

Green Biomaterials: fundamental principles

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Green Biomaterials: fundamental principles

It happened in the middle of 2020 when I was thinking to organize a thought regarding the design of an environmentally safe and harmless biomaterial, as per *Green Chemistry Principles*. Right at that moment, the word “*Green Biomaterials*” was envisioned. Now, my dream has come true up on realization of “*Green Biomaterials*”.

“Navid Rabiee”

Green Biomaterials brings forth together and integrates knowledge, technology, and research to launch a new era of need-based reform to concepts that serve the society and humanity at large. It enriches and directs our attention to the environment, with relevance to public health and related technologies. The *Green Biomaterials* journal has the mission of officially defining the field of *Green Biomaterials* and strives to offer researchers with new technological and creative concepts in the design, synthesis, manufacturing, development, and optimization of *Green Biomaterials*—materials that embody and reflect green and healthy principles concerned with the environment and physiological systems. *Green Biomaterials* is grounded on a well-defined scientific/technological basis, which relies on a wide range of expertise thanks to the knowledge and experience of its multidisciplinary editorial board members. The underlying premise is to have the efficient interface between researchers and technologists who are enthusiastic to publish their most recent achievements in the field, with emphasis on precise configuration of concepts. These principles ought to harmonize with the definitions, terms, and concepts of Materials Science, Biomaterials, Green Chemistry, and Sustainability within a new background.

The decision to launch *Green Biomaterials* as a new journal was not made lightly. Extensive and candid discussions took place among prominent chemists, engineers, researchers, and scientists from diverse backgrounds, weighing factors like the proliferation of journals, academic credibility, and industrial relevance. It was only after reaching a consensus on the importance and timeliness of the project that such a decision was made. The supportive evidence included an upsurge in recent publications related to the *Green Biomaterials* domain, increased emphasis on relevant research by major national and international funding agencies, and growing recognition within the industry and clinical centers regarding the concepts of *Green Biomaterials*. The emergence of the fundamental principles of both Green Chemistry [1] and Biomaterials [2] as guiding ideologies in chemistry, medicine, physics, biomedical science and engineering, and biology has played a pivotal role in the evolution of *Green Biomaterials*.

Green Biomaterials provides a unique forum for the publication of innovative research into the development of alternative green and sustainable technologies to synthesize, and modify a wide range of bioactive materials. *Green*

Biomaterials will be at the frontier of this incessantly evolving interdisciplinary scientific field, aiming to publish the latest professional achievements to reduce the environmental impacts of the chemical industry by adhering to the basis of greener technologies that are inherently non-toxic to living things and the environment. Submissions on all aspects of research relating to this endeavor are warmly welcomed.

Green Biomaterials is grounded on ten fundamental principles, and eight application-oriented principles, which are expected to be updated over time.

Fundamental principles of *Green Biomaterials*:

1. Prevention of toxic waste
2. Application of waste-free reactions
3. Use of safer and greener solvents
4. Use of renewable and non-toxic feedstocks
5. Use of nature-inspired protocols and strategies
6. Use of natural and sustainable components as active reagents
7. Reduced Carbon Footprint
8. Life Cycle Sustainability
9. Resource Conservation
10. Energy-efficient production

Application-oriented principles of *Green Biomaterials*:

1. Design non-toxic products
2. Real-time and *in situ* analysis to prevent toxic reactions/materials
3. Design biodegradable and biocompatible products/materials
4. Design multifunctional non-toxic bioactive materials
5. Design bioactive materials with easy and rapid clearance from physiological systems
6. Design (bio)-recyclable products/materials
7. Rapid life cycle assessment to assess the overall environmental impact from production to disposal
8. Maintain or improve the intended functionality and durability of the biomaterials while adhering to environmental principles

We eagerly anticipate a diverse range of article types and perspectives that encompass the advancement and practical application of *Green Biomaterials* principles in research, education, industry and clinical applications. Additionally, we welcome innovative ideas and thoughts on any pertinent issue related to *Green Biomaterials*, whether they pertain to education, governmental regulation, industry, clinics, the wider public, or research avenues. The journal seeks to serve as a platform for deliberating the numerous emerging and contentious issues within the realm of *Green Biomaterials*.


The last decades have witnessed some remarkable achievements in chemistry and biomaterials, which have become increasingly reliant on toxic chemical industry products to sustain our current quality of life and enhance our well-being [3,4]. However, public awareness has witnessed a paradigm shift away from substances dangerous to the environment, which are often associated with various harmful chemical enterprises for (bio)medical and clinical usage, thus overshadowing the benefits of these products [5,6]. On the basis of global support from experts, this journal, *Green Biomaterials*, will serve as a forum to discuss the means and inspiration for scientists to offer a greener future through positive changes in the design, manufacturing, and optimization of more sustainable materials.

References

- [1] Lane MKM, Rudel HE, Wilson JA, et al. Green chemistry as just chemistry. *Nat Sustain.* 2023;6(5):502–512.
- [2] Stoddart A, Cleave V. The evolution of biomaterials. *Nat Mater.* 2009;8(6):444–445.
- [3] Katiyar NK, Goel G, Hawi S, et al. Nature-inspired materials: emerging trends and prospects. *NPG Asia Mater.* 2021;13(1):56.
- [4] Huebsch N, Mooney DJ. Inspiration and application in the evolution of biomaterials. *Nature.* 2009;462(7272):426–432.
- [5] Peppas NA, Khademhosseini A. Make better, safer biomaterials. *Nature.* 2016;540(7633):335–337.
- [6] Funk M, Ash C. A cleaner, greener future for chemicals. *Science.* 2020;367(6476):378–379.

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