AUCTORES
Globalize your Research

New Medical Innovations and Research

Yuri Pivovarenko *

Open Access

Review Article

Microbiota as a Source of Heat for the Body

Yuri Pivovarenko

Research and Training Center 'Physical and Chemical Materials Science' Under Kyiv Taras Shevchenko University and NAS of Ukraine, Kiev, Ukraine.

***Corresponding Author:** Yuri Pivovarenko. Research and Training Center 'Physical and Chemical Materials Science' Under Kyiv Taras Shevchenko University and NAS of Ukraine, Kiev, Ukraine.

Received date: May 19, 2025; Accepted date: May 26, 2025; Published date: May 29, 2025

Citation: Yuri Pivovarenko, (2025), Microbiota as a Source of Heat for the Body, *J New Medical Innovations and Research,* 6(5);
DOI:10.31579/2767-7370/159

Abstract:

Both classical thermodynamics and statistical physics convince us that all gases cool when they expand. Apparently, this is why the fact that hydrogen gas heats up when it expands is generally ignored, at least by biologists and physicians. By drawing attention to such a radical difference in the thermodynamic properties of gaseous hydrogen and the gases that make up the air, it is shown here that it is precisely this difference that allows revising some traditional views both on the driving force of the evolution of life and on the true purpose of some features of life activity. Thus, it is shown here that this revision allows considering the human microbiota as an evolutionarily fixed source of both hydrogen and heat. At the same time, it has been shown that this revision allows radically reconsidering the generally accepted views on the root cause of the emergence of symbiosis of mitochondria and cells, including human ones. It is also shown that the true purpose of breathing may be to cool the human body, which is heated by the expansion of hydrogen produced by both the human microbiota and the mitochondria. Given that all of these ideas are unusual, especially for physicians, their rationale and medical implications are discussed in detail here; in particular, physicians are asked to consider that any inflammation may be a consequence of excess hydrogen production by both the human microbiota and the mitochondria contained within human cells.

Keywords: microbiota; breathing; cooling; pranayama; hydrogen therapy; cancer; bioenergetics

Introduction

The mathematical calculations underlying classical thermodynamics and statistical physics show that all gases must cool when they expand [1, 2]. As a result, both classical thermodynamics and statistical physics effectively force us to neglect the fact that both hydrogen and helium heat up as they expand [3] (it is perhaps worth noting here that such neglect seems particularly surprising in relation to helium, whose molecular structure and properties most closely correspond to the ideas about the structure and properties of an ideal gas that underlie both classical thermodynamics and statistical physics [1, 2]). Thus, given that intestinal gas can contain up to 50% hydrogen [4], it turns out that the human body is constantly in contact with gaseous mixtures, namely intestinal gas and air, which have fundamentally different thermodynamic properties. Since this difference in thermodynamic properties is usually not taken into account, it is proposed to discuss its impact on the human organism; it is hoped that the evolutionary approach used here can make this discussion more logical.

Discussion

So, based on this very difference, one can conclude that the expanding hydrogen gas of intestinal origin (actually microbial [5, 6]) heats the human body, and the air, both surrounding and inhaled, cools it. At the same time, this provides grounds for revising traditional views on the liver as the most powerful producer of heat in the human body [7, 8]. Thus, it is quite likely that most of the heat is not produced by the liver itself, but comes into it from the intestine along with the blood of the portal vein [9], previously heated by the expanded intestinal hydrogen. This, in turn, allows us to consider *Escherichia coli* not only as the most powerful producer of hydrogen gas in the human intestine [10 – 12], but also as the main supplier of heat for the human body.

Developing this idea, it is also worth adding that it is *Escherichia coli* that allows considering the human body as a kind of hydrogen-air electrochemical cell (Figure 1). Thus, based on this consideration, the electrical currents that undoubtedly flow between the human intestine and those human organs that come into contact with the air, primarily the lungs and skin, can also be considered as sources of heat (of course, this statement is based on the fact that any electric current generates heat [13]).

