Mito

Mitochondrial Analysis

Transform Your Cellular Health at the Source

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Biological Sex:
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Report for Sarah Smith

Date Received:
10/19/2025

Complex I	Complex II	Complex II + III	Complex IV	Citrate Synthase
Low	Low-Normal	Low	Normal	High
27%	52%	9%	94%	212%

Results Summary

[redacted]

You may benefit from supporting your body with key nutrients such as CoQ10, vitamin C, vitamin K2 (in the form of MK-4), riboflavin, iron, sulfur, and sulfur amino acids. Additionally, methylene blue and near-infrared light (700-1000 nm) may offer support. It's also important to minimize inhibitors of mitochondrial complexes I, II, and III in your diet, lifestyle, and medications. You may also benefit from a high-carb, low-fat diet, as well as supplemental glycine.

Your detailed action plan is found on page 18. In the next few pages, we explain your results in more detail.

Methods Used to Measure Your Respiratory Chain Activities

Buccal cells were isolated from your oral mucosa and analyzed for the enzymatic activities of citrate synthase, complex I, complex II, complex II + III, and complex IV of the mitochondrial respiratory chain. Citrate synthase is the first enzyme in the citric acid cycle, which operates inside the mitochondrion but is not part of the respiratory chain. These assays use standard spectrophotometric procedures to test the ability of substrates to be processed by these enzymes and electrons to flow to their proper targets.

All values were first expressed as **nanomoles per minute per milligram buccal protein**. Citrate synthase activity was then expressed as a percentage of control means. Citrate synthase can act as a marker of mitochondrial density but can also be upregulated in response to the cell's perception of a respiratory chain deficit. In the latter case, the balance between the respiratory chain and citrate synthase is often more informative than the absolute activity of the respiratory chain enzymes. Therefore, **respiratory chain enzymes were then normalized to citrate synthase activity** and then expressed as a percentage of control means.

The table below gives normal ranges based on 95% confidence intervals in control samples. Your percentages listed on the previous page are a percentage of the mean control. For example, if your citrate synthase was "100%," you can derive its activity in nanomoles per minute per milligram buccal protein by multiplying 100% times 12.1 in the below table, meaning it was operating at 12.1 nanomoles per minute per milligram buccal protein. You can then compare that to the normal range and conclude that it is normal.

Due to the lack of large sample sizes and associated statistical precision in these normal ranges, the Mitome analysis categorizes results as a percentage of control means into normal (70-140%), low (≤ 50%), high (≥ 200%), or low or high normal between these ranges, based on standardized cutoffs for the sake of optimal pattern analysis. This is the basis for the descriptors you see on the previous page and for any patterns we derive from those descriptors.

Enzyme Normal Ranges and Mean Activities

Activity Name	Normal Range	Mean ± SD
Citrate Synthase (CS)	4.4-22	12.1 ±5.1
Complex I (normalized to CS)	3.4- 11.9	6.8 ±2.0
Complex II (normalized to CS)	0.03-0.35	0.194 ±0.08
Complex II + III (normalized to CS)	0.032-0.152	0.092 ±0.03
Complex IV (normalized to CS)	0.15- 0.6	0.31 ±0.1

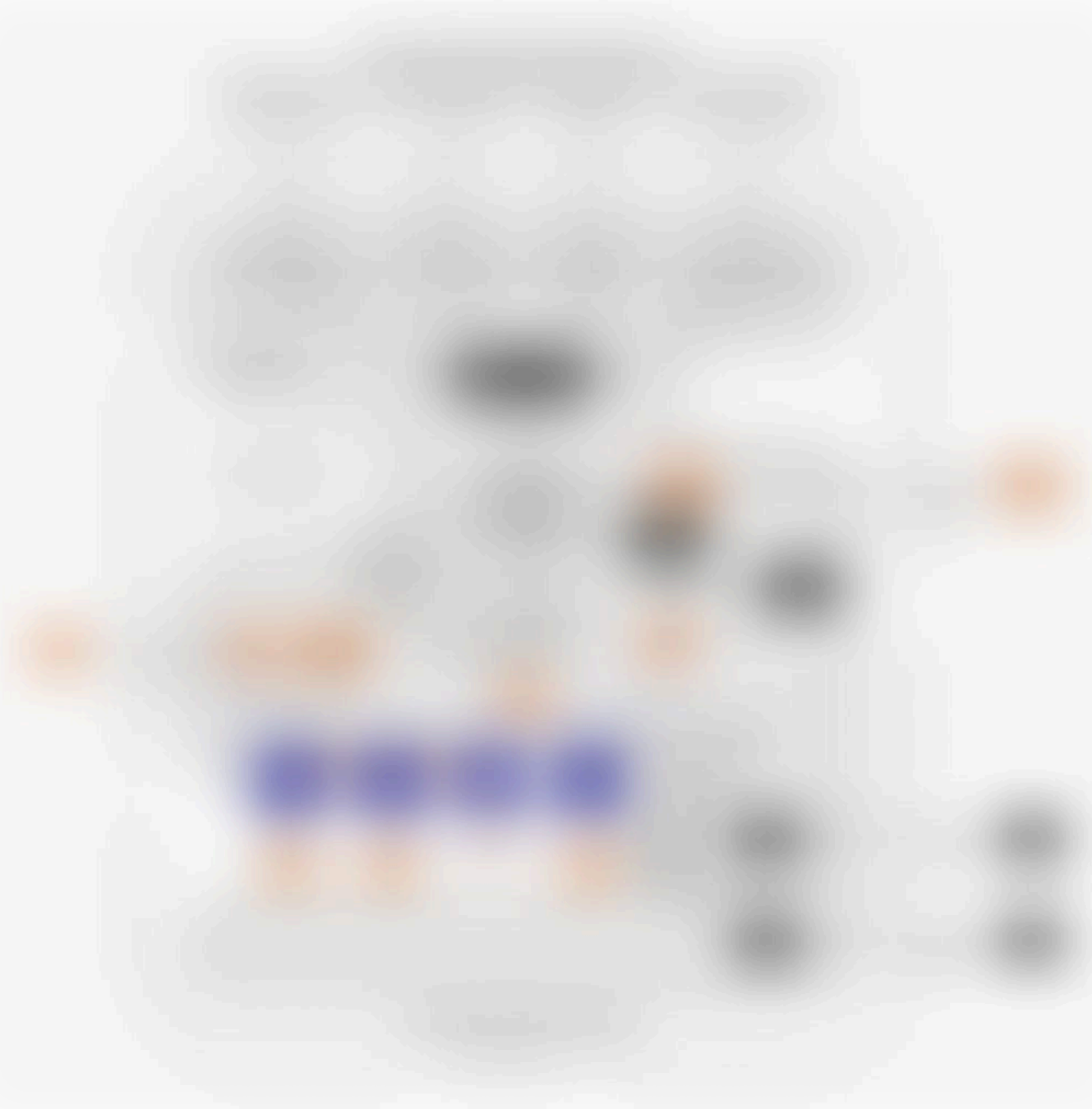
How We Interpret Citrate Synthase Activity

An Overview of Mitochondrial Energy Metabolism

Food is broken down into molecules such as amino acids, fatty acids, pyruvate, and ketone bodies that provide usable energy. These enter the mitochondria and are primarily converted to acetate, which is joined to coenzyme A (CoA) a derivative of the B vitamin pantothenic acid (vitamin B5), to form acetyl CoA. This acetyl CoA then enters the citric acid cycle, where the acetyl group is broken down into smaller components. Most of the usable energy is extracted as high-energy electrons that are carried away on NADH, a derivative of the B vitamin niacin (vitamin B3), which delivers them to complex I of the mitochondrial respiratory chain.

A portion of the high-energy electrons are sent to the respiratory chain as succinate, which delivers them to complex II, becoming fumarate with the help of FAD, a derivative of the B vitamin riboflavin (vitamin B2) which transfers them within complex II by interconverting with FADH2. The carbons of the acetyl group are released as carbon dioxide The respiratory chain is where we make 90% of our ATP, the main energy currency of the cell. We breathe in oxygen from the air, which draws electrons through the chain as it is converted to water. Electrons flow from complex I or II through complexes III and IV, using coenzyme Q10 (Q) and cytochrome C (C) as intermediaries. Complexes I, III, and IV use this energy to pump hydrogen ions (H+), which are used by ATP synthase to power ATP production.

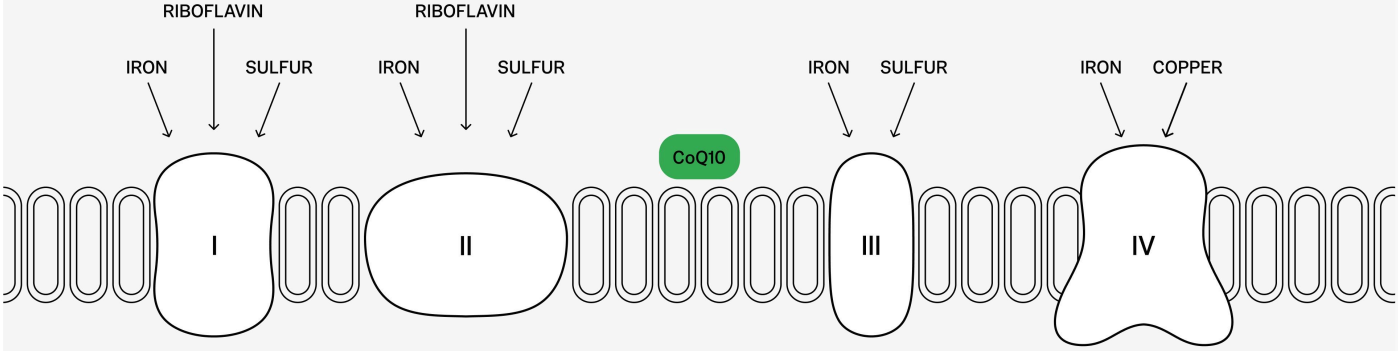
How Your Mitochondria Metabolizes Food to Energy



Interpreting Your Results

Nutritional Support for Mitochondrial Complexes

Each complex has unique nutrients that serve as cofactors to power the complex.



Impairments in Mitochondrial Function

Your test results reveal reduced complex I, II, and II + III activity, a critical finding that demands attention.

Complex I, II, and II + III dysfunction are primary drivers of mitochondrial inefficiency and have profound implications for cellular energy production, oxidative stress management, and long-term health outcomes.

As shown in the figure above, the complex II + III step measures everything between complex II and III, including the vitamin-like substance CoQ10 that bridges the gap between the two complexes. This measurement may have came in low simply because you need more CoQ10.

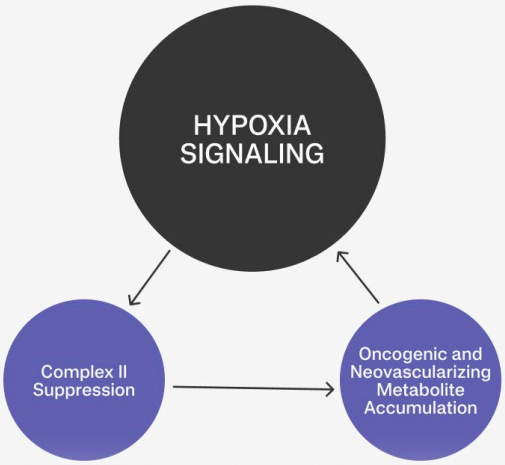
Potential Roles of Hypoxia in Suppressing Complex II

Excessive Hypoxia Signaling

A deficit in complex II can be genetic or nutritional but is often due excessive hypoxia signaling.

This suppresses complex II in order to increase the accumulation of metabolites that will lock in the hypoxia response when the cell perceives that the hypoxia is chronic.

