

Controlled and Novel Drug Delivery

Second Edition

Controlled and Novel Drug Delivery

Assuring the quality, efficacy, safety and affordability of pharmaceutical formulations is the greatest challenge before the pharmaceutical manufacturers as well as the regulators. Drug delivery to the target site, tissue, cell or receptor is another goal to be realized and students must appreciate these concepts. We have made remarkable progress but are still far away from the realization of the ideal drug delivery.

Controlling the fate of drug release administered into the body by any route has always been a fascinating challenge to pharmaceutical researchers. Simultaneously, optimization of drug delivery by maximizing the therapeutic benefit and minimizing the unwanted effects of drugs in the body has been the ultimate goal of pharmaceutical scientists over the decades. Precisely, this is aimed to realize the concept of *Magic Bullet* by Paul Ehrlich.

This led to the evolution of concepts of controlled and novel drug delivery as against the conventional drug delivery that results into unintended protracted blood level concentrations leading to therapeutic disadvantages.

The first edition of *Controlled and Novel Drug Delivery* was published in 1997. As such the area of controlled and novel drug delivery is undergoing transformation at a faster pace. Hence the second edition of this book has been enthusiastically brought out to encompass the recent developments. All the chapters have been contributed by knowledgeable authors who are experts in their own fields and hence readers are assured of up-to-date information in all the areas of controlled and novel drug delivery.

Controlled and Novel Drug Delivery is aimed to provide useful reading material to postgraduate students and teachers, researchers and scientists craving for the most relevant knowledge.

