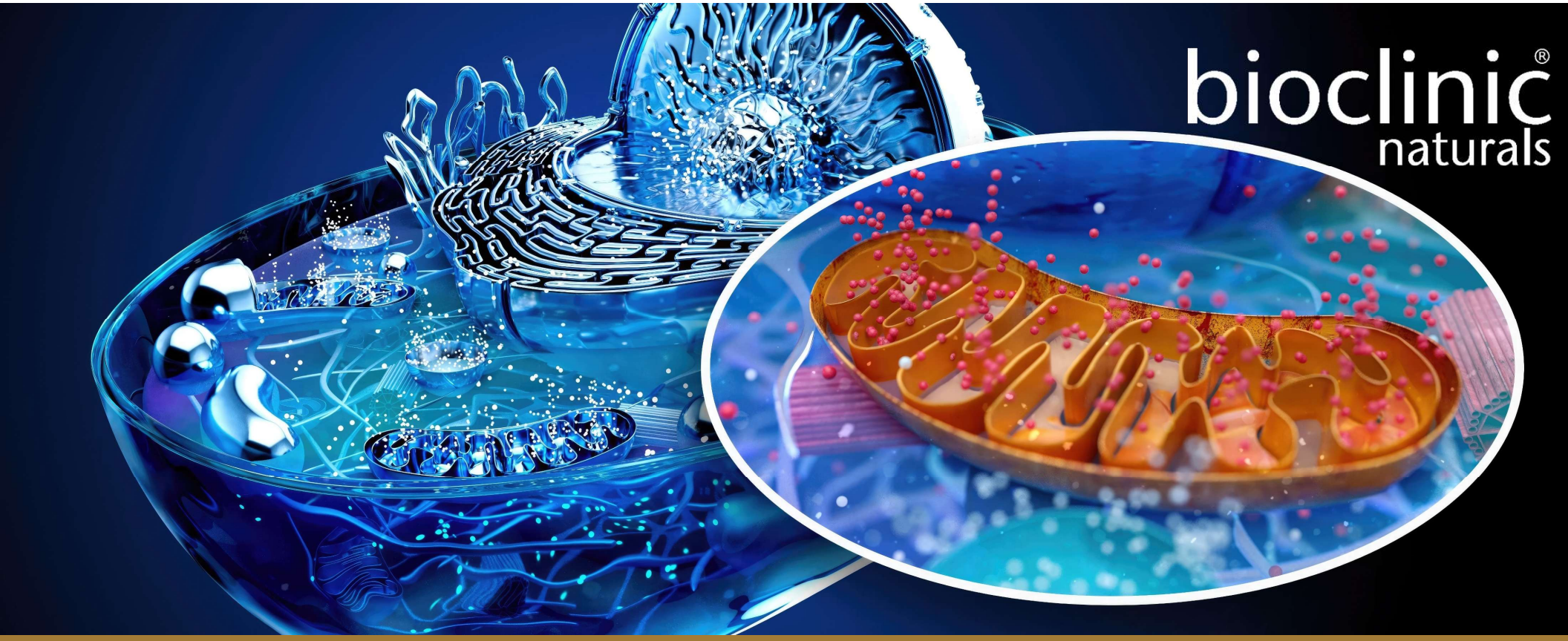
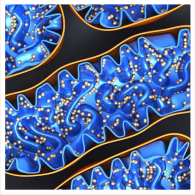


Fuel for Thought: Mind, Muscle & Mitochondria

Presented by Liesl Blott
Clinical Services and Education Manager
B.Pharm; BHSc (Western Herbal Medicine); AdvDip (Naturopathy); GradDip (Marketing Management)



Our minds, bodies and energy are inextricably linked to mitochondrial health and function.

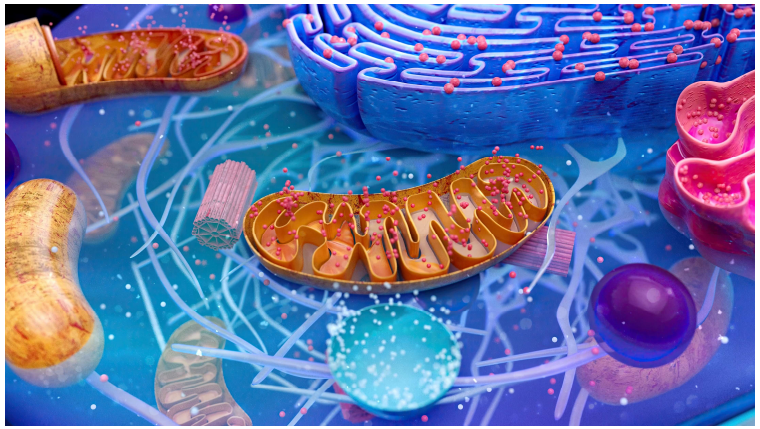


Mitochondrial energy fuels both mental and physical wellbeing.

The health of the brain and body also shape mitochondrial integrity, resilience and function.



This presentation explores this dynamic relationship and provides insights into core foundational nutrients and interventions to fuel these interconnected systems and pathways.

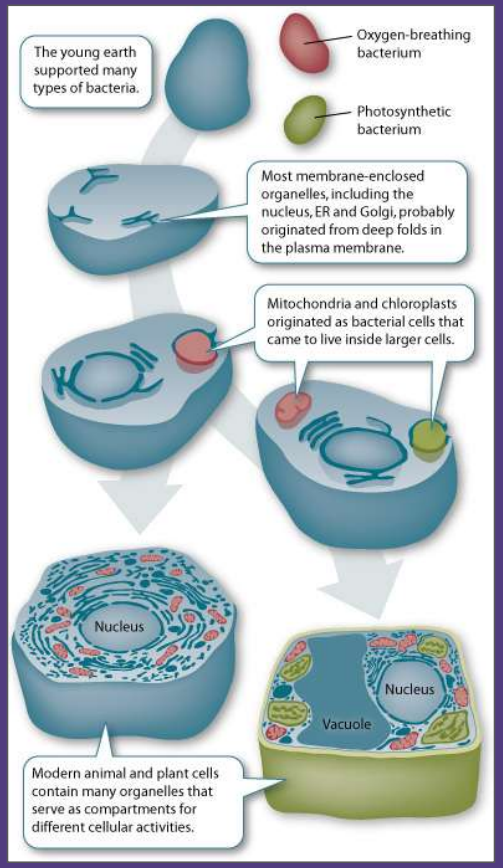


✓ Mind

✓ Muscle

✓ Mitochondria

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Endosymbiosis Theory

The Evolution of the Cell

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Once upon a time….

About 2 billion years ago, ancestral bacteria were engulfed by a host organelle to form an endosymbiotic relationship that sparked life as we know it.[1]

The bacteria inside the cell became what we now call mitochondria.[1]

The mitochondria now sustain human life via energy production, intracellular signaling and a host of other activities.[1]

There are 100's to 1000's of mitochondria in each cell.[1]

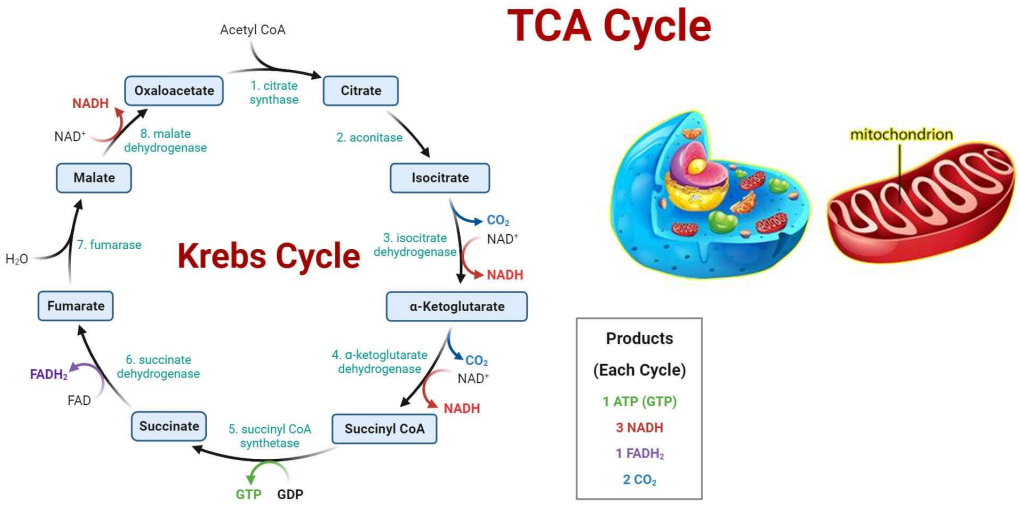
Cells that need more energy typically have more mitochondria.[1]

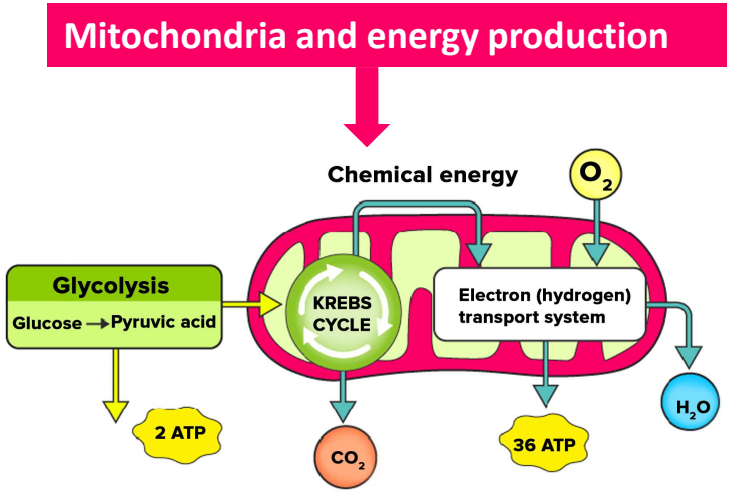
Picard et al 2018

Mitochondria: 'Energy factories'

Mitochondria:

- Are often called the 'powerhouse of the cell.'[1]
- They produce ATP, a storage molecule of energy.[1-3]
- Energy is released from ATP when needed to drive cellular and physiological processes.[1-3]





O_2 = oxygen
ATP = energy units

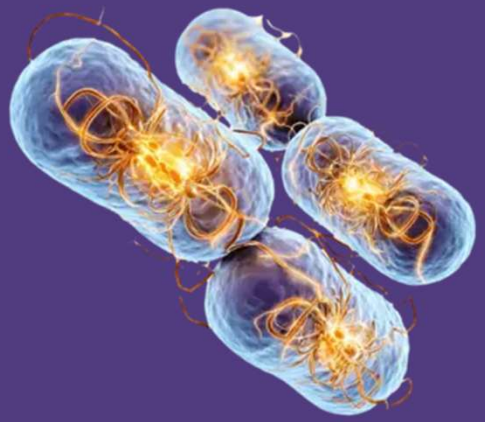
Krebs Cycle: Steps, Enzymes, Energy Production, Diagram

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"Without the vital force the material organism is unable to feel, or act, or maintain itself […].

Without the vital force the body dies."

Samuel Hahnemann (1833)



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Mitochondria – source of our vitality

Mitochondria transform the air we breathe and the food we eat to produce an energy charge that drives all aspects of our existence.[1]

They sense, integrate, and signal information about their environment.[1]

Mitochondria exchange information between themselves as well as serving as information hubs for communication between our cells.[1]

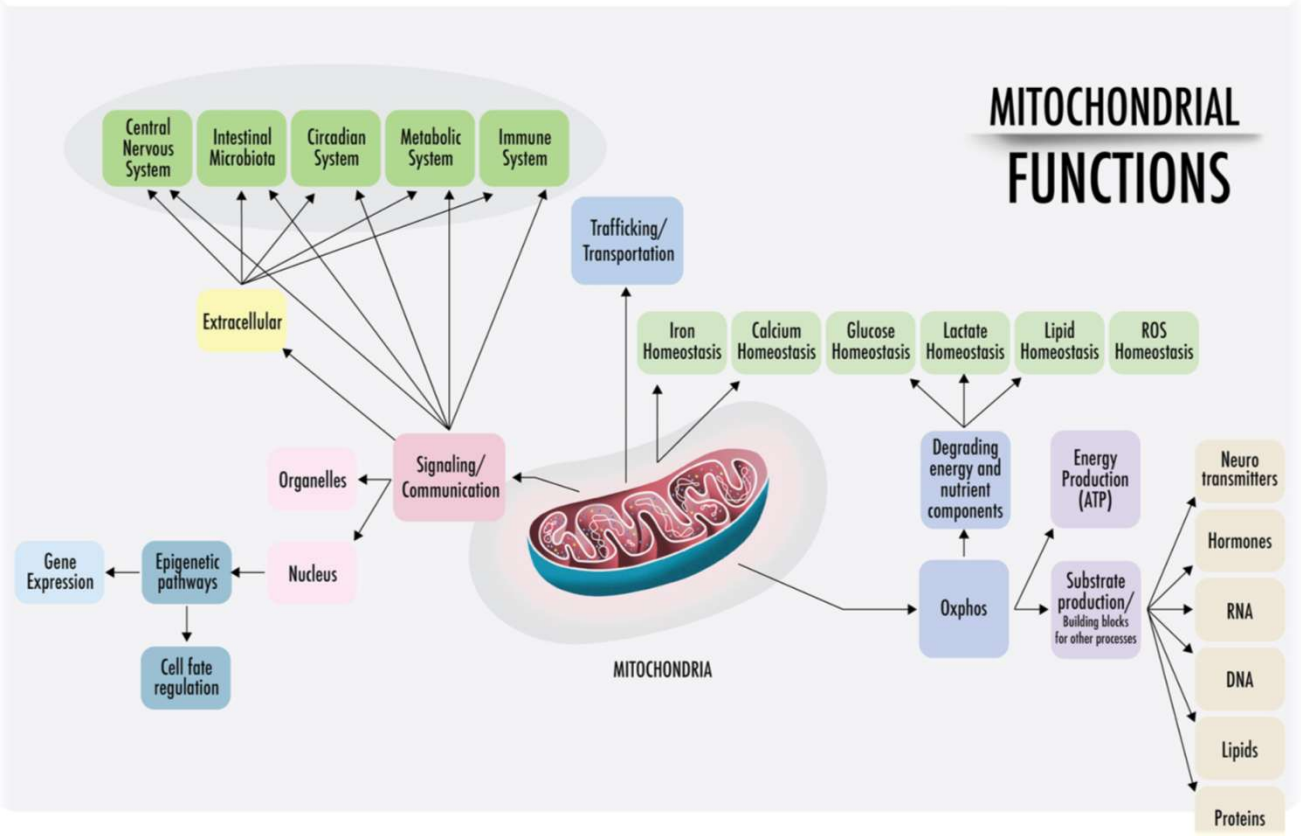
They adapt to heat, environmental, metabolic, energetic and emotional stress to equip us to cope with our world and to maintain a state of health.[1,3]

Mitochondria influence – positively or negatively - almost all aspects of our life experience.[2]

They are the source of our vitality.[1]

Picard et al 2018; Piacrd et al 2022; Casanova et al 2023.

Mitochondria: Beyond energy production



- Synchronise core pathways.
- Maintain homeostasis.
- Involved in production of hormones and neurotransmitters.
- Involved in production of RNA, DNA, lipids and proteins.
- Involved in trafficking, signalling and messaging between cells.
- Determine cell fate:
  - Replicate, repair or retire…
  - Whether cells live or die.
- How we age….

Casanova A, Wevers A, Navarro-Ledesma S, Pruimboom L. Mitochondria: It is all about energy. Frontiers in physiology. 2023 Apr 25;14:1114231.

