquinone increases and ubiquinol decreases, this indicates greater usage of ubiquinol to manage free radicals. The more this balance tilts toward less ubiquinol, the greater the oxidative stress.

Ubiquinol: Contributing to Cellular Energy and Antioxidant Defenses

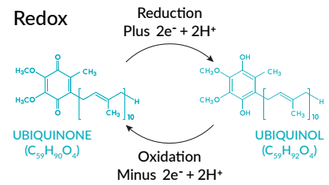
Ubiquinol is naturally produced in the body. As the active antioxidant form of CoQ10, it is used both in the production of ATP and to neutralize ROS that are produced during that process.

Lipid soluble and concentrated in the mitochondria,[14] **ubiquinol helps:**

- **Support cellular energy generation**[15]
  - **Neutralize ROS** at the source[11]
    - **Protect lipids** against peroxidation and damage[11,16]
      - **Maintain mitochondrial membrane integrity**

Ubiquinone and ubiquinol form a redox pair that cycles between oxidized and reduced states during energy generation and antioxidant activity. Ubiquinone is part of the electron transport chain, and once it is reduced by an enzyme complex, it becomes the antioxidant ubiquinol. When ubiquinol acts as an antioxidant and donates its electrons, it is oxidized and returns to being ubiquinone. This is known as a redox cycle.[14]

CoQ10 Redox Cycle



Research shows that ubiquinol plays a key role in both **energy generation and antioxidant protection** by being able to cycle back and forth between ubiquinone and ubiquinol.[11,14]

The levels of ubiquinol decline with age, due to a decreased ability to convert ubiquinone to ubiquinol and an increased demand for its antioxidant activity because of greater ROS production.[17,18]

Ubiquinol's vital role in antioxidant protection has been broadly investigated and shown to positively affect cardiovascular function,[16,19] preconception wellness,[20-23] menopausal well-being,[24-26] healthy aging,[19,27-29] and sports nutrition.[30,31]

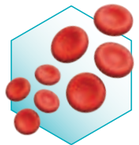
Ubiquinol is ubiquitous, as it is naturally found in almost every cell in the body.[15]

95% of the total CoQ10 in the blood is in the ubiquinol form.[32]

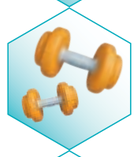
Mitochondrial Function Through the Aging Process

The passage of time is accompanied by the accumulation of wear and tear on all parts of the body, down to the very smallest of them. Healthy lifestyle habits such as eating a nutritious diet, getting regular exercise, prioritizing sleep, and managing stress make a profound difference, even at the mitochondrial level.[2]

However, even under the best of circumstances, aging is characterized by some decline in mitochondrial function. This triggers cellular changes that, over time, manifest in many conditions associated with aging.[14,18,33] **Ubiquinol's role in maintaining cellular homeostasis supports healthy cellular function in the face of daily environmental stresses, whatever the stage of life.**



Clinical studies show that supplementation with Kaneka Ubiquinol® **increases plasma ubiquinol levels.**[19,27]



Research demonstrates a positive correlation between total CoQ10 status and percentage plasma ubiquinol and **overall physical functioning** in older adults.[28,29]

Higher blood ubiquinol levels also promote **cardiovascular health**[19] and **muscle health.**[28]

With age, the body is less able to convert ubiquinone into ubiquinol.[17,32]

Mitochondrial Efficiency and Cardiovascular Health

Cardiomyocytes—heart muscle cells—contain a large number of mitochondria to meet the high energy demands placed on them.[35] Their high metabolic rate also generates greater amounts of ROS, increasing susceptibility to oxidative stress.[11,36]

Changes in mitochondrial efficiency may affect energy output and, in turn, affect heart function.[14,35]

Oxidative balance is an important factor in maintaining vascular tone and healthy blood flow in blood vessels.[37]

Excess ROS can directly affect the function of endothelial cells (which form the inner lining of vessels) from the mitochondrial to the cellular and tissue levels.[38]

