

# How Biodegradable Polymers Can be Effective Drug Delivery Systems for Cannabinoids? Prospectives and Challenges

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**Abstract:** Cannabinoids are compounds found in and derived from the *Cannabis* plants that have become increasingly recognised as significant modulating factors of physiological mechanisms and inflammatory reactions of the organisms, thus inevitably affecting maintenance of homeostasis. Medical *Cannabis* popularity has surged since its legal regulation growing around the world. Numerous promising discoveries bring more data on cannabinoids' pharmacological characteristics and therapeutic applications. Given the current surge in interest in the medical use of cannabinoids, there is an urgent need for an effective method of their administration. Surpassing low bioavailability, low water solubility, and instability became an important milestone in the advancement of cannabinoids in pharmaceutical applications. The numerous uses of cannabinoids in clinical practice remain restricted by limited administration alternatives, but there is hope when biodegradable polymers are taken into account. The primary objective of this review is to highlight the wide range of indications for which cannabinoids may be used, as well as the polymeric carriers that enhance their effectiveness. The current review described a wide range of therapeutic applications of cannabinoids, including pain management, neurological and sleep disorders, anxiety, and cancer treatment. The use of these compounds was further examined in the area of dermatology and cosmetology. Finally, with the use of biodegradable polymer-based drug delivery systems (DDSs), it was demonstrated that cannabinoids can be delivered specifically to the intended site while also improving the drug's physicochemical properties, emphasizing their utility. Nevertheless, additional clinical trials on novel cannabinoids' formulations are required, as their full spectrum therapeutical potential is yet to be unravelled.

**Keywords:** cannabinoids, drug delivery systems, cannabidiol, tetrahydrocannabinol, biodegradable polymers, nanomedicine

## Introduction

Cannabinoids are obtained from plants belonging to the genus *Cannabis*, *Cannabaceae* family. *Cannabis*, particularly *Cannabis sativa*, has been known for its therapeutic and psychotomimetic applications for over 6000 years. Every *Cannabis sativa* plant produces active compounds, but the levels and proportions of these compounds vary among different varieties. These variations cannot be attributed solely to genetic makeup, as environmental factors such as climate and growing conditions may also influence them. Therefore, it is more accurate to refer to these variables as chemical varieties or chemovars, instead of strains.<sup>1</sup> The main active components present in *Cannabis sativa* comprise  $\Delta^9$ -tetrahydrocannabinol ((6aR,10aR)-6,6,9-trimethyl-3-pentyl-6a,7,8,10a-tetrahydrobenzo[c]chromen-1-ol) (THC) and cannabidiol (2-[(1R,6R)-3-methyl-6-prop-1-en-2-ylcyclohex-2-en-1-yl]-5-pentylbenzene-1,3-diol) (CBD).<sup>2</sup>

The mechanism of action of cannabinoids is dependent on their interaction with two cannabinoid receptors known as CB1 and CB2, which are found throughout the central and peripheral nervous systems. They are present in axons, dendrites, and cell bodies, and they influence neuronal, glial, and microglial activity.<sup>3</sup> When these receptors are activated, they inhibit adenylyl cyclase production causing hyperpolarization of neurons, which stops the transmission of electric

# Biodegradable Polymers As Drug Delivery Systems

**Liqun Yang, Jianshe Hu, Shuai  
Jiang, Yeh-Hsing Lao, Yang Yao**



## **Biodegradable Polymers As Drug Delivery Systems:**

**Biodegradable Polymers as Drug Delivery Systems** Mark Chasin,1990-08-31 Reviews the properties synthesis and formulations of a number of well studied polymers increasingly being used in site specific or systematic administration of pharmaceutical agents For each of the polymers discusses the background chemistry and synthesis the formulation of microcapsules solv

**Biomaterials Science** Buddy D. Ratner,2004-07-29 Completely revised and expanded update of the best selling classic text reference which defined an entire subject field

**Polymeric Drug Delivery Systems** Glen S. Kwon,2005-04-12 Emphasizing four major classes of polymers for drug delivery water soluble polymers hydrogels biodegradable polymers and polymer assemblies this reference surveys efforts to adapt modify and tailor polymers for challenging molecules such as poorly water soluble compounds peptides proteins and plasmid DNA

**Handbook of Biodegradable Polymers** Abraham J. Domb,Joseph Kost,David Wiseman,1998-02-04 Handbook of Biodegradable Polymers the seventh volume in the Drug Delivery and Targeting book series provides a source manual for synthetic procedures properties and applications of bioerodible polymers The authors describe widely available materials such as polyactides collagen and gelatin as well as polymers of emerging importance such as the genetically engineered and elastin based polymers which are either proprietary or in early stages of development Section I addresses synthetic absorbable polymers and Section 2 profiles natural semi synthetic and biosynthetic polymers Section 3 discusses the surface characterization of degradable polymers the modeling of biodegradation and non medical polymers This book is ideal for researchers from academia and industry as well as chemists pharmacists and physicians who deal with biopolymers drug delivery and targeting bioengineering and implantable devices

