Perspective

Journal of Medicinal and Organic Chemistry

Biodegradable Polymers in Pharma: Advancing Sustainable and Controlled Drug Delivery

Emma Lavigne*

Dept. of Polymer Chemistry, Lyon Institute, France

*Author for correspondence: elavigne@lyoninst.fr

Received: 01-Aug-2025, Manuscript No. jmoc-26-184927; **Editor assigned:** 03-Aug-2025, PreQC No. jmoc-26-184927 (PQ); **Reviewed:** 18-Aug-2025, QC No. jmoc-26-184927; **Revised:** 21-Aug-2025, Manuscript No. jmoc-26-184927 (R); **Published:** 30-Aug-2025, DOI: 10.37532/jmoc.2025.8(4).308-309

Introduction

Biodegradable polymers have become a cornerstone in pharmaceutical science, offering innovative solutions for drug delivery, tissue engineering, and regenerative medicine. These polymers degrade into non-toxic, biocompatible byproducts, eliminating the need for surgical removal and minimizing long-term side effects. Their versatility in forming nanoparticles, microspheres, hydrogels, and implantable devices makes them ideal for controlled and targeted drug delivery, improving therapeutic efficacy and patient compliance [1,2].

Discussion

Biodegradable polymers are broadly classified into natural and synthetic types. Natural polymers, such as chitosan, gelatin, and alginate, offer inherent biocompatibility, biodegradability, and minimal immunogenicity. Synthetic polymers, including polylactic acid (PLA), polyglycolic acid (PGA), and their copolymer PLGA, provide tunable mechanical properties, degradation rates, and drug release profiles. By selecting appropriate polymer types and molecular weights, researchers can precisely control drug encapsulation, release kinetics, and polymer degradation to match therapeutic needs [3-5].

In drug delivery, biodegradable polymers enhance the pharmacokinetic and pharmacodynamic profiles of active compounds. Encapsulation protects labile drugs from enzymatic or chemical degradation, extends circulation time, and allows sustained release. For example, PLGA-based microspheres have been employed to deliver peptide hormones, anticancer agents, and vaccines, offering prolonged therapeutic effects and reduced dosing frequency. Nanoparticles formulated from biodegradable polymers can be surface-modified with ligands, antibodies, or peptides to achieve targeted delivery, reducing off-target toxicity and improving tissue specificity.

Beyond drug delivery, biodegradable polymers play a critical role in tissue engineering and regenerative medicine. Scaffolds made from these materials support cell adhesion, proliferation, and differentiation while gradually degrading as new tissue forms. Hydrogels derived from biodegradable polymers can act as drug depots or cell carriers, responding to environmental stimuli such as pH, temperature, or enzymatic activity to release therapeutics in a controlled manner.

Challenges include potential variability in degradation rates under physiological conditions, scalability of polymer synthesis, and regulatory hurdles for clinical translation. Advances in polymer chemistry, surface modification, and composite materials are addressing these limitations, enhancing biocompatibility, stability, and reproducibility.

Conclusion

Biodegradable polymers are a transformative platform in pharmaceutical science, enabling controlled, targeted, and sustainable drug delivery. Their versatility in formulation, tunable degradation, and biocompatibility make them indispensable in modern therapeutics, tissue engineering, and regenerative medicine. As material science, polymer engineering, and biomedical research continue to advance, biodegradable polymers are poised to play an increasingly central role in developing safer, more effective, and patient-friendly pharmaceutical solutions.

References

1. Bilen O, Ballantyne CM (2016) Bempedoic Acid (ETC-1002) An Investigational Inhibitor of ATP Citrate Lyase. Curr Atheroscler Rep 18: 61.

2. Zagelbaum NK, Yandrapalli S, Nabors C, Frishman WH (2019) Bempedoic Acid (ETC-1002): ATP Citrate Lyase Inhibitor: Review of a First-in-Class Medication with Potential Benefit in Statin-Refractory Cases. Cardiol Rev 27: 49-56.

3. Benoit Viollet, Bruno Guigas, Nieves Sanz Garcia, Jocelyne Leclerc, Marc Foretz, et al. (2012) Cellular and molecular mechanisms of Bempedoic Acid. An overview, Clincal Science (London) 122: 253- 270.

4. Phan BA, Dayspring TD, Toth PP (2012) Ezetimibe therapy: mechanism of action and clinical update. Vasc Health Risk Manag 8:415-27.

5. Kosoglou T, Statkevich P, Johnson-Levonas AO, Paolini JF, Bergman AJ, et al. (2005) A review of its metabolism, pharmacokinetics and drug interactions. Clin Pharmacokinet 44: 467-94.