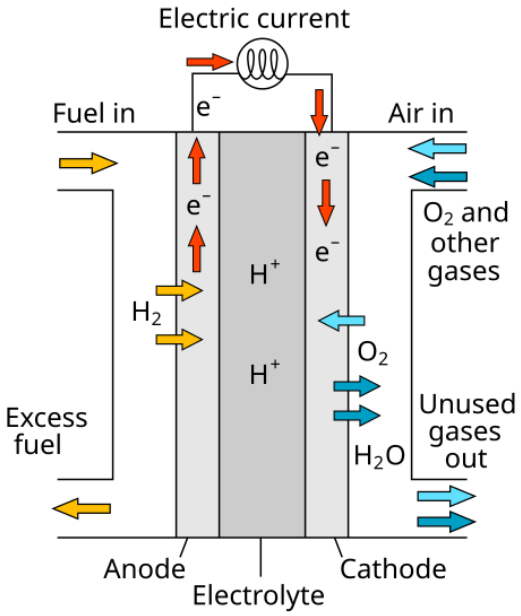

Figure 1: This is a diagram of a hydrogen-air electrochemical cell [3]. The red arrows indicate the movement of electrons from the compartment with an aqueous solution saturated with hydrogen gas to the compartment with an aqueous solution saturated with air.

In any case, all these considerations mean that the contribution of *Escherichia coli* to the functioning of the human body may be much greater than is commonly believed. Moreover, these same considerations provide grounds for rethinking the role of symbiosis that occurs between humans and other bacteria that make up the human microbiota [14 – 17].

To make this rethinking more justified, it is worth analyzing the emergence of this very symbiosis in historical terms.

Thus, it is currently believed that the atmosphere of the ancient Earth contained quite a lot of hydrogen (Figure 2, bottom left) and was completely free of oxygen.

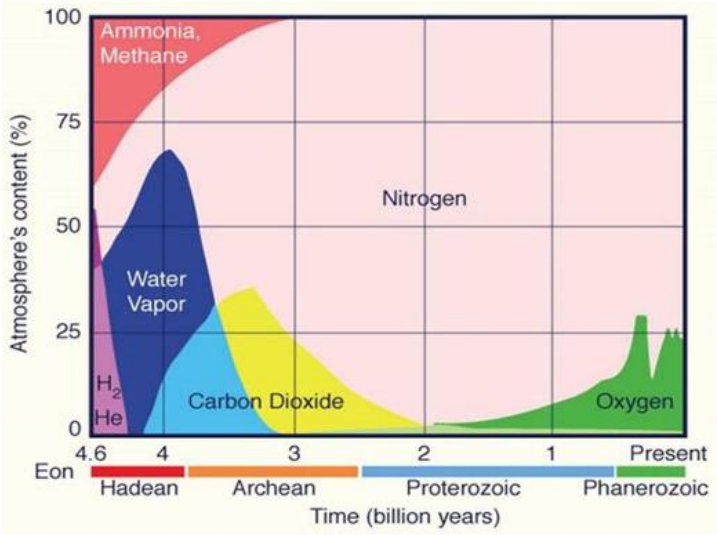

Figure 2: This is a diagram that shows current views on the evolution of the Earth's atmosphere [18].

This, accordingly, indicates that primordial life arose and developed in waters containing hydrogen. Moreover, it suggests that the disappearance of hydrogen from the environment surrounding ancient cells forced those that did not produce hydrogen to look for sources of it. Thus, it is likely that it was precisely the need of these cells for hydrogen that prompted them to form a symbiosis with hydrogen-producing bacteria of the genera *Clostridium*, *Enterobacter*, *Klebsiella*, *Citrobacter* and *Bacillus* [19]. Therefore, this symbiosis should be considered as an evolutionary adaptation that allowed ancient cells that did not produce hydrogen to survive. Accordingly, the fact that these particular genera of bacteria form the modern human microbiota should be considered the result of evolution, preserved since ancient times.

