



Review Article

***Marchantia polymorpha* L.: An Emerging Model Plant System to Study Contemporary Plant Biology – A Review**

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Abstract

The liverwort, *Marchantia polymorpha* L., one of the species of first land plants is a promising model plant system for the analysis of diverse facets of contemporary plant biology. The unique characteristics of the plant such as dominant haploid gametophytic generation enables the isolation and disruption of mutant for genetic analysis, rapid sexual and asexual reproduction can be induced under controlled conditions which leads to the formation of genetically homogeneous lines and also the complete organelle genome sequence of chloroplast and mitochondria has been established. In addition, the ongoing whole genome sequencing of *M. polymorpha* by the community sequencing plan at the Joint Genome Institute specifies the conservation of several mechanisms of biological science that are instituted in other terrestrial plants in a smaller extent of intricacy. Thus, with the development of several feasible and reliable genetic transformation strategies, *in vitro* cell culture, gene silencing, targeted gene modification and its critical evolutionary position make this plant as a potential model plant to study evolutionary and developmental biology in detail.

Keywords

Bryophyta; Evolution; Liverworts; Molecular Genetics; Transformation

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Introduction

For nearly 200 years, *Marchantia polymorpha* L. is intensively used as an investigational organism to study several physiological and morphological changes in a response to environmental factors (Shimamura, 2015; Bowman, 2016). But now it is gaining importance as a model plant system for contemporary plant science due to availability of several molecular genetics tools such as transformation techniques which can be utilized to understand the several aspects of evolutionary and developmental biology of plants in detail.

Based on the morphological, fossil record and molecular analysis, liverworts are thought as the

earliest land plant to grow and inhabit the primordial landscape (Mishler and Churchill, 1984; Kenrick and Crane, 1997a; Qui *et al.*, 2006; Qiu *et al.*, 2008; Kato, 2010). Further, the genome analysis showed that the a lot of the regulatory gene families are conserved (Floyd and Bowman, 2007; Rensing *et al.*, 2008; Banks *et al.*, 2011; Nystedt *et al.*, 2013). Therefore, along with mosses and hornworts, liverworts are a key group in comparative genomics to understand the genetic basis of evolutionary and developmental biology of land plants.

M. polymorpha is dioecious in sexuality. The gametophytic (haploid) generation is dominant in the life cycle, which gives remarkable benefits over

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Botany: An Introduction to Plant Biology James D. Mauseth,2019-11-25 Botany An Introduction to Plant Biology Seventh Edition provides a modern and comprehensive overview of the fundamentals of botany while retaining the important focus of natural selection analysis of botanical phenomena and diversity **Plant Biology and Biotechnology** Bir Bahadur,Manchikatla Venkat Rajam,Leela Sahijram,K.V. Krishnamurthy,2015-07-02 This volume offers a much needed compilation of essential reviews on diverse aspects of plant biology written by eminent botanists These reviews effectively cover a wide range of aspects of plant biology that have contemporary relevance At the same time they integrate classical morphology with molecular biology physiology with pattern formation growth with genomics development with morphogenesis and classical crop improvement techniques with modern breeding methodologies Classical botany has been transformed into cutting edge plant biology thus providing the theoretical basis for plant biotechnology It goes without saying that biotechnology has emerged as a powerful discipline of Biology in the last three decades Biotechnological tools techniques and information used in combination with appropriate planning and execution have already contributed significantly to economic growth and development It is estimated that in the next decade or two products and processes made possible by biotechnology will account for over 60% of worldwide commerce and output There is therefore a need to arrive at a general understanding and common approach to issues related to the nature possession conservation and use of biodiversity as it provides the raw material for biotechnology More than 90% of the total requirements for the biotechnology industry are contributed by plants and microbes in terms of goods and services There are however substantial plant and microbial resources that are waiting for biotechnological exploitation in the near future through effective bioprospection In order to exploit plants and microbes for their useful products and processes we need to first understand their basic structure organization growth and development cellular process and overall biology We also need to identify and develop strategies to improve the productivity of plants In view of the above in this two volume book on plant biology and biotechnology the first volume is devoted to various aspects of plant biology and crop improvement It includes 33 chapters contributed by 50 researchers each of which is an expert in his her own field of research The book begins with an introductory chapter that gives a lucid account on the past present and future of plant biology thereby providing a perfect historical foundation for the chapters that follow Four chapters are devoted to details on the structural and developmental aspects of the structures of

