



# TruHealth

## Report

kilm mi

Age: 24 | Sex: Female

ID#: 56MTHNH

Collected: 10/22/2024 | Reported: 10/22/2024

# Welcome to your personalized report on **Epigenetic Biomarkers**

## **What are Epigenetic Biomarkers?**

Epigenetic biomarkers are specific biological markers derived from analyzing DNA methylation patterns in your genome. Unlike traditional blood-based metrics of your health such as serum levels, which provide a single snapshot in time, epigenetic biomarkers uniquely offer insights into ongoing biological functions by predicting levels of nutrients, metabolites, and other essential biochemical entities. These epigenetic measurements are based on patterns in your DNA methylation landscape, influenced by both genetic and environmental factors. Epigenetic biomarkers provide a more stable and comprehensive view of your health over time, reflecting long-term exposures and trends rather than short-term fluctuations.

## **Epigenetic Biomarkers vs Serum Levels**

Serum levels represent a direct measurement of substances in your blood at a specific point in time. These levels can vary based on recent meals, exercise, stress, and other transient factors. In contrast, epigenetic biomarkers are derived from DNA methylation patterns, providing a broader and more consistent indication of health, which isn't as influenced by short-term changes. This makes epigenetic biomarkers especially useful for understanding long-term health trends and risks.

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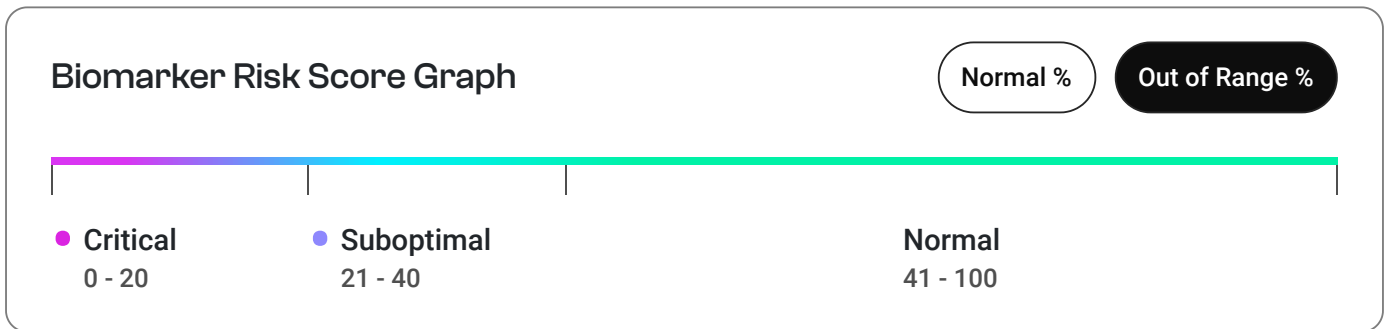
Epigenetic biomarkers provide a more stable and comprehensive view of your health over time, reflecting long-term exposures and trends rather than short-term fluctuations.

## **The Harvard Cohort: The Data Behind TruHealth's Analytics**

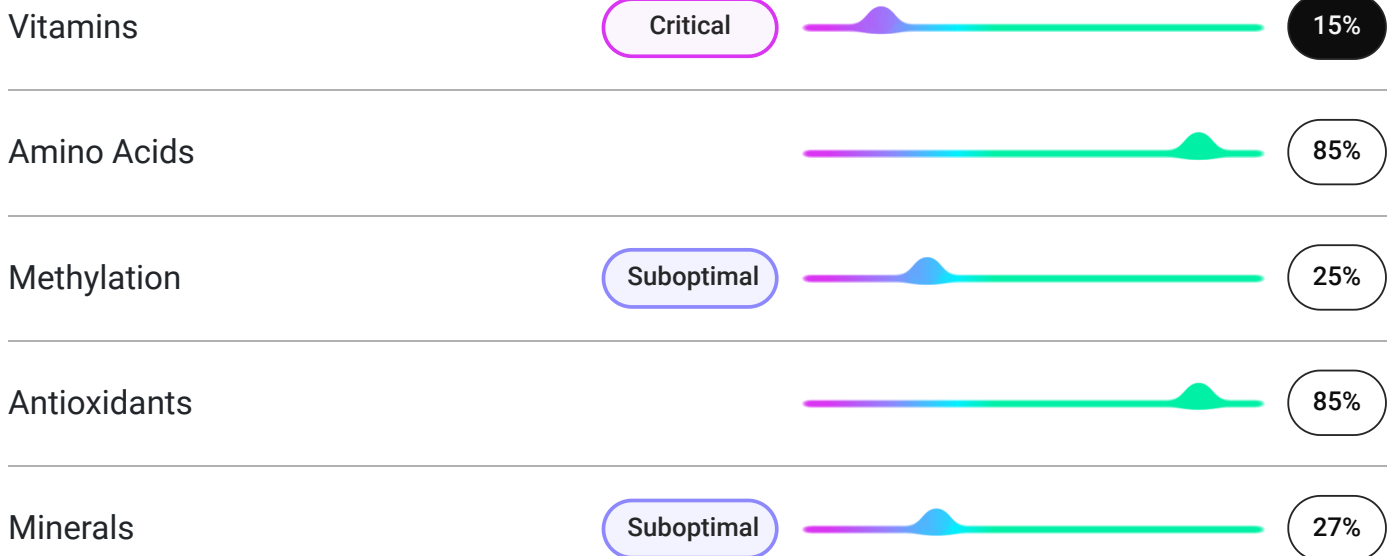
Our algorithms and biomarkers are validated using data from the Massachusetts General Brigham (MGB) Biobank, a comprehensive biorepository containing more than 130,000 high-quality samples from over 100,000 consented patients. These samples are linked to detailed EMR data, which includes the patients' lifetime medical histories. The biobank also incorporates survey data on lifestyle, environment, and family history. This cohort data, derived from routine healthcare visits and measured throughout the patients' lives, forms the basis of comparison for the epigenetic biomarkers in this report. When you see percentile comparisons in your report, they reflect how your biomarkers align with those in this robust, diverse, and extensively studied population.