Reasoning in the same way, it can be assumed that the assimilation of mitochondria by these same ancient cells had the goal of reproducing a hydrogen-containing internal environment in them; naturally, such an assumption is based on the fact that hydrogen atoms are the main products of the mitochondrial Krebs cycle (Figure 3).

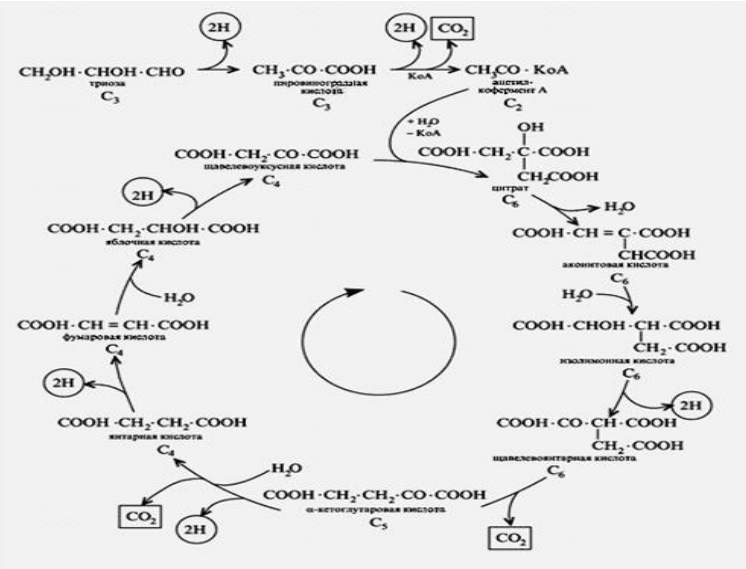

Figure 3: This is the Russian language diagram of the mitochondrial Krebs cycle that seems most suitable for this article; the suitability of this diagram is that it is free from many details that obscure the fact that the main products of mitochondria are hydrogen atoms.

The pairs of hydrogen atoms formed in the cycle are circled [18].

Apparently, it soon "became clear" to ancient cells that all these types of symbiosis are not only sources of necessary hydrogen, but also sources of excess heat released by hydrogen during its expansion [3]. Therefore, ancient cells were forced to find ways to both cool themselves and limit the uncontrolled expansion of hydrogen gas. Given this, it is likely that the necessary cooling was originally achieved by ancient cells using currents of water and air that existed in the environment, which over time developed into systems of multicellular organisms that ensure the circulation of biological fluids such as blood and lymph, as well as air.

Since the inhaled air is now seen solely as a source of oxygen, and the blood as its supplier, the proposed view of the original purpose of all these systems may seem surprising. To make this view more acceptable, it is worth noting that oxygen gas appeared in the Earth's atmosphere much later than the first forms of life (Figure 2, right). At the same time, it is useful to consider separately the contribution of the emerging gaseous oxygen to the cooling of the cells.

First of all, it should be taken into account that oxygen molecules can react in the mitochondria with hydrogen atoms (in fact, with NADH) formed in the Krebs cycle (Figure 3), thus creating water (Figure 4) and hydrogen peroxide. Secondly, it should not be forgotten that oxygen molecules are also capable of binding hydrogen atoms carried by NADH, thus forming superoxide anions and hydrogen ions: $NADH + O_2 \rightarrow NAD^{\bullet} + O_2H$ ($\rightarrow O_2^- + H^+$) (1) [20 – 23]. All this, accordingly, shows that molecular oxygen supplied with air prevents the formation of hydrogen gas, which produces heat during expansion.

Although all this is sufficient to confirm the role of molecular oxygen in cellular cooling, the contribution of hydrogen ions formed together with superoxide anions (1) cannot be ignored. So, given that under terrestrial conditions only water enriched with uncompensated hydrogen ions is capable of evaporating [18, 24], thereby cooling any aqueous environment [1, 2], it turns out that hydrogen ions formed in mitochondria also contribute to the cooling of cells.

