Journal of Developmental Origins of Health and Disease

www.cambridge.org/doh

Celebrating 280 birth years of Lamarck: revisiting his legacy in the concept of Developmental Origins of Health and Disease

Elena Zambrano[1,2] and Carlos A. Ibáñez[1]

[1]Reproductive Biology, Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, Mexico City, Mexico and [2]Facultad de Química, Universidad Nacional Autónoma de México, México City, Mexico

Editorial

Cite this article: Zambrano E and Ibáñez CA. (2025) Celebrating 280 birth years of Lamarck: revisiting his legacy in the concept of Developmental Origins of Health and Disease. *Journal of Developmental Origins of Health and Disease* **16**: e8, 1–3. doi: 10.1017/S2040174425000030

Received: 24 December 2024
Accepted: 18 January 2025

Keywords:
Lamarck; Inheritance of acquired characteristics; Developmental programing; Developmental Origins of Health and Disease concept

Corresponding author:
Carlos A. Ibáñez;
Email: carlos_albertoibc@comunidad.unam.mx

Abstract

In 2024, we are celebrating the 280th anniversary of Jean-Baptiste Lamarck, whose early theories on inheritance and environmental adaptation have advanced the foundational concepts of Developmental Origins of Health and Disease (DOHaD). This proposal aims to explore how some Lamarckian ideas align with contemporary understandings of how environmental factors in early life can affect health throughout an individual's lifetime and across generations. This text not only honors an important historical milestone but also reflects on how a DOHaD notion might have been present since the earliest years of biological science. It bridges historical scientific thought with present-day scientific research.

Celebrating 280 birth years of Lamarck: revisiting his legacy in the concept of Developmental Origins of Health and Disease

Jean Baptiste Pierre Antoine de Monet, Chevalier de Lamarck (1744–1829), a prominent French naturalist, made significant contributions during the 18th century, a period that marked the height of the Enlightenment. Lamarck's most prolific period occurred during the development of the French Revolution from 1789 to 1799. The Enlightenment was characterized by the flourishing of rationalist thought, which placed reason at the center of the acquisition of knowledge. This undoubtedly resulted in the great advancement of scientific knowledge in subsequent years, particularly in the field of biology.

Lamarck's Zoological Philosophy

Lamarck's contributions helped lay the foundation for modern biology. He coined the term biology. In 1809, he published his greatest work, *"Zoological Philosophy or Exposition Concerning the Natural History of Animals,"* in which he proposed two laws by which animals acquire and inherit characteristics [1]. The first law states that the use or disuse of body structures causes them to grow or shrink over generations. The second law states that such changes are inherited (Fig 1*a*). In 1830 the British Charles Lyell, the father of modern geology, criticized Lamarckian principles, saying that they lacked evidence and probably misrepresented the concept with a hypothetical example of neck lengthening in giraffes, suggesting that giraffe necks lengthened over generations as they stretched to reach higher leaves, and that these changes were inherited by their offspring (Fig 1*b*). It should be made clear that Lamarck never proposed this example, and that this interpretation by Lyell probably caused a delay in the proper understanding of Lamarck's ideas regarding the inheritance of acquired traits. Evidence later in the 19th century ruled out Lamarck's laws as a mechanism for explaining the evolution of living things. However, his ideas represent the first formal proposal that established the change of species over time, in contrast to fixism, a theory that held that living things were unchanging from the moment of their creation. In this way, it could be concluded that the complexity of living things is constantly increasing over time, i.e., evolving, and that animal species are not the product of creation.

Contributions to the field of biology after Lamarck

In 1859, Charles Darwin, an English naturalist, published his seminal work, *"The Origin of Species by Means of Natural Selection"*[2]. In this revolutionary text, Darwin presented the findings he had gathered during his voyage on the HMS Beagle in the 1830s. He proposed that the evolution of living beings over time is directed by a process called "natural selection," in which environmental conditions can favor or hinder the reproduction of species. However, Charles Darwin's work did not fully elucidate the mechanisms underlying the evolution of living beings over time. It was not until the seminal contributions of August Friedrich Leopold Weismann,

