Macromolecules: An Indian Journal

**Editorial** | Vol 18 Iss 1

# Drug Delivery Polymers and Controlled Therapeutic Systems

**Ahmed Farouk***

Department of Pharmaceutical Materials and Polymer Science, Alexandria Institute of Biotechnology, Egypt,

***Corresponding author:** Ahmed Farouk. Department of Pharmaceutical Materials and Polymer Science, Alexandria Institute of Biotechnology, Egypt,

E-mail: ahmed.farouk@alexbiotech.edu.eg

**Received:** march 04, 2025; **Accepted:** march 18, 2025; **Published:** march 27, 2025

## Abstract

**Drug delivery polymers are specialized macromolecular materials designed to transport therapeutic agents within the body and release them in a controlled and targeted manner. These systems improve drug stability, enhance bioavailability, and reduce side effects by controlling the rate and location of drug release. Advances in polymer chemistry, nanotechnology, and biomedical engineering have enabled the development of sophisticated polymer-based delivery systems for a wide range of medical treatments. This article discusses the principles, materials, and applications of drug delivery polymers in modern healthcare.**

***Keywords:** Drug delivery polymers, controlled release, biodegradable polymers, polymer nanoparticles, targeted therapy, hydrogels, sustained release, biomedical polymers, polymer carriers, therapeutic systems*

## Introduction

Drug delivery polymers have transformed pharmaceutical science by enabling controlled and sustained release of therapeutic agents. Traditional drug administration methods often lead to rapid absorption followed by a sharp decline in drug concentration, which may reduce effectiveness and increase the risk of side effects. Polymer-based delivery systems are designed to release drugs gradually over time, maintaining therapeutic levels in the body for extended periods [1]. This controlled release improves treatment efficiency and patient compliance. Biodegradable polymers play a crucial role in drug delivery because they can break down into non-toxic products after fulfilling their function. Materials such as polylactic acid, polyglycolic acid, and their copolymers are widely used to fabricate microspheres, nanoparticles, and implantable devices for sustained drug release [2]. These polymers allow drugs to be encapsulated within a matrix that gradually degrades or permits diffusion, providing predictable release profiles. Targeted drug delivery represents another important advancement in polymer-based systems. By modifying polymer carriers with specific ligands or antibodies, drugs can be directed toward particular tissues or cells, such as tumor sites, reducing damage to healthy tissues [3]. Nanotechnology has

**Citation:** Ahmed Farouk. Drug Delivery Polymers and Controlled Therapeutic Systems. Macromol Ind J. 18(1):332.

significantly contributed to this field, enabling the development of polymer nanoparticles that can cross biological barriers and deliver drugs with high precision. Hydrogels and polymeric micelles are also widely used in controlled delivery applications. Hydrogels can swell in biological fluids and release drugs through diffusion, while micelles formed from amphiphilic block copolymers can encapsulate hydrophobic drugs, improving their solubility and bioavailability [4]. Recent research has focused on stimuli-responsive drug delivery systems that release drugs in response to changes in pH, temperature, or enzymatic activity, offering new possibilities for personalized medicine [5]. These innovations demonstrate how polymer science continues to reshape modern therapeutic strategies.

**Conclusion**

Drug delivery polymers have become essential tools in modern medicine, enabling controlled, sustained, and targeted delivery of therapeutic agents. Their versatility and tunable properties make them valuable in treating a wide range of diseases, including cancer, infections, and chronic conditions. Continued advances in biodegradable materials, nanotechnology, and smart polymer systems will further enhance the effectiveness and precision of polymer-based drug delivery technologies. Next comes Polymer Characterization, a subject that may sound procedural but is actually the detective work of polymer science—because before understanding what a material can do, scientists must first understand exactly what it is, down to the length, shape, and arrangement of its molecular chains

**REFERENCES**

1. Shanks RA, Kong I. General purpose elastomers: structure, chemistry, physics and performance. Advances in Elastomers I: Blends and Interpenetrating Networks. 2013 Mar 30:11-45.
2. Kojio K, Furukawa M, Motokucho S, Shimada M, Sakai M. Structure− mechanical property relationships for poly (carbonate urethane) elastomers with novel soft segments. Macromolecules. 2009 Nov 10;42(21):8322
3. Ducrot E, Chen Y, Bulters M, Sijbesma RP, Creton C. Toughening elastomers with sacrificial bonds and watching them break. Science. 2014 Apr 11;344(6180):186-9.
4. Mark JE. Some unusual elastomers and experiments on rubberlike elasticity. Progress in Polymer Science. 2003 Aug 1;28(8):1205-21.
5. Estes GM, Cooper SL, Tobolsky AV. Block polymers and related heterophase elastomers. Journal of Macromolecular Science—Reviews in Macromolecular Chemistry. 1970 Jan 1;4(2):313-66.