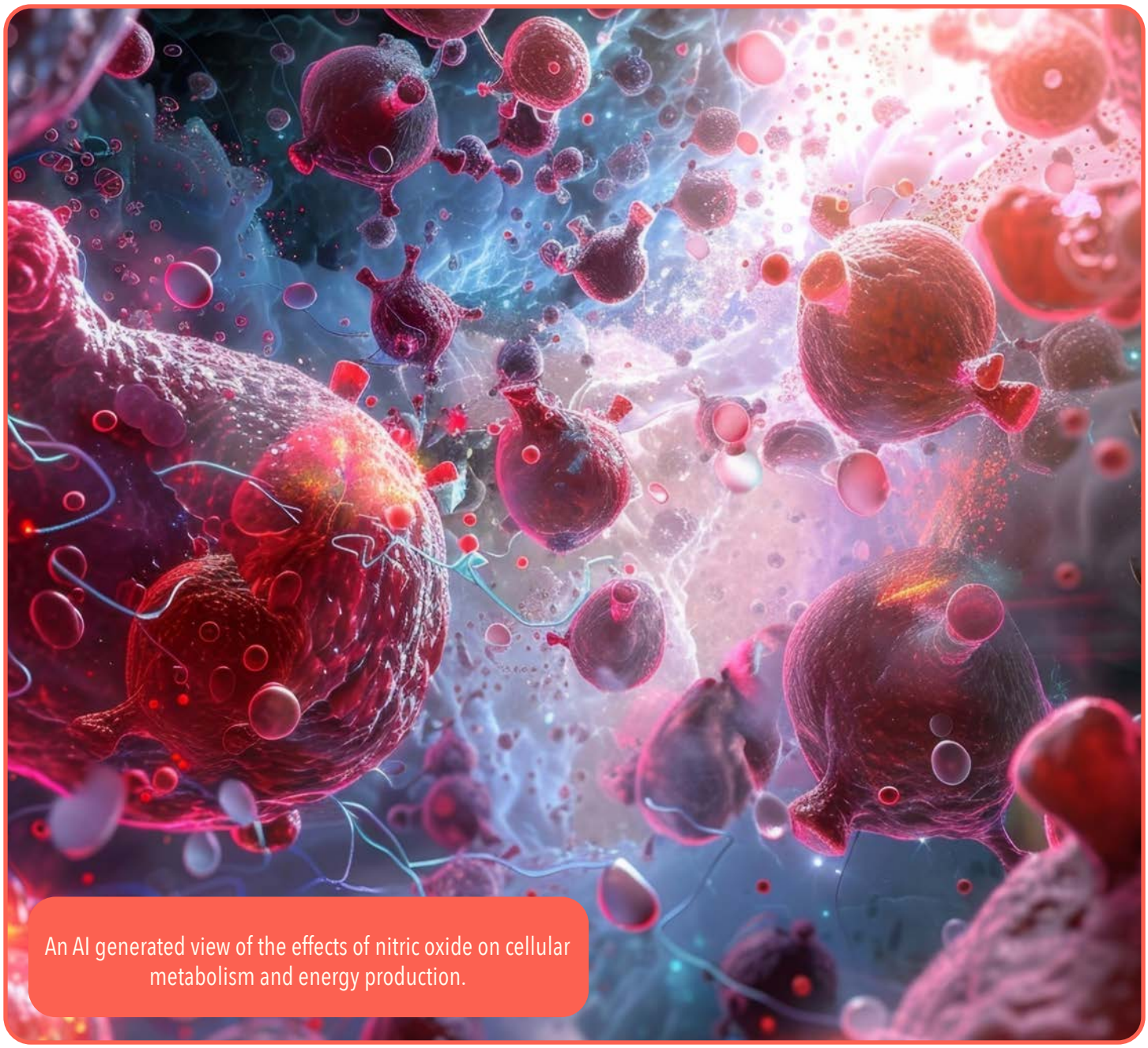
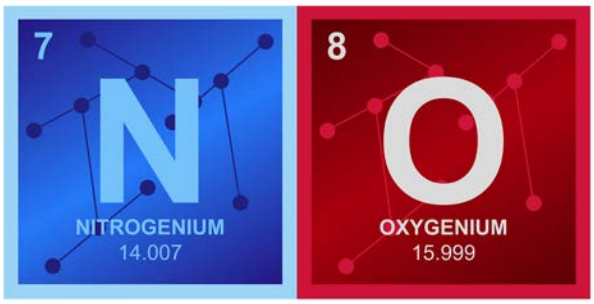
CAN YOU SAY NO TO A HEALTHIER BODY?

A Layperson's Introduction to Nitric Oxide

by David W. Borchers, Ed. D.



An AI generated view of the effects of nitric oxide on cellular metabolism and energy production.



MANY OF US have seen multiple advertisements proclaiming the virtues of routinely adding nitric oxide (NO) supplements to our diets. What most of us probably haven't come to realize is how important this chemical is for good health, involving multiple aspects of several human body systems – most noteworthy, our cardiovascular system. Together, let's learn a bit more about this fascinating topic, along with some words and terms that might not be part of our routine vocabulary choices. A helpful lexicon for quick reference can be found at the end of this paper to give definitions for the unfamiliar terms.

Cardiovascular (our heart and blood transport system) health is a critical aspect of overall well-being, and its importance is underscored by the rising incidence of heart disease worldwide. And NO stands out prominently among the various biochemical agents that play a vital role in maintaining heart health. This small, soluble gas is synthesized endogenously (within the organism or cell) and serves numerous physiological functions, particularly within the cardiovascular system. Understanding how nitric oxide contributes to cardiovascular health requires a closer examination of its biochemical properties and active mechanisms.