plants and their principal organs These chapters provide the molecular biological basis for the regulation of morphogenesis of the form of plants and their organs involving control at the cellular and tissue levels Details on biodiversity the basic raw material for biotechnology are discussed in a separate chapter in which emphasis is placed on the genetic species and ecosystem diversities and their conservation Since fungi and other microbes form an important component of the overall biodiversity special attention is paid to the treatment of fungi and other microbes in this volume Four chapters respectively deal with an overview of fungi arbuscularmycorrhizae and their relation to the sustenance of plant wealth diversity and practical applications of mushrooms and lichens associated with a photobiont Microbial endosymbionts associated with plants and phosphate solubilizing microbes in the rhizosphere of plants are exhaustively treated in two separate chapters The reproductive strategies of bryophytes and an overview on Cycads form the subject matter of another two chapters thus fulfilling the need to deal with the non flowering Embryophyte group of plants Angiosperms the most important group of plants from a biotechnological perspective are examined exhaustively in this volume The chapters on angiosperms provide an overview and cover the genetic basis of flowers development pre and post fertilization reproductive growth and development seed biology and technology plant secondary metabolism photosynthesis and plant volatile chemicals A special effort has been made to include important topics on crop improvement in this volume The importance of pollination services apomixes male sterility induced mutations polyploidy and climate changes is discussed each in a separate chapter Microalga nutraceuticals vegetable oil based nutraceuticals and the importance of alien crop resources and underutilized crops for food and nutritional security form the topics of three other chapters in this volume There is also a special chapter on the applications of remote sensing in the plant sciences which also provides information on biodiversity distribution The editors of this volume believe the wide range of basic topics on plant biology that have great relevance in biotechnology covered will be of great interest to students researchers and teachers of botany and plant biotechnology alike

A Textbook of Plant Biology William Neilson-Jones, Mabel Cheveley Rayner, 1920 **Plant Biology** F (Francis) 1876-1936 Cavers, 2023-07-18

This essential textbook provides a comprehensive introduction to the science of plant biology With clear explanations and helpful illustrations it covers topics such as the structure and function of plant cells photosynthesis plant growth and development and the classification of plants Whether you are a student a teacher or simply someone interested in the natural world this book is an indispensable guide to the study of botany This work has been selected by scholars as being culturally important and is part of the knowledge base of civilization as we know it This work is in the public domain in the United States of America and possibly other nations Within the United States you may freely copy and distribute this work as no entity individual or corporate has a copyright on the body of the work Scholars believe and we concur that this work is important enough to be preserved reproduced and made generally available to the public We appreciate your support of the preservation process and thank you for being an important part of keeping this knowledge alive and relevant

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Botany: An Introduction To Plant Biology Dr. Smriti Kukshal, Dr. R.P. Kuksal, 2023-03-30 Botany is a subfield of biology that focuses on the study of plant life and growth from a scientific standpoint It is an expansive scientific field that studies a wide range of topics related to plants i e algae fungi Pteridophytes Gymnosperm etc These topics include growth reproduction metabolism development illnesses chemical qualities and the evolutionary links between the many groups of organisms Botany is one of the oldest disciplines and its origins may be traced back to early human efforts to identify which plants were safe to eat which were useful for medicine and which were harmful to humans The study of botany has expanded to include more than 550000 species at this point in time This significance may be seen via a variety of lenses such as the influence that it has on farming medicine and efforts to preserve the natural world The use of botany in agricultural settings is among its most significant uses Research in botany has resulted in the creation of new and better crop types that are more resistant to invasive organisms infectious illnesses and the effects of environmental stress This has significantly contributed to an increase in global food security as well as a reduction in poverty in a number of developing nations

