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May 2024

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PLUS

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References: 1. *Neuropharmacology*. 2016 2016/09/01/;108:426-39. 2. *Journal of Cellular Physiology*. 2016;231(9):1903-12. 3. *J Alzheimers Dis*. 2016;49(4):971-90.

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Aging Pathways**

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LIFE EXTENSION (ISSN 1524-198X) Vol. 30, No. 5 ©2024 is published monthly except bi-monthly in April by LE Publications, Inc. at 3600 West Commercial Blvd., Fort Lauderdale, FL 33309-3338. LE Publications, Inc. All rights reserved. Published 13 times a year. Subscription rate: \$40 per year in the United States. US \$47 in Canada. US \$60 in other countries. Mail subscriptions or address changes to: LE Publications, Inc., P.O. Box 407198, Fort Lauderdale, FL 33340-7198, USA. Or phone us toll-free at: 1-800-841-5433. Canada Subscriptions: Publications mail agreement number 40028967. Return undeliverable Canadian addresses to PO Box 503, RPO West Beaver Creek, Richmond Hill, ON L4B4R6. You will be sent your first issue within six weeks after LE Publications, Inc. receives your subscription fee. Periodicals Postage paid at Fort Lauderdale, FL and at additional mailing offices. POSTMASTER: Send address changes to Life Extension, P.O. Box 407198, Ft. Lauderdale, Florida 33340-7198, USA. Printed in USA. The articles in this magazine are intended for informational purposes only. They are not intended to replace the attention or advice of a physician or other health-care professional. Anyone who wishes to embark on any dietary, drug, exercise, or other lifestyle change intended to prevent or treat a specific disease or condition should first consult with and seek clearance from a qualified health-care professional. LEGAL NOTICE: Health claims contained in articles and advertisements in this publication have not been approved by the FDA with the exception of FDA-approved, qualified health claims for calcium, antioxidant vitamins, folic acid and EPA and DHA omega-3 fatty acids, and selenium as noted where applicable. *Life Extension Magazine®* does not endorse any of the businesses or the products and/or services that may appear in advertisements for non-Life Extension branded products or services contained in it, except to state that they are advertisers who may have paid Life Extension for placement of an advertisement in this publication. Life Extension disclaims any and all responsibilities or warranties as to the accuracy of information contained in advertisements for non-Life Extension branded products or services. For Canadian customers send change of address information and blocks of undeliverable copies to P.O. Box 1051, Fort Erie, ON L2A 6C7.



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† Ratings based on results of the 2023 ConsumerLab.com Survey of Supplement Users. More information at www.consumerlab.com/survey.

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Rationale for Combined Interventions



WILLIAM FALOON



A massive scientific review published in **2023** describes “aging” as a top global concern.¹

The authors emphasize the **urgent** need for effective interventions to decrease late-life disorders and improve **human** healthspans.

The authors note that the number of compounds that have extended **lifespan** in laboratory models has nearly **tripled** in recent years. These compounds largely function via **differing** biological *mechanisms*.

This prompted the authors to propose a rationale for combinations of **anti-aging** interventions, something that readers of this magazine attempt to do today.

In recent years, low-cost **nutrients** have been identified that are associated with *longer* **lifespans**.

One challenge is to ingest **optimal** **potencies** that target specific age-accelerating pathways. None of us wants to omit **affordable** nutrients that have life-extending potential.

A nutrient that has garnered attention in recent years is **spermidine**. Found in wheat and other foods, **spermidine** has been shown to increase median **lifespan** in different species, including:²⁻⁶



Observational studies in people associate increased **spermidine** ingestion with lower risk of **cardiovascular**⁷ and **cognitive** disorders,^{8,9} along with reduced **mortality**.¹⁰⁻¹²

Spermidine functions via several mechanisms including boosting **cellular housekeeping** (autophagy).^{4,13-15} Some scientists describe **spermidine** as a **calorie-restriction** mimetic.¹⁶

We welcome randomized controlled trials that attempt to validate the lifespan-enhancing effects of differing interventions in people. For those seeking to delay degenerative aging now, we don't have time to wait for results from multi-decade clinical trials.



Taurine and Lithium

A landmark study published in the journal *Science* described the amino acid **taurine** as an “**anti-aging intervention**.”¹⁷

The authors of this study demonstrated how **taurine** levels **plummet** as **people** grow older. They showed *higher* levels of taurine are associated with *lower* BMI and lower prevalence of **abdominal obesity**, **inflammation**, and **type II diabetes**.

When taurine was supplemented in middle-aged mice, life expectancy *increased* by **18%-25%**. Taurine-fed mice appeared healthier, having *less* body fat, *more* bone mass, and *better* **insulin sensitivity**.

The dose of **taurine** found to be effective at supporting cardiovascular health in **human** trials is about **5,000 mg** a day.¹⁸⁻²⁰

It requires **1,500 mg** of wheat germ to obtain the desired potency of **spermidine**.^{2,4,9-11,21}

A mineral we’ve talked about for many years is **lithium**. In regions with *higher* lithium in drinking water, people tend to **live longer**.²²⁻²⁴

Managing the bottles and swallowing the capsules needed to obtain these potencies can be challenging.

This prompted the formulation of a *combination* of **nutrients** into a daily scoop of powder. The savings and ability to easily ingest *higher* potencies make compliance simpler than it has been.

The article on page 32 of this month’s issue outlines the science that supports nutrients associated with *longer* life and enhanced healthspans.

The box below summarizes a massive review emphasizing the need for *combination* approaches to target **aging**.

What Can You Do Today?

The most important steps to avoid premature morbidities and mortality are to optimize **blood pressure** *and* have comprehensive **blood tests**.

Blood tests can identify *correctable* risk factors long *before* they manifest outwardly as serious illness or death.

The most popular test our supporters order is the **Male** or **Female Blood Panels** described on the next page.

Commercial labs charge around **\$2,500** for *all* these tests, but they are available once a year from **Life Extension®** for only **\$224**—a savings of around **90%**.

Upon receiving your order, we’ll send you a list of blood draw stations in your area where you can walk in at your **convenience** for a blood draw and then receive **rapid reporting** of the results.

Blood tests can be ordered 24-hours-a-day by calling **1-800-208-3444** or visiting **www.LifeExtension.com/sales/lab-tests**

For longer life,



William Faloon, Co-Founder
Life Extension®

(References for this editorial can be found on page 10.)

Compound Combinations Targeting Longevity: Challenges and Perspectives

“Anti-aging drug therapy is one of the most promising strategies to combat aging.”

“Most geroprotective compounds affect only a few biological targets.”

“There is a great rationale for use of combinations of anti-aging interventions.”

“Aging is currently at the top of the major global concerns, urgently requiring effective, large-scale interventions to decrease the number of late-life disorders and improve human healthspan.”

Published January 13, 2023¹

COMPREHENSIVE BLOOD TESTS AT LOW LAB SALE PRICES



Commercial labs charge around **\$2,500** for blood tests needed to evaluate cardiac, inflammatory, immune, and other degenerative risk factors.

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Apolipoprotein B (ApoB)
Homocysteine
Total Cholesterol
LDL (low-density lipoprotein)
HDL (high-density lipoprotein)
Triglycerides

MINERALS

Magnesium (serum)
Ferritin (measure of iron status)
Calcium
Potassium
Phosphorus
Sodium
Iron
Chloride

ORGAN FUNCTION

Kidney: creatinine, BUN, uric acid, BUN/creatinine ratio
Liver: AST, ALT, LDH, GGT, bilirubin, alkaline phosphatase

COMPLETE BLOOD COUNT (CBC)

Blood proteins: albumin, globulin, total protein, albumin/globulin ratio
Immune Cells including: lymphocytes, monocytes, eosinophils, neutrophils, basophils
Red Blood Cells including: hemoglobin, hematocrit, MCV, MCH, MCHC, RDW
Platelets

HORMONES

Free and Total Testosterone
DHEA-S
Estradiol (an estrogen)
TSH (thyroid function)
Vitamin D (25-hydroxyvitamin D)

CANCER MARKER

PSA (Prostate Specific Antigen)

FEMALE PANEL

GLUCOSE PROFILE

Insulin
Hemoglobin A1c
Glucose

CARDIAC MARKERS

C-Reactive Protein (high sensitivity)
Apolipoprotein B (ApoB)
Homocysteine
Total Cholesterol
LDL (low-density lipoprotein)
HDL (high-density lipoprotein)
Triglycerides

MINERALS

Magnesium (serum)
Ferritin (measure of iron status)
Calcium
Potassium
Phosphorus
Sodium
Iron
Chloride

ORGAN FUNCTION

Kidney: creatinine, BUN, uric acid, BUN/creatinine ratio
Liver: AST, ALT, LDH, GGT, bilirubin, alkaline phosphatase

COMPLETE BLOOD COUNT (CBC)

Blood proteins: albumin, globulin, total protein, albumin/globulin ratio
Immune Cells including: lymphocytes, monocytes, eosinophils, neutrophils, basophils
Red Blood Cells including: hemoglobin, hematocrit, MCV, MCH, MCHC, RDW
Platelets

HORMONES

Progesterone
Free and Total Testosterone
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TSH (thyroid function)
Vitamin D (25-hydroxyvitamin D)

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After you order and receive our form, you can visit a blood-draw facility we suggest at your convenience in your area or the **Life Extension Nutrition Center** in Ft. Lauderdale.

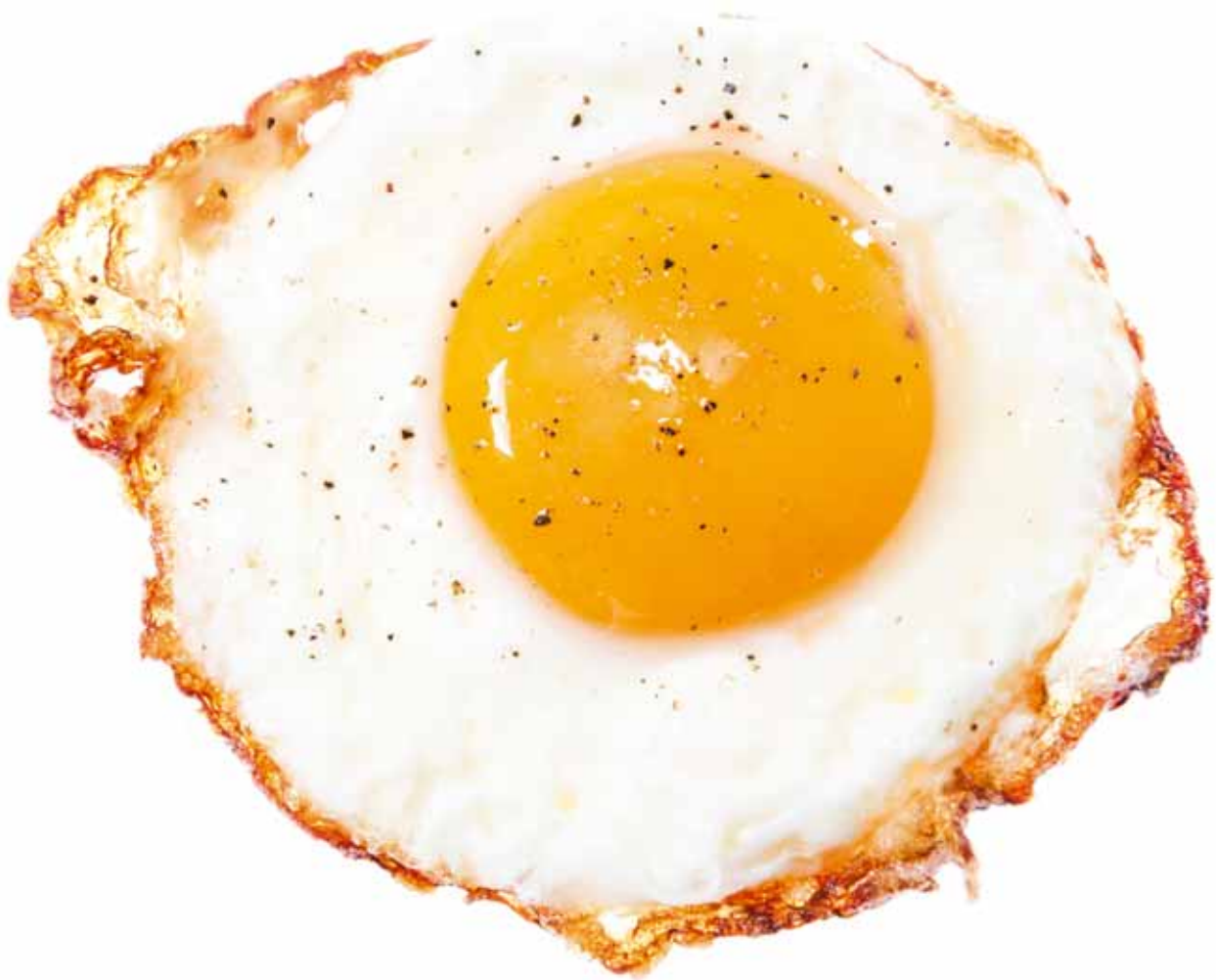
Lab tests are available in the continental United States and Anchorage, AK, only. Not available in Maryland.

Restrictions apply in MA, NY, NJ, and RI. Kits not available in PA. The Lab Test Sale expires on **July 8, 2024**.



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In the News



Resveratrol Associated with Improved Endothelial Function in Diabetes Patients

A randomized, double-blind, crossover study revealed improvement in endothelial function (health of the inner arterial lining) in people with chronic kidney disease and diabetes who received resveratrol compared to those given a placebo.*

The study included 28 diabetics with stage 3 chronic kidney disease. Participants received **400 mg** resveratrol per day or a placebo for six weeks. Endothelial function was measured by brachial artery flow-mediated dilation at the beginning and end of the study. Other factors, including estimated glomerular filtration rate, hemoglobin A1c, blood pressure, and nitroglycerin-mediated dilation, were also measured at these time points.

