

Chronopharmacology

Time-Dependent Pharmacotherapy

Editors

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Foreword

Medicine is evolving, with chronopharmacology leading the way. By aligning drug therapy with natural rhythms, it improves outcomes, reduces side effects, and personalizes treatments. “Chronopharmacology: Time-Dependent Pharmacotherapy” delves into how medication timing impacts conditions like heart disease, cancer, sleep disorders, and diabetes. It explores circadian science, AI-driven schedules, and time-sensitive drug systems, bridging research and practical applications for smarter healthcare.

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I deeply thank my father, Mr. Hafiz Jalil Ahmad Siddiqui, and my mother, Mrs. Afsar Jahan Siddiqui, for their blessings and unwavering belief in me. My heartfelt appreciation goes to my wife, Mrs. Nagma Siddiqui, for her patience, understanding, and steadfast support, which has been a pillar of strength throughout this journey.

My beloved sons, Muhammad Yahya Siddiqui and Muhammad Zakaria Siddiqui, are my greatest joy and inspiration. Their love brings immense happiness, and I dedicate this work to them as a testament to lifelong learning and perseverance.

I deeply appreciate everyone who contributed to this book. Their support and dedication made this endeavor possible.

Mohd Aftab Siddiqui

My heartfelt thanks go to the contributors for their knowledge, research, and commitment, which have made this volume a valuable resource. I also deeply appreciate the publishing team for their steadfast support and professionalism throughout this journey. I am deeply grateful to Dr. Mohd Aftab Siddiqui for his visionary leadership and to Dr. Mohd Nazam Ansari for his impactful collaboration, both of which have made this journey enriching. My sincere thanks also extend to MESCO Institute of Pharmacy for fostering a supportive environment that has been vital to my growth.

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I owe my deepest gratitude to my parents for their sacrifices and unconditional support, and to my brothers for their encouragement and inspiration. I am profoundly thankful to my husband, Dr. Mohammad Tariq, for his unwavering support and love, and to my son, Afraz Kamil, whose joy and laughter inspire me and give meaning to every achievement. This book is the product of collective effort, and I deeply appreciate everyone who contributed to its creation.

Afreen Usmani

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Mohd Nazam Ansari

Preface

Chronopharmacology, an emerging interdisciplinary field, examines how endogenous biological rhythms influence drug efficacy and safety. Rooted in circadian biology, it explores the temporal dimension of pharmacokinetics and pharmacodynamics, offering a paradigm shift in optimizing drug therapy based on the body's internal timekeeping mechanisms. Human physiology operates on circadian rhythms—approximately 24-hour cycles regulating sleep, hormone secretion, metabolism, and cellular repair. Traditional pharmacology often neglects these rhythms, leading to inconsistent therapeutic outcomes and increased adverse effects. Chronopharmacology addresses this gap, emphasizing time-of-day-dependent drug responses to improve therapeutic precision and minimize toxicity.

This volume provides a comprehensive exploration of the scientific basis and clinical potential of chronopharmacology. It integrates molecular, physiological, and pharmacological insights to inform evidence-based chronotherapeutic strategies. **Chapter 1** introduces circadian systems and biological rhythms, emphasizing their role in physiological regulation. **Chapter 2** reviews the historical evolution of chronotherapy and the incorporation of temporal biology into pharmacological practice. **Chapter 3** details the fundamentals of chronopharmacokinetics and chronopharmacodynamics, illustrating time-dependent drug behavior. **Chapter 4** focuses on cardiovascular chronotherapy, addressing optimal timing of antihypertensives and related agents. **Chapter 5** discusses chronotherapy in oncology, highlighting circadian-informed chemotherapy to enhance efficacy and reduce toxicity. **Chapter 6** explores chronopharmacological approaches to sleep disorders, emphasizing rhythmic alignment of therapeutics. **Chapter 7** examines the circadian regulation of metabolism and its implications for diabetes treatment. **Chapter 8** presents chrono-drug delivery systems, emphasizing formulations designed for synchronized drug release. **Chapter 9** introduces artificial intelligence applications for optimizing drug timing via predictive modeling. **Chapter 10** projects future trends and the clinical integration of chronopharmacology into precision medicine.

As precision medicine advances, chronopharmacology offers a vital framework for aligning therapeutic interventions with biological time. This book aims to support researchers, clinicians, and students in applying chronotherapeutic

principles to enhance clinical outcomes and deepen our understanding of time-dependent drug action.

Mohd Aftab Siddiqui

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