# Biomarkers Overview

This section of the TruHealth report provides a comprehensive overview of an individual's general health and nutrition markers, each derived from one or more epigenetic biomarkers that reflect underlying cellular health and function. These markers are presented in a normalized percentile range, allowing for a straightforward comparison with a reference population. A score of 0 indicates the worst outcome, representing potential areas of concern or risk, while a score of 100 signifies the best possible outcome, highlighting areas of optimal health. The percentile ranking provides an easy-to-interpret indication of how an individual's health status compares to the broader population, offering valuable insights into their relative standing in terms of metabolic health, immune function, inflammation, mitochondrial activity, and more. This comparison against a carefully studied cohort gives context to these markers, enabling users to understand areas where they may need intervention or where they are already performing well.



## NUTRITION



Healthy Fats

Critical



9%

## GENERAL HEALTH MARKERS

Metabolic



55%

Immune Markers

Suboptimal



37%

Bone and Mineral

Critical



15%

Neurocognitive



70%

Microbiome

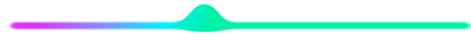
Suboptimal



21%

Inflammation

Suboptimal



40%

Stress

Suboptimal



29%

Toxins



74%

Mitochondrial Function

Suboptimal



74%

Oxidative Defense



74%

NAD+ Metabolism

Critical



15%

Ketones



74%

Supplements



74%

# TOP PERSONALIZED RECOMMENDATIONS

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Personalized recommendations are generated by analyzing individual post-registration questionnaire data and comparing key health indicators to an ideal reference population. Based on these factors, the top six suggestions are selected to help optimize health outcomes. These recommendations focus on areas with the greatest potential for improvement, providing practical and individualized steps to guide progress toward an ideal health profile.

## AMINO ACIDS

### L-Aspartic Acid

High-intensity interval training (HIIT).

⊗ NAC, L-Theanine, GABA

## ANTIOXIDANTS

### Ergothioneine

Increase intake of mushrooms, legumes.

🔗 Ergothioneine

## BONE AND MINERAL MARKERS

### Calcium

Reduce excessive calcium intake (dietary or supplements).

⊗ Vitamin K2 to counteract high calcium levels.

## ANTIOXIDANTS

### Oxidative Stress Marker

Increase antioxidant intake through foods rich in sulfur and vitamin C.

🔗 N-acetylcysteine (NAC), vitamin C

## OXIDATIVE DEFENSE

### Heat Shock Proteins (Cellular stress protector)

Stress management, Sauna, HIIT.

⊗ Curcumin, Glutamine

## SUPPLEMENTS

### Palmitoylethanolamide

Reduce PEA-rich foods (egg yolks, soybeans, peanuts).

⊗ Reduce supplementation.

# EPIGENETIC BIOMARKERS RISK SCORES

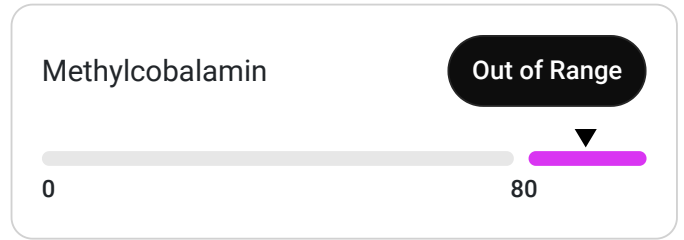
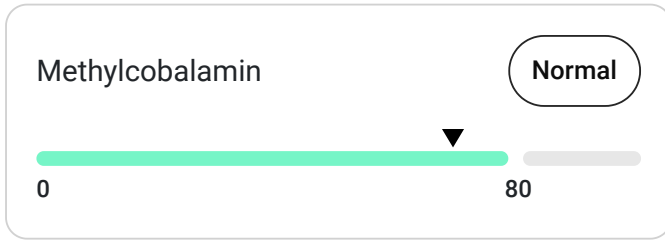
The **Epigenetic Biomarkers Risk Scores** section of the report provides a detailed breakdown of specific **epigenetic biomarkers** derived from your epigenome, each linked to relevant **risk scores** and associated **biomarkers**. Every epigenetic biomarker is accompanied by a concise explanation of its function in the body and its relationship to disease or health outcomes. The **optimal and suboptimal ranges** for these biomarkers vary, depending on whether the biomarker is most beneficial at **high, low, or midrange levels**. For biomarkers identified as suboptimal, personalized **lifestyle** and **supplement recommendations** are provided for improvement. Additionally, prior epigenetic biomarker values are displayed to **track changes over time**, offering insight into progress and areas that may need continued attention.

