

CHAPTER 24

Natural Products (Secondary Metabolites)

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CHAPTER OUTLINE

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Introduction

Natural products have primary ecological functions.

Plants produce a vast and diverse assortment of organic compounds, the great majority of which do not appear to participate directly in growth and development. These substances, traditionally referred to as **secondary metabolites**, often are differentially distributed among limited taxonomic groups within the plant kingdom. Their functions, many of which remain unknown, are being elucidated with increasing frequency. The **primary metabolites**, in contrast, such as phyto-sterols, acyl lipids, nucleotides, amino acids, and organic acids, are found in all plants and perform metabolic roles that are essential and usually evident.

Although noted for the complexity of their chemical structures and biosynthetic pathways, **natural products** have been widely perceived as biologically insignificant and have historically received little attention from most plant biologists. Organic chemists, however, have long been interested in these novel phytochemicals and have investigated their chemical properties extensively since the 1850s. Studies of natural products stimulated development of the separation techniques, spectroscopic approaches to structure elucidation, and synthetic methodologies that now constitute the foundation of contemporary organic chemistry. Interest in natural products was not purely academic but rather was prompted by their great utility as dyes, polymers, fibers, glues, oils, waxes, flavoring agents, perfumes, and drugs. Recognition of the biological properties of myriad natural products has fueled the current focus of this field, namely, the search for new drugs, antibiotics, insecticides, and herbicides. Importantly, this growing appreciation of the highly diverse biological effects produced by natural products has prompted a reevaluation of the possible roles these compounds play in plants, especially in the context of ecological interactions. As illustrated in this chapter, many of these compounds now have been shown to have important

Natural Products The Secondary Metabolites

Awanish Kumar, Sunil Kumar



Natural Products The Secondary Metabolites:

Natural Products James Ralph Hanson, 2003 Natural products are compounds that are produced by living systems and the secondary metabolites are those which give particular species their characteristic features These natural products include polyketides terpenoids phenylpropanoids alkaloids and antibiotics The study of these natural products has played a major part in the development of organic and medicinal chemistry and we are now starting to understand the important ecological role that these compounds have The aim of this book is to describe the major features of these compounds and the way in which chemical and physical methods have been used to establish their structures and then to show how these structures can be rationalised in biosynthetic terms The first chapter describes the classes of natural product their biological activity and isolation Subsequent chapters attempt to link chemical and spectroscopic strategies in structure elucidation contrasting the classical chemical strategies that were used in the past with modern spectroscopic methods The final chapter describes the biosynthesis of natural products The elucidation of the structures of natural products brings together many elements taught in courses on functional group chemistry stereochemistry and elementary spectroscopy This book will therefore be welcomed by lecturers and students of second year chemistry courses Ideal for the needs of undergraduate chemistry students Tutorial Chemistry Texts is a major series consisting of short single topic or modular texts concentrating on the fundamental areas of chemistry taught in undergraduate science courses Each book provides a concise account of the basic principles underlying a given subject embodying an independent learning philosophy and including worked examples

Natural Secondary Metabolites Márcio Carochio, Sandrina A. Heleno, Lillian Barros, 2023-02-21 This book focuses on the different compounds polyphenols sterols alkaloids terpenes that arise from the secondary metabolism of plants and fungi and their importance for research and industry These compounds have been the backbone and inspiration of various industries like the food pharmaceutical and others to produce synthetic counterparts Furthermore many of these compounds are still widely used to carry out specific functions in all these industries This book offers a compilation of different texts from world leading scientists in the areas of chemistry biochemistry plant science biotechnology which compile information on each group of secondary metabolism compounds and their most important applications in the food pharmaceutical cosmetic and textile industry By showcasing the best uses of these compounds the chemistry behind their production in plants and fungi this book is a valuable resource and a go to artifact for various audiences The new approach this book offers by linking research and the application of these compounds makes it interesting as an inspiration for new research or as a hallmark of what has been done in the secondary metabolism of plants and fungi in recent years Although this book may be technical it is also enjoyable as an integral reading experience due to a structured and integrated flow from the origins of secondary metabolism in organisms to the discovery of their effects their high intensity research in recent years and translation into various industries Beyond learning more on their chemistry synthesis metabolic pathway readers will understand their