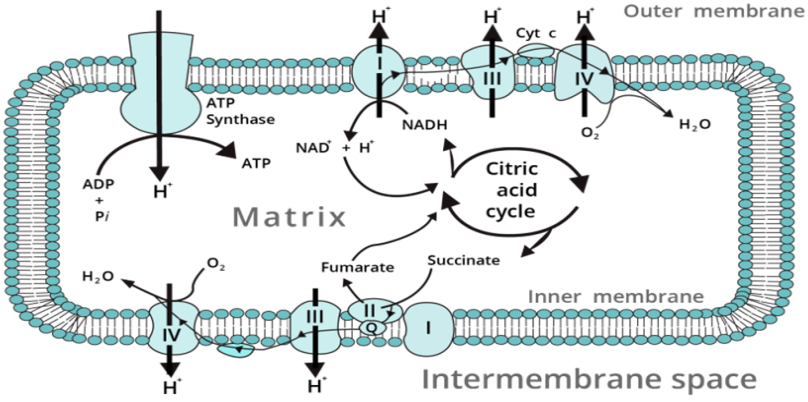

Figure 4. This is a typical diagram of a working mitochondrion. From this diagram, it is clear that molecular oxygen can react with hydrogen atoms supplied by NADH from the Krebs cycle and thus neutralize them [18].

Thus, it turns out that the appearance of oxygen in the Earth's atmosphere transformed mitochondria into organelles capable of producing hydrogen atoms, but preventing the heating of cells. Accordingly, NAD and FAD,

in particular mitochondrial ones (Figure 4), can be considered the first substances that prevented the formation of hydrogen gas from its atoms formed in the Krebs cycle (Figure 3), and, thus, the heating of cells. (Reasoning in the same way, one can also conclude that other hydrogen atom carriers, first of all, the ubiquitous quinones, i.e. ubiquinones [25, 26], arose for a similar purpose).

So, it turns out that with the appearance of oxygen in the Earth's atmosphere, mitochondria turned into organelles capable of regulating heat production in various ways. To complete the picture, it is worth adding that as a result of all these reactions (Figure 4), molecular oxygen loses the ability to form a gas that cools during expansion.

Conclusion

Although the proposed concept is based on the real properties of hydrogen and oxygen gases, it may look unusual to both biologists and doctors. Therefore, it is worth demonstrating the biological and medical advantages of this very concept.

Thus, thanks to this concept, most species of normal human microbiota become heat suppliers for the human body. This, in turn, allows explaining quite clearly the anti-cancer effects of the good human microbiota [27 – 29]. So, given the high sensitivity of cancer cells to heat [30 – 33], it is quite possible that it is the heat produced by this microbiota that determines its anti-cancer activity. Thus, it turns out that it is this concept that allows proposing for the first time an explanation for the anti-cancer effect of heat that does not appeal to disturbances in biochemical reactions in cancer cells [30, 31], but is based on their lower heat capacity compared to healthy cells [34]. This, apparently, also forces reconsidering the generally accepted views on the nature of the anticancer effects of hydrogen therapy, especially hydrogen inhalation [35 – 38], which are mainly based on the reducing properties of hydrogen [3].

It is obvious that the proposed concept also allows reconsidering the established views on the activity of mitochondria. In particular, it is this concept that allows assuming that mitochondria generate energy in the form of heat released both during the expansion of hydrogen gas and during the occurrence of electric currents in the mitochondrial electron transport chains [39]. Developing this point of view, it can be assumed that ATP molecules are not carriers of the mysterious “biological energy”, but act exclusively as donors of phosphate residues, the addition of which to target substances causes their polarization, increasing chemical activity, for example, as in the case of glucose and fatty acids.

To make the latter assumption more acceptable, it is worth noting that it is the electrostatic repulsive forces [13] arising between the ionized phosphates in the doubly phosphorylated glucose molecule (D-glucose-1,6-bisphosphate) that break it into two fragments. Thus, it turns out that completely ordinary electrostatic forces, i.e. those acting without the participation of any “biological energy”, transform the glucose molecule into its metabolites.