At the end of the study, participants who received resveratrol had significantly greater flow-mediated dilation compared with the placebo group. Other measured factors remained unchanged in both the resveratrol and placebo groups, which suggests that the improvement in flow-mediated dilation occurred independently of changes in traditional cardiovascular risk factors.

Editor's Note: Compounds known as polyphenols, which include resveratrol, may help combat atherosclerosis because of their ability to limit oxidative stress and support a healthy inflammatory response in endothelial cells.

* *Clin J Am Soc Nephrol.* 2023 Oct 16.

Melatonin May Improve Athletic Recovery in Male Soccer Players

A systematic review found a decrease in oxidative stress, muscle damage, and inflammatory markers in association with melatonin use among professional male soccer players.*

Researchers reviewed eight interventional studies that compared the effects of melatonin to a placebo or no melatonin among 152 male soccer players. The studies evaluated the hormone's effect on physical performance, blood markers, and other factors. Melatonin dosages ranged from **5 to 8 mg**.

Five of the studies found a reduction in oxidative stress after sports practice in association with melatonin. Exercise can cause an increase in oxidative stress.

Three studies found improvement in inflammation, which can also be generated by exercise.

Muscle damage as assessed by creatine kinase and lactate dehydrogenate levels, was reduced in three of the studies.

Editor's Note: None of the studies included women in their samples.

* *Nutrients*. 2023;15(20):4467.





Hair Loss Linked to Vitamin D Insufficiency

The results of a systematic review and meta-analysis of 23 case-control studies showed an association between non-scarring alopecia (hair loss) and low serum levels of vitamin D.*

Non-scarring alopecia includes androgenetic alopecia, female pattern hair loss, alopecia areata, and other types of hair loss.

The research team found an association between having non-scarring alopecia and decreased serum 25(OH)D concentrations.

Vitamin D deficiency, defined as a 25(OH)D level of less than **20 ng/mL**, was associated with more than three times the risk of androgenic alopecia, four times the risk of female pattern hair loss and a **60%** greater risk of diffuse hair loss compared with healthy controls.

Editor's Note: The studies included 3,374 individuals with non-scarring alopecia and 7,296 controls.

* *J Cosmet Dermatol.* 2023 Nov 27.

Exercise Enhances Memory and Cognitive Function in Older Adults

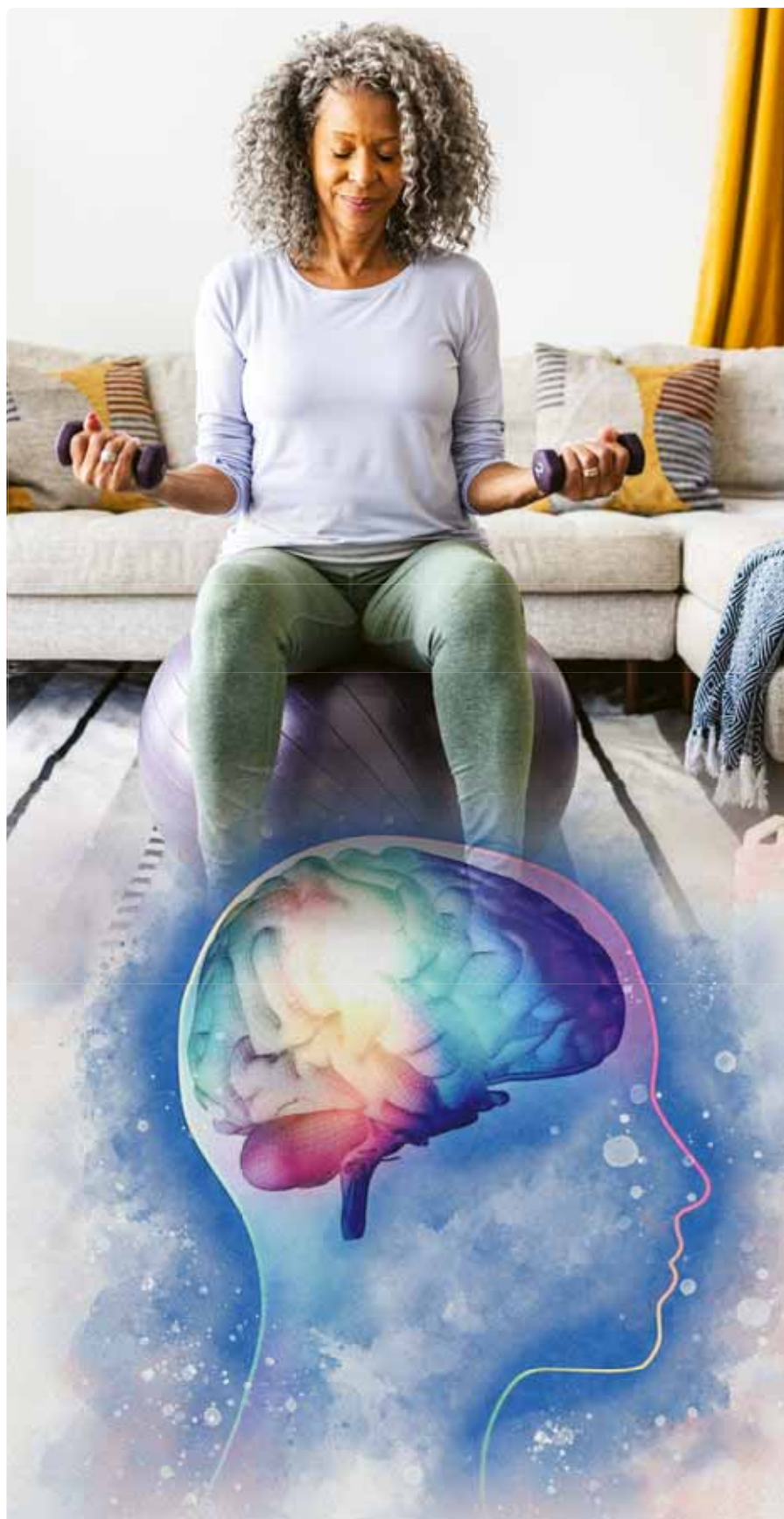
Both healthy older adults and those with mild cognitive decline benefit from improved cognitive function after exercising, according to a study published in the *Journal of Alzheimer's Disease Reports*.*

Researchers divided 33 older adults who had previously been sedentary into two groups. One group did brisk walking for 30 minutes, four times per week for 12 weeks. The other group did not exercise.

After 12 weeks, individuals in the exercise group performed better on the cognitive tests, regardless of whether they were healthy or had mild cognitive impairment.

Editor's Note: Brain scans also revealed that the exercise group had enhanced within-network and between-network connectivity of core brain networks. The researchers suggested that the increase in neural connections could explain the improvements in memory performance, both in healthy adults and in those with impaired cognitive function.

* *Journal of Alzheimer's Disease Reports*, vol 7, no. 1, pp. 399-413, 2023.



"Good stuff!"

Steven

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REVIEW

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*European Journal of Nutrition. 2011;50(5):387-389.

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Item #01778

100 vegetarian capsules

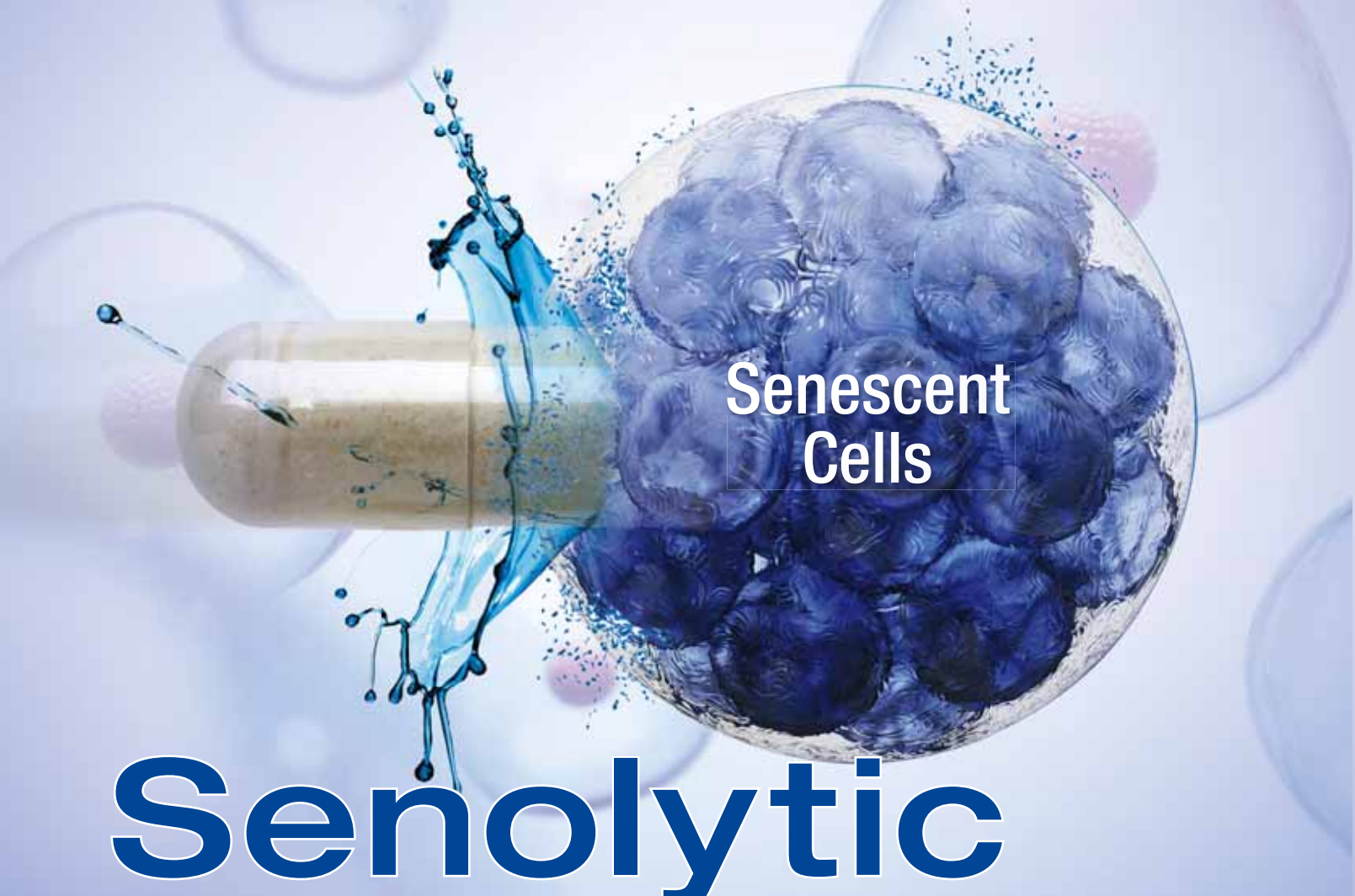
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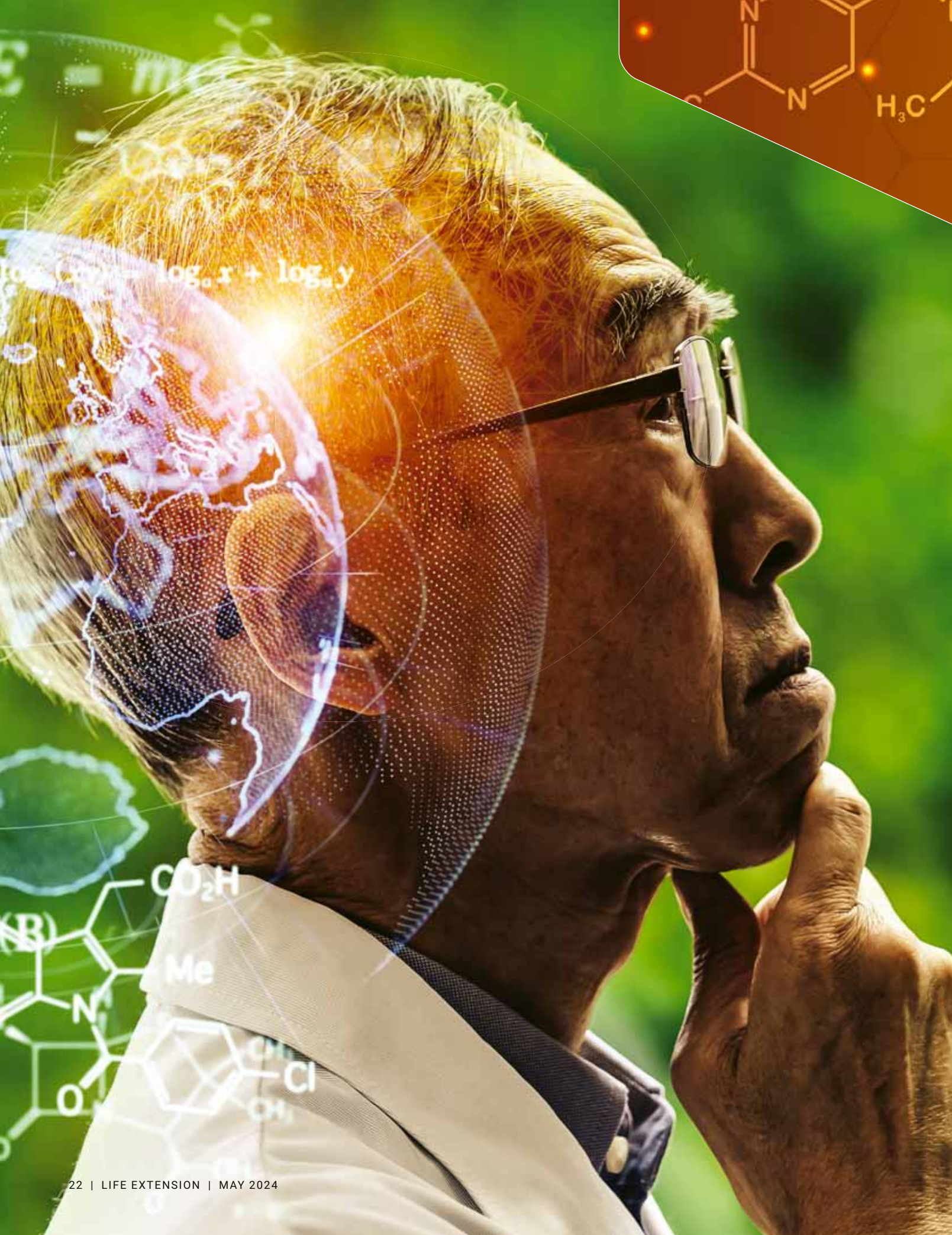
The **Senolytic Activator®** formula provides the following nutrients:

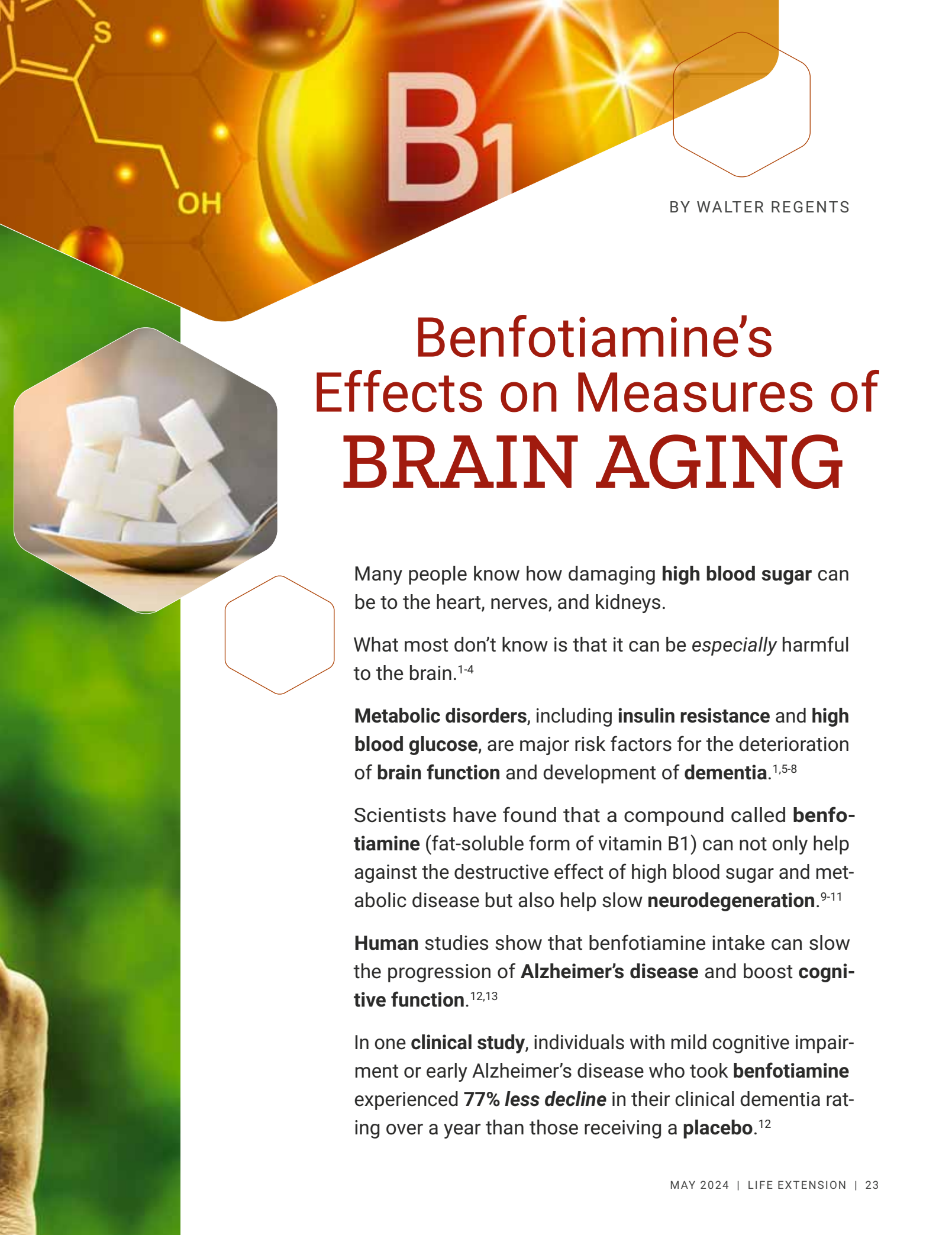
- **THEAFLAVINS** (polyphenols from black tea)
- **BIO-QUERCETIN** (ultra-absorbable form)
- **APIGENIN** (a natural flavonoid)
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The suggested dose of the **Senolytic Activator®** is **3 capsules** once a week. Each bottle lasts 3 months and costs very little.

For full product description and to order **Senolytic Activator®**, call 1-800-544-4440 or visit www.LifeExtension.com

These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.





B1

BY WALTER REGENTS

Benfotiamine's Effects on Measures of BRAIN AGING

Many people know how damaging **high blood sugar** can be to the heart, nerves, and kidneys.

What most don't know is that it can be *especially* harmful to the brain.¹⁻⁴

Metabolic disorders, including **insulin resistance** and **high blood glucose**, are major risk factors for the deterioration of **brain function** and development of **dementia**.^{1,5-8}

Scientists have found that a compound called **benfotiamine** (fat-soluble form of vitamin B1) can not only help against the destructive effect of high blood sugar and metabolic disease but also help slow **neurodegeneration**.⁹⁻¹¹

Human studies show that benfotiamine intake can slow the progression of **Alzheimer's disease** and boost **cognitive function**.^{12,13}

In one **clinical study**, individuals with mild cognitive impairment or early Alzheimer's disease who took **benfotiamine** experienced **77% less decline** in their clinical dementia rating over a year than those receiving a **placebo**.¹²

Metabolic Abnormalities Harm the Brain

Advanced glycation end products are toxic compounds formed when the body's proteins, fats, and nucleic acids irreversibly bind with sugars.

They can potentially impact several aspects of health, including blood sugar levels that can provoke and worsen diabetes, cardiovascular, and neurodegenerative diseases.¹⁴ Glycation happens in normal individuals but in diabetics the process is *accelerated*.¹⁵

Not only does glycation damage brain structures, but accumulation of advanced glycation end products (**AGEs**) in the brain is a mechanism that has linked diabetes to cognitive impairment.^{1,16,17}

The link between metabolic disease and brain disease is so close, doctors often refer to Alzheimer's disease as **type III diabetes**.¹ Individuals with **diabetes**, for example, have **double the risk of developing dementia**.^{18,19}

The *higher* the blood glucose levels, the *higher* the risk. But diabetics are not the only ones in danger.

Alarming, even *slight elevations* in glucose increase the risk of **cognitive decline**.^{5,20-22} Individuals with **pre-diabetes** have an **18%** greater chance of developing dementia than those with normal glucose.⁵

Thiamine and Healthy Brain Function

Thiamine is an essential nutrient also known as **vitamin B1**. It is required for cellular metabolism.⁹⁻¹¹

Thiamine is particularly crucial in the **brain**, where it is neuroprotective and helps mitigate glycation and AGE-related tissue damage.^{9,23}

Without adequate thiamine, the brain's metabolism is compromised, and the damage done by glycation is accelerated. Studies have found that thiamine function is significantly *diminished* in those with neurodegenerative disorders such as **Alzheimer's** and **Parkinson's** disease.^{9,10,24}

Benfotiamine is a **fat-soluble** form of thiamine that is far *more bioavailable* than regular thiamine and provides additional mechanisms of brain protection.¹⁰

Brain Benefits of Benfotiamine

Benfotiamine is converted into **thiamine** in the body. Oral intake of benfotiamine has been shown to rapidly restore body levels of thiamine.⁹⁻¹¹

But benfotiamine isn't *just* a more **bioavailable** thiamine. It has been shown to offer benefits to **brain health** that are not seen with thiamine alone.^{9,10}

Animal models of neurodegenerative disease have found that benfotiamine helps prevent **brain damage** and improve **cognitive function**.^{9-11,25-27}

It does this in multiple ways, including by:

- **Restoring thiamine levels.** Benfotiamine converts into thiamine, which ensures that there is enough available for thiamine-dependent enzymes to function optimally.¹⁰
- **Anti-glycation activity.** Glycation in the brain diminishes the function of vital proteins, contributing to disease. Benfotiamine is a potent anti-glycation nutrient.^{10-12,23}
- **Anti-inflammatory activity.** Oxidative stress and chronic inflammation in the brain accompany metabolic disease and cognitive dysfunction. Benfotiamine shields the brain from both of these threats.⁹⁻¹¹
- **Improving metabolic health.** Excess activity of the enzyme GSK-3 (glycogen synthase kinase-3) has been implicated as a potential target in insulin resistance and metabolic abnormalities in the brain.^{28,29} Preclinical studies suggest benfotiamine reduces GSK-3 activity, which could help protect brain function.^{9-11,25}

Human Studies of Benfotiamine

The neuroprotective properties of **benfotiamine** have been demonstrated in studies of adults with early cognitive impairment or Alzheimer's disease.^{12,13}

In one **placebo-controlled trial study**, individuals with a diagnosis of mild cognitive impairment or early Alzheimer's disease were randomized to receive either **300 mg of benfotiamine** twice daily for a year or a **placebo**. Patients were assessed on the *Alzheimer's Disease Assessment Scale-Cognitive Subscale* and *Clinical Dementia Rating score*.¹²

Those in the **benfotiamine** group experienced better preservation of **cognitive function** as well as a **77% less decline** in the Clinical Dementia Rating Scale than those receiving the **placebo**.

The Alzheimer's Disease Assessment Scale-Cognitive Subscale score was **43% lower** in the **benfotiamine** group as compared to placebo.¹² (Lower by this measure means improved cognitive function.)

WHAT
YOU
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TO
KNOW

In addition, while **glycation** increased by almost **10%** in the **placebo** group, it *decreased* by more than **5%** in those receiving **benfotiamine**.¹²

An earlier pilot study recruited five patients with mild-to-moderate Alzheimer's disease, assessing their cognitive status at baseline with the Mini Mental Status Examination (**MMSE**).

Prior to treatment, participants also underwent brain scans to detect the toxic protein **beta-amyloid**, and its presence was confirmed in all of them. Study participants received **300 mg** of **benfotiamine** per day over the course of 18 months.¹³

At the end of the study period, they retook the **MMSE** and underwent another **PET** scan to see if the benfotiamine supplementation led to any improvements. The results were impressive. Four out of five patients demonstrated **cognitive improvement** on the **MMSE**. Over that time, the five subjects *improved* by an average of **3.2 points** on the **Mini-Mental State Exam (MMSE)**, a common screening tool for cognitive impairment.¹³

Even a one-point change in **MMSE** is considered meaningful, though the usual expected change is a decrease.³⁰ That makes this 3.2 point average improvement not only highly clinically meaningful but also remarkable.

These studies indicate that benfotiamine can slow cognitive deterioration and even improve cognitive function in those with early signs of dementia.

Guard Against Cognitive Decline

- Elevated blood sugar and the resulting toxic glycation increase the risk for **cognitive decline** and **dementia**. Even slightly elevated blood glucose significantly increases the risk of dementia.
- **Thiamine** is a vitamin that is crucial for energy metabolism in cells.
- While thiamine absorption is limited, its precursor **benfotiamine** has superior bioavailability and rapidly increases thiamine levels in the body.
- **Benfotiamine** improves brain cell metabolism, fights harmful glycation, and defends against cognitive decline in multiple other ways.
- In **human studies**, benfotiamine slows the progression of, or even reverses, cognitive decline in those with early signs of dementia.

Summary

Elevated blood sugar and toxic glycation contribute to decline in cognitive function and risk for dementia.

Thiamine is a vitamin that is crucial to normal metabolism in the brain. The thiamine precursor **benfotiamine** protects the brain against damage done by metabolic disease and high blood sugar.

Human studies of benfotiamine have demonstrated its ability to **slow** or **reverse cognitive decline** in individuals with early dementia. •

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

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References

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Three NUTRIENTS that Drive HEALTHY AGING

BY MICHAEL DOWNEY



As we age, cellular damage accumulates, chronic conditions crop up, and mortality risks skyrocket.¹

In recent years, three nutrients were independently shown to **delay aging** processes and support **healthy lifespan** in cell and animal studies:

- The amino acid **taurine**,
- The polyamine **spermidine** from wheat-germ, and
- The mineral **lithium**.

Seeking confirmation in **humans**, scientists turned to large epidemiological observational studies.

They found that *higher* dietary intake correlates with lower **mortality** and reduced **risk** of several **age-related conditions** (also known as increased **healthspan**).²⁻⁷

These findings suggest that supplementation with **taurine**, **lithium**, and **spermidine** may promote **healthy aging** and longevity.





Taurine

Taurine is an amino acid found in nearly all tissues.^{8,9}

It is produced in small amounts by the body, but levels drop with age. In epidemiological studies, by human adulthood, **taurine** production may be *inadequate* to maintain optimal health.^{9,10}

In the large, over 25-year-long epidemiological study EPIC-Norfolk, researchers found a correlation between *higher* blood **taurine** levels and lower risks of various age-associated pathologies.^{11,12}

Another large population study, coordinated by the **World Health Organization** and spanning 24 populations in 16 countries, showed that *higher* urinary levels of taurine were associated with **lower mortality** rates from ischemic **stroke**.^{2,13}

In human randomized controlled studies, oral taurine intake has been shown to improve markers of health implicated in **rapid-onset aging**,¹⁴⁻¹⁷ along with supporting multiple aspects of cardiovascular health, like blood pressure,¹⁸⁻²⁰ lipid profile,¹⁸ fasting glucose,^{15,21,22} athletic performance,^{19,23} and cognition.^{17,24}

In animal studies, taurine extends lifespan. Taurine intake:¹¹

- Increased median lifespan in worms by **23%**,
- Increased median lifespan in mice by up to **12%**,
- Increased life expectancy in *elderly* mice by up to **25%**, and
- Improved multiple biomarkers of aging in middle-aged monkeys.

