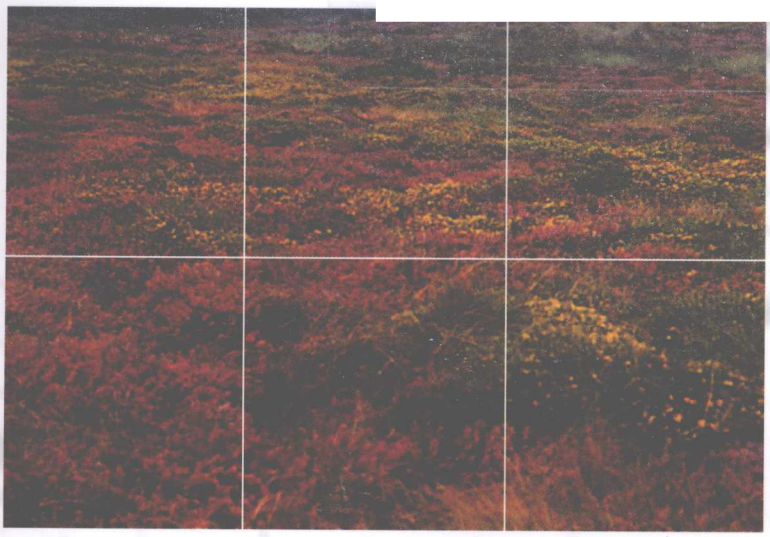
精要速览系列

Instant Notes

PLANT BIOLOGY (SECOND EDITION)

植物生物学（第二版）



·导读版·

Andrew Lack & David Evans

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精要速览系列
Instant Notes in

Plant Biology

Second Edition

植物生物学

（第二版，导读版）

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内 容 简 介

“精要速览系列(Instant Notes Series)”丛书是国外教材“Best Seller”榜的上榜教材。该系列结构新颖，视角独特；重点明确，脉络分明；图表简明清晰；英文自然易懂，被国内多所重点院校选用作为双语教材。

本书第二版在保持第一版格式和风格基础上，新增认识植物(B 部分)；对全书章节安排进行调整，将介绍分类大纲、与水的关系、代谢等内容提前，将花和种子合并到一起；进一步加大分子技术篇幅。

本书适合普通高等院校生命科学、医学、农学等相关专业使用，也可作为双语教学参考教材使用。

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第二版前言

植物科学向来是生物学中的一个基础领域。在过去 20 年中，随着大量新信息的涌现使该学科的重点发生根本的变化。这些新信息多数源自分子生物学技术，使人们对植物各种生命过程的理解更加深入，使植物生物学在各个方面都得以进一步的阐明。基因组分析和基因转移的成功开创了植物生物技术操作的可能性，这在几十年前是不可想象的。随着对生物多样性认识的深化，生态学理论得到进一步发展，对植物与植物间、其他生物间以及植物与其他生物间的相互关系有了新的启示。植物育种工作者、生态学家以及许多其他领域的人们都已真正地意识到正不断减少的植物资源的经济和艺术价值。

本书涵盖了现代植物生物学的所有领域。在撰写此书时，我们始终铭记在心的是：面对一系列高级课程的大学生需要一部可接受的课本，使之能洞悉植物科学的全貌；它的深度与广度应适合植物生物学专业的一年级和二年级大学生，专门化知识有待于通过高级课程去学习。本书还旨在为分子生物学家和生物技术学家提供一条可行的途径，使他们对所工作的对象有一个初步的了解，为深入认识提供基础背景。它既可帮助大学生们学习，也使其他领域的专家得以了解植物科学。本书和所有精要速览系列图书一样，在每个部分前列出要点，作为复习速览，帮助读者在读完每一部分后再加以记忆，如在考试前。我们将名词术语在能够理解的前提下削减到最低限度，尽可能减少采用老的生物学知识，以求本书能适用于期刊工作者、环保工作者以及那些关心植物生物学重要事件或对其有真正兴趣的人们。