Finally, it is worth noting that the proposed concept allows doctors to consider any inflammation as a consequence of excessive hydrogen production by both the human microbiota and the mitochondria contained in human cells. Accordingly, this concept gives doctors the basis to use breathing exercises that cool the human body, in particular for Sitali Pranayama, as a means of treating any inflammation; in any case, they may recommend these exercises based on evidence that body cooling promotes human longevity [40 – 42].

References

1. Reif F. (1965). Statistical Physics. Berkeley Physics Course, Volume 5. NY: McGraw-Hill Book Company.
2. Fenn J.B. (1982). Engines, Energy, and Entropy. New York, San Francisco: W.H. Freeman and Company.
3. Nekrasov B.V. (1974). Basics of General Chemistry, Volume 1. Moscow: Chemistry. In Russian.
4. Intestinal gas section in the Encyclopedia Britannica.
5. Mutuyemungu E., Singh M., Liu S. and Rose D.J. (2023). Intestinal gas production by the gut microbiota: A review. Journal of Functional Foods. 100.
6. Campbell A., Gdanetz K., Schmidt A.W. and Schmidt T.M. (2023). H_2 generated by fermentation in the human gut microbiome influences metabolism and competitive fitness of gut butyrate producers. Microbiome. 11(1).
7. Abumrad N.A. (2017). The liver as a hub in thermogenesis. Cell Metabolism. 26(3), 454-455.
8. Yousef H., Ahangar E.R. and Varacallo M.A. (2023). Physiology, Thermal Regulation. Treasure Island (FL): StatPearls Publishing.
9. Chung K.W. and Chung H.M. (2008). Cross Anatomy. Lippincott Williams & Wilkins.
10. Maeda T., Sanchez-Torres V. and Wood T.K. (2012). Hydrogen production by recombinant *Escherichia coli* strains. Microbial Biotechnology. 5(2), 214-225.
11. Trchounian K., Sargsyan H. and Trchounian A. (2014). Hydrogen production by *Escherichia coli* depends on glucose concentration and its combination with glycerol at different pHs. International Journal of Hydrogen Energy. 39(12), 6419-6423.
12. Bekbayev K., Mirzoyan S., Toleugazykyzy A. et al. (2022). Growth and hydrogen production by *Escherichia coli* during utilization of sole and mixture of sugar beet, alcohol, and beer production waste. Biomass Conversion and Biorefinery. 14, 909-919.
13. Purcell E.M. and Morin D.J. (2013). Electricity and Magnetism in BPC, 3rd Edition. Cambridge: Cam-bridge University Press.
14. Marchesi J.R. and Ravel J. (2015). The vocabulary of microbiome research: a proposal. Microbiome. 3.
15. Sender R., Fuchs S. and Milo R. (2016). Revised estimates for the number of human and bacteria cells in the body. PLOS Biology. 14(8).
16. Hou K., Wu Z.X., Chen X.Y. et al. (2022). Microbiota in health and diseases. Signal Transduction and Targeted Therapy. 7(1).
17. Walaa M.K., Fadia C. and Shannon H. (2022). Recent advances in understanding the structure and function of the human microbiome. Frontiers in Microbiology. 13.
18. Pivovarenko Y. (2024). Diseases as a legacy of the Great Oxidative Event, or how mitochondria became pathogenic and sweating became healing. Journal of Cancer Research and Cellular Therapeutics. 8(5).
19. Su X., Zhao W. and Xia D. (2018). The diversity of hydrogen-producing bacteria and methanogens within an in situ coal seam. Biotechnology for Biofuels. 11.
20. Murphy M.P. (2009). How mitochondria produce reactive oxygen species. The Biochemical Journal. 417(1), 1-13.
21. Grivennikova V.G. and Vinogradov A.D. (2013). Partitioning of superoxide and hydrogen peroxide production by mitochondrial respiratory complex I. Biochimica and Biophysica Acta. 1827(3), 446-454.
22. Mailloux R.J. (2015). Teaching the fundamentals of electron transfer reactions in mitochondria and the production and detection of reactive oxygen species. Redox Biology. 4, 381-398.
23. Robb E.L., Hall A.R., Prime T.A. et al. (2019). Control of mitochondrial superoxide production by reverse electron transport at complex I. The Journal of Biological Chemistry. 293(25), 9869-9879.
24. Pivovarenko Y. (2024). Water evaporation as an electromagnetic phenomenon. European Journal of Applied