importance to different research and industry Secondary Metabolites Ramasamy Vijayakumar,Suresh Raja,2022-08-17 This book provides an overview of secondary metabolites in three sections Introduction Secondary Metabolites General Reviews and Biotechnological Interventions and Plant Secondary Metabolites It discusses the antimicrobial anticancer and antioxidant activities of secondary metabolites biotechnological interventions in the production and research of secondary metabolites and the secondary metabolites of plants Bioactive Secondary Metabolites from Medicinal Plants of Africa Aman Dekebo,2025-07-31 This book provides a comprehensive overview of bioactive compounds derived from African traditional medicinal plants shedding light on their potential applications in modern medicine It compiles crucial information on compounds with proven in vitro and in vivo activity against various diseases providing a foundation for further research in drug discovery The book also introduces the use of these bioactive secondary metabolites in cosmetics nutrition and pest control with detailed description of medicinal plant species including their botanical names ethnomedicinal uses and pharmacological activities making it an invaluable resource for researchers and pharmaceutical companies Key concepts include the exploration of secondary metabolites from plants in Ethiopia Egypt Kenya Uganda Zimbabwe Cameroon Tanzania Madagascar and Nigeria and their industrial applications The chapters cover ethnobotanical knowledge bioactivities and chemical profiling of these plants including the ethnobotanical and phytochemical studies of Ethiopian flora the role of rose scented geranium in the perfume industry and the use of fruits and vegetables in treating respiratory ailments Readers will also discover insights into the use of secondary metabolites for pest control the conservation strategies for endangered African plants and the synthesis of bio nanoparticles for therapeutic applications The book presents a detailed analysis of medicinal plants with anti malarial antileishmanial improve sexual desire and antimicrobial properties highlighting their significance in traditional and modern medicine This volume is an essential resource for researchers graduate students and professionals in the fields of natural products phytochemistry and pharmaceuticals It provides a unique perspective on the integration of traditional African medicine with contemporary scientific research offering valuable insights into the potential of these bioactive compounds in drug development *Secondary Metabolites* Derek J. Chadwick,Julie Whelan,2008-04-30 A comprehensive review of current thinking on the biosynthesis function and evolution of secondary metabolites in animals plants and microorganisms Examines the traditional context of secondary metabolites as natural products having no obvious part to play in the producing organism s life cycle Covers issues related to genetic and antibiotic applications **Secondary Metabolites and Biotherapeutics** Awanish Kumar,Sunil Kumar,2024-02-29 Secondary Metabolites and Biotherapeutics presents the latest biotechnological advancements in the production of target secondary metabolites for medicinal use including topics such as transcriptomics nanotechnology gene editing tools like CRISPR CAS secondary metabolites source and production Secondary metabolites derived from plants as a response to stress have always played a vital role in the pharmaceutical industry to produce medicines However their limited production in plants have always raised concerns for

large scale production With the advancement of modern biotechnology researchers around the globe are now able to engineer plants with specific chemical compositions This book is a valuable resource to researchers in biotechnology medical sciences pharmaceutical biotechnology pharmacology and plant biology Provides updates in the field of secondary metabolite used in therapy Covers the latest biotechnological advancements in the production of target secondary metabolites for the purpose of medicinal use Elucidates the medicinal value of the plants used traditionally by different ethnic groups for treating various disorders Presents the medicinal value of endophytes Comprehensive Natural Products II ,2010-03-05 This work presents a definitive interpretation of the current status of and future trends in natural products a dynamic field at the intersection of chemistry and biology concerned with isolation identification structure elucidation and chemical characteristics of naturally occurring compounds such as pheromones carbohydrates nucleic acids and enzymes With more than 1 800 color figures Comprehensive Natural Products II features 100% new material and complements rather than replaces the original work 1999 Reviews the accumulated efforts of chemical and biological research to understand living organisms and their distinctive effects on health and medicine Stimulates new ideas among the established natural products research community which includes chemists biochemists biologists botanists and pharmacologists Informs and inspires students and newcomers to the field with accessible content in a range of delivery formats Includes 100% new content with more than 6 000 figures 1 3 of these in color and 40 000 references to the primary literature for a thorough examination of the field Highlights new research and innovations concerning living organisms and their distinctive role in our understanding and improvement of human health genomics ecology environment and more Adds to the rich body of work that is the first edition which will be available for the first time in a convenient online format giving researchers complete access to authoritative Natural Products content In Vitro Production of Plant Secondary Metabolites M. Anuradha,S. Balasubramanya,2025-03-21 This book addresses the literature gap by providing both theoretical foundations and practical insights into in vitro plant secondary metabolite production It emphasizes the urgency to address the strategies and scientific methods for producing the secondary metabolites in the laboratory conditions This book includes chapters on various in vitro strategies and laboratory methods which are crucial for understanding and implementing techniques in this applied field It equips the readers with the knowledge essential for contributions to pharmaceuticals agriculture and various industries thus filling a critical void currently present in the literature and practical applications in this field This book is structured to cater to a diverse audience including graduate students and researchers It is specifically tailored to address the key aspects of plant cell tissue and organ culture and aligns seamlessly with the curriculum requirements for the courses offered in plant biotechnology The modules on cell cultures secondary metabolite production and metabolic engineering are also integral components for these courses *Bioactive Natural Products for Pharmaceutical Applications* Dilipkumar Pal,Amit Kumar Nayak,2020-12-14 This book covers the recent innovations relating to various bioactive natural products such as alkaloids