Nitric oxide (NO) is a crucial molecule in the body that plays various roles in maintaining health and supporting physiological functions. While it is not consumed directly through the diet (nitric oxide is a gas under normal conditions), certain dietary components can influence its production within the human body. So, why is nitric oxide so important? How does it relate to our diet and health? What are the best sources of NO ?

Nitric Oxide Research History: The Little Guy with a Big Job

Nitric oxide is a simple molecule with a profound impact on biochemistry and cardiovascular physiology. Its discovery and subsequent research have paved the way for significant advances in understanding vascular biology, cell signaling, and therapeutic applications. The journey of nitric oxide research is a remarkable story of scientific exploration and innovation. Research on nitric oxide has evolved significantly over the last few decades, revealing its crucial role in various biological processes.

Early 19th Century Interest – What Comprise Gases?

The first recordings of nitrous oxide (N_2O) were made in the 19th century, but nitric oxide as a distinct molecule wasn't the focus of research attention until much later. However, in the latter part of the 1800s, scientists began to explore the chemistry of gases, including nitrogen oxides.

20th Century: Recognition of Biochemical Roles – What On Earth is EDRF?

In the last few decades of the 20th century, the importance of nitric oxide in biology began to be recognized, particularly in cardiovascular research. In 1976, Robert F. Furchgott discovered that the endothelial cells of blood vessels release a factor that causes vasodilation. He referred to this factor as endothelium-derived relaxing factor (EDRF).

Researchers then began to isolate and identify EDRF. In 1987, it was identified as nitric oxide by Furchgott, Louis J. Ignarro, and Ferid Murad. Their collective work showed that NO is produced by endothelial cells and plays an essential role in regulating blood pressure and flow. This revelation was a turning point in biochemistry, as scientists began to recognize nitric oxide not just as a toxic gas or pollutant, but as a critical signaling molecule in various biological systems. The identification of nitric oxide's role in vasodilation shed light on various cardiovascular conditions, including hypertension and atherosclerosis.

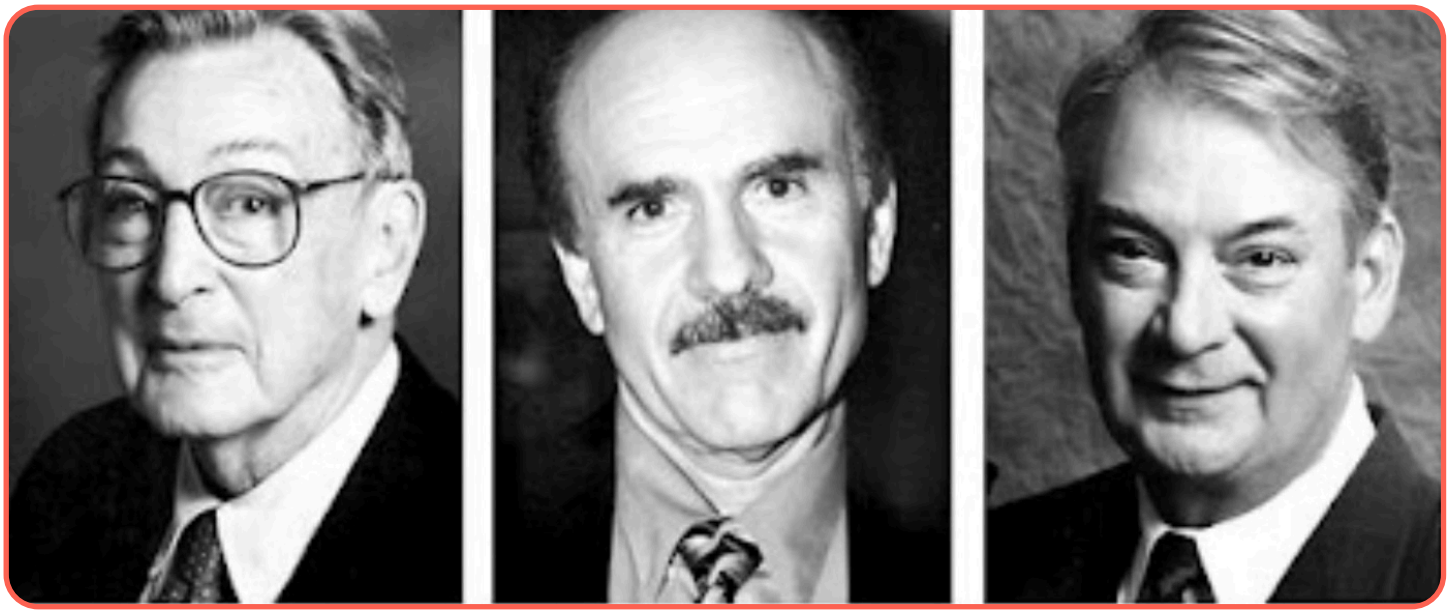
Nobel Prize Recognition

In 1998, the research contributions of Furchgott, Ignarro, and Murad were recognized with the Nobel Prize in Physiology or Medicine. Their findings established nitric oxide as a signaling molecule in the cardiovascular system and initiated further investigations into its role in other bodily functions.

Continuing Research: We Have Only Just Begun

Following the Nobel Prize award, interest in nitric oxide surged, and research expanded into various fields, such as:

- *Neuroscience*: NO was found to function as a neurotransmitter in the brain.
- *Immunology*: It was discovered that nitric oxide plays a role in the immune response, particularly in the function of macrophages.



In 1998, the research contributions of Robert Furchgott (left), Louis Ignarro (middle), and Ferid Murad (right) were recognized with the Nobel Prize in Physiology or Medicine. Their findings established nitric oxide as a signaling molecule in the cardiovascular system and initiated further investigations into its role in other bodily functions.