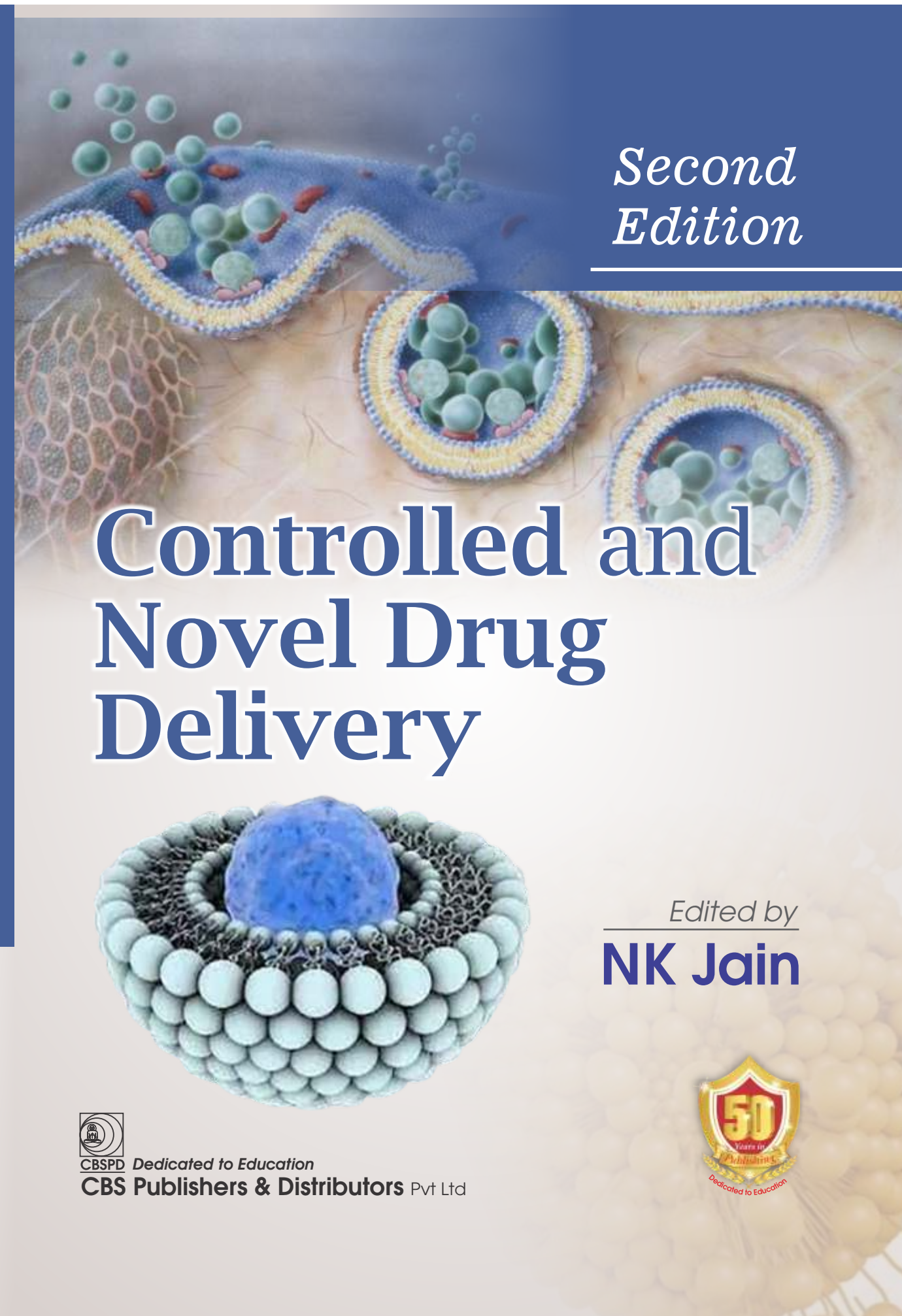


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4819/XI, Prahad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India
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New Delhi | Bengaluru | Chennai | Kochi | Kolkata | Lucknow | Mumbai
Hyderabad | Jharkhand | Nagpur | Patna | Pune | Uttarakhand



Second Edition

Edited by
Jain



Second Edition

Edited by
NK Jain



Edited by

NK Jain PhD

is an internationally renowned academician and researcher who superannuated from Department of Pharmaceutical Sciences, Dr HS Gour University, Sagar, MP in 2014 after rendering more than 40 years of dedicated and distinguished service as a teacher and 25 years as professor.

Starting his academic career in 1973, he worked as Lecturer in Pharmacy, Holkar College, Indore; Reader in Pharmaceutical Technology, MS University, Baroda; Professor and Principal, College of Pharmacy, Nasik; Professor and Head, Department of Pharmaceutical Sciences, Dr HS Gour University, Sagar; Principal, College of Pharmacy, New Delhi; Visiting Professor, Dubai Pharmacy College, Dubai (UAE); and Head, Pharmacy Department, Delhi University. Subsequent to his superannuation, he rendered his services as Director, ISF College of Pharmacy, Moga, Punjab, and as Emeritus Fellow (UGC) at Rajiv Gandhi Technological University, Bhopal.

Prof Jain is the author of 24 celebrated books in pharmaceutical sciences, including a series on controlled and novel drug delivery systems, and has contributed over 60 chapters in national and international books. He has to his credit nearly 500 publications in reputed pharmaceutical journals and has supervised 54 PhD and 142 MPharm candidates. In 2022 an international book written by him *Hybrid Nano-materials for Drug Delivery* was published under the banner of Woodhead Publishing, Elsevier.

Prof Jain has been the recipient of IDMA Research Award in Industrial Pharmacy (1990, 1997 and 2004); Motan Devi Dandiya Award for Best Publication in Pharmacy (1999); ML Khorana Prize for Best Research Paper in Pharmaceutics and Biopharmaceutics published in *IJPS* (2003); ML Khorana Memorial Prize for Best Paper in the field of Pharmaceutics and Biopharmaceutics published in *IJPS* (2006); 'Teacher of the Year 2003' award of the Association of Pharmaceutical Teachers of India; Dr Manju Sree Pal Memorial Award of the Association of Pharmaceutical Teachers of India for Best Pharmaceutical Scientist (2008); Schroff Memorial National Award for his outstanding contributions as an author, academician and scientist by the Indian Hospital Pharmacists' Association (2008); and Motan Devi Dandiya Biennial Prize in Pharmacy for Best Publication (2010). He was elected for the prestigious Indian Association of Pharmaceutical Scientists and Technologists (IAPST) Lifetime Achievement Award conferred at the 5th IAPST Annual Convention at Manipal University, Karnataka, in 2012. In 2021 he was conferred the Lifetime Achievement Award by IPA, MP State Branch, at Indore. In 2022 he was decorated with the Lifetime Achievement Award by the Association of Pharmaceutical Teachers of India.