本书第二版在保持第一版的格式和风格的基础上，对全书的一些结构做了调整，并从头至尾对内容进行了更新。本版的主要变化是增加了 B 部分——认识植物。该部分是为了向读者介绍现代植物科学中的主要技术，已取得研究进展的基础。因此，我们必须要一个“技术”部分，使读者能够回顾和追溯，我们认为很有必要对这个部分有一个深刻地理解。在本书的其他部分，对章节顺序做了调整，将介绍分类大纲、与水的关系、代谢等部分提前，将在第一版中分开的花和种子部分归并到一起，使得能更好地将结构、功能和生理学联系起来。分子技术在第一版中占了较大的篇幅，此版中更多。由于分子技术已渗透到整个植物科学中，在新版中纳入了分子技术和其他的进展，使得有些部分改动较大，有些部分重点也作了更改。我们的指导原则仍然是让大学生了解植物科学中的最新研究进展，学习更多的知识，而不仅是对该多样化和快速发展学科的一时兴趣。

致　谢

我们首先要感谢我们的家人在整个写作过程中给予的大力支持，Margaret Evans 帮助完成了图解部分，我们的同事和助手给予了建议、指出相关工作的问题、做出评论，全面支持我们的著作工作，有时甚至是无意识的。还要感谢 Taylor & Francis 出版集团的诸位编辑，尤其是 Liz Owe，给予的鼓励、支持和提出的很多宝贵意见。我们还要感谢我们在 Aberdeen 和 Aberystwyth 的就读时代，那些引导我们进入植物生物学领域的人以及多年来我们在 Oxford Brookes 教过的学生们，他们对本书的选材有着重要的作用，没有他们的参与，我们不可能以简明易懂的方式来表述植物科学的基本纲要。

PREFACE TO SECOND EDITION

Plant science has always been a fundamental area of biology, but the emphasis in the subject has changed radically in the last two decades with a plethora of new information, much of it deriving from techniques of molecular biology. This has deepened our understanding of plant processes and has illuminated almost all aspects of plant biology. The ability to analyze genomes and to transfer genes has opened possibilities for plant biotechnology and genetic manipulation undreamed of in earlier decades. There have been advances in ecological knowledge that, with increased awareness of the richness of biodiversity, have shed new light on the relationships between plants, other organisms and their interdependence. Plant breeders, ecologists and many people outside plant biology have become acutely conscious of the aesthetic and economic value of the resources, so often dwindling, of the plant kingdom.

In this book we have covered all these aspects of modern plant biology. We have written it keeping in mind an undergraduate faced with a range of advanced courses, needing an affordable text that gives insight into the whole range of plant science. Its scope and depth are suitable for a first and second year undergraduate student of plant biology; specialism will need an advanced text. We have aimed it also at molecular biologists and biotechnologists needing an accessible route to understanding the basis of the systems on which they work. It is intended to provide the fundamental background required for true understanding. It should aid undergraduates in their learning and give insight for specialists into areas of plant science not their own. As in all Instant Notes books we have provided 'Key Notes' at the start of each section. These are intended solely as revision notes, e.g. before an exam, to prompt a reader's memory after reading the section fully. We have kept technical and jargon terms to a minimum needed for understanding and any such term is defined at first mention. We have assumed minimal previous knowledge of biology and hope that the book will prove useful to journalists, environmentalists and those with a genuine interest in the key issues of plant biology as they seek to be informed about the issues that they deal with.

For the second edition of this book we have made a number of structural changes and have updated the text throughout while keeping to the format and style of the first edition. A major change for this edition is adding Section B, Understanding Plants. This is designed to introduce readers to the major techniques in modern plant science and indicate the basis on which advances are being made. As such it is, inevitably, a 'technical' section but we hope one that the reader can refer back to. We feel it is needed to foster a critical understanding of the subject. In the rest of the book we have changed the order of the sections, introducing an outline classification and water relations and metabolism earlier and putting together the topics on flowering and seeds that had been separated in the first edition. This has allowed us to integrate structure, function and physiology more closely. Molecular techniques loomed large in the first edition and loom larger now. We have incorporated these and other advances throughout this new edition as they permeate all of plant science. The result is that some parts have been substantially rewritten and the emphasis has changed in many places. Our guiding principle remained the needs of an undergraduate wanting to understand all the latest advances in plant science, while remaining accessible to any with more than a passing interest in this diverse and rapidly moving subject.

