

## **APPLICATION OF BIOTECHNOLOGY TO MITIGATE THE CONSEQUENCES OF RADIOLOGICAL AND CHEMICAL CONTAMINATION**

Talibov A.M.

Institute of Control Systems, Baku, Azerbaijan

Hashimov E.G.

National Defense University, Baku, Azerbaijan

Azerbaijan Technical University, Baku, Azerbaijan

Akhundov R.G.

National Defense University, Baku, Azerbaijan

The increasing risk of radiological and chemical contamination due to industrial accidents, warfare, and environmental disasters presents significant challenges to both public health and environmental sustainability. Traditional methods of decontamination, such as chemical agents and mechanical processes, often have limited efficiency, are resource-intensive, and can pose additional environmental risks. In this context, biotechnology offers innovative solutions to reduce the consequences of radiation and chemical pollution, leveraging biological systems to degrade contaminants, enhance recovery, and protect ecosystems and human health. Biotechnology provides a range of tools and strategies for managing radiological and chemical contamination, including bioremediation, phytoremediation, and the use of biosensors. These approaches capitalize on natural biological processes to break down or neutralize harmful substances in contaminated environments. One of the most promising applications of biotechnology in this field is the use of microorganisms and plants to detoxify chemicals and radiation, transforming hazardous compounds into less toxic or harmless substances.

Microbial bioremediation involves the use of microorganisms such as bacteria, fungi, and algae that naturally metabolize or break down toxic substances. These organisms can be harnessed to clean up areas contaminated by chemicals, heavy metals, and radioactive isotopes. For example, certain bacteria have been shown to degrade organic pollutants such as pesticides, solvents, and petroleum hydrocarbons. In the case of radiological contamination, specific strains of bacteria and fungi have the ability to absorb and accumulate radioactive materials, reducing their bioavailability and toxicity. Phytoremediation, on the other hand, utilizes plants to extract, sequester, or detoxify contaminants from the soil, water, and air. Some plants, known as hyperaccumulators, have the ability to absorb large quantities of toxic substances, including heavy metals and radioactive elements, through their roots. These plants can then either store the contaminants in their tissues or transfer them to other parts of the plant for removal. Phytoremediation is especially useful in areas where soil contamination is severe, as plants not only absorb pollutants but can also stabilize the soil, preventing further contamination and erosion.

Another innovative application of biotechnology in mitigating radiological and chemical contamination is the development of biosensors. These devices are

designed to detect the presence of specific contaminants in the environment with high precision and sensitivity. Biosensors use biological components such as enzymes, antibodies, or nucleic acids to interact with the contaminant and generate a measurable signal. They can be used in real-time monitoring of environmental pollution, enabling rapid detection and response to contamination events. Beyond these direct remediation methods, biotechnology also offers potential for enhancing the resilience of ecosystems and organisms exposed to radiation and chemical pollutants. Genetic engineering techniques can be employed to develop plants and microorganisms with improved resistance to toxic substances, enabling them to thrive in contaminated environments and accelerate the decontamination process. By modifying the genetic makeup of organisms to express specific detoxification pathways or stress-resistant proteins, scientists can create more efficient bioremediation agents capable of handling higher concentrations of contaminants.

While the application of biotechnology to address radiological and chemical contamination holds great promise, there are several challenges to overcome. The effectiveness of bioremediation processes can be influenced by environmental factors such as temperature, pH, and nutrient availability, which can impact the growth and activity of microorganisms or plants involved in the remediation process. Moreover, the scalability of biotechnological approaches remains a challenge, as large-scale implementation of these methods requires careful planning and monitoring to ensure their success. In conclusion, biotechnology offers a suite of promising tools to mitigate the consequences of radiological and chemical contamination. As research in this field progresses, it is likely that biotechnological approaches will play an increasingly important role in environmental cleanup efforts, contributing to the restoration of ecosystems and the protection of human health in the face of chemical and radiological pollution.

### References

1. Akhundov R. G. Military conflicts and environmental safety // Abstracts of the Fourteenth International Scientific and Technical Conference. – Kharkiv, Ukraine, – 25-26 April 2024, Vol 2, – p.89-90.
2. Axundov R. Q. Radiasiya, kimyəvi və bioloji mühafizə sisteminin təkmilləşdirilmə istiqamətləri // Müdafiə sənayesi üzrə ixtisaslı kadr hazırlığı: radioelektron, aerokosmik sistemlər və robotlar” mövzusunda II Respublika elmi-texniki konfransın materialları, –Bakı: AzTU. – 2023. – C. 89-92.
3. Akhundov R. Application of means of remote radiation reconnaissance // Modern trends in the development of information and communication technologies and management tools. Abstracts of the Thirteenth International Scientific and Technical Conference. – Kharkiv, Ukraine. – 2023. – T. 2. – C. 8-9.
4. Ахундов Р. Г. Влияние военной деятельности на окружающую среду // Санкт-Петербург. – 2024. – Т. 29. – №. 1. – С. 51.
5. Axundov, R.Q. Radiasiya, kimyəvi və bioloji mühafizə sisteminin texniki təminatının analizi // “Milli təhlükəsizlik və müasir hərbi sənəti” mövzusunda keçirilmiş respublika elmi-praktik konfransın materialları , – Bakı: MMU Hİİ, – 1-2 noyabr, – 2023, – s.470-472.