Prof Jain is globally known for his excellent research in the field of controlled and novel drug delivery including dendrimer drug delivery. According to a ranking announced by the Stanford University Scientists, his name is included in top 2% scientists in the world in the area of pharmacology and pharmacy consecutively for four years. He is highly respected in academic circles as a role model teacher and researcher and is equally active even years after superannuation.



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Novel Drug Delivery

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NK Jain PhD

Ex Professor

Department of Pharmaceutical Sciences

Dr Harisingh Gour Vishwavidyalaya

Sagar, MP, India



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4819/XI Prahlad Street, 24 Ansari Road, Daryaganj, New Delhi 110 002, India

Ph: 011-23289259, 23266861 e-mail: delhi@cbspd.com Website: www.cbspd.com

Corporate Office: 204 FIE, Industrial Area, Patparganj, Delhi 110 092, India

Ph: 011-49344934 Fax: 011-49344935 e-mail: publishing@cbspd.com; publicity@cbspd.com

Branches

- **Bengaluru:** Seema House 2975, 17th Cross, KR Road, Banasankari 2nd Stage, Bengaluru 560 070, Karnataka, India
Ph: +91-80-26771678/79 Fax: +91-80-26771680 e-mail: bangalore@cbspd.com
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Ph: +91-44-26680620, 26681266 Fax: +91-44-42032115 e-mail: chennai@cbspd.com
- **Kochi:** 42/1325, 1326, Power House Road, Opposite KSEB, Power House, Ernakulum 682018, Kochi, Kerala, India
Ph: +91-484-4059061-67 Fax: +91-484-4059065 e-mail: kochi@cbspd.com
- **Kolkata:** 147, Hind Ceramics Compound, 1st Floor, Nilgunj Road, Belghoria, Kolkata 700 056, West Bengal, India
Ph: +91-33-25330055/56 e-mail: kolkata@cbspd.com
- **Lucknow:** Basement, Khushnuma Complex, 7 Meerabai Marg (behind Jawahar Bhawan), Lucknow 226 001, UP, India
Ph: +91-522-4000032 e-mail: tiwari.lucknow@cbspd.com
- **Mumbai:** PWD Shed, Gala No. 25/26, Ramchandra Bhatt Marg, Next JJ Hospital Gate No. 2, Opp. Union Bank of India, Noorbaug, Mumbai 400 009, Maharashtra, India
Ph: +91-22-66661880/89 e-mail: mumbai@cbspd.com

Representatives

- | | | | | | |
|--------------------|--------------|--------------------|--------------|----------------------|--------------|
| • Hyderabad | 0-9885175004 | • Jharkhand | 0-9811541605 | • Nagpur | 0-9421945513 |
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Preface to the Second Edition

Controlling the fate of drug release administered into the body by any route has always been a fascinating challenge to pharmaceutical researchers. Simultaneously, optimization of drug delivery, by maximizing the therapeutic benefits and minimizing the unwanted effects of drugs in the body, has been the ultimate goal of pharmaceutical scientists over the decades. Precisely, this is aimed to realize the concept of 'Magic Bullet' by Paul Ehrlich. This led to the evolution of concepts of novel drug delivery as against the conventional drug delivery that resulted in unintended protracted blood level concentrations leading to therapeutic disadvantages. We have made considerable progress but are still far away from the realization of the ideal drug delivery.

Controlled, targeted, novel and individualized drug delivery encompasses the futuristic spectrum of pharmaceutical challenge to global health management. The regulatory agencies across the globe are also challenged to establish, standardize and implement the relevant requirements.

The first edition of the book '*Controlled and Novel Drug Delivery*' published 25 years ago is quite popular even today amongst postgraduate students, researchers, and teachers. The author considers his moral obligation to the readers to provide an up-to-date account of the relevant matter. As such the area of controlled and novel drug delivery is undergoing very fast transformation. Hence, a revised edition of this book has been enthusiastically perused.

All the chapters have been contributed by experts in their own fields and hence readers are assured of up-to-date information in all areas of controlled and novel drug delivery.

Suggestions for further improvement in this book are cordially welcome.

NK Jain

Preface to the First Edition

The 'magic bullet' concept of Paul Ehrlich though realized very late, offers a logical solution to the age-old problem of unrelated and unwanted effects of therapeutic agents and optimizing the drug therapy in its true sense. Although 'controlled' drug delivery can be considered as the progenitor of magic bullet concept in practice, the term 'controlled' has been used with the widest possible meaning.