Physics. 6(3), 19-25.
25. Taylor J.B. and Triggle D.J. (2007). Comprehensive Medicinal Chemistry II. Elsevier Ltd.
26. Sood B., Patel P. and Keenaghan M. (2024). Coenzyme Q10. Treasure Island (FL): StatPearls Publishing.
27. Viaud S., Daillère R., Boneca I. G. et al. (2014). Gut microbiome and anticancer immune response: really hot Sh*t! Cell Death and Differentiation. 22(2), 199-214.
28. Gately S. (2019). Human microbiota and personalized cancer treatments: role of commensal microbes in treatment outcomes for cancer patients. Cancer Treatment and Research. 178, 253-264.
29. Zhao L.Y., Mei J.X., Yu G. et al. (2023). Role of the gut microbiota in anticancer therapy: from molecular mechanisms to clinical applications. Signal Transduction and Targeted Therapy. 8.
30. Mondovi' B. Strom R.,. Rotilio G. et al. (1969). The biochemical mechanism of selective heat sensitivity of cancer cells. European Journal of Cancer. 5(2), 129-136.
31. Turano C., Ferraro A., Strom R. et al. (1970). The biochemical mechanism of selective heat sensitivity of cancer cells: III. Studies on lysosomes. European Journal of Cancer. 6(2), 67-72.
32. Rossi-Fanelli A., Cavaliere R., Mondovì B. and Moricca G. (1977). Selective Heat Sensitivity of Cancer Cells. Berlin, Heidelberg, New York: Springer-Verlag.
33. Hannon G., Tansi F.L., Hilger I. and Prina-Mello A. (2021). The effects of localized heat on the hallmarks of cancer. Advanced Therapeutics. 4(7).
34. Pivovarenko Y. (2023). Positively charged water as a tumor growth stimulator. Biomedical Sciences. 9(3), 64-72.
35. Li S., Liao R., Sheng X. et al. (2019). Hydrogen gas in cancer treatment. Frontiers in Oncology. 9.
36. Zhang X., Tao G., Zhao Y. et al. (2022). Molecular hydrogen inhibits colorectal cancer growth via the AKT/SCD1 signaling pathway. BioMed Research International. 2022.
37. Noor M.N.Z.M., Alauddin A.S., Wong Y.H. et al. (2023). A systematic review of molecular hydrogen therapy in cancer management. Asian Pacific Journal of Cancer Prevention. 24(1), 37-47.
38. Chitapanarux I., Onchan W., Chakrabandhu S. et al. (2024). Pilot feasibility and safety study of hydrogen gas inhalation in locally advanced head and neck cancer patients. OncoTargets and Therapy. 17, 863-870.
39. Ahmad M., Wolberg A. and Kahwaji C.I. (2023). Biochemistry, Electron Transport Chain. Treasure Island (FL): StatPearls Publishing.
40. Keil G., Cummings E. and de Magalhães J.P. (2015). Being cool: how body temperature influences ageing and longevity. Biogerontology. 16(4), 383-397.
41. Lee H.J., Alirzayeva H., Koyuncu S. et al. (2023). Cold temperature extends longevity and prevents disease-related protein aggregation through PA28γ-induced proteasomes. Nature Aging. 3, 546-566.
42. Boulares A., Jdidi H. and Douzi W. (2025). Cold and longevity: Can cold exposure counteract aging? Life Sciences. 364.

DOI:10.31579/2767-7370/159