Botany: Alchemy of Life Pasquale De Marco, 2025-08-09 Embark on a captivating journey into the realm of botany where the study of plants unveils the intricate tapestry of life on Earth From the towering redwoods that have witnessed centuries of change to the delicate wildflowers that bloom in ephemeral beauty plants are essential to our planet s ecosystems and our own survival This comprehensive guide delves into the diverse and captivating world of botany exploring the history science and applications of this multifaceted field Through engaging chapters you will unravel the secrets of plant anatomy physiology and ecology gaining a deeper understanding of how plants function and interact with their environment Trace the evolution of botany from its ancient roots in herbalism to the cutting edge advancements in plant biotechnology highlighting the remarkable contributions that botanists have made to our understanding of the natural world Encounter the pioneers of botany from Theophrastus the father of botany to Carl Linnaeus the renowned taxonomist and explore the major discoveries that have shaped our knowledge of plants Discover the practical applications of botany that

extend far beyond the realm of academia touching every aspect of our lives Examine the essential role that plants play in providing food medicine and shelter and delve into the innovative ways that botanists are harnessing plant based resources for sustainable development and environmental conservation Whether you are a seasoned botanist a curious nature enthusiast or simply someone who appreciates the beauty and wonder of the plant world this book offers a wealth of knowledge and inspiration Join us on a botanical journey that will deepen your appreciation for the green wonders that surround us and empower you to make informed decisions about the future of our planet If you like this book write a review

Essentials of Plant Anatomy Ameyatma Mahajan, 2025-02-20 *Essentials of Plant Anatomy* is a comprehensive guide to understanding the intricate structure and organization of plant tissues and organs This book delves into the fundamental principles of plant anatomy exploring diverse cell types tissue systems and anatomical adaptations that enable plants to grow develop and thrive in various environments We embark on a journey through the microscopic world of plant cells learning about the specialized functions and interactions of different cell types within tissues such as epidermis parenchyma collenchyma and sclerenchyma The book illuminates the role of these tissues in supporting plant growth providing structural support storing nutrients and facilitating essential metabolic processes like photosynthesis and gas exchange Furthermore we delve into the complex organization of plant organs such as roots stems leaves and flowers unraveling anatomical adaptations that enable plants to absorb water and nutrients from the soil transport fluids and nutrients throughout the plant and engage in reproductive processes like pollination and seed dispersal Through detailed illustrations diagrams and explanatory text *Essentials of Plant Anatomy* provides readers with a deeper understanding of the developmental processes that shape plant morphology and anatomy from meristematic tissue activity to the formation of specialized structures such as stomata trichomes and vascular bundles This book serves as an invaluable resource for students educators researchers and plant enthusiasts seeking to deepen their knowledge of plant structure and function Whether used as a textbook for academic courses or as a reference guide for botanical research it offers a rich and insightful exploration of the fascinating world of plant anatomy

The Biology of Plants Terri Grodzicker, 2012 Plants are integral to human wellbeing and many species have been domesticated for over ten thousand years Evidence of plant scientific investigation and classification can be found in ancient texts from cultures around the world Chinese Indian Greco Roman Muslim etc while early modern botany can be traced to the late 15th and early 16th centuries in Europe During the past several decades plant biology has been revolutionized first by molecular biology and then by the genomic era The model organism *Arabidopsis thaliana* has proved an invaluable tool for investigation into fundamental processes in plant biology many of which share commonalities with animal biology Plant specific processes from reproduction to immunity and second messengers have also yielded to extensive investigation With the genomes of more than thirty plant species now available and many more planned in the near future the impact on our understanding of plant evolution and biology continues to grow Our increased ability to engineer plant species