Drugs were there, are there, and will be there till there is life on this planet. However, over the years, we have learnt that optimization of drug therapy is of paramount importance and in the process, patient safety, convenience, economic and industrial feasibility are not to be overlooked.

From the crude drugs to supramolecules, from drug extracts to drug-loaded erythrocytes, liposomes and other carriers *vis a vis* the growing emphasis on site specific and receptor-specific drug delivery systems, there has been a complete shift in the approach the ingenious pharmacist is adopting.

Most of the diseases are related to metabolic disorders. We have yet to devise meaningful metabolic parameters which would monitor the healthy state to disease condition. Paul Ehrlich's magic bullet is yet another step in this direction. In future, a health conditioning kit may be developed which would monitor metabolic disorders and daily, weekly or monthly screening through a computerized health check-up should be possible.

In future, it should be possible to design individualized drug delivery systems taking care of the exact requirement of the drug at the specific site for a definite time interval for an individual patient.

Many of my colleagues in Indian universities have been feeling that some attempt should be made to focus our contribution in the field of research in novel drug delivery and I being the author of some of the most popular text books in pharmacy and also being actively involved in research, the choice rested upon me. I took up the challenge and took nearly three years in turning out a dream into reality. One more consideration in our mind had been our postgraduate students who always complain about the paucity of really useful books on novel drug delivery. Similarly my friends in R&D laboratories in industry have, over the years, been encouraging me to take up such an activity.

This book is a humble attempt to present an overview of the advances in novel drug delivery systems based on the contributions from the scientists working in Indian universities and research laboratories. The coverage of the topics is obviously wide though not exhaustive. Therefore, there may be few repetitions in some chapters but this could be acceptable if contributors' perception of the depth of the topic is to be honored.

The untiring efforts of all the learned contributors are gratefully acknowledged. They have been very considerate in acceding to my research students Mr. Ajay J Khopade and Mr Sanjay Jain for their most active cooperation in the preparation of this book. The Publisher, CBS Publishers & Distributors, Delhi, took keen interest in the publication of this book and I am personally thankful to them.

I am obliged to Dr SN Sharma, Emeritus Professor, Hamdard University, New Delhi, my teacher and mentor who has been kind enough to accede to my request to write a foreword for this book.

Lastly I must acknowledge the moral support and understanding from my wife, Dr Asha, and sons, Master Parijat and Kshitij.

This is a modest beginning and with the encouragement and support of our readers and contributors it should be possible for me to continue my mission. The present volume should be useful to graduate and postgraduate students and teachers, pharmaceutical industries and R&D personnel.

Suggestions from any corner for improving this volume and for the preparation of subsequent volumes would be appreciated and personally acknowledged.

NK Jain

Contributors

Abhay Singh Chauhan

Medical College of Wisconsin
School of Pharmacy, Milwaukee
Wisconsin 53226, USA

Abhijeet Pandey

Department of Pharmaceutics
Manipal College of Pharmaceutical Sciences
Manipal Academy of Higher Education
Manipal 576104, India

Abhishek Jha

Doctoral Candidate
Department of Pharmaceutical
Engineering and Technology
Indian Institute of Technology
Banaras Hindu University
Varanasi 221005, India

Afsana Sheikh

Department of Pharmaceutics
School of Pharmaceutical Education
and Research
Jamia Hamdard
New Delhi 110062, India

Amirhossein Sahebkar

Applied Biomedical Research Center
Mashhad University of Medical Sciences
Mashhad 9177948954, Iran

Anand More

National Institute of Pharmaceutical Education
and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Ankit Kumar

Pharmaceutics and Pharmacokinetics Division
CSIR—Central Drug Research Institute
Lucknow 226031, India

Avinash Pawar

National Institute of Pharmaceutical
Education and Research (NIPER)
Hyderabad 500037, India

Bhakti Pawar

National Institute of Pharmaceutical Education
and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Bhupendra G Prajapati

Shree SK Patel College of Pharmaceutical
Education & Research
Faculty of Pharmacy, Ganpat University
Ganpat Vidyanagar 384012, India