Andrew J. Lack and David E. Evans

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缩 略 词

2,4-D	2,4-dichlorophenoxyacetic acid	2,4-二氯苯氧乙酸
2,4,5-T	2,4,5-trichlorophenoxyacetic acid	2,4,5 三氯苯氧乙酸
ABA	abscisic acid	脱落酸
ABP	auxin binding protein	生长素结合蛋白
ACC	1-aminocyclopropane-1-carboxylic acid	氨基环丙烷羧酸
AGP	Arabidopsis Genome Project	拟南芥基因组计划
AM	arbuscular mycorrhiza	丛枝菌根
AMP	adenosine monophosphate	腺苷一磷酸
AS	asparagine synthase	天冬酰胺合酶
ATP	adenosine triphosphate	腺苷三磷酸
bp	base pair	碱基对
Bp	before the present (era)	纪元前
CAM	crassulacean acid metabolism	景天酸代谢
CaMPK	calmodulin-dependent protein kinase	依赖钙调素的蛋白激酶
cDNA	complementary deoxyribonucleic acid	互补脱氧核苷酸
CDPK	calcium-dependent protein kinase	钙依赖蛋白激酶
CDPK	cyclin-dependent protein kinase	周期素依赖蛋白激酶
CoA	coenzyme A	辅酶 A
DAG	diacylglycerol	二酰甘油
DDT	1,1-bis(p-chlorophenyl)-2,2,2-trichloroethane	滴滴涕,二氯二苯三氯乙烷
DNA	deoxyribonucleic acid	脱氧核糖核酸
EM	ectomycorrhiza	外生菌根
ER	endoplasmic reticulum	内质网
EST	expressed sequence tag	表达序列标签
FADH	flavin adenine dinucleotide (reduced)	还原型黄素腺嘌呤二核苷酸
Fd	ferredoxin-dependent	依赖于铁氧还蛋白的
GA	gibberellic acid	赤霉酸
GARC	gibberellic acid response complex	赤霉酸效应复合体
GARE	gibberellic acid response element	赤霉酸效应元件
GM	genetically modified	基因修饰
GOGAT	glutamate synthase	谷氨酸合酶
GS	glutamine synthase	谷氨酰胺合酶
GSH	glutathione	谷胱甘肽
IAA	indole-3-acetic acid	吲哚-3-乙酸
IP_3	inositol triphosphate	肌醇三磷酸
LDP	long day plant	长日植物
LEA	late embryogenesis abundant	晚期胚胎富集
LSD	lysergic acid diethylamine	麦角酸二乙酰胺
mRNA	messenger ribonucleic acid	信使核糖核酸

NAA	naphthalene acetic acid	萘乙酸
NADP	nicotinamide adenine dinucleotide phosphate	烟酰胺腺嘌呤二核苷酸磷酸，辅酶Ⅱ
NADPH	nicotinamide adenine dinucleotide phosphate (reduced)	还原型烟酰胺腺嘌呤二核苷酸磷酸，还原型辅酶Ⅱ
NE	nuclear envelope	核被膜
NPA	1-N-naphthylphthalamic acid	萘氨甲基苯甲酸
Pa	Pascals	帕[斯卡](压力单位)
PCR	polymerase chain reaction	聚合酶链反应
PEP	phosphoenolpyruvate	磷酸烯醇式丙酮酸
PG	polygalacturonase	多聚半乳糖醛酸酶
PGS	plant growth substance	植物生长物质
PIP_2	phosphatidyl inositol bisphosphate	磷脂酰肌醇二磷酸
PLC	phospholipase C	磷脂酶 C
pm	plasma membrane	质膜
ppm	parts per million	百万分之一
PS-Ⅰ/Ⅱ	photosystem Ⅰ/Ⅱ	光系统Ⅰ/Ⅱ
QTL	quantitative trait locus	数量性状位点
RAPD	random amplified polymorphic DNA	随机扩增多态 DNA
RET	resonance energy transfer	能量共振转移
RFLP	restriction fragment length polymorphism	限制性片段长度多态性
RNA	ribonucleic acid	核糖核酸
RNase	ribonuclease	核糖核酸酶
SAM	s-adenosyl methionine	S-腺苷甲硫氨酸
SDP	short-day plant	短日植物
SI	self incompatibility	自交不亲和性
T-DNA	transferred DNA	转化 DNA
TGN	trans Golgi network	高尔基体外侧网络
UDP glucose	uridine diphosphoglucose	尿苷二磷酸葡萄糖
UV	ultraviolet	紫外线
VIR	virulence region for infection	毒性区