- *Pharmacology*: The development of drugs that utilize nitric oxide or its pathways (such as sildenafil, e.g., Viagra), highlighted its therapeutic potential.

Research has continued to further understand the mechanisms and pathways involving nitric oxide, including its dual role as both a signaling molecule and a potentially harmful agent at *high concentrations*[1] due to oxidative stress.

Nitric Oxide in Cardiovascular Research: A Balancing Act

The understanding of nitric oxide's role in the cardiovascular system has continued to evolve. For example, researchers have uncovered the mechanisms by which nitric oxide influences vascular tone, platelet function, and immune response. In the cardiovascular system, nitric oxide is produced from the amino acid L-arginine, a reaction promoted and accelerated (catalyzed) by a family of enzymes known as nitric oxide synthases (NOS). There are three primary isoforms of NOS: neuronal (nNOS), inducible (iNOS), and endothelial (eNOS). Each plays a distinct role in the body, with eNOS (also called NOS3) being critical for maintaining vascular homeostasis.

The impact of nitric oxide extends beyond vasodilation. It also inhibits platelet aggregation and adhesion, preventing blood clot formation and thus playing a protective role against heart disease. Furthermore, NO's anti-inflammatory properties help reduce endothelial dysfunction, which is primary in the pathogenesis of various cardiovascular diseases. Now here's a slightly horrifying statistic: about 695,000 people died in the USA from cardiovascular disease in 2021, making it the number 1 cause of death for American adults, accounting for over 20% of all fatalities! (https://usafacts.org)

NO: Friend or Foe?

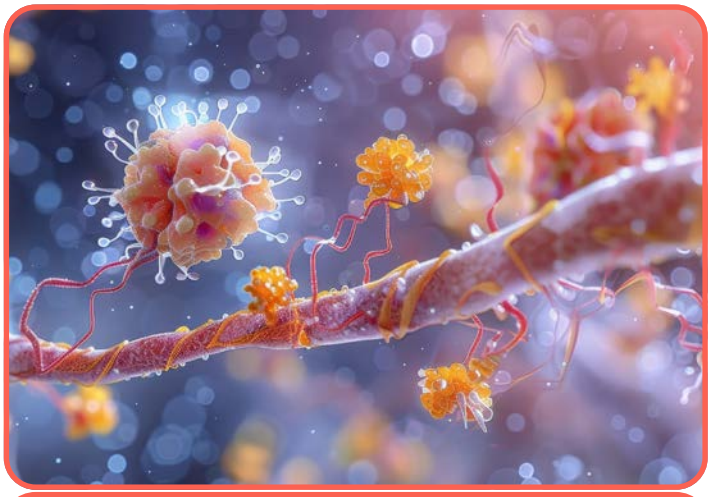
There is a caution to note. As with just about any good thing, too much nitric oxide could be a problem. NO plays a complex role in cancer biology, and whether it acts as a friend or foe can depend on various factors, including its concentration, the specific type of cancer, and the context in which it is produced.

A. Friend (Potential Anticancer Effects)

Tumor Suppression: At low concentrations (see footnote), nitric oxide can promote apoptosis (programmed cell death) and inhibit tumor growth. It has been shown to enhance immune responses, aiding the body in targeting and destroying cancer cells. Vasodilation: NO can increase blood flow to tissues, which may support the delivery of immune cells to tumors.

1 We've all heard the expression: "Too much of a good thing…". This applies to NO as well. The amount of nitric oxide the body can handle varies depending on individual health, the method of production (via supplements, food, or naturally in the body), and the condition being treated. Because nitric oxide is a gas generated within our bodies, it is impossible to prescribe a specific dosage. However, supplements that boost nitric oxide levels often contain compounds like L-arginine or L-citrulline. Excessive intake of these (and similar NO-inducing supplements) can lead to side effects including nausea, diarrhea, bloating, low blood pressure (hypotension), headaches, changes in heart rate, and allergic reactions in sensitive individuals. Any of these symptoms should serve as identifiers of possible over-production of nitric oxide or reaction to excessive NO-promoting agents. While Cardio Miracle's owner and chief evangelist believes that the CM formulation makes overdosing extremely unlikely, it is important to consult a healthcare professional in connection with any new supplement regimen, especially if there are preexisting health conditions or concerns regarding cardiovascular health.

NO inhibits platelet aggregation and adhesion, preventing blood clot formation and thus playing a protective role against heart disease.



NO serves as a signaling molecule in the brain, facilitating communication between neurons and contributing to brain health.

B. Foe (Potential Cancer Promotion)

High Concentrations: At higher concentrations (see footnote), nitric oxide can contribute to tumor progression. It may promote angiogenesis (the formation of new blood vessels), which tumors can exploit to grow and spread.

Genetic Damage: NO can also react with other molecules to form reactive nitrogen species that can cause DNA damage and mutations, potentially leading to cancer development. Essentially, nitric oxide can have both protective and harmful effects on cancer, and its role is largely determined by the context in which it is involved. Ongoing research continues to explore how NO can be manipulated for therapeutic benefits in cancer treatment.

The Importance of Nitric Oxide: We Can't Live Without It!

Nitric oxide (NO) is important for the following benefits:

Vasodilation: Nitric oxide helps relax and widen blood vessels, promoting better blood flow and reducing blood pressure. This can be beneficial for cardiovascular health.

Regulation of Blood Flow: It plays a vital role in regulating blood flow in various organs, ensuring that they receive sufficient oxygen and nutrients.

Immune Function: Nitric oxide is involved in the immune response, helping to combat pathogens and infections by enhancing the capabilities of immune cells.

