

# Contents in Detail

## SECTION ONE

### Cells: Water, Solutions, and Surfaces 1

#### 1 Plant Physiology and Plant Cells 3

- 1.1 Some Basic Postulates 3
- 1.2 Prokaryotic Cells: Bacteria and Blue-Green Algae 5
- 1.3 Eukaryotic Cells: Protist, Fungal, and Plant 6
- 1.4 The Cell Wall 8
- 1.5 Eukaryotic Protoplasts 12
- 1.6 The Components of Cytoplasm 13
- 1.7 The Nucleus 23
- 1.8 The Vacuole 24
- 1.9 Flagella and Cilia 25
- 1.10 The Plant Cell 26
- 1.11 A Definition of Life 26

#### 2 Diffusion, Thermodynamics, and Water Potential 27

- 2.1 Plants and Water 27
- 2.2 Diffusion Versus Bulk Flow 31
- 2.3 Kinetic Theory 32
- 2.4 A Model of Diffusion 33
- 2.5 Thermodynamics 34
- 2.6 Chemical Potential and Water Potential 37
- 2.7 Chemical- and Water-Potential Gradients 38
- 2.8 Vapor Density, Vapor Pressure, and Water Potential 40
- 2.9 The Rate of Diffusion: Fick's First Law 42
- 2.10 Caveat 43

#### 3 Osmosis 44

- 3.1 An Osmotic System 44
- 3.2 The Components of Water Potential 45
- 3.3 Units for Water Potential 47
  - Personal Essay: Pursuing the Questions of Soil-Plant-Atmosphere Water Relations, Ralph O. Slatyer 48*
- 3.4 Dilution 50
- 3.5 The Membrane 51
- 3.6 Measuring the Components of Water Potential 52
  - Boxed Essay: Colloids: Characteristic Components of Protoplasm 62*

#### 4 The Photosynthesis-Transpiration Compromise 66

- 4.1 Measurement of Transpiration 66
- 4.2 The Paradox of Pores 70
- 4.3 Stomatal Anatomy 71
- 4.4 Environmental Effects on Stomates 74
  - Personal Essay: Must We Write? Page W. Morgan 76*
- 4.5 Stomatal Mechanics 76
- 4.6 Stomatal Control Mechanisms 78
- 4.7 The Role of Transpiration: "What Good Is Transpiration?" 81
- 4.8 The Role of Transpiration: Energy Exchange 82
- 4.9 Energy Exchanges of Plants in Ecosystems 87
- 4.10 The Heat-Balance Equations 88
  - Personal Essay: Ventilation in Waterlilies: A Biological Steam Engine, John Dacey 90*



- 23.6 Phytochrome and the Role of the Dark Period 515
- 23.7 Time Measurement in Photoperiodism 517
- 23.8 Detecting Dawn and Dusk 521
- 23.9 The Florigen Concept: Flowering Hormones and Inhibitors 523
- 23.10 Responses to Applied Plant Hormones and Growth Regulators 525  
*Personal Essay: Gibberellins, a Fascinating and Highly Diverse Class of Plant Hormones, Richard P. Pharis 526*
- 23.11 The Induced State 529
- 23.12 Floral Development 529
- 23.13 Where Do We Go from Here? 529

## **24 Molecular Genetics and the Plant Physiologist, Ray A. Bressan and Avtar K. Handa 531**

- 24.1 Gene Cloning 532
- 24.2 Analysis of Gene Expression in Plants 538
- 24.3 Genetic Modification of Plants Using Recombinant DNA Technology 541
- 24.4 Mechanisms Controlling Expression of Genes 543
- 24.5 Examples of Isolated Genes that Affect Physiological Processes 545

## **SECTION FOUR**

### **Environmental Physiology 549**

#### **25 Topics in Environmental Physiology 551**

*Personal Essay: The Challenge of a New Field: Plant Physiological Ecology, Park S. Nobel 552*

- 25.1 The Problems of Environmental Physiology 552
- 25.2 What Is the Environment? 555
- 25.3 Some Principles of Plant Response to Environment 556  
*Personal Essay: Limiting Factors and Maximum Yields: A Controlled Ecological Life-Support System (CELSS), Frank B. Salisbury 560*
- 25.4 Ecotypes: The Role of Genetics 564
- 25.5 Plant Adaptations to the Radiation Environment 566

#### **26 Stress Physiology 575**

- 26.1 What Is Stress? 575
- 26.2 Stressful Environments 577
- 26.3 Water Stress: Drought, Cold, and Salt 581
- 26.4 Mechanisms of Plant Response to Water and Related Stresses 591
- 26.5 Chilling Injury 597
- 26.6 High-Temperature Stress 598
- 26.7 Acidic Soils 599
- 26.8 Other Stresses 600

## **APPENDICES**

### **A The Système Internationale: The Use of SI Units in Plant Physiology 601**

### **B Radiant Energy: Some Definitions 607**

- B.1 Basic Concepts and Terms 607
- B.2 Wave Phenomena 608
- B.3 Particle Phenomena 608
- B.4 The Spectrum and Light Sources 609
- B.5 Radiation Quantities 612
- B.6 Mechanisms of Absorption and Emission 613
- B.7 Quantifying Absorption, Transmission, and Reflection 614
- B.8 Thermal Radiation 614

### **C Gene Replication and Protein Synthesis: Terms and Concepts 616**

- C.1 The Central Dogma of Molecular Biology 616
- C.2 The Double Helix 616
- C.3 Transcription: Copying DNA to Make RNA 617
- C.4 Translation: Protein Synthesis in the Cytoplasm 617
- C.5 The Genetic Code 617
- C.6 The Steps of Protein Synthesis 618

### **References 620**

### **Index of Species and Subjects 658**

### **Author Index 674**