Chronic excessive activation of this response can promote the growth of cancers and the excess formation of blood vessels, which can lead to abnormalities visible from the skin, such as petechiae, purpura, and varicose veins.



Impairments in Mitochondrial Function

Block in Complex III Function

The low complex II + III result may be due to a CoQ10 deficit or to a block at complex III. If complex III is blocked, supplements of vitamin C, sulfur amino acids (methionine and cysteine), and infrared light could help you, because these all bypass the first three complexes and feed energy directly into complex IV.

Optimizers & Bottlenecks

Your Bottleneck	Things That Hurt	Things That Help

Complex II

[illegible]

Complex I

Complex I functions as the critical supercharger of your respiratory chain. When dysfunctional, your cells produce 40% less ATP from the same food intake—dramatically reducing your energy output and metabolic efficiency.

This substantial energy deficit not only manifests as daily fatigue but compromises your body's ability to perform essential maintenance and repair functions necessary for optimal health and longevity.

Addressing **low complex I** activity is therefore a non-negotiable priority for restoring full mitochondrial capacity and ensuring your cells can generate maximum energy for both immediate performance and long-term cellular health. We want 100% of the ATP we can make.

The three nutrients most important to complex I are **riboflavin, iron,** and **sulfur.**

Riboflavin: Sources of riboflavin are listed in the previous section on Complex II.

Iron: Sources of iron are listed in the previous section on Complex II + III.

Sulfur: Sources of sulfur are listed in the previous section on Complex II + III.

Metformin and **berberine** are two common supplements that hurt complex I activity. Caprolactam is a complex I inhibitor that can leach from **nylon clothing** while sweating. A larger list of inhibitors can be found in the table on page 9. If you are using any of these for medical purposes, you may want to discuss their use with your doctor.

Your Personal Protocol

The protocol we have put together for you below is meant to be streamlined and simplified, giving you the highest-impact strategies curated for their ability to synergize together and address your specific bottlenecks, and assembled to be implemented **one at a time in the specific order they are given for maximal effect**.

In order to simplify and streamline the protocol, we have to assume that you're already optimized on all the basics. Therefore, before trying to implement your protocol, we ask that you run through the checklist below to make sure you're hitting all the General Mitochondrial Health points.
If not, stop and try to implement them, take some time to stabilize on your new normal, and then implement your Personal Protocol.

The Supplements are Unique to You

The Mitome report does not focus on generic recommendations for mitochondrial support.

This is not primarily a test of whether your mitochondrial function is good or bad.

It is a test of what the specific, limiting bottleneck in your mitochondrial function is, and the resulting protocol is uniquely tailored to you and not expected to be generalized to most people around you.

The Amount and Step-by-Step Order of Your Protocol are Critical

You may already be taking a supplement that is recommended in your protocol. If you are, compare it to the amount range given. The doses are selected based on a synthesis of the human trial literature, case reports, and Dr. Masterjohn's prior experience with clients. If you are already exceeding the top of the amount range, you can skip that step in the protocol. If you are not, however, you should use that step as an opportunity to experiment with the amount you are using.

The order of the protocol is highly curated to avoid stimulating pathways that will run into downstream energetic blocks. It is critical to implement each step one at a time and in the order provided.

Setting Up Your Tracking

Protocol Snapshot

Complex I, II and III Inhibitors: Remove Unnecessary Exposures | Altitude and Oxygen Adjustment | Assess Manganese Overload | Iron | Vitamin C | Alpha-Ketoglutaric Acid | Ubiquinol | Riboflavin | Sulfur/Cysteine | Vitamin K2 (MK-4) | Near Infrared Light | Medications | Low-Fat, High-Carbohydrate Diet | Glycine | Adjust Your Carbohydrate Intake | Methylene Blue

Your Protocol Recommendations

03 Assess the Possibility of Manganese Overload and Detox If Necessary

04 Iron

Suggested Range:
Proferrin Clear, 1–4 capsules per day, taken with meals.

Before supplementing, you can try increasing your intake of red meat and decreasing your intake of plant foods.

If you are a vegetarian, you can try increasing your intake of greens. If you are open to eating egg yolks, shellfish, or fish, eating these alongside greens will improve iron absorption.

If the foods do not optimize your labs, find the lowest dose of the supplement that does.

Ideally this step is optimized by running several labs: an iron panel (serum iron, unbound and total iron-binding capacity [UIBC and TIBC], iron saturation %, transferrin, ferritin, and soluble transferrin receptor. Calculate the transferrin saturation by dividing serum iron by transferrin and multiplying it by 0.709. Aim to keep iron saturation and transferrin saturation in the 30-40% range and soluble transferrin receptor under 3 mg/L. Cut back on iron if iron or transferrin saturation run consistently above 40% while soluble transferrin receptor is simultaneously under 3 mg/L.

If ferritin is above 200 ng/mL while iron and transferrin saturation are below 30% and/or soluble transferrin receptor is above 3 mg/L, try bringing ferritin down with one or two scoops of whey protein, 1000 milligrams per day of curcumin, and 1000 milligrams once or twice per day of black seed oil.

If your complete blood count (CBC) shows you are anemic despite these labs being optimized, work with your doctor to find the cause of anemia and resolve it.

Once your labs are fully optimized, you can move on to step 5.

05 Vitamin C

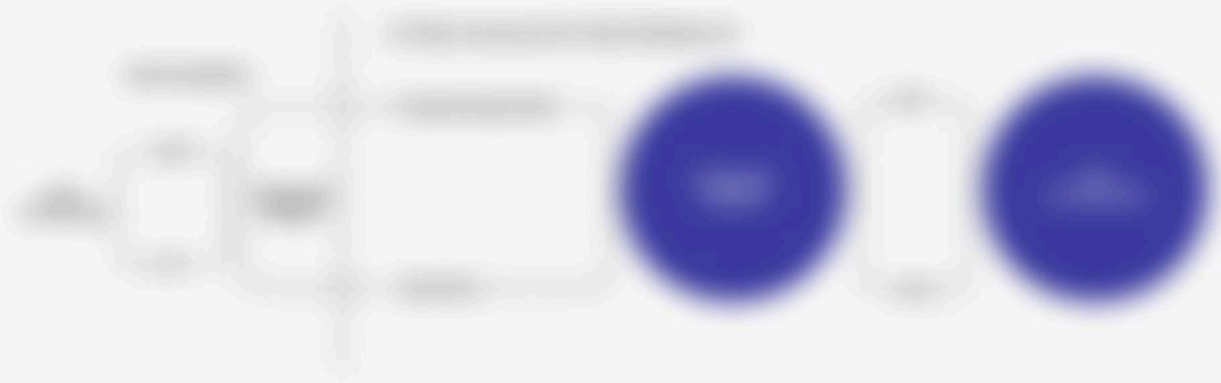
06 Alpha-Ketoglutaric Acid

Suggested Range: 1000-4000 milligrams of alpha-ketoglutaric acid.

Alpha-ketoglutaric acid cannot be obtained from specific foods in defined amounts due to large variability and poor database coverage, so supplements are the only option for this step.

See the discussion on the right side, however, for whether this supplement is needed.

Additional Mitochondrial Support Strategies

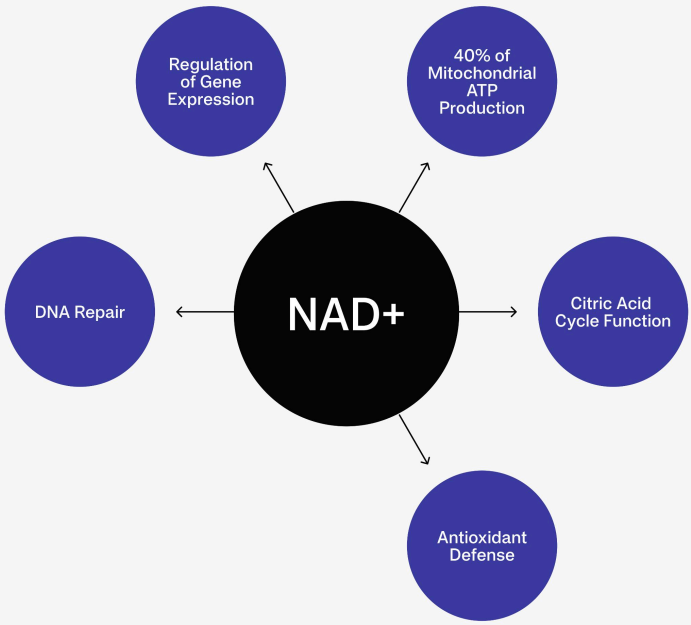


Disclaimer(s): This report contains affiliate links, meaning we may earn a commission if you click on a link and make a purchase through one of our affiliate partners. Please see the Affiliate Disclosure on our Website Terms of Use for more information. The supplements and the doses listed are provided as general parameters based on our analysis of cellular function and scientific literature to predict what would be most helpful when optimizing mitochondrial health. This should be reviewed with your healthcare provider before implementation. Individual needs may vary. This analysis and the associated sample protocol are for informational purposes only and are not intended to diagnose, treat, cure, or prevent any disease. Always consult with a qualified healthcare professional before starting any supplement protocol.

NAD+

Suggested Range:
Tru Niagen, 300 milligrams per day.

Many mitochondrial problems are due to genetic deficiencies in replicating or repairing mitochondrial DNA. These often respond to supplementation with NAD+ precursors such as nicotinamide riboside.



NAD+ Role in Mitochondrial Function

Fasting-Feeding Reset

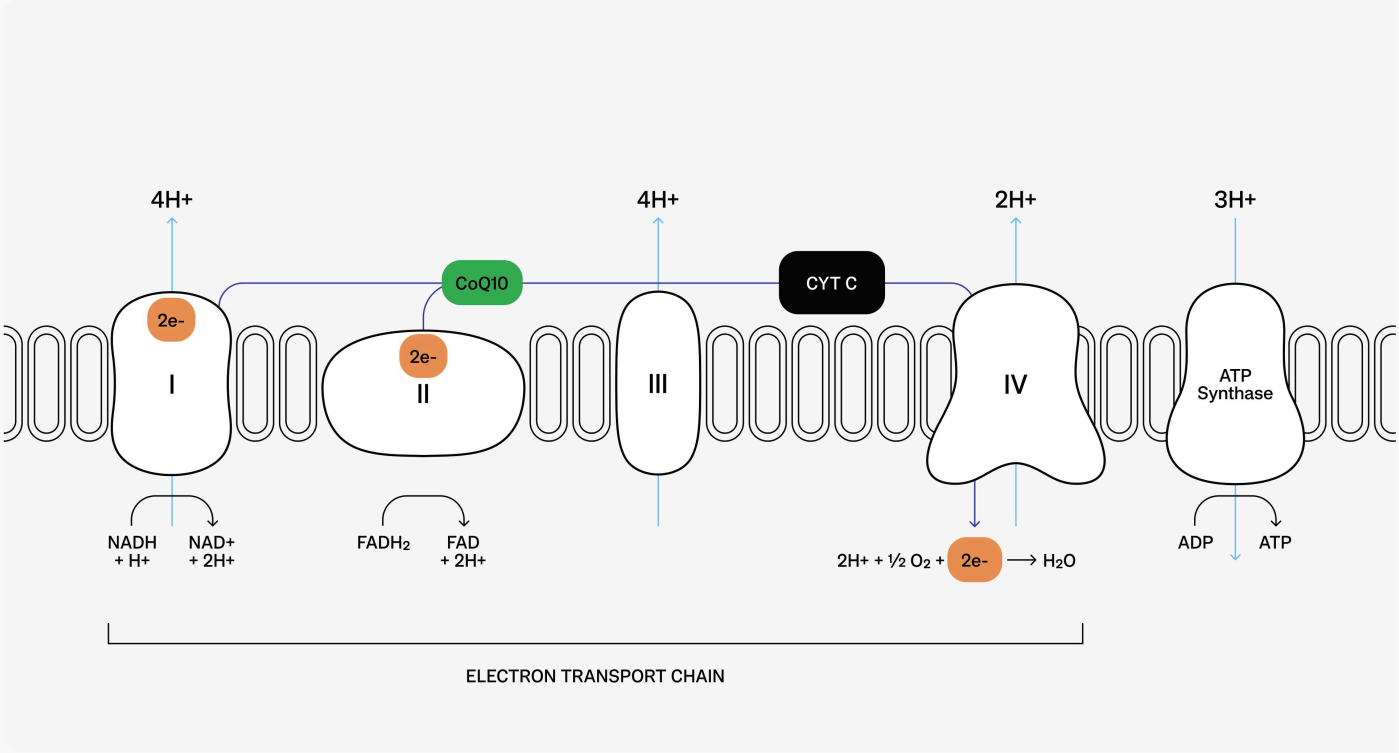
The Research Backing Your Protocol

We analyzed the four major respiratory chain complexes within your mitochondria and categorized you into one or more of twelve distinct patterns. This breakthrough analysis represents a fundamental advancement in longevity, as mitochondrial function is now recognized as one of the primary drivers of biological aging. By identifying your specific bioenergetic profile, we've pinpointed exactly what you should be focused on for optimizing not just your daily energy production, but the cellular mechanisms that determine your health trajectory over decades. Email us to join our waitlist for how to take your Mitome results to the next level with whole genome sequencing for even further individualization and optimization.