Neurotransmission: NO serves as a signaling molecule in the brain, facilitating communication between neurons and contributing to brain health.

Exercise Performance: Increased levels of nitric oxide can enhance exercise performance by improving blood flow and oxygen delivery to muscles, reducing fatigue, and improving endurance.

Inflammation Relief: Inflammation plays a critical role in the development of atherosclerosis, a condition characterized by the buildup of plaques in the arterial walls. Nitric oxide exerts anti-inflammatory effects by suppressing the expression of adhesion molecules on endothelial cells, which are crucial for the recruitment of inflammatory cells to the site of injury. By mitigating inflammation, NO contributes to the stabilization of atherosclerotic plaques and protects against the progression of cardiovascular disease.

Insulin Sensitivity and Secretion: Emerging research suggests that nitric oxide may also play a role in insulin sensitivity, insulin secretion, the lessening of insulin resistance, and glucose metabolism. In conditions such as metabolic syndrome and type 2 diabetes, impaired NO production can exacerbate endothelial dysfunction and vascular complications. Enhancing NO bioavailability through lifestyle interventions, such as exercise and dietary modifications, has shown promise in improving metabolic conditions and vascular health in diabetes populations.

Foods and Supplements that Contribute to Nitric Oxide Production

Nitrates: Foods like beets, radishes, spinach, celery, cabbage, arugula, and other leafy greens are high in nitrates. When consumed, nitrates are converted into nitric oxide in the body.

Amino Acids: The amino acid arginine is a precursor to nitric oxide. Foods rich in arginine include red meat, poultry, fish, nuts, and seeds.

Citrulline, another amino acid found in watermelon and some nuts, can also contribute to NO production.

Antioxidants: Certain fruits and vegetables that are high in antioxidants (such as vitamin C and vitamin E) can help protect us from oxidative stress, thereby supporting and even boosting the availability of NO in the body.

L-arginine and L-citrulline Supplements: These supplements are often used by athletes to increase nitric oxide production, improve blood flow, and enhance exercise and athletic performance.

Oxidative Stress: Really, Who Needs More?

Oxidative stress refers to an imbalance between the production of reactive oxygen species (ROS) and the body's ability to detoxify these reactive products or repair the resulting damage. This condition can lead to cellular damage and is associated with various diseases and aging. Unfortunately, nitric oxide - the simple chemical compound so essential to good health - can readily react with superoxides to form peroxynitrite (ONOO-, the bad guys in this story), contributing significantly to oxidative stress. Peroxynitrite can lead to nitration and oxidation of proteins, lipids, and nucleic acids. Oxidative stress can also be caused or exacerbated by conditions such as diabetes, obesity, and ischemia, which can enhance oxidative stress, including mitochondrial dysfunction, inflammation, and premature aging. Exposure to pollutants, UV radiation, tobacco smoke, and other environmental toxins can also increase ROS levels and promote oxidative stress.

When antioxidant defenses are overwhelmed or insufficient, oxidative stress can lead to cellular injury, contributing to the development of diseases such as cancer, cardiovascular diseases, neurodegenerative disorders, and more. Not good!

A Few Words about Superoxides

Superoxides are a type of reactive oxygen species (ROS) that contain an extra electron. They can play both beneficial and harmful roles in biological systems:

Benefits:

- *Cell Signaling*: Superoxides can act as signaling molecules in various physiological processes, including immune responses and cellular signaling pathways.
- *Antimicrobial Activity*: They can help fight infections by destroying pathogens in immune cells.

B. Risks

- *Oxidative Stress:* High levels of superoxides can lead to oxidative stress, damaging cellular components like DNA, proteins, and lipids. This is associated with various diseases, including cancer, neurodegenerative disorders, and cardiovascular diseases.
- *Inflammation*: Elevated superoxide levels can contribute to chronic inflammation, which may exacerbate many health conditions.

Superoxides can have both positive and negative effects depending on their concentration and the context in which they are produced. Maintaining balance is key to healthy cellular function.

Therapeutic Applications and Future Directions

The importance of nitric oxide in cardiovascular health has led to numerous therapeutic applications. Medications such as nitroglycerin (first synthesized by Italian chemist Ascanio Sobrero in 1847), commonly used to treat angina, release nitric oxide, which helps alleviate chest pain by dilating blood vessels. Moreover, research into nitric oxide donors and inhibitors has provided insights into treating conditions like heart failure and pulmonary hypertension.

Recent advances in gene therapy and nanotechnology have also opened exciting possibilities for delivering nitric oxide to target tissues, enhancing its therapeutic effects while minimizing side effects. Furthermore, ongoing research aims to better understand the complex signaling pathways associated with nitric oxide and their implications in cardiovascular diseases.

As research continues, nitric oxide will undoubtedly remain a central figure in the quest to understand and treat cardiovascular diseases. The future holds promise for further breakthroughs, enhancing our ability to promote heart health and improve patient outcomes.

Cardio Miracle: A Boosting, Brightening, Benefiting Blend

We've seen all the ads ... there are dozens of popular nitric oxide supplements available for purchase from a variety of health food and nutrition markets. All of them provide some measure of cardiovascular health benefit, and most are worthy of our investigation. So, what's unique about Cardio Miracle?