## There are Three Different Ranges for Each Epigenetic Biomarkers (EBPs)

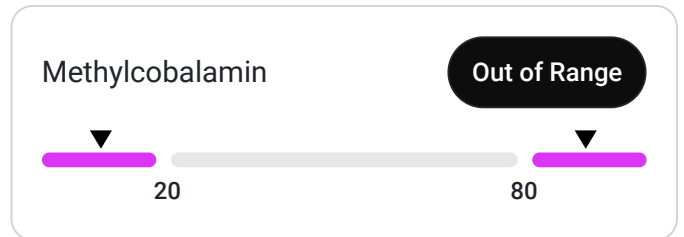
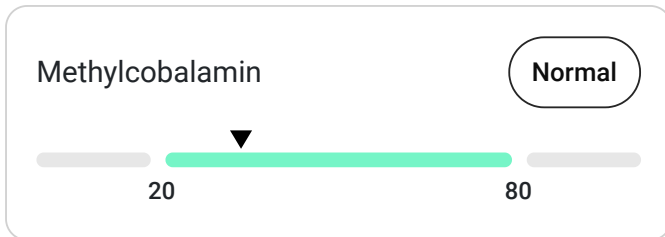
In the below section, each epigenetic biomarker will be presented as your percentile when compared against the reference population. Each epigenetic biomarker is identified by our science team as ideal when LOW, MIDDLE, or HIGH. When the ideal biomarker is thought to be LOW, a percentile of 0% is best. When the MIDDLE is ideal, 50% is best. When HIGH is ideal, 100% is best.

Normal Out of Range Critically Out of Range

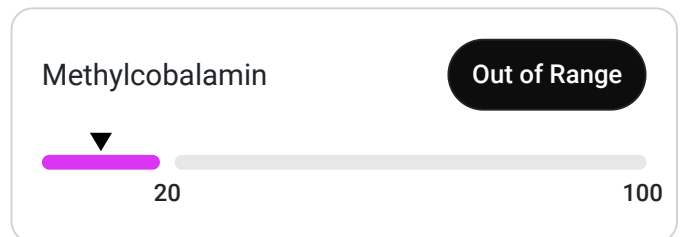
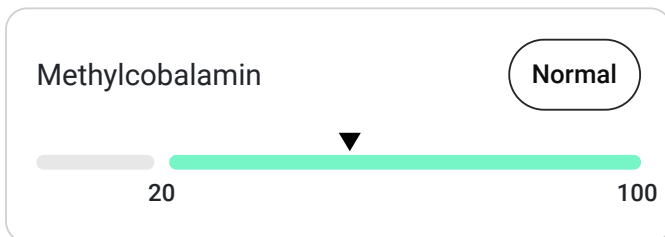
Example: Normal Range is **LOW**



Example: Normal Range is **MIDDLE**



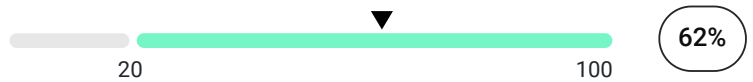
Example: Normal Range is **HIGH**



# VITAMINS

## Vitamin A

Retinol



Retinol (Vitamin A) is essential for vision, immune function, and cellular communication.

## Vitamin B2

Riboflavin



A B-vitamin essential for energy production and cellular function

## Vitamin B3

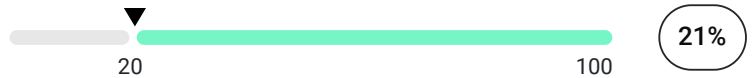
Nicotinamide



Nicotinamide is a form of vitamin B3, essential for NAD+ production and cellular energy. Low levels are associated with lower NAD+ production, and high levels are associated with inhibition of Sirtuins and NAD+ recycling pathways.

## Vitamin B5

Pantothenic Acid



Pantothenic Acid (Vitamin B5) is essential for CoA synthesis and energy metabolism.

## Vitamin B6

Pyridoxine, Pyridoxine-5'-Phosphate



Pyridoxine (Vitamin B6) is a coenzyme in amino acid metabolism and neurotransmitter synthesis.

## Vitamin B7

Biotin



A B-vitamin important for hair, skin, and nail health, as well as metabolism.