Brahmeshwar Mishra

Professor of Pharmaceutics
Department of Pharmaceutical Engineering and
Technology
Indian Institute of Technology
(Banaras Hindu University)
Varanasi 221005, India

Chandrakantsing V Pardeshi

Department of Pharmaceutics
RC Patel Institute of Pharmaceutical Education
and Research
Shirpur 425405, India

Dilip Panwar

Pharmaceutics and Pharmacokinetics Division
CSIR—Central Drug Research Institute
Lucknow 226031, India

Dinesh Kumar Mishra

Professor and Principal
Indore Institute of Pharmacy
Opposite IIM, IIST Campus
Indore 453331 India

Dipankar Bhadra

Ex-Technical Director
Cisen Pharmaceutical India Pvt. Ltd.
Verna, Goa

Ex-General Manager
Ipca Lab Ltd.
Charkop Industrial Estate
Kandivali, Mumbai 400067
India

Ekta Pardhi

National Institute of Pharmaceutical Education and Research (NIPER)
Hyderabad 500037, India

Ganesh B Shevkar

Department of Pharmaceutics
Sandip Institute of Pharmaceutical Sciences
Nashik 422213, India

Garima Joshi

Department of Pharmaceutical Sciences
Mohanlal Sukhadia University
Udaipur 313001, India

Gundawar Ravi

Department of Quality Assurance
Manipal College of Pharmaceutical Sciences
Manipal Academy of Higher Education (MAHE)
Manipal 576104, India

Isaac Anderson

Marquette University
Milwaukee
Wisconsin 53226 USA

Kailash Ahirwar

National Institute of Pharmaceutical Education and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Kanchan Bharti

Department of Pharmaceutical Engineering and Technology
Indian Institute of Technology
Banaras Hindu University
Varanasi 221005, India

Kavit Rawal

Institute of Pharmaceutical Sciences
University of Lucknow,
Lucknow 226031, India

Keerti Jain

Department of Pharmaceutics
National Institute of Pharmaceutical Education and Research-Raebareli (NIPER-R),
Lucknow 226002, India

Khushwant S Yadav

Shobhaben Pratapbhai Patel School of Pharmacy and Technology Management
SVKM'S NMIMS (Deemed to be University)
Mumbai 400056, India

Kinjal Parikh

Faculty of Pharmacy
The Maharaja Sayajirao University of Baroda
Kalabhavan, Vadodara 390001, India

Krutika K Sawant

Department of Pharmacy
Faculty of Pharmacy
Maharaja Sayajirao University of Baroda
Kalabhavan, Vadodara 390001, India

Le Pham

Medical College of Wisconsin
School of Pharmacy, Milwaukee
Wisconsin 53226, USA

Lubna Azmi

Department of Pharmaceutical Chemistry
Institute of Pharmaceutical Sciences
University of Lucknow,
Lucknow 22603, India

Madhu Sharma

Pharmaceutics and Pharmacokinetics Division
CSIR-Central Drug Research Institute
Lucknow 226031, UP, India
and
Academy of Scientific and Innovative Research (AcSIR),
Ghaziabad 201002, India

Mahi Mhatre

National Institute of Pharmaceutical Education and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Mayank Kumar Singh

The National Dendrimer & Nanotechnology Center, NanoSynthons LLC, Mount Pleasant
Michigan 48858, USA

Mitali Patel

Maliba College of Pharmacy
UKA Tarsadia University
Bardoli 394350, India

Namdev Dhas

Department of Pharmaceutics
Manipal College of Pharmaceutical Sciences
Manipal Academy of Higher Education (MAHE)
Manipal 576104, India

Nazeer Hasan

Department of Pharmaceutics
School of Pharmaceutical Education and Research
Jamia Hamdard 110062
New Delhi 110062, India

Neelesh Kumar Mehra

Pharmaceutical Nanotechnology
Research Laboratory
National Institute of Pharmaceutical Education and Research (NIPER)
Hyderabad 500037, India

Neelima Anup

National Institute of Pharmaceutical Education and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Nikhil Rai

Pharmaceutics and Pharmacokinetics Division
CSIR-Central Drug Research Institute
Lucknow 226031, India

NK Jain

Former Professor and Head
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470003, India

Parth Thakkar

Pharmacy Department
Faculty of Pharmacy
The Maharaja Sayajirao University of Baroda
Kalabhavan, Vadodara 390001, India