Spermidine

Spermidine is a polyamine (a compound having two or more amino groups) found in all living organisms and many foods, including mushrooms, legumes, corn, and whole grains.²⁵ It is commonly extracted from **wheat germ**.

Spermidine is also known to mimic the anti-aging effects of **caloric restriction**, such as support of **autophagy** (the recycling of old or damaged cell parts, often referred to as “cellular housekeeping”).²⁶

In humans, levels of spermidine decline with aging.²⁷

This is a potential problem. Human epidemiological observational studies show *higher* dietary intake of spermidine is correlated with lower risk of chronic diseases and reduced mortality.

Spermidine is considered an age-delaying agent that helps protect against chronic disorders and reduce mortality.^{6,26}

Several **human** observational studies found a correlation between *higher* dietary intake of spermidine and:^{5,7,28-30}

- Lower **mortality** risk,
- Decreased risk of cardiovascular issues and related mortality,
- Reduced **cognitive** impairment risk, and
- Lower **blood pressure**.

Pre-clinical studies have demonstrated that spermidine may help dissolve **amyloid plaques** in the brain by **autophagy**. This may help with age-related memory decline.

A **clinical trial** of participants aged 60-100 years found that oral spermidine supplementation at doses of **0.9 - 3.3 mg/d** (wheat germ extract) improved **memory** scores as compared to **placebo**.³¹

Pre-clinical and clinical evidence has shown that functions aided by **spermidine** include:^{6,27,30,32,33}

- Metabolism of lipids,
- Regulation of cell growth,
- Lowering of inflammation levels,
- Neuroprotection,
- Cardioprotection,
- Enhanced anticancer immune response (in rodent models), and
- Autophagy.

In animal studies, **spermidine** intake increases median **lifespan** by:^{28,33-37}

- **3-fold** in yeast,
- **30%** in flies,
- **15%** in worms, and
- **10%** in old mice.

Lithium

Lithium is a mineral found in rocks and subsoil in some geographical areas. Some natural water sources contain small amounts of this element.

Pre-clinical evidence has shown that **lithium** can:³⁸⁻⁴³

- Inhibit **GSK-3 (glycogen synthase kinase-3)**, an age-accelerating enzyme,
- Help maintain *longer* **telomeres** (protective caps on the ends of chromosomes tied to increased longevity),
- Regulate **genes** related to healthy DNA,
- Help protect against dysfunctional **senescent cells** that contribute to age-related disease and accelerated aging,
- Increase activity of beneficial neurotransmitters,



Age the Healthy Way

- Animal and human studies show that higher dietary intake of the nutrients **taurine, spermidine, and lithium** is correlated with lower mortality, better health, and increased longevity.
- In animal studies, each of these compounds substantially increases median **lifespan**.
- Human data show that these nutrients inhibit a broad range of age-related diseases and promote **healthy aging**.

- Increase **brain-derived neurotrophic factor**, a signaling molecule that protects brain cells and augments their function, and
- Reduce buildup of **beta-amyloid**, a plaque associated with Alzheimer's disease.

Studies indicate that lithium can promote healthy overall **aging** and reduce **mortality**.

Lithium administration was shown to increase **lifespan** in both roundworms³⁸ and fruit flies.³⁹ In one study, lithium increased the lifespan of worms by an astonishing **46%**.⁴⁴

In **humans**, people taking high-dose lithium for medical reasons generally have lower **mortality** rates, including lower rates of death due to cardiovascular disease.^{45,46}

Other human observational data revealed that the rates of **death** from **Alzheimer's** are *higher* in areas with *low* levels of lithium in the water.⁴⁷

Two other observational studies showed that people living in areas with lithium in the drinking water tend to **live longer**.^{3,4}

How They Work

These three nutrients may beneficially influence the hallmarks of **aging** in multiple ways.

Taurine promotes **DNA repair** processes in the body, which help protect against mitochondrial dysfunction, inflammation, and cell senescence.^{48,49}

Spermidine helps regulate **autophagy**, helps promote anti-inflammatory activity, and suppresses harmful compounds produced by senescent cells.^{28,32,50-52}

Lithium may help prevent the shortening of **telomeres** associated with aging. By inhibiting the age-accelerating enzyme **GSK-3**, it supports cell defense and synthesis of the energy source glycogen.^{38,53}

Together, these actions may help reduce the risk of age-associated disorders and promote healthy aging.



Summary

The compounds **taurine**, **spermidine**, and **lithium** have been shown to potentially **slow the aging process**, inhibit development of age-related disease, and extend longevity.

Large observational **human** studies suggest that each of these nutrients prolongs healthy human **lifespan**.

Taken *together*, taurine, spermidine, and lithium may have significant mechanistic benefits on **healthy aging**. •

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

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References: 1. *Nutrients*. 2020 Nov 28;12(12).
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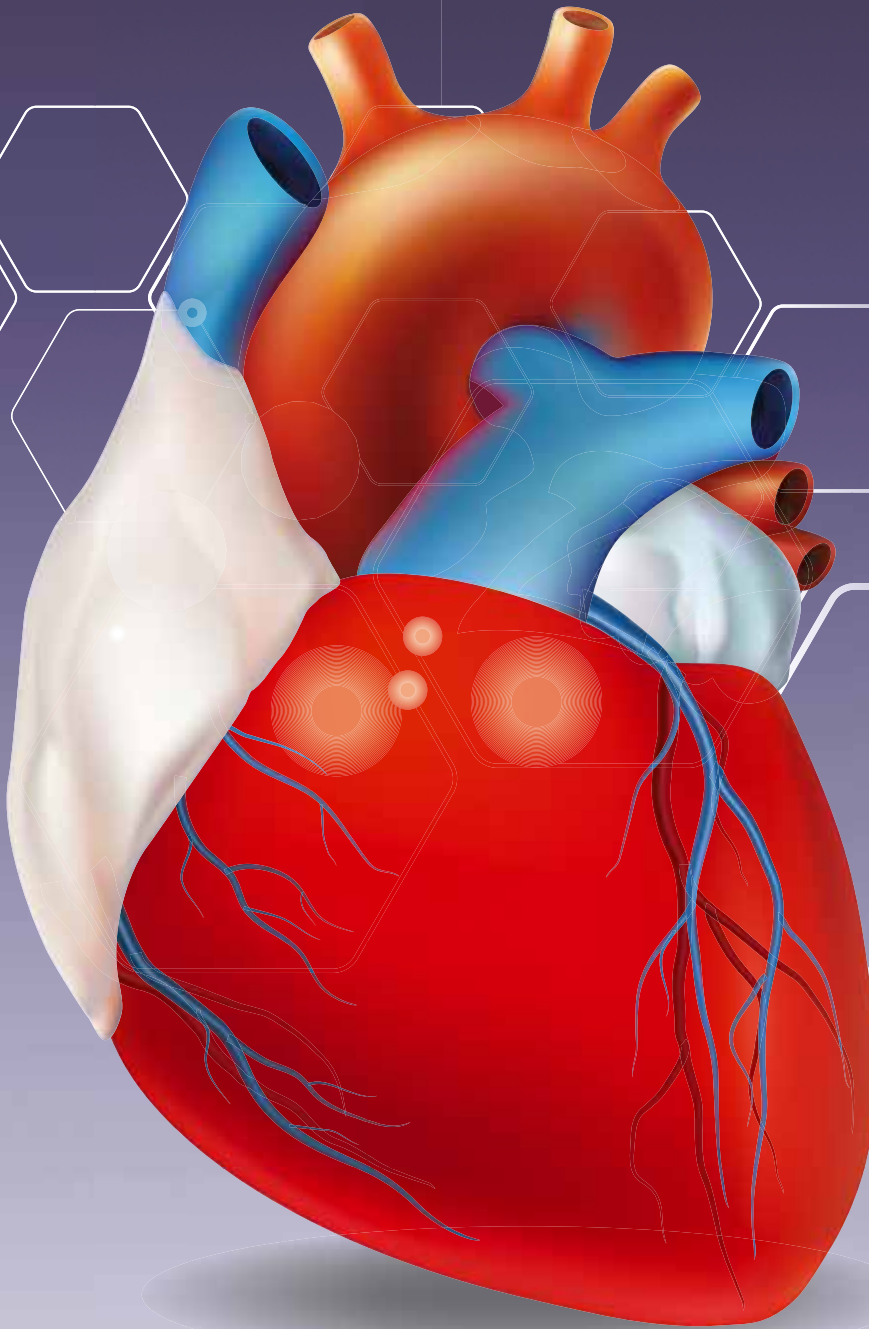


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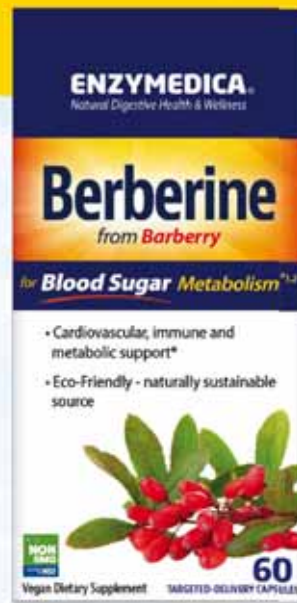
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Lithium

People tend to *live longer* in areas where **lithium** is abundant in the drinking water.⁶⁻⁸

Spermidine

In epidemiological studies, higher intake correlates with longer healthspan.⁹⁻¹¹ A clinical study showed **spermidine** supplementation *improved* memory scores.¹²

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These nutrients may promote **healthy aging** by supporting cardiovascular health, exercise performance, and cognitive function.

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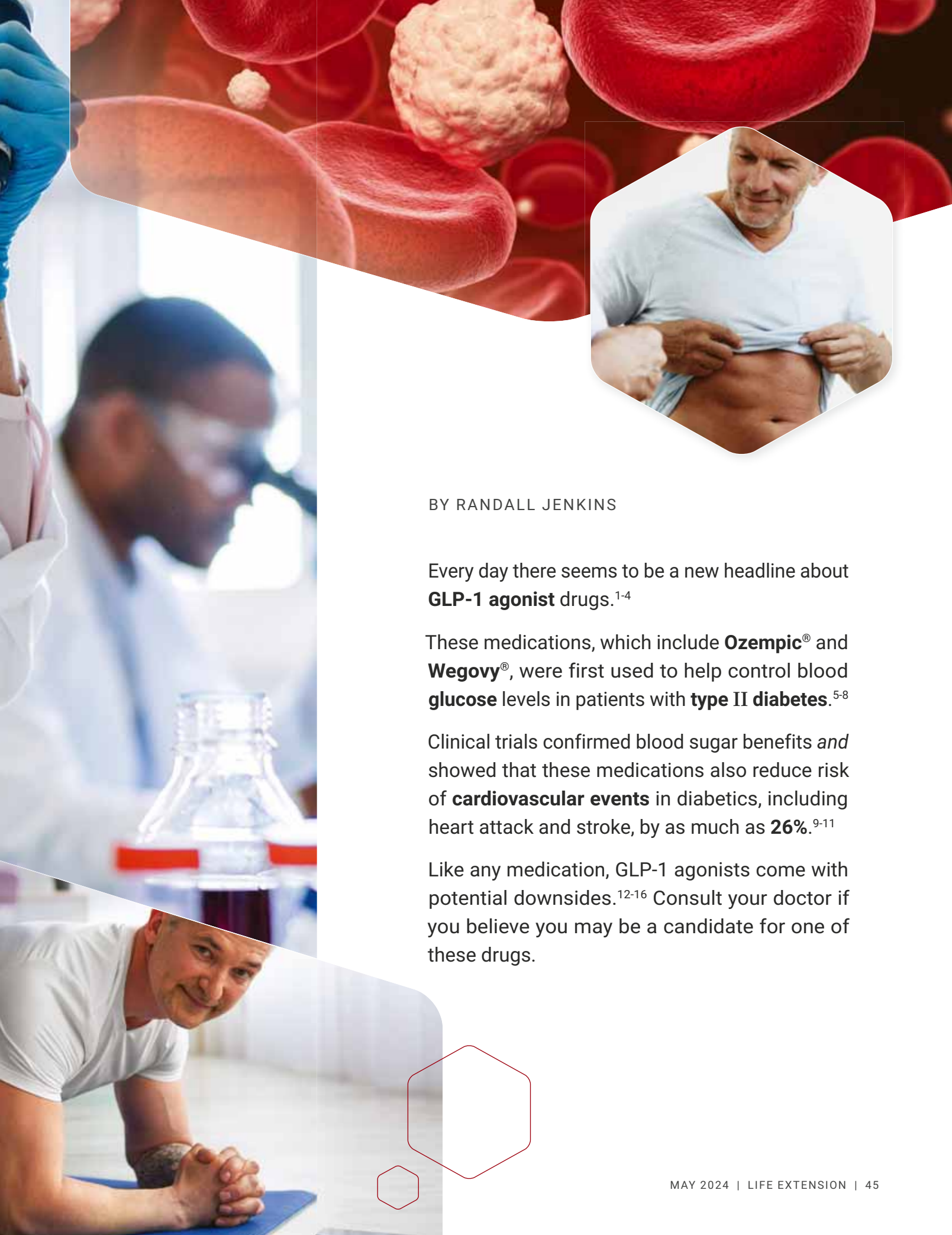
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GLP-1 AGONISTS

for Diabetes, Obesity,
and Heart Health



BY RANDALL JENKINS

Every day there seems to be a new headline about **GLP-1 agonist** drugs.¹⁻⁴

These medications, which include **Ozempic®** and **Wegovy®**, were first used to help control blood **glucose** levels in patients with **type II diabetes**.⁵⁻⁸

Clinical trials confirmed blood sugar benefits *and* showed that these medications also reduce risk of **cardiovascular events** in diabetics, including heart attack and stroke, by as much as **26%**.⁹⁻¹¹

Like any medication, GLP-1 agonists come with potential downsides.¹²⁻¹⁶ Consult your doctor if you believe you may be a candidate for one of these drugs.