## Vitamin B8

Inositol, Myoinositol



Inositol is a carbohydrate involved in cell membrane formation and insulin signal transduction.

## Recommendations



Increase inositol through foods like fruits, grains, nuts, and avoid excess caffeine.

Inositol

### Vitamin C

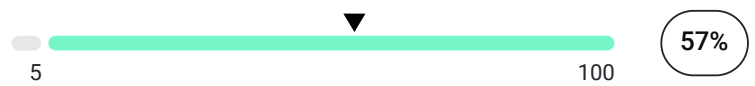
Ascorbic Acid 2-Sulfate



A B-vitamin important for hair, skin, and nail health, as well as metabolism.

### Vitamin C

Ascorbic Acid 3-Sulfate



A B-vitamin important for hair, skin, and nail health, as well as metabolism.

### Vitamin D

Cholecalciferol



A form of Vitamin D; important for bone health and immune function.

## Recommendations

Increase sun exposure, consume fortified foods like milk.

Vitamin D3 (cholecalciferol)

### Vitamin E

Alpha-Tocopherol



A form of Vitamin E with strong antioxidant properties. High levels can be associated with reduced gamma-tocopherol function, and low levels can be associated with poor antioxidant function.

## AMINO ACIDS

### Methionine

Methionine



An essential amino acid involved in protein synthesis and detoxification processes.

### Cysteine

Cysteine



Amino acid involved in protein synthesis and antioxidant functions

### S-Methylmethionine

S-Methylmethionine



A methylated form of methionine involved in methylation reactions

### Taurine

Taurine



A sulfur-containing amino acid with antioxidant properties.

### Recommendations

Increase taurine intake with foods such as shellfish, dark meat poultry, beef, seaweed.

Taurine, magnesium

### Glutamine

Glutamine



An amino acid essential for gut health.

### Arginine

Arginine



An amino acid involved in protein synthesis and nitric oxide production.

### Tyrosine

Tyrosine



An amino acid involved in protein synthesis and a precursor to neurotransmitters such as dopamine and norepinephrine.

### L-Aspartic Acid

L-Aspartic Acid



L-Aspartic Acid is a non-essential amino acid important in the urea cycle and energy production. Low levels may impair protein synthesis and neurotransmitter function, while high levels could indicate metabolic stress.

### Valine

N-carbamoylvaline



N-carbamoylvaline is a derivative of valine, playing a role in nitrogen metabolism. Abnormal levels might indicate stress on nitrogen metabolism from diet or inflammation.

## Recommendations

Reduce BCAAs or protein intake. Increase hydration and physical activity.

⊗ NAC, AKG, L-Citrulline

## Valine

N-acetylvaline



N-acetylvaline is involved in valine metabolism, an essential amino acid. Low levels could affect muscle recovery, while high levels could reflect metabolic stress.

## Recommendations

Consume more protein-rich foods such as chicken, fish, eggs, Greek yogurt, lentils, tofu, and quinoa.

⊗ Valine

## Asparagine

Asparagine



An amino acid involved in metabolic processes.

## Threonine

N-acetylthreonine



N-acetylthreonine is an acetylated derivative of threonine, essential for protein production. Low levels could impair immune function and recovery, while high levels might suggest dietary imbalances.

## Glycine

Glycine



An amino acid involved in detox and sleep.

## Carnosine

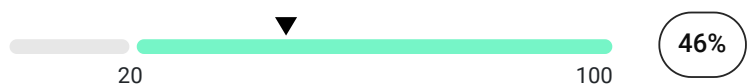
N-acetylcarnosine



A derivative of carnosine, which acts as an antioxidant in the body.

## Cystathionine

Cystathionine



Intermediate in methionine metabolism and cysteine biosynthesis

### Histidine

N-acetylhistidine



A derivative of histidine, important for metal ion binding and antioxidant functions. Low levels could affect muscle recovery, while high levels may indicate inflammation or stress.

### Citrulline

Citrulline



Non-essential amino acid involved in nitric oxide production and vascular health.

## METHYLATION

### Vitamin B2

Riboflavin



A B-vitamin essential for energy production and cellular function

### Vitamin B6

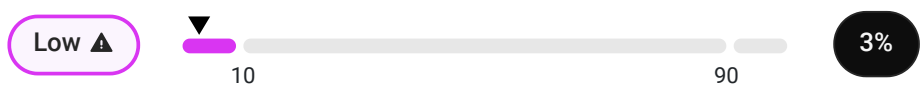
Pyridoxine, Pyridoxine-5-Phosphate (vitamin B6)



Pyridoxine (Vitamin B6) is a coenzyme in amino acid metabolism and neurotransmitter synthesis.

### Methionine

Methionine



An essential amino acid involved in protein synthesis and detoxification processes.

### Choline

Choline



Essential nutrient involved in brain health and fat metabolism.

### Betaine

Betaine



A methyl donor involved in liver function and cell hydration.