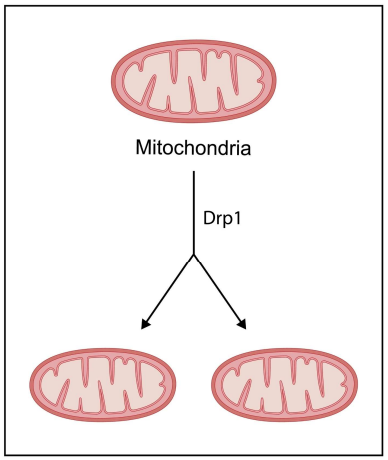
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Balancing mitochondrial fission and fusion

- Mitochondria undergo continual cycles of fission and fusion.[1,2]
- Balance between these two processes is crucial for resilience and adaptation to environmental, metabolic and cellular stresses.[1,2]
- Conversely, imbalance between fission and fusion is associated with a range of diseases and health conditions.[1.2]

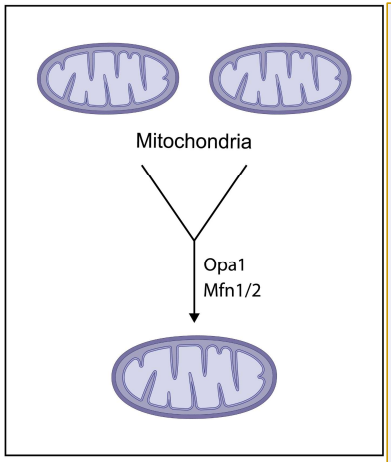
FISSION

- Maintains mitochondrial numbers and distribution.[1]
- Facilitates adaption to increased energy demand.[1]
- Plays a role in cellular quality control by removing damaged mitochondria through a process known as mitophagy.[1,3]



Fission

'Strength in numbers'



Fusion

'Quality over quantity'

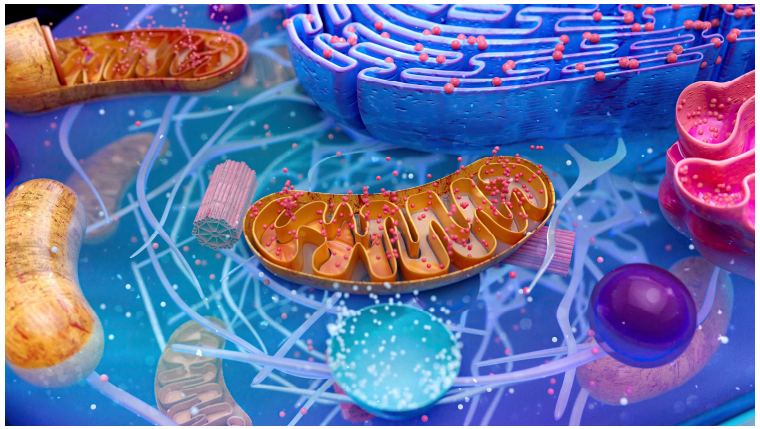
FUSION

- Combines the content of different mitochondria, which dilutes damaged components and promotes exchange of mtDNA.[1,2]
- Helps to optimise mitochondrial integrity and function.[1]
- Enhances the ability of mitochondria to adapt to stress.[1,3]

Thompson 2024; Adebayo et al 2021; Zhang et al 2023.

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Mitochondria and health



✓ Mind

✓ Muscle

✓ Mitochondria

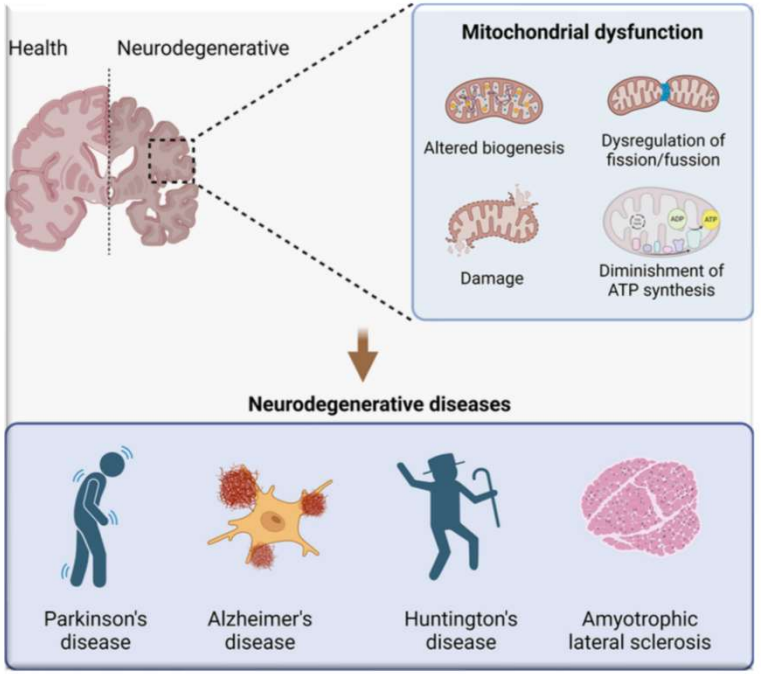
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Mitochondria & brain health

- Mitochondrial dysfunction has been identified as determining factor for disease progression in some neurodegenerative disorders.[1-3]
- It may also predispose to disease onset.[1-3]

Mitochondrial dysfunction can result in:[1]

- Altered biogenesis and increased mitochondrial DNA mutations.
- Dysregulation of mitochondrial dynamics.
- Diminished energy production in the brain.
- Increased oxidative stress.
- Imbalance in cell death signaling.



Guan et al 2025

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Mitochondria & muscle

Skeletal muscle mitochondria show significant plasticity in response to exercise, adjusting their volume, structure and capacity.[1,2]

Exercise enhances the quality of the mitochondrial pool in muscles.[3]

Regular increased energy demands from exercise leads to production of more mitochondria with a higher density of electron transport chain.[3]

This improves energy output and muscle performance.[3]

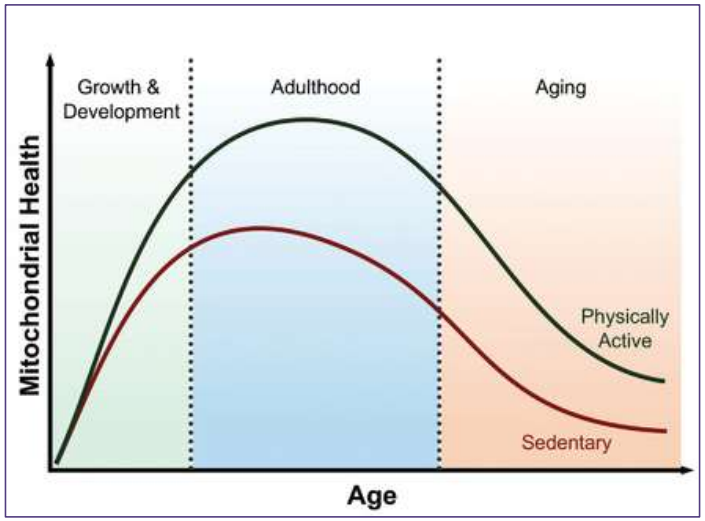
Exercise also helps maintain mitochondrial integrity by influencing processes involved in the degradation of damaged or dysfunctional mitochondria.[3]

Aging, a sedentary life and chronic disuse of muscles is associated with reduced mitochondrial health and capacity and a decline in mitochondrial biogenesis.[1-3]

Mitochondria affect muscle health and function.



Muscle use (exercise) affects mitochondrial health and function.

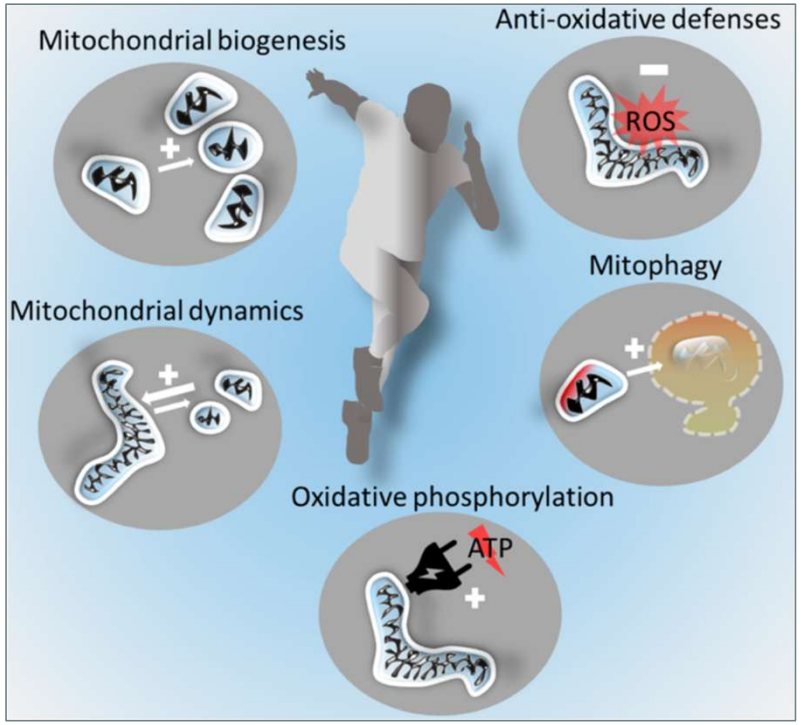


Exercise and mitochondrial health.[2]

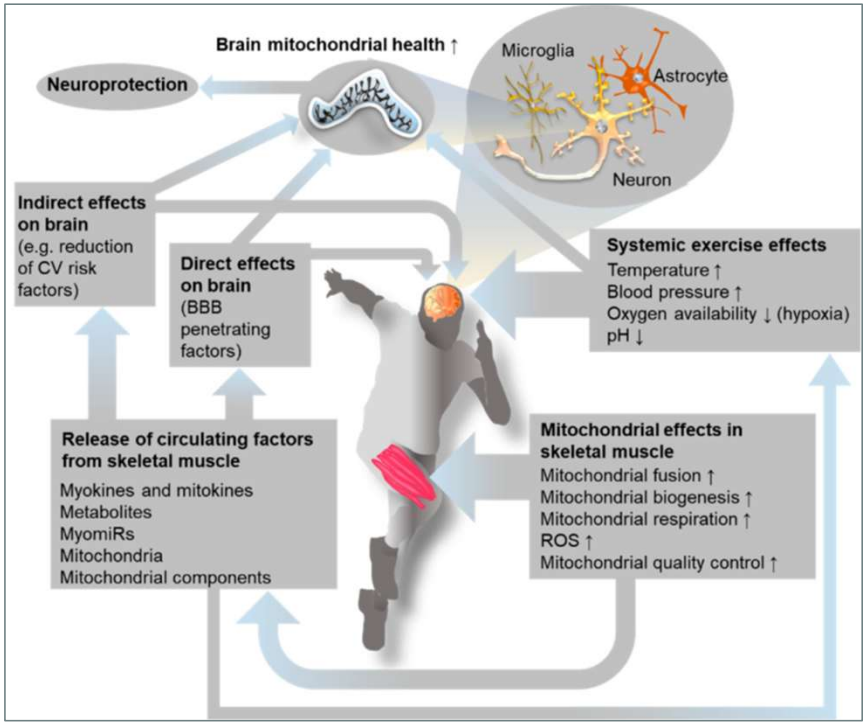
Casuso et al 2020; Memme et al 2021; Hood et al 2019.

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Mitochondria, exercise and the muscle-brain axis



Effect of exercise on mitochondria[1]



Central role of mitochondria and muscle-brain communication[1]

1. Burtscher J, Millet GP, Place N, Kayser B, Zanou N. The muscle-brain axis and neurodegenerative diseases: the key role of mitochondria in exercise-induced neuroprotection. International Journal of Molecular Sciences. 2021 Jun 17;22(12):6479.

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Mitochondria, mind & stress

Mitochondria influence our ability to adapt to stress – emotional, environmental, metabolic and cellular.[1-3]

They also act as cellular sensors that translate stress, including emotional and psychosocial stress, into physical changes within the body.[1]

Chronic stress can induce recalibration in mitochondrial numbers, as well as influence mitochondrial quality, integrity and capacity.[1,2]



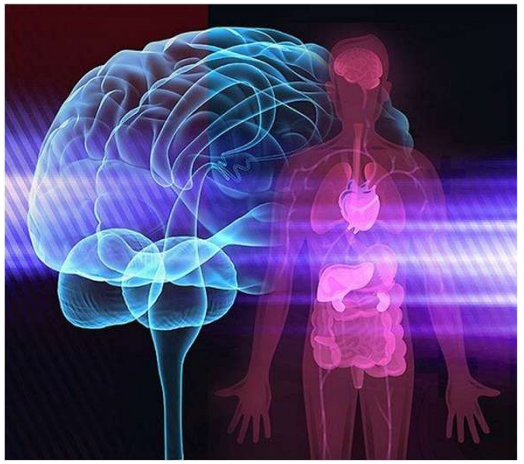
Chronic or severe stress may result in mitochondrial dysregulation and dysfunction.[2,3]

- Reduced brain ATP.
- Inefficient energy production and feelings of exhaustion.
- Altered neurotransmitter regulation and associated mood disorders.
- Altered mitochondrial DNA.
- Increased risk of cellular aging and neurodegeneration.

Picard et al 2018a, Picard et al 2018b; Daniels et al 2020.

Linking mind & body

Psychosomatic medicine explores the relationship between mental wellbeing and physical wellbeing.[1,2]



Mitochondrial psychobiology takes this one step further.

This studies:

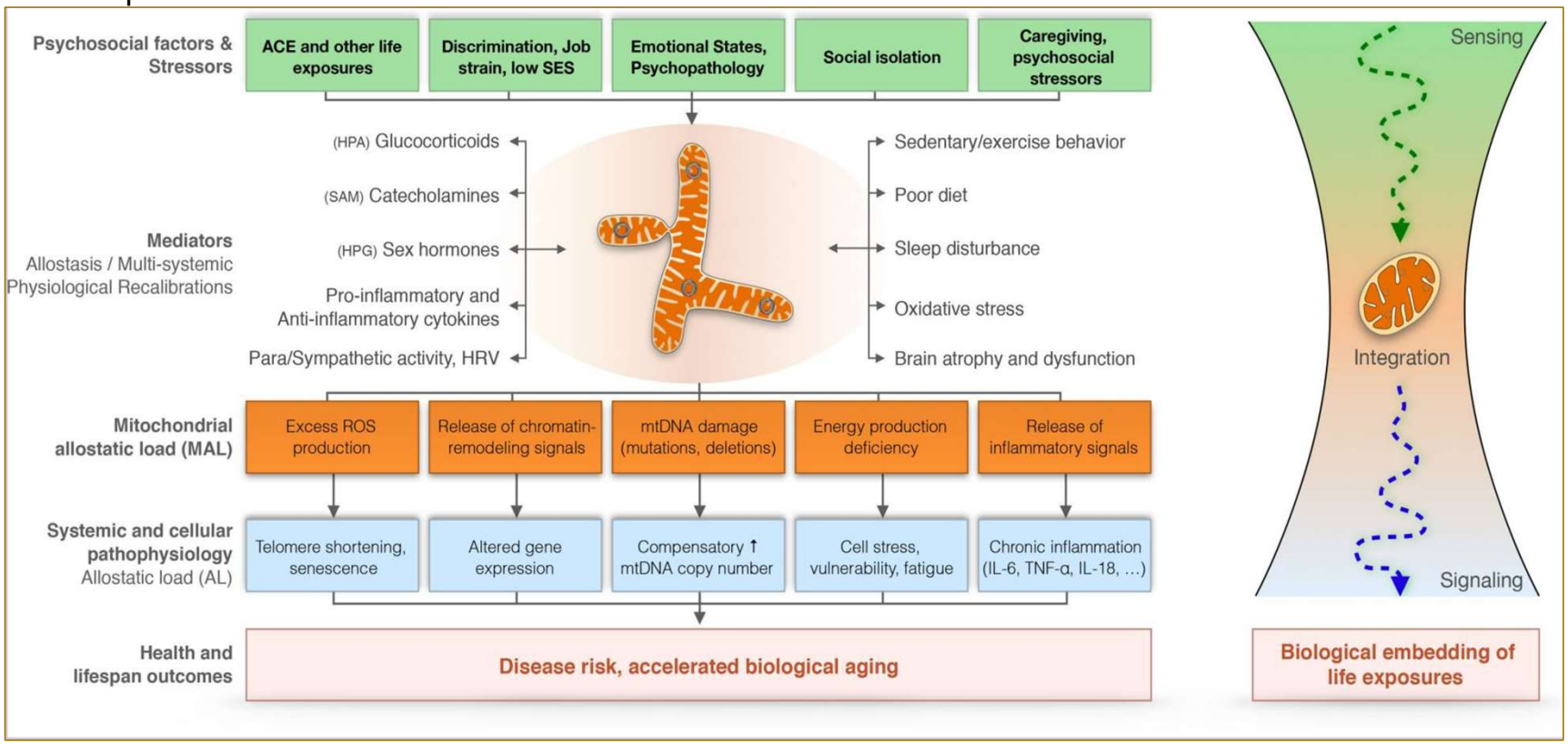
- How psychosocial factors and emotional states affect mitochondrial function and influence communication between brain and body.[2]
- How mitochondria influence neural, endocrine and immune systems pathways, as well as overall health, in response to psychological experiences.[2]

Picard et al 2018; Picard et al 2019.

