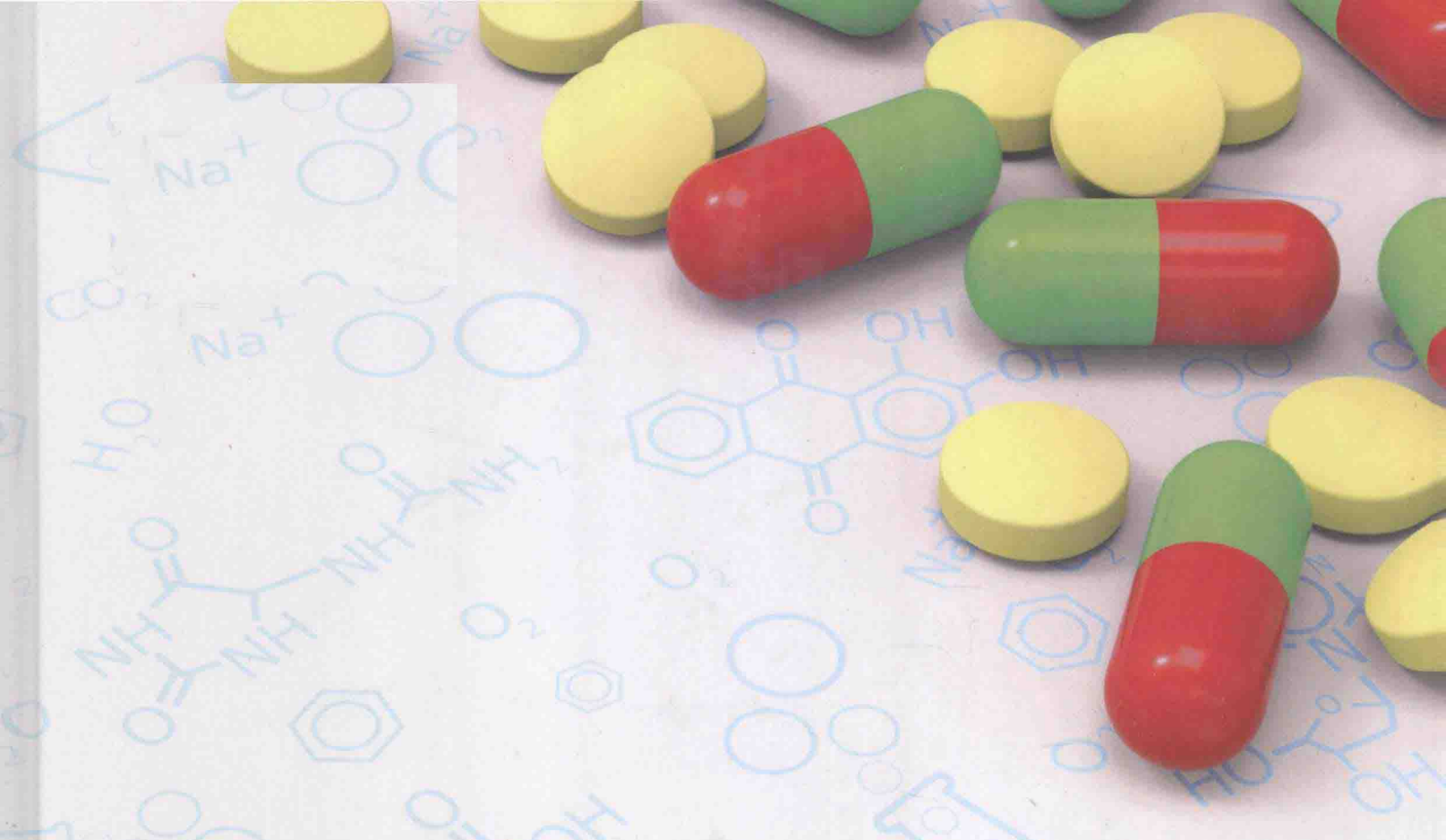

PHARMACEUTICS

BASIC PRINCIPLES AND APPLICATION TO PHARMACY PRACTICE

EDITED BY
ALEKHA K. DASH | SOMNATH SINGH | JUSTIN TOLMAN

PHARMACEUTICS

Basic Principles and Application to Pharmacy Practice

Edited by

ALEKHA K. DASH, RPH, PHD
Creighton University, Nebraska, USA

SOMNATH SINGH, PHD
Creighton University, Nebraska, USA

JUSTIN TOLMAN, PHARMD, PHD
Creighton University, Nebraska, USA

ELSEVIER

AMSTERDAM • BOSTON • HEIDELBERG • LONDON
NEW YORK • OXFORD • PARIS • SAN DIEGO
SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO
Academic Press is an imprint of Elsevier

Academic Press is an imprint of Elsevier
525 B Street, Suite 1900, San Diego, CA 92101-4495, USA
32 Jamestown Road, London NW1 7BY, UK
225 Wyman Street, Waltham, MA 02451, USA

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
A catalog record for this book is available from the Library of Congress

ISBN: 978-0-12-386890-9

Printed and bound in the United States of America

14 15 16 17 10 9 8 7 6 5 4 3 2 1

PHARMACEUTICS

We dedicate this text to our teachers and professors who inculcated in us a love of scientific principles and pharmaceutics.

Preface

Pharmaceutical education in the United States of America has been undergoing substantial changes over the past several decades to address changes in a pharmacist's role in the provision of pharmaceutical care. Pharmacy education has had a historical perspective that prepared student pharmacists to engage in pharmaceutical dispensing or pursue graduate pharmaceutical education focused on research. Any clinically-focused education was then obtained through post- baccalaureate training and experience. The currently evolving perspective of pharmacy education is focused on preparing student pharmacists as providers of clinical pharmaceutical care and as the medication expert in the healthcare system.

