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Foundations and Advances in Pharmaceutical Sciences

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**Published by: - Book Rivers**

**Website: - <https://www.bookrivers.com>**

**Email: [publish@bookrivers.com](mailto:publish@bookrivers.com)**

**First Print Edition - 2026**

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**Title: Foundations and Advances in Pharmaceutical Sciences**

**Editor: Anas Islam**

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**ISBN: 978-93-7837-257-5**

**MRP: 499/-INR**

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**(Printed in India)**

## PREFACE

Pharmaceutical sciences continue to evolve through the integration of natural product research, drug design, formulation development, and pharmacological evaluation. The increasing complexity of healthcare demands a multidisciplinary understanding of medicines, from their origin and development to their therapeutic application and regulatory evaluation. This book, *Integrated Pharmaceutical Sciences: From Natural Sources to Therapeutic Applications*, was prepared to provide a concise and structured overview of major domains within pharmaceutical sciences.

The book presents fundamental and applied concepts related to pharmacognosy, pharmaceutics, pharmaceutical chemistry, and pharmacology in an integrated manner. Each chapter has been designed to provide clear academic content with emphasis on practical relevance, recent developments, and current pharmaceutical approaches. Topics included range from natural drug sources and phytochemicals to novel drug delivery systems, toxicological screening, regulatory aspects, nanotechnology, and personalized medicine.

This book is intended for undergraduate and postgraduate students, researchers, and academic professionals seeking a compact interdisciplinary resource in pharmaceutical sciences. The contributors have aimed to maintain scientific accuracy while presenting the material in a concise and accessible format.

We hope this book will contribute to academic learning and encourage further exploration in the field of pharmaceutical sciences.

**ANAS ISLAM**

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## **Chapter - 4**

### **Phytochemicals and Therapeutic Potential**

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#### **4.1. Introduction**

Plants synthesise a vast array of organic compounds classified broadly into primary and secondary metabolites. Primary metabolites, including carbohydrates, amino acids, and lipids, maintain fundamental cellular processes such as respiration and photosynthesis. Secondary metabolites are not essential for basic vegetative growth. Plants produce these compounds to mediate ecological interactions. These interactions include defence against herbivores and pathogens, attraction of pollinators, and competition with neighbouring plant species. The structural complexity of these ecological defence molecules allows them to interact with biological targets across diverse species. Humans exploit these specific interactions for pharmacotherapy.

The pharmacological efficacy of phytochemicals relies on evolutionary conservation. Protein structures, including enzymes, ion channels, and cell surface receptors, exhibit sequence and structural homology across different kingdoms of life. A phytochemical synthesised by a plant to inhibit an insect nervous system receptor may bind to homologous receptors in the human central nervous system. This cross-species target interaction forms