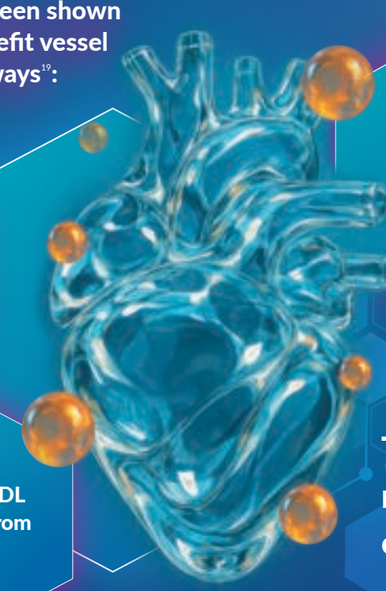
In addition, ROS can oxidize circulating LDL particles in the blood, which has been associated with changes in vascular health.[16,19,39]

Clinical research shows that Ubiquinol supplementation improves blood markers associated with heart health.[40,41] Additional studies highlight the relevance of these markers as indicators associated with cardiovascular health.[42,43]

In addition, ubiquinol helps to maintain mitochondrial membrane integrity, which is now understood to be foundational for maintaining heart and blood vessel structure and function, particularly with age.[18,44,45]

Kaneka Ubiquinol® has been shown in a clinical study to benefit vessel health in the following ways[19]:

- **Enhancing nitric oxide (NO) production**
- **Facilitating proper vasodilation and blood circulation**
- **Protecting LDL cholesterol from oxidation**



The heart is one of the most energy-demanding organs in the body.[35]

The Energy and Antioxidant Needs of Reproductive Cells

Healthy mitochondrial function is essential for the proper function of reproductive cells,[44] which have high energy demands[20] and are sensitive to oxidative stress.

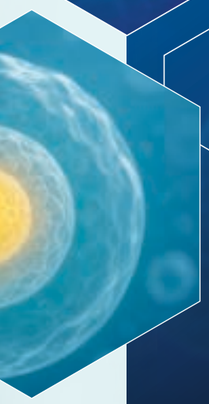
Age-related changes in oxidative stress and mitochondrial function have been associated with changes in sperm health,[47] oocyte function, and ovarian reserve—particularly in women over 35.[48]

Female preconception support

Ubiquinol's potent antioxidant activity supports mitochondrial function and cellular energy generation—essential for oocyte quality and overall egg health.[21,48,49]

Male preconception support

Kaneka Ubiquinol® supports healthy sperm function, including morphology, concentration, and motility,[22,23] and provides antioxidant protection to seminal fluid.[50]



Menopause and Redox Balance

During the menopausal transition, declining estrogen levels are associated with reduced antioxidant defenses and higher oxidative stress.[24,51-53]

Higher oxidative stress can put a strain on ubiquinol levels which, over time, may impact mitochondrial function.

Kaneka Ubiquinol® supports **general health and well-being** during and after menopause.

80%

In a consumer use study, **80% of menopausal women** taking 200 mg of Kaneka Ubiquinol® per day reported **decreased irritability, sensitivity, stress, and mood swings** after 60 days of supplementation.[25,26]

Antioxidant capacity is decreased in postmenopausal women.[51]