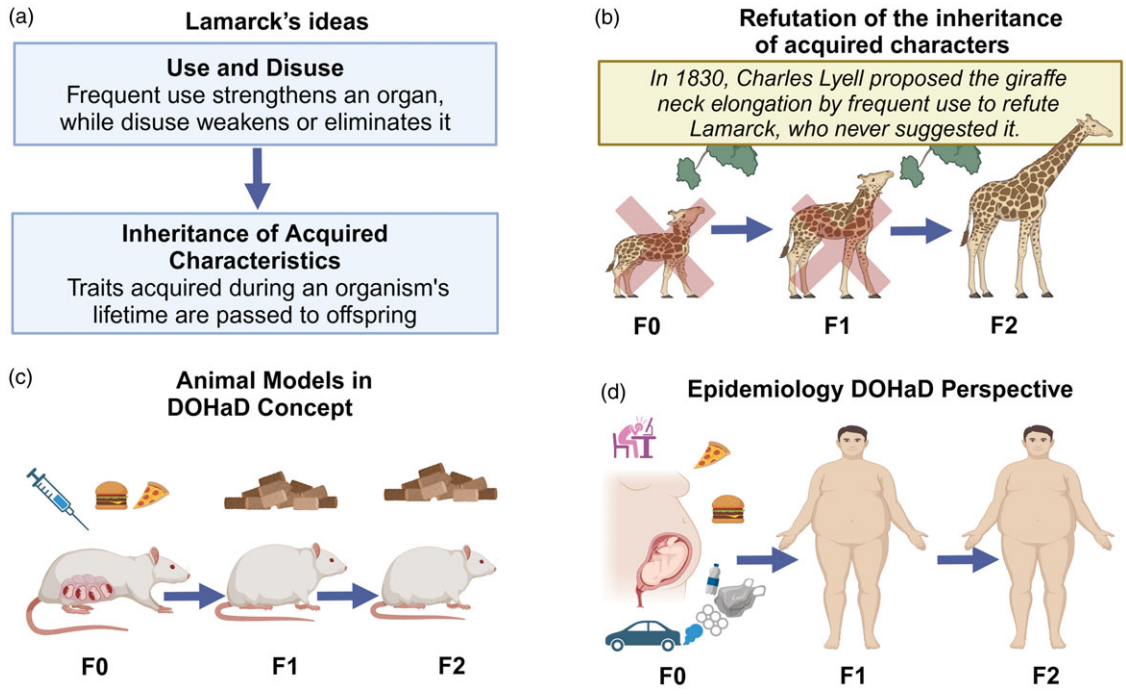

Figure 1. Lamarckian ideas and transmission of physiological traits in response to environment in the context of DOHaD. Lamarck's laws, outlined in *Philosophie Zoologique* (1809), propose that frequent use strengthens organs while disuse weakens them, and that traits acquired during an organism's lifetime are inherited by offspring (*a*). The hypothetical neck elongation in giraffes across generations by Charles Lyell is now discredited by modern biology (*b*). Obesity programing due to high-fat diet exposure has been demonstrated in animal models across generations until the late 20th century (*c*). The present-day DOHaD perspective proposes that intergenerational transmission of physiological alterations, including obesity predisposition, occurs across generations, shaped by environmental conditions (*d*). These ideas underscore how environmental factors, such as diet, program metabolic traits, influencing long-term health. Created in BioRender.

Gregor Johann Mendel, and Thomas Hunt Morgan that the genetic mechanisms underlying evolution were established[3]. As a result, the influence of environmental factors on heritable traits was largely overlooked until new scientific insights began to emerge in the late 20th century.

Foundations of Developmental Origins of Health and Disease concept

As the 19th century progressed and the 20th century was entered, the concepts of gene, genotype, and phenotype were established. A substantial body of experimental models (Fig 1*c*), clinical and epidemiological studies (Fig 1*d*) conducted since the late 20th century has demonstrated that, while the phenotype is determined in part by the genotype, unfavorable environmental exposure, particularly during critical stages of development such as gestation and lactation, can result in alterations in the differentiation of the organism and changes in the growth trajectory of the individual, thereby predisposing it to the development of various diseases. This phenomenon was initially described as the "Fetal Programming Hypothesis." As the evidence supporting this hypothesis grew, it evolved to be called "Developmental Programming" until it became the concept of the "Developmental Origins of Health and Disease (DOHaD)"[4]. While these findings do not provide a validation of Lamarckian inheritance, they underscore the significance mechanisms, can influence gene expression, thereby demonstrating the environmental shaping of phenotypic traits across generations.