# ANTIOXIDANTS

## Vitamin A

Retinol

Low

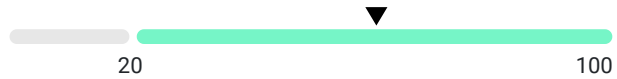


17%

Retinol (Vitamin A) is essential for vision, immune function, and cellular communication.

## Vitamin B2

Riboflavin

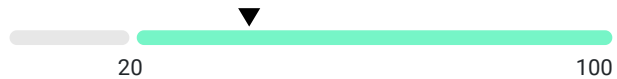


61%

A B-vitamin essential for energy production and cellular function

## Vitamin C

Ascorbic acid 2-sulfate



40%

A sulfated form of Vitamin C.

## Vitamin C

Ascorbic acid 3-sulfate



87%

Another sulfated form of Vitamin C.

## Vitamin E

Alpha-tocopherol

Low ▲



1%

A form of Vitamin E with strong antioxidant properties.

## N-Acetyl Cysteine

N-Acetyl Cysteine



86%

A precursor of glutathione, important for detoxification and antioxidant defense.

## Carotenoids

Lutein



82%

A carotenoid with antioxidant properties, found in green leafy vegetables.

## Carotenoids

Carotene diol

High ▲



100%

Carotenoid found in plants; antioxidant properties.

## S-Adenosyl-Glutathione

S-Adenosyl-Glutathione

Low



17%

A compound involved in the antioxidant response and detoxification

## Acetyl-L-Carnitine

Acetyl-L-Carnitine

Low ▲



1%

A compound involved in fatty acid metabolism and mitochondrial energy production.

## Ergothioneine

Ergothioneine



80%

An antioxidant that helps protect cells from oxidative damage.

## Uric Acid

Urate

Low



8%

Uric acid is an antioxidant byproduct of purine metabolism. High levels may indicate risk for gout, CVD, HTN, and metabolic disorders, while low levels could reduce antioxidant defense and increase oxidative stress.

# MINERALS

## Iron

Iron

Low ▲



3%

Iron is essential for oxygen transport and DNA synthesis, often measured to assess anemia.

## Iron

Transferrin



48%

A blood protein that binds iron and transports it throughout the body.

## Recommendations

Maintain a balanced diet with adequate iron and protein; avoid excessive blood donations.

🔗 Iron supplements if low.

## Magnesium

Magnesium

Low



6%

An essential mineral involved in over 300 biochemical reactions in the body.

## Potassium

Potassium

High



91%

Potassium is an essential electrolyte that regulates fluid balance, nerve signals, and muscle contractions.

## Calcium

Calcium

Low

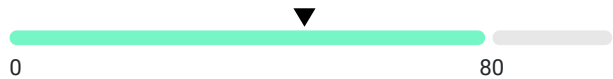


9%

Essential mineral involved in bone health, muscle function, and nerve transmission.

## Copper

Ceruloplasmin



49%

Protein that carries copper in the blood, important for iron metabolism.

# HEALTHY FATS

## DHA

Docosahexaenoate (DHA; 22:6n3)



60%

An omega-3 fatty acid that plays a key role in brain health and inflammation.

## DPA

Docosapentaenoic acid

Low




16%

A lesser-known omega-3 fatty acid involved in inflammatory processes.

## Recommendations

Increase consumption of fatty fish (salmon, sardines).

 Fish oil or algae supplements.

## EPA

Eicosapentaenoate (EPA; 20:5n3)

Low 



2%

An omega-3 fatty acid with anti-inflammatory effects, found in fish oils.

### Omega 3

Omega-3



Omega-3 is a polyunsaturated fatty acid with essential roles in reducing inflammation and supporting heart, brain, and joint health. High levels may indicate adequate dietary intake, while low levels could suggest poor dietary consumption or increased risk of inflammatory conditions.

### Omega 6

Omega-6



Omega-6 is a polyunsaturated fatty acid involved in cell function and inflammation regulation. High levels may indicate excessive intake of processed foods or an imbalance with omega-3, potentially promoting inflammation. Low levels could suggest insufficient dietary intake or impaired fat metabolism.

### Pentadecanoate

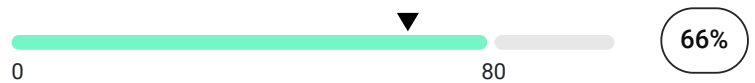
Pentadecanoate (C15:0)



Pentadecanoate (C15:0) is a saturated fatty acid with potential anti-inflammatory properties. High levels may indicate metabolic stress or excessive intake of specific dietary fats, while low levels could suggest impaired fat metabolism.

### Lipid Peroxidation

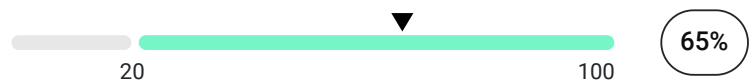
Phospholipase A2



Phospholipase A2 is an enzyme that plays a key role in inflammation by breaking down phospholipids.

### Lipid Peroxidation

Glutathione peroxidase



An enzyme that protects against oxidative damage.

