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AND SCIENCE OF UKRAINE  
NATIONAL UNIVERSITY  
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NATIONAL ERASMUS+ OFFICE IN UKRAINE  
EUROPEAN STUDIES PLATFORM



PROCEEDINGS  
VIII INTERNATIONAL CONFERENCE  
EUROPEAN DIMENSIONS OF  
SUSTAINABLE DEVELOPMENT



MAY 5-7, 2026, KYIV

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## ESG PRINCIPLES IN BIOTECHNOLOGY AS A DRIVER OF SUSTAINABLE DEVELOPMENT

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The biotechnology sector functions within a complex, highly regulated system encompassing advanced research and development (R&D), clinical trials, the handling of sensitive biological materials, and globally distributed supply chains. Under these conditions, the integration of Environmental, Social, and Governance (ESG) principles constitutes a necessary prerequisite for ensuring sustainable development, regulatory compliance, and long-term sectoral competitiveness.

The importance of ESG in biotechnology is determined by the specific nature of the sector, which combines scientific innovation with a direct impact on human health, food systems, and the environment. Therefore, ESG provides a structured approach to managing environmental, social, and governance risks throughout the entire lifecycle of biotechnological products.

The environmental dimension focuses on reducing energy consumption, greenhouse gas emissions, water use, and hazardous waste generation. This is especially important because laboratories and biotechnological production facilities are highly resource-intensive. These aspects are regulated within the European Union by frameworks such as the European Green Deal, Directive 2008/98/EC on waste, and Regulation (EU) 2020/852.

The social dimension includes ensuring patient safety, maintaining ethical standards in clinical trials, protecting personal and genetic data, and promoting equitable access to biotechnology products. These issues are governed by international and European regulations, including the WMA Declaration of Helsinki, Regulation (EU) 536/2014 on clinical trials, and the Regulation (EU) 2016/679 (General Data Protection Regulation, GDPR).

Key strategies for ESG implementation in biotechnology include the development of energy-efficient laboratories, the use of green chemistry approaches, the transition to low-carbon biomanufacturing, and the application of circular economy principles, such as reducing single-use plastics and improving biowaste management. Other important measures include ensuring ethical conduct in research, promoting equal opportunities, inclusivity, and balanced representation across gender, age, and professional groups within the workforce, as well as implementing ESG reporting in line with international standards such as the Global Reporting Initiative (GRI), the Sustainability Accounting Standards Board's (SASB) Biotechnology & Pharmaceuticals Standard, and the International Sustainability Standards Board (ISSB).

The integration of ESG principles creates value at different stages of the biotechnology value chain. It helps reduce environmental impact, improve resource efficiency, strengthen public trust, and enhance governance practices. At the same time, several challenges remain, including high resource consumption, complex bioethical issues (especially in genomics and gene editing), differences in regulatory requirements between countries, and limited transparency of supply chains.

ESG principles are an important driver of sustainable development in biotechnology, helping to balance innovation with environmental and social responsibility.