

# **Executive Summary – Redox Matters**

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The discovery of Redox Signaling is one of the most important medical breakthroughs of our lifetime. Redox signaling molecules are the deepest cell-signaling molecules ever discovered. They are naturally produced in mitochondria and the cell, and they control all cell functions. They live and function at the interface of energy and matter - where cellular communication activates biological programming and animates all cell processes - and even life itself.

This cellular communication is part of the cellular programming and design which allow cells to respond to their changing environment and conditions. The purpose of this innate system is to help the cell maintain a state of balance or homeostasis, without which, disease and inflammation follow. The function of these cellular systems is to activate pathway genes (called 'gene expression') which in turn activate the immune system, reduce inflammation, and help the body and mind to stay healthy and young.

This is the inherent "detect repair and replace" mechanism built into our cellular blueprints. And Redox signaling activates it! This is the "Inner Doctor." When it is awake and well, we are too!

Diets, nutrition supplements, and activities that help support health, do so precisely because they can in some measure affect these signaling pathways that activate genes which in turn protect and restore our cellular health. Supplements which enhance these signaling pathways and the transcription factors that activate them, do so because they obey these laws of cellular health.

However, over time mitochondria become less efficient. They gradually increase reactive oxygen molecules (ROS) produced during the process of energy production within Krebs cycle. This leads to cellular oxidation and loss of cellular homeostasis. Cell signaling and protective gene expression also decrease with age. This adds up to wrinkles, sagging skin, weight gain, gray hair, lost memories & fading relationships, hurting joints, vascular problems, accelerated aging, autoimmune disorders, hormone problems - and more medical intervention.

The science of cell signaling and reduction-oxidation and how cells talk to each other is one of today's most exciting fields of medical research. What used to be referred to as "free radical biology and medicine" is now referred to as "redox biology and medicine," recognizing the more fundamental role which redox signaling plays with health. The more accurate focus on "redox biology" verses "free radical biology," highlights the new understanding that reactive oxygen molecules play an important role as signaling messengers, which is to activate pathway genes that protect our health.

Thus, the now outdated "antioxidant mindset" focus which attempted to eliminate all free radicals using antioxidant supplements, is now being replaced with "redox signaling" science which recognizes the central role of redox signaling to our health. This field of study is seeking to better understand the operational and functional basics of cellular health and the central role redox biology plays in its existence.

Central to this understanding is the role of the mitochondria and the nucleus, where energy is created and the cell's DNA is located, respectively. What ties these together and directs their interactions, are lines of cellular communication (pathways) that use unique signaling messengers which "speak" a special language called "signal transduction" – otherwise known as redox signaling. It is the signaling that occurs along these pathways which manage and control all levels of health in the cell and within the body.

When this signaling or cell communication works well then important pathway genes can direct the DNA to respond in healthy ways. When the signaling becomes muted or is diminished, then the cell does not respond in healthy ways, and sickness, disease, and accelerated aging occur. We would almost always discover this as symptoms or wayward laboratory values were produced. By and large, medical interventions propose to resolve these 'health problems' with medications and procedures that cause the symptoms and bad lab values to diminish. This is much like silencing a smoke alarm without finding and fixing the source of the problem that caused the alarm to turn on. While reducing symptoms and improving quality of life is always appreciated and often needed, it rarely resolves the root cause of the problem - which was faulty cellular signaling and lack of optimum gene expression in the first place.

Because health is more than the absence of symptoms, this new cellular health and redox biology science introduces a higher level of health. It should be thought of and regarded as wellness! This means that "healthcare" is very different from "disease-care." This higher wellness state occurs when cells are healthy and functioning as designed, with healthy cell signaling activity occurring at the most foundational level. In fact, this is where epigenetic forces best effect their positive effect on gene expression and healthy DNA activity. This explains why all health begins and is controlled by the foundation of functional cellular communication channels. It also explains sickness, meaning that ill health occurs when this system doesn't work well resulting in more sickness, slower recovery, and accelerated aging.

The fundamentals of this new science is focused on how a cell, any cell, knows when to respond to, and how to survive its changing and often harmful environment. Our noxious and toxic world easily create a condition within the body called *oxidative stress*. How well cells deal with oxidative stress and inflammation is a function of their healthy signaling activity – the ability determines how well they perform the metabolic functions they were designed for, and ultimately their final fate.

The natural result of cellular oxidative injury yields varying states of dysfunction that express or show up in life as signs and symptoms, aches and pains, diseases and comorbidities, aging minds and infirm bodies – all of which too often is managed through outside intervention instead of correcting the inside cellular root causes.

Central to a cell's functional capability and even its survival, is the state or degree of its homeostasis or redox balance. This status is called the *oxidative state* which describes or defines the degree of oxidation present in a cell. This is the functional balance between molecules called *oxidants* and those called *reductants*. When the balance shifts to having more oxidants, then oxidative stress results. If this imbalance is not neutralized or corrected it results in molecular and cellular damage due to the run-away oxidative insult and free-radical injury, and the resulting inflammation produced.

The central point is how a cell recognizes this imbalance and how well it activates important signaling pathways that control the necessary gene expression that will produce the antioxidant defense (reductants) to reduce oxidation and downregulate the inflammatory response. This speaks to an

undergirding and foundational level of managed control over health and disease, and dictates how well the body is able to respond to changing conditions and health challenges.

