Chapter 12
Policy Implications of Gene Editing and Biotechnology Regulation

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ABSTRACT

Gene editing and biotechnology represent transformative advancements with profound potential to reshape medicine, agriculture, and environmental management. However, their rapid development poses significant regulatory and ethical challenges that require comprehensive policy frameworks. This chapter explores the policy implications surrounding gene editing technologies, such as CRISPR, highlighting the balance between fostering innovation and ensuring public safety, ethical standards, and equitable access. It discusses regulatory approaches adopted worldwide, the role of international cooperation, and the socio-political dynamics influencing governance. By examining current legislative landscapes and emerging best practices, the chapter aims to inform policymakers, legal scholars, and industry stakeholders about effective governance models that align with ethical imperatives and technological progress.

1. INTRODUCTION

In the rapidly evolving landscape of the 21st century, artificial intelligence (AI), environmental sustainability, and advanced healthcare technologies are shaping global societal and legal frameworks. The convergence of these domains demands a multidisciplinary approach that integrates regulatory oversight, ethical consider-

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ations, technological innovation, and socio-economic realities. This chapter aims to explore the complex regulatory responses that govern AI in healthcare and medical diagnostics, with a focus on the broader implications for sustainability and environmental law.

AI technologies, particularly generative AI and machine learning, are revolutionizing diverse sectors including finance (Ali & Aysan, 2024, 2025; Ali, Zafar, & Aysan, 2024), healthcare (Mennella, Maniscalco, De Pietro, & Esposito, 2024; Sheliemina, 2024), and environmental management (Arya & Rastogi, 2024; Emon et al., 2025). Their transformative potential is accompanied by significant ethical and legal challenges such as data privacy, algorithmic bias, and accountability (Shukla & Taneja, 2024; Veluru, 2024). The deployment of AI in medical diagnostics, for instance, has introduced new regulatory complexities that require careful governance frameworks to ensure patient safety and efficacy (Larson et al., 2021; Naili, Mangkunegara, Purwono, & Baballe, 2025; Pesapane et al., 2021).

Simultaneously, the urgency of the climate crisis underscores the critical role of legal mechanisms in promoting sustainability and environmental protection (Akindele & Chabinga, 2024; Ali, 2024; Aloamaka, 2024). International environmental law has evolved to address issues ranging from renewable energy deployment (Jafarizadeh et al., 2024; Oduro, Uzougbo, & Ugwu, 2024) to biodiversity protection (Singh & Kaunert, 2025; Saikia, 2024). These efforts often intersect with technological advances such as AI-driven climate monitoring and green technology (Emon et al., 2025; Eswaran & Eswaran, 2025), requiring integrated policy models that balance innovation and regulation (Schünemann et al., 2024).

Governance of emerging technologies such as genome editing and AI-enhanced cybersecurity further complicates this landscape. Regulatory frameworks must grapple with ethical issues surrounding biotechnology (Bartkowski, Theesfeld, Pirscher, & Timaeus, 2018; Brookes & Smyth, 2024; Friedrichs et al., 2019) and AI-driven warfare (Batabyal, 2024; Al-Sinani & Mitchell, 2024). At the same time, the digital transformation of firms demands human-centric approaches to AI adoption, emphasizing responsible innovation (Fenwick, Molnar, & Frangos, 2024; Rashid & Kausik, 2024).

Recent regulatory initiatives, such as the EU Artificial Intelligence Act (Butt, 2024) and international efforts toward just climate transitions (Chowdhury, 2024), exemplify the challenges of crafting laws that are both flexible enough to accommodate rapid technological change and robust enough to protect societal interests. The legal complexities of AI in healthcare are highlighted by considerations of patient rights, safety, and the right to science (Ho, 2023; Terry, 2019; Verma, Rao, Eluri, & Sharma, 2020).