The science behind the underlying lab test includes hundreds of papers on the utility of testing respiratory chain results in biopsies and skin fibroblasts, and the studies showing the correlation between cheek swab and muscle biopsy results.

Mitome is an proprietary interpretive algorithm built on the base layer of the respiratory chain testing that is based on Dr. Masterjohn's unique analysis of the published literature as well as an in-house sample of over 150 clients analyzed over the past two years where respiratory chain analysis was cross-referenced to whole genome sequencing and testing of amino acids, organic acids, vitamin concentrations inside and outside cells, acylcarnitine and acylglycine profiles, complete blood counts, metabolic panels, and assorted other biochemical markers, as well as client responses to protocols derived from this data.

Mitome synthesizes the unique pattern analysis generated from this dataset with published biochemical literature and insights from case reports of respiratory chain disorders to produce a unique protocol for each person.



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The supplement suggestions and dosage guidelines included in this report are based on our proprietary analysis of mitochondrial function, interpreted from your cheek swab sample and current scientific literature. These recommendations are provided for general informational and educational purposes only.

This report is not intended to diagnose, treat, cure, or prevent any disease, and is not a substitute for professional medical advice, diagnosis, or treatment. The content has not been reviewed or approved by the U.S. Food and Drug Administration (FDA).

Interpretation of results may be affected by sample quality, laboratory variability, and the evolving nature of mitochondrial science. The findings presented here are not intended for clinical or diagnostic use.

Always consult a licensed healthcare professional before beginning any supplement protocol, making dietary changes, or taking action based on this report. Individual responses and needs may vary.

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For questions or support, contact us at support@mito.me or visit www.mito.me.

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Client ID:
MITO-252866

Biological Sex:
Female

Kaitlyn Quebbemann

Date Received:

Complex I	Complex II	Complex II + III	Complex IV	Citrate Synthase
Low	Normal	Low	Normal	High
37%	72%	10%	88%	237%

Results Summary

Your mitochondrial complex I activity is at 37% of normal function, and your mitochondrial complex II + III activity is at 10% of normal function, which are low, while your mitochondrial complex II activity is significantly higher than your mitochondrial complex I activity. Complex I is the first and largest enzyme in the electron transport chain—the cellular process that generates most of your ATP (energy) – and is especially important for your ability to burn carbohydrates, while complex II + III is responsible for making energy from all fuel types, and complex II is more important for burning fat. This combined dysfunction reduces your cells' ability to efficiently metabolize all fuels for energy production, potentially decreasing your overall energy capacity by up to 60%, which substantially reduces your energy production, affecting both your daily performance and your body's capacity to maintain long-term health functions. However, complex II functioning much better than complex I means your cells generate ATP more efficiently when using fat as a primary fuel source compared to carbohydrates, which can allow a low-carbohydrate, high fat diet to **create an energetic advantage.**

You may benefit from supporting your body with key nutrients such as CoQ10, vitamin C, vitamin K2 (MK-4), sulfur amino acids, riboflavin, iron, sulfur, methylene blue, succinate, alpha-ketoglutarate, and glutamine. Additionally, near-infrared light (700-1000 nm) may offer support. It's also important to minimize inhibitors of mitochondrial complexes I and III in your diet, lifestyle, and medications. A low-carb, high-fat diet may further support optimal function.

If you have experimented with a low-carb diet in the past and did not find it helpful, we have included suggestions for how to address this in your protocol.

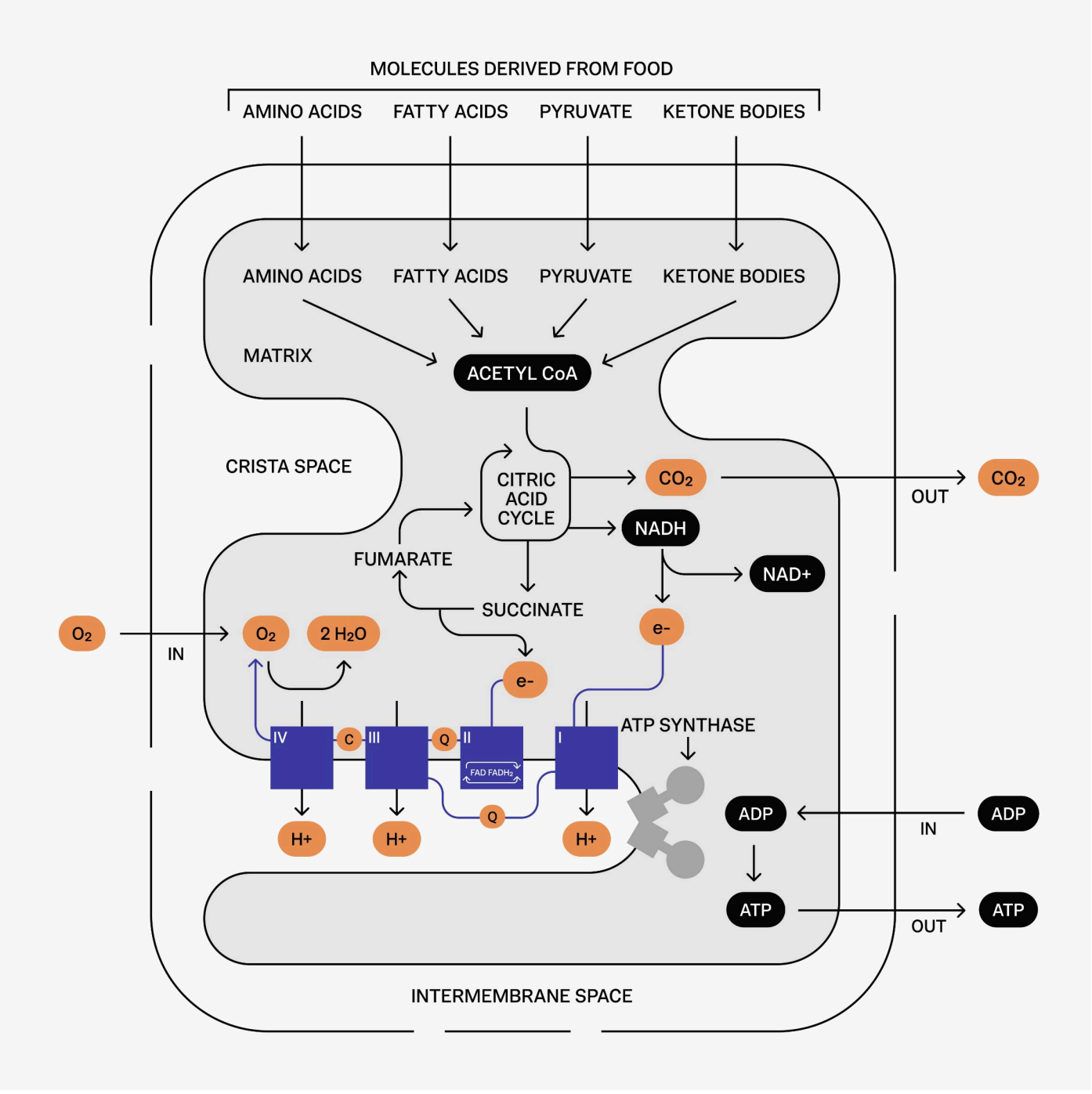
Your detailed **action plan is on page 13**, with the following sections providing an in-depth explanation of your results.

An Overview of Mitochondrial Energy Metabolism

Food is broken down into molecules such as amino acids, fatty acids, pyruvate, and ketone bodies that provide usable energy. These enter the mitochondria and are primarily converted to acetate, which is joined to coenzyme A (CoA) a derivative of the B vitamin pantothenic acid (vitamin B5), to form acetyl CoA. This acetyl CoA then enters the citric acid cycle, where the acetyl group is broken down into smaller components. Most of the usable energy is extracted as high-energy electrons that are carried away on NADH, a derivative of the B vitamin niacin (vitamin B3), which delivers them to complex I of the mitochondrial respiratory chain.

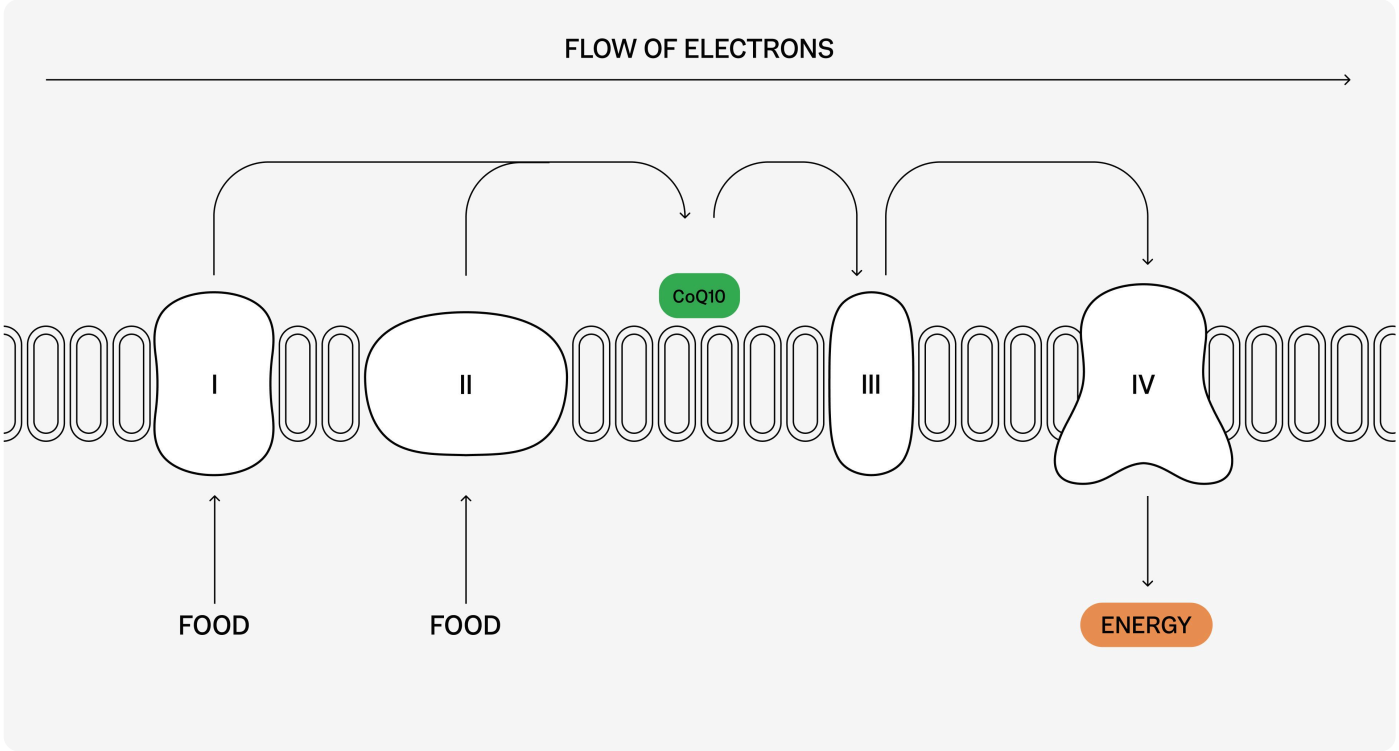
A portion of the high-energy electrons are sent to the respiratory chain as succinate, which delivers them to complex II, becoming fumarate with the help of FAD, a derivative of the B vitamin riboflavin (vitamin B2) which transfers them within complex II by interconverting with FADH2. The carbons of the acetyl group are released as carbon dioxide The respiratory chain is where we make 90% of our ATP, the main energy currency of the cell. We breathe in oxygen from the air, which draws electrons through the chain as it is converted to water. Electrons flow from complex I or II through complexes III and IV, using coenzyme Q10 (Q) and cytochrome C (C) as intermediaries. Complexes I, III, and IV use this energy to pump hydrogen ions (H+), which are used by ATP synthase to power ATP production.

