Journal of Current Scientific Research

Biotechnology 2.0

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Abstract

Biotechnology has changed our relationships and perspectives of the world, influencing industry and serving as a catalyst for scientific discoveries. With this change, biotechnology enters a new age known as Biotechnology 2.0. "Modern Biotechnology" and "Artificial Intelligence" are getting married. In order to lessen food poverty, this idea incorporates the most recent advancements in genetic engineering, medicine, environmental preservation, and agricultural productivity and loss reduction strategies. The importance of openness and public involvement in addressing public concerns and advancing moral behavior in biotechnology's future, fostering cooperation among diverse stakeholders, and accomplishing this in a sustainable way for the good of society and humanity cannot be overstated, especially with the backing of biotechnology governance.

Short Communication

Open Access &

Peer-Reviewed Article

DOI: 10.14302/issn.2766-8681.jcsr-23-4811

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Keywords:
Biotechnology 2.0, Society, Industry, Biotechnology Governance, Ethical.

Received: November 02, 2023

Accepted: November 27, 2023

Published: December 06, 2023

Academic Editor:

Karunamoorthy Jayamoorthy, St. Joseph's College of Engineering.

Citation:

Raúl Isea (2023) Biotechnology 2.0. Journal of Current Scientific Research - 2(2):1-7. https://doi.org/10.14302/issn.2766-8681.jcsr-23-4811

Introduction

Biotechnology has undeniably transformed various aspects of our lives, altering the way we live, work, and interact with the world around us. It has brought about significant medical breakthroughs, fostering advancements in agriculture, and shaping society as a whole. In fact, we think that biotechnology is like the superhero of science, using living organisms and systems to create innovative solutions.

As the world's population grows, so will the demand for food, making biotechnology an essential tool for addressing food security concerns [34]. Thus, biotechnology can ensure that food production keeps pace with population growth, preventing famine and, ultimately, improving global food security. In this scenario, genetic modification and precision farming techniques can be used to engineer crops that are resistant to harsh environmental conditions while increasing yield and nutritional value [1].

Although Hungarian agricultural engineer Karl Ereky first used the term "biotechnology" in scientific literature in 1919, biotechnology has come a long way since its humble beginnings in ancient times when people discovered the art of fermentation to make bread and beer, known as 'Ancient Biotechnology' [15].

From 1800 to nearly the middle of the twentieth century, the second phase of biotechnology evolution and development, known as 'Classical Biotechnology', arrived by using microorganisms to obtain a useful product for the industry, where modified foods or other useful products for human use were obtained [35].

Another biotechnology revolution happened during World War II (WWII), when important discoveries gave rise to contemporary biotechnology, the 'Modern

Biotechnology'. Two seminal discoveries, Watson and Crick's 1953 discovery of DNA structure [32] and Cohen and Boyer's 1973 discovery of the recombinant DNA method [24], bridged the gap between genetics and biotechnology. During WWII, British scientist Chaim Weizemann invented bacterial fermentation techniques for organic compounds [35].

The world continues to progress with the use of living organisms or their components to create new products and processes with enormous potential to revolutionize a variety of industry impulses by including cutting-edge technologies and techniques such as genetic engineering [25], genome editing [18], synthetic biology [23], and more, which have revolutionized the way we understand and manipulate biological systems in our times. It is vital to reinterpret the notion of biotechnology in order to adapt it to modern times.

According to popular opinion, biotechnology is an interdisciplinary discipline within the biological sciences that includes any technological application that uses biological systems, living organisms, or the products of them to modify or produce products or processes for specific objectives. This definition is improper and outdated. Instead of being an interdisciplinary subject that limits interpretations to a single method, biotechnology should be a transdisciplinar field that incorporates many viewpoints from a broad variety of scientific fields. Furthermore, it is incorrect to believe that it just addresses technology challenges because advancements in the basic sciences are necessary to understand technological processes.

On the other hand, artificial intelligence (AI) emerges as a new author in the twenty-first century, engaged in all scientific fields [5]. According to Xu et al. [37], this kind of contact has become more commonplace and has such strong synergy that it is hard to distinguish between the two.