Cardio Miracle is a dietary supplement marketed for cardiovascular health. As of the last knowledge update in October 2023, here are some of its ingredients:

- *Beetroot Powder*: Known for its high nitrate content, which can improve blood flow and reduce blood pressure

- *L-Arginine*: An amino acid that helps in the production of nitric oxide, which supports healthy circulation
- *L-Citrulline*: Another amino acid that can enhance nitric oxide levels and improve blood flow
- *Vitamin D3*: An antioxidant that supports cardiovascular health
- *Natural Antioxidants*: Mushroom powder, grape seed, guava, citrus, mango, hawthorn berry, pine bark, quercetin (a flavonoid antioxidant), and watermelon extracts
- *Organic Vegetables and Fruits*: Carrot, pineapple, acerola, blueberry, and coconut powders

Ohio University Study: Maintaining a Healthy, Winning Score

A recent study was implemented by two researchers (Dawoud, H., and Malinski, T.) at Ohio University. Knowing both the historical and burgeoning research demonstrating the benefits of nitric oxide in cardiovascular as well as several other related areas of health, they intended to investigate and quantify these potential benefits by examining what was happening at the biochemical level in living organisms. Remarkably, science now has tools to investigate intra-cellular processes and activity.

Dawoud and Malinski knew that to maximize the efficacy of NO, at least two molecular-level actions must take place simultaneously: the production of NO must be increased, and the formation of ONOO- (known as peroxynitrite, essentially the destruction of NO) must be decreased. If these events could be measured numerically, they could be quantified by before and after treatment comparison in ratio form – essentially the concentration quantity NO/ONOO-.

Human umbilical vascular endothelial cells were isolated into primary cultures from Caucasian American donors and were then appropriately incubated. As an intervening variable to be tested in their investigation, they chose the supplement known as Cardio Miracle. Experimental measurements were performed with electrochemical nanosensors (having diameters of approximately 250 nanometers – approximately 9.8 x 10^{-6} inches!). The sensors were calibrated and positioned near the endothelium membrane.

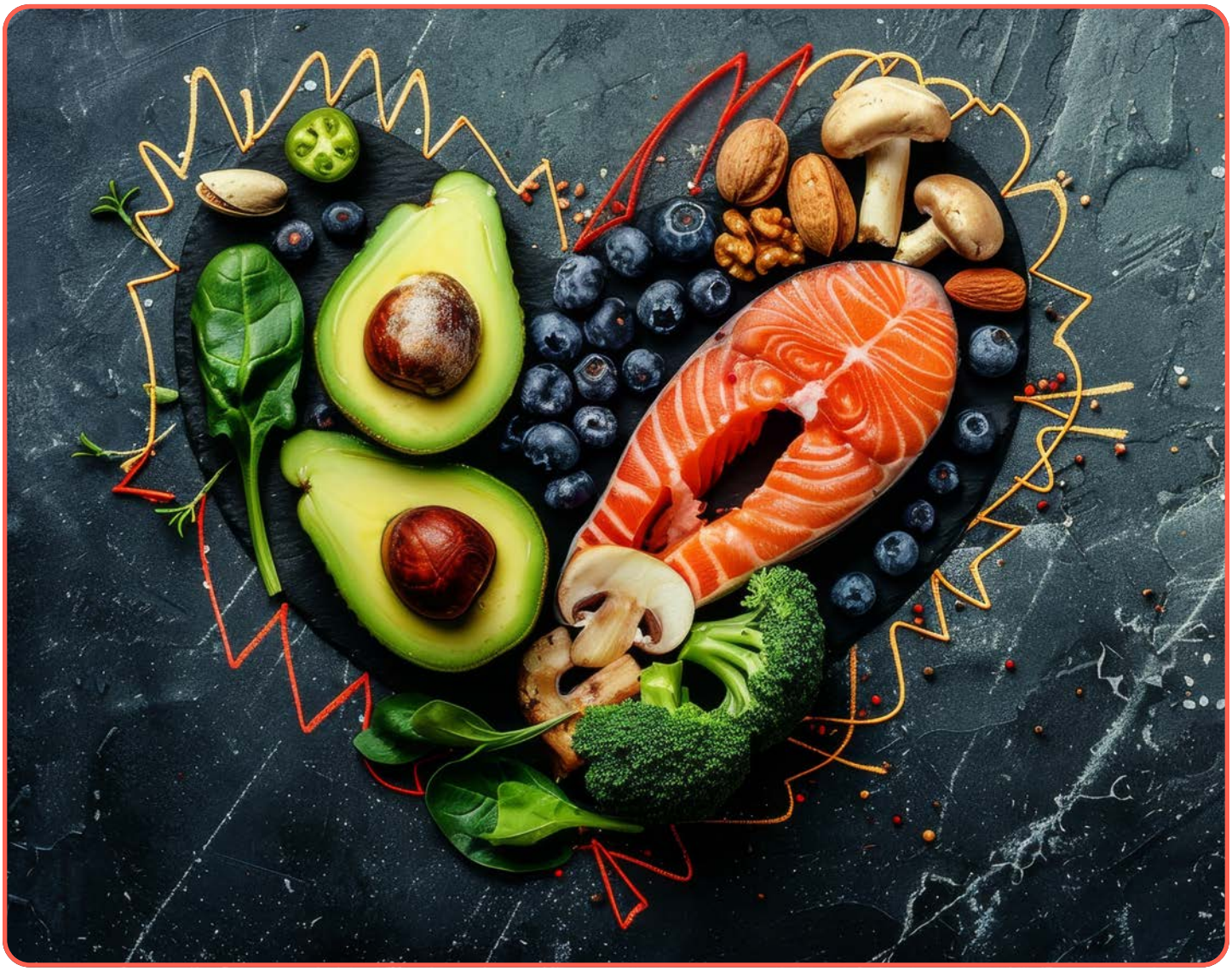
NO is produced by the endothelium, but in the absence of effective antioxidants, NO immediately begins to degrade into ONOO- and becomes useless. Independent treatments were performed: The researchers discovered that the introduction of antioxidants alone (to decrease the rapid formation of peroxynitrite) increased the NO/ONOO- ratio-quantity by 15%. When a mixture of L-arginine, L-citrulline, and vitamin D3 was introduced, the static ratio increased by approximately 25%. For the third test, the authors reported – "… a clear synergistic effect [was] shown with a combination treatment between this group and the antioxidant group, [Cardio Miracle], with about 50% improvement." (p.19). They also note in their report that the molecule NO helps prevent unwanted attachments to the cell wall (endothelium), such as platelets, roaming cells, bacteria, and cholesterol (p.20). Additionally, the level of toxic ONOO- produced by the vascular cell walls decreased significantly by 10-15% with lasting effects up to 12 hours (p.20).