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Mitochondria: The intersection of psychosomatic medicine

Conceptual model



Mitochondrial allostatic load – structural and functional changes that mitochondria undergo in response to chronic stressors

Allostatic load – cumulative effect of multiple stressors

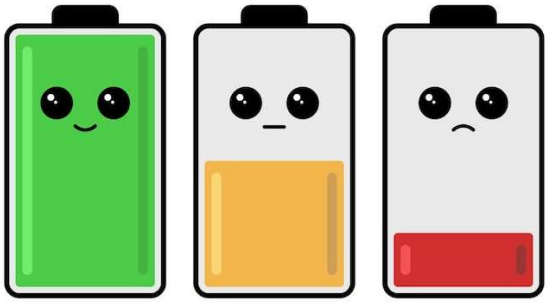
*ACE – Adverse child event. **SES – Socioeconomic status

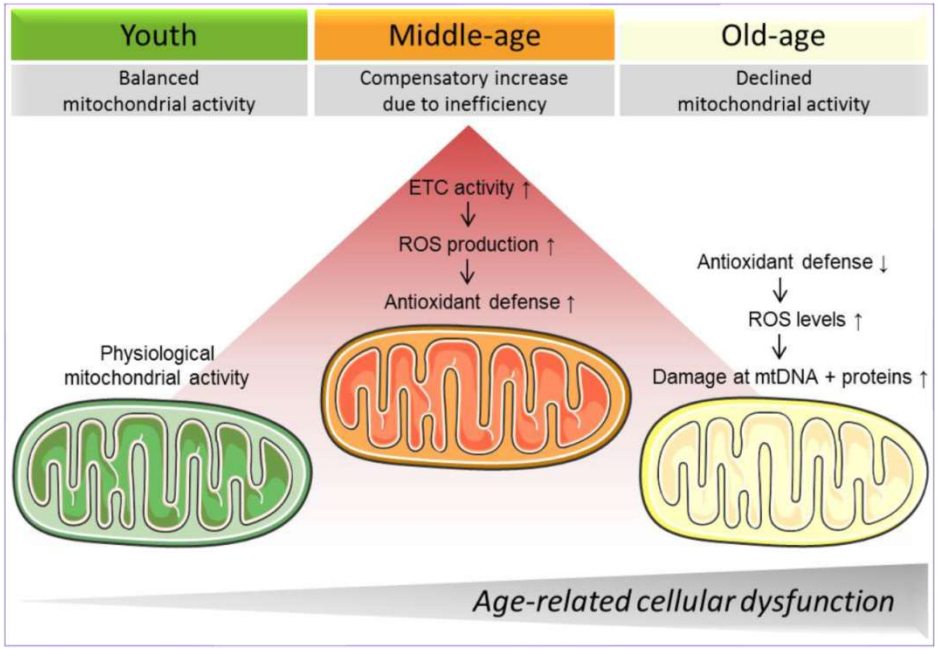
Picard M, McEwen BS. Psychological Stress and Mitochondria: A Conceptual Framework. Psychosom Med. 2018 Feb/Mar;80(2):126-140.

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Maintaining charge

- When we don't have enough mitochondrial charge….
- It affects our bodies, our minds, our energy, our mood…all that we do.[1]
- Short term – we function in 'low power mode'.[1]
- Long term – mitochondrial dysfunction is associated with many disease processes and faster aging.[1-4]



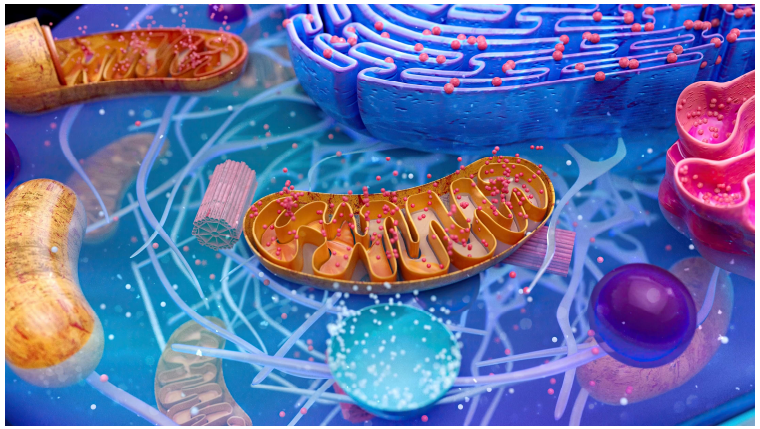


Madreiter-Sokolowski et al 2018.

Picard et al 2018; Pizzorno 2014; San-Millán et al 2023; Madreiter-Sokolowski et al 2018.

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Diet & Lifestyle Interventions



✓ Mind

✓ Muscle

✓ Mitochondria

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Maintaining mitochondrial charge

Sleep



Sleep is essential for mitochondrial health.[2,3]

Sleep also supports clearance of ROS and glymphatic waste, which influence mitochondrial function.[3]

Circadian alignment



Optimise natural light-dark cycles.

Mitochondrial dynamics and signalling are under circadian clock regulation.[1,2]

Exercise



Exercise improves mitochondrial health and function.[4]

Exercise can increase adaption, as well as both the number & efficiency of mitochondria.[4]

Nutrition



A healthy diet provides nutrients to support mitochondrial health.

Research suggests the Mediterranean diet may directly influence mitochondrial function.[5]

Emotional wellbeing



Live life with joy, happiness and purpose.

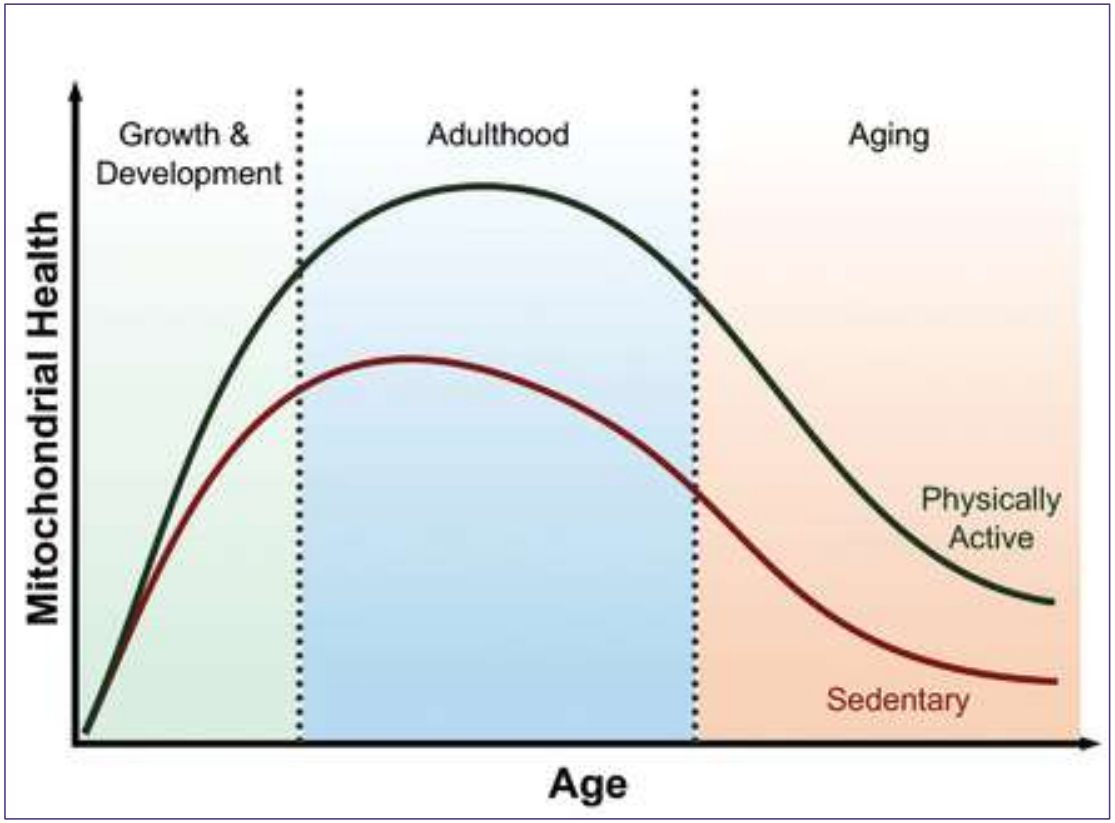
Positive mood improves mitochondrial capacity.[6]

High cortisol disrupts mitochondrial function.[7]

Ezagouri et al 2018; Casanova et al 2023; Hartmann & Kempf 2023; Picard et al 2018; Picard et al 2018b; Pollicino et al 2023; Memme et al 2021

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Exercise & mitochondrial health



Memme et al 2021

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Mediterranean diet influences mitochondria

Nutrient		Mitochondrial effect
Polyphenols		• Reduces oxidative stress. • Increases energy production. • Helps maintain normal mitochondrial structure. • Modulates mitophagy.
Polyunsaturated fatty acids		• Regulates mitochondrial membrane structure and function. • Improves mitochondrial function and induces fusion processes. • Improves mitochondrial dynamics and bioenergetics. • Upregulates mitochondrial electron transport chain.
Resveratrol		• Improves mitochondrial biogenesis. • Activates SIRT1 and APMK pathways to reduce oxidative stress.
Lycopene		• Regulates expression of complexes in the respiratory chain. • Improves mitochondrial dysfunction.
Delphinidin (anthocyanin)		• Protects against oxidative stress and anti-inflammatory actions. • Increases expression of factors involved in mitochondrial biogenesis.
Chlorogenic acid		• Enhances SIRT1 activity. • Upregulates AMPK and PGC-1 expression to maintain mitochondrial biogenesis.

Pollicino F, Veronese N, Dominguez LJ, Barbagallo M. Mediterranean diet and mitochondria: New findings. Experimental Gerontology. 2023 Jun 1;176:112165.

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The power of positive thinking

Clinical research has demonstrated a direct correlation between daily mood and mitochondrial function.[1]

Positive feelings, such as joy and inspiration, resulted in higher mitochondrial energy production capacity* within 1-3 days.[1]

These findings suggest that our mitochondria can respond to our emotional states![1]

Conversely, research suggests chronic stress can induce functional recalibrations in mitochondria - leading to lower baseline mitochondrial energy production capacity.

Positive thinking = more energy



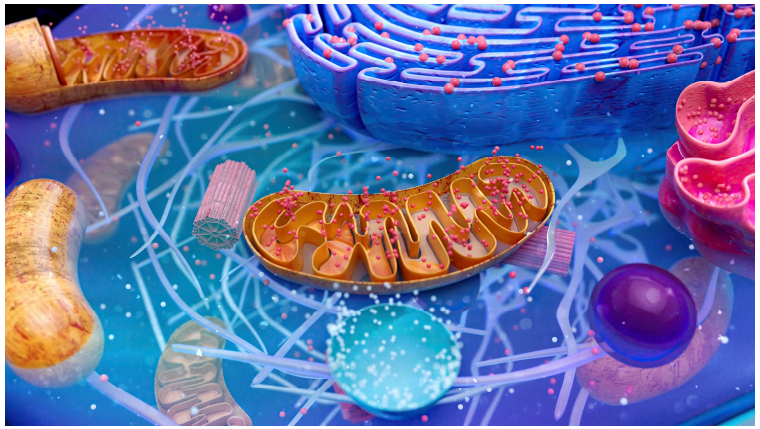
*Using the Mitochondrial Health Index (MHI), which integrates different measures of mitochondrial function.[1]

Study N=90

Picard M, Prather AA, Puterman E, Cuillerier A, Coccia M, Aschbacher K, Burelle Y, Epel ES. A mitochondrial health index sensitive to mood and caregiving stress. Biological psychiatry. 2018 Jul 1;84(1):9-17.

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Foundational Interventions



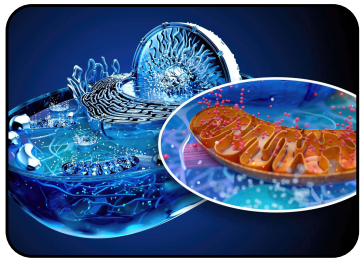
- ✓ Mind
- ✓ Muscle
- ✓ Mitochondria

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Supporting mind, muscle & mitochondria







Mind

- Brain function
- Cognitive health
- Stress and mood
- Neuroprotection
- Neurodegeneration
- Neuroinflammation

Muscle

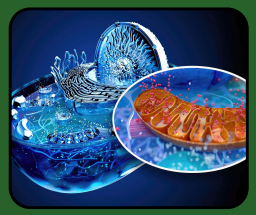
- Muscle health
- Muscle function
- Exercise recovery
- Inflammation
- Depletions

Mitochondria

- Function
- Integrity
- Capacity
- Biogenesis
- Fission & fusion
- Oxidative stress

Omega-3 Fatty Acids	Ubiquinol/ CoQ10
NAD^+ Precursors	Creatine
Alpha-Lipoic Acid	Quercetin
Acetyl-L-Carnitine	Iron
Magnesium	

Key therapeutic targets



Mitochondria

- Supporting energy production and capacity.
- Supporting function.
- Supporting integrity, resilience and adaptation.



Mind

- Supporting brain health and cognitive function.
- Stress and mood support.



Muscle

- Muscle health and function.
- Recovery, repair or inflammation.
- Addressing depletions.

Omega 3 fatty acids (EPA & DHA)



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✓ Mind | ✓ Muscle | ✓ Mitochondria

Mitochondria

Capacity

Resilience & adaptation

EPA & DHA have a significant impact on mitochondrial membrane integrity and influence mitochondrial resilience and ability to adapt.[1]

EPA & DHA has been shown to: (*in vitro* and *in vivo*)

Energy production and capacity

- Improve mitochondrial bioenergetics and energy production.[1-3]

Resilience and adaption

- Influence mitochondrial fusion and fission.[2,4,5]
- Modulate mitochondrial biogenesis.[2,4,5]
- Increase mitochondrial DNA (mtDNA) replication.[2,4,5]
- Improve mitochondria-related redox status and ↓ ROS generation.[2,6]
- Provide mitochondrial neuroprotective effects.[7]

Muscle

Recovery & inflammation

- Omega-3 fatty acids have anti-inflammatory properties and have been shown to reduce exercise-induced muscle damage.[8]

Smith 2024; de Oliveira et al 2017; Sun et al 2014; Lee et al 2016; Xiao et al 2026; Do et al 2025; Katyare et al 2025; Doussat et al 2024.