### Lipid Peroxidation

Octadecadienedioate (C18:2-DC)



C18:2-DC is a dicarboxylic acid, linked to lipid metabolism and energy regulation. High levels could be linked to metabolic disorders, while low levels may indicate impaired lipid metabolism or energy production.



# METABOLIC

## HgbA1c

HgbA1c



Measure of blood sugar levels over a period of time, indicative of glucose control.

## Glucose

Glucose



Blood sugar level, related to diabetes risk.

## Fat Burning Marker

Palmitoylcarnitine



Palmitoylcarnitine plays a role in fatty acid transport into mitochondria for oxidation. High levels can signal impaired fatty acid oxidation, while low levels might affect energy production from fats.

### Recommendations

Increase omega-3 and L-carnitine intake, aerobic exercise, quality sleep, and manage stress.

🔗 Improve mitochondrial function with L-carnitine, omega-3 fatty acids, CoQ10, alpha-lipoic acid, and B vitamins.

## Satiety Hormone

Leptin



Leptin is a hormone produced by fat cells that helps regulate appetite and energy balance by signaling the brain to reduce hunger and increase energy expenditure. High levels may indicate leptin resistance and excess body fat, while low levels can suggest insufficient fat reserves or impaired metabolic function.

### Recommendations

Increase caloric intake with healthy fats and proteins, and engage in strength training to boost leptin. Ensure proper sleep for optimal leptin regulation.

🔗 Omega-3 fatty acids to support fat metabolism and zinc to aid hormone regulation. Alpha-lipoic acid and vitamin D may help improve leptin sensitivity and production.

# IMMUNE MARKERS

## White Blood Cell Count

White Blood Cell Count

Low



5%

Measures the amount of white blood cells in the blood, important for immune function.

## Neutrophil count

Neutrophil count

High

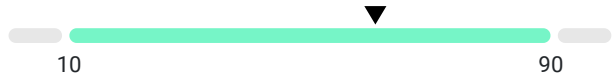


91%

Neutrophil count indicates levels of neutrophils, important for immune defense.

## Lymphocyte count

Lymphocyte count



61%

A type of white blood cell, important for immune system function.

## Recommendations

Increase intake of immune-boosting foods such as citrus, garlic, and zinc supplements.

 Zinc, vitamin C, echinacea.

## CRP

CRP

High ▲



99%

Inflammation marker, linked to cardiovascular and chronic diseases

## Recommendations

Anti-inflammatory interventions, improving diet and exercise

 Omega-3 fatty acids, curcumin, resveratrol, green tea extract, and vitamin D

# BONE AND MINERAL

## Calcium

Calcium

Low



9%

Essential mineral involved in bone health, muscle function, and nerve transmission.

## Phosphorus

Phosphorus

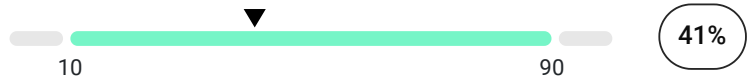


29%

Phosphorus is a mineral critical for bone formation, energy production, and cellular function.

## Magnesium

Magnesium



An essential mineral involved in over 300 biochemical reactions in the body.

# NEUROCOGNITIVE

## Brain Aging Marker

Amyloid-beta precursor protein (APP)



A precursor protein involved in the generation of amyloid-beta, implicated in Alzheimer's disease.

## Memory Health Protein

Neurogranin



Neurogranin is a calmodulin-binding protein, linked to synaptic plasticity and cognition. High levels can be linked to neurodegenerative diseases (e.g., Alzheimer's), while low levels might impair synaptic plasticity and cognitive function.

## Recommendations

Stress management, ensure adequate sleep, engage in moderate exercise (avoiding overtraining).

⊗ L-theanine, magnesium, ashwagandha, phosphatidylserine, and bacopa monnieri.

## Brain Inflammation Marker

Quinolate



Quinolate is a metabolite in the kynurenine pathway linked to neuroinflammation. High levels are linked to neurotoxicity and neurodegenerative disorders, while low levels may impair tryptophan metabolism and affect immune function.

## Dopamine Metabolites

Dopamine 3-O-sulfate



Dopamine 3-O-sulfate is a metabolite of dopamine involved in neurotransmitter regulation, playing a role in detoxifying excess dopamine and maintaining neurotransmitter balance.

## Dopamine Metabolites

Dopamine 4-sulfate



Dopamine 4-sulfate is a metabolite of dopamine involved in neurotransmitter regulation and detoxification, helping maintain dopamine balance in the brain and body.

## Cell Repair Marker

Transforming growth factor beta (TGF-beta)



A cytokine involved in cell growth, proliferation, differentiation, and apoptosis, with key roles in immune response and inflammation.

## Brain Anti-inflammatory

Protein

Progranulin



Progranulin is a protein involved in wound healing, inflammation, and neurodegeneration.