Thus, Biotechnology 2.0 is the next generation of biotechnology, incorporating advanced techniques developed from gene editing, synthetic biology, and bioinformatics, among other fields. For all of these factors, Biotechnology 2.0 is the marriage between 'Mdern Biotechnology' and AI, bringing man into an intelligent society.

It is important to remember that modern biotechnologies [9, 14, 16, 38] entail the manufacture of valuable items from whole creatures or parts of organisms, such as molecules, cells, tissues, and organs. Recent technological developments include genetically altered plants and animals, cell therapies, and nanotechnology; and when we mix current 'modern biotechnology' with Artificial Intelligence [6, 11, 22, 26, 27], we get new solutions that can help with food security, health and well-being, clean water, and clean energy, among other things.

What do you mean by food security? We are aware that hunger and food insecurity are perennial problems in developing countries. Genetic modification (GM) of crops, which contain genes from several species, has the potential to alleviate global food shortages. However, there are still concerns regarding the advantages and environmental effects of genetically modified crops. GM crops may fail to germinate, kill beneficial organisms, degrade soil fertility, and pass on insecticidal or viral resistance to wild relatives of the crop species.

Furthermore, Biotechnology 2.0's potential and influence are projected to explode with the coming of Society 5.0 [17], an era that aims to seamlessly integrate technology into every area of our lives. For instance, by altering the specific genes that cause different diseases, genetic engineering motivated by Biotechnology 2.0 may be able to eradicate hereditary disorders [2, 20]. These revolutionary findings have the potential to drastically improve public health and save millions of lives.

However, if we want to make sure that these advancements serve society as a whole and do not injure anyone or exacerbate already-existing socioeconomic imbalances, it is imperative that ethical considerations about the usage of this new Biotechnology 2.0 be highlighted going forward. Comprehensive restrictions and criteria need to be put in place in order to strike a balance between development and responsible innovation [29]. Thus, the idea of "biotechnological governance" (more on this notion later) was developed.

In fact, we believe that openness and public participation are critical components for resolving public concerns and eliciting support for ethical methods. Governments, organizations, and stakeholders must work together to create strong frameworks that assure the ethical application of biotechnology in a future society. Furthermore, encouraging multidisciplinary partnerships among scientists, ethicists, legislators, and the general public will aid in collective knowledge and decision-making.

We must remember that Society 5.0 is a human-centered civilization that combines economic and technical achievements via the use of data systems [7, 17, 21]. It depicts a long-term balance of people, nature, and technology. The concept was first presented in Japan's 5th Science and Technology Basic Plan, after the hunting, agricultural, industrial, and information societies. According to Professor Harayama Yuko, a member of the Elsevier Foundation, ORCID, and the French National Research Agency, the goal of Society 5.0 is to create a society that makes people happy and provides them with a sense of value [17].

For all this, Biotechnology 2.0 can bring about unprecedented advances in medicine by gaining a deep understanding of our genetic makeup and manipulating it for the betterment of human health. Healthcare and medicine have the potential to be transformed from personalized medicine to improved diagnostics and have the potential to improve patient care and outcomes [19]. However, concerns about data privacy and trust and ensuring equitable access to these advances must be addressed.

Biotechnology 2.0 should make significant breakthroughs in the potential to increase crop yields, pest control, agricultural sustainability, and food security [10]. These technologies have the potential to aid in the resolution of global food issues, but they must be developed and used ethically in order to deliver long-term environmental and societal advantages [31].

This new transition has no bearing on the many fields of research that have been separated into subdisciplines based on common uses and applications. For example, Red Biotechnology relates to medicinal procedures, whereas White or Gray Biotechnology refers to industrial activities. Green denotes agricultural operations, whereas Gold, or Bioinformatics, denotes the combination of biological processes with informatics for healthcare data processing. Blue incorporates marine and aquatic habitats, as well as biomass conversion into fuels and medicines. Yellow improves food production, with alcohol and cheese fermentation being the most prevalent applications. Violet is concerned with the enforcement of laws and ethical norms, whereas Dark is concerned with the use of biotechnology for weapons or conflict [3].