How Your Mitochondria Metabolizes Food to Energy



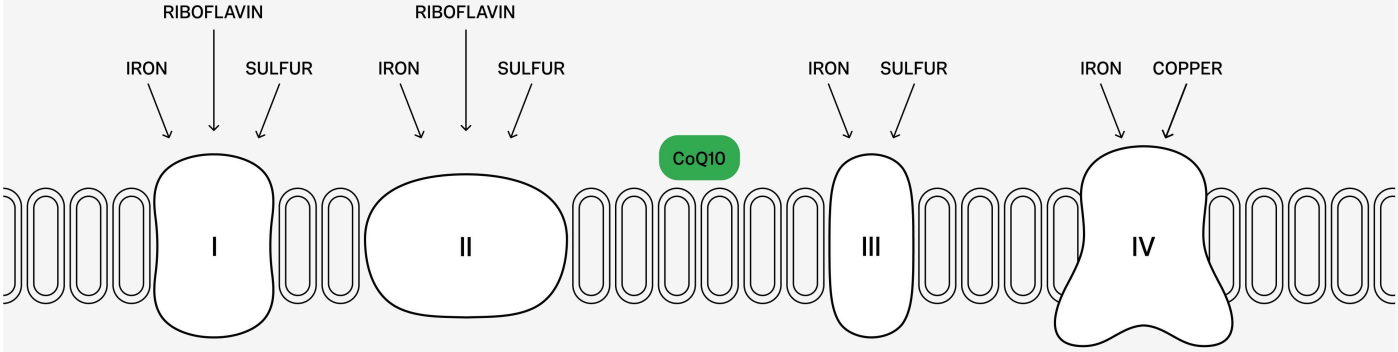
Interpreting Your Results

Each complex that we measured tests a specific aspect of your mitochondrial function. Together, the complexes form the major parts of the **respiratory chain**, which is shown below. Most foods that you eat enter in at complex I or II. Electrons are particles that carry energy from your food through the chain. CoQ10 is a vitamin-like substance that moves electrons from complexes I and II to complex III. Our **complex II + III** measurement includes a glimpse of how CoQ10 is functioning. Electrons finally move to complex IV. The movement of electrons across this chain drives the production of cellular energy.



Nutritional Support for Mitochondrial Complexes

Each complex has unique nutrients that serve as cofactors to power the complex.



Impairments in Mitochondrial Function

Your test results reveal **reduced complex I and II + III activity**, a critical finding that demands attention.

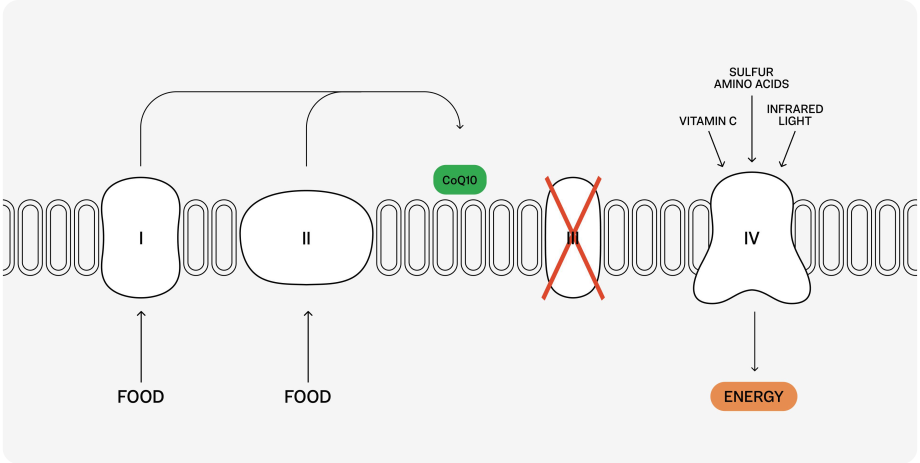
Complex I and II + III dysfunction is a primary driver of mitochondrial inefficiency and has profound implications for cellular energy production, oxidative stress management, and long-term health outcomes.

As shown in the figure above, the complex II + III step measures everything between complex II and III, including the vitamin-like substance CoQ10 that bridges the gap between the two complexes. This measurement may have came in low simply because you need more CoQ10.

Impairments in Mitochondrial Function

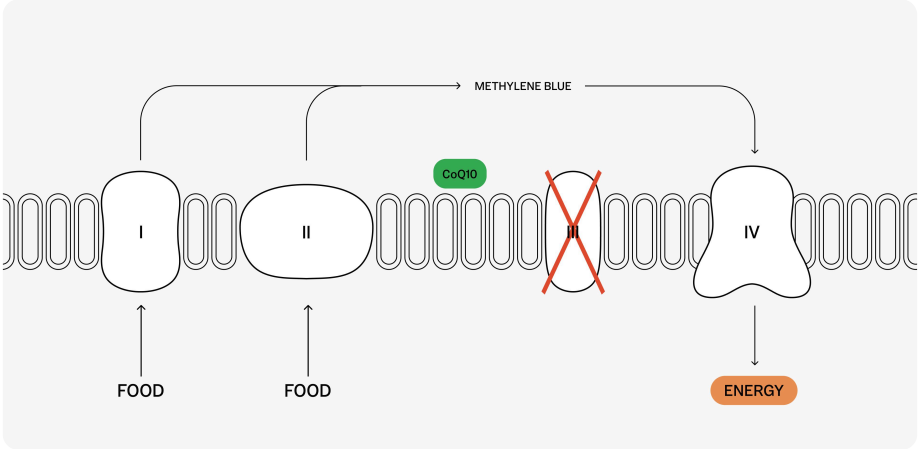
Block in Complex III Function

The low complex II + III result may be due to a CoQ10 deficit or to a block at complex III. If complex III is blocked, supplements of vitamin C, sulfur amino acids (methionine and cysteine), and infrared light could help you, because these all bypass the first three complexes and feed energy directly into complex IV.



How Methylene Blue Rewires the Respiratory Chain

Further, as shown in the figure, methylene blue can help take energy from complexes I and II and drop it off at complex IV, skipping over a block at complex III. This can help you extract even more energy from your food.



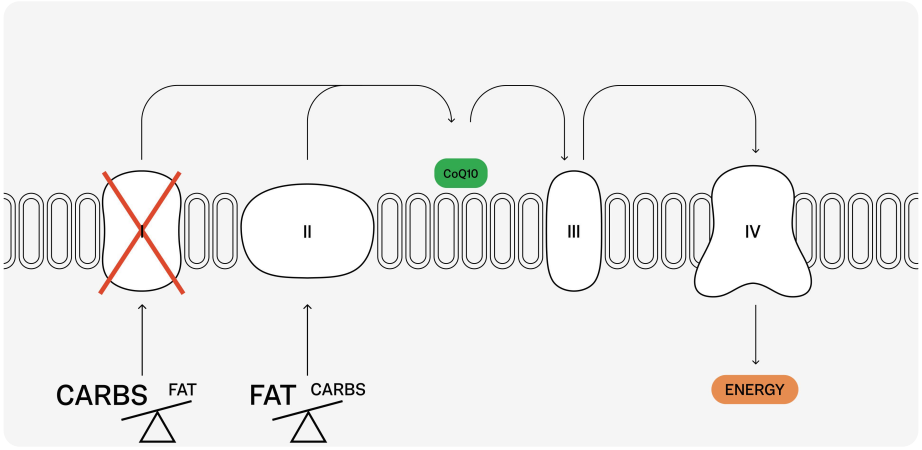
Fix Complex I, Feed Complex II

Because your complex I is low and complex I is powered by riboflavin, iron, and sulfur, these three nutrients may be especially important for you. In addition, many inhibitors of complex I are shown in the table on the following page.

While both carbs and fat feed into both complexes I and II, as shown in the figure, carbs make much greater use of complex I than fats do, whereas fats make much greater use of complex II than carbs do. This means you may run better on a low-carb, high-fat diet.

There are other factors that govern your tolerance of fat versus carbohydrate, and they include your status of riboflavin (vitamin B2), pantothenic acid (vitamin B5) and CoQ10, so if you have not done well on a low-carb diet in the past we will help guide you through these synergistic factors in your protocol.

Addressing these specific mitochondrial bottlenecks are essential not only for improving current energy levels but for preserving long-term cellular integrity and health span.



Optimizers & Bottlenecks

The table below lists a variety of nutrients, lifestyle factors, environmental toxicities, and medications that may help or hurt each notable issue we found in your respiratory chain. This is meant as a general reference for you. The pages that follow explain each component in more detail. Your final protocol simplifies this by selecting the factors we consider most important for you, reconciling any conflicts, and placing everything in the ideal order for you to experiment with.