glycosides flavonoids anthraquinones steroids polysaccharides tannins and polyphenolic compounds volatile oils fixed oils fats and waxes proteins and peptides vitamins marine products camptothecin piperines carvacrol gedunin GABA ginsenosides and their applications in the pharmaceutical fields related to academic research and industry **Biotechnology for the Future** Jens Nielsen, Sabine Arnold, 2005-08-26 Ce livre historique peut contenir de nombreuses coquilles et du texte manquant Les acheteurs peuvent generalement telecharger une copie gratuite scannee du livre original sans les coquilles aupres de l editeur Non reference Non illustre 1864 edition Extrait 2 Elle a ete reproduite avec plus ou moins d etendue apres Xenophon par Ciceron Des devoirs i 32 cf Lettres familiales v 12 par Maxime de Tyr discours IV par Philostrate Vie d Apollonius v 10 Vie des sophistes preambule par Themistius discours III par St Basile De la lecture des auteurs paiens ch iv Elle a ete imitee par Lucien Sur un songe ch Vi xvi par Philon le juif Des recompenses par Silius Italicus Les Puniques chant xv Beaucoup de peintres anciens en firent un sujet de tableau comme nous l apprend Philostrate Xenophon l avait il lue dans le livre de Prodicus ou entendue repeter par Socrate Peut etre mais on conjecturerait aussi bien sans temerite qu il l entendit reciter par le sophiste lui meme Prisonnier des Thebains vers 395 avant J C Xenophon obtint sa liberte sous caution pour assister aux conferences que Prodicus donnait alors a Thebes meme Douze ou quinze annees plus tot Aristophane avait fait jouer sur le theatre d Athenes sa comedie de Plutus il la refondit et la fit jouer de nouveau en 390 C est peut etre dans l intervalle entre ces deux dates qu il introduisit dans l action de sa piece une scene episodique qui rappelle par quelques traits le debat de la Vertu et de la Volupte on y voit une defense des merites de la Pauvrete allegues par ellememe Fidele aux lois de son art l auteur comique ne cherche pas les effets d une eloquence majestueuse paree solennelle

Biotechnological Approaches to Enhance Plant Secondary Metabolites Mohd. Shahnawaz, 2021-11-04 Thousands of secondary metabolites are produced by plants to withstand unfavourable environmental conditions and are important molecules for nutraceutical agro cosmetic and pharmaceutical industries etc Harvesting of plants for the extraction of these important metabolites can threaten the plant germplasm and various medicinally important plants are at the verge of extinction Based on need various methods and strategies were developed and followed by researchers from time to time to save the plant germplasm and produce important secondary metabolites efficiently to meet their growing demands Biotechnological Approaches to Enhance Plant Secondary Metabolites Recent Trends and Future Prospects provides a comprehensive introduction and review of state of the art biotechnological tools in this field of research at global level The methodologies are highlighted by real data examples in both in vitro and in vivo level studies The book Highlights and provides overviews of the synthesis classification biological function and medicinal applications of the recent advancements for the enhanced production of novel secondary metabolites in plants Provides an overview of the role of induced mutation salinity stress and brassinosteroids impact to increase the secondary metabolic contents in plants and suggests an increase in enzymatic activity in plants could be due to various point mutations which in turn could play a role at transcriptome levels

Discusses the significant role of endophytes to enhance the contents of plant secondary metabolites Alternatively suggests the urgent need to set up the standard operating procedures using hydroponics system of cultivation for significant enhancement of secondary metabolite contents Enlists various in vitro techniques to enhance plant secondary metabolites contents using plant tissue culture approaches Provides a systematic overview of state of the art biotechnological tools CRISPER Cas9 and RNAi to enhance the plant secondary metabolite contents Recommends CRISPER Cas9 technology over RNAi ZFNs and TALENs because of its relatively simple and high precision method with an easily programmable tool This serves as a reference book for the researchers working in the field of plant secondary metabolites and pharmaceutical industries at global level **Fungal Jewels: Secondary Metabolites** Nancy Keller,Jonathan Palmer,Ozgur