What are GLP-1 Agonists?

GLP-1 agonists are a relatively new class of drugs. They bind to and activate a cellular **receptor** for the hormone **GLP-1 (glucagon-like peptide-1)**.

This cell **receptor** is most abundant in the insulin-secreting part of the pancreas. It is also present in the nervous system and throughout the gastrointestinal tract, as well as the cardiovascular system, kidneys, and lungs.^{17,18}

The formal name of this drug class is **GLP-1 receptor agonists**, but in common usage this has been shortened to **GLP-1 agonist**. These drugs act on the **GLP-1** hormone receptor.

First developed as **anti-diabetes** medications, in the pancreas these drugs stimulate production of **insulin**, the hormone that helps reduce blood glucose levels after a meal.^{3,19}

They also slow down the emptying of the stomach after eating and promote a feeling of fullness or satiety.¹⁹

Multiple meta-analyses of randomized controlled **clinical trials** have firmly established that GLP-1 agonist drugs are highly effective in type II diabetics for reducing blood sugar as well as hemoglobin A1C, a marker of longer-term glucose control. Some of these studies also found that these medications reduce systolic blood pressure.^{5,6,8}

What has received so much attention is that these and other studies have also found that patients taking this class of drugs have had **significant weight loss**.

In part, this is because GLP-1 agonists activate receptors in the area of the brain that controls hunger.^{3,19,20} They stimulate **satiety**, the sense of feeling full after a meal, reducing cravings and caloric intake. GLP-1 agonists are approved for use in some people with type II diabetes, and two of them are FDA-approved for weight loss in certain people and situations.

In such individuals starting a GLP-1 agonist drug, it is recommended to also adopt a reduced-calorie meal plan and to increase physical activity at the same time.

Impressive Clinical Results

GLP-1 agonists have been found to offer benefit for a variety of common chronic conditions. Here are a few highlights:

TYPE II DIABETES

Meta-analyses of placebo-controlled trials of GLP-1 agonists in patients with **type II diabetes**^{5,6,8} have consistently shown that they are effective at reducing blood glucose.⁵⁻⁸

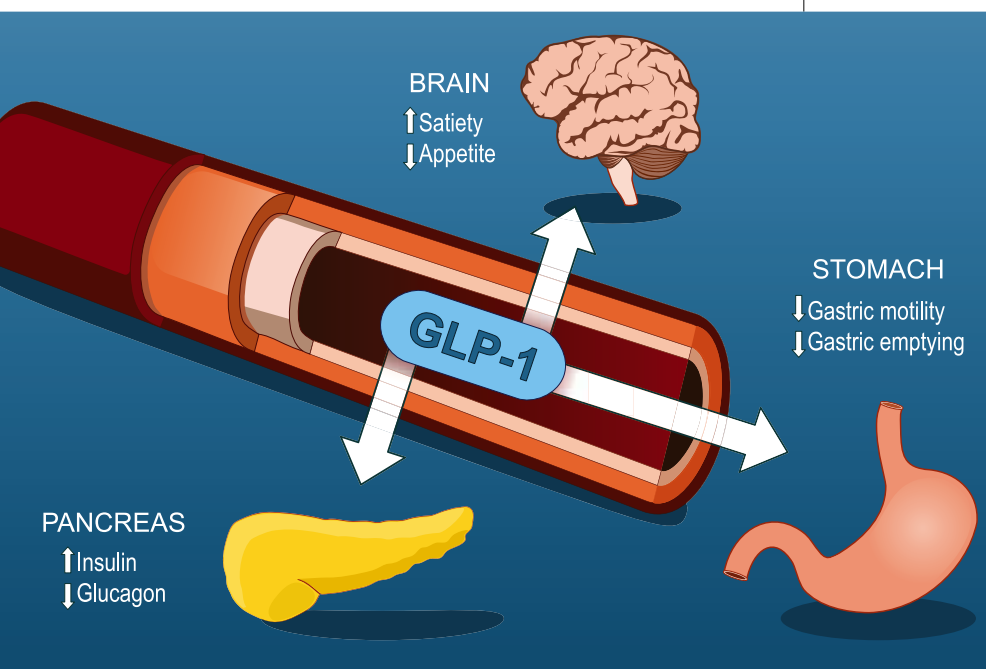
A **hemoglobin A1c (HbA1c)** test shows the average blood sugar level over two to three months. This value is higher in those with *poor* glucose control. In many clinical studies, use of a GLP-1 agonist has resulted in significantly lower HbA1c levels.

WEIGHT LOSS

The meta-analyses of randomized controlled trials in type II diabetics referenced above also found that, on average, subjects lost significant weight while taking these medications.^{5,6,8}

In a trial of non-diabetic adults with **obesity**,²¹ all patients received a lifestyle intervention and were randomized to receive either weekly injections of **semaglutide**—the drug in **Ozempic®** and **Wegovy®**—or placebo. The semaglutide group experienced an average of nearly **15% reduction in body weight** after 68 weeks, compared to **2.4%** in a placebo group.

This corresponds to an average loss of almost **34 pounds** in the treatment group, compared to less than **six pounds** in those who took a placebo.



REDUCTION IN CARDIOVASCULAR EVENTS

Both diabetes and obesity are risk factors for **cardiovascular disease**, which is damaging to both the heart and blood vessels. Rates of cardiovascular disease are much *higher* in those with poorly controlled diabetes and/or excess body weight. It makes sense that by controlling blood glucose and reducing weight, GLP-1 agonists could also *lower* cardiovascular risk.

Recent analyses have started to look at these effects and here too the results are encouraging. A meta-analysis of randomized controlled trials that included over **56,000** subjects taking GLP-1 agonists for diabetes found that the drugs reduced major **cardiovascular events** (including stroke and heart attack) and death from cardiovascular and all causes by **12%**.¹⁰

Two trials^{9,11} designed specifically to test cardiovascular effects of these drugs found that type II diabetics treated with **semaglutide** had a remarkable **21%** and **26%** reduction in risk for major cardiovascular events, including non-fatal stroke and heart attack, and death from cardiovascular causes.

To evaluate whether GLP-1 agonists could improve cardiovascular health in people without diabetes, the recent SELECT trial enrolled **17,604** nondiabetic overweight or obese adults with cardiovascular disease.²² They were randomized to receive **semaglutide** or a placebo.

The results of this trial have not been published in the medical literature yet, so they should be assessed with caution. But the preliminary results reported in the news and on the drug company's website^{1,23} have exceeded expectations. Even in those without diabetes, use of this drug led to a **20% reduction in cardiovascular events and death**.

These findings show that GLP-1 agonists can be game changers in improving blood glucose control and body weight and in reducing risk of cardiovascular events and death.

Need for Caution

GLP-1 agonists have been generally well tolerated in trials. However, there are potential concerns that should be considered before starting these medications.^{4,14,16,24}

Gastrointestinal **side effects**, including nausea and vomiting at higher doses, are by far most common,²⁵ and a reason for discontinuation of treatment.^{25,26} Therefore, starting with lower doses and a slower dose titration may help minimize this risk.²⁷



The Skinny About GLP-1 Agonists

- Drugs called **GLP-1 agonists**, which include **Ozempic®** and **Wegovy®**, have caused a buzz in the medical community and the media.
- Originally designed to reduce blood glucose levels in people with type II diabetes, GLP-1 agonists also promote significant **weight loss** in obese or overweight adults.
- Clinical trials have also found that GLP-1 agonists can reduce risk for major **cardiovascular events**, including cardiovascular-related death, heart attack, and stroke, by **20% or more**.
- Gastrointestinal problems are common side effects, and safety concerns remain about long-term use. Consult a doctor if you think GLP-1 agonists may benefit you.

For those patients using GLP-1 agonist drugs for weight loss, various side effects have been reported including nausea, vomiting, abdominal pain, diarrhea, constipation, gastroenteritis, and certain incidents of pancreatitis and bowel obstruction.²⁸⁻³¹

Anyone considering using a GLP-1 agonist should consult with a doctor and weigh potential side effects against the many benefits.

Summary

GLP-1 agonists are the subject of tremendous “buzz” and exuberance in the medical community and the media.

Originally designed to help manage **type II diabetes**, these medications have also been found to induce significant **weight loss**.

Clinical trials show that these drugs also reduce **cardiovascular events** and **death** by **20%** or more in those with type II diabetes and in overweight or obese adults without diabetes.

GLP-1 agonists can cause gastrointestinal symptoms, and concerns remain about their long-term effects, but they have tremendous potential to control blood sugar, promote weight loss, and protect cardiovascular health. •

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

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References

1. *BJU Int.* 2009 Aug;104(3):352-60.
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ANTI-CANCER PROPERTIES of VITAMIN D



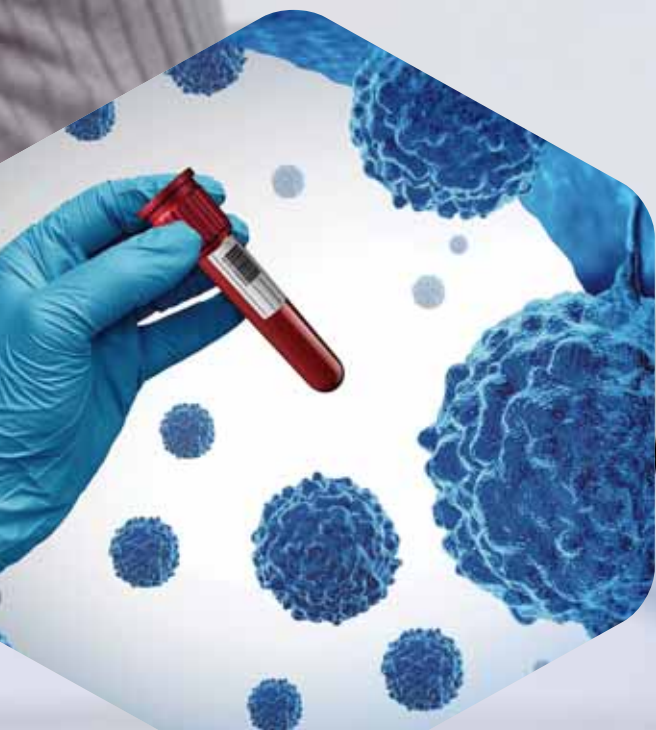
BY MARTIN STEIN

Vitamin D plays a variety of roles in cells throughout the body.^{1,2}

One of its functions is to help prevent abnormal growth that could transform into **cancer**.^{1,3-5}

Some observational studies have noted a clear association of cancer incidence and vitamin D deficiency.⁵⁻⁷

In a subset analysis of a six-year **clinical trial**, people taking **vitamin D3** had a lower risk of developing **metastatic** or **fatal cancer** than those who received **placebo**.⁸



Dangers of Low Vitamin D

In a study based on the well-known **NHANES** survey of Americans and their health, more than **40%** of Americans are estimated to have insufficient levels of **vitamin D** in their blood.⁹

In this study, vitamin D deficiency was seen in all age groups, and was higher in women and individuals with darker skin color. In people aged **20-29 years** the rates of deficiency were even greater.⁹

The damaging effects of these kinds of low vitamin D levels are underappreciated. Vitamin D is more than a vitamin. It is also a very important **prohormone**—a kind of hormone precursor.¹⁰

Adequate **vitamin D** levels are critical for bone health, immune function, glucose metabolism, and more.¹¹ Vitamin D can also regulate the growth, development, and death of certain cells—in ways that may slow the development and progression of malignancies.¹

Anti-Cancer Activity

Cancer is caused by mutations that allow cells to grow and spread uncontrollably.

Vitamin D can help limit the ability of cancer cells to reproduce, grow, and spread.^{1,5,12}

Here are just a few of vitamin D's known anti-cancer mechanisms:^{1,3,5,12}

- **Impeding Cancer Cell Growth.** Vitamin D helps prevent the abnormal, excessive growth of cancer cells by arresting its **cell cycle**, the process that can allow cancer cells to divide out of control.
- **Promoting Cancer Cell Death.** Apoptosis is a process by which cells shut down and die, ridding the body of aged or damaged cells. Cancer cells can evade apoptosis and propagate out of control. Vitamin D *reverses* this, promoting beneficial apoptosis.
- **Starving Cancer of Nutrients.** Vitamin D helps block **angiogenesis**, the formation of blood vessels that deliver nutrients to cancers. This reduces the nutrient supply to cancer cells and limits their growth.
- **Reducing Metastasis.** Aggressive cancers can invade surrounding tissue and eventually **metastasize**, spreading through the body. Vitamin D interferes with cancer cells' ability to invade and metastasize.



The Cancer, Low Vitamin D Link

Human observational studies have shown an association between low vitamin D levels and increased risk for many **cancers**.^{5,13,14}

Vitamin D deficiency is typically defined by the **World Medical Association (WMA)** as having a 25-hydroxyvitamin D blood level below **20 ng/mL**.¹⁵ This is quite common in cancer patients.^{6,7,16} Multiple observational studies have found a high rate of vitamin D deficiency in cancer patients, often in the range of **62%-67%** of patients.¹⁷⁻¹⁹

In studies evaluating *specific* cancer types, the same pattern is seen: Those with lower circulating levels of vitamin D have the highest rates of cancer, including breast, lung, head and neck cancers, melanoma, colorectal cancers, and bladder cancers.²⁰⁻²⁸

Here are a few examples:

- In a meta-analysis of **11** observational studies, individuals with the *highest* circulating vitamin D levels had a **39%** lower risk of developing **colorectal cancer** than those with *lower* vitamin D levels.²¹
- A combined analysis of **three clinical studies** found that a 25-hydroxyvitamin D blood level greater than **60 ng/mL** was associated with an **80%** lower risk of **breast cancer** compared to individuals who had vitamin D deficiency (**<20ng/ml**).²³
- Vitamin D may not only help reduce the risk of cancer development, but it may also impact how **aggressively** cancers behave.