Your Bottleneck	Things That Hurt	Things That Help
Low Complex I	High-carbohydrate diets, Antidiabetics (berberine, metformin, troglitazone, rosiglitazone, pioglitazone), aspirin, celastrol (from thunder god vine), flavonoids from Annonacee fruits, rhein, capsaicin, papaverine, tetrahydropapaverine, and natural antimicrobials (e.g., piericidin A, phenalamide A2, aurachin A and B, thiangazole, aureothin, myxothiazole), insecticides (fenpyroximate, pyridaben, tebufenpyrad, fenazaquin,cyhalothrin, benzothiadiazole), preservatives (phenoxan), anti-helminths (benzimidazole, 2M-TIO), antibiotics (myxalamid, pterulone, pterulinic acid, and those ending in -mycin), antipsychotics (haloperidol, chlorpromazine, fluphenazine, risperidone, clozapine, quetiapine), antidepressants (sertraline, fluoxetine, imipramine, citalopram, amitriptyline, desipramine, mirtazapine, paroxetine) cholesterol-lowering drugs (fenofibrate, ciprofibrate, gemfibrozil, atorvastatin) antiarrhythmics (flunarizine, amiodarone), antihistamines (cinnarizine), muscle relaxant metabolites (laudanosine), narcotics (meperidine), antiseptics (dequalinium chloride), and anesthetics (bupivacaine, lidocaine, halothane), AZT (an antiretroviral), doxorubicin, cyclophosphamide, flutamide, dantrolene, and phenytoin, caprolactam from nylon clothing, PVC, catechol (from rubber/plastic), the solvent DMSO, the fish poison rotenone and its derivative deguelin, inorganic mercury, and arsenic	Riboflavin, iron, sulfur
Low Complex II + III	Acetaminophen, aspirin, piericidin A and antibiotics ending in -mycin, the anesthetic bupivacaine, diabetes drugs (pioglitazone, ciglitazone, darglitazone, muraglitazar, troglitazone, rosiglitazone), cholesterol-lowering drugs (atorvastatin, cerivastatin, fluvastatin, lovastatin, simvastatin, pravastatin), antidepressants (sertraline, fluoxetine, paroxetine, imipramine, amitriptyline, desipramine, venlafaxine, mirtazapine, tianeptine, nefazodone), immunosupressives (leflunomide, teriflunomide, sirolimus), antifungals and fungicides (myxothiazol, famoxadone, azoxystrobin, diuron, maneb, picoxystrobin, ethylene bisdithiocarbamate), HIV drugs (AZT, zalcitabine), amiodarone (antiarrhythmic) diclofenac (NSAID), tamoxifen (cancer), ethylxanthate (used in mining) aluminum, bisulfate (additive), promethazine (antihistamine), chlorpromazine (antipsychotic) propylhexidrine, used in the nasal decongestant Benzedrex and the appetite suppressant Eventin, and the serotonin-releasing drug fenfluramine, sold under the brand names Fintepla and Pondimin, lead	CoQ10, iron, sulfur, sulfur amino acids, vitamin C, vitamin K2 (as MK-4), near infrared (700-1000 nm), methylene blue
Complex II functions much better than Complex I	High-carb diet, excessive glycine	High-fat, low-carb diet, succinate, alpha-ketoglutarate, glutamine

Complex II + III

Our **complex II + III** measurement encompasses complexes II and III together, along with the vitamin-like substance CoQ10 that bridges the gap between them.

Because energy moves from complexes I and II through this step on the way to complex IV, a block at this step hurts the function of everything that comes before it. That means it takes a huge whack at your ability to burn fat, feel energized, and to invest energy in your performance and long-term health.

Addressing **low complex II + III** activity is therefore a non-negotiable priority for restoring full mitochondrial capacity and ensuring your cells can generate maximum energy for both immediate performance and long-term cellular health. We want 100% of the ATP we can make.

Fortunately, most people who show low complex II + III can resolve it simply by supplementing with CoQ10.

However, it is possible that your block lies deep within complex III rather than at the point of CoQ10, in which case too much CoQ10 could actually put stress on your mitochondria. Later in your protocol, we teach you how to figure this out by measuring your finger prick lactate to optimize your CoQ10 dose.

Complex III depends on two nutrients, **iron** and **sulfur**. You may be able to improve your complex III function by obtaining enough of these nutrients.

Iron: 8 milligrams per day covers most people's needs; women with heavy periods may need up to 18 milligrams, while needs rise to 22 milligrams in pregnancy and 27 milligrams during lactation. 8 milligrams can be obtained from 10 ounces of red meat. While many plant foods are rich in iron, plant foods are universally rich in a wide variety of inhibitors of iron absorption, so the simplest way to get enough iron is to increase red meat and decrease plant foods. Where this is impractical or undesirable for other reasons, the supplement Proferrin Clear can be used in most cases. For cases of duodenal inflammation from a gastrointestinal disorder or surgical removal of large sections of the duodenum, a part of the intestines, iron bisglycinate can be used instead.

Sulfur: Sulfur is best obtained from the sulfur amino acids that occur in protein. These are richest in eggs and dairy, next richest in meat and fish, and lowest in plant proteins. However, if you just make sure to get a half gram to one gram of protein per pound of bodyweight (or one to two grams per kilogram bodyweight) per day from natural foods, you will get enough sulfur. The easiest way to do this is to consume an animal protein roughly the size of your palm (or a third the size of a dinner plate) with every meal, or to focus on legumes (lentils, peas, and beans) as your primary source of plant food.

Complex III inhibitors include **acetaminophen (Tylenol)**, several **anesthetics** (isoflurane, sevoflurane, propofol), **antibiotics** ending in -mycin, **mold toxins,** some commercial **fungicides**, and **propylhexedrine**, used in the nasal decongestant Benzedrex, the appetite suppressant Eventin, and the serotonin-releasing drug **fenfluramine**, sold under the brand names Fintepia and Pondimin. If you are using any medications in this list you may wish to discuss this with your doctor.

If complex III function cannot be fully rescued by supplying needed nutrients and removing inhibitors, two types of strategies may improve energy production: the first relies on feeding complex IV directly; the second relies on moving energy from complexes I and II to complex IV, skipping over complex III.

Vitamin C, vitamin K2 in the MK-4 form, sulfur amino acids (methionine and cysteine), and near infrared light in the 700-1000 nanometer range all feed complex IV directly.

Methylene blue, a synthetic dye with a century-long history of use in medicine that can be bought online without a prescription, can help with the second strategy. This second strategy allows more total energy to be produced than the first one, but both strategies can be used together.

Complex I

Complex I functions as the critical supercharger of your respiratory chain. When dysfunctional, your cells produce 40% less ATP from the same food intake—dramatically reducing your energy output and metabolic efficiency.

This substantial energy deficit not only manifests as daily fatigue but compromises your body's ability to perform essential maintenance and repair functions necessary for optimal health and longevity.

Addressing **low complex I** activity is therefore a non-negotiable priority for restoring full mitochondrial capacity and ensuring your cells can generate maximum energy for both immediate performance and long-term cellular health. We want 100% of the ATP we can make.

The three nutrients most important to complex I are **riboflavin, iron,** and **sulfur**.

Riboflavin: 6 milligrams of riboflavin per day covers nearly everyone's needs. The best sources of this nutrient are liver, kidney, heart, and almonds. Just one or two servings per day of these foods gives you enough. Alternatively, you can also get enough from four or five servings of these foods: red meat, cheese, eggs, salmon, mushrooms, seaweed, sesame, wheat germ and bran.

Iron: Sources of iron are listed in the previous section on Complex II + III.

Sulfur: Sources of sulfur are listed in the previous section on Complex II + III.

Metformin and **berberine** are two common supplements that hurt complex I activity. Caprolactam is a complex I inhibitor that can leach from nylon clothing while sweating. A larger list of inhibitors can be found in the table on page 11. If you are using any of these for medical purposes, you may want to discuss their use with your doctor.

Feeding Complex II

Since your complex II functions much better than your complex I, you are an excellent candidate for a **low-carbohydrate, high-fat, ketogenic diet.** This means restricting starches like bread, pasta, whole grains, legumes (lentils, peas, and beans), fruit, root vegetables like potatoes and carrots, fruits, fruit juices, and added sugars. In place of these foods, you incorporate coconut, macadamia nuts, avocados, egg yolks, fatty meats, and added fats and oils like MCT oil, butter, and olive oil.

There are other factors involved in whether you tolerate carbohydrate or fat best. You may have had a contradictory experience in the past due to poor fat digestion or due to a genetic problem with fat metabolism that could respond to vitamin B2, vitamin B5, or CoQ10. We help guide you through these considerations in your protocol.

Other nutrients that feed primarily into complex II are **succinate, alpha-ketoglutarate**, and **glutamine**. Succinate and alpha-ketoglutarate are best gotten from supplements, while glutamine can be gotten from both supplements and food. The best food sources of glutamine are chicken drumsticks and pork hindshanks. Milk, cheese, whey protein, and casein have moderate amounts of glutamine.
If you use chicken drumsticks or pork hindshanks for glutamine it is important to add them over and above the protein you are currently eating because their high glutamine content comes at the expense of many other important amino acids.

By following this precise sequence, you're not only optimizing current cellular function but systematically addressing the key mitochondrial factors that influence biological aging and longevity potential.

Your Personal Protocol

The protocol we have put together for you below is meant to be streamlined and simplified, giving you the highest-impact strategies curated for their ability to synergize together and address your specific bottlenecks, and assembled to be implemented **one at a time in the specific order they are given for maximal effect**.

In order to simplify and streamline the protocol, we have to assume that you're already optimized on all the basics. Therefore, before trying to implement your protocol, we ask that you run through the checklist below to make sure you're hitting all the General Mitochondrial Health points.
If not, stop and try to implement them, take some time to stabilize on your new normal, and then implement your Personal Protocol.

The Supplements are Unique to You

The Mitome report does not focus on generic recommendations for mitochondrial support.

This is not primarily a test of whether your mitochondrial function is good or bad.

It is a test of what the specific, limiting bottleneck in your mitochondrial function is, and the resulting protocol is uniquely tailored to you and not expected to be generalized to most people around you.

The Amount and Step-by-Step Order of Your Protocol are Critical

You may already be taking a supplement that is recommended in your protocol. If you are, compare it to the amount range given. The doses are selected based on a synthesis of the human trial literature, case reports, and Dr. Masterjohn's prior experience with clients. If you are already exceeding the top of the amount range, you can skip that step in the protocol. If you are not, however, you should use that step as an opportunity to experiment with the amount you are using.

The order of the protocol is highly curated to avoid stimulating pathways that will run into downstream energetic blocks. It is critical to implement each step one at a time and in the order provided.

Setting Up Your Tracking

Develop a quantitative health score for the things you care most about related to your well being, and record it on a daily basis to track how it changes while implementing the protocol.

Measure glucose, ketones, and lactate at least three times before and after each step of the protocol so that if anything becomes too much for your body you have an objective and leading indicator. Measure them at least upon waking. You may add another metric such as after lunch or before bed if you have repeated cyclical health problems that occur at specific times during the day, or if you collect exploratory data and notice one or more of the values is usually highly abnormal at a certain time of the day.

Recommended products for doing this: KetoMojo meter and strips (glucose and ketones), Novabiomedical Lactate Plus meter, Novabiomedical Lactate Plus strips, alcohol pads; If you plan to do a LOT of testing, extra KetoMojo strips, extra lactate strips, and extra 30g lancets.

When testing, wash finger with soap, rinse, wipe with alcohol pad, puncture, lightly massage finger if needed but do not squeeze, wipe away first 2-3 drops of blood, then test.

Waking glucose should be under 90 and close to 80; waking lactate should be 0.5-0.9; postprandial glucose should be under 140 at any time point and ideally close to 100 after one hour; postprandial lactate should be under 1.5 and ideally 0.9-1.2.

Our recommended format for tracking: Keep a spreadsheet where each row represents a day. Have a column each for your glucose, ketones, and lactate, and for each quantitative health score you track, and include a final column for any notes that may be important. When you make major changes in your protocol, insert a highlighted header row. The highlighted header rows will allow you to more easily spot how changes in your protocol led to changes in your results.

By following this precise sequence, you're not only optimizing current cellular function but systematically addressing the key mitochondrial factors that influence biological aging and longevity potential.

