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Editorial

Postgenomics in Latin America: a (still) tenuous hypothesis

IN HER BOOK *The century of the gene*, the American historian of science, Evelyn Fox Keller (2002), describes the vibrant process through which genetics emerged, consolidated, and transformed as a field of knowledge. This trajectory was neither linear nor straightforward. Her account shows how each advance in the understanding of DNA generated new questions, sometimes leading to the partial refutation of previous hypotheses and, at other times, to the need to fundamentally rethink the questions themselves, including the often mechanistic and reductionist assumptions underlying them. The history of genetics, to paraphrase Fox Keller, is a history of learning not only about molecular mechanisms and biotechnologies, but also about how politics and culture interact with science, its metaphors, and its categories.

During the first half of the twentieth century, in a world convulsed by global wars and the rise of Nazism, microscopic curiosity and the still imprecise concept of the gene guided much of the research agenda of a young discipline determined to understand the "mechanisms of life." The description of the double helix structure characteristic of the DNA molecule, which Rosalind Franklin, James Watson and Francis Crick elucidated through their research at the Cavendish Laboratory of the University of Cambridge in the early 1950s (Watson 2000), marked a turning point and led to the reorganization of a field that now understood what DNA was made of and, albeit with varying definitions, what genes were. A few years later, the "genetic code" and the "central dogma of molecular biology" were established, stating that the primary function of genes is the synthesis of proteins (Crick 1970). Although this idea has been significantly expanded in recent years, the "book of life" seemed to be opening up, gradually becoming accessible to a science eager to decipher it.

In the second half of the twentieth century, during the Cold War, the parallel development of new knowledge about DNA and the technologies that enabled it added further complexity and uncertainty. Examples include the emergence of the idea of "split" or "fragmented" genes composed of exons and introns, as well as the description of complex mechanisms of alternative splicing linked to gene expression and protein synthesis. In the 1970s, recombinant DNA technology also became widespread, representing a new step in the manipulation of DNA, as well as in social and cultural imaginaries and in the political and bioethical debates asso-

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ciated with this possibility (Berg and Mertz 2010). The 1980s saw the emergence of the polymerase chain reaction (PCR), a technique that enables the massive copying and rapid amplification of DNA segments, thereby facilitating the detailed study of previously undetectable genetic material. The possibilities opened up by this technology coincided with the consolidation of molecular biology as a specific branch of biology. At the same time, innovations in DNA sequencing technologies were advancing: by the late 1970s, the Sanger sequencing method had been developed, which was later supplanted, about two decades later, by next-generation sequencing (NGS) techniques, which became commercially widespread in the mid-2000s.

The turn of the millennium brought numerous developments. Among them were the expansion of a process known as "globalization" and the temporary and fragile consolidation of multicultural legal paradigms in much of the Western world. In this context, the Human Genome Project (HGP) was launched in the early 1990s, with its results published in 2003. The HGP was a large-scale international collaborative initiative, primarily based in the United States. Its objective was to map and sequence the human genome for the first time. Authors such as Fox Keller (2015) and Richardson and Stevens (2015) agree that this project represented a watershed moment —not only in genomic knowledge, but more fundamentally in how we understand the human condition. The postgenomic era inaugurated by this development is characterized by an unprecedented hybridization between disciplines such as biology and computer science, the conceptualization of the gene as information, a non-deterministic view of genetic processes, and the opening of a horizon of radical transformation in medical therapies, which have become molecular, preventive, personalized, and data-driven. This paradigmatic shift has been further reinforced by the development of gene-editing technologies such as CRISPR-Cas9 (which earned Emmanuelle Charpentier and Jennifer A. Doudna the 2020 Nobel Prize), as well as by the expansion of genome-wide association studies (GWAS), whose increasing accessibility has been accompanied by rapid and profound changes in how relationships between genetics, genomics, health, disease, environment, ancestry, class, and gender are investigated and understood.

This dossier seeks to contribute to the multiple debates emerging from three interrelated dimensions. The first is linked to the attempt to give empirical substance to the analysis of the transformations that characterize postgenomics. We aim to provide empirically grounded analyses that examine how the postgenomic era is taking shape in specific Latin American contexts. The second dimension also concerns the Latin American context but focuses on the future —or desirable— role of postgenomics within fragile and fragmented health systems, persistent sociodemographic inequalities, and scientific practices often dependent on global centers of knowledge production and insufficiently funded. Is postge-

nomics possible —or even desirable— in Latin America? A concrete question in this regard concerns how postgenomics might be integrated into public healthcare systems, particularly at the primary care level. The third dimension highlights the need for political and bioethical debates to ensure that postgenomics contributes to the construction of more livable worlds for a greater number of people, with a focus on reducing inequalities. As will be shown, the contributions in this issue address these three dimensions with varying emphases.

In the article entitled "Questions and challenges of precision oncology and immunotherapy in Latin America: perspectives on access and equity," Martha Estefania Vázquez-Cruz and Carla Daniela Robles Espinoza examine aspects of precision oncology in Latin America, particularly in Mexico, and raise questions regarding access to and equity in such treatments within a context marked by two stark realities: the projected doubling of cancer cases by 2070 and the current increase in costs and inequalities in access to oncological treatments. They emphasize the urgent need to design and implement comprehensive strategies that prioritize both prevention and equitable access to effective, high-quality care. Among the specific scenarios they analyze are the "translational gap"—that is, the distance between developments in basic research and the diagnostic and therapeutic options available to patients—the barriers to implementing genomic technologies in clinical practice, the exorbitant costs of treatments, and the challenges posed by large, often transnational pharmaceutical companies as key actors in this domain. What role should pharmaceutical companies and Latin American states play in ensuring access to potentially curative treatments? What opportunities does precision medicine offer to Latin American societies? To what extent is its implementation dependent on healthcare governance? According to the authors:

> […] precision oncology and immunotherapy represent revolutionary advances in cancer treatment, but their benefits remain limited for most patients in Latin America due to prohibitive costs, infrastructural deficiencies, and gaps in translational research. These persistent inequalities are not only technical or economic, but also ethical. (pp. 34-35)

In the work entitled "What ethics, from what world, and for what world? Theoretical and methodological notes for bioethical teaching and action in postgenomic contexts from a critical Latin American perspective", Nahuel Pallitto and Natacha Salomé Lima propose an ethical reflection that takes a step back by interrogating the world in which postgenomic developments —here insightfully termed (post-)genomics— take place. Through a reflective and essayistic approach grounded in Latin American bioethical thought, the authors foreground the situated perspective from which ethical inquiry emerges. "Today," they argue,

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"with the exponential advancement of new (post-)genomic and molecular technologies, it is more urgent than ever for bioethics education to provide the philosophical concepts and methods necessary for critical and situated thinking" (p. 44). From this standpoint, they pose key questions: "Is (post-)genomics an adequate response to the plurality of Latin American worlds? What conceptual tools do we have to determine when it is —and when it is not?" (p. 44). These questions invite collective reflection that disrupts the inertial flow of biotechnological development. Such reflection requires a bioethics capable of addressing not only the ontic dimensions of phenomena, but also their ontological and metaphysical implications. This form of critical, collective inquiry is essential for developing socially meaningful scientific and medical responses.

Bioethical reflection is further developed in the article "The particular case of genomic data generated by next-generation sequencing (NGS) in pediatrics: an analysis from the perspective of progressive autonomy", by Verónica Goris and Laura F. Belli. This work examines the ethical and practical challenges associated with incidental findings made possible by the use of next-generation sequencing technologies in pediatric public healthcare settings in Argentina. The authors note that the use of these technologies for molecular diagnosis has increased steadily in recent years.

> These methods allow for the simultaneous analysis of a large number of genes, potentially yielding incidental findings with both immediate and future clinical implications. In this context, the management of genomic information in children and adolescents presents significant ethical and regulatory challenges for healthcare teams. (p. 66)

This type of reflection contributes to improving diagnostic practices while also encouraging critical examination of the scope and limitations of NGS, particularly in comparison to more targeted approaches such as targeted sequencing (T-NGS). The authors focus on how such information should be managed in relation to progressive autonomy, informed consent, and the rights of minors. How can progressive autonomy be incorporated into the design of informed consent processes —not merely to legitimize medical practice, but to promote more respectful, inclusive, and context-sensitive approaches to genomic technologies? The article highlights the importance of addressing these questions in concrete contexts, particularly in the absence of clear consensus regarding appropriate responses to incidental findings.

In the article "Genetic mutations, subjectivating mutations: approaches to genetic technologies for detecting BRCA mutations in the experiences of women with breast cancer in Argentina", Leila Martina Passerino analyzes the impact of genetic technologies —particularly tests detecting mutations in the BRCA1 and

BRCA2 genes— on the lives and subjectivities of women affected by breast cancer, either directly or through close family members. These tests rely on statistical estimations generated by continuously updated algorithms based on large-scale data. Passerino demonstrates how these technologies transform understandings of breast cancer biology and reshape the range of available preventive and therapeutic options. She shows how abstract notions such as genetic risk are interpreted and enacted by different individuals. The empirical findings indicate that genetic testing does not necessarily lead to effective prevention or improved care; in some cases, it contributes to increased stress, individualization of responsibility, and overdiagnosis, revealing its ambivalent nature. While acknowledging the potential positive effects associated with these technologies, the article critically examines how genetic testing and BRCA mutations function as highly performative cultural constructs that may give rise to iatrogenic practices.

Finally, in "Why? How and when? Precision medicine and public medical education in Argentina", Ana Mines Cuenya explores how precision medicine —its epistemological foundations and practical tools— interacts with medical training processes in Argentina. Based on empirical research, the study analyzes three key dimensions: 1) transformations in curricula and academic programs; 2) the teaching of genetics and genomics throughout medical education, and, 3) the development of clinical skills related to family history, environment, and lifestyle. The findings show a gradual shift toward more integrated curricula, where the previously rigid separation between biomedical knowledge and clinical skills is becoming less pronounced. They also demonstrate that genetics and genomics are gaining increasing prominence both in early training and in advanced clinical education. Finally, the study highlights the practical, epistemological and ontological challenges involved in teaching fundamental clinical skills such as patient interviewing and medical history-taking. How should clinicians incorporate family history and environmental factors into initial consultations? How should such information be interpreted and used? What does "lifestyle" mean in medical practice, and how should it be assessed? This work offers valuable insights into the challenges of training physicians capable of integrating postgenomic perspectives into clinical practice.

This dossier also includes an interview with Dr. Rosa Liascovich entitled: "Opening paths: genetics for public and community health," conducted by Lucía Ariza and Ana Mines Cuenya. The interview provides an important resource for critically reflecting on the potential contributions of genetics to public health. The dossier concludes with a review of a key volume on the relationships between genomics, nation, race, and health in Latin America: *Genomics of mestizo culture. Race, nation, and science in Latin America*, edited by Carlos López Beltrán, Peter Wade, Eduardo Restrepo and Ricardo Ventura Santos.

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We hope that this collection of works contributes to ongoing debates regarding the possibilities, risks, scope, and implications of developments in genetics and genomics in Latin America.

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Guest Editors

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