Pooja Das Bidla

Pharmaceutics Research Projects Laboratory
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470002, India

Prabhat Ranjan Mishra PhD, FNASc

Senior Principal Scientist and Head
Professor (AcSIR; Biological Sciences)
Area Coordinator—Preclinical and
Translational Research
Sitapur Road, Lucknow 226031, India

Prashant Kesharwani M Pharm, PhD

Assistant Professor & Ramanujan Fellow
Department of Pharmaceutics
School of Pharmaceutical
Education and Research
Jamia Hamdard,
New Delhi 110062, India

Pritish K Panda

Pharmaceutics Research Projects Laboratory
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470002, India

Pushpendra Kumar Tripathi

Institute of Pharmaceutical Sciences
University of Lucknow, Lucknow 226031, India

Rakesh Kumar Sahoo

Department of Pharmacy
School of Chemical and Pharmacy
Central University of Rajasthan
Ajmer 305817, India

Rakesh Kumar Tekade

National Institute of Pharmaceutical Education and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Rakhee Kapadia

SIRT-Pharmacy
SAGE University
Bhopal 462022, India

Rati Yadav

National Institute of Pharmaceutical Education and Research (NIPER)
Hyderabad 500037, India

Ravindra Vasave

National Institute of Pharmaceutical Education and Research (NIPER),
Hyderabad 500037, India

Remya KM

Department of Pharmacy
School of Chemical and Pharmacy
Central University of Rajasthan
Ajmer 305817, India

Rohan Chand Sahu

Department of Pharmaceutics
National Institute of Pharmaceutical Education and Research-Raebareli (NIPER-R),
Lucknow 226002, India

Sanjay B Patil

Shri Neminath Jain Brahmacharyashram's
Shriman Sureshdada Jain
College of Pharmacy
Neminagar, Chandwad,
Nashik 423101, India

Sanjay K Jain

Professor of Pharmaceutics
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470002, India

Sanya Batheja

Department of Pharmacy
School of Chemical and Pharmacy
Central University of Rajasthan
Ajmer 305817, India

Sarjana Raikwar

Pharmaceutics Research Projects Laboratory
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470002, India

Shashi Bala Singh

National Institute of Pharmaceutical Education
and Research (NIPER)
Hyderabad 500037, India

Shivani Saraf

Pharmaceutics Research Projects Laboratory
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470002, India

Srinivas Hebbar

Department of Pharmaceutics
Manipal College of
Pharmaceutical Sciences
Manipal Academy of Higher Education (MAHE)
Manipal 576104, India

Stanzin Sonam

Department of Pharmaceutics
National Institute of Pharmaceutical Education
and Research-Raebareli (NIPER-R)
Lucknow 226002, India

Sulekha Bhadra

Group Leader
Nano Research Lab
NSRT, Rusan Pharma, Kandla SEZ
Gandhidham 370203, India

Sunny Rathee

Pharmaceutics Research Projects Laboratory
Department of Pharmaceutical Sciences
Dr Harisingh Gour Vishwavidyalaya
Sagar 470002, India

Sushma R Singh

Dr LH Hiranandani College of Pharmacy
Ulhasnagar 421003, India

Swapnil Jain

Department of Pharmaceutics
HR Patel Institute of Pharmaceutical Education
and Research
Shirpur 425405, India

Tanisha Gupta

National Institute of Pharmaceutical Education
and Research-Ahmedabad (NIPER-A)
Gandhinagar 382355, India

Tathagata Dutta

Chief Technology Officer,
JODAS Expoim Pvt. Ltd.
Hyderabad 500100, India

Teeja Suthar

Department of Pharmaceutics
National Institute of Pharmaceutical Education
and Research-Raebareli (NIPER-R),
Lucknow 226002, India

Umesh Gupta

Assistant Professor
Department of Pharmacy
School of Chemical Sciences and Pharmacy
Central University of Rajasthan
Bandarsindri, Ajmer 305817, India

Vidhu Aeri

Department of Pharmacognosy and
Phytochemistry
School of Pharmaceutical
Education and Research
Jamia Hamdard University
New Delhi 110062, India

Vinay Kumar

Department of Pharmacy
School of Chemical and Pharmacy
Central University of Rajasthan
Ajmer 305817, India

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