General Mitochondrial Health

First make sure your diet is providing a good baseline intake of all nutrients. The best way to get all your micronutrients in is to have an average daily intake of one or two ounces of liver; one or two oysters; a tablespoon or two of unfortified nutritional yeast; several servings of something rich in vitamin C such as bell peppers or strawberries; two to four servings of a calcium-rich food like dairy, bones (but not bone broth), or three to five servings of dark greens (mainly napa cabbage, Chinese mustard greens, bok choy, kale, or broccoli); and a large volume of potassium-rich foods, such as the lean portions of meat, eggs, and milk; legumes, such as lentils, peas, and beans; or tubers such as potatoes; and fruits and vegetables. Include small amounts of pro-digestive foods like fermented vegetables, ginger, or bitters at each meal, and focus on foods you digest well.

If you don't follow these rules of thumb, track your diet in Cronometer (see How to Track Your Diet in Cronometer) to make sure you are hitting all the micronutrient targets.

If you cannot meet your micronutrient targets with foods, use a **high-quality** multivitamin such as **Adapt Naturals** and **Seeking Health Optimal Multivitamin Chewable**.

Make sure to get a half hour of outdoor sunlight each morning (even if it is raining, get outside under shelter), enough sun each day to feel warmed by it at least once, and some unprotected sun on your skin in the afternoon. You should never get burned and you never need to experience any color change to obtain maximal benefit from the sun.

Each week, your exercise should include at least one all-out 30-second sprint (not necessarily running, it could be on a bike or rower but should be an attempt to hit your maximal heart rate) and preferably a series of four to eight of these sprints with short rests between them in interval format, one cardio session where you hit a pace you could only sustain for an hour carried out for that duration, one cardio session where you hit a mix of different intensities (a sports game or group workout class could fit), and six to nine sets of resistance exercise for each of the following domains: upper body vertical pull (e.g. pullup), upper body vertical push (e.g. overhead press), upper body horizontal pull (e.g. row), upper body horizontal push (e.g. pushup), lower body pull (e.g. deadlift), lower body push (e.g. squat), horizontal rotation (self-explanatory), and diagonal rotation (e.g. regular and reverse chop and lifts). Make sure elements of your exercise challenge your balance, your ability to quickly change directions, your ability to be quick on your feet, and your ability to respond to unexpected stimuli outside your control (such as having to catch a ball that someone else throws). Get as much light movement in as possible, aiming for at least one if not several hours per day.

Make time for psychologically winding down before bed and getting eight hours of sleep every night.

Spend some time in nature at least once a week, even if it's just a walk on the beach or through the woods.

Maintain healthy practices for coping with psychological and emotional stress, maintain a strong sense of purpose, and maintain healthy relationships with friends and family.

Make an effort to minimize the use of plastic in cooking, water supply, and food storage; to minimize the use of toxic sanitizers and cleaners; to maintain a mold-free living environment; to use natural fabrics for clothing rather than synthetics; and to be a minimalist toward pharmaceuticals, using them only when necessary.

Be deliberate and mindful about your use of wifi and cell phones. Turn your wifi off when you sleep, use wired connections instead of wireless whenever it is practical, and put maximal distances between your electronic devices and your body whenever you can, especially between your cell phone and your head, and your reproductive organs.

Protocol Snapshot

Complex I and III Inhibitors: Remove Unnecessary Exposures | Assess Manganese Overload | Ubiquinol | Iron | Sulfur/Cysteine | Vitamin K2 (MK-4) | Vitamin C | Near Infrared Light | Riboflavin | Ketogenic Diet | Fire in a Bottle Disodium Succinate | Alpha-Ketoglutaric Acid | Glutamine | Adjust Your Carbohydrate Intake | Methylene Blue

Your Protocol Recommendations

Implement each of these items **one at a time**. Let any effects on health metrics or home measurements stabilize before moving on to the next step. When a supplement amount is given, start with the lowest amount. **Whenever practical, spread the supplement amount out across the day**. If it helps, let it stabilize, and move up to the next amount. Move up in the same increment as the starting supplement amount. Let each amount stabilize and keep increasing until reaching the point of diminishing returns. Then hold that amount, or revert to the most recent one right before it, stabilize, and move on to the next step.

If you experience an adverse effect, cut the supplement amount down, even below the starting amount, and find the supplement amount that produces benefit. If there is no such thing, remove the item from the protocol. Generally each item should be beneficial and you should keep it as part of your routine as you move on to the next item.

An increase in blood glucose, blood lactate, or a negative change in a quantitative health score that lasts longer than one week should be considered an adverse effect for this purpose.

If you find the highest amount of something had as much additional benefit as all previous amount increases, carefully experiment with even higher supplement amounts. Unless a specific timeframe is given below, assume that a supplemental amount may take at least one week to know whether it is working.

Supplements are focused on here for simplicity; however, you may wish to review the **foods** mentioned as good sources of each relevant nutrient in the previous section. If you tolerate them well, you can try increasing them before you try supplementing the nutrient.

Again, this protocol is meant to be implemented **one at a time in the specific order they are given for maximal effect.**

01 Complex I and III Inhibitors: Remove Unnecessary Exposures

Review the following list and eliminate any unnecessary exposures. If you are on a medication in the list, discuss with your physician whether there are alternatives you can use. Acetaminophen, antidiabetics (berberine, metformin, troglitazone, rosiglitazone, pioglitazone, ciglitazone, darglitazone, muraglitazar), aspirin, celastrol (from thunder god vine), flavonoids from Annonacee fruits, rhein, capsaicin, papaverine, tetrahydropapaverine, and natural antimicrobials (e.g., piericidin A, phenalamide A2, aurachin A and B, thiangazole, aureothin), antifungals and fungicides (myxothiazol, famoxadone, azoxystrobin, diuron, maneb, picoxystrobin, ethylene bisdithiocarbamate), insecticides (fenpyroximate, pyridaben, tebufenpyrad, fenazaquin,cyhalothrin, benzothiadiazole), preservatives (phenoxan), anti-helminths (benzimidazole, 2M-TIO), antibiotics (myxalamid, pterulone, pterulinic acid, and those ending in -mycin), antipsychotics (haloperidol, chlorpromazine, fluphenazine, risperidone, clozapine, quetiapine), antidepressants (sertraline, fluoxetine, imipramine, citalopram, amitriptyline, desipramine, mirtazapine, paroxetine, venlafaxine, tianeptine, nefazodone) cholesterol-lowering drugs (fenofibrate, ciprofibrate, gemfibrozil, atorvastatin, cerivastatin, fluvastatin, lovastatin, simvastatin, pravastatin), immunosupressives (leflunomide, teriflunomide, sirolimus), antiarrhythmics (flunarizine, amiodarone), antihistamines (cinnarizine), muscle relaxant metabolites (laudanosine), narcotics (meperidine), antiseptics (dequalinium chloride), and anesthetics (bupivacaine, lidocaine, halothane), doxorubicin, cyclophosphamide (cancer), flutamide, dantrolene, phenytoin, caprolactam from nylon clothing, PVC, catechol (from rubber/plastic), AZT and zalcitabine (HIV drugs), diclofenac (NSAID), tamoxifen (cancer), ethylxanthate (used in mining), bisulfate (additive), promethazine (antihistamine), propylhexidrine (used in the nasal decongestant Benzedrex and the appetite suppressant Eventin), serotonin-releasing drug fenfluramine (sold under the brand names Fintepla and Pondimin), the solvent DMSO, the fish poison rotenone and its derivative deguelin, inorganic mercury, aluminum, lead, and arsenic.

Evaluate and consider alternatives if you have occupational or environmental exposure to any of these including commercial fungicides. Nylon clothes touching the skin can release the complex I inhibitor caprolactam, mentioned above, during perspiration, if you find you are exposed consider alternatives. If you are dealing with an indoor mold problem, move or remediate.

02 Assess the Possibility of Manganese Overload and Detox If Necessary

Low complex II + III is often due to low CoQ10 status (ubiquinol is the most bioavailable form, so this is what you will supplement with in step 3) and this is often because we are deficient in one of the many nutrients needed to make our own CoQ10. It is therefore very important to make sure you are following the suggestions for nutrient adequacy outlined in "General Mitochondrial Health" before undertaking these steps.

After assorted nutrient deficiencies, manganese overload is the most common reason to have a deficit of CoQ10. Therefore, it is important to address prior to supplementing with ubiquinol as it is always preferable to maximize your own ability to synthesize this critical molecule.

The most complete way to assess the possibility of subtle but important degrees of manganese overload is as follows:

- Run whole genome sequencing.
- Run a hair test for essential and toxic elements.
- Run an iron panel (iron, TIBC, UIBC, iron saturation %) and transferrin.
- Run a blood manganese test from LabCorp, Quest, or your locally available laboratory in whole blood or red blood cells **and** in plasma or serum. **Alternatively**, you can run the Vibrant America Micronutrient Panel, which has the necessary manganese measurements.

You **do** have manganese overload if any **ONE** of the following bullet points are true:

- You are homozygous for the common H63D or C282Y polymorphisms in the HFE gene, heterozygous for C282Y, or you have at least one of the variants listed in this PDF; AND your current iron saturation or your transferrin saturation (calculated as serum iron divided by serum transferrin times 0.709) is higher than 40%. If you are barely above 40%, you can retest to see if you are consistently above 40%. If you already know you have iron overload and have been treating it with blood donations or phlebotomy, you should either a) use an iron saturation from before the first time you donated blood or received a phlebotomy treatment or b) assume you do indeed have manganese overload if you are missing this data.
- Red blood cell, white blood cell, or whole blood manganese is above the reference range (do not use plasma or serum for this).
- Your plasma or serum manganese-to-iron ratio is above 5 (do not use red blood cell, white blood cell, or whole blood for this). This is calculated by dividing manganese by iron and multiplying by 1000.
- Hair manganese is above the reference range.

If you do not have manganese overload, proceed directly to step 3.

If you do have manganese overload, follow these steps first:

a. **Maintain a low-manganese diet and an iron-to-manganese ratio of 4:1.** Use Cronometer to get your manganese down to 2 milligrams per day and your iron to at least four times this. This is most easily done with a largely carnivore diet that moderates or minimizes seafood and excludes mussels. Any fats and oils, such as tallow, butter, ghee, coconut oil, olive oil, palm oil, can be used. Any dairy products can be used. If you need more carbs and do not tolerate milk, corn (preferably nixtamalized) is the best choice for starch. Potatoes and white rice can also be used, but only in small quantities. Grapefruit, oranges, apples, pummelos, clementines, limes, honeydew, longans, litschis, and starfruit are the best choices for fruit. In smaller amounts, pears, plantains, bananas, cherries, peaches, raisins, dates, papaya, cranberries, and pomegranate can be acceptable. If you need to avoid grains and fructose, non-GMO dextrose powder could be used. Use the Nutrient Ratio Tool for brainstorming other foods.
b. **Controlled Hypoxia.** Select one of the following options. **Option 1**: Use an altitude tent or a simulated altitude mask during sleep and part of the evening for 11-12 hours three times a week. **Option 2**: Spend 5-6 days per month at 5-8,000 feet altitude. **Option 3:** Fire in a Bottle Disodium Succinate, 400-2400 milligrams per day. **Option 4:** L-carnitine fumarate, 855-5985 milligrams (1-7 capsules) per day. If any of these cause headache, fatigue, nausea, or abnormal breathing patterns, or trouble sleeping, cut back on your exposure to what feels safe. If using actual altitude exposure you can mitigate the effect by using canned oxygen or an oxygen machine. If the supplements cause flushing, itching, or trouble sleeping, you can moderate their dose to what is sustainably comfortable and you can try taking them only at breakfast to see if it removes a negative effect on sleep.