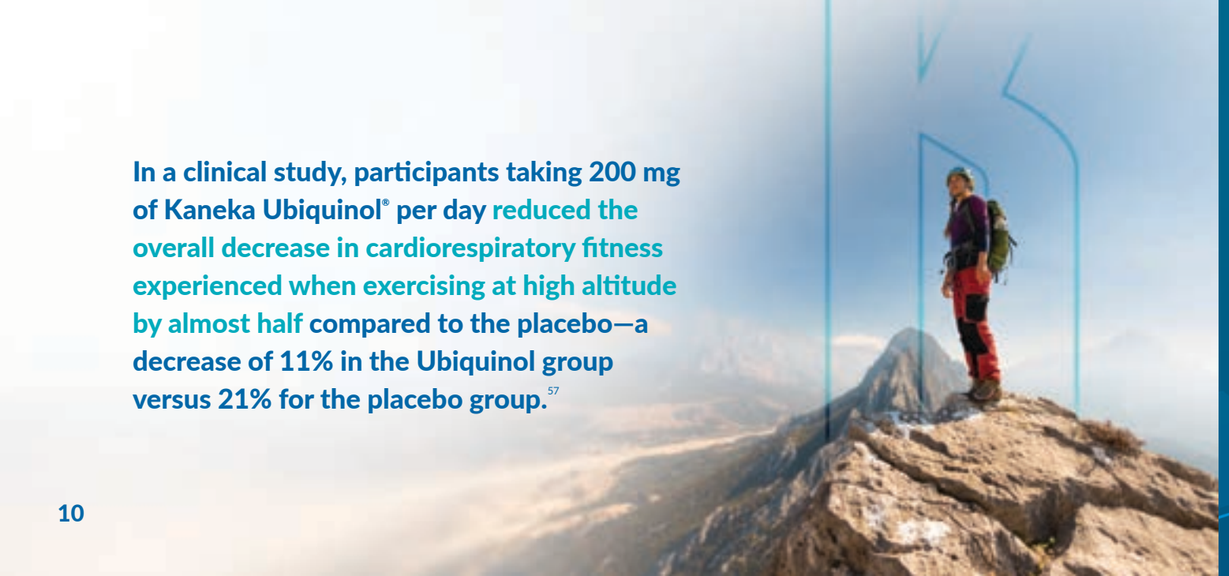
Oxidative stress markers increase after menopause.[24,52,53]

Ubiquinol for Exercise Performance

During exercise, contraction of the heart and muscles increases, upping the demand for ATP as much as 10-fold.[54] This is why heart muscle cells contain three to five times more mitochondria than most other cells,[54] and other muscle cells are dense with mitochondria in specialized arrangements for maximal ATP generation and access. The increase in ATP generation also elevates the production of ROS, leading to greater oxidative stress during and following exercise.[55]

Athletic ability is influenced by training intensity, age, and baseline fitness,[56] as well as stressors such as high altitude. **Exercising at high altitude can further challenge oxidative balance** by increasing hypoxia-driven ROS production and placing an additional strain on oxygen delivery and cardiorespiratory capacity.[30]

In a clinical study, participants taking 200 mg of Kaneka Ubiquinol® per day reduced the overall decrease in cardiorespiratory fitness experienced when exercising at high altitude by almost half compared to the placebo—a decrease of 11% in the Ubiquinol group versus 21% for the placebo group.[57]



Recent research shows that Kaneka Ubiquinol® supports physical performance by:

- Promoting a **healthy oxidative balance** during exercise[31]
- Supporting **energy metabolism** during exercise[15]
- Helping the body **adapt to rigorous exercise**[57,58]
- **Enhancing peak power production** in elite athletes when taken at 300 mg per day[59]
- Promoting **healthy cardiovascular performance** when exercising at high altitudes[57,58]

Kaneka UBIQUINOL®

The Kaneka Ubiquinol® Difference

At Kaneka Nutrients, our **commitment to scientific rigor and quality assurance** drives the development, safety, and efficacy of our ingredients.

Kaneka Ubiquinol® is **2x better absorbed** than conventional CoQ10 supplements[60] and does not require conversion to be absorbed into the blood and to function as an antioxidant.[19,61]

Research demonstrates that **200 mg of Kaneka Ubiquinol® increases ubiquinol levels by approximately 8x** compared to baseline in healthy adults when taken daily for at least 30 days.[27]

Kaneka Ubiquinol®: Backed by Science. Trusted by 200+ Brands.

USA MADE

Made in the USA

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18+ years of positive consumer experience with Kaneka Ubiquinol® supplementation

100+

Backed by 100+ clinical studies using Kaneka Ubiquinol®

50 years

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Mitochondria and Ubiquinol

01

Ubiquinol's lipid solubility enables it to concentrate within the mitochondrial membrane.[14,19]

02

Ubiquinol helps transfer electrons between complexes on the electron transport chain.[15]

03

ROS are natural byproducts of mitochondrial energy generation.[11]

04

Ubiquinol helps to neutralize ROS created by the electron transport chain.[11]

05

By keeping ROS in check, ubiquinol helps maintain the integrity of the mitochondrial membrane.[11, 18]

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