Omega 3's: Mind

EPA and DHA have been shown to:[1-10]

- Mitigate oxidative stress.[1]
- Reduce neuroinflammation.[2,3]
- Promote neuronal membrane integrity.[4]
- Support synaptic plasticity.[5,6]
- Modulate neurotransmitter pathways.[7,8]
- Have neuroprotective properties.[9,10]

(combined human and animal research)

1. Sahebi S, Rezvani Kakhki B. Omega-3 Fatty Acids in Alzheimer's Disease Prevention Among Elderly Women: Mechanisms of Action, Clinical Evidence, and the Critical Role of Early Intervention. Nutrition and Dietary Supplements. 2025 Dec 31:159-73.

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✓ Mind | ✓ Muscle | ✓ Mitochondria

Support brain health and cognition

Regular intake of omega-3 fatty acids is associated with improvements in memory, attention and reduced cognitive decline in clinical research.[1,4,13]

A population study involving > 215 000 older adults (median 8.6-year follow-up) reported that regular intake of fish oil supplements, was associated with a 14% reduction in risk of dementia.[1,14]

In patients diagnosed with mild-to-moderate AD, a study showed supplementation with DHA 1700 mg & EPA 600 mg for 6 months slowed the rate of cognitive decline (n=174).[1,15]

Omega-3 supplementation may mitigate menopause-related vulnerability to Alzheimer's disease in women with the APOE-E4 genetic variation.[1,16-18]

Fish oil supplementation appears to enhance glymphatic function and improve clearance of beta-amyloid and other neurotoxic metabolites from the brain (animal research).[11,12,19]

Sahebi et al 2025; Calder 2006; Layé et al 2018; Yurko-Mauro et al 2010; Wu et al 2008; Akbar et al 2005; McNamara et al 2010; Liu et al 2015; Hashimoto et al 2002; Lim et al 2005; Liu et al 2020; Reddy et al 2020; Yi et al 2011; Liu et al 2022; Freund-Levi et al 2006; Yassine et al 2023; Tan et al 2012; Wieczorek-Szukala et al 2023; Ren et al 2017.

Omega 3's support emotional wellbeing



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✓ Mind | ✓ Muscle | ✓ Mitochondria

Mood support

Epidemiological and clinical studies indicate that low omega-3 status correlates with a higher incidence of some mood disorders.[1-3]

Omega-3 fatty acid intake, particularly EPA, has been shown to support healthy mood balance and to support general emotional and mental wellbeing.[1-9]

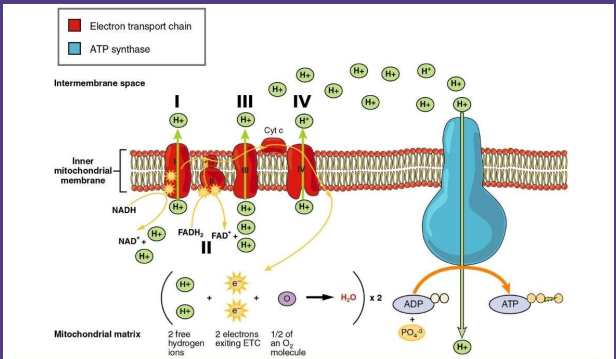
A meta-analysis reported that fish oil supplements may support management of depressive symptoms:[9]

- at least 1000 mg EPA.
- Or combined EPA & DHA with ≥ 60% EPA (e.g. 600 mg EPA & 400 mg DHA).

Fish oil supplements have been used as adjunct therapy with antidepressant drugs, with benefits attributed mainly to EPA.[3,7]

NatMed Pro 2026; Brain & Cohen 2015; Grosso et al 2014; Bruinsma et al 2000; Feart et al 2008; Appleton et al 2015; Mocking et al 2016; Martins et al 2009; Sublette et al 2011

CoQ10 / Ubiquinol:



CoQ10 is a component of the mitochondrial inner membrane and carries electrons from complex I and II to complex III



CoQ10 transports electrons

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Mitochondria

Energy production

Integrity, resilience and adaptation.

- CoQ10 carries electrons in the electron transport chain and is a core component of mitochondrial energy production.[1-3]
- As ubiquinol, it is also an important antioxidant.[1-3]
- Research suggests ubiquinol promotes cellular resilience and helps maintain mitochondrial homeostasis and function.[4]
- Age-related decline in ubiquinol levels may contribute to the ↑ in mitochondrial dysfunction associated with aging.[1]
- Ubiquinol has been shown to enhance mitochondrial activity, protecting against progression of aging and age-related disease in animal research.[4]

Pallotti et al 2021; Rodick et al 2018; Braun & Cohen 2015, Tian et al 2014.

CoQ10 / Ubiquinol:



Strenuous aerobic exercise (such as marathon running and cycling) increase CoQ10/ubiquinol requirements.[1,2,4]

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✓ Mind | ✓ Muscle | ✓ Mitochondria

Muscle

Function

Recovery & repair

- As CoQ10 is essential for energy production, CoQ10 status will affect our capacity to produce energy in skeletal muscles.[1-3]
- Signs and symptoms of possible CoQ10 /ubiquinol deficiency include muscle fatigue, muscle aches and pains.[4]
- Ubiquinol may also help protect muscle cells from damage during intense exercise due to its antioxidant actions.[1-3,5]

Research with CoQ10 / ubiquinol has demonstrated:[4-8]

- Improved exercise tolerance.
- Reduced exercise-induced fatigue.
- Increased aerobic capacity in trained men.

Alf et al 2013; Rodick et al 2018; Acosta et al 2016; Drobnic et al 2022; Bonetti et al 2000; NatMed Pro 2026; Linus Pauling institute; Mizuno et al 2008; Kunching et al 2022.

CoQ10 / Ubiquinol:



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Mind

Brain health & cognition

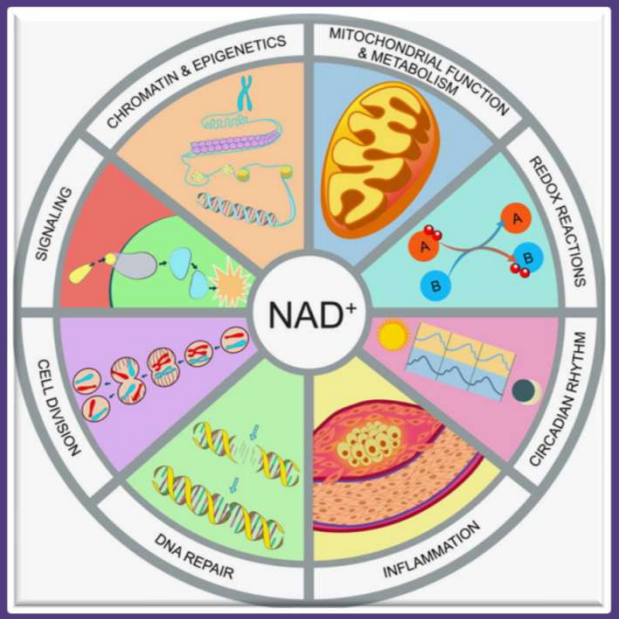
- The brain and nervous system are areas of the body with high energy needs and are therefore affected by mitochondrial energy production.[1-4]
- Ubiquinol, is also an important antioxidant.[3] Oxidative stress is a contributing factor for neurological disorders and age-related cognitive decline.[2-4]
- In women, oestrogen decline from perimenopause onwards, is associated with increased oxidative stress. This may contribute to the increased prevalence of AD seen in women, compared to men.[5]

Research with ubiquinol / CoQ10 in brain health has demonstrated:

- An association has been reported between CoQ10 status and
  - Cognitive function in older adults.[2]
  - Neurodegenerative disease, especially in older adults.[2-4]
  - Some mood disorders.[2-4]

Alf et al 2013; Rodick et al 2018; Acosta et al 2016; Drobnic et al 2022; Bonetti et al 2000; NatMed Pro 2026; Linus Pauling institute; Mizuno et al 2008; Kunching et al 2022.

NAD+ and NAD+ Precursors
(NR and NMN)



Rajman et al 2018

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✓ Mind **✓ Muscle** **✓ Mitochondria**

- NAD+ plays a key role in mitochondrial function, cellular energy production and is involved in many other biological processes.[1-6]
- NAD+ levels fall steadily as we age, which is thought to contribute to several age-related health conditions, promote inflammation and increase cellular injury.[1-6]

Cellular energy and mitochondrial function

- NAD+ is involved in the release and transfer of energy from food as ATP.[4]

Sirtuins and cell signalling

- Sirtuins are a class of protein enzymes that are dependent on NAD+.[1-4]
- Sirtuins play a major regulatory role in almost all cellular functions.[1-3]
- Sirtuins exist in mitochondria, as well as other parts of the cell.

Cell survival/fate

- NAD+ regulates many biological processes involved in cell division and cell survival.[4]
- And is also involved in DNA repair and epigenetically modulated gene expression.[4]

Sharma et al 2022; Bita et al 2023; Johnson et al 2018' Rajman et al 2018; Imai et al 2014; Mehmel et al 2020

NAD+ precursors: NR vs NMN

NR is a small molecule and enters cells easily. NR converts to NMN in the cell and then to NAD+

Supplemental NMN is a bigger molecule. Mechanisms of entry into cell has been the basis for some debate.

Both ultimately result in increased mitochondrial activity of NAD+.

There are differences in research.

	Nicotinamide riboside (NR)	Nicotinamide mononucleotide (NMN)
	Both precursors to NAD+	
Research focus[2-18]	Longer history of human clinical research, including more safety data: • Increased NAD+ in **mitochondria**. • Healthy **aging** and **longevity**. • **Mind & neuroprotective** effects. • **Cardiovascular**	Human research is more limited • Increased NAD+ in **mitochondria**. • Healthy **aging** and **longevity**. • **Muscle:** Physical performance. • **Metabolic** function.
Absorption and bioavailability[1]	• Smaller molecule. • Ready uptake into cells via a group of specialised transporters (ENTs). • NR is converted to NMN and then to NAD+ in a final single step.	• Bigger molecule • Mechanisms for entry in the cell less clear. • As the molecule is larger, it was thought NMN needed to be broken down to NR first, then converted back to NMN once in the cell. • New evidence suggests a transporter (Slc12a8).

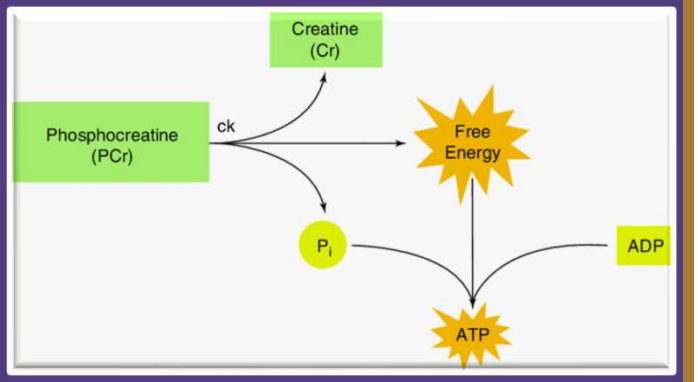
*Emerging research suggests gut bacteria may also play a role in conversion of both NR and NMN.[20]

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Creatine

✓ Mitochondria

Energy production & capacity



Populations with increased needs include:

- Vegetarian/vegan diets
- Aging individuals
- Women

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✓ Mind | **✓ Muscle** | **✓ Mitochondria**

Creatine supports energy metabolism.[1]

About 95% percent of creatine is stored in skeletal muscle where it exists in dynamic equilibrium with phosphocreatine.[1]

During short bursts of intense activity, phosphocreatine converts to creatine.[2]

This releases energy and fuels short term production of ATP in times of increased cellular demand. [2]

Creatine also improves resynthesis of phosphocreatine during recovery from intense exercise.[1]

Availability of phosphocreatine for use by muscle is thought to delay the breakdown of muscle glycogen stores.[1]

Gropper et al 2018; Sousa et al 2019.

Creatine

✓ Muscle



bioclinic® naturals

✓ Mind | ✓ Muscle | ✓ Mitochondria

Muscle health and function (combined with resistance training)

Increases total and lean body mass and improves body composition.[1]

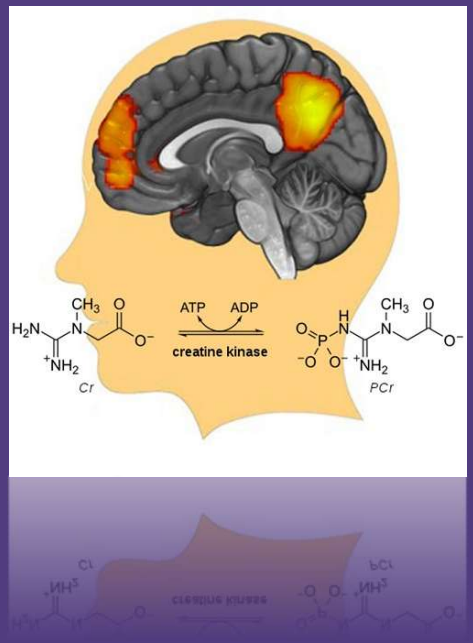
Promotes muscle strength, muscle stamina and exercise performance in high-intensity short-duration resistance exercise tasks.[1,2]

In women, creatine helps counter the loss of muscle mass and strength associated with declining oestrogen, progesterone and testosterone during and after perimenopause.[3,4]

Fatigue can affect workout intensity and recovery time, especially as people get older.[3,5] Creatine increases energy availability in cells and helps fuel mitochondrial energy production.[5]

Branch 2003; Mills et al 2020; NatMed Pro 2026; Gropper 2018

Creatine



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✓ Mind | ✓ Muscle | ✓ Mitochondria

Brain heath and cognition

Mind

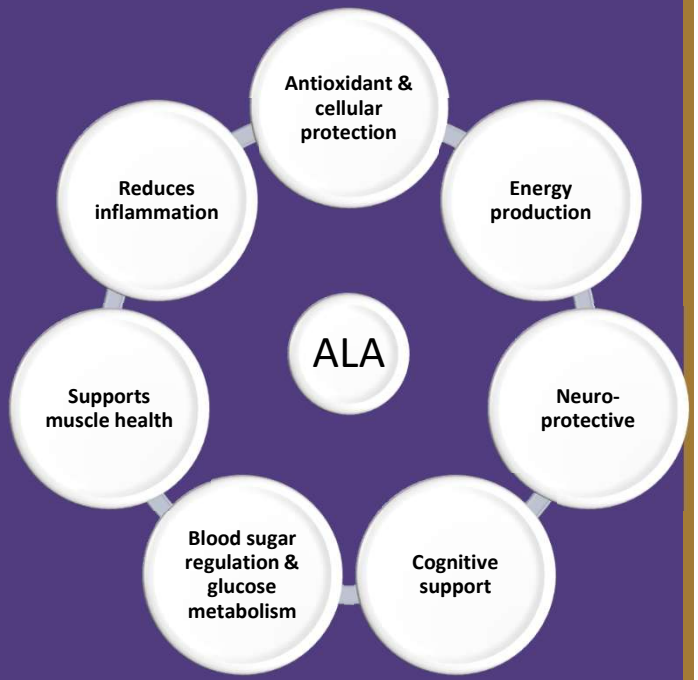
- As an immediate source of energy for the brain and neurons, creatine plays a pivotal role in brain energy homeostasis.[1,2]
- Creatine may also have neuroprotective actions and support neuroplasticity.[2]

Research

- Clinical research has demonstrated that creatine intake can improve measures of brain and cognitive function including:[1-3]
  - Recognition memory and short-term memory.
  - Reasoning and mathematical processing.
  - Reduction in mental fatigue when doing mental tasks.
- A review reports that benefits seem greatest in stressed or aging individuals.[2]

Gropper et al 2018; Sousa et al 2019; Branch 2003; Mills et al 2020; Kreider et al 2014; Smith-Ryan et al 2025.

