# Why Your Cells Need NAD


NAD is indispensable for life and is found in every cell in your body. It's critical not only for cellular energy production but is also key to countless metabolic pathways and helps to protect and maintain your DNA.

## Essential For Cellular Energy

Nicotinamide adenine dinucleotide, or NAD, was first discovered in the early 1900s by two scientists who were working to identify substances that are essential for cells to function (1). Researchers Arthur Harden and William John Young showed that metabolic reactions could not take place without the help of certain factors, including NAD. Hans von Euler-Chelpin was the first to purify and isolate the NAD molecule and went on to share the 1929 Nobel Prize in Chemistry with Harden (2).

Years later in 1936 Otto Warburg, another Nobel Prize-winning scientist, was able to build on previous research by identifying how NAD contributes to cellular energy generation. His work revealed that NAD acts as an energy transferring agent in cellular metabolism (3).

NAD exists in two forms: NAD+ and NADH. The two forms of NAD accept and transfer electrons at critical steps in cellular energy metabolism. The conversion of NAD+ to NADH and back again is part of a continuous cycle of energy generation in living cells. Without NAD, cells could not generate the energy they need for everything they do.

## A Master Regulator

Now, almost a century after its initial discovery, advances in molecular biology are revealing an even greater role for NAD in our cells beyond energy metabolism. NAD is a key molecule in regulating cellular processes and is involved in pathways linked to gene expression, DNA repair, longevity, and wellbeing.

Cells rely on a class of signaling proteins called sirtuins to help maintain internal balance and cellular health. Sirtuins regulate key activities within cells, including gene expression, DNA repair, and cellular aging (4). Sirtuins are so fundamental to maintaining the healthy function of a cell's DNA they are sometimes called the guardians of the genome (5).

In the 1990s, scientists discovered that sirtuins can only function in the presence of NAD (6). This discovery revealed a new role for NAD as a master regulator of gene expression, among other functions (7). Because sirtuins are dependent on NAD, their activity is directly linked to the energy status of a cell. However, NAD levels decline with age (8, 9). Lower levels of NAD limit the activity of sirtuins, in turn limiting the ability of the cell to function.

## Support Cellular Health

NAD is key in many elements of cellular health, from energy generation to helping regulate cell functions. Our cells can create NAD when all the necessary nutrients are available, including vitamin B3

*continued...*

... continued

and the essential amino acid, tryptophan. However, the amount of NAD in our cells decreases over time, and lower levels of NAD can negatively impact our health and wellbeing.

Research has linked many healthy lifestyle choices to maintaining youthful levels of NAD in cells (10). For example, regular exercise, good sleep habits, and nutritious foods help to promote healthy NAD levels. Intermittent fasting is another strategy that can help maintain NAD levels in cells (11). Supplementing with NAD and other nutrients may also support NAD levels and cellular health.

Since it was first discovered over 100 years ago, the vital role NAD plays in the health of cells has become increasingly clear. It is essential for cellular energy production and for helping to regulate many key processes in cells, from gene expression to DNA repair. NAD levels decline with age throughout the body, but good nutrition and healthy lifestyle choices can help to support more youthful NAD levels and overall cellular health.

**References**


1. Harden A, Young W J. The alcoholic ferment of yeast-juice. Part II.—The coferment of yeast-juice. Proc R Soc Lond B Biol Sci. 1906; 78(526): 369-375.
2. The Nobel Prize in Chemistry 1929. NobelPrize.org. Nobel Prize Outreach AB 2022. Sat. 30 Jul 2022. https://www.nobelprize.org/prizes/chemistry/1929/summary/
3. Warburg O, Christian W. Pyridin, der wasserstoffübertragende Bestandteil von Gärungsfermenten. Helvetica Chimica Acta. 1936;19(1): E79-E88.
4. Imai S, Guarente L. NAD+ and sirtuins in aging and disease. Trends Cell Biol. 2014;24(8):464-471. doi:10.1016/j.tcb.2014.04.002
5. Ghosh S, George S, Roy U, Ramachandran D, Kolthur-Seetharam U. NAD: a master regulator of transcription. Biochim Biophys Acta. 2010;1799(10-12):681-693. doi:10.1016/j.bbagrm.2010.08.002
6. Bosch-Presegué L, Vaquero A. Sirtuins in stress response: guardians of the genome. Oncogene. 2014;33(29):3764-3775. doi:10.1038/onc.2013.344
7. Imai S, Armstrong CM, Kaeberlein M, Guarente L. Transcriptional silencing and longevity protein Sir2 is an NAD-dependent histone deacetylase. Nature. 2000;403(6771):795-800. doi:10.1038/35001622
8. Zhu XH, Lu M, Lee BY, Ugurbil K, Chen W. In vivo NAD assay reveals the intracellular NAD contents and redox state in healthy human brain and their age dependences. Proc Natl Acad Sci U S A. 2015;112(9):2876-2881. doi:10.1073/pnas.1417921112
9. Massudi H, Grant R, Braidy N, Guest J, Farnsworth B, Guillemin GJ. Age-associated changes in oxidative stress and NAD+ metabolism in human tissue. PLoS One. 2012;7(7):e42357. doi:10.1371/journal.pone.0042357
10. Poljsak B, Kovač V, Milisav I. Healthy Lifestyle Recommendations: Do the Beneficial Effects Originate from NAD+ Amount at the Cellular Level? Oxid Med Cell Longev. 2020 Dec 12;2020:8819627.
11. Green CL, Lamming DW, Fontana L. Molecular mechanisms of dietary restriction promoting health and longevity. Nat Rev Mol Cell Biol. 2022;23(1):56-73. doi:10.1038/s41580-021-00411-4