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EDITORIAL

What does Colombia require to earn a Nobel Prize in Medicine?

¿Qué necesita Colombia para ganar un Premio Nobel de Medicina?

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Last year, two of the most academically recognized and publicly admired Colombian scientists in the health field passed away: Francisco Lopera and Manuel Elkin Patarroyo. With them, Colombia lost two opportunities for nomination to the Nobel Prize in Physiology or Medicine. For some, it may seem exaggerated to think that their contributions could have reached such a distinction; however, both fulfilled the three fundamental attributes required by the Nobel Committee of the Karolinska Institute: having discovered physiology or medicine (not merely a technical or cumulative advance); that such a finding transformed scientific understanding or medical practice; and that the results had been replicated and accepted by the international scientific community [1]. In this analysis, we intentionally omit the requirement of being alive at the time of the award announcement.

Latin America has received fourteen Nobel Prizes in the areas of Literature, Peace, Medicine, and Chemistry, two of which correspond to Colombia (Table 1) [1]. The Literature category usually recognizes individual creativity, where Latin American culture and idiosyncrasy have borne fruit with indisputable literary contributions. The Nobel Peace Prize, on the other hand, acknowledges political efforts grounded in ideals. Our region has faced situations and challenges that some leaders have addressed with innovative approaches to achieve peace, whose analysis and impact have contributed to that purpose. In contrast, contributing to science and society in the fields of Medicine and Chemistry requires interdisciplinary and transdisciplinary work, access to frontier technologies, as well as the curiosity and scientific tenacity needed to formulate, support, and test solid hypotheses.

Although the number of Nobel Prizes obtained by a country does not constitute an adequate measure of scientific development, it does represent a seal of excellence that, in practice, is frequently used to assess investment in science, positioning in university rankings, or international leadership [2]. Colombia has also fallen into the temptation of proposing an indicator based on the Nobel Prize and supporting it with bibliometric data [3]. However, such results do not necessarily reflect the perception of the national scientific community regarding the real possibilities of our researchers being nominated, nor compliance with the requirements of the Karolinska Institute.

In an editorial published in 2015, *PLOS Computational Biology* humorously summarized ten rules for winning a Nobel Prize [4]. Although its advice is well-founded, recommendations such as “conduct experiments when you are lucky” or “be related to a Nobel laureate” are not exactly easy to follow. However, the remaining suggestions can be synthesized into three essential attributes: being a good observer of mistakes, fostering collaborative work, and maintaining constructive interpersonal relationships.

Table 1. Latin America Nobel Prizes*

Name	Country	Category	Year	Contribution
Carlos Saavedra Lamas	Argentina	Peace	1936	Mediation in international conflicts in Latin America.
Gabriela Mistral	Chile	Literature	1945	Lyric poetry of maternal and humanist inspiration.
Bernardo Houssay	Argentina	Medicine	1947	Discovery of the role of the pituitary gland in carbohydrate metabolism.
Miguel Ángel Asturias	Guatemala	Literature	1967	Literature with indigenous roots and social denunciation.
Luis Federico Leloir	Argentina	Chemistry	1970	Discoveries on sugar nucleotides and carbohydrate biosynthesis.
Pablo Neruda	Chile	Literature	1971	Poetry of visionary force and political commitment.
Adolfo Pérez Esquivel	Argentina	Peace	1980	Defense of human rights under dictatorships.
Gabriel García Márquez	Colombia	Literature	1982	Novels and short stories with magical realism.
César Milstein	Argentina	Medicine	1984	Development of monoclonal antibodies.
Octavio Paz	Mexico	Literature	1990	Poetry and essays of outstanding literary quality.
Rigoberta Menchú	Guatemala	Peace	1992	Defense of indigenous rights and social justice.
Mario J. Molina	Mexico	Chemistry	1995	Research on the ozone layer and CFCs.
Mario Vargas Llosa	Perú	Literature	2010	Narrative power and cultural impact.
Juan Manuel Santos	Colombia	Peace	2016	Peace process with the FARC (Revolutionary Armed Forces of Colombia)

*: The Venezuelan Baruj Benacerraf was not included because he became a naturalized citizen of the United States and developed his career in that country. The Nobel Prize organization refers to him as American

Adapting these guidelines to the Colombian context requires studying success stories of our scientists with nomination potential and, from that reflection, proposing actions that foster the development of medicine with a global vision. Table 2 lists some national researchers with significant scientific contributions who meet the Karolinska Institute Committee's criteria for a Nobel Prize nomination in Physiology or Medicine. This selection, of course, is discretionary and may leave out other scientists who have also made remarkable contributions. The aim is to examine their experiences to understand better the opportunities for scientific development that could enable Colombia to achieve contributions of global impact.

The career of Dr. Francisco Lopera reflects the qualities of a meticulous and disciplined observer, combined with a charisma that inspired trust among his patients and disciples, and that was embodied in his dream of finding a drug capable of modifying Alzheimer's disease. The transparent and forward-looking approach with which he led the Neuroscience Group of Antioquia succeeded in capturing the attention of the pharmaceutical industry, which supported his search for a treatment for this dementia and offered hope to patients carrying the "paisa" mutation [10].

Dr. Pelayo Correa exalted the value of data. He understood that histopathology reports constituted a reliable source for research and, with the support of the National Cancer Institute in Bethesda (Maryland), together with the pathology professors of the Universidad del Valle, promoted the establishment of the Cali Cancer Registry. The data from this registry revealed the high incidence of gastric cancer in the population of the Nariño region, and his observations and analyses made it possible to identify the associated environmental factors. Subsequently, he demonstrated that incidence could be modified through the control of *Helicobacter pylori* infection and dietary changes. His later investigations deepened the understanding of the abrupt rupture in the coevolution between a bacterium and the human host [11,12].