Alpha Lipoic Acid



bioclinic® naturals

✓ Mind | ✓ Muscle | ✓ Mitochondria

Mitochondria

Energy production

Antioxidant

- ALA is involved in mitochondrial energy production.[1-4]
- It is a cofactor for several mitochondrial energy complexes.[1-4]
- As an antioxidant, ALA helps reduce mitochondrial oxidative stress.[1]
- ALA is also involved in regeneration of other antioxidants.[2-4]

Mind

Brain health and cognition

- ALA is considered to have neuroprotective properties.[1]
- Research suggests ALA aids in CNS cellular and mitochondrial repair as well as potentially being beneficial for some neuropathies.[1,3]

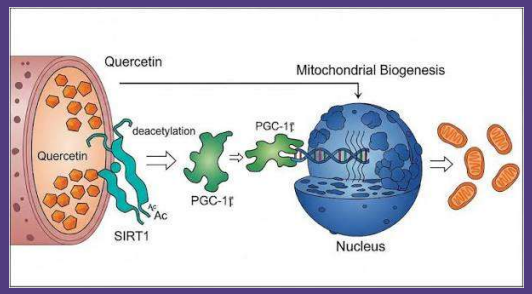
Muscle

Recovery & repair

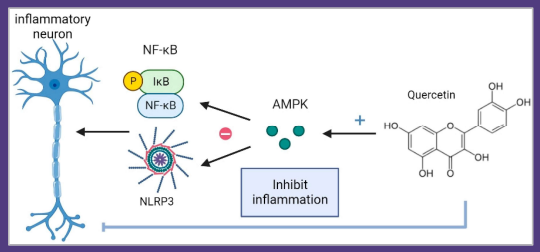
- When taken during periods of intensive training, ALA (300 mg daily for 6 days) has been shown to reduce muscle damage and inflammation and improve muscle recovery.[7]

Dos Santos et al 2019; Superti et al 2024; NatMed Pro; Capece et al 2022; Hager et al 2007; Hager et al 2001; Isenmann et al 2020.

Quercetin



Proposed role of quercetin in the mitochondrial biogenesis pathway.[3]



Proposed role of quercetin in the reducing neuroinflammation.[5]

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✓ Mind | ✓ Muscle | ✓ Mitochondria

Mitochondria

Integrity & resilience

Quercetin can modulate pathways associated with:[1]

- Mitochondrial adaption.
- Mitochondrial biogenesis (↑ number of mitochondria in cells).
- Membrane potential, redox status and ATP production.
- Mitochondrial-induced apoptosis.

Muscle

Recovery & protective

- Quercetin has been shown to improve cycling endurance and reduced fatigue (100 mg for 7 days) .[2]
- Preliminary data suggests quercetin has potential to:[3,4]
  - Regulate the inflammatory response.
  - Combat exercise-induced oxidative stress.
  - Increase exercise tolerance.

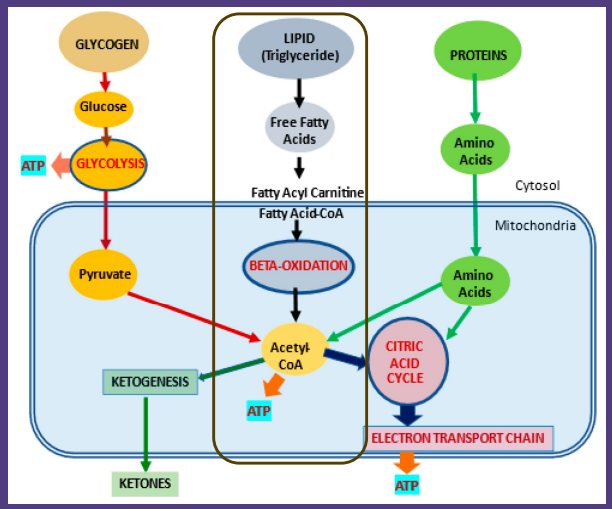
Mind

Brain function

- Quercetin has antioxidant and neuroprotective properties.[5]
- Animal research suggests quercetin may provide benefit in some mood disorders, as well as some in neurodegenerative diseases.[5,6]

de Oliveira et al 2016; Li et al 2025; Davis et al 2009; Ruiz-Iglesias et al 2021; Chiang et al 2023; Wróbel-Biedrawa et al 2022

Acetyl-L-Carnitine



Virmani et al 2022.[3]

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✓ Mind | ✓ Muscle | ✓ Mitochondria

Mitochondria

Energy production

Integrity

- Acetyl-L-carnitine plays an important role in mitochondrial energy production.[1,2]
- It facilitates transfer of long-chain fatty acids across the inner mitochondrial membrane for β-oxidation, which generates ATP.[1-4]
- Acetyl-L-carnitine also helps protect mitochondria from oxidative stress and is involved in mitochondrial detoxification.[3,4]

Muscle

Function

- Acetyl-L-carnitine is concentrated in tissues that oxidise fatty acids as dietary fuel, such as muscle cells.[1,5]

NatMed Pro Database; Malaguarnera et al 2007; Virmani et al 2022; Gropper et al 2018; NIH 2026, Helbing et al 2024

Acetyl-L-Carnitine



bioclinic® naturals

✓ Mind | ✓ Muscle | ✓ Mitochondria

Brain function and cognition

Mind

Acetyl-L-carnitine

- Involved in modulation of brain energy.[1,2]
- Has neuro-modulatory actions.[1,3]
- Assists in production and modulation of neurotransmitters.[4]
- May have neuroplasticity effects in some regions of the brain.[4]
- Stimulates membrane phospholipid synthesis, which leads to stabilisation of cell membranes.[5]

Research

- Acetyl-L-carnitine supports cognitive health in aging subjects.[2,3,6-8]
- Acetyl-L-carnitine (2 g daily) has also reduced mental fatigue and improved cognitive function in adults ≥ 100 years old.[9]

Pettegrew et al 2000; Virmani et al 2004; Hudson et al 2003; Veronese et al. 2018; Thal et al 1996; Salvioli et al 1994; Passeri et al 1990; Malaguarnera et al 2007.

Iron

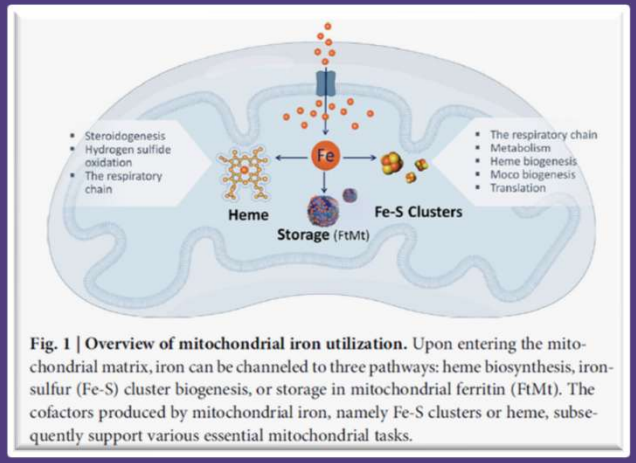


Fig. 1 | Overview of mitochondrial iron utilization. Upon entering the mitochondrial matrix, iron can be channeled to three pathways: heme biosynthesis, iron-sulfur (Fe-S) cluster biogenesis, or storage in mitochondrial ferritin (FtMt). The cofactors produced by mitochondrial iron, namely Fe-S clusters or heme, subsequently support various essential mitochondrial tasks.

Zirchri-David et al 2025

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✓ Mind	✓ Muscle	✓ Mitochondria

Mitochondria

Function

Integrity

- Mitochondrial function and iron homeostasis are interrelated.[1-3]
- Mitochondria are biosynthetic hubs for essential iron cofactors.[1-3]
- These iron cofactors, in turn, enable mitochondrial pathways, such as energy and metabolite production.[1-3]
- Iron is also an electron carrier within the electron transport chain.[1-3]

Mind

Brain function and cognition

- Iron is involved in numerous neurological processes.[4]
- Iron deficiency impairs synaptic plasticity and cognitive function.[4]

Muscle

Function

Depletions

- Adequate iron is needed for muscle function and to ensure muscles receive sufficient oxygen for energy production.[5,6]
- Iron deficiency can lead to fatigue and decreased muscle strength and endurance.[5,6]
- This may relate to both oxygen supply and mitochondrial function.
- Low-grade inflammation from strenuous exercise can increase hepcidin levels, which in turn affects iron status.[7]

Paul et al 2017; Ben Zichri-David et al 2025; Dietz et al 2021; Boccio et al 2003; McClung 2012; Reinke et al 2021; Gaffney-Stomberg et al 2012

Magnesium



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✓ Mind | ✓ Muscle | ✓ Mitochondria

Mitochondrial

Energy production

Function

- Magnesium contributes to mitochondrial energy production, mainly as part of Mg-ATP complex.[4,8]
- Disruption of magnesium homeostasis influences mitochondrial health and function.[8]

Mind

Stress & mood

Depletion

- Magnesium supports:[1-3]
  - Neurotransmitter synthesis and transmission.
  - Emotional wellbeing, stress and mood regulation.
- Chronic stress has been associated with magnesium depletion.[3]

Muscle

Function

Depletion

- Magnesium also plays an essential role in regulating muscle relaxation and contraction cycles, in conjunction with calcium.[4-7]
- Magnesium counters calcium-induced muscle contraction. Inadequate magnesium levels can increase the risk of muscle spasms and cramps.[6]

Boyle et al 2017; NatMed Pro 2025. Braun & Cohen 2015; Gropper et al 2018; Hechtman 2019; Altura et al 2001; Covino 2019; Killilea et al 2022.

Which magnesium to use?

L-threonate

BRAIN & NERVOUS SYSTEM

- Magtein® is a patented form of magnesium L-threonate.
- It was developed to cross the blood-brain barrier, supporting delivery of magnesium to the brain & neurons.[1]
- Magtein® has been shown to increase brain magnesium levels in animal research.[1]
- In human clinical trials, Magtein® has been shown to enhance cognitive performance and memory, support healthy mood balance and promote sleep quality.[2-4]

Orotate

HEART & CV HEALTH

- Magnesium orotate improves energy production in cardiac cells and helps maintain cardiac muscle function.[5-7]
- Magnesium orotate has been shown to support heart health and healthy CV system function.[5,6-9]
- Magnesium also helps to maintain vasodilation of blood vessels.[10]

Glycinate

BROADER USE

- Often selected for relaxation & stress.
- High bioavailability, easily absorbed and gentle on the stomach.[11-14]
- Well-suited to ongoing daily use.[15]
- Versatile for individuals requiring magnesium support across multiple body systems.[13,15]
- A 'fully reacted' or 'fully chelated' magnesium glycinate contains only magnesium glycinate and no residual inorganic magnesium from manufacturing.

Citrate

BROADER USE

- Often selected for muscle cramps, migraine or constipation.
- Citrate is poorly absorbed through the colon, so can act as an osmotic laxative.[16]
- Versatile for individuals requiring magnesium support across multiple body systems.
- Beneficial if using for constipation, but more GI adverse effects if not.

Slutsky et al 2010; Hausenblas et al 2024; Lopresti et al 2026; Hewlings et al 2022; Rosenfeldt 1998; Rosenfeldt et al 1998; Classen 2004; Stepura et al 2009; Geiss et al 1998; Del Gobbo et al 2013; Blancquaert et al 2019; Yin et al 2017; EFSA 2008; Uberti et al 2020; Siebrecht et al 2013; Rao et al 2021.

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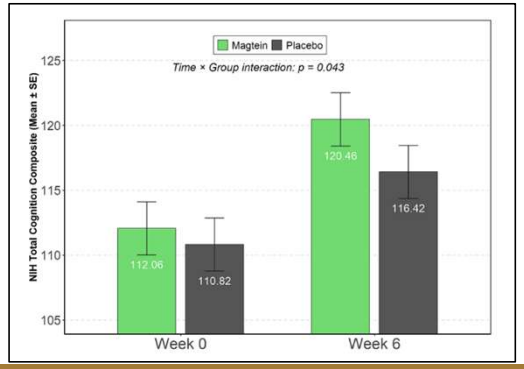
Magtein®

Magnesium L-threonate as Magtein®

✓ Mind | ✓ Muscle | ✓ Mitochondria

Cognitive performance[1]

- A randomised, double-blind, placebo-controlled study found that healthy adults taking Magtein® (2 g daily for 6 weeks), compared to placebo, had significant improvements in:[1]
  - Overall cognitive ability (20-fold improvement).
  - Working and episodic memory.
  - Reaction time.
- Participants receiving Magtein® also demonstrated a 7.5-year reduction in estimated cognitive age (based on composite change sensitive score).[1]

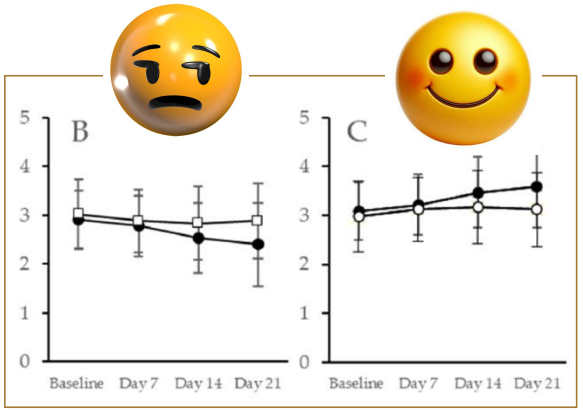


Mood balance[2]

- Clinical research shows that Magtein® (1 g daily for 3 weeks) can improve mood balance compared to placebo, including:
  - Lower self-reported ratings for 'grouchy mood' and 'anger'.
  - Higher self-reported rating for 'good mood'.

Magtein® reduced anger and 'being grouchy'

Magtein® improved 'good mood'



- Black – Magtein group
- White - placebo

1. Lopresti AL, Smith SJ. The effects of magnesium L-threonate (Magtein®) on cognitive performance and sleep quality in adults: a randomised, double-blind, placebo-controlled trial. Front Nutr. 2026 Jan 12;12:1729164.
2. Hausenblas HA, Lynch T, Hooper S, Shrestha A, Rosendale D, Gu J. Magnesium-L-threonate improves sleep quality and daytime functioning in adults with self-reported sleep problems: A randomized controlled trial. Sleep Med X. 2024 Aug 17;8:100121.

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Magtein®: Sleep Quality



✓ Mind | ✓ Muscle | ✓ Mitochondria

- Magtein® (1 g daily for 21 days) has been shown to improve sleep quality, particularly deep sleep, compared with placebo.[1]
- Improved daily activities, productivity and alertness were also reported after more refreshing sleep in the group taking Magtein®.

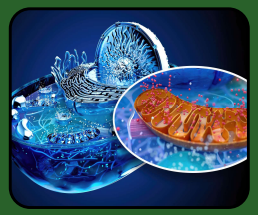
- Deep sleep is recognised as the most restorative sleep stage. It is also the stage when the glymphatic system clears metabolic waste from the brain.[1,2]
- Evidence suggests that sleep quality may contribute to cognitive health and memory by influencing glymphatic function, neural pathways, and interconnected brain networks.[2]

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Hausenblas et al 2024; Ma et al 2025

Recap: Core nutrient interventions

Omega-3 Fatty Acids	Ubiquinol/ CoQ10
NAD^+ Precursors	Creatine
Alpha-Lipoic Acid	Quercetin
Acetyl-L-Carnitine	Iron
Magnesium	



Mitochondria

- Supporting energy production and capacity.
- Supporting function.
- Supporting integrity, resilience and adaptation.



