



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 **A Textbook of Plant Biology** William Neilson-Jones,Mabel Cheveley Rayner,1920 *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, arbuscular mycorrhizae 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, apomixis, male sterility, induced mutations, polyploidy and climate changes is discussed each in a separate chapter. Microalgae, 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.

Issues in Life Sciences—Botany and Plant Biology Research: 2012 Edition, 2013-01-10. Issues in Life Sciences Botany and Plant Biology Research 2012 Edition is a ScholarlyEditions eBook that delivers timely, authoritative and comprehensive information about Plant Nutrition and Soil Science. The editors have built Issues in Life Sciences Botany and Plant Biology Research 2012 Edition on the vast information databases of ScholarlyNews. You can expect the information about Plant Nutrition and Soil Science in this eBook to be deeper than what you can access anywhere else as well as consistently reliable, authoritative, informed and relevant. The content of Issues in Life Sciences Botany and Plant Biology Research 2012 Edition has been produced by the world's leading scientists, engineers, analysts, research institutions and companies. All of the content is from peer-reviewed sources and all of it is written, assembled and edited by the editors at ScholarlyEditions and available exclusively from us. You now have a source you can cite with authority, confidence and credibility. More information is available at <http://www.ScholarlyEditions.com>. **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, Gymnosperms, 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 550,000 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.

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.

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

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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 **Modern Plant**

Physiology R. K. Sinha, 2004 In this book new developments in tissue culture stress physiology secondary metabolites are discussed Subjective and objective questions have been provided at the end of each chapter and tabulated differences between allied processes like Fluorescence and Phosphorescence provided **Handbook of Plant Science, 2 Volume Set** Keith Roberts, 2007-12-10 Plant Science like the biological sciences in general has undergone seismic shifts in the last thirty or so years Of course science is always changing and metamorphosing but these shifts have meant that modern plant science has moved away from its previous more agricultural and botanical context to become a core biological discipline in its own right However the sheer amount of information that is accumulating about plant science and the difficulty of grasping it all understanding it and evaluating it intelligently has never been harder for the new generation of plant scientists or for that matter established scientists And that is precisely why this Handbook of Plant Science has been put together Discover modern molecular plant sciences as they link traditional disciplines Derived from the acclaimed Encyclopedia of Life Sciences Thorough reference of up to the minute reliable self contained peer reviewed articles cross referenced throughout Contains 255 articles and 48 full colour pages written by top scientists in each field The Handbook of Plant Science is an authoritative source of up to date practical information for all teachers students and researchers working in the field of plant science botany plant biotechnology agriculture and horticulture Plant Epigenetics Coming of Age for Breeding Applications, 2018-11-21 Epigenetics and Breeding Volume 88 the latest release in the Advances in Botanical Research series brings together the experiences and critical information teachers researchers and managers must consider from both scientific and legal points of view as they relate to biotechnology New chapters in this updated volume include sections on Epigenetic Mechanisms in Plants Epigenomic Diversity and Applications to Breeding Epigenetics in Breeding EpiRILs Lessons from

Arabidopsis Transposable Elements as a Tool for Plant Improvement Epigenome Editing Epigenetics and Grafting Sexual and Non sexual reproduction Epigenetics in Cereals and more Encompasses various aspects of botanical research including its historical background current status recent research outcomes and potential future developments Written by highly competent authors from all continents Provides data that is based on facts and written in a dispassionate and non polemical tone *Abiotic Stress Management for Resilient Agriculture* Paramjit Singh Minhas,Jagadish Rane,Ratna Kumar

Pasala,2017-10-06 This book offers a state of the art overview of on abiotic stresses in terms of the challenges scope and opportunities coping strategies for adaptation and mitigation using novel tools for building resilience in agricultural crops and livestock as well as for policy implementation Divided into four major parts advances and prospects for understanding stress environments adaptation and mitigation options crop based mitigation strategies and mitigation options in animal husbandry the book focuses on problem solving approaches and techniques that are essential for the medium to long term sustainability of agricultural production systems The synthesis and integration of knowledge and experiences of specialists from different disciplines offers new perspectives in the versatile field of abiotic stress management and as such is useful for various stakeholders including agricultural students scientists environmentalists policymakers and social scientists *The*

Microscopic and Chemical Parts of Plants Thomas P. Hanna,1999 The plant s cells and their several specialized working subunits are examined in addition to chemical traits like color scent and the hormonal effects that turn leaves toward the light and allow other adaptations to the surroundings And the major processes driven by chemical changes over time that together are the life cycle of the plant are considered BOOK JACKET *Land of Plants in Motion* Thomas R. H.

Havens,2020-06-30 *Land of Plants in Motion* is the first in any language to examine two companion stories 1 the rise of an East Asian floristic zone and how the Japanese islands evolved an astonishing wealth of plant species and 2 the growth of Japanese botanical sciences The majority of plant species regarded as Japanese trace their origins to western China and the eastern Himalaya but are so indigenized that they often seem native today Early modern scientists in Japan drew on knowledge of Chinese herbal medicine but achieved distinctive insights into plant life commensurate with but separate from their European counterparts Scholars at the University of Tokyo pioneered Japanese plant biology in the late nineteenth century They incorporated Western botanical methods but sought a degree of difference in taxonomy while also gaining international legitimacy through publications in English Japan s age of empire 1895 1945 was less about plant exploration and more about plant collection for both scientific and economic benefits Displays of species from throughout the empire made Japan s sphere of colonization and conquest visible at home The infrastructure for research and instruction expanded slowly after World War Two new laboratories botanical gardens scholarly societies and publications eventually allowed for great diversity of specialized study especially with the growth of molecular biology in the 1970s and DNA research in the 1980s Basic research was harmed by cuts in government funding during 2012 2017 but Japanese plant biologists continue to

enjoy international esteem in many fields of scholarship

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