- In one observational study of men with **prostate cancer**, their levels of vitamin D were found to be inversely associated with a tumor proliferation marker. This lends credence to the hypothesis that vitamin D may protect against tumor progression.²⁶

Clinical Trials

Many experts, including those at **Life Extension**, recommend daily intake of **5,000 to 8,000 IU** of **vitamin D3**. It is widely available to Americans in high potency capsules at modest cost.

Unfortunately, clinical trials evaluating vitamin D's effect on cancer have mostly used doses of **2,000 IU** or below. In people with low levels, these doses are unlikely to bring their blood levels into what many consider an optimal range (over **50 ng/mL**).

Researchers often give the same dose of vitamin D to all study participants. This is an error, because overweight/obese people and those with absorption challenges need *higher* doses of vitamin D.^{29,30} A dose that might properly elevate serum vitamin D in a normal weight person can have little effect on someone with a high body mass index (BMI). In many cases, this may mean researchers are failing to give adequate vitamin D to people who need it the most.

Even so, benefits have been shown.

A **six-year**, multicenter clinical trial called VITAL enrolled more than **25,000** adults who were randomized to receive **2,000 IU** of **vitamin D** and / or **1 gram omega-3** fish oil supplementation, or placebo.

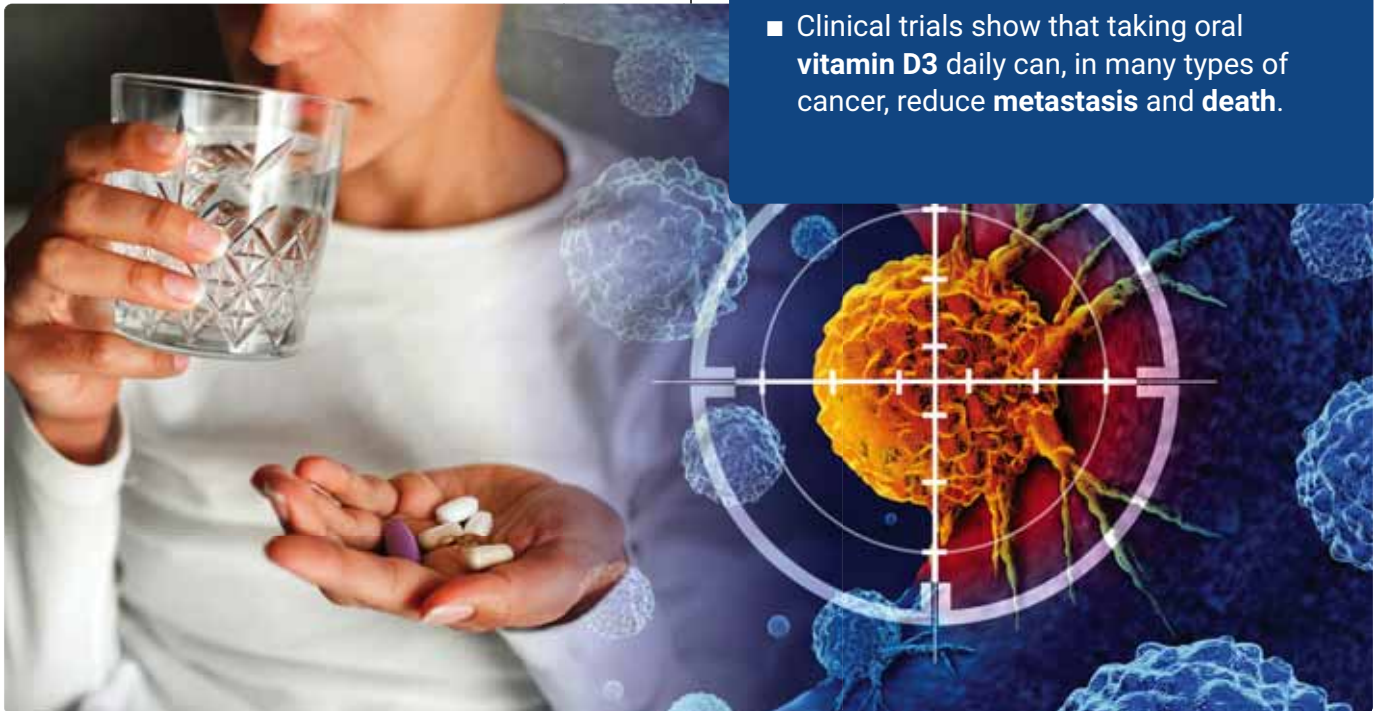
Participants were randomized into four groups:

- Active vitamin D and fish oil
- Active vitamin D and placebo instead of fish oil
- Placebo instead of vitamin D and active fish oil
- Placebo pills instead of either vitamin D or fish oil

WHAT
YOU
NEED
TO
KNOW

Vitamin D's Role in the Fight Against Cancer

- Low levels of vitamin D are extremely common. Observational studies have often shown that low vitamin D status is associated with increased risk of cancer development.
- Clinical trials show that taking oral **vitamin D3** daily can, in many types of cancer, reduce **metastasis** and **death**.





A significant **17% reduction** in advanced cancer (metastatic or fatal) incidence was found in those who received vitamin D.

When analyzed by BMI (body mass index) categories of normal weight, overweight, and obese, a significant **38% risk reduction** was seen in the vitamin D group that had normal BMI (**25-<30**).⁸ This may indicate that study participants with a *higher* BMI should have received more vitamin D than **2,000 IU/day**.

Another double-blind, placebo-controlled trial evaluated patients with **digestive tract cancers**, including esophagus, stomach, small intestine, colon, and rectum, administering oral vitamin D supplementation at a dose of **2,000 IU/day** beginning two to four weeks after cancer surgery.³¹

This trial did not show a change in five-year relapse-free survival. But a later analysis of the trial data examined whether mutations in the **p53** tumor suppressor gene, in the tumors themselves, predicted the likelihood of a beneficial response to vitamin D supplementation.³² **P53** is the most commonly mutated gene in human cancers³³

When considering the **p53** mutation status, the results of vitamin D supplementation were quite remarkable. In people with **p53 mutations**—meaning their cells had lost an innate ability to suppress tumor cell proliferation—relapse or death was **73% less** likely to occur in those supplemented with vitamin D compared to placebo.

The follow-up period in this study was over **five years** and results indicate that cancer patients with **p53 mutations** may be more likely to respond favorably to vitamin D.

In a meta-analysis of five randomized controlled trials, vitamin D supplementation conferred a **13% lower** risk of cancer death. This benefit was largely attributable to daily vitamin D dosing rather than bolus dosing.³⁴

This evidence shows that vitamin D supplementation reduces cancer death, that it is especially effective in those whose tumors carry the most common cancer-promoting mutations, and that overweight and obese individuals probably require *higher* doses of vitamin D to gain these benefits.

Summary

Vitamin D has been shown to defend against the development and progression of **cancer** in multiple ways.

In many observational studies, people with *low* levels of vitamin D have often been found to have *higher* rates of many types of cancer.

Several clinical trials show that taking daily oral **vitamin D3** can help reduce the risk of cancer **metastasis** and **death**. •

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

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Formulated with **lemon verbena** leaf and **hibiscus flower** extracts to promote satiety and encourage weight loss[†] in just 8 weeks.

Item #02504 | 30 vegetarian capsules | 1 bottle **\$22.50** | 4 bottles **\$20** each

For full product description and to order **Body Trim and Appetite Control**, call **1-800-544-4440** or visit **www.LifeExtension.com**

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[†] This supplement should be taken in conjunction with a healthy diet and regular exercise program. Individual results are not guaranteed and results may vary.

These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.

In with
the Good

Out with
the Bad

"I'm happy
with this
product!"

Laura

VERIFIED CUSTOMER
REVIEW

FLORASSIST® GI

for a Healthy Digestion

Phages target bad intestinal bacteria, allowing beneficial strains to flourish.

FLORASSIST® GI provides a 7-strain blend of **probiotics** in a **dual encapsulation** formula to deliver beneficial bacteria and **phages** where you need them the most.



Dual-Encapsulation Delivery



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Restore Youthful
Cellular Energy

NEXT-GENERATION
LIPOLIC ACID

Super R-Lipoic Acid is more bioavailable, stable, and potent, achieving **10-30 times** higher peak blood levels. This unique **sodium-R-lipoate** can help you reach peak plasma concentrations within just 10-20 minutes of supplementation.

Suggested dose is one to two capsules daily.



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60 vegetarian capsules
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4 bottles **\$32.50 each**

For full product description
and to order **Super R-Lipoic Acid**,
call **1-800-544-4440** or visit
www.LifeExtension.com

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ULTIMATE PROTECTION
FOR YOUR LIVER



Item #01922
60 softgels

1 bottle **\$21**
4 bottles \$18.75 each



Advanced Milk Thistle contains standardized, top-grade potencies of ***silymarin***, ***silybin***, ***isosilybin A***, and ***isosilybin B***, providing a full spectrum of liver-supportive compounds.

The **silymarin** contained in **Advanced Milk Thistle** is absorbed nearly **5 times** better than silymarin alone, and its bioavailability to the liver is **10 times** better.

For full product description and to order **Advanced Milk Thistle**, call **1-800-544-4440** or visit **www.LifeExtension.com**

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Liposomal-Hydrogel™



VITAMIN

"I feel better about my
immune system with it."

Mary

VERIFIED CUSTOMER REVIEW



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Vitamin C 24-Hour Liposomal Hydrogel™ Formula,
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Buffered **ascorbate** encased in two plant extracts (liposomes plus hydrogel fenu-greek) increases blood (plasma) exposure nearly **seven times** more compared to an equivalent dose of regular vitamin C.

It also maintains *higher* vitamin levels throughout the day.¹

Just one vegetarian tablet daily provides **around-the-clock** vitamin C support.

1. Akay Internal Study. Liposomal hydrogel vitamin C pharmacokinetics. Data on file. 2021.



Vitamins D and K as well as Iodine perform multiple functions for heart and bone health.

Life Extension® brings these three nutrients together in one convenient capsule.

VITAMINS D and K + IODINE = Convenience + Cost Savings



CAUTION: Individuals consuming more than 50 mcg 2,000 IU/day of vitamin D (from diet and supplements) should periodically obtain a serum 25-hydroxy vitamin D measurement. Do not exceed 250 mcg per day unless recommended by your doctor. Vitamin D supplementation is not recommended for individuals with high blood calcium levels. If you have a thyroid condition or are taking antithyroid medications, do not use without consulting your healthcare practitioner. If you are taking a vitamin K antagonist (e.g. warfarin), consult your healthcare practitioner before taking this product.

Just one capsule daily provides:

Vitamin D3	5,000 IU (125 mcg)
Vitamin K1	1,000 mcg
Vitamin K2 (MK4)	1,000 mcg
Vitamin K2 (MK7)	100 mcg
Iodine	1,000 mcg

Item #02040
60 capsules
1 bottle **\$18**
4 bottles \$16.50 each

For full product description and to order **Vitamins D and K with Sea-Iodine™**, call **1-800-544-4440** or visit **www.LifeExtension.com**



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GO WITH THE FLOW



Ultra Prostate Formula is designed to address essential factors involved in prostate health: size & function, hormone metabolism and yes, even nighttime flow.

It is our most advanced prostate-health supplement.

Item #02029

60 softgels

1 bottle **\$29.25**

4 bottles \$27 each



For full product description and to order **Ultra Prostate Formula**,
call **1-800-544-4440** or visit **www.LifeExtension.com**

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What is PQQ?

BY LAURIE MATHENA



Mitochondria are tiny powerplants that supply energy to the cells throughout your body.¹

With age, your body produces less mitochondria, and existing ones can become damaged and dysfunctional.^{1,2}

This results in a cellular “energy shortage” that contributes to age-related problems like insulin resistance,^{2,3} cognitive decline,⁴ and macular degeneration.^{5,6}

A compound called **pyrroloquinoline quinone (PQQ)** has the potential to ward off health issues by stimulating the creation of healthy, **new mitochondria**.⁷⁻¹⁰

Additionally, animal studies have shown that boosting **PQQ** levels improves eye health, while guarding against metabolic disease, liver damage, and kidney damage.

One animal model showed that PQQ increased **lifespan** by an average of **30%**.^{11,12}

In a **human trial** of individuals with age-related cognitive decline, supplementing with **21.5 mg** of **PQQ** for 12 weeks resulted in improvement of composite memory, reaction time, and cognitive flexibility compared to placebo.¹³

Another study showed that supplementing with PQQ leads to improvements in attention and working memory.¹⁴

Aging and Mitochondrial Dysfunction

The body is a complex machine that requires an incredible amount of energy to run efficiently. That energy comes from energy factories called **mitochondria** that convert food into energy the body can use.

Healthy mitochondria divide on their own to replenish their numbers. This is a remarkable process known as **mitochondrial biogenesis**. Mitochondrial biogenesis is critical for protecting cells from premature aging.^{2,15,16}

But with age, this process slows.

When mitochondria become damaged and die off, it creates a cellular energy shortage that accelerates aging and disease.

Mitochondrial dysfunction is *especially* damaging to the organs and tissues that have the greatest energy requirements, like our brain, heart, retina, pancreas, and liver.^{17,18}

Fortunately, with the right boost, mitochondria can continue to grow, repair, and replenish themselves even in later life.

That's where **PQQ** comes in.