These evolutions have increased the need for pharmacy education to be solidly-grounded in scientific principles. Key domains of pharmaceutical knowledge include: medicinal chemistry and pharmacology for an understanding of drug molecule properties and mechanisms of action; pharmaceutics and biopharmaceutics to utilize physicochemical properties of drugs to develop a safe, effective and reliable drug product and their interactions with human physiology; pharmacokinetics and pharmacodynamics to explain drug movement and pharmacologic effects within systems; pharmacy practice to interpret the role of medications in the diagnosis, treatment, and prevention of disease; and social and administrative studies to evaluate health services and patient safety. Pharmaceutical education should substantively address all of these domains to provide scientific foundations for rational clinical decision making. Additionally, only pharmacy education can provide the scientific depth and breadth across these various levels of knowledge domains.

This textbook is intended to provide a basic scientific introduction to the fields of pharmaceutics and biopharmaceutics specifically tailored to meet the need of practice of Pharmacy. Current educational resources in these fields are principally focused on a historical perspective of pharmaceutical education. They either provide a mathematically rigorous and theoretical introduction to these fields or are briefly integrated into larger resources focused on other knowledge domains. *Pharmaceutics: Basic Principles and Application to Pharmacy Practice* will help pharmacy students gain the scientific foundation to understand drug physicochemical properties, practical aspects of dosage forms and drug delivery systems, and the biological applications of drug administration.

Alexha H. Dash
Justin Tolman
Somnath Singh

Pharmaceutics: Basic Principles and Application to Pharmacy Practice includes a companion website with a full color image bank and flip videos featuring difficult processes and procedures, as well as sample questions for students to test their knowledge. To access these resources, please visit booksite.elsevier.com/9780123868909.

Acknowledgments

We would like to thank all our family members for their unstinted support during the preparation of this text. We would also like to acknowledge the following individuals who have contributed to this book or supplemental materials:

Daniel Munt
Barbara Bittner
Dawn Trojanowski
Megan Huslig
Roger Liu
Katherine Smith

List of Contributors

Eman Atef School of Pharmacy-Boston, Massachusetts College of Pharmacy and Health Sciences, Boston, MA, USA

Harsh Chauhan College of Pharmacy, Creighton University, Omaha, NE, USA

Alekha K. Dash Department of Pharmacy Sciences, School of Pharmacy and Health Professions, Creighton University, Omaha, NE, USA

Vivek S. Dave St. John Fisher College, Wegmans School of Pharmacy, Rochester, NY USA

Hari R. Desu Department of Pharmaceutical Sciences, University of Tennessee Health Science Center, Memphis, TN, USA

Ramprakash Govindarajan Research and Development, GlaxoSmithKline, Research Triangle Park, North Carolina, USA

Chong-Hui Gu Vertex Pharmaceuticals, Inc., Cambridge, MA, USA

Mohsen A. Hedaya Department of Pharmaceutics, Faculty of Pharmacy, Kuwait University, Safat, Kuwait

Seon Hepburn University of Marweyland, School of Pharmacy, Baltimore, MD, USA

Stephen W. Hoag University of Marweyland, School of Pharmacy, Baltimore, MD, USA

Megan Huslig Affiliation to come

Sunil S. Jambhekar LECOM Bradenton, School of Pharmacy, Bradenton, FL, USA

Anuj Kuldipkumar Vertex Pharmaceuticals, Inc., Cambridge, MA, USA

Maria P. Lambros Department of Pharmaceutical Sciences, College of Pharmacy, Western University of Health Sciences, Pomona, CA, USA

Ram I. Mahato Department of Pharmaceutical Sciences, University of Tennessee Health Science Center, Memphis, TN, USA

Sarat K. Mohapatra Department of Pharmacy Sciences, School of Pharmacy and Health Professions, Creighton University, Omaha, NE, USA

Kalpana Nagpal Department of Pharmaceutical Sciences, G. J. University of Science and Technology, Hisar, India

Ajit S. Narang Drug Product Science and Technology, Bristol-Myers Squibb, Co., New Brunswick, NJ, USA

Sangita Saini PDM College of Pharmacy, Sarai Aurangabad, Bahadurgarh, Haryana, India

Shailendra Kumar Singh Department of Pharmaceutical Sciences, G. J. University of Science and Technology, Hisar, India

Somnath Singh Pharmacy Sciences, School of Pharmacy and Health Professions, Creighton University, Omaha, NE, USA

Laura A. Thoma Department of Pharmaceutical Sciences, University of Tennessee Health Science Center, Memphis, TN, USA; Creighton University School of Pharmacy and Health Professions, Omaha, NE, USA

Contents

6. Biopolymers

SOMNATH SINGH AND JUSTIN TOLMAN

II

PRACTICAL ASPECTS OF PHARMACEUTICS

7. Drug, Dosage Form, and Drug Delivery Systems

ALEKHA K. DASH

8. Solid Dosage Forms

ALEKHA K. DASH

9. Liquid Dosage Forms

HARI R. DESU, AJIT S. NARANG, LAURA A. THOMA AND RAM I. MAHATO

10. Aerosol Dosage Forms

JUSTIN A. TOLMAN AND MEGAN HUSLIG

11. Semisolid Dosage Forms

SHAILENDRA KUMAR SINGH, KALPANA NAGPAL AND SANGITA SAINI

12. Special Dosage Forms and Drug Delivery Systems

SARAT K. MOHAPATRA AND ALEKHA K. DASH

III

BIOLOGICAL APPLICATIONS OF PHARMACEUTICS

PART I

PHYSICAL PRINCIPLES AND PROPERTIES OF PHARMACEUTICS