Cardio Miracle and Diabetes: Biochemical Teamwork!

NO derived from endothelial cells activates endocytosis (the transfer of nutrients into, and the removal of pathogens and unwanted proteins from the cell), prevents pancreatic beta cell islet dysfunction, reverses damaged or dysfunctional glucose and arginine-stimulated insulin secretion, and lowers beta cell islet inflammation. Conjointly, these individual functions promote and support pancreatic beta cell regeneration (Fliri, A., p.2)

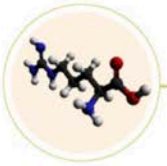
When at Least a Good Part of the NO Story Has Been Said and Done: CM?

Conclusion: There is plenty of historical and current scientific evidence that would encourage us to increase the bioavailability of nitric oxide in our constantly aging bodies! Minimally, NO can help lower blood pressure, provide for better blood flow (and therefore nutrient distribution), decrease the incidence of migraines, boost energy, combat obesity and other-related type 2 diabetes, and ward off infection and related sickness. In an age and culture where medications and supplement advertisements flood our media, this investigation provides convincing evidence that we should take an earnest look at NO supplementation choices for our diets. Based on the science only, with no personal experience with the product, I concluded what the science suggested: that Cardio Miracle is one of the very best of breed. Now, having met the developer and some of the scientists researching, using, and recommending Cardio Miracle, I'm truly excited to test it on myself and with my family! §



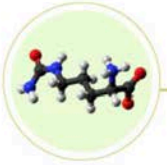
L-ARGININE (AAKG)

Arginine is an amino acid that plays a critical role in the functioning of the body. In addition to helping the body make protein, it is used to make nitric oxide. Arginine also stimulates the production of creatine which helps muscles contract.



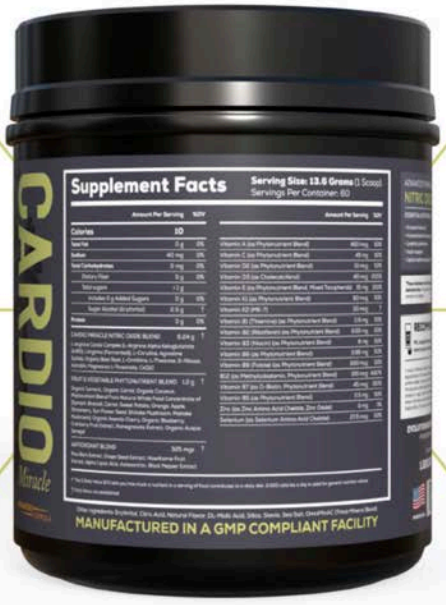
L-CITRULLINE

L-Citrulline is a precursor to arginine in the body. L-citrulline converts to arginine which then converts to Nitric Oxide (NO). It essentially acts like a time-released L-arginine extending the life of L-arginine so it can continue to trigger the nitric oxide production.



ASTRAGIN™

AstraGin™ is a proprietary ingredient that holds a U.S. patent for "method for enhancing nutrient absorption." AstraGin™ has been shown to support increased arginine absorption by 67% and L-citrulline absorption by 45% - as well as minerals and vitamins.

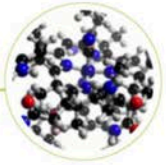


VITAMIN D3

Vitamin D is an essential fat-soluble vitamin, sometimes called the sunshine vitamin, plays a role in calcium and phosphorus balance important in bone health, and nerve and muscle activity.

VITAMIN B12

Vitamin B12 is an essential nutrient for the body, and is needed to protect DNA and RNA, support energy, protect nerve and brain cells, stimulate serotonin production, support digestion, and support immune function.



TURMERIC

It's a scientifically accepted fact that turmeric bolsters the body's immune system. The massive benefits this miracle root offers, gives additional support to Cardio Miracle's nitric oxide boosting ingredients.

NO can help lower blood pressure, provide for better blood flow (and therefore nutrient distribution), decrease the incidence of migraines, boost energy, combat obesity and other-related type 2 diabetes, and ward off infection and related sickness. In an age and culture where medications and supplement advertisements flood our media, this investigation provides convincing evidence that we should take an earnest look at NO supplementation choices for our diets.

Appendices

A: Common Food Sources of Antioxidants

Antioxidants work by neutralizing free radicals, which are unstable molecules that can cause oxidative stress and damage cells. This oxidative damage is linked to various health issues, including aging, cancer, and heart disease. By stabilizing free radicals, antioxidants help to:

- Protect cell membranes and DNA from damage
- Reduce inflammation in the body
- Support the immune system
- Improve overall health and longevity

Common food sources:

Berries (e.g., blueberries, strawberries, raspberries): Rich in vitamins C and E, flavonoids, and other polyphenols. They help combat oxidative stress and inflammation.

Dark chocolate: Dark chocolate contains flavonoids such as catechins (plant-derived polyphenols). These antioxidants can improve heart health and reduce oxidative damage.

Nuts (e.g., walnuts, pecans): Nuts provide vitamin E and various polyphenols. They support heart health and reduce inflammation.