Nubia Muñoz was a disciple of Dr. Pelayo Correa at the Cali Cancer Registry, and motivated by her mentor's guidance, she decided to study the relationship between infections and cancer. With training at Johns Hopkins University in the United States, she worked on this hypothesis alongside Dr. Harald Zur Hausen in Lyon, France. Although they initially failed to demonstrate a link between herpes viruses and cervical cancer, Dr. Zur Hausen later suggested exploring another candidate: the human papillomavirus (HPV). Research conducted with samples from Brazil and, subsequently, from other regions of the world, established the causal relationship between HPV and cervical cancer. This discovery led Dr. zur Hausen to receive the Nobel Prize and Dr. Nubia Muñoz to be nominated. The development of HPV vaccines, based on these findings, has prevented thousands of deaths from cervical cancer. In this case, the role of her mentor, international collaboration, and training in diverse fields (pathology and public health) were crucial in providing her with a broad perspective of the problem that guided her scientific work [13].

Table 2. Colombian scientists who meet the Committee's nomination criteria

Researcher	Specialty / Area	Main Contribution	Impact on Medicine
Francisco Lopera	Neurology	Identification of the "paisa" mutation (PSEN1 E280A) that causes early-onset Alzheimer's.	Enables the study of the disease decades before symptoms; foundation for worldwide preventive trials [5].
Manuel Elkin Patarroyo	Immunology	Development of the first synthetic vaccine against malaria (SPf66).	Paved the way for synthetic vaccines and generated debates on research and patents [6].
Nubia Muñoz	Cancer Epidemiology	Demonstrated the causal relationship between human papillomavirus (HPV) and cervical cancer.	Provided the scientific basis for the development and global use of HPV vaccines [7].
Pelayo Correa	Gastrointestinal Pathology	Description of Correa's cascade, the histological sequence leading to gastric cancer; link with Helicobacter pylori.	Basis for prevention, diagnosis, and treatment strategies for gastric cancer [8].
Rodolfo Llinás	Neuroscience	Llinás' Law, or the law of the non-interchangeability of neuronal function.	Explains why different types of neurons, even when similarly connected, perform distinct functions in the brain [9].

The case of Dr. Manuel Elkin Patarroyo is unique. In addition to embodying the qualities of an outstanding scientist, he was convinced that it was possible to conduct high-level science from Colombia. His career can be considered a case study for those analyzing strategies to promote and finance scientific research. He succeeded in transforming an idea into a project and, ultimately, into a milestone: the development of the first synthetic vaccine against malaria. This achievement represented a global breakthrough, both conceptually and technically, and his recognition extended beyond the controversies. Dr. Pat arroyo's decision to remain in Colombia to carry out his work revealed advantages that could be replicated in future research models, among them, proximity to the real landscape of tropical diseases. It is difficult to fully understand such a problem when research is conducted exclusively from a cutting-edge laboratory without ever having direct contact with a malaria patient or the conditions of disease transmission [14].

Finally, Dr. Rodolfo Llinás achieved recognition as a neuroscientist after migrating early, first to Australia and later to New York. During his scientific training, he worked with two neurophysiologists: the Swiss Walter Rudolf Hess and Sir John Carew Eccles, both Nobel Prize laureates in Medicine, who influenced the critical thinking that led him to challenge prevailing assumptions about neuronal plasticity involving the replacement of function at the cellular level. Llinás' Law revolutionized neuroscience because it defined future strategies for the treatment of neurodegenerative diseases [10]. The case of Dr. Llinás demonstrates the strength of mentorship and how early integration into a scientific community can be an exceptional advantage.

What lessons can we learn from the trajectory of the most prominent Colombian scientists to promote the development of medical research? First, sources of information were decisive for the advancement of their careers and the formulation of innovative ideas. Second, the value of cooperative networking with other scientists, often in a transdisciplinary manner, stands out, as it allowed them to refine their hypotheses and define better strategies for validating them.

For Colombia's science funding system, these experiences translate into the need to promote specific calls aimed at consolidating reliable information registries and biobanks of samples for research purposes. The Cali Cancer Registry is a successful example that has served as a model for other registries in Manizales, Pasto, Barranquilla, and Bucaramanga in Colombia, as well as in Quito and Montevideo in South America. Similarly, biobanks of tissues, cells, genetic material, or microorganisms, conceived with a prospective character and for research purposes, represent a key driver for the advancement of medical research in Colombia and worldwide.

This type of project requires funding calls different from those currently offered by Minciencias, since they involve developments with horizons of at least ten years and demand a transformation in the strategy of relationships among researchers. At present, with limited resources, calls

tend to privilege individual competitiveness, which generates winners and losers and classifies researchers and groups. Why not shift that competitive logic to one of collaboration?

The focus should be directed toward calls for knowledge networks that can grow synergistically, leverage the information generated in scientific registries and biobanks, and develop robust projects capable of competing for resources from international funders. Colombia participates only timidly in the Ibero-American Programme on Science and Technology for Development (CYTED), partly due to the limited capacity of its internal scientific networks to organize, present strong proposals, and successfully compete for funding in international arenas [15].

Colombia has had admirable medical scientists, and it is time to honor them by learning from the virtues and strategies that enabled them to make groundbreaking contributions to medicine and physiology. National science requires greater collaboration and forward-looking initiatives to develop and contribute to health. Perhaps it will take a disruptive, unusual, and irreverent idea for a Colombian to achieve a Nobel Prize. Still, at the very least, it is essential to create the conditions that allow the training of the geniuses capable of transforming medicine and physiology.

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