Mind

- Supporting brain health and cognitive function.
- Stress and mood support.

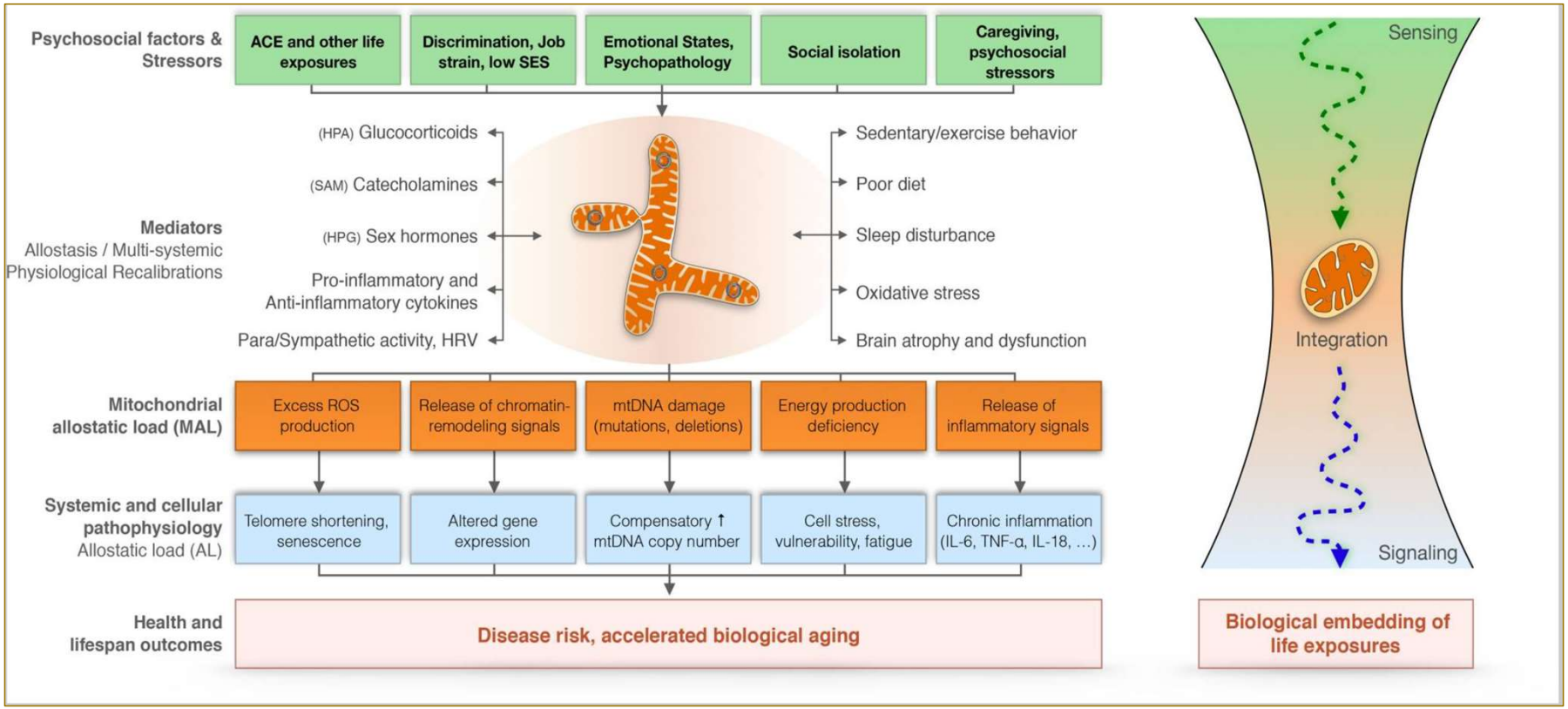


Muscle

- Muscle health and function.
- Recovery, repair or inflammation.
- Addressing depletions.

Recap- Mitochondria are the link between mind & body

Conceptual model



*ACE – Adverse child event. **SES – Socioeconomic status

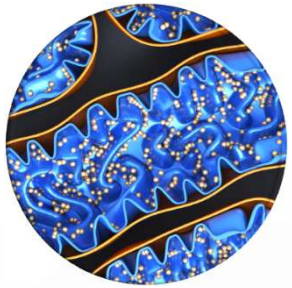
Picard M, McEwen BS. Psychological Stress and Mitochondria: A Conceptual Framework. Psychosom Med. 2018 Feb/Mar;80(2):126-140.

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Final thoughts



Mitochondria connect mind, muscle and vitality.



Mitochondria cannot produce the energy that sustains life without us giving them capacity to do so.



Lifestyle foundations such as diet, sleep, movement and stress management, supported by targeted nutrients, help build mitochondrial resilience.



Supporting mitochondrial health supports the energy that powers how we think, move, adapt - and helps maintain healthier minds and bodies.



Thank you!

Any questions?

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Clinical Services & Education Manager

lblott@factorsgroup.com

References

- Acosta MJ, Vazquez Fonseca L, Desbats MA, et al. Coenzyme Q biosynthesis in health and disease. Biochim Biophys Acta. 2016; 1857(8):1079-1085.
- Adebayo M, Singh S, Singh AP, Dasgupta S. Mitochondrial fusion and fission: The fine-tune balance for cellular homeostasis. FASEB journal: Official publication of the Federation of American Societies for Experimental Biology. 2021 Jun;35(6):e21620.
- Aguiar AF, Januário RS, Junior RP, Gerage AM, Pina FL, Do Nascimento MA, Padovani CR, Cyrino ES. Long-term creatine supplementation improves muscular performance during resistance training in older women. European journal of applied physiology. 2013 Apr;113(4):987-96.
- Airhart SE, Shireman LM, Risler LJ, Anderson GD, Nagana Gowda GA, Raftery D, Tian R, Shen DD, O'Brien KD. An open-label, non-randomized study of the pharmacokinetics of the nutritional supplement nicotinamide riboside (NR) and its effects on blood NAD+ levels in healthy volunteers. PloS one. 2017 Dec 6;12(12):e0186459.
- Akbar M, Calderon F, Wen Z, Kim HY. Docosahexaenoic acid: a positive modulator of Akt signaling in neuronal survival. Proceedings of the National Academy of Sciences. 2005 Aug 2;102(31):10858-63.
- Alf D, Schmidt ME, Siebrecht SC. Ubiquinol supplementation enhances peak power production in trained athletes: a double-blind, placebo-controlled study. Journal of the International Society of Sports Nutrition. 2013; 10:24.
- Altura BM, Altura BT. Tension headaches and muscle tension: is there a role for magnesium? Med Hypotheses. 2001 Dec;57(6):705-13.
- Appleton KM, Sallies HM, Perry R et al. Omega-3 fatty acids for depression in adults. Cochrane Database Syst Rev. 2015; (11): CD004692.
- Avgerinos KI, Spyrou N, Bougioukas KI, Kapogiannis D. Effects of creatine supplementation on cognitive function of healthy individuals: A systematic review of randomized controlled trials. Experimental gerontology. 2018 Jul 15;108:166-73.
- Bagheri S, Haddadi R, Saki S, Kourosh-Arami M, Rashno M, Mojaver A, Komaki A. Neuroprotective effects of coenzyme Q10 on neurological diseases: a review article. Front Neurosci. 2023 Jun 23;17:1188839.
- Barnig C, Bezema T, Calder PC, Charloux A, Frossard N, Garssen J, Haworth O, Dilevskaya K, Levi-Schaffer F, Lonsdorfer E, Wauben M, Kraneveld AD, Te Velde AA. Activation of resolution pathways to prevent and fight chronic inflammation: Lessons From asthma and inflammatory bowel disease. Front Immunol. 2019 Jul 23;10:1699.
- Ben Zichri-David S, Shkuri L, Ast T. Pulling back the mitochondria's iron curtain. NPJ Metabolic Health and Disease. 2025 Mar 4;3(1):6.
- Biţă A, Scorei IR, Ciocîlteu MV, Nicolaescu OE, Pîrvu AS, Bejenaru LE, Rău G, Bejenaru C, Radu A, Neamţu J, Mogoşanu GD, Benner SA. Nicotinamide riboside, a promising vitamin B_3 derivative for healthy aging and longevity: Current Research and Perspectives. Molecules. 2023 Aug 15;28(16):6078.
- Blaauw R, Calder PC, Martindale RG, Berger MM. Combining proteins with n-3 PUFAs (EPA+ DHA) and their inflammation pro-resolution mediators for preservation of skeletal muscle mass. Critical Care. 2024 Feb 1;28(1):38.

References

- Blancquaert L, Vervaet C, Derave W. Predicting and testing bioavailability of magnesium supplements. Nutrients. 2019 Jul 20;11(7):1663.
- Boccio JR, Iyengar V. Iron deficiency: causes, consequences, and strategies to overcome this nutritional problem. Biol Trace Elem Res. 2003 Jul;94(1):1-32.
- Bonetti A, Solito F, Carmosino G, et al. Effect of ubidecarenone oral treatment on aerobic power in middle-aged trained subjects. J Sports Med Phys Fitness 2000;40:51-7.
- Boyle NB, Lawton C, Dye L. The effects of magnesium supplementation on subjective anxiety and stress-A systematic review. Nutrients. 2017 Apr 26;9(5):429.
- Brakedal B, Dölle C, Riemer F, Ma Y, Nido GS, Skeie GO, Craven AR, Schwarzlmüller T, Brekke N, Diab J, Sverkeli L. The NADPARK study: A randomized phase I trial of nicotinamide riboside supplementation in Parkinson's disease. Cell metabolism. 2022 Mar 1;34(3):396-407.
- Branch JD. Effect of creatine supplementation on body composition and performance: a meta-analysis. Int J Sport Nutr Exerc Metab. 2003 Jun;13(2):198-226.
- Braun, L, Cohen M. Herbs and Natural Supplements, an Evidence-Based Guide 4e, Vol 2. Elsevier. 2015.
- Bruinsma KA, Taren DL. Dieting, essential fatty acid intake, and depression. Nutr Rev. 2000 Apr;58(4):98-108.
- Burtscher J, Millet GP, Place N, Kayser B, Zanou N. The muscle-brain axis and neurodegenerative diseases: the key role of mitochondria in exercise-induced neuroprotection. International Journal of Molecular Sciences. 2021 Jun 17;22(12):6479.
- Calder PC. Polyunsaturated fatty acids, inflammation, and inflammatory diseases. Am J Clin Nutri. 2006; 83 (suppl):1505s-19s.
- Calderin EP, Zheng JJ, Boyd NL, McNally L, Audam TN, Lorkiewicz P, Hill BG, Hellmann J. Exercise-induced specialized proresolving mediators stimulate AMPK phosphorylation to promote mitochondrial respiration in macrophages. Molecular Metabolism. 2022 Dec 1;66:101637.
- Capece U, Moffa S, Improta I, Di Giuseppe G, Nista EC, Cefalo CMA, Cinti F, Pontecorvi A, Gasbarrini A, Giaccari A, Mezza T. Alpha-lipoic acid and glucose metabolism: A comprehensive update on biochemical and therapeutic features. Nutrients. 2022 Dec 21;15(1):18.
- Carnitine. Fact Sheet for Health Professionals. 2026 [cited August 2026] National Institute of Health (NIH). Office of Dietary Supplements.
- Casanova A, Wevers A, Navarro-Ledesma S, Pruimboom L. Mitochondria: It is all about energy. Frontiers in physiology. 2023 Apr 25;14:1114231.
- Casuso RA, Huertas JR. The emerging role of skeletal muscle mitochondrial dynamics in exercise and ageing. Ageing research reviews. 2020 Mar 1;58:101025.
- Chiang MC, Tsai TY, Wang CJ. The potential benefits of quercetin for brain health: a review of anti-inflammatory and neuroprotective mechanisms. International journal of molecular sciences. 2023 Mar 28;24(7):6328.
- Christen S, Redeuil K, Goulet L, Giner MP, Breton I, Rota R, Frézal A, Nazari A, Van den Abbeele P, Godin JP, Nutten S. The differential impact of three different NAD+ boosters on circulatory NAD and microbial metabolism in humans. Nature Metabolism. 2026 Jan 15:1-2.

References

- Classen HG. Magnesium orotate--experimental and clinical evidence. Rom J Intern Med. 2004;42(3):491-501.
- Coenzyme Q10. 2022. [cited July 2022]. Linus Pauling Institute. Oregon State University. Micronutrient Information Center. Oregon State University [internet].
- Conze D, Brenner C, Kruger CL. Safety and metabolism of long-term administration of NIAGEN (nicotinamide riboside chloride) in a randomized, double-blind, placebo-controlled clinical trial of healthy overweight adults. Scientific reports. 2019 Jul 5;9(1):9772.
- Covino C. Nutritional medicine (supplementation) In: Hechtman L. Clinical Naturopathic Medicine 2nd ed. Elsevier Australia. 2019. p167-169.
- Daniels TE, Olsen EM, Tyrka AR. Stress and Psychiatric Disorders: The Role of Mitochondria. Annu Rev Clin Psychol. 2020 May 7;16:165-186
- Davis JM, Murphy EA, Carmichael MD, Davis B. Quercetin increases brain and muscle mitochondrial biogenesis and exercise tolerance. American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 2009 Apr;296(4):R1071-7.
- de Oliveira MR, Nabavi SF, Nabavi SM, Jardim FR. Omega-3 polyunsaturated fatty acids and mitochondria, back to the future. Trends in food science & technology. 2017 Sep 1;67:76-92.
- de Oliveira MR, Nabavi SM, Braidy N, Setzer WN, Ahmed T, Nabavi SF. Quercetin and the mitochondria: A mechanistic view. Biotechnol Adv. 2016 Sep-Oct;34(5):532-549.
- de Souza LC, Moris JM, Gordon PM, Heileson JL, Funderburk LK. From fish oil to resolution: a narrative review on the potential of SPM-enriched marine oil for exercise-induced muscle damage recovery. Nutrients. 2025 Jun 16;17(12):2014.
- Del Gobbo LC, Imamura F, Wu JH, de Oliveira Otto MC, Chiuve SE, Mozaffarian D. Circulating and dietary magnesium and risk of cardiovascular disease: a systematic review and meta-analysis of prospective studies. Am J Clin Nutr. 2013 Jul;98(1):160-73.
- Dietz JV, Fox JL, Khalimonchuk O. Down the iron path: mitochondrial iron homeostasis and beyond. Cells. 2021 Aug 25;10(9):2198.
- Do LH, Da Costa RT, Solesio ME. Effects of nutrients and diet on mitochondrial dysfunction: An opportunity for therapeutic approaches in human disease. Biomedicine & Pharmacotherapy. 2025 Oct 1;191:118493.
- Dolopikou CF, Kourtzidis IA, Margaritelis NV, Vrabas IS, Koidou I, Kyparos A, Theodorou AA, Paschalis V, Nikolaidis MG. Acute nicotinamide riboside supplementation improves redox homeostasis and exercise performance in old individuals: a double-blind cross-over study. European Journal of nutrition. 2020 Mar;59(2):505-15.
- Dos Santos SM, Romeiro CF, Rodrigues CA, Cerqueira AR, Monteiro MC. Mitochondrial dysfunction and alpha-lipoic acid: Beneficial or harmful in Alzheimer's disease?. Oxidative Medicine and Cellular longevity. 2019;2019(1):8409329.