Follow this step for at least one month. Look for improvements in glucose or lactate or in the health metrics you are tracking,. You may arrive at several outcomes:

- You did not see a benefit. Move on to step 3.
- The benefits kept increasing on a weekly basis but are starting to hit diminishing returns OR you obtained a benefit at first but you lost it by the end of the month or starting having adverse effects. STOP this step and move on to the next, but consider at the very end of your protocol whether you can return to this step but use lower doses, lower frequencies, or a periodic cycling to obtain maximal benefit.
- The benefits kept increasing beyond one month. If so, continue this step until they stabilize.
- The benefits have stabilized for three to four weeks. This may mean you've hit a "sweet spot" with the strategies. KEEP them, and move on to the next step.

03 Ubiquinol

Suggested Range:
Ubiquinol, 100-400 milligrams per day, taken with meals.

You can obtain a small amount of CoQ10 on the order of 20 milligrams per day by eating heart, but you can only get these doses from supplements.

If you experience overstimulation or insomnia when taking ubiquinol, try 150-600 micrograms of Mo-Zyme taken with meals, 500-1500 milligrams of taurine taken with water before meals, and/or 500-1500 milligrams of glutathione taken with water before meals.

If ubiquinol brings your glucose and lactate into optimal ranges, you may be able to skip the following steps addressing iron, cysteine, vitamin K2 as MK-4, vitamin C, near infrared, and methylene blue. However, if ubiquinol raises your lactate, proceed directly to those steps and consider experimenting with higher doses of ubiquinol after you have completed them if you have gotten your lactate down to healthy levels.

04 Iron

Suggested Range:
Proferrin Clear, 1–4 capsules per day, taken with meals.

Before supplementing, you can try increasing your intake of red meat and decreasing your intake of plant foods.

If you are a vegetarian, you can try increasing your intake of greens. If you are open to eating egg yolks, shellfish, or fish, eating these alongside greens will improve iron absorption.

If the foods do not optimize your labs, find the lowest dose of the supplement that does.

Ideally this step is optimized by running several labs: an iron panel (serum iron, unbound and total iron-binding capacity [UIBC and TIBC], iron saturation %, transferrin, ferritin, and soluble transferrin receptor. Calculate the transferrin saturation by dividing serum iron by transferrin and multiplying it by 0.709. Aim to keep iron saturation and transferrin saturation in the 30-40% range and soluble transferrin receptor under 3 mg/L. Cut back on iron if iron or transferrin saturation run consistently above 40% while soluble transferrin receptor is simultaneously under 3 mg/L.

If ferritin is above 200 ng/mL while iron and transferrin saturation are below 30% and/or soluble transferrin receptor is above 3 mg/L, try bringing ferritin down with one or two scoops of whey protein, 1000 milligrams per day of curcumin, and 1000 milligrams once or twice per day of black seed oil.

If your complete blood count (CBC) shows you are anemic despite these labs being optimized, work with your doctor to find the cause of anemia and resolve it.

Once your labs are fully optimized, you can move on to step 5.

05 Sulfur/Cysteine

Suggested Range:
N-Acetyl-Cysteine (NAC), 600-2400 mg, taken with water before meals.

Before trying a supplement, you can try eating more animal protein, with an emphasis on eggs and dairy. Each 100 grams of protein from these sources is equal to 1-5 grams of NAC.

If you experience overstimulation, insomnia, allergies, or nausea when taking NAC, try 150-600 micrograms of Mo-Zyme taken with meals, 500-1500 milligrams of taurine taken with water before meals, and/or 500-1500 milligrams of glutathione taken with water before meals.

Long-term use of NAC can degrade the lining of the gut, so do not use amounts higher than 600 milligrams per day for longer than three to four months.

If withdrawing NAC after three to four months causes a loss of health benefits, try diversifying the your supply of sulfur across other sources, such as S-adenosyl-methionine (SAMe), 600-2400 mg per day, glutathione 500-1500 mg per day, or L-methionine 375-1500 mg. Note that SAMe can alter mood, so be careful with it if you have psychological or mood sensitivities to supplements.

06 Vitamin K2 (MK-4)

Suggested Range:
Innovix K2, 1–4 capsules per day, taken with meals.

You can also obtain K2 from natto, goose liver, aged cheese, and dark chicken meat.

07 Vitamin C

Suggested Range:
Non-GMO Ascorbic Acid, 1–2 grams with water on an empty stomach, one hour before each meal, three to four times a day.

You can also obtain vitamin C from raw acerola, amla, strawberries, and bell peppers, but these high doses are needed to circumvent a block in complex III, so hitting the dose requirements is essential to the ability of vitamin C to work at this point in the protocol.

08 Near Infrared Light

Five to thirty minutes per day (700-1000 nanometers) on each part of the body. For example, Saunaspace (expensive, whole body), LUMEBOX Red Light, or RedRush Pulse (less expensive, sit by it a lot, turn to face different sides). You can also get near infrared from the sun, but you have to be very careful to manage not getting burned, and these devices allow a greater dose of near infrared without exposure to burning rays.

09 Riboflavin

Suggested Range: 3 mg to 400 mg per day.

Start with food by using liver, kidney, red meat, almonds, cheese, eggs, salmon, mushrooms, seaweed, sesame, wheat germ, and milk to push your daily intake up to 5-6 milligrams.

If you have no problem digesting the glycerin in liquid supplements, use one to four droppers of liquid riboflavin to add 6.5-25 milligrams above and beyond your diet.

If you cannot digest the glycerin well, you can measure out capsules using a milligram scale to adjust their dose downward.

Use 1-3 capsules of Thorne Riboflavin 5'-Phosphate, to add 36.5-109.5 milligrams above and beyond your diet.

Use 2-4 capsules of any 100 milligram riboflavin per capsule supplement to add 200-400 milligrams above and beyond your diet.

If you wish to find your optimal dose as quickly as possible, you can start with a "riboflavin flush" by taking one capsule of the Thorne supplement at each of three meals for two weeks, and then stopping the supplement and starting with the food-only approach. This will help flush your system with as much riboflavin as it can take up to pull you out of any longstanding deficit relatively quickly.

Regardless of whether you do the flush step, every dose above 6 milligrams per day from food should be given at least a week to work its magic. Ideally, you work up in increments of 6-7 milligrams per day each week even after you get to the Thorne supplement. If you tolerate the glycerin in the liquid, you can do this by progressing from four droppers to one Thorne capsule, then by adding droppers to the Thorne capsule each time you go up by 6.5 milligrams. Once you are at one Thorne capsule and four droppers, you can progress to two Thorne capsules, and so on. Once you are above 100 milligrams, you can do the same thing by mixing and matching the 100-milligram supplement with the Thorne supplement and the dropper.

While riboflavin has no toxicity, excesses of riboflavin can bias your system to overuse fatty acids for energy. If you are not on a keto diet, this can lead to glucose intolerance. Excess riboflavin can also accelerate undesirable production of hydrogen sulfide and sulfite.

Therefore, you always want to move very slowly and find the minimal dose that produces the maximal desired effect.

Your goal is not to reach 400 milligrams. Your goal, instead, is to find the lowest dose that produces the maximal benefit. For most people, this will be in the 3-6 milligram range, but some people may have genetic idiosyncrasies that require higher doses.

If you experience overstimulation, insomnia, allergies, or nausea when taking riboflavin, try 150-600 micrograms of Mo-Zyme taken with meals, 500-1500 milligrams of taurine taken with water before meals, and/or 500-1500 milligrams of glutathione taken with water before meals.

10 Ketogenic Diet

Either bring net carbs (carbs minus fiber) down to 20 grams per day all at once, or cut them down by 30 grams per day each week as you ease into the diet. Replace them with macadamia nuts or fresh coconut to keep food-based magnesium and potassium up, or with oils and fats added to the sauces that you use to cook meats. Opt for fattier cuts of meat and fish, full-fat versions of dairy products, and eggs with the yolks. Make sure to cook meat in a manner where you can consume all of the juices, since this will help keep your potassium up. Spend your carbohydrate allotment primarily on potassium-rich vegetables. Some people experience a "keto flu" for a brief period, but this can be avoided if you keep your salt and potassium levels up. Give this diet at least eight weeks to determine how beneficial it is.

If you have had a bad experience with this diet in the past, or if you face trouble implementing it for the first time here, you may need aids to your digestion and metabolism of fat. Problems digesting fat may respond to bitters and lipase. Problems metabolizing fat may respond to riboflavin (vitamin B2), pantothenic acid or pantethine (vitamin B5), or CoQ10 (ubiquinol). You can get more riboflavin by emphasizing liver, heart, kidney, and almonds. You can get more pantothenic acid by emphasizing liver and Sari Nutritional Yeast. You can get more CoQ10 by emphasizing heart. If you supplement, you should start with low doses and titrate up slowly. With riboflavin, move up in 6.5-milligram increments using liquid riboflavin and potentially progressing to Thorne Riboflavin 5'-Phosphate, and to any 100 milligram riboflavin per capsule supplement. For vitamin B5, use 3-drop increments of liquid B5, potentially progressing to higher-dose pantothenic acid or pantethine. For CoQ10, try ubiquinol starting with once a week and progressing as high as 300-400 milligrams per day.

Judge this according to its net benefit to you. Since it is possible to have problems with fat metabolism that are not rooted in the respiratory chain and do not respond to these nutrients, keep this step in place only if it has proven beneficial and otherwise discard it and move on to the next step.

11 Fire in a Bottle Disodium Succinate

Suggested Range:
Fire in a Bottle Disodium Succinate, 400-2400 milligrams per day, taken with meals.

Succinate cannot be obtained from specific foods in defined amounts due to large variability and poor database coverage, so supplements are the only option for this step. It is used here to disproportionately feed complex II since your complex II is working better than your complex I. The key sign the succinate is necessary and beneficial is that it further boosts your health and well being and improves your glucose and lactate numbers beyond that achieved with the ketogenic diet alone.

12 Alpha-Ketoglutaric Acid

Suggested Range:
Alpha-Ketoglutaric Acid, 1000 to 4,000 milligrams per day, taken with meals.

Alpha-ketoglutaric acid cannot be obtained from specific foods in defined amounts due to large variability and poor database coverage, so supplements are the only option for this step. It is used here to disproportionately feed complex II since your complex II is working better than your complex I. The key sign the the alpha-ketoglutarate is necessary and beneficial is that it further boosts your health and well being and improves your glucose and lactate numbers beyond that achieved in previous steps.

13 Glutamine

Suggested Range:
Glutamine, 5-20 grams per day, taken with water before meals. Cut back on the dose if you experience overstimulation or headache.

You can use foods to reach these levels of glutamine, but keep in mind that you are probably already eating at least 5-10 grams of glutamine from food and these values are meant to bring your intake **above what you are already eating**. The glutamine content of animal proteins is low in eggs (4.65%), organ meats (5.51% in a blend of "chicken byproducts"), beef loin (6.61%) and chicken breast (6.11%); it is intermediate in dairy proteins (9.4% in cow milk, 9.1% in whey protein, 11.3% in casein); and it is high in the leg meat of chicken and pork (22.5% in chicken gastrocnemius and 21.12% in pig gastrocnemius). The gastrocnemius is part of the drumstick in chicken and the hindshank in pigs.

Therefore, you can add 20 grams of glutamine to your diet by adding to your baseline protein intake just under 100 grams of protein from chicken drumstick or pork hindshank or 200 grams of protein from dairy. Note that chicken drumstick and pork hindshank are so rich in glutamine because they are deficient in other amino acids. You cannot replace your current protein intake with those foods, you have to add those foods to go above and beyond your current protein intake. Therefore, the most practical way to increase glutamine is to eat more dairy protein, since dairy protein is well balanced enough that you can use it toward your standard protein allotment alongside getting more glutamine.

Glutamine is meant to funnel energy disproportionately into complex II. The key sign it is necessary and beneficial is that it further boosts your health and well being and improves your glucose and lactate numbers beyond that achieved in previous steps.