Bayram,2017-04-10 Fungal natural products are friends and foes of humans such as deleterious mycotoxins cytotoxic carcinogenic compounds or beneficial compounds such as antibiotics fungicides insecticides antiviral and antitumor metabolites Understanding fungal diversity and estimation of fungal species on our planet poses a great challenge to researchers This complexity is further multiplied by secondary metabolite diversity of fungi which requires interdisciplinary studies It is extremely important to understand the fungal secondary metabolism to stop human animal and plant diseases caused by fungi and harvest their valuable metabolites Furthermore many secondary metabolite gene clusters are silenced under laboratory conditions It is vital to develop effective methods to activate those clusters in order to discover novel potent metabolites This e book is a compilation of original review articles contributed by leading fungal secondary metabolite researchers with a wide range of expertise Important aspects of fungal secondary metabolism including regulation genome mining evolution synthetic biology and novel methods have been discussed This book will be a great source to those people who are interested in understanding overall structure diversity and regulation of production of these tiny but precious chemicals *Bioactive Compounds* Leila Queiroz Zepka,Tatiele Casagrande Do Nascimento,Eduardo

Jacob-Lopes,2021-09-29 Bioactive Compounds Biosynthesis Characterization and Applications is an authoritative compilation of chapters on bioactive compounds with proven activities It provides valuable information about biosynthesized active compounds that can be used for the further development of products in various industries Chapters cover such topics as biosynthesis characterization separation and purification and applications of bioactive molecules It describes and discusses bioresources of animal vegetal and microbial origin as potential sources of flavonoids polysaccharides sterols polyphenols amino acids and others This book provides insight into future developments in the field and as such is an essential resource for academicians industrial researchers and practitioners in biomolecules with biological activity Key features Describes several classes of bioactive compounds and their associated activities Highlights potential contributions of bioactive compounds as alternatives in the prevention and or treatment of diseases Contains information relevant to the development and use of new products **In Vitro Propagation and Secondary Metabolite Production from Medicinal Plants:**

Current Trends (Part 1) Mohammad Anis, Mehrun Nisha Khanam, 2024-02-29 This book is a comprehensive review of secondary metabolite production from plant tissue culture. The editors have compiled 12 meticulously organized chapters that provide the relevant theoretical and practical frameworks in this subject using empirical research findings. The goal of the book is to explain the rationale behind in vitro production of secondary metabolites from some important medicinal plants. Biotechnological strategies like metabolic engineering and the biosynthesis, transport and modulation of important secondary metabolites are explained along with research studies on specific plants. In addition to the benefits of secondary metabolites, the book also aims to highlight the commercial value of medicinal plants for pharmaceutical and healthcare ventures. Topics covered in this part include: 1. Elicitation Strategies and Metabolic Engineering to boost metabolite production with case studies in metabolic engineering with examples of *Scaevola*, *Taccada* and *Catharanthus roseus*; 2. Stress response investigation and the role of glandular trichomes as bio cell factories; 3. Plant growth regulators and rapid regeneration techniques using swift plantlets; regeneration and phytochemical characterization; 4. Nutraceuticals, antimicrobials and genomic applications of in vitro cultures with an example of Hassawi rice and its genomics; 5. Sustainable approaches for saving endangered medicinal plants. The book caters to a wide readership. It primarily prepares graduate students, researchers, biotechnologists, giving them a grasp of the key methodologies in the secondary metabolite production. It is a secondary reference for support executives, industry professionals and policymakers at corporate and government levels to understand the importance of plant tissue culture and maximizing its impact in the herbal industry.

Secondary Metabolites Ramasamy Vijayakumar, Suresh S.S. Raja, 2018-09-05 This book consists of an introductory overview of secondary metabolites which are classified into four main sections: microbial secondary metabolites, plant secondary metabolites, secondary metabolites through tissue culture technique and regulation of secondary metabolite production. This book provides a comprehensive account on the secondary metabolites of microorganisms, plants and the production of secondary metabolites through biotechnological approach like the plant tissue culture method. The regulatory mechanisms of secondary metabolite production in plants and the pharmaceutical and other applications of various secondary metabolites are also highlighted. This book is considered as necessary reading for microbiologists, biotechnologists, biochemists, pharmacologists and botanists who are doing research in secondary metabolites. It should also be useful to MSc students, MPhil and PhD scholars, scientists and faculty members of various science disciplines.

Biotechnological Production of Plant Secondary Metabolites Ilkay Erdogan Orhan, 2012 Modern techniques have been developed to overcome problems associated with the extraction of natural products from plants. These techniques include production of secondary metabolites by biotechnological methods such as plant tissue culture and microbial.