A 引　言

A1 引言

要　点

什么是植物?

有花植物是植物界中最重要的类群，因此，本书主要介绍有花植物。生物首先划分为原核生物和真核生物。真核生物中除包含有三个主要的多细胞生物界，即植物界、动物界和真菌界以外，还包含一类属于几个平行界中的原生生物。在此，我们仅介绍植物界和类似植物的原生生物。

植物的共同特征

植物源自古老的绿藻。植物是能进行光合作用的自养生物(极少数除外)。植物具有叶绿素 a 和叶绿素 b[①]；具有含纤维素的细胞壁、液泡，有二倍体和单倍体的世代交替现象。大多数维管植物的营养体结构相似，而生殖结构则不同。

分　类

真正的植物[②]有四类，即苔类、角苔类、藓类和维管植物。维管植物包括蕨类、石松类、木贼类和种子植物。藻类包含了几个单细胞类群和三个多细胞为主的类群，即褐藻、红藻和绿藻[③]。

生活史

所有的植物[④]都有二倍体和单倍体的世代交替。二倍体的孢子体产生单倍体孢子，孢子萌发产生配子体。配子结合形成二倍体细胞[⑤]，并能长成新的孢子体。在苔藓植物中，配子体是主要植物体；在维管植物中，孢子体占优势；在大多数蕨类、木贼类和石松类植物中，配子体能独立生活，而在其他维管植物中配子体极度简化，雌配子体留在了孢子体上。在藻类中，不同的类群变化很大，表现为孢子体简化或者配子体简化。

相关主题

藻类(O1)　　维管植物的早期进化(P1)

苔藓植物(O2)

注①：有些藻类没有叶绿素 b

注②：此划分与国内教科书上的不一致。国内教科书一般把这些归为高等植物，分为苔藓植物门、蕨类植物门、裸子植物门和被子植物门。

注③：红藻和绿藻中都有单细胞种类。

注④：该处应指高等植物。藻类有具世代交替的，也有没有世代交替的。

注⑤：即合子。

目　录

CONTENTS

A1 INTRODUCTION

Key Notes

What is a plant?

Flowering plants are by far the most important plants and this book is primarily a study of them. The most fundamental dividing line between living organisms is that between prokaryote and eukaryote cells. Within the eukaryotes there are three main multicellular kingdoms, plants, animals and fungi and a heterogeneous group, the protists, belonging to several equivalent kingdoms. We include here only plants and some plant-like protists for comparison.

Unifying features of plants

Plants derive from a green algal ancestor. Plants are photosynthetic and autotrophic (with very few exceptions); have chlorophyll *a* and *b*; have a cellulose cell wall and a cell vacuole and have an alternation of diploid and haploid generations. Vegetative structure is similar across most vascular plants; reproductive structures differ.

Classification

There are four divisions of true plants, liverworts, hornworts, mosses and tracheophytes or vascular plants, the last including ferns, lycopsids, horsetails and the seed plants. Algae consist of several unicellular divisions and three main multicellular divisions: brown algae, red algae and green algae.