# MICROBIOME

## Gut and Immune Barrier

Lactotransferrin



Lactotransferrin (Lactoferrin) supports gut health through its antimicrobial, anti-inflammatory, and immune-modulating properties. It promotes a healthy gut microbiome by inhibiting the growth of harmful bacteria, fungi, and viruses, while encouraging the growth of beneficial bacteria.

## Bacterial Toxin Indicator

Lipopolysaccharide-binding protein



Protein involved in immune response to bacterial infections.

## Recommendations

Reduce intake of pro-inflammatory foods and manage bacterial exposure. Increase dietary intake of fiber, probiotics, and omega-3 fatty acids.

⊗ Probiotic reduction, omega-3 modulation, fiber.

## Phenylalanine Dysbiosis

### Marker

Phenylacetylglutamine



Phenylacetylglutamine is a gut microbial metabolite associated with renal and cardiovascular health. High levels may indicate gut microbiome disturbances or metabolic stress, while low levels could suggest impaired detoxification processes.

## Gut-Brain Health Marker

Indoleacetate



Indoleacetate is a microbial metabolite of tryptophan, linked to gut health. High levels are associated with gut microbiota activity and can signal dysbiosis or inflammation, while low levels may suggest reduced microbial activity or impaired serotonin metabolism.

# INFLAMMATION

## CRP

CRP



Inflammation marker, linked to cardiovascular and chronic diseases

## IL-6

IL-6



IL-6 (Interleukin-6) is a cytokine involved in inflammation and the immune response.

## Recommendations

Anti-inflammatory medications and stress management.

⊗ Omega-3 fatty acids, curcumin, resveratrol, green tea extract, and vitamin D

## Oxidative Stress Marker

Methionine sulfone



An oxidized form of methionine, a marker of oxidative stress. High levels may indicate excessive oxidative stress or impaired sulfur amino acid metabolism, while low levels could affect protein synthesis and antioxidant production.

## Serum amyloid A-1 protein

Serum amyloid A-1 protein

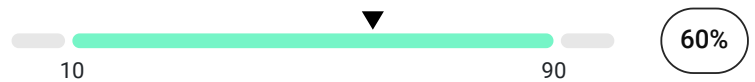


An acute-phase protein linked to inflammation

# STRESS

## Cortisol

Cortisol



Primary stress hormone, affects metabolism and immune response

## DHEA

Dehydroepiandrosterone sulfate (DHEA-S)



A major circulating steroid, precursor to androgens and estrogens.

## Recommendations

Regular strength training, prioritize quality sleep to support hormone production, manage stress through mindfulness practices, chronic stress depletes DHEA. Consume a diet rich in healthy fats like avocados, olive oil, and fatty fish.

 DHEA supplements, Zinc, Magnesium.

## Adrenal Activity Marker

VMA



VMA is a metabolite of catecholamines (epinephrine and norepinephrine), and high levels are linked to catecholamine excess, while low levels might indicate adrenal insufficiency or low catecholamine turnover.

## Chronic Stress Marker

Kynurenine



Kynurenine is a metabolite of tryptophan, involved in immune modulation and neurobiology. High levels are associated with inflammation and neurodegenerative diseases, while low levels may indicate impaired tryptophan metabolism.

# TOXINS

## PFAS (Forever Chemicals)

Perfluorooctanesulfonate (PFOS)



PFOS is a synthetic fluorosurfactant found in various industrial products, linked to adverse health effects.

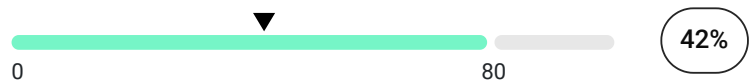
### Recommendations

Strict avoidance of contaminated water and food.

⊗ Activated charcoal, NAC, glutathione.

## PFAS (Forever Chemicals)

Perfluorooctanoate (PFOA)



PFOA is a man-made chemical used in manufacturing non-stick surfaces and can affect human health.

## Acrolein (Pollution and Smoking)

S-(3-hydroxypropyl)mercapturic acid (HPMA)



A metabolite associated with detoxification of certain chemicals and pollutants

## Polycyclic aromatic hydrocarbons (Air Pollution)

2-hydroxyfluorene sulfate



A metabolite indicating polycyclic aromatic hydrocarbons (PAHs) exposure.

## Pesticides

Glyphosate



Glyphosate is a broad-spectrum herbicide commonly used to control weeds, known for its role in agricultural practices but controversial due to potential health and environmental risks.

### Recommendations

Consume organic foods to avoid exposure, increase fiber intake to support detoxification, stay hydrated, engage in regular exercise, and support gut health with probiotics.

⊗ Activated charcoal, chlorella, milk thistle, NAC (N-acetylcysteine), and glutathione

## Lead Exposure

Bone Lead Predictor



This measure reflects long-term lead accumulation in the body, particularly within the skeleton, which stores lead for decades. Elevated levels can be associated with chronic health risks, including hypertension and cognitive decline, due to lead's prolonged presence in bone tissue and periodic release into the bloodstream.