Green tea: Green tea is high in catechins, particularly epigallocatechin gallate (EGCG), which is known for its anti-inflammatory and cancer-fighting properties.

Spinach and other dark leafy greens: These contain vitamins C and E, beta-carotene, and other carotenoids, which help reduce oxidative stress in cells.

Cruciferous vegetables (e.g., broccoli, Brussels sprouts): Cruciferous vegetables are rich in vitamins, minerals, and various phytonutrients that help detoxify the body and prevent cell damage.

Fruits (e.g., oranges, kiwi, pomegranate): Many fruits are high in vitamin C, which helps regenerate other antioxidants and protects against oxidative damage.

Legumes (e.g., black beans, lentils): Legumes are packed with antioxidants like flavonoids and phenolic acids, which support overall health.

Red wine: Red wine contains resveratrol and other polyphenols that may promote heart health and longevity when consumed in moderation.

Spices (e.g., turmeric, cinnamon): Turmeric contains curcumin, and cinnamon is rich in polyphenols, both of which have powerful antioxidant properties.

B: Practical NO Enhancers

Incorporating a combination of these factors in a weekly regimen can help support the body's production and absorption of nitric oxide, promoting overall cardiovascular health:

Exercise: Physical activity increases blood flow and shear stress on the endothelial cells, stimulating NO production.

Diet: Consuming foods high in nitrates (e.g., beetroot, spinach) and those rich in L-arginine (e.g., nuts, seeds, poultry) can enhance NO levels.

Hydration: Adequate hydration supports cardiovascular health, allowing for better blood flow and NO availability.

Avoiding Smoking: Tobacco smoke contains oxidants that can reduce NO production and bioavailability.

Managing Blood Pressure: High blood pressure can impair endothelial function, reducing NO availability. Keeping blood pressure within a healthy range can improve NO production.

Stress Management: Chronic stress can affect cardiovascular health and reduce NO levels. Techniques like meditation and mindfulness may help.

Sleep: Quality sleep supports overall health and can aid in the proper functioning of the cardiovascular system, contributing to enhanced NO production.

Temperature: Body temperature and external environmental conditions can influence endothelial function and NO bioavailability.

C: The Future of Nitric Oxide and Cardiovascular Research

The future of nitric oxide (NO) and cardiovascular research is promising, with several key areas likely to see significant advancements:

Mechanistic Understanding: Continued research is expected to deepen our understanding of the mechanisms through which nitric oxide influences vascular health, inflammation, and metabolic processes.

Therapeutic Applications: There is ongoing interest in developing nitric oxide-based therapies for various cardiovascular conditions. These may include targeted delivery systems that provide localized effects, potentially reducing side effects compared to systemic NO donors.

Biomarkers: Nitric oxide and its metabolites are being investigated as biomarkers for cardiovascular risk assessment and disease progression, allowing for earlier detection and intervention.

Chronic Conditions: Research may focus on the role of nitric oxide in chronic cardiovascular conditions such as hypertension, atherosclerosis, and heart failure, exploring how modulation of NO pathways can lead to new treatment strategies.

Personalized Medicine: Advancements in genomics and biotechnology could lead to personalized approaches in NO-related therapies, considering individual variations in NO pathways among patients.

Combination Therapies: The exploration of nitric oxide in combination with other therapeutic agents (like statins, antihypertensives, or newer classes of cardiovascular drugs) may enhance treatment efficacy.

Non-Pharmacological Approaches: Research may also focus on lifestyle factors that influence nitric oxide production, such as dietary nitrates, exercise, and stress, emphasizing a more holistic approach to cardiovascular health. §

About the Author: David Borchers hails from central New Hampshire and is a proud dad of four delight-providing children and an amazing wife of almost 54 years. It is David's often-spoken blessing that all love God and understand His sovereignty and creativity in this wonderful world and universe. From his early years, David was an investigator and experimenter. If it could come apart with a crescent wrench and a screwdriver, it probably ended up in pieces – and most often put back together. All things electrical, chemical, or mechanical were fair game. The house basement became his laboratory, and it was not unusual to find a battery, wires, and salt solution being used to produce small amounts of hydrogen gas to be tested with a glow stick, a bicycle being repaired, or a new "invention" comprised of wood and screws. David began his formal training as a mechanical engineer at Tufts University, later transitioning to a degree in experimental psychology and education. He began teaching in 1974 at a local public school, and later joined the staff at Laconia (NH) Christian School as an instructor in primarily math and science at both the middle and high school levels. Before becoming school principal, David acquired his M. Ed. in Administration and Supervision from Plymouth State University, and years later in 2008, received his Ed. D. in Child, Youth, and Family (dissertation topic: early childhood parenting for maximum academic success) from Nova-Southeastern University. Music, poetry, hiking, gardening, piano tuning, and handyman services are among David's alter-interests and "tent-making" projects. He serves as a founding board member of One Voice Ministries (a Central New Hampshire Christian performing arts ministry), and for the past 18 years has served as lead pastor at Lochmere Baptist Church. ***Below: Dave Borchers with his wife Cathy and four "delight-providing" children (circa 2010).***