14 Adjust Your Carbohydrate Intake

If you gradually eased into the keto diet, make a note of whether there was a place on the way down when you felt your best. Conversely, if you plunged into it cold turkey, start adding carbs back incrementally, and see where you feel your best. Ultimately, this should prove, at minimum, a worthwhile experiment to see at what proportion of fat and carbohydrate you operate optimally.

15 Methylene Blue

Suggested Range:
Methylene Blue

Methylene Blue carefully titrated from 0.5 milligrams gradually to as high as 200 milligrams, stopping at the maximally beneficial point. Use intervals of 0.5 milligrams and spend at least one to two weeks at each dose.

Do not follow this step if you are on SSRIs, and stop this step if you experience any health problems associated with excess serotonin, such as fast heart rate, pupil dilation, excessive sweating, shivering, tremor, jerky movements, or exaggerated reflexes.

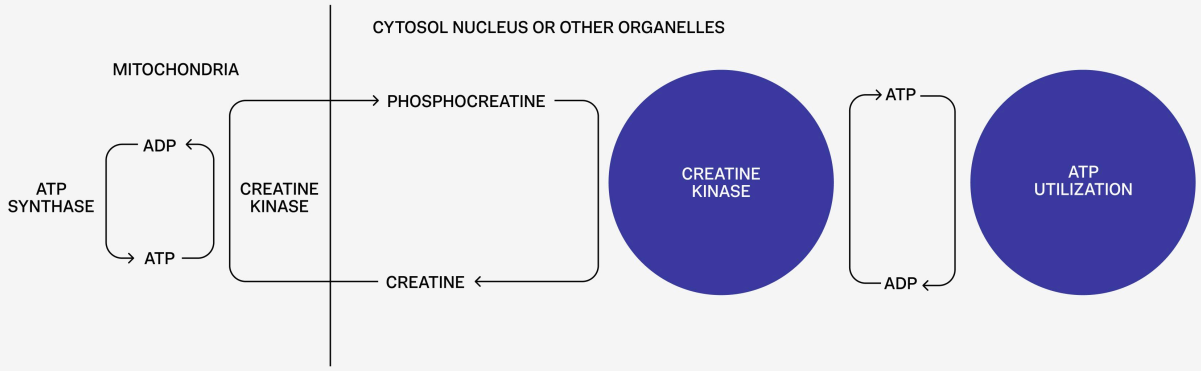
Additional Mitochondrial Support Strategies

While the protocol represents a personalized action plan matched to your unique results, there are strategies for boosting mitochondrial health that everyone should try, so we have added some things here that may also help. You can try them before or after your personalized protocol, but it is important to always try one thing at a time so you know what works and what doesn't.

Creatine

Creatine is like your second mitochondria. It spreads the effect of mitochondrial energy production throughout your cells. Most people who do not eat one to two pounds of meat per day need to supplement with creatine. Any brand using "Creapure" can be used. Saturation takes takes 5 days of 20 grams per day or one month of 3 grams per day. Supplements of anything should always be spread out evenly across the day when practical but with creatine this is especially essential for maximum absorption. After reaching saturation, stay on a maintenance dose of 3 grams per day. Any changes observed after saturation is reached should stabilize before moving on to the next step. If you see a rise in glucose, try lowering your net carbs to the point where glucose normalizes. Creatine may raise your needs for potassium, magnesium, or sodium. If you have the sense that any benefits declined when reducing to a maintenance dose, carefully titrate up to higher doses, with the possibility that 7-8 grams per day could be optimal, and without ruling out the possibility that long-term use of 20 grams per day could be necessary.

Can you use food instead? You can definitely give it a shot. One to two pounds of meat or fish per day will provide 3-5 grams of creatine, toward the higher end if it is red meat or salmon cooked rare and toward the lower end if it is white meat or fish and cooked well done. On a vegetarian diet, you would have to eat about a half kilogram each of quinoa and tofu to obtain enough arginine and methyl donors to synthesize your own creatine. If you don't meet either of these criteria, you probably need to supplement creatine. Even if you do, you will need a supplement if your optimal intake is 7-8 grams per day or more.

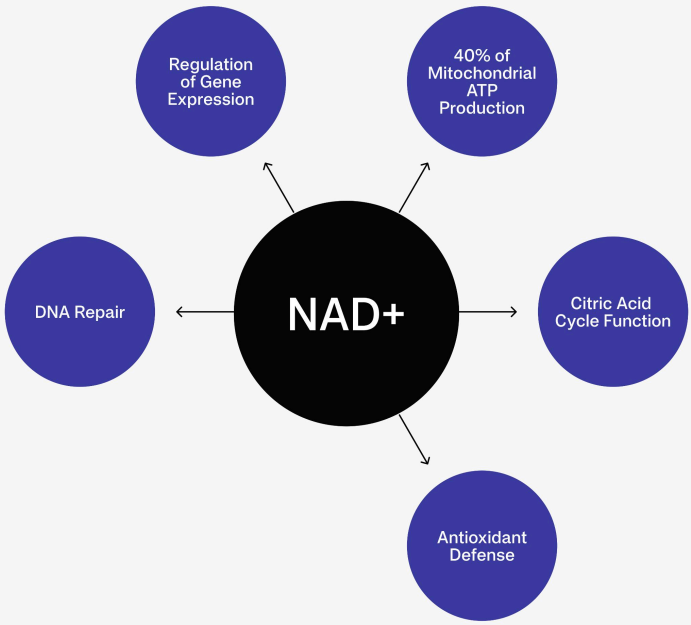


Creatine Kinase Reaction

NAD+

Suggested Range:
Tru Niagen, 300 milligrams per day.

Many mitochondrial problems are due to genetic deficiencies in replicating or repairing mitochondrial DNA. These often respond to supplementation with NAD+ precursors such as nicotinamide riboside.



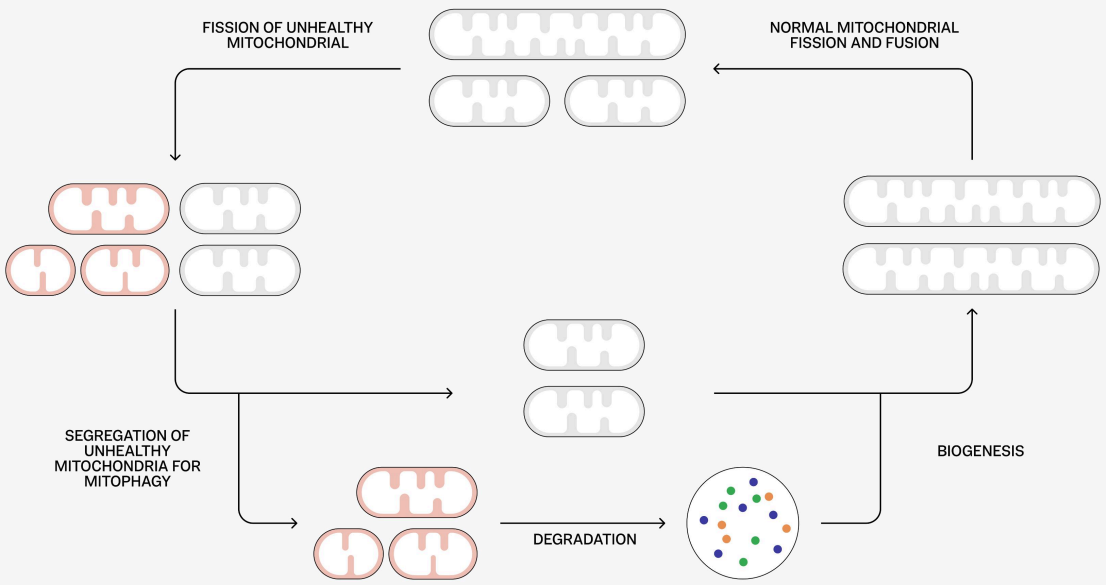
NAD+ Role in Mitochondrial Function

Fasting-Feeding Reset

Mitochondrial problems caused by deficiencies in replicating or repairing mitochondrial DNA, or from toxic insults (for example, from chemotherapy drugs or antibiotics) may be perfectly repairable if the repair processes can be sufficiently stimulated. That is the purpose of the fasting-feeding reset.

Before undertaking this, clear with your doctor that you are healthy enough to fast and that it is not contraindicated with any medications you are on or any health condition such as liver or kidney disease, or a fatty acid oxidation disorder. Avoid fasting if pregnant, lactating, very underweight, or if you have an eating disorder. Seek medical supervision for water fasts lasting longer than three days.

- Choose a fasting program that you feel comfortable with, such as a one-meal-a-day program or a 3-day or 7-day water fast.
- Accentuate the fasting state in two ways: 1) take 500-1000 milligrams of Mitopure Urolithin A before bed prior to a single fast day or prior to a within-day intermittent fasting period, or each morning of a longer multi-day fast; 2) during each fasting period, do one hour of steady-state cardio at a pace that you would have difficulty continuing for longer than one hour, that keeps you breathing noticeably heavier but not huffing and puffing so hard you would be unable to talk. You can have black tea, plain herbal tea, or black coffee during the fasting period, but only without any sweetener, milk, cream, or any substitute. During the fasting phase, abstain from the supplements you are otherwise taking in your protocol besides the urolithin A. Reserve them for the feeding phase.
- When the fasting period is over, put equal and opposite emphasis on the refeeding period. If the fasting period was a full day or longer, you can follow standard approaches to gradually ease into eating to make sure your digestion catches up, but don't start counting this as a true "feeding" phase until you are eating enough to fully make up for any weight lost during the fasting period. You are NOT trying to lose weight during this approach, which should be an endeavor you may or may not wish to take independently from this. Do not take urolithin A during the feeding phase. Focus any exercise on short bursts of high intensity or resistance training but above all **prioritize rest**. Eat a calorie load that not only meets your needs for the day but also causes a regain of all the weight lost in the fasting phase, that includes whole-food starches and fruits at every meal, and that has at least a third of the plate devoted to a whole-food animal protein. Protein should measure in at a minimum of 0.5 grams for every pound of bodyweight and an ideal of 1 gram per pound of bodyweight. Multiply these by 2.2 if you are measuring your weight in kilograms. During the refeeding phase, supplement with 1600 milligrams of S-adenosyl-methionine (SAMe), 3 grams of L-arginine, and 9 grams of L-leucine, each taken before meals with some water.
- Repeat this cyclically until you feel you have gained maximal benefit or you notice diminishing returns.



Mitochondrial Quality Control Cycle

The Research Backing Your Protocol

We analyzed the four major respiratory chain complexes within your mitochondria and categorized you into one or more of twelve distinct patterns. This breakthrough analysis represents a fundamental advancement in longevity, as mitochondrial function is now recognized as one of the primary drivers of biological aging. By identifying your specific bioenergetic profile, we've pinpointed exactly what you should be focused on for optimizing not just your daily energy production, but the cellular mechanisms that determine your health trajectory over decades. Email us to join our waitlist for how to take your Mitome results to the next level with whole genome sequencing for even further individualization and optimization.

Mitome is an proprietary interpretive algorithm built on the base layer of the respiratory chain testing that is based on Dr. Masterjohn's unique analysis of the published literature as well as an in-house sample of over 150 clients analyzed over the past two years where respiratory chain analysis was cross-referenced to whole genome sequencing and testing of amino acids, organic acids, vitamin concentrations inside and outside cells, acylcarnitine and acylglycine profiles, complete blood counts, metabolic panels, and assorted other biochemical markers, as well as client responses to protocols derived from this data.

Mitome synthesizes the unique pattern analysis generated from this dataset with published biochemical literature and insights from case reports of respiratory chain disorders to produce a unique protocol for each person.