References

- Doussat C, Brioche T, Casas F, Capel F, Feillet-Coudray C. Dietary omega 3 fatty acids and skeletal muscle metabolism: a review of clinical and preclinical studies. OCL. 2024 Jul 1;31:13.
- Drobnic F, Lizarraga MA, Caballero-García A, Cordova A. Coenzyme Q_{10} supplementation and its impact on exercise and sport performance in humans: A recovery or a performance-enhancing molecule? Nutrients. 2022 Apr 26;14(9):1811.
- Dunn J, Grider MH. Physiology, Adenosine Triphosphate. [Updated 2023 Feb 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK553175/
- Ekanayake A, Peiris S, Ahmed B, Kanekar S, Grove C, Kalra D, Eslinger P, Yang Q, Karunanayaka P. A review of the role of estrogens in olfaction, sleep and glymphatic functionality in relation to sex disparity in Alzheimer's disease. American Journal of Alzheimer's Disease & Other Dementias®. 2024 Jul 30;39:15333175241272025.
- European Food Safety Authority (EFSA). Opinion on certain bisglycinates as sources of copper, zinc, calcium, magnesium and glycinate nicotinate as source of chromium in foods intended for the general population (including food supplements) and foods for particular nutritional uses-Scientific Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food. EFSA Journal. 2008 Jun;6(6):718.
- Ezagouri S, Asher G. Circadian control of mitochondrial dynamics and functions. Current Opinion in Physiology. 2018 Oct 1;5:25-9.
- Feart C. Peuchant E. Letenneur L et al. Plasma eicosapentaenoic acid is inversely associated with severity of depressive symptomatology in the elderly: data from the Bordeaux sample of the Three-City Study. Am J. Clin Nutr 2008; 84(5):1156-62.
- Fernández-Portero C, Amián JG, Bella R, López-Lluch G, Alarcón D. Coenzyme Q10 levels associated with cognitive functioning and executive function in older adults. J Gerontol A Biol Sci Med Sci. 2023 Jan 26;78(1):1-8.
- Freund-Levi Y, Eriksdotter-Jönhagen M, Cederholm T, Basun H, Faxen-Irving G, Garlind A, Vedin I, Vessby B, Wahlund LO, Palmblad J. ω-3 fatty acid treatment in 174 patients with mild to moderate Alzheimer disease: OmegAD study: a randomized double-blind trial. Archives of Neurology. 2006 Oct 1;63(10):1402-8.
- Gaffney-Stomberg E, McClung JP. Inflammation and diminished iron status: mechanisms and functional outcomes. Current Opinion in Clinical Nutrition and Metabolic Care. 2012; 15(6):605-613
- Geiss KR, Stergiou N, Jester, Neuenfeld HU, Jester HG. Effects of magnesium orotate on exercise tolerance in patients with coronary heart disease. Cardiovasc Drugs Ther. 1998 Sep;12 Suppl 2:153-6.
- Gropper SS, Smith JL, Carr TP. Advanced Nutrition and Human Metabolism 7th ed. Australia: Cengage Learning. 2018.
- Grosso G, Pajak A, Marventano S, Castellano S, Galvano F, Bucolo C, Drago F, Caraci F. Role of omega-3 fatty acids in the treatment of depressive disorders: a comprehensive meta-analysis of randomized clinical trials. PLoS One. 2014 May 7;9(5):e96905.

References

- Guan Y, Li L, Yang R, Lu Y, Tang J. Targeting mitochondria with natural polyphenols for treating neurodegenerative diseases: a comprehensive scoping review from oxidative stress perspective. Journal of Translational Medicine. 2025 May 23;23(1):572.
- Hager K, Marahrens A, Kenklies M, Riederer P, Munch G. Alpha-lipoic acid as a new treatment option for Azheimer type dementia. Arch Gerontol Geriatr 2001;32(3);275-282.
- Hager K., Kenklies M., McAfoose J., Engel J., Münch G. Alpha-lipoic acid as a new treatment option for Alzheimer's disease--a 48 months follow-up analysis. J Neural Transm Suppl 2007;(72):189-193.
- Hartmann C, Kempf A. Mitochondrial control of sleep. Current Opinion in Neurobiology. 2023 Aug 1;81:102733.
- Hashimoto M, Hossain S, Shimada T, Sugioka K, Yamasaki H, Fujii Y, Ishibashi Y, Oka JI, Shido O. Docosahexaenoic acid provides protection from impairment of learning ability in Alzheimer's disease model rats. Journal of Neurochemistry. 2002 Jun 1;81(5):1084-91.
- Hausenblas HA, Lynch T, Hooper S, Shrestha A, Rosendale D, Gu J. Magnesium-L-threonate improves sleep quality and daytime functioning in adults with self-reported sleep problems: A randomized controlled trial. Sleep Med X. 2024 Aug 17;8:100121.
- Hechtman L, le Roux C. The Neurological System. Psychological Systems In: Hechtman L. Clinical naturopathic medicine 2nd ed. Elsevier Australia. 2019. p. 1359-1268
- Hewlings SJ, Kalman D. A randomized, double-blind, placebo-controlled, comparator trial evaluating Magtein® magnesium supplement on quality of life as related to levels of stress, anxiety, fear and other indicators. EC Nutrition. 2022;17(3):7-14.
- Hood DA, Memme JM, Oliveira AN, Triolo M. Maintenance of skeletal muscle mitochondria in health, exercise, and aging. Annual review of physiology. 2019 Feb 10;81(1):19-41.
- Hudson S, Tabet N. Acetyl-L-carnitine for dementia. Cochrane Database Syst Rev. 2003; 2003(2):CD003158.
- Igarashi M, Nakagawa-Nagahama Y, Miura M, Kashiwabara K, Yaku K, Sawada M, Sekine R, Fukamizu Y, Sato T, Sakurai T, Sato J. Chronic nicotinamide mononucleotide supplementation elevates blood nicotinamide adenine dinucleotide levels and alters muscle function in healthy older men. npj Aging. 2022 May 1;8(1):5.
- Imai S, Guarente L. NAD+ and sirtuins in aging and disease. Trends Cell Biol. 2014 Aug;24(8):464-71.
- Irie J, Inagaki E, Fujita M, Nakaya H, Mitsuishi M, Yamaguchi S, Yamashita K, Shigaki S, Ono T, Yukioka H, Okano H. Effect of oral administration of nicotinamide mononucleotide on clinical parameters and nicotinamide metabolite levels in healthy Japanese men. Endocrine journal. 2020;67(2):153-60.
- Isenmann E, Trittel L, Diel P. The effects of alpha lipoic acid on muscle strength recovery after a single and a short-term chronic supplementation-a study in healthy well-trained individuals after intensive resistance and endurance training. Journal of the International Society of Sports Nutrition. 2020 Dec 1;17(1):61.

References

- Jiménez-Jiménez FJ, Alonso-Navarro H, García-Martín E, Agúndez JAG. Coenzyme Q10 and dementia: A systematic review. Antioxidants (Basel). 2023 Feb 20;12(2):533.
- Joffre C, Dinel AL, Chataigner M, Pallet V, Layé S. n-3 Polyunsaturated fatty acids and their derivates reduce neuroinflammation during aging. Nutrients. 2020 Feb 28;12(3):647.
- Johnson S, Imai SI. NAD^+ biosynthesis, aging, and disease. F1000Res. 2018 Feb 1;7:132.
- Kaneka Internal Report. Real-life UBIQUINOL study on 200 postmenopausal women. Expansion Consulteam. 2024.
- Karczewski M, Simic S, Saleh L, Nowak A, Schubert MG, Moretti D, Swinkels DW, Beuschlein F, Suter PM, Krayenbuehl PA. The magnitude of the plasma hepcidin response to oral iron supplements depends on the iron dosage. Swiss Med Wkly. 2024 Feb 19;154:3635.
- Katayoshi, T., Uehata, S., Nakashima, N., Nakajo, T., Kitajima, N., Kageyama, M., & Tsuji-Naito, K. (2023). Nicotinamide adenine dinucleotide metabolism and arterial stiffness after long-term nicotinamide mononucleotide supplementation: a randomized, double-blind, placebo-controlled trial. *Scientific Reports*, 13(1), 1–9.
- Katyare SS, Mali AV. Omega-3 fatty acids and mitochondrial functions. In Omega-3 Fatty Acids: Keys to Nutritional Health and Disease 2025 May 20 (pp. 405-409). Cham: Springer Nature Switzerland.
- Killilea DW, Killilea AN. Mineral requirements for mitochondrial function: A connection to redox balance and cellular differentiation. Free Radical Biology and Medicine. 2022 Mar 1;182:182-91.
- Kim M, Seol J, Sato T, Fukamizu Y, Sakurai T, Okura T. Effect of 12-week intake of nicotinamide mononucleotide on sleep quality, fatigue, and physical performance in older Japanese adults: a randomized, double-blind placebo-controlled study. Nutrients. 2022 Feb 11;14(4):755.
- Konofal E, Lecendreux M, Arnulf I, Mouren MC. Iron deficiency in children with attention-deficit/hyperactivity disorder. Arch Pediatr Adolesc Med 2004;158:1113-15
- Kunching S, Nararatwanchai T, Chalermchai T, Wongsupasawat K, Sitiprapaporn P, Thipsiriset A. The effects of ubiquinol supplementation on clinical parameters and physical performance of trained men. Songklanakarin Journal of Science & Technology. 2022 Jan 1;44(1).
- Layé S, Nadjar A, Joffre C, Bazinet RP. Anti-inflammatory effects of omega-3 fatty acids in the brain: physiological mechanisms and relevance to pharmacology. Pharmacological Reviews. 2018 Jan 1;70(1):12-38.
- Lee MS, Shin Y, Moon S, Kim S, Kim Y. Effects of eicosapentaenoic acid and docosahexaenoic acid on mitochondrial DNA replication and PGC-1α gene expression in C_2C_{12} muscle cells. Prev Nutr Food Sci. 2016 Dec;21(4):317-322.
- Li Y, Li K. Quercetin in endurance training: a review of its antioxidant and fatigue-resisting properties. Natural Product Communications. 2025 Nov;20(11):1934578X251400640.

References

- Liao B, Zhao Y, Wang D, Zhang X, Hao X, Hu M. Nicotinamide mononucleotide supplementation enhances aerobic capacity in amateur runners: a randomized, double-blind study. Journal of the International Society of Sports Nutrition. 2021 Jul 8;18(1):54.
- Lim GP, Calon F, Morihara T, Yang F, Teter B, Ubeda O, Salem Jr N, Frautschy SA, Cole GM. A diet enriched with the omega-3 fatty acid docosahexaenoic acid reduces amyloid burden in an aged Alzheimer mouse model. The Journal of Neuroscience. 2005 Mar 23;25(12):3032-40.
- Liu JJ, Green P, Mann JJ, Rapoport SI, Sublette ME. Pathways of polyunsaturated fatty acid utilization: implications for brain function in neuropsychiatric health and disease. Brain Research. 2015 Feb 9;1597:220-46.
- Liu X, Hao J, Yao E, Cao J, Zheng X, Yao D, Zhang C, Li J, Pan D, Luo X, Wang M, Wang W. Polyunsaturated fatty acid supplement alleviates depression-incident cognitive dysfunction by protecting the cerebrovascular and glymphatic systems. Brain Behav Immun. 2020 Oct;89:357-370.
- Liu X, Zhuang P, Li Y, Wu F, Wan X, Zhang Y, Jiao J. Association of fish oil supplementation with risk of incident dementia: a prospective study of 215,083 older adults. Clinical Nutrition. 2022 Mar 1;41(3):589-98.
- Lopresti AL, Smith SJ. The effects of magnesium L-threonate (Magtein®) on cognitive performance and sleep quality in adults: a randomised, double-blind, placebo-controlled trial. Front Nutr. 2026 Jan 12;12:1729164.
- Ma J, Chen M, Liu GH, Gao M, Chen NH, Toh CH, Hsu JL, Wu KY, Huang CM, Lin CM, Fang JT, Lee SH, Lee TMC. Effects of sleep on the glymphatic functioning and multimodal human brain network affecting memory in older adults. Mol Psychiatry. 2025 May;30(5):1717-1729.
- Madreiter-Sokolowski CT, Sokolowski AA, Waldeck-Weiermair M, Malli R, Graier WF. Targeting mitochondria to counteract age-related cellular dysfunction. Genes (Basel). 2018 Mar 16;9(3):165.
- Malaguarnera M, Cammalleri L, Gargante MP, Vacante M, Colonna V, Motta M. L-Carnitine treatment reduces severity of physical and mental fatigue and increases cognitive functions in centenarians: a randomized and controlled clinical trial. Am J Clin Nutr. 2007 Dec;86(6):1738-44.
- Martens CR, Denman BA, Mazzo MR, Armstrong ML, Reisdorph N, McQueen MB, Chonchol M, Seals DR. Chronic nicotinamide riboside supplementation is well-tolerated and elevates NAD+ in healthy middle-aged and older adults. Nature communications. 2018 Mar 29;9(1):1286.
- Martins JG. EPA but not DHA appears to be responsible for the efficacy of omega-3 long chain polyunsaturated fatty acid supplementation in depression: evidence from a meta-analysis of randomized controlled trials. J Am Coll Nutr. 2009; 28(5):525-42
- McClung JP. Iron status and the female athlete. [Review]. J Trace Elem Med Biol. 2012; 26(2-3):124-6.

References

- McNamara RK, Able J, Jandacek R, Rider T, Tso P, Eliassen JC, Alfieri D, Weber W, Jarvis K, DelBello MP, Strakowski SM. Docosahexaenoic acid supplementation increases prefrontal cortex activation during sustained attention in healthy boys: a placebo-controlled, dose-ranging, functional magnetic resonance imaging study. The American Journal of Clinical Nutrition. 2010 Apr 1;91(4):1060-7.
- Mehmel M, Jovanović N, Spitz U. Nicotinamide riboside-The current state of research and therapeutic uses. Nutrients. 2020 May 31;12(6):1616.
- Memme JM, Erlich AT, Phukan G, Hood DA. Exercise and mitochondrial health. The Journal of Physiology. 2021 Feb;599(3):803-17.
- Mills S, Candow DG, Forbes SC, Neary JP, Ormsbee MJ, Antonio J. Effects of creatine supplementation during resistance training sessions in physically active young adults. Nutrients. 2020;12(6):1880.
- Mizuno K, Tanaka, M, Nozaki S et al. Antifatigue effects of coenzyme Q10 during physical fatigue. Nutrition 2008;24(4):293-299.
- Mocking RJT, Hamsen I, Assies J. Meta-analysis and meta-regression of omega-3 polyunsaturated fatty acid supplementation for major depressive disorder. Transl Psychiatry. 2016; 6(3): e 756.
- Monzio Compagnoni G, Di Fonzo A, Corti S, Comi GP, Bresolin N, Masliah E. The role of mitochondria in neurodegenerative diseases: the lesson from Alzheimer's disease and Parkinson's disease. Molecular neurobiology. 2020 Jul;57(7):2959-80.
- Moretti D, Goede JS, Zeder C, Jiskra M, Chatzinakou V, Tjalsma H, Melse-Boonstra A, Brittenham G, Swinkels DW, Zimmermann MB. Oral iron supplements increase hepcidin and decrease iron absorption from daily or twice-daily doses in iron-depleted young women. Blood. 2015 Oct 22;126(17):1981-9.
- Nankivell MC, Rosenfeldt F, Pipingas A, Pase MP, Reddan JM, Stough C. Coenzyme Q10 and cognition: a review. Nutrients. 2025 Sep 8;17(17):2896.
- Natural Medicines Database. Therapeutic Research Centre. Available from: Natural Medicines Database. Therapeutic Research Centre. [Internet].
- Nemeth E, Ganz T. The role of hepcidin in iron metabolism. Acta Haematol. 2009;122(2-3):78-86.
- Okabe K, Yaku K, Uchida Y, Fukamizu Y, Sato T, Sakurai T, Tobe K, Nakagawa T. Oral administration of nicotinamide mononucleotide is safe and efficiently increases blood nicotinamide adenine dinucleotide levels in healthy subjects. Frontiers in Nutrition. 2022 Apr 11;9:868640.
- Pallotti F, Bergamini C, Lamperti C, Fato R. The roles of coenzyme Q in disease: Direct and indirect involvement in cellular functions. Int J Mol Sci. 2021 Dec 23;23(1):128.
- Passeri M, Cucinotta D, Bonati PA, Iannuccelli M, Parnetti L, Senin U. Acetyl-L-carnitine in the treatment of mildly demented elderly patients. Int J Clin Pharmacol Res. 1990;10(1-2):75-9.