Food insecurity and world hunger are persistent problems in developing nations. Crops that have undergone genetic modification (GM) to incorporate genes from other animals may help alleviate the world's food problem. The advantages and effects of GM crops on the environment remain, nevertheless, under debate. There are others who argue that decreasing hunger in developing nations can be aided by export revenue derived from increased agricultural production. Potential benefits of biotechnology include the ability to manage animals, store crops, and maintain yields while using less pesticides, herbicides, and fertilizers. In order to satisfy customer demand for sustainable agriculture, GM crops can be combined with other cutting-edge agricultural technology in an environmentally friendly manner. More Green Revolutions may materialize by assisting small and marginal farmers, which would help fight world hunger and malnutrition.

The world's rising population, along with environmental concerns, necessitates the development of sustainable food production systems. Despite agricultural modernization, large losses in crop quality and quantity occur each year, primarily owing to weed species, which constitute the most major biotic constraint on agricultural productivity. Globally, roughly 1800 weed species reduce plant productivity by 31.5%, resulting in economic losses of USD 32 billion each year [Kubiak et al., 2022]. Biotechnology can help by increasing food production on the same land area, decreasing pressure to expand into wilderness, rain forests, and marginal lands, reducing post-harvest losses, displacing resource- and energy-intensive inputs, and encouraging sustainable practices such as conservation tillage, precision agriculture, and integrated crop management [Kubiañ et al., 2022].

In addition, we must talk about Biotechnology Governance [36, 33], which includes the control and monitoring of biotechnological breakthroughs. It is critical that these technologies are used properly, ethically, and for the greater good of society. However, some say that the only principle driving the development and application of these technologies should be biotechnology governance. One of the reasons why biotechnology governance should be the sole guiding concept is its ability to handle ethical problems [33]. Biotechnological breakthroughs, such as genetic engineering and cloning, create difficult ethical issues. These activities have serious ramifications for human life and dignity and need rigorous thought and control.

Biotechnological innovation has resulted in great advances but also in inherent potential dangers. Despite these reservations, biotechnology has advanced swiftly, resulting in disparities in country governance systems and regulatory mechanisms for biological research. For this reason, Biotechnology 2.0 is now more powerful and accessible than ever before, thanks to synthetic biology technologies like CRISPR. However, due to the worldwide nature of the subject, implementing control measures for biotechnology misuse remains difficult. Understanding the language of DNA for expression, especially novel activities vital for engineering biology, is still an ongoing project. Much remains unknown about the natural environment, such as infectious illnesses and human immune system reactions. The governance foundations that are being laid now may have long-term and favorable effects on the future trajectory of biotechnology, ensuring its benefits.

A single emphasis on Biotechnology Governance [36] enables efficient decision-making procedures in situations where decision-makers may have competing interests or goals. It becomes simpler to manage complicated concerns and make informed decisions in a timely way by condensing the approach through a single idea, such as biotechnology governance. For all of this, we must maintain a single emphasis on biotechnology governance, which is critical for the appropriate development and use of these technologies. It guarantees that ethical concerns are prioritized while limiting possible hazards connected with their use. Furthermore, it facilitates efficient decision-making processes by eliminating conflicts between different guiding principles. As biotechnology advances, it becomes increasingly important to prioritize effective governance mechanisms to protect both human well-being and our environment.

Finally, Carter et al. [18] say that the basic goal of corporate governance is to successfully manage an organization's risks, particularly consumer agency relationships, in order to optimize the outcome of resource deployment by the organization as measured against pre-determined objectives [28]. Patients and patient organizations, for example, may be considered stakeholders in the context of corporate governance in biotech, in addition to traditional stakeholders such as shareholders and regulators [12].

Conclusion

Biotechnology 2.0, an amalgamation of modern biotechnology and artificial intelligence, offers previously unimagined opportunities in agriculture, medicine, and environmental conservation. However, in order to fully realize its potential, careful consideration of the ethical implications and responsible use are required. We can harness the power of Biotechnology 2.0 to benefit society, promote equality, and protect the environment by addressing concerns, providing transparency, and engaging in inclusive decision-making processes. Biotechnology has a unique opportunity to shape our future in Society 5.0 and Industry 5.0, and it is our responsibility to ensure that it does so ethically and responsibly.

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