

The background of the cover is a detailed, high-magnification photograph of plant cells, likely from a leaf. The cells are arranged in a regular, grid-like pattern, with prominent cell walls and visible cytoplasm. The color is a muted, olive-green, and the lighting creates a sense of depth and texture.

An Introduction to
Plant Structure
and Development

Plant Anatomy for the Twenty-First Century

SECOND EDITION

CHARLES B. BECK

CAMBRIDGE

Contents

Preface to the second edition	page xiii
Preface	xv
Acknowledgements	xvii
General references	xx

Chapter 1	Problems of adaptation to a terrestrial environment	1
	Perspective: the origin of vascular plants	1
	Structural adaptations	3
	Preview of subsequent chapters	5
	References	6
	Further reading	7

Chapter 2	An overview of plant structure and development	8
	Perspective: origin of multicellularity	8
	Some aspects of the shoot system of the vascular plant	10
	Apical meristems	13
	Primary tissue regions of the stem and root	17
	Vascular bundle types	23
	Secondary growth	26
	Cells of the xylem	29
	Cells of the phloem	33
	References	35
	Further reading	36

Chapter 3	The protoplast of the eukaryotic cell	38
	Perspective	38
	Morphology of the protoplast	39
	Vacuoles	51
	Movement of organelles in the protoplast	51
	Ergastic substances	53
	References	55
	Further reading	57

Chapter 4	Structure and development of the cell wall	58
	Perspective	58
	Structure and composition of the cell wall	59
	Growth of the cell wall	65
	Cell wall development	68

Plasmodesmata	72
References	77
Further reading	81

Chapter 5	Meristems of the shoot and their role in plant growth and development	83
Perspective		83
Apical meristems		83
Formation of leaf primordia		90
Transitional tissue regions		92
Intercalary meristems		95
The primary peripheral thickening meristem of monocotyledons		96
Cell growth and development		97
The effect of hormones on cell growth and development		98
Genetic control of cell growth and development		99
Role of the cytoskeleton in cell growth and development		100
Cell shaping by microtubules		102
References		103
Further reading		106

Chapter 6	Morphology and development of the primary vascular system of the stem	108
Perspective		108
Cellular composition and patterns of development of primary xylem		109
Cellular composition and patterns of development of primary phloem		112
Differentiation of primary vascular tissues		113
The role of auxin in the development of the primary vascular system		119
References		121
Further reading		122

Chapter 7	Sympodial systems and patterns of nodal anatomy	123
Perspective: leaf traces		123
Nodal structure of pteridophytes		123
Sympodial systems of seed plants		125
Leaf trace lacunae		134
The cauline vs. foliar nature of vascular bundles in the eustele		135
Phyllotaxy		136
References		139
Further reading		140

Chapter 8	The epidermis	141
	Perspective	141
	Epidermis of the shoot	141
	Epidermis of the root	149
	Stomata	149
	Signal transduction and movement in guard cells	152
	Development of stomata	153
	References	155
	Further reading	156
Chapter 9	The origin of secondary tissue systems and the effect of their formation on the primary body in seed plants	157
	Perspective: role of the vascular cambium	157
	The effect of secondary growth on the primary body	160
	The effect of secondary growth on leaf and branch traces	162
	References	165
	Further reading	165
Chapter 10	The vascular cambium: structure and function	166
	Perspective	166
	Structure of the vascular cambium	166
	General overview of cambial activity	169
	Plant hormones and cambial activity	173
	Submicroscopic structure of cambial initials	174
	The onset of dormancy and the reactivation of dormant cambium	175
	Cytokinesis in fusiform initials	177
	The problem of differential growth of cambial cells and immature cambial derivatives	178
	References	179
	Further reading	182
Chapter 11	Secondary xylem	184
	Perspective	184
	Overview of the structure of secondary xylem	184
	Secondary xylem of gymnosperms	187
	Resin ducts	193
	Secondary xylem of dicotyledons	194
	Differentiation of tracheary elements	199
	Patterns of distribution of xylary elements and rays	207
	Tyloses	211
	Evolution in secondary xylem of dicotyledons	213
	Mechanism of water transport	215

References	216
Further reading	220
<hr/>	
Chapter 12 The phloem	222
Perspective: evolution of the phloem	222
Gross structure and development of the phloem	223
The nature and development of the cell wall of sieve elements	228
Role of the cytoskeleton in wall development	231
The nature and development of the protoplast of sieve elements	232
Nature and function of P-protein	234
Distinctive features of the phloem of gymnosperms	236
The nature and function of companion cells and Strasburger cells	237
The mechanism of transport in the phloem	241
References	242
Further reading	245
<hr/>	
Chapter 13 Periderm, rhytidome, and the nature of bark	247
Perspective	247
Periderm: structure and development	247
Formation of rhytidome	250
Lenticels	252
The outer protective layer of monocotyledons	253
References	254
Further reading	254
<hr/>	
Chapter 14 Unusual features of structure and development in stems and roots	255
Perspective	255
Primary peripheral thickening meristem	255
Secondary growth in monocotyledons	256
Anomalous stem and root structure	257
References	263
Further reading	263
<hr/>	
Chapter 15 Secretion in plants	264
Perspective	264
Substances secreted by plants	264
Mechanisms of secretion	265
Internal secretory structures	266
External secretory structures	270
References	276
Further reading	278

Chapter 16	The root	279
Perspective: evolution of the root		279
Gross morphology		281
Contractile roots and other highly specialized root systems		282
Apical meristems		283
The quiescent center and its role in development		286
Primary tissues and tissue regions		288
Lateral transport of water and minerals in the young root		295
Development of primary tissues		297
Auxin and tissue patterning		301
Lateral root development		302
Adventitious roots		306
Secondary growth		306
The root cap: its function and role in gravitropism		307
Mycorrhizae		312
Nitrogen fixation in root nodules		313
Root-stem transition		315
References		316
Further reading		321

Chapter 17	The leaf	324
Perspective: evolution of the leaf		324
Basic leaf structure		325
Leaf development		334
The role of the cytoskeleton in leaf development		340
The role of genetics in leaf development		341
Variations in leaf form, structure, and arrangement		343
Structure in relation to function		346
Photosynthesis and phloem loading		346
Leaf structure of C ₃ and C ₄ plants		348
Supporting structures in leaves		349
Transfusion tissue in conifers		350
Leaf abscission		351
References		353
Further reading		357

Chapter 18	Reproduction and the origin of the sporophyte	361
Perspective: the plant life cycle		361
Reproduction in gymnosperms		362
Reproduction in angiosperms		366
Development of the seed in angiosperms		373
Fruit development and the role of fruits in seed dispersal		377
Seed germination and development of the seedling		380
Floral morphogenesis		381
Pollen-pistil interactions		384

Self-incompatibility	387
Role of the cytoskeleton in pollen tube growth	388
References	390
Further reading	394
Glossary	398
Index	433