Essential to this management (or mismanagement) are the myriad signaling pathways and pathway genes that manage the cellular communications necessary for cellular health. Optimum signaling capability successfully and functionality restores redox homeostasis and reduces oxidative stress within the cellular environment. This enables cells to detect problems, respond to them in a timely and sufficient manner, and to repair the damage or replace themselves when necessary. This *detect repair and replace* mechanism prevents the deterioration of our bodies and brains, restores health when lost, and repairs injury when it occurs.

This new redox biology science embraces the basic cell biology of mitochondrial activity, biological energy production, and the creation of reactive oxygen species along with their specific subset of signaling messenger molecules. These reactive molecules (also known as redox signaling molecules) function as the cell's signaling messengers that drive and direct the metabolic pathways that govern gene expression inside all cells. Nothing happens inside a cell without there being a signal or directive to take action, including the wonderfully resilient immune system designed to protect and safeguard our body.

This redox signaling is the essential component of all cell signaling pathways involved in the regulation of cellular functions including cell growth, metabolism and metabolic pathways, hormone signaling and modulation, regulation and status of the immune system, and the control of a wide array of DNA transcription factors, and a variety of other physiological functions.

This signal transduction, the movement of electrons like a hot potato changing hands from one molecule to the next, is the basis and essence of life and of all life processes. As such it sits at the root-cause level of both health and disease. When it works well, cell health is improved and/or maintained (a condition of *ease*), and when it is impaired or dysfunctional the health of the cell and body suffer.

Modern medicine's pharmacologic interventions are not capable of correcting these basic redox deficiencies – certainly not on a broad scale. As such, the action of medications on cells is about symptom management rather than on correcting foundational cell processes gone awry, which when corrected improve a cell's ability to heal itself naturally under its own power.

At a cellular level this is fundamentally the difference between being *acted upon* and *acting*. The grounding premise is that to solve 'root-cause' problems it is necessary to apply 'root-cause-solutions.' The closer the corrective action is to the origin of the problem, the better the solution!

This obviously applies equally well to both prevention and correction. Laboring away in the "leaves and branches" of the disease management "tree" may be necessary in order to deal with distressing symptoms and life-altering health issues, but the better strategy is to move out of the tree's canopy to address the "roots" of the problem. This is the essence and beauty and power of addressing cellular signaling pathways which conduct the business of health in the cell.

The marvelous quality of cells is that they have an inherent native capacity to function better (if not optimally) when supplied with the right ingredients and living conditions. They have enormous capacity to repair or replace themselves, and by extension heal the body - provided they are not terminally damaged. It is helpful to think of this ability and the native biochemistry involved as our "Inner Doctor."

Restoring health once compromised is best accomplished by returning an affected cell to its native base capabilities and cellular functions as best as possible. When the basic rules of cellular health and redox signaling are followed, and the building and repair materials are optimally provided (through diet and supplementation), the cell is then able to act on its own to heal and maintain health as nature designed within its own programming.

This science of redox biology and cell signaling is currently one of the best kept 'secrets' in modern healthcare. While the knowledge of redox biology has been around for decades, exciting research and development and advancements in technology are now coming of age and seeing the light. The abundance of emerging research is foretelling a future filled with new redox-based solutions that capitalize on these fundamental principles both within the pharmaceutical as well as the health and wellness landscapes.

As happens with every advancement in scientific understanding and breakthrough in technology, these redox biology developments create new approaches to prevention and health recovery. With news like this it is understandable why the public's awareness of these new cellular health principles and modalities are being readily accepted and utilized.

Redox principles restore power and choice to people seeking health and wellness. Redox wellness means less need and reliance on costly medical intervention to manage disease. Better management of redox biology translates to increased healthspan, vibrant minds, and healthier bodies. Redox signaling is a gigantic step forward in reclaiming and maintaining health. It activates and makes nature's nutrition more bioavailable, and can reduce the need for medical intervention.

Restoring health processes through natural redox-based solutions is to effectively 'turn back the hands of time,' or at least slow them down. Redox signaling is more than the Fountain of Youth, it is the Fountain of Health! As such, better managed redox signaling biology now intersects with all-things health, to oppose the effects of relentless aging and disease.

Soon the concepts of redox energy production and cell signaling, along with redox-based healing, will become common household terms understood and spoken by all people. Already there is increased public and professional awareness which is driving demand by a public seeking more control over their foundational health status.

Interestingly, the science of redox biology legitimizes and explains the cascading mechanisms of action for a wide number of lifestyle measures - all of which increase mitochondrial efficiency and cell signaling activity. It is this enhanced bio-oxidative efficiency and native redox signaling which activates important protective gene pathways and feed forward to create healthy gene expression and cellular health.

Combining healthy lifestyle practices with their natural bio-oxidative effects, with enhanced redox replenishment, introduces new possibilities never before experienced in history. Restoring and maintaining health can now for the first time happen with a physiologic specificity previously unseen. Healthy gene expression can now be manipulated and managed like never before by applying and activating these basic laws of redox biology.

This emerging "secret formula" of improved redox biology is a most fundamental health strategy that promises to change the health and disease-care landscape for generations to come. Those who

understand and utilize these breakthroughs in cellular communication will have the advantage in regards to truly enjoying a healthy longevity.

Redox Matters is not a cursory high-level or Reader's Digest look at health. Rather it is a serious look at how the body works to defend and heal itself at the cellular level. Redox signaling is THE mechanism-of-action that is utilized by all cells to activate healthy gene expression. This is how cells are designed to function. When cell signaling is depressed or becomes dysfunctional, disease and aging result. If you are sick, tired, hurting, toxic, running out of energy, or aging too fast, there is a good chance it is because your cells are not working like they should. There is a good chance you have a redox deficiency.