## MITOCHONDRIAL FUNCTION

### Energy Balance Marker

Dynamin-1-like protein (DRP1)



DRP1 is a protein involved in mitochondrial fission, crucial for cellular energy production and regulation of apoptosis. Elevated levels are linked to mitochondrial fission and could contribute to mitochondrial dysfunction.

### ATP synthase (Enzyme)

ATP synthase subunit beta (ATP5B)



A component of the mitochondrial ATP synthase complex, high levels are associated with cellular stress and mitochondrial dysfunction.

### Energy Transport Protein

Electron transfer flavoprotein subunit alpha (ETF $\alpha$ )



Involved in mitochondrial fatty acid oxidation. Low levels could impair fatty acid oxidation, while high levels may indicate abnormal energy metabolism.

### Energy-regulating Enzyme

Pyruvate dehydrogenase kinase (PDK)



PDK inhibits pyruvate dehydrogenase, affecting glucose metabolism. High levels can inhibit pyruvate dehydrogenase activity, impacting glucose metabolism, while low levels might increase glucose oxidation, potentially leading to metabolic imbalances.



# OXIDATIVE DEFENSE

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## Myeloperoxidase (MPO)

Myeloperoxidase (MPO)



An enzyme released during inflammation and used as a marker for oxidative stress.

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## ROS Production Marker

Cytochrome b-245 (NADPH oxidase 2)



Involved in reactive oxygen species (ROS) production and immune response

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## Oxidative Stress Indicator

Methionine sulfone



An oxidized form of methionine, a marker of oxidative stress. High levels may indicate excessive oxidative stress or impaired sulfur amino acid metabolism, while low levels could affect protein synthesis and antioxidant production.

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## Oxidative Damage Marker

Allantoin



Allantoin is formed through oxidation of uric acid and thus serves as a marker of oxidative stress. Higher levels of allantoin in the blood increased oxidative stress, inflammation, or other stress-related metabolic disturbances.

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## Heat Shock Proteins (Cellular stress protector)

Heat shock proteins (HSPs)



Family of proteins produced in response to stressful conditions, key in repair. High levels are a marker of cellular stress and protein damage, while low levels could impair the cell's ability to manage stress.

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# NAD+ METABOLISM

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## Byproduct marker (indicates inefficiency in NAD recycling)

N1-methyl-2-pyridone-5-carboxamide (2PY)



N1-methyl-2-pyridone-5-carboxamide (2PY) is a metabolite of NAD+ that can accumulate with increased NAD+ production. Elevated 2PY levels may inhibit enzymes like PARP, potentially impairing DNA repair and cellular energy metabolism, which could negatively affect longevity.

### Nicotinamide (Precursor)

Nicotinamide



Nicotinamide is a form of vitamin B3, essential for NAD+ production and cellular energy. Low levels are associated with lower NAD+ production, and high levels are associated with inhibition of Sirtuins and NAD+ recycling pathways.

### Nicotinamide riboside (NR, Precursor)

Nicotinamide riboside



Nicotinamide Riboside is a precursor to NAD+. Low levels can lead to reduced NAD+ production and decreased cellular energy, while high levels of NR indicate efficient NAD+ synthesis but could suggest over-reliance on supplementation.

### 1-MNA (NAD+ Metabolite)

1-Methylnicotinamide



1-MNA is produced by the enzyme NNMT. A byproduct of NAD+ metabolism. While it has anti-inflammatory and vasoprotective effects, elevated levels can signal increased NNMT activity, which diverts nicotinamide away from NAD+ recycling, potentially lowering NAD+ availability.

## KETONES

### Beta Hydroxybutyrate

3-hydroxybutyrate (BHBA)



3-Hydroxybutyrate (BHBA) is a ketone body produced during fat metabolism, primarily in the liver, and serves as an alternative energy source for the brain and muscles, especially during periods of low carbohydrate intake or fasting.

### Acetoacetate

Acetoacetate



Acetoacetate is a ketone body produced in the liver during fat metabolism, serving as an alternative energy source for the brain and muscles, especially during periods of low carbohydrate availability or

fasting.

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## SUPPLEMENTS

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### Alpha-ketoglutarate

Alpha-ketoglutarate



Alpha-ketoglutarate is a key intermediate in the Krebs cycle, crucial for energy production, amino acid metabolism, and cellular function regulation.

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### Spermidine

Spermidine



Spermidine is a polyamine compound involved in cellular growth, proliferation, and apoptosis, known for its potential role in promoting autophagy and longevity, and is found in foods like aged cheese, soy products, and whole grains.

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### Palmitoylethanolamide

Palmitoylethanolamide



Palmitoylethanolamide (PEA) is a fatty acid amide that has anti-inflammatory and analgesic properties, commonly used as a natural supplement to support pain relief and reduce inflammation in various conditions.

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### Creatine

Creatine



Creatine is a natural compound that boosts ATP production for energy, commonly used to enhance athletic performance, increase muscle mass, and support brain health by improving cognitive function and brain energy metabolism.

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