PQQ Creates New Mitochondria

PQQ (pyrroloquinoline quinone) is a water-soluble, vitamin-like compound found in plants, yeast, and certain bacteria.

PQQ helps mitochondria in three important ways:

- By promoting the creation of healthy, new mitochondria,^{16,19-24}
- By clearing out defective mitochondria,^{19,25} which helps ensure cell survival,¹⁵ and
- By boosting the energy production of existing mitochondria.^{20,26,27}

In a human study, a single dose of PQQ (equaling **13 mg** for an average-sized adult) led to improved measurements of urinary oxidant levels (indicators of mitochondrial efficiency).

This team of scientists also evaluated the impact of a higher daily dose of PQQ supplementation after three days (equaling about **20 mg** per day for an average-sized adult) and found that measurements

of **inflammation** (such as **C-reactive protein** and **interleukin-6**) were decreased.⁸

In a study of healthy men who completed a six-week aerobic training program, those given **20 mg** of **PQQ** daily more than **doubled** their **PGC-1 alpha** levels (mitochondrial-generating protein) as compared to placebo.⁷

Brain Protection

The brain uses more energy than any other organ in the body,²⁸ so it is one of the hardest hit when mitochondrial function declines.

Aging, dysfunctional mitochondria are known as contributors to age-related **brain** disorders, including **Alzheimer's** and **Parkinson's** disease.^{15,23,29}

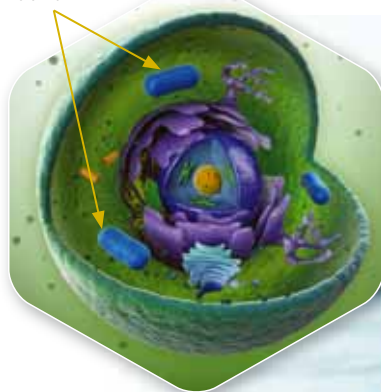
By helping mitochondria perform more efficiently and by promoting the development of *new* mitochondria, PQQ may help prevent these and other disorders.^{19,23,29,30}

In a human study, participants aged 20–65 years received **20 mg** of PQQ or placebo for 12 weeks. Supplementing with PQQ led to **improvements in memory test scores** after eight weeks. In older adults, at the end of 12 weeks, further improvements in complex and verbal memory were observed.³¹

Researchers have found preclinical evidence that PQQ may slow the progression of both conditions—or possibly even prevent them altogether.^{30,32-37}

That's because, in addition to boosting mitochondrial function, PQQ has been found to *prevent* the accumulation of abnormal proteins (such as **beta-amyloid** and **alpha-synuclein**) associated with neurodegeneration.³²⁻³⁴

MITOCHONDRIA





Prevent Metabolic Issues

Mitochondrial dysfunction contributes to metabolic issues like obesity, insulin resistance, and type II diabetes, as well as cardiovascular disease.^{24,38,39}

PQQ helps improve many factors that contribute to metabolic syndrome. PQQ affects insulin signaling via multiple pathways. That is why studies suggest that PQQ may be beneficial in insulin resistance and type II diabetes.⁴¹

In an animal study of metabolic syndrome, obese rats treated with PQQ for five weeks experienced the following benefits (compared to the untreated group):^{24,40}

- Significant improvements in blood sugar control, insulin levels, and insulin sensitivity,
- Reductions in harmful inflammatory cytokines, and
- Healthier blood lipid levels, including total cholesterol, triglycerides, LDL (“bad”) cholesterol, and HDL (“good”) cholesterol.

Kidney and Liver Health

Two serious side effects of metabolic issues like obesity and diabetes are kidney and liver damage. PQQ has considerable potential for remedying metabolic diseases including diabetes, nonalcoholic fatty liver disease (NAFLD), and chronic kidney disease.⁴¹

In rodent models of diabetes, the kidneys show signs of significant damage and **fibrosis** (scarring). Kidney function is decreased and there are signs of oxidative stress and **inflammation** seen in the tissues.^{42,43}

In an animal model of diabetes, giving animals PQQ significantly reduced the structural damage to their kidneys, while improving kidney function.^{42,43}

And in a preclinical study of NAFLD (nonalcoholic fatty liver disease), PQQ protected the liver from fat accumulation by supporting the creation of **new** mitochondria, improving lipid metabolism, and boosting antioxidant protection.⁴⁴

Eye Protection

Abnormal mitochondrial function is often found in three of the leading causes of blindness: macular degeneration, glaucoma, and diabetic retinopathy.^{6,9}

Cell studies from eyes of human donors with macular degeneration show **under-functioning mitochondria** in the **retinal pigment epithelium**. Researchers used PQQ to treat **retinal pigment epithelial cells** from human organ donors who had age-related macular degeneration.⁹

In half of the tissue samples, administering PQQ led to a **50%-350%** improvement in the mitochondrial function of these critical retinal cells.

The treated cells also had a **59%** increase in the production of ATP, which is the form of energy that the cells use.

Summary

PQQ helps promote healthy aging by promoting the production of healthy, new mitochondria.

Enhancing the body’s cellular energy with PQQ has the potential to improve memory and eye health, while protecting against metabolic, liver, and kidney disease.

PQQ also has the potential to increase lifespan.

Taking **10 to 20 mg** of PQQ daily is a practical way to support healthy aging. •

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

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Check Your Health with Lab Tests

DR. SCOTT FOGLE, ND



Lab tests can assess a wide array of health concerns and point the way to potential solutions.

In this interview, **Dr. Scott Fogle, ND**, discusses some of the best tests available to help you and your physician understand your current health status.

LE: With the annual lab test sale happening, people are wondering: What are some must-have tests **Life Extension** offers?

Dr. Fogle: We work with nine different labs, which provide us with amazing options. Our most popular tests remain our **Male** and **Female Panels**. If you got those tests from a commercial lab, you would pay around \$2,500, but during our sale we offer them at \$224. These are valuable, comprehensive tests.

LE: What's one of *your* favorite tests?

Dr. Fogle: The **GI360 Stool Analysis** for gastrointestinal (GI) issues looks for dysbiosis of your gut flora and the major pathogens that cause trouble in your gut. It also offers an excellent assessment of your digestive abilities.

LE: Is that test different from the popular **SIBO Home Breath Kit**?

Dr. Fogle: Yes, the GI360 is a stool test that takes a broad and comprehensive look at your GI health. The SIBO kit is a breath test looking for bacteria that have overgrown and proliferated in your small intestine. This bacterial overgrowth can cause gas, bloating, diarrhea, constipation, and cramping.

LE: Food allergies also affect your GI health. Can you test for those?

Dr. Fogle: Food allergies and sensitivities can cause systemic inflammation, headaches, migraine, foggy brain, musculoskeletal problems, fatigue, skin issues, mood disturbances, and more. We offer both **food allergy profiles** and **food sensitivity panels**. Food allergies are tested via IgE antibody reactions, while sensitivities are tested via IgG and IgA antibodies.

Our **Advanced Food Sensitivity Panel** tests for IgG sensitivities to **240** foods and is our most popular choice during the sale. For those suspecting numerous possible food reactions, our **Elite Food Sensitivity Panel** adds IgA testing for a closer look at sensitivities to those foods.

LE: More news keeps coming out about environmental pollutants and toxins. What tests can help identify them in our bodies?

Dr. Fogle: We offer an **Environmental Pollutants Profile**, a convenient at-home urine test that reveals levels of harmful toxins such as xylene, toluene, benzene, trimethylbenzene, styrene, phthalates, parabens, and MTBE. For harmful heavy metals we offer the **Toxic Metals Panel** fecal test, which looks at the worst offenders including arsenic, lead, mercury, uranium, and many more. Annual testing for toxin exposure is a good idea.

LE: What **new tests** are being offered during the annual sale?

Dr. Fogle: Let me start with hair loss. It's not just a genetic issue; you can test for medical conditions that contribute to or accelerate it. We created two panels, a **Basic** and **Comprehensive Hair Loss Panel**. The basic panel looks at the most common causes, such as excessive DHT (dihydrotestosterone), which has a negative effect on hair follicles. It also measures thyroid-stimulating hormone to check thyroid health, low ferritin (an iron marker) for anemia, C-reactive protein for excessive inflammation, and low or high cortisol related to acute or chronic stress, all of which can be factors in hair loss.

LE: What does the Comprehensive Hair Loss Panel offer?

Dr. Fogle: It includes everything in the basic panel plus additional tests that delve deeper. It checks antinuclear antibodies (ANA) as a general autoimmune screening test and has more advanced thyroid testing to look for hormone imbalances or significantly high or low levels.

LE: You mentioned that **stress** can contribute to hair loss?

Dr. Fogle: Yes. The good news is that often that type of hair loss can be recovered, and tests provide clues of current or ongoing stress. The stress hormone cortisol rises during acute stress, and low levels can point to chronic stress and implication in hair loss. Also, stress can cause an increase in what's known as reverse T3 hormone levels. The **Reverse T3** blood test and **Cortisol** blood or urine tests can indicate various stages and degrees of stress.



LE: Do you have other **new tests**?

Dr. Fogle: People are concerned about mold at home, work, or school. We finally have a lab that can deliver good testing for mold and mycotoxins (the toxins molds secrete). We are now offering a **Mold Exposure Mycotoxin** urine test to see what mycotoxins are present in the urine, indicating the body's exposure to mycotoxins from food and environment. We also offer an **EMMA (Environmental Mold & Mycotoxin Analysis)** test that checks for mold and mycotoxins in a suspected environment by swabbing dust from any area of concern.

LE: How dangerous are mycotoxins?

Dr. Fogle: They are associated with a wide range of symptoms and diseases including immune dysfunction and even cancer. Common complaints are respiratory and sinus concerns, cognitive dysfunction, neurological issues, significant fatigue, changes in mood, and more.

LE: Testing urine can identify which mycotoxins may be causing these symptoms?

Dr. Fogle: Correct. The **Mold Exposure Mycotoxin** test checks for exposure to **16** of the worst-of-the-worst mycotoxins. Knowing which one is most prevalent in your body is helpful to identify foods to avoid or which mold may be lurking behind the walls in your home.

LE: Are foods or moldy environments more likely sources of mycotoxins?

Dr. Fogle: Both can be, but most issues stem from water-damaged buildings. This makes it important



to use the **EMMA** test along with the mycotoxin urine test. Dust is collected from a suspected location to directly examine the mold and mycotoxins in that environment. EMMA results can be compared to urinary mycotoxin results to see if your body's mycotoxin exposure aligns with the mold and mycotoxins in a building. Doing both tests provides a more complete picture of mold exposure, which can help confirm the source of mycotoxins in the urine.

LE: Do different mycotoxins cause different health issues?

Dr. Fogle: Yes, some specific symptoms are related to different mycotoxins. For example, ochratoxin A from the common **Aspergillus** mold family is associated with fatigue, dermatitis, and

irritated bowel issues. Satratoxins from **black mold** are associated with fatigue, breathing issues, and nervous system dysregulation. Black mold is difficult to directly test for because it is heavy and sticky and doesn't circulate in the air easily. But what do circulate are the satratoxins it produces, and now we can test for those. •

Dr. Scott Fogle is Executive Director of Clinical Information and Laboratory Services at **Life Extension**.

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



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○ CARDIO CORE ESSENTIALS (LC100086) Essential cardiovascular risk factors provide a low-cost analysis of your heart and vascular function. CBC • Chem/Metabolic Panel • Lipid/Cholesterol Profile • ApoB • C-Reactive Protein (high sensitivity)	\$89	\$66.75
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○ PERSONALIZED AMINO ACID HEALTH ASSESSMENT* (LC100090) An in-depth analysis of amino acid metabolism provides insight into various health concerns, such as maldigestion, GI dysbiosis, neurological issues and more, with a personalized report of diet and supplementation suggestions. Provided as an at-home urine collection kit.	\$299	\$224.25
○ ENVIRONMENTAL POLLUTANTS PROFILE** (LC100089) Toxic pollutants affect our bodies in several different ways. This test helps assess possible exposure to several common environmental pollutants by measuring their urinary metabolites.	\$149	\$111.75

Know YOUR NUMBERS

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GI360™ ** STOOL ANALYSIS (LC100088) Best and most advanced assessment of microbiome dysbiosis, diversity and digestive health, the GI360™ provides the most information about gut and microbiome health. Contains all the tests included in the CPP and CSAP along with cutting-edge markers of microbiome diversity and dysbiosis.	\$499	\$379.25
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ENVIRONMENTAL MOLD & MYCOTOXIN ANALYSIS* (LC900008) Worried about mold in your home or office? Check for mold and mycotoxins by swabbing a dusty area in your home!	\$399	\$299.25
BODY AND HOME MOLD & MYCOTOXIN COMBO TEST* (LC900009) Combine the two tests above for additional savings to check if the mycotoxins in your body are the same as those in your home!	\$749	\$561.75

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FEMALE ELITE PANEL (LC100017) CBC/Chemistry/Lipids Panel • Free and total Testosterone • Estradiol • Total Lipids • Estrone • DHEA-S • Progesterone • Pregnenolone • DHT • FSH • LH • TSH • Free T3 • Free T4 • Reverse T3 • IGF-1 • SHBG • Vitamin D 25-OH • hs-CRP • Ferritin • TIBC • Homocysteine • Insulin • Hemoglobin A1c • Cortisol • ApoB • Magnesium	\$575	\$431.25
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Beans

BY LAURIE MATHENA



Some foods deserve the title of superfood because they help keep you *healthy*. Beans deserve the title because they could help you *live longer*.

Beans come in a number of varieties. The most popular include garbanzo, navy, red, white and black beans.

Dan Buettner is an author who has spent years researching Blue Zones, which are areas of the world where people routinely live past 100 years old.

Buettner said, “In every Blue Zone I have visited, beans and other legumes were—and still are—a major component of the daily diet.”

Beans are considered a legume plant.

