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EMERGING TRENDS IN BIOTECHNOLOGY

Emerging Trends in Biotechnology



Dr. Imran Hussain
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Emerging Trends in Biotechnology

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Preface

Biotechnology stands at the forefront of scientific innovation, transforming the way we understand and interact with living systems. From advancements in genetic engineering and molecular diagnostics to breakthroughs in sustainable agriculture, environmental management, and personalized medicine, the field continues to evolve at an unprecedented pace. The present volume, *Emerging Trends in Biotechnology*, thoughtfully edited by Dr. Imran Hussain and Dr. Sujeet Pratap Singh, brings together diverse perspectives and cutting-edge developments that reflect the dynamic nature of this discipline.

This book offers a comprehensive overview of contemporary research areas, including synthetic biology, bioinformatics, nanobiotechnology, and translational research. It highlights not only the scientific progress achieved in recent years but also the practical applications that address global challenges such as food security, climate change, and human health. By integrating theoretical insights with real-world applications, this volume serves as a valuable resource for students, researchers, and professionals alike.

Dr. Imran Hussain has meticulously curated contributions that emphasize interdisciplinary approaches and innovation-driven research. The chapters presented in this book underscore the

importance of collaboration between academia, industry, and policy frameworks in advancing biotechnology for societal benefit. Moreover, the inclusion of emerging tools such as artificial intelligence and omics technologies reflects the future direction of the field.

I am confident that this book will inspire readers to explore new ideas, foster critical thinking, and contribute to the advancement of biotechnology. It is a timely and significant contribution that will undoubtedly serve as a reference for years to come. I congratulate Dr. Imran Hussain for his dedicated efforts in bringing together this important work and extend my best wishes for its success.

Editors:
Dr. Imran Hussain &
Dr. Sujeet Pratap Singh

TABLE OF CONTENTS

Chapter No.	Chapter Title	Page No.
Chapter 1	Jasmonic Acid-Mediated Defense in <i>Vicia faba</i> : Alleviating Fungicide-Induced Oxidative Stress <i>Aneeta Tiwari and Ashish Verma</i>	1 - 25
Chapter 2	Natural Bioactives for Skin Therapeutics: <i>Cydonia oblonga</i> and Cyanobacteria-Based Approaches <i>Anjeeta Singh and Kaiser Younis</i>	26 - 47
Chapter 3	Polyhydroxybutyrate (PHB): Microbial Production, Properties, Extraction and Biomedical Applications <i>Anuj Yadav and Roohi</i>	48 - 77
Chapter 4	Physical Properties, Extraction, Stability, and Applications of Steviol Glycosides from <i>Stevia</i> <i>rebaudiana</i> <i>Farhana Trannum and Soban Ahmad Faridi</i>	78 - 97
Chapter 5	Molecular Insights and Therapeutic Advances in Breast Cancer <i>Heena Bano and Rahul Singh</i>	98 - 128
Chapter 6	Antimicrobial, Antioxidant and Anticancer Potential of <i>Andrographis paniculata</i> : Phytochemical Insights and Biomedical Implications <i>Hina Khatoon, Mohammad Haneef and Salman Akhtar</i>	129 – 153

Chapter 7 Essential Oils from *Cymbopogon flexuosus*: 154 - 187
Biosynthesis, Extraction, Phytochemistry,
Applications, and Cultivation

Nargis Aftab and Ahamad Faiz Khan

Chapter 8 Stress-Responsive Mechanisms in 188 - 215
Cyanobacteria: Implications for Bioremediation
and Crop Enhancement

Pratibha and Alvina Farooqui

Chapter-2

Natural Bioactives for Skin Therapeutics: *Cydonia oblonga* and Cyanobacteria-Based Approaches

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Abstract

Scytonemin, a lipid-soluble indole-alkaloid pigment synthesized by certain cyanobacteria, has emerged as a potent natural UV-screening compound with strong antioxidant and anti-inflammatory properties. Its unique chemical structure enables absorption across a broad UV spectrum, particularly in the UVA range, making it highly effective in preventing oxidative damage and photoaging. This chapter explores the mechanisms of UV protection offered by scytonemin and the various strategies for its integration into topical skin formulations. Special emphasis is placed on nanoemulsion-based delivery systems, which improve solubility, enhance dermal penetration, and ensure stability. By combining natural photoprotective efficacy with advanced formulation technologies, scytonemin offers a promising alternative to conventional synthetic sunscreens, aligning with the growing demand for sustainable, biocompatible skincare solutions. The chapter also addresses formulation parameters, safety profiles, and regulatory considerations, paving the way for the development of next-generation cosmeceuticals rooted in nature and supported by science.

Keywords: *Cydonia oblonga*, Scytonemin, Nanoemulsion, UV protection, Antimicrobial activity, Antioxidant activity, Cyanobacteria.

1. Introduction

The therapeutic potential of natural products in modern pharmaceutical and cosmeceutical industries is increasingly being recognized due to their biocompatibility, safety profile, and diverse bioactivities. *Cydonia oblonga* Mill., commonly known as quince, is a prominent member of the Rosaceae family. Traditionally, this fruit-bearing medicinal plant has been utilized for its therapeutic properties in the management of several diseases including cancer, diabetes, hepatitis, ulcers, and respiratory and urinary infections (Karimi et al., 2017). Its pharmacological potential is attributed to its abundance of secondary metabolites such as phenolics, steroids, flavonoids, terpenoids, tannins, organic acids, glycosides, and sugars. The various parts of *C. oblonga*—including seeds, leaves, and fruits—have demonstrated a wide range of bioactivities, such as antioxidant, antibacterial, antifungal, anti-inflammatory, hepatoprotective, antidepressant, antidiarrheal, hypolipidemic, diuretic, and hypoglycemic effects.

A notable compound derived from quince seeds is glucuronoxylan, a polysaccharide mucilage known for its therapeutic application in dermal patches to enhance wound healing (Karimi et al., 2017). Historically, quince seed mucilage has also been used as a home remedy for wound care due to its healing and soothing properties (Sadeghi Mahoonak et al., 2017). In addition, quince extracts have long served dual purposes as dietary supplements and treatment agents for various infections and inflammatory conditions (Church et al., 2013).

The growing interest in natural-origin treatments—such as plant extracts, honey, and even insect-derived substances—has led to the exploration of these products as affordable, sustainable alternatives