**Pharmaceutical Applications of Polymers for Drug Delivery** David S. Jones,David Jones,2004 Annotation The review focuses on the use of pharmaceutical polymer for controlled drug delivery applications Examples of pharmaceutical polymers and the principles of controlled drug delivery are outlined and applications of polymers for controlled drug delivery are described The field of controlled drug delivery is vast therefore this review aims to provide an overview of the applications of pharmaceutical polymers The review is accompanied by approximately 250 abstracts taken from papers and books in the Rapra Polymer Library database to facilitate further reading on this subject

**Advances in Polymeric Systems for Drug Delivery** Raymond Bonnett,2002-03-07 This title examines new drug delivery strategies utilizing intelligent polymeric materials that perform sensing processing and response functions The authors demonstrate the design of polymers with integrated intelligent functions to achieve site specific and temporally controlled drug delivery specifically for pharmaceutical applications Using stimuli responsive polymers as molecular devices for self regulation and externally modulated drug delivery systems are reviewed from multi disciplinary perspectives employing materials science and bio engineering as an important foundation

**Polymers for Controlled Drug Delivery** Peter J. Tarcha,2023-06-14 Polymers for Controlled Drug Delivery addresses the challenges of designing macromolecules

that deliver therapeutic agents that function safely and in concert with living organisms The book primarily discusses classes of polymers and polymeric vehicles including particulates such as latexes coacervates ion exchange resins and liposomes as well as non particulate vehicles such as enteric coatings mediators and bioadhesives Other topics discussed include diffusion biodegradation controlled delivery animal model studies for toxicity metabolism and elimination testing and FDA requirements for clinical studies Drug delivery researchers will find this book to be an invaluable reference tool

NATURAL POLYMERS FOR DRUG DELIVERY ,2016      **Biodegradable Hydrogels for Drug Delivery** Haesun Park,Kinam Park,Waleed S.W. Shalaby,1993-05-17 Providing easy access to the subject both for those who are just starting to work in the field and for experienced professionals this book presents a broad survey of hydrogel synthesis degradation and use for drug delivery Bringing information relevant to biodegradable hydrogels into one resource the book covers the mechanisms of biodegradation types of biodegradable hydrogels chemical and physical gels chemical and enzymatic degradation and examples of biodegradable drug delivery systems An authoritative reference it gives readers a comprehensive systematic science based reference that covers all aspects of biodegradable hydrogels      **Polymeric Drugs and Drug Delivery Systems** Raphael M. Ottenbrite,Sung Wan Kim,2019-04-30 Polymeric materials are now playing an increasingly important role in pharmaceuticals as well as in sensing devices in situ prostheses and probes and microparticle diagnostic agents This new volume consists of twenty two recent research based reports on the developments in these areas of pharmaceutical and biomaterials technology The reports w      *Drug Delivery Systems in Cancer Therapy* Dennis M. Brown,2003-09-08 Leading experts survey the currently available technologies designed to improve the delivery of today s cancer chemotherapeutic agents The authors review both the theoretical and practical considerations governing conventional and nonconventional methods of drug administration and identify promising opportunities for product development In their outline and discussion of the use of novel formulation technologies including synthetic polymers and biomaterials for prolonged or sustained drug release to achieve potentially greater therapeutic effect they profile those technologies that have resulted in a number of approved and late stage clinical products      *Polymers for Pharmaceutical Technologies* Mr. Rohit Manglik,2024-01-01 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels      **Handbook of Polyester Drug Delivery Systems** Jakub Sarto,2017-02      Excipient Development for Pharmaceutical, Biotechnology, and Drug Delivery Systems Ashok Katdare,Mahesh Chaubal,2006-07-28 To facilitate the development of novel drug delivery systems and biotechnology oriented drugs the need for new yet to be developed and approved excipients continues to increase Excipient Development for Pharmaceutical Biotechnology and Drug Delivery Systems serves as a comprehensive source to improve understanding of excipients and forge potential new avenues for

regulatory approval This book presents detailed up to date information on various aspects of excipient development testing and technological considerations for their use It addresses specific details such as historical perspective preclinical testing safety and toxicology evaluation as well as regulatory quality and utility aspects The text also describes best practices for use of various functional excipients and extensive literature references for all topics Biodegradable Polymers in Clinical Use and Clinical Development Abraham J. Domb, Neeraj Kumar, 2011-05-12 This book focuses on biodegradable polymers that are already in clinical use or under clinical development Synthetic and natural polymers will be included This excludes polymers that have been investigated and did not reach clinical development The purpose of this book is to provide updated status of the polymers that are clinical use and those that are now being developed for clinical use and hopefully will reach the clinic during the next 5 years The book provides information that of interest to academics and practicing researchers including chemists biologists and bioengineers and users physicians pharmacists