Life cycles

All plants have an alternation of diploid and haploid generations. Diploid sporophytes produce haploid spores. These germinate to produce gametophytes. Gametes from these fuse to form a diploid cell that can grow into a new sporophyte. In bryophytes the gametophyte is the main plant. In the tracheophytes the sporophyte is dominant, with gametophytes free-living in most ferns, horsetails and some clubmosses, but much reduced in other vascular plants, the female gametophytes being retained on the sporophyte. There is great variation among the algae with different groups showing reduction of either the sporophyte or the gametophyte.

Related topics

The algae (O1)
The bryophytes (O2)
Early evolution of vascular plants (P1)

What is a plant?

The science of plant biology is primarily the study of **flowering plants** or **angiosperms**. Flowering plants are by far the most important group of plants in the world, providing the overwhelming majority of plant species, perhaps 400 000 in all, and most of the biomass on land. They are the basis for nearly all our food. This book is mainly about flowering plants.

Historically the science of **plant biology**, or **botany**, has included all living organisms except animals, but it is clear that there is a major division of life between cells with a simple level of organization, the **prokaryotes**, and those with much more complex cells, the **eukaryotes**. The prokaryotes include bacteria, or Eubacteria, and Archaea and will not be considered further in this

book except in relation to plants, although some retain plant-like names, such as referring to the gut 'flora' for the bacteria in mammalian guts, and 'blue-green algae' for the **cyanobacteria**. Among eukaryotes three main multicellular kingdoms are recognized: **animals, plants** and **fungi**. The remaining eukaryotes are mainly unicellular but with a few multicellular groups such as **slime molds** and large **algae**. They are a heterogeneous group, forming several kingdoms of equivalent status to the three large ones and referred to for convenience, as the **protists**.

There is no clear boundary between protists and plants and authors differ in which organisms they include within the plants. Multicellular **green algae** have many features in common with land plants and are the modern group closest to the ancestors of plants. Along with the **brown algae** and **red algae**, they are the dominant photosynthetic organisms in shallow seas. These three algal groups form quite separate evolutionary lines. Unicellular planktonic groups, again from several different evolutionary origins among the protists, form the basis of the food chain in the deep sea. All these algae are photosynthetic and are considered in this book only for comparison with the true plants in Topic O1. Other protists, animals and fungi will not be considered further except in relation to plants. Plant groups other than flowering plants, such as mosses, ferns and conifers, differ in various ways and these are considered in sections O, P and Q.

Unifying features of plants

Evidence from morphology and from DNA suggests that all plants share an ancestor among the green algae dating from between 450 and 500 million years ago in the Silurian era, perhaps earlier. To characterize the features that define plants as different from other eukaryotes is almost impossible since every feature has exceptions, but usually these exceptions are among plants that have lost the feature or are shared with some algae.

- They are **photosynthetic** and obtain all their nutrients from inorganic sources, i.e. they are **autotrophic** and the start of a food chain. The large algae and many planktonic protists are also photosynthetic. A few plants derive all or part of their nutrients from other organisms (Topics M6, M7) but these are closely related to other, photosynthetic, flowering plants.
- The photosynthetic pigment is **chlorophyll**, and consists of two forms, ***a*** and ***b***, contained within chloroplasts. The green algae and some unicellular protists share these pigments. Other large algae have chlorophyll *a*, some having another chlorophyll, *c*, as well.
- The cells have a **cell wall**, made predominantly of the polysaccharide **cellulose**, and a **vacuole** in addition to the **cytoplasm**.
- There is an **alternation of** diploid and haploid **generations**, another feature shared with some algae. Often one of these is much reduced and may not live independently.

Vegetative structure and physiology are similar throughout the seed plants (flowering plants, conifers and some smaller groups) and there are many similarities with other vascular plants as well, but the reproductive structures differ markedly. Bryophytes differ more fundamentally in vegetative and reproductive structure (Topics O2, O3).

Outline classification

A basic classification of plants and the larger photosynthetic algae is given in *Box 1*. Plants similar to present-day liverworts were probably the earliest land