Lexicon

1. *Angina*: Chest pain or discomfort resulting from insufficient blood flow to the heart muscle, often due to coronary artery disease.
2. Antioxidants: Molecules that inhibit the oxidation of other molecules, helping to neutralize free radicals and reduce oxidative stress in the body. They protect cells from damage and may contribute to overall health.
3. Atherosclerosis: A condition in which fatty deposits (plaques) build up in the walls of arteries, leading to narrowing and reduced blood flow, which can result in heart disease or stroke.
4. Beta Cell: A type of cell in the pancreas that produces and secretes insulin, which helps regulate blood sugar levels.
5. Cardiovascular: Relating to the heart and blood vessels; encompasses the circulatory system.
6. Cell Signaling: The process by which cells communicate with each other through signaling molecules, triggering responses that influence cellular functions.
7. Endothelial: Refers to the thin layer of cells lining the blood vessels and lymphatic vessels, playing a key role in vascular biology and regulating blood flow and vascular permeability.
8. Homeostasis: The maintenance of stable internal conditions (like temperature and pH) in the body despite external changes.
9. Immune Response: The body′s defense mechanism against foreign substances, pathogens, and infections, involving the activation of immune cells.
10. Inducible: Capable of being activated or expressed in response to certain stimuli; often used in reference to proteins or genes.
11. Ischemia: Ischemia is a medical condition characterized by a reduced blood flow to a tissue or organ, resulting in a lack of oxygen and nutrients needed for cellular metabolism and function.
12. Isoform: Different forms of the same protein that arise from alternative splicing or variations in the gene sequence.
13. L-Arginine: L-Arginine specifically refers to the ″L″ form of arginine, which is the biologically active form of the amino acid found in supplements. When people refer to arginine in the context of dietary supplements, they are usually talking about L-arginine.
14. L-citrulline: L-citrulline is a non-essential amino acid, which means the body can produce it on its own. It is synthesized in the body from L-arginine. It is also produced during the urea cycle, where it helps in the elimination of ammonia from the body. Foods rich in citrulline include watermelon, cucumbers, and other gourds.
15. Macrophages: A type of white blood cell that plays a vital role in the immune system. They are large phagocytic cells that engulf and digest cellular debris, foreign substances, and pathogens.
16. Metabolic pathway: In biochemistry, a linked series of chemical reactions occurring within a cell.
17. Metabolic Syndrome: A cluster of conditions including increased blood pressure, high blood sugar, excess body fat around the waist, and abnormal cholesterol levels that occur together, increasing the risk of heart disease, stroke, and diabetes.
18. Mitochondria: Organelles known as the ″powerhouses″ of the cell, responsible for producing energy (ATP) through cellular respiration.
19. Nanotechnology: The manipulation of matter on an atomic or molecular scale, often used in medical applications for targeted drug delivery and other therapeutic strategies.
20. Neurotransmission: The process by which signaling molecules called neurotransmitters are released by neurons to communicate with target cells (neurons, muscles, or glands).
21. Nitrates: Form of nitrogen found in the environment; compounds that contain nitrogen and oxygen, often used in medications to treat angina by dilating blood vessels.
22. Nitration: A chemical process that introduces a nitro group (NO_2) into an organic compound, often affecting its properties and reactivity.
23. Nucleic Acid: Biopolymers essential for all known forms of life, nucleic acids (DNA and RNA) are made up of nucleotide monomers. They store and transmit genetic information and are involved in protein synthesis.
24. Oxidative Stress: An imbalance between free radicals and antioxidants in the body, leading to cell damage and contributing to various diseases.
25. Pathogenesis: The development and progression of a disease, including the biological mechanisms involved.
26. Peroxynitrite: A reactive scavenging molecule that forms when nitric oxide (NO) and superoxide (O_2-) radicals combine in a diffusion-controlled reaction.
27. Peroxide: A chemical compound containing an oxygen-

oxygen single bond, often involved in oxidation reactions and signaling in biological systems. It is water with an extra oxygen atom loosely attached (H_2O_2) making it highly reactive and eager to oxidize other molecules.

28. Platelets: Small, disc-like cell fragments in the blood that are crucial for blood clotting. They gather at a site of injury to help stop bleeding by clumping together.
29. Pulmonary: Related to the lungs; often used in the context of respiratory function or diseases.
30. Reactive Nitrogen Species (RNS): Chemically reactive molecules containing nitrogen, which can lead to cellular signaling events and stress responses in the body.
31. Reactive Oxygen Species: Reactive oxygen species (ROS) are highly reactive molecules that contain oxygen. They are formed as natural byproducts of the normal metabolism of oxygen in cells and can also be generated by external factors such as pollution, UV radiation, and certain drugs. Common examples of ROS include superoxide anion (O_2-), hydrogen peroxide (H_2O_2), and hydroxyl radical -OH). ROS play a dual role in biological systems. At low to moderate concentrations, they are involved in cell signaling and the immune response. However, at high concentrations, they can cause oxidative stress, leading to cellular damage, inflammation, and contributing to various diseases, including cancer, cardiovascular disease, and neurodegenerative disorders. Antioxidants, both enzymatic and non-enzymatic, help to neutralize ROS and mitigate their harmful effects.
32. Signaling Molecule: Any molecule that transmits information from one cell to another, initiating a response; examples include hormones and neurotransmitters.
33. 32. Signaling Pathways: Cascades of molecular interactions through which cells respond to external signals, leading to appropriate cellular responses.
34. Superoxides: Highly reactive molecules formed when oxygen receives an extra electron, creating a type of free radical. Superoxides play a role in cell signaling but can also cause oxidative damage if not regulated.
35. Synthase: A synthase is an enzyme that catalyzes the synthesis of a particular compound from smaller, simpler molecules without the need for ATP (adenosine triphosphate which captures chemical energy from food for cell use) as an energy source. Synthases typically facilitate the formation of larger, more complex molecules through condensation reactions, which can involve joining two substrates with the release of a small molecule, such as water.
36. Vascular: Relating to, consisting of, or affecting the blood vessels or other vessels that convey fluids within a living organism.
37. Vasodilation: The widening of blood vessels, which decreases blood pressure and increases blood flow.

Additional Reading

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