**Polymeric Drug Delivery Systems** Glen S. Kwon, 2005-04-12 Emphasizing four major classes of polymers for drug delivery water soluble polymers hydrogels biodegradable polymers and polymer assemblies this reference surveys efforts to adapt modify and tailor polymers for challenging molecules such as poorly water soluble compounds peptides proteins and plasmid DNA **Synthetic Polymeric Materials-Based Drug Delivery Systems for Inflammatory Diseases** Harish Dureja, Vimal Arora, Paul A. McCarron, Vandana B. Patravale, Kamal Dua, 2025-09-22 This book provides a comprehensive overview of synthetic polymers and their applications in designing delivery systems for the management of inflammatory diseases It presents introductory insights into inflammatory conditions delves into the role of synthetic polymers and examines diverse delivery approaches Synthetic Polymeric Materials Based Drug Delivery Systems for Inflammatory Diseases explores the potential of synthetic polymers in designing drug delivery systems for managing inflammatory diseases including inflammatory lung diseases inflammatory bowel diseases and inflammatory skin diseases as well as other conditions like cancer neurodegenerative disorders rheumatoid arthritis and eye related inflammatory conditions It also discusses the role of synthetic polymers in modulating immune system responses in different disease conditions Furthermore it analyzes the 3D printing technologies employed for the preparation of drug delivery systems based on synthetic polymers Toward the end the book highlights the challenges and prospects of synthetic polymers in designing delivery systems for the effective management of inflammatory diseases and their clinical usage This book is intended for researchers and professionals in the fields of pharmaceutical sciences nanotechnology and drug delivery systems Key Features Highlights the role of a synthetic polymer based drug delivery system against inflammatory responses Explores the cutting edge technology of 3D printing and its application in preparing drug delivery systems based on synthetic polymers Provides valuable insights into how synthetic polymers can be used to modulate immune system responses Presents regulatory compliance using synthetic polymers in drug delivery systems for inflammatory diseases Examines challenges associated with synthetic polymers in drug delivery systems for

inflammatory diseases      **Advanced Biomaterials in Biomedical Engineering and Drug Delivery Systems** Naoya Ogata, Sung W. Kim, Jan Feijen, Teruo Okano, 2012-12-06 First of all I would like to share the great pleasure of the successful five day symposium with every participant in the 5th Iketani Conference which was held in Kagoshima from April 15 Tuesday to 22 Saturday 1995 Outstanding speakers enthusiastically presented their up to the minute results Relatively little time was allotted for each presentation to ensure as much time as possible for intensive discussions on the particular topics that had just been presented I was delighted to see that the lectures were of high quality and the discussions were lively exciting and productive in a congenial atmosphere We also had 92 papers in the poster session in which young and relatively young scientists made every effort to present the novel results of their research in advanced biomaterials and drug delivery systems DDS I believe some of the research is most promising and will become noteworthy in the twenty first century It was a privilege for me to deliver a lecture at the special session of the symposium In my introductory remarks I pointed out five key terms in multifaceted biomaterials research materials design concept or methodology devices properties demanded and fundamentals I am confident that innovative progress in device manufacturing for end use e g artificial organs vascular grafts and DDS can be brought about only through properly designed advanced materials that exhibit the desired functionality at the interface with any living body      Drug Delivery Systems Kewal K. Jain, 2008-03-07 In this concise and systematic book a team of experts select the most important cutting edge technologies used in drug delivery systems They take into account significant drugs new technologies such as nanoparticles and therapeutic applications The chapters present step by step laboratory protocols following the highly successful Methods in Molecular Biology™ series format offering readily reproducible results vital for pharmaceutical physicians and scientists      **Biodegradable Polymers for Biomedical Applications , volume III** Liqun Yang, Jianshe Hu, Shuai Jiang, Yeh-Hsing Lao, Yang Yao, 2025-02-03 Biodegradable polymers are an important class of polymers due to their good biodegradability and biocompatibility The research and application of biodegradable polymers in biomedical fields have attracted extensive attention especially in that of drug delivery tissue engineering and regenerative medicine Biodegradable polymers can be broken down in vivo through enzymatic and non enzymatic degradation For biomedical applications the chemical and mechanical properties degradation mechanism and products and other factors of the polymers play a critical role in their degradation behaviors and application Thus many essential issues must be considered in the design of biodegradable polymers for biomedical application For instance sufficient mechanical strength is important for scaffold materials to provide three dimensional space for cells and its degradation rate must be compatible with tissue regeneration When used as the drug carriers for some implants controllable degradation rate is also required for the biodegradable polymers to avoid explosive release besides good permeability More importantly the biodegradable polymers must have good biocompatibility to avoid adverse reactions such as inflammation in the body and the degradation products must be non toxic and should not be accumulated in the body To meet such

requirements the chemical and physical as well as the degradation properties of polymers must be properly tailored

## The Enigmatic Realm of **Biodegradable Polymers As Drug Delivery Systems**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing lacking extraordinary. Within the captivating pages of **Biodegradable Polymers As Drug Delivery Systems** a literary masterpiece penned by way of a renowned author, readers embark on a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book's core themes, assess its distinct writing style, and delve into its lasting affect the hearts and minds of those that partake in its reading experience.

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