References

- Paul BT, Manz DH, Torti FM, Torti SV. Mitochondria and Iron: current questions. Expert Rev Hematol. 2017 Jan;10(1):65-79. doi: 10.1080/17474086.2016.1268047. Epub 2016 Dec 12. Erratum in: Expert Rev Hematol. 2017 Mar;10(3):275.
- Pettegrew JW, Levine J, McClure RJ. Acetyl-L-carnitine physical-chemical, metabolic, and therapeutic properties: relevance for its mode of action in Alzheimer's disease and geriatric depression. Mol Psychiatry. 2000 Nov;5(6):616-32.
- Picard M, McEwen BS, Epel ES, Sandi C. An energetic view of stress: Focus on mitochondria. Frontiers in Neuroendocrinology. 2018 Apr 1;49:72-85.
- Picard M, McEwen BS. Psychological stress and mitochondria: a conceptual framework. Biopsychosocial Science and Medicine. 2018 Feb 1;80(2):126-40.
- Picard M, Prather AA, Puterman E, Cuillerier A, Coccia M, Aschbacher K, Burelle Y, Epel ES. A mitochondrial health index sensitive to mood and caregiving stress. Biological Psychiatry. 2018 Jul 1;84(1):9-17.
- Picard M, Trumpff C, Burelle Y. Mitochondrial psychobiology: Foundations and applications. Current Opinion in Behavioral Sciences. 2019 Aug 1;28:142-51.
- Picard M. Energy transduction and the mind–mitochondria connection. The Biochemist. 2022 Aug 30;44(4):14-8.
- Pizzorno J. Mitochondria—fundamental to life and health. Integrative Medicine: A Clinician's Journal. 2014 Apr;13(2):8.
- Pollicino F, Veronese N, Dominguez LJ, Barbagallo M. Mediterranean diet and mitochondria: New findings. Experimental Gerontology. 2023 Jun 1;176:112165.
- Prokopidis K, Giannos P, Triantafyllidis KK, Kechagias KS, Forbes SC, Candow DG. Effects of creatine supplementation on memory in healthy individuals: a systematic review and meta-analysis of randomized controlled trials. Nutr Rev. 2023 Mar 10;81(4):416-427.
- Rae C, Digney AL, McEwan SR, Bates TC. Oral creatine monohydrate supplementation improves brain performance: a double-blind, placebo-controlled, cross-over trial. Proc Biol Sci. 2003 Oct 22;270(1529):2147-50.
- Rajman L, Chwalek K, Sinclair DA. Therapeutic potential of NAD-boosting molecules: The In Vivo Evidence. Cell Metab. 2018 Mar 6;27(3):529-547.
- Rao SS, Brenner DM. Efficacy and safety of over-the-counter therapies for chronic constipation: an updated systematic review. The American journal of gastroenterology. 2021 Mar 17;116(6):1156.
- Reddy OC, van der Werf YD. The sleeping brain: Harnessing the power of the glymphatic system through lifestyle choices. Brain Sci. 2020 Nov 17;10(11):868.
- Reinke S, Taylor W, Duda G et al. Absolute and functional iron deficiency in professional athletes during training and recovery. Int J Cardiol. 156(2):186-91, 2012 Apr 19.
- Remie CM, Roumans KH, Moonen MP, Connell NJ, Havekes B, Mevenkamp J, Lindeboom L, de Wit VH, van De Weijer T, Aarts SA, Lutgens E. Nicotinamide riboside supplementation alters body composition and skeletal muscle acetylcarnitine concentrations in healthy obese humans. The American journal of clinical nutrition. 2020 Aug 1;112(2):413-26.

References

- Ren H, Luo C, Feng Y, Yao X, Shi Z, Liang F, Kang JX, Wan JB, Pei Z, Su H. Omega-3 polyunsaturated fatty acids promote amyloid-β clearance from the brain through mediating the function of the glymphatic system. The FASEB Journal. 2017 Jan;31(1):282-93.
- Rodick TC, Seibels DR, Babu JR et al. Potential role of coenzyme Q10 in health and disease conditions. Nutrition and Dietary Supplements. 2018; 10:1-11
- Rosenfeldt FL, Richards SM, Lin Z, Pepe S, Conyers RA. Mechanism of cardioprotective effect of orotic acid. Cardiovasc Drugs Ther. 1998 Sep;12 Suppl 2:159-70.
- Rosenfeldt FL. Metabolic supplementation with orotic acid and magnesium orotate. Cardiovasc Drugs Ther. 1998 Sep;12 Suppl 2:147-52.
- Ruiz-Iglesias P, Gorgori-González A, Massot-Cladera M, Castell M, Pérez-Cano FJ. Does flavonoid consumption improve exercise performance? Is it related to changes in the immune system and inflammatory biomarkers? A systematic review of clinical studies since 2005. Nutrients. 2021 Mar 30;13(4):1132.
- Sahebi S, Rezvani Kakhki B. Omega-3 Fatty Acids in Alzheimer's Disease Prevention Among Elderly Women: Mechanisms of Action, Clinical Evidence, and the Critical Role of Early Intervention. Nutrition and Dietary Supplements. 2025 Dec 31:159-73.
- Salvioli G, Neri M. L-acetylcarnitine treatment of mental decline in the elderly. Drugs Exp Clin Res. 1994;20(4):169-76.
- San-Millán I. The key role of mitochondrial function in health and disease. Antioxidants. 2023 Mar 23;12(4):782.
- Shang P, Zhang Y, Ma D, Hao Y, Wang X, Xin M, Zhang Y, Zhu M, Feng J. Inflammation resolution and specialized pro-resolving lipid mediators in CNS diseases. Expert Opin Ther Targets. 2019 Nov;23(11):967-986.
- Sharma C, Donu D, Cen Y. Emerging Role of Nicotinamide Riboside in Health and Diseases. Nutrients. 2022 Sep 20;14(19):3889.
- Siebrecht S. Magnesium Bisglycinate as safe form for mineral supplementation in human nutrition. Int. J. Orthomol. Relat. Med. 2013;144:1-6.
- Slayo M, Rummel C, Singhaarachchi PH, Feldotto M, Spencer SJ. The role of n-3-derived specialised pro-resolving mediators (SPMs) in microglial mitochondrial respiration and inflammation resolution in Alzheimer's disease. Molecular Neurodegeneration. 2025 Mar 21;20(1):35.
- Slutsky I, Abumaria N, Wu LJ, Huang C, Zhang L, Li B, Zhao X, Govindarajan A, Zhao MG, Zhuo M, Tonegawa S. Enhancement of learning and memory by elevating brain magnesium. Neuron. 2010 Jan 28;65(2):165-77.
- Smith M. Omega-3 fatty acids and mitochondrial function: Implications for metabolic health. J Clin Nutr Metab. 2024;8:2.
- Smith-Ryan AE, DelBiondo GM, Brown AF, Kleiner SM, Tran NT, Ellery SJ. Creatine in women's health: bridging the gap from menstruation through pregnancy to menopause. J Int Soc Sports Nutr. 2025 Dec;22(1):2502094.
- Sousa A, Ribeiro J, Figueiredo P. Physiological demands in sports practice. The Sports Medicine Physician. 2019. Apr 13 (pp. 37-44). Cham: Springer International Publishing.

References

- Stepura OB, Martynow AI. Magnesium orotate in severe congestive heart failure (MACH). Int J Cardiol. 2009 Jan 9;131(2):293-5.
- Sublette ME, Ellis SP, Geant AL, Mann JJ. Meta-analysis of the effects of eicosapentaenoic acid (EPA) in clinical trials in depression. J Clin Psychiatry. 2011; 72 (12):1577-84.
- Sun R, Wang X, Liu Y, Xia M. Dietary supplementation with fish oil alters the expression levels of proteins governing mitochondrial dynamics and prevents high-fat diet-induced endothelial dysfunction. British Journal of Nutrition. 2014 Jul;112(2):145-53.
- Superti F, Russo R. Alpha-Lipoic Acid: Biological mechanisms and health benefits. Antioxidants (Basel). 2024 Oct 12;13(10):1228.
- Tan ZS, Harris WS, Beiser AS, Au R, Himali JJ, Debette S, Pikula A, Decarli C, Wolf PA, Vasan RS, Robins SJ. Red blood cell omega-3 fatty acid levels and markers of accelerated brain aging. Neurology. 2012 Feb 28;78(9):658-64.
- Thal LJ, Carta A, Clarke WR, Ferris SH, Friedland RP, Petersen RC, Pettegrew JW, Pfeiffer E, Raskind MA, Sano M, Tuszynski MH, Woolson RF. A 1-year multicenter placebo-controlled study of acetyl-L-carnitine in patients with Alzheimer's disease. Neurology. 1996 Sep;47(3):705-11.
- Thompson S. Mitochondrial dynamics: Understanding the balance between fusion and fission. Cell Mol Biol. 2024. 70: 351.
- Tian G, Sawashita J, Kubo H, Nishio SY, Hashimoto S, Suzuki N, Yoshimura H, Tsuruoka M, Wang Y, Liu Y, Luo H, Xu Z, Mori M, Kitano M, Hosoe K, Takeda T, Usami S, Higuchi K. Ubiquinol-10 supplementation activates mitochondria functions to decelerate senescence in senescence-accelerated mice. Antioxid Redox Signal. 2014 Jun 1;20(16):2606-20.
- Tiberi M, Chiurchiù V. Specialized pro-resolving lipid mediators and glial cells: Emerging candidates for brain homeostasis and repair. Front Cell Neurosci. 2021 Apr 26;15:673549
- Uberti F, Morsanuto V, Ruga S, Galla R, Farghali M, Notte F, Bozzo C, Magnani C, Nardone A, Molinari C. Study of magnesium formulations on intestinal cells to influence myometrium cell relaxation. Nutrients. 2020 Feb 22;12(2):573.
- Veronese N, Stubbs B, Solmi M, Ajnakina O, Carvalho AF, Maggi S. Acetyl-L-carnitine supplementation and the treatment of depressive symptoms: A systematic review and meta-analysis. Psychosom Med. 2018 Feb/Mar;80(2):154-159.
- Virmani A, Binienda Z. Role of carnitine esters in brain neuropathology. Mol Aspects Med. 2004 Oct-Dec;25(5-6):533-49.
- Visioli F, Ingram A, Beckman JS, Magnusson KR, Hagen TM. Strategies to protect against age-related mitochondrial decay: Do natural products and their derivatives help? Free Radic Biol Med. 2022 Jan;178:330-346.
- Vreones M, Mustapic M, Moaddel R, Pucha KA, Lovett J, Seals DR, Kapogiannis D, Martens CR. Oral nicotinamide riboside raises NAD+ and lowers biomarkers of neurodegenerative pathology in plasma extracellular vesicles enriched for neuronal origin. Aging Cell. 2023 Jan;22(1):e13754.

References

- Wang DD, Airhart SE, Zhou B, Shireman LM, Jiang S, Melendez Rodriguez C, Kirkpatrick JN, Shen DD, Tian R, O'Brien KD. Safety and tolerability of nicotinamide riboside in heart failure with reduced ejection fraction. Basic to translational science. 2022 Dec 1;7(12):1183-96.
- Wieczorek-Szukala K, Markiewicz M, Walczewska A, Zgorzynska E. Docosahexaenoic acid (DHA) reduces LPS-induced inflammatory response via ATF3 transcription factor and stimulates Src/Syk signaling-dependent phagocytosis in microglia. Cell Physiol Biochem. 2023 Nov 1;57(6):411-25.
- Wróbel-Biedrawa D, Grabowska K, Galanty A, Sobolewska D, Podolak I. A flavonoid on the brain: quercetin as a potential therapeutic agent in central nervous system disorders. Life. 2022 Apr 15;12(4):591.
- Wu A, Ying Z, Gomez-Pinilla F. Docosahexaenoic acid dietary supplementation enhances the effects of exercise on synaptic plasticity and cognition. Neuroscience. 2008 Aug 26;155(3):751-9.
- Xiao K, Zhang M, Lv Q, Xu Q, Gong H, Xu X, Guo J, Chen S, Zhao J, Liu Y. Mitochondrial fusion protein mitofusin-2 mediates the protection of fish oil against porcine intestinal injury induced by deoxynivalenol. J Nutr. 2026 Aug 24:101801.
- Yassine H, Arellanes IC, Mazmanian A, De La Cruz L, Martinez J, Contreras L, Kono N, Liu BS, Badie D, Bantugan MA, Grindon A. Baseline findings of PreventE4: a double-blind placebo controlled clinical trial testing high dose DHA in APOE4 carriers before the onset of dementia. The Journal of Prevention of Alzheimer's disease. 2023 Nov;10(4):810-20.
- Yi L, Maier AB, Tao R, Lin Z, Vaidya A, Pendse S, Thasma S, Andhalkar N, Avhad G, Kumbhar V. The efficacy and safety of β-nicotinamide mononucleotide (NMN) supplementation in healthy middle-aged adults: a randomized, multicenter, double-blind, placebo-controlled, parallel-group, dose-dependent clinical trial. Geroscience. 2023 Feb;45(1):29-43.
- Yi SH, Kable JA, Evatt ML, Singh RH. A randomized, placebo-controlled, double-blind trial of supplemental docosahexaenoic acid on cognitive processing speed and executive function in females of reproductive age with phenylketonuria: A pilot study. Prostaglandins, Leukotrienes and Essential Fatty Acids. 2011 Dec 1;85(6):317-27.
- Yin LH, Liu XP, Yi LY, Wang J, Zhang YJ, Feng YF. Structural characterization of calcium glycinate, magnesium glycinate and zinc glycinate. Journal of Innovative Optical Health Sciences. 2017 May 14;10(03):1650052.
- Yoshino J, Baur JA, Imai SI. NAD^+ Intermediates: The biology and therapeutic potential of NMN and NR. Cell Metab. 2018 Mar 6;27(3):513-528.
- Yoshino M, Yoshino J, Kayser BD, Patti GJ, Franczyk MP, Mills KF, Sindelar M, Pietka T, Patterson BW, Imai SI, Klein S. Nicotinamide mononucleotide increases muscle insulin sensitivity in prediabetic women. Science. 2021 Jun 11;372(6547):1224-9.
- Yurko-Mauro K, McCarthy D, Rom D, Nelson EB, Ryan AS, Blackwell A, Salem Jr N, Stedman M, Midas Investigators. Beneficial effects of docosahexaenoic acid on cognition in age-related cognitive decline. Alzheimer's & Dementia. 2010 Nov;6(6):456-64.

References

- Zhang X, Zhou H, Chang X. Involvement of mitochondrial dynamics and mitophagy in diabetic endothelial dysfunction and cardiac microvascular injury. Archives of Toxicology. 2023 Dec;97(12):3023-35.
- Zhao L, Cao J, Hu K, He X, Yun D, Tong T, Han L. Sirtuins and their biological relevance in aging and age-related diseases. Aging Dis. 2020 Jul 23;11(4):927-945.
- Zhou B, Wang DD, Qiu Y, Airhart S, Liu Y, Stempien-Otero A, O'Brien KD, Tian R. Boosting NAD level suppresses inflammatory activation of PBMCs in heart failure. The Journal of Clinical Investigation. 2020 Nov 2;130(11):6054-63.