to a variety of ends may provide novel solutions to ensure adequate and reliable food production and renewable energy even as climate change impacts our environment The decision to focus the 2012 Symposium on plant science reflects the enormous research progress achieved in recent years and is intended to provide a broad synthesis of the current state of the field setting the stage for future discoveries and application This is the first Symposium in this historic series focused exclusively on the botanical sciences Plants are integral to human wellbeing and many species have been domesticated for over ten thousand years Evidence of plant scientific investigation and classification can be found in ancient texts from cultures around the world Chinese Indian Greco Roman Muslim etc while early modern botany can be traced to the late 15th and early 16th centuries in Europe During the past several decades plant biology has been revolutionized first by molecular biology and then by the genomic era The model organism *Arabidopsis thaliana* has proved an invaluable tool for investigation into fundamental processes in plant biology many of which share commonalities with animal biology Plant specific processes from reproduction to immunity and second messengers have also yielded to extensive investigation With the genomes of more than thirty plant species now available and many more planned in the near future the impact on our understanding of plant evolution and biology continues to grow Our increased ability to engineer plant species to a variety of ends may provide novel solutions to ensure adequate and reliable food production and renewable energy even as climate change impacts our environment The decision to focus the 2012 Symposium on plant science reflects the enormous research progress achieved in recent years and is intended to provide a broad synthesis of the current state of the field setting the stage for future discoveries and application This is the first Symposium in this historic series focused exclusively on the botanical sciences

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environmentally safe means of disease control This comprehensive book examines in depth the development and exploitation of induced resistance Chapters review current knowledge of the agents that can elicit induced resistance genomics signalling cascades mechanisms of defence to pests and pathogens and molecular tools Further chapters consider the topical application of inducers for disease control microbial induction of pathogen resistance transgenic approaches pathogen population biology trade offs associated with induced resistance and integration of induced resistance in crop protection The book concludes with a consideration of socio economic drivers determining the use of induced resistance and the future of induced resistance in crop protection

Ethylene in Plants Chi-Kuang Wen, 2014-10-28 This book focuses on recent advances in our understanding of the signal transduction pathway of ethylene its interaction with other hormones and its roles in biological processes It discusses at which point plants could have acquired ethylene signaling from an evolutionary perspective Ethylene was the first gaseous hormone to be identified and triggers various responses in higher plants Our grasp of ethylene signaling has rapidly expanded over the past two decades due in part to the isolation of the components involved in the signal transduction pathway The book offers a helpful guide for plant scientists and graduate students in related areas

Modern Concepts of Plant Biology Cristiano Shepherd, 2019-06-26 Plant biology is the sub discipline of biology that is concerned with the scientific study of plants and their biological processes It is a multidisciplinary subject integrating principles of different areas of science and technology It explores the study of plant structure growth differentiation reproduction diseases evolution taxonomy etc Such studies are made using multiple techniques of optical microscopy live cell imaging plant chemistry and chromosome number analysis besides others Botany has wide applications in agriculture forestry and horticulture It is also crucial for the production of commercial products like staple foods fiber drugs rubber etc It also has relevance in energy production environmental management and in the maintenance of biodiversity This book strives to provide a fair idea about this discipline and to help develop a better understanding of the latest advances within this field The aim of this book is to present researches that have transformed this discipline and aided its advancement Those who want to broaden the expanse of their knowledge will be immensely assisted by it

A Long-range Plan for the Multinational Coordinated Arabidopsis Thaliana Genome Research Project, 1990 *Annual Plant Reviews, Biochemistry of Plant Secondary Metabolism* Michael Wink, 2011-06-13 This brand new Annual Plant Reviews volume is the second edition of the highly successful and well received Annual Plant Reviews Volume 2 This exciting new volume provides an up to date survey of the biochemistry and physiology of plant secondary metabolism The volume commences with an overview of the biochemistry physiology and function of secondary metabolism followed by detailed reviews of the major groups of secondary metabolites alkaloids and betalains cyanogenic glucosides glucosinolates and nonprotein amino acids phenyl propanoids and related phenolics terpenoids cardiac glycosides and saponins A final chapter discusses the evolution of secondary metabolism This carefully compiled new edition brings together chapters from some of the world's leading experts in plant secondary

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