The Biosynthesis of Secondary Metabolites R.B. Herbert, 1989-03-31 The chief purpose of such new editions is to bring the text up to date. This I have tried to do. The danger with such endeavours is that the book becomes corpulent. This I have tried to avoid. In so doing I am evermore conscious of

how much material has had to be omitted As before the references ca 770 of them which are cited are intended in part to provide the reader with access to material that has been omitted I am deeply grateful to Mrs Marjorie Romanowicz for preparing the typed manuscript for this edition with customary accuracy and efficiency to my wife Margaret for checking the references and to research students Karl Cable Lucy Hyatt Mashupye Kgaphola and Andrew Knaggs for helping with the checking of the manuscript Richard Herbert April 1988 Preface to the first edition This is a book about experiments and results of experiments The results described are the fruit of thirty years labour in the field of secondary metabolism Secondary metabolism more than any other part of the chemistry of life has been the special preserve of organic chemists Investigation of secondary metabolism began with curiosity about the structures of compounds isolated from natural sources i e secondary metabolites Coeval with structure determination there has been a curiosity about the origins and mechanism of formation of secondary metabolites or natural products as they have been called It is the experimental outcome of this curiosity that is described here

Biosynthesis and Molecular Genetics of Fungal Secondary Metabolites, Volume 2

Susanne Zeilinger, Juan-Francisco Martín, Carlos García-Estrada, 2015-06-15 Fungi produce many chemically diverse secondary metabolites whose biological roles largely remain elusive Within the increasing number of sequenced fungal genomes several important genes involved in secondary metabolite formation have been identified Most of these genes are clustered and their coordinated transcription is controlled in a complex way by both narrow pathway specific regulators as well as broad global transcription factors responsive to environmental cues In recent years it was discovered many of the newly identified gene clusters are silent under laboratory conditions suggesting that the biosynthetic potential of fungi is far from being exploited Besides identifying novel bioactive metabolites from still unexplored sources the activation of these gene clusters by several approaches may result in the discovery of new substances with antibiotic and pharmaceutical benefits This book covers recent advances in the field of fungal secondary metabolisms ranging from methodologies to biological aspects and will include the latest knowledge on fungal molecular biology genomics and metabolomics With the related volume by Professor Juan Francisco Martin where the most relevant and well studied fungal secondary metabolites are compiled this book provides a comprehensive overview of the state of the art of research on fungal secondary metabolites

Secondary Metabolites and Drug Discovery Umar Ali Dar, Mohd. Shahnawaz, Neha Singh, 2025-08-22 This book explores the promising potential of plant and microbe derived compounds in drug discovery offering insights into safer alternatives to synthetic drugs and highlighting the vital role of natural products in treating diseases with fewer side effects Plants and microbes are a promising source for natural products with the potential to play a major role in drug discovery Due to advances in the fields of science technology engineering and medicine the commercial pharmaceutical industry is growing across the globe Currently allopathy uses synthetic pharmaceutical drugs for the treatment of diseases but this practice also exposes patients to significant side effects Since ancient times other systems of medicine have been developed that utilize

plant based extracts and molecules to treat various diseases with fewer side effects While changes in lifestyle including diet have had a significant impact on the increased risks of various diseases there is substantial scientific evidence both epidemiological and experimental that vegetables and fruits are key features of diets associated with lower risks of diseases such as cancers and infections These efforts to identify and create medications from plants are leading to increased manufacturing for larger clinical trials The continuing scientific research of medicinal plants will undoubtedly provide a wealth of novel structurally varied bioactive chemicals This edited volume provides an overview of various medical systems with a special focus on microbial and plant based drug molecules for treating communicable and non communicable diseases making it an invaluable resource for researchers scientists and practitioners interested in the potential of plant and microbe derived secondary metabolites in the ongoing search for innovative effective and safer medicines Readers will find this book Provides an overview of different types of sources and drug molecules used in allopathic homeopathic ayurvedic Chinese and Unani systems of medicine Highlights past and current methods of alternative complementary folklore and integrative medicines Discusses the benefits and side effects of the drug molecules used in different systems of medicine at the global level Explores microbial and plant based drug molecules for treating various communicable and non communicable diseases Audience Researchers academics industry and governmental experts working in the fields of natural science natural products synthetic chemistry pharmacology and medicinal chemistry

Plant Cell Culture Secondary Metabolism Toward Industrial Application Frank DiCosmo, Masanaru Misawa, 1996-07-10 Plant cell cultures are used extensively in studies of secondary metabolism for the biosynthesis of pharmaceuticals flavors essences and pigments This book highlights recent developments in the in vitro growth of cultured plant cells and in the production of valuable secondary metabolites Plant Cell Culture Secondary Metabolism details research on many exciting areas including

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