Indeed, research has shown that every **20-gram** increase in dietary intake of legumes per day reduces risk of mortality by **8%!**¹ This finding led the researchers to call beans “the most important dietary predictor of survival in older people of different ethnicities.”

Every variety of bean has its own unique nutrient profile, so eating a variety is best. They are a good source of protein and fiber, while being a low glycemic-index carbohydrate.

Black beans, for example, provide **14.5 grams** of protein and **16.6 grams** of fiber in **one cup**.²

Because beans are high in fiber, they can help stabilize blood sugar levels.

In an animal study, consuming a variety of beans for three weeks was shown to improve gut health by boosting beneficial bacteria and promoting intestinal barrier function.³

In a study that followed 9,632 people for an average of 19 years, results showed that consuming legumes four times per week was associated with a **22% lower** risk of coronary heart disease and an **11% lower** risk of cardiovascular disease.⁴

Another study showed that consuming just **½ cup** of beans per day was associated with a **38% lower** risk of **heart attack**.⁵

In a randomized controlled trial of patients with metabolic syndrome participants were randomized to receive meals with black beans, fiber, or antioxidants. Blood samples were taken before and five hours after a meal. Insulin was lowered after a black bean meal as compared to meals with fiber or antioxidants.⁶

In a review of clinical trials, type II diabetics who consumed legumes on a regular basis showed reductions in fasting blood glucose, A1c, fasting blood insulin, and two-hour post-prandial blood glucose.⁷

Beans and legumes—whether dry or canned—provide a low-cost way to include more superfoods in your diet. These versatile foods can be added to casseroles, tossed into salads, made into a soup, added to tacos, or served as traditional beans and rice. ●

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02424	Joint Mobility
01600	Krill Healthy Joint Formula
00451	MSM (Methylsulfonylmethane)
02231	NT2 Collagen™

KIDNEY & BLADDER SUPPORT

- 00862 Cran-Max® Cranberry Whole Fruit Concentrate
- 01424 Optimized Cran-Max®
- 01921 Uric Acid Control
- 01209 Water-Soluble Pumpkin Seed Extract

LIVER HEALTH & DETOXIFICATION

- 01922 Advanced Milk Thistle • 60 softgels
- 01925 Advanced Milk Thistle • 120 softgels
- 02240C Anti-Alcohol Complex
- 01651 Calcium D-Glucarate
- 01571 Chlorophyllin
- 02402 FLORASSIST® Liver Restore™
- 02521 Glutathione
- 01541 Glutathione, Cysteine & C
- 01393 HepatoPro
- 01608 Liver Efficiency Formula
- 01522 Milk Thistle • 60 veg capsules
- 01534 N-Acetyl-L-Cysteine
- 01884 Silymarin
- 02361 SOD Booster

LONGEVITY & WELLNESS

- 00457 Alpha-Lipoic Acid
- 01625 AppleWise
- 02414 Bio-Fisetin™
- 01214 Blueberry Extract
- 01438 Blueberry Extract and Pomegranate
- 02270 DNA Protection Formula
- 02431 Essential Youth - L-Ergothioneine
- 02119 GEROPROTECT® Ageless Cell™
- 02415 GEROPROTECT® Autophagy Renew
- 02401 GEROPROTECT® Stem Cell
- 02211 Grapeseed Extract
- 02527 Healthy Aging Powder
- 00954 Mega Green Tea Extract (decaffeinated)
- 00953 Mega Green Tea Extract (lightly caffeinated)
- 01513 Optimized Fucoidan with Maritech® 926
- 02230 Optimized Resveratrol Elite™
- 01637 Pycnogenol® French Maritime Pine Bark Extract
- 02210 Resveratrol Elite™
- 02301 Senolytic Activator®
- 01208 Super R-Lipoic Acid
- 01919 X-R Shield

LUNG HEALTH

- 02512 Healthy Lungs

MEN'S HEALTH

- 02209 Male Vascular Sexual Support
- 00455 Mega Lycopene Extract
- 02306 Men's Bladder Control
- 02515 Men's Vitality Packs
- 01789 PalmettoGuard® Saw Palmetto and Beta-Sitosterol
- 01790 PalmettoGuard® Saw Palmetto/Nettle Root Formula and Beta-Sitosterol
- 01373 Prelox® Enhanced Sex for Men
- 01940 Super MiraForte with Standardized Lignans
- 02500 Testosterone Elite
- 01909 Triple Strength ProstaPollen™
- 02029 Ultra Prostate Formula

MINERALS

- 01661 Boron
- 02107 Extend-Release Magnesium
- 01677 Iron Protein Plus
- 02403 Lithium
- 01459 Magnesium Caps
- 01682 Magnesium (Citrate)
- 01328 Only Trace Minerals
- 01504 Optimized Chromium with Crominex® 3+
- 02309 Potassium with Extend-Release Magnesium
- 01740 Sea-Iodine™
- 01879 Se-Methyl L-Selenocysteine
- 01778 Super Selenium Complex
- 00213 Vanadyl Sulfate
- 01813 Zinc Caps

MISCELLANEOUS

- 00577 Potassium Iodide

MOOD & STRESS MANAGEMENT

- 02519 Ashwagandha Plus
- 02434 Calm-Mag
- 02312 Cortisol-Stress Balance
- 00987 Enhanced Stress Relief
- 01683 L-Theanine
- 02175 SAMe (S-Adenosyl-Methionine)
200 mg, 30 enteric coated vegetarian tablets
- 02176 SAMe (S-Adenosyl-Methionine)
400 mg, 30 enteric coated vegetarian tablets
- 02174 SAMe (S-Adenosyl-Methionine)
400 mg, 60 enteric coated vegetarian tablets
- 02429 Theanine XR™ Stress Relief

MULTIVITAMINS

- 02199 Children's Formula Life Extension Mix™
- 02354 Life Extension Mix™ Capsules
- 02364 Life Extension Mix™ Capsules without Copper
- 02356 Life Extension Mix™ Powder
- 02355 Life Extension Mix™ Tablets
- 02357 Life Extension Mix™ Tablets with Extra Niacin
- 02365 Life Extension Mix™ Tablets without Copper
- 02292 Once-Daily Health Booster • 30 softgels
- 02291 Once-Daily Health Booster • 60 softgels
- 02313 One-Per-Day Tablets
- 02317 Two-Per-Day Capsules • 60 capsules
- 02314 Two-Per-Day Capsules • 120 capsules
- 02316 Two-Per-Day Tablets • 60 tablets
- 02315 Two-Per-Day Tablets • 120 tablets
- 02428 Whole Food Multivitamin

NERVE & COMFORT SUPPORT

- 02202 ComfortMAX™
- 02303 Discomfort Relief

PERSONAL CARE

- 02322 Hair, Skin & Nails Collagen Plus Formula
- 01278 Life Extension Toothpaste
- 00408 Venotone
- 02304C Youthful Collagen
- 02252 Youthful Legs

PET CARE

01932	Cat Mix
01931	Dog Mix
02523	DOG Hip & Joints
02524	DOG Multivitamin & Probiotics
02522	DOG Skin & Coat
02525	DOG Stress & Behavior

PROBIOTICS

01622	Bifido GI Balance
01825	FLORASSIST® Balance
02421	FLORASSIST® Daily Bowel Regularity
02125	FLORASSIST® GI with Phage Technology
01821	FLORASSIST® Heart Health
02250	FLORASSIST® Mood Improve
02208	FLORASSIST® Immune & Nasal Defense
02120	FLORASSIST® Oral Hygiene
02203	FLORASSIST® Prebiotic
02505	FLORASSIST® Probiotic Women's Health

SKIN CARE

02423	Daily Skin Defense
01938	Shade Factor™
02129	Skin Care Collection Anti-Aging Serum
02130	Skin Care Collection Day Cream
02131	Skin Care Collection Night Cream
02096	Skin Restoring Ceramides

SLEEP

01512	Bioactive Milk Peptides
02300	Circadian Sleep
01511	Enhanced Sleep without Melatonin
02234	Fast-Acting Liquid Melatonin
01669	Glycine
02308	Herbal Sleep PM
01722	L-Tryptophan
01668	Melatonin • 300 mcg, 100 veg capsules
01083	Melatonin • 500 mcg, 200 veg capsules
00329	Melatonin • 1 mg, 60 capsules
02503	Melatonin • 3 mg, 60 gummies
00330	Melatonin • 3 mg, 60 veg capsules
00331	Melatonin • 10 mg, 60 veg capsules
00332	Melatonin • 3 mg, 60 veg lozenges
02201	Melatonin IR/XR
01787	Melatonin 6 Hour Timed Release 300 mcg, 100 veg tablets
01788	Melatonin 6 Hour Timed Release 750 mcg, 60 veg tablets
01721	Optimized Tryptophan Plus
01445	Quiet Sleep Melatonin • 5 mg, 60 veg capsules
02502	Rest & Renew
02526	Serene Sleep

VITAMINS

01533	Ascorbyl Palmitate
00920	Benfotiamine with Thiamine
01945	BioActive Complete B-Complex
00102	Biotin
00084	Buffered Vitamin C Powder
02229	Fast-C® and Bio-Quercetin®

02075	Gamma E Mixed Tocopherol Enhanced with Sesame Lignans
02070	Gamma E Mixed Tocopherol & Tocotrienols
01913	High Potency Optimized Folate
01674	Inositol Caps
02244	Liquid Vitamin D3 • 50 mcg (2000 IU)
02232	Liquid Vitamin D3 (Mint) • 50 mcg (2000 IU)
01936	Low-Dose Vitamin K2
00373	No Flush Niacin
01939	Optimized Folate (L-Methylfolate)
01217	Pyridoxal 5'-Phosphate Caps
01400	Super Absorbable Tocotrienols
02334	Super K
01863	Super Vitamin E
02422	Vegan Vitamin D3
02028	Vitamin B5 (Pantothenic Acid)
01535	Vitamin B6
00361	Vitamin B12 Methylcobalamin
01536	Vitamin B12 Methylcobalamin 1 mg, 60 veg lozenges
01537	Vitamin B12 Methylcobalamin 5 mg, 60 veg lozenges
02228	Vitamin C and Bio-Quercetin® 60 veg tablets
02227	Vitamin C and Bio-Quercetin® 250 veg tablets
01753	Vitamin D3 • 25 mcg (1000 IU), 90 softgels
01751	Vitamin D3 • 25 mcg (1000 IU), 250 softgels
01713	Vitamin D3 • 125 mcg (5000 IU), 60 softgels
01718	Vitamin D3 • 175 mcg (7000 IU), 60 softgels
01758	Vitamin D3 with Sea-Iodine™
02040	Vitamins D and K with Sea-Iodine™

WEIGHT MANAGEMENT & BODY COMPOSITION

02479	7-Keto® DHEA Metabolite 100 mg, 60 veg capsules
02207	AMPK Metabolic Activator
02504	Body Trim and Appetite Control
02478	DHEA Complete
02506C	Mediterranean Weight Management
01432	Optimized Saffron
02511	Thermo Weight Control
02509	Waistline Control™

WOMEN'S HEALTH

01942	Breast Health Formula
01626	Enhanced Sex for Women 50+
01894	Estrogen for Women
02204	Menopause 731™
02319	Prenatal Advantage
01649	Soy Isoflavones
02513	Women's Bladder Support

The Cherry on Top

Magnesium is a sweet way to prioritize whole-body health—especially the heart and bones.

With two different forms that provide immediate-and longer-lasting benefits, you'll savor **Extend-Release Magnesium** long after you've taken it.

"Great product."

Roniele

VERIFIED CUSTOMER
REVIEW



Item #02107
60 vegetarian capsules
1 bottle **\$9.75**
4 bottles \$8.75 each

GLUTEN
FREE

NON
GMO
LE CERTIFIED

VEGETARIAN
LE CERTIFIED

For full product description and to order **Extend-Release Magnesium**,
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CAUTION: If taken in high doses, magnesium may have a laxative effect. If this occurs, divide dosing, reduce intake, or discontinue product.

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These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.



Super Omega-3

Fish oil is a popular supplement people use to boost omega-3 levels in the heart, brain, eyes, and other tissues.

Super Omega-3 provides healthy components of the Mediterranean diet, including highly purified fish oil, sesame lignans and standardized olive fruit extracts.

2,400 mg
of EPA + DHA
in four softgels



**GLUTEN
FREE**

**NON
GMO
LE CERTIFIED**

Item #01982
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1 bottle **\$30.75** | 4 bottles \$29.00 each

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CAUTION: If you are taking anti-coagulant or anti-platelet medications, or have a bleeding disorder, consult your healthcare provider before taking this product.

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IN THIS EDITION OF *LIFE EXTENSION* MAGAZINE®



7 **RATIONALE FOR COMBINED INTERVENTIONS**

A **2023** review stressed the **urgent** need for combination approaches to target **aging**.



22 **THE HUMAN BRAIN AND BENFOTIAMINE**

Benfotiamine has been shown to improve **cognition** scores in **clinical studies** compared to **placebo**.



32 **TARGET MULTIPLE AGING PATHWAYS**

Scientists have identified nutrients that correlate with **reduced mortality** and **greater healthspan** by favorably modulating multiple *mechanisms of aging*.



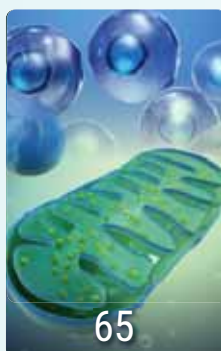
44 **GLP-1 FOR DIABETES, OBESITY, AND CARDIAC FUNCTION**

GLP-1 agonist drugs are game changers in controlling **blood sugar** and **body weight**. Clinical trials show a **20% reduction** in cardiovascular events and death.



52 **VITAMIN D AND CANCER**

Clinical trials indicate who is most likely to benefit by supplementing with more **vitamin D**.



65 **WHAT IS PQQ?**

By promoting the generation of *new* cellular mitochondria, **PQQ** helps promote full-body health.

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