The field of study of DOHaD is currently experiencing a period of significant research activity on a global scale. This area of study involves the transmission of phenotypic alterations from one generation to another, which can lead to an increased predisposition to "non-communicable" diseases, such as hypertension, obesity, and diabetes, among others. For instance, the offspring of obese mothers exhibit an increased predisposition to obesity and diabetes. This phenomenon is explained in the context of epigenetics, a field of modern biology. The term "epigenetics" was coined by Conrad H. Waddington in 1942 to denote the branch of biology that studies the causal interactions between genes and their products. This branch of biology elucidates the diverse mechanisms through which a gene is expressed, influenced by environmental factors. These alterations in gene expression, resulting from changes in the packaging of genetic material, can be transmitted from one generation to the next. Such changes do not involve alterations in the sequence of nitrogenous bases in DNA. Instead, they involve modifications to the packaging of chromatin by changes in the proteins that bind to DNA, typically the histone terminal regions. Alternatively, these changes can involve the methylation of cytosine residues in DNA, thereby either inhibiting or increasing the expression of genetic information in the region. These alterations can occur during the developmental process of an individual, influenced by various environmental factors.

The notion that the phenotype emerges from the interplay between genes and the environment finds concurrence with Lamarck's laws, which stipulate that the development of characteristics in organisms is derived from the utilization and disuse of bodily structures. In this conceptual framework, the concept of utilization and disuse is implicitly determined by an organism's responses to diverse environmental stimuli. Conversely, the heritability of acquired traits finds its rationale in the context of epigenetic mechanisms, which, once established by the environment, can be transmitted from parent to offspring.

https://doi.org/10.1017/S2040174425000030 Published online by Cambridge University Press

It is important to acknowledge that, despite the scientific validation of the intergenerational transmission of epigenetic modifications, our understanding of the mechanisms underlying this process remains limited.

Conclusions

Lamarck's ideas have probably been undervalued before the development of epigenetics, because they have been associated with the search for an explanation of speciation. However, in his time, one of the main tasks of naturalists, inspired by the ideas of the Enlightenment, was to dismiss fixism in the light of the Enlightenment. Lamarck's work is fundamental in the development of the biological sciences by formally discarding the idea that species are immutable and do not undergo change over time. Thus, naturalists after Lamarck had a fundamental frame of reference for the construction of the concept of evolution.

In the present context, Lamarck's ideas are to some extent compatible with the experimental evidence in the field of epigenetics and the findings that support the DOHaD concept. It is likely that findings subsequent to Charles Darwin's evolutionary theory have overshadowed Lamarck's initial proposals. Lamarck's ideas are commonly contrasted with Darwin's ideas in the context of evolutionary theory, so it is very likely that he is only remembered as the thinker who did not succeed in explaining the origin of species. However, in the current context, taking up Lamarck's ideas in essence is important in the understanding of various phenomena related to human health, especially in the context of the intergenerational transmission of chronic degenerative diseases.

Acknowledgements. The authors acknowledge the institutional support of the Instituto Nacional de Ciencias Médicas y Nutrición Salvador Zubirán, and the Universidad Nacional Autónoma de México.

Financial support. This research received no specific grant from any funding agency, commercial or not for-profit sectors.

Competing interests. None.

References

1. JBPAdMd Lamarck. *Philosophie zoologique, ou Exposition des considérations relatives à l'histoire naturelle des animaux, Nouvelle édition*, 1830. Nouvelle édition. Paris : J. B. Baillière; Londres : Même Maison; Bruxelles : Au Dépôt de la Librairie Médical Française.
2. Darwin C. *On the Origin of Species by Means of Natural Selection, or, The Preservation of Favoured Races in the Struggle for Life*, 1859. London: John Murray.
3. Buskes C. *La herencia de Darwin: la evolución en nuestra visión del mundo*, 2009. Barcelona: Herder.
4. Gluckman PD, Buklijas T, Hanson MA. Chapter 1 -The developmental origins of health and disease (DOHaD) concept: past, present, and future. In *The Epigenome and Developmental Origins of Health and Disease* (ed Rosenfeld cs), 2016; pp. 1–15. Academic Press, Boston.

https://doi.org/